Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

Volume 1

January 2018

Prepared for:

Volta River Authority, Ghana

VOLTA RIVER AUTHORITY

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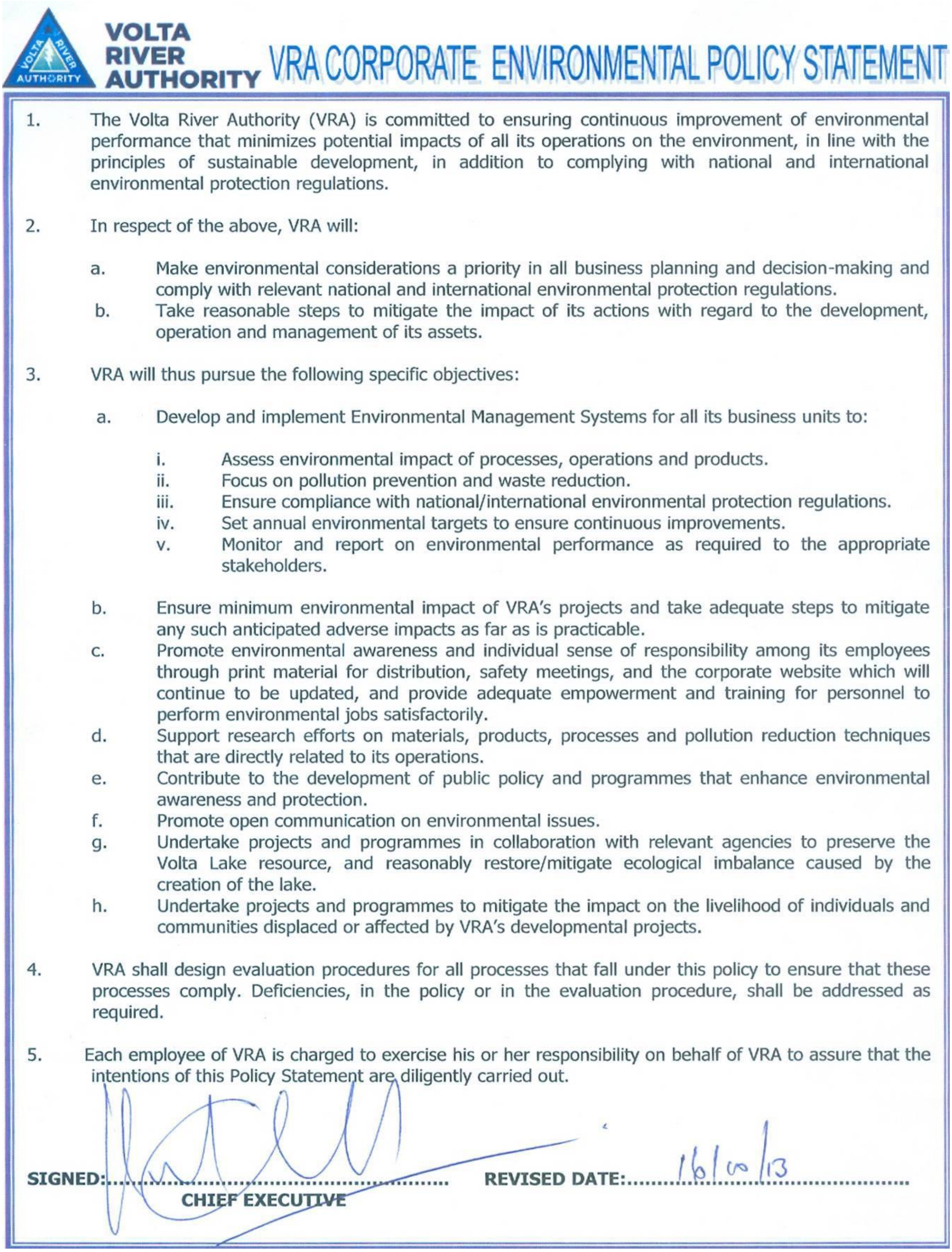
SELJEN CONSULT

Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

PART A: ESIA REPORT



VOLTA RIVER AUTHORITY

VRA CORPORATE ENVIRONMENTAL POLICY STATEMENT

1. The Volta River Authority (VRA) is committed to ensuring continuous improvement of environmental performance that minimizes potential impacts of all its operations on the environment, in line with the principles of sustainable development, in addition to complying with national and international environmental protection regulations.

2. In respect of the above, VRA will:

   a. Make environmental considerations a priority in all business planning and decision-making and comply with relevant national and international environmental protection regulations.
   b. Take reasonable steps to mitigate the impact of its actions with regard to the development, operation and management of its assets.

3. VRA will thus pursue the following specific objectives:

   a. Develop and implement Environmental Management Systems for all its business units to:

      i. Assess environmental impact of processes, operations and products.
      ii. Focus on pollution prevention and waste reduction.
      iii. Ensure compliance with national/international environmental protection regulations.
      iv. Set annual environmental targets to ensure continuous improvements.
      v. Monitor and report on environmental performance as required to the appropriate stakeholders.

   b. Ensure minimum environmental impact of VRA's projects and take adequate steps to mitigate any such anticipated adverse impacts as far as is practicable.
   c. Promote environmental awareness and individual sense of responsibility among its employees through print material for distribution, safety meetings, and the corporate website which will continue to be updated, and provide adequate empowerment and training for personnel to perform environmental jobs satisfactorily.
   d. Support research efforts on materials, products, processes and pollution reduction techniques that are directly related to its operations.
   e. Contribute to the development of public policy and programmes that enhance environmental awareness and protection.
   f. Promote open communication on environmental issues.
   g. Undertake projects and programmes in collaboration with relevant agencies to preserve the Volta Lake resource, and reasonably restore/mitigate ecological imbalance caused by the creation of the lake.
   h. Undertake projects and programmes to mitigate the impact on the livelihood of individuals and communities displaced or affected by VRA's developmental projects.

4. VRA shall design evaluation procedures for all processes that fall under this policy to ensure that these processes comply. Deficiencies, in the policy or in the evaluation procedure, shall be addressed as required.

5. Each employee of VRA is charged to exercise his or her responsibility on behalf of VRA to assure that the intentions of this Policy Statement are diligently carried out.

SIGNED:.. **REVISED DATE:** 16/10/13
CHIEF EXECUTIVE

Environmental & Social Impact Assessment for the proposed development of a Wind Energy Facility in Wokumagbe and Goi (WPP2), Ghana

ESIA REPORT

January 2018

Prepared for:
The Volta River Authority

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REPORT DETAILS

Title:	Environmental & Social Impact Assessment for the proposed development of a Wind Energy Facility in Wokumagbe and Goi (WPP2), Ghana ESIA REPORT
Project Description:	This Environmental & Social Impact Assessment (ESIA) Report forms part of a series of reports and information sources that are being provided during the ESIA Process for the proposed project. In accordance with the EIA Regulations, the purpose of the ESIA Report is to: • Present the details of and need for the proposed project; • Describe the affected environment, including the planning context, at a sufficient level of detail to facilitate informed decision making; • Provide an overview of the ESIA Process being followed, including public consultation; • Assess the predicted positive and negative impacts of the project on the environment; • Provide recommendations to avoid or mitigate negative impacts and to enhance the positive benefits of the project; • Provide an Environmental Management Plan (EMP) for the design, construction and operational phases of the project.
Prepared for:	The Volta River Authority (VRA) Contact Person: Chief Executive Volta River Authority P. O. Box MB 77 Accra, Ghana
Prepared by:	Seljen Consult Limited P. O. Box At 140, Achimota Accra Ghana CSIR P O Box 320, Stellenbosch, 7599, South Africa Tel: +27 21 888 2567
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Mapping:	Abulele Adams
Date:	January 2018

PROJECT NAME	Wind Energy Facility in Wokumagbe and Goi (WPP2)
CLIENT NAME	VOLTA RIVER AUTHORITY
REPORT NAME	Environmental & Social Impact Assessment - Final Draft Report
EPA REFERENCE	CE 5641

Name	Responsibility	Signature	Date
Kofi Gatu	Team Leader - Seljen Consult Limited		15/03/18
Ben A. Sackey	Manager, Environment & Social Impact		26/02/18
Ing. Ada Asomontsi	Project Director		28/2/2018
Ing. Emmanuel Antwi- Darkwa	Ag. Chief Executive		5/3/18

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APPENDICES

EPA INFORMATION REQUIREMENTS

Content contained in the Draft ESIA Report to be submitted to EPA	**Location in this ESIA Report**
An Introduction which analysis the need for the undertaking	Chapter 1
Approach to the ESIA Process including the legal context and Public participation	Chapter 2
A description of the undertaking	Chapter 3
Alternatives to the undertaking including alternative situations where the undertaking is not proceeded with;	
Matters on site selection including a statement of the reasons for the choice of the proposed site and whether any other alternative site was considered	
An identification of existing environmental conditions including social, economic and other aspects of major environmental concern	Chapter 4
An indication whether any area outside Ghana is likely to be affected by the activities of the undertaking	
Consultation with members of the public likely to be affected by the operations of the undertaking	Chapter 5
Information on potential, positive and negative impacts of the proposed undertaking from the environmental, social, economic and cultural aspect in relation to the different phases of development of the undertaking	Chapter 6 and 7
The potential impact on the health of people	
Proposals to mitigate any potential negative socio-economic, cultural and public health impacts on the environment	
Proposals for payment of compensation for possible damage to land or property arising from the operation of the undertaking; and	
Proposals to be developed to monitor predictable environmental impact and proposed mitigating measures	Chapter 8
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An Environnemental Management Plan (EMP)	
Conclusion	Chapter 9
Reference List	Chapter 10
Maps, plans, tables, graphs, diagrams and other illustrative material that will assist with comprehension of the contents of the environmental impact statement	Chapter 1, Chapter 2, Chapter 3, Chapter 4, Chapter 5, Chapter 6, Chapter 7, Chapter 8
Appendices	

EXECUTIVE SUMMARY

PROJECT OVERVIEW

VRA proposes to construct and operate two wind energy facilities as follows:

- 76MW Wind Power Project 1 (Anloga Extension) located at Anloga, Anyanui & Srogbe communities in the Keta Municipal in the Volta Region (Site A)
- 76.5MW Wind Power Project 2 (Wokumagbe and Goi) located in Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region (Site B)

Two separate Environmental and Social Impact Assessment (ESIA) reports will be submitted to the Environmental Protection Agency (EPA) for decision-making. The contents of this ESIA Report refer to WPP2. SELJEN Consult and the Council for Scientific & Industrial Research (CSIR), a South African research council, have been appointed to undertake the ESIA process for the proposed projects.

Under the provisions of the Ghana Environmental Assessment Regulations, 1999 (LI 1652), power generation and transmission projects are categorized under environmentally critical projects for which an Environmental Permit is required from the Environmental Protection Agency (EPA). It is an offence under Regulation 29 of the Environmental Assessment Regulations LI 1652 of 1999 to start a project without an Environmental Permit.

Section 2.3 of the Environmental Impact Assessment (EIA) Guidelines for the Energy Sector, Volume 1, dated September 2011, indicates that all wind farms exceeding 20 hectares or exceeding an installed capacity of 15MW falls into the category for which an ESIA Study is required. The EPA has issued formal guidance on regulatory requirements and the ESIA process. The environmental assessment processes have been further outlined in Volume 2 of the EIA Guidelines for the Energy Sector. It is therefore a legal requirement in Ghana that development projects such as a 76.5 MW Wind Power Project 2 should be subjected to an ESIA.

Further details on the relevant legislation can be found in Chapter 2 of this draft ESIA report.

The purpose of the ESIA is to identify, assess and report on any potential impacts the proposed project, if implemented, may have on the receiving environment. The environmental assessment therefore needs to show the Competent Authority and the project proponent, VRA, what are the potential impacts of the proposed activities on the biophysical and socio-economic environment and how such impacts can be, as far as possible, enhanced or mitigated and managed as the case may be. Chapter 6 of the ESIA report contains further details of the methodology used to determine and rate impact significance.

NEED FOR THE PROJECT

The Republic of Ghana is currently facing considerable constraints in the availability and stability of electricity supply. Due to the inability to meet the increasing demand for electricity and instabilities in the national grid due to poor water inflows for hydro power, load shedding has been a prominent feature in the country. In 2013, a 1231.50 MW thermal plant has been constructed to alleviate these constraints. However, the increase in thermal generation capacity has led to an increasing exposure to the risk of fuel price escalations, fuel supply risks (in the case of pipeline gas), and an increase in carbon emissions. This has also meant that the Ghanaian electricity consumers have been exposed to high and volatile electricity prices linked to oil prices over the last ten years.

In view of the above as well as the limitations on national reserves of oil and gas, it is essential to broaden the outlook on the country energy mix and to increase the share of the renewable sources as alternative to crude oil and gas. As at September 2017, 63.4% of electricity in Ghana was generated from fossil fuels and 36.1% from hydro power with only 0.5% being generated from renewable sources, specifically solar power[1].

Within this context, the Government of Ghana (GoG) has launched an "energy economy" initiative, which forms part of the National Renewable Energy Law, with the mandate to increase renewable energy production, with particular attention to the electrification of rural communities by 2020, The Volta River Authority (VRA), in line with the National Renewable Energy Law, has in-turn set a 5-10 years' Renewable Energy (RE) generation capacity target, taking cognisance of the local and export demand and the system constraints. VRA's RE Development Programme Phase 1 (REDP1) aims at developing about 164.5 MW of installed renewable energy capacity and this program consists of three components, specifically (a) 152 MW Wind Power Phase 1 (which includes the proposed WPP1 and WPP2) (b) 14.5 MW Solar Power Phase 1 and (c) Renewable Energy Planning & Development Integration. The proposed construction and operation of WPP2 is the focus of this ESIA report.

PROJECT APPLICANT

The Volta River Authority (VRA) was established in 1961 by an Act of Parliament (Act 46). It is the main power generation company in Ghana, solely owned by the Government of Ghana (GoG).

PROJECT EIA TEAM

As mentioned above, the SELJEN CONSULT has been appointed to undertake the ESIA process. The ESIA project team, including the relevant specialists are indicated in the table below:

NAME	ORGANISATION	ROLE/STUDY TO BE UNDERTAKEN
Kofi Gatu	Seljen Consult Limited	*ESIA Team Leader* • Design and implementation of social surveys as part of baseline study • Sociologist for rapid socio-economic and environmental appraisal of project area

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[1] Source: (http://www.vra.com/resources/facts.php)

NAME	ORGANISATION	ROLE/STUDY TO BE UNDERTAKEN
		• Lead expert responsible for data collection and literature review of socio-economic data environment. • Conduct of social impact assessment as contribution to the ESIA • Undertake the Public Consultation Process • Due diligence for quality project reporting • Drafting Reports and Quality Assurance
Paul Andrew Lochner	CSIR	*Project Advisor* • Environmental Management Expert / ESIA Specialist • Execution of contract • Supervision and coordination for effective implementation of project activities • Due diligence for quality project reporting • Overall management of the wind power project • Review and assure timely compilation and submission of all reports. • Coordinate preparation of project Environmental Scoping as well as Detailed ESIA reports with support from his team
Dr. James Kojo Adomako	University of Ghana	*Terrestrial Ecologist* • Responsible for supervision of data collection and literature review of biological environment • Identify floral species in the area of environmental influences of the project • Draw up a list of floral and faunal species in the study area and identifies environmental impacts. • Lead in the preparation of the “Ecological Survey & Habitat Assessment Study” Report.
Dr. Erasmus Owusu	University of Ghana	*Ornithologist* • Undertake Birds Impact Assessment • Rapid appraisal of avifaunal, including bats, in the project area to identify impact on these, • Provide inputs in the preparation of the “Ecological Survey & Habitat Assessment Study” Report.
Patrick Morant	Council for Scientific and Industrial Research	*Ecological Specialist* • Bird Specialist Review
Dr Andrews Agyekumhene	Muni-Pomadze Ramsar SiteWildlife Division (Forestry Commission)	Bird Surveys and Specialist Study Review
Dr. Wazi Apoh	University of Ghana	*Heritage Impact Assessment Specialist* • Assess the terrain to identify and map out prehistoric, Iron Age and historic archaeological and other heritage sites • Conduct interviews and collect relevant oral accounts, including migration and settlement histories of descendant communities in the project areas

NAME	ORGANISATION	ROLE/STUDY TO BE UNDERTAKEN
		• Measure, describe and record vital ethnographic objects and surface archaeological materials in project areas • Undertake video and photographic documentation of sites, objects, landscape, the built environment, craft production processes, sacred ceremonies, and other tangible lifeways in the project areas • Lead in the preparation of the "Historical Resources & Cultural Heritage Assessment Study" Report.
Emmanuel Hayford	Ghana Civil Aviation Authority	*Aviation & Telecommunication Impact Assessment* • Generate graphical overlays to determine proximity to key installations • Undertake aeronautical study regarding the wind turbines and effects on safety of air navigation • Prepare "Aviation & Communication Impact Analysis Study Report"
Charles Amankwah	Ghana Wildlife Division	*Wetland Impact Assessment Specialist* • Assist in the desktop aquatic biodiversity assessment of the study area. • Provide inputs in the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of any ecological sensitive areas • Recommend buffer zones and No-go areas around any delineated aquatic areas based on the relevant legislation or best practice • Provide quality assurance in the wetlands impact assessment migratory measures development.
Alex Whitehead	Sustainable Development Planning	*Wetland Impact Assessment Specialist* • Assist in the desktop aquatic biodiversity assessment of the study area. • Provide inputs in the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of any ecological sensitive areas • Recommend buffer zones and No-go areas around any delineated aquatic areas based on the relevant legislation or best practice • Provide quality assurance in the wetlands impact assessment migratory measures development.
Frank Cudjoe	Home Select & Appraisers	*Property Valuation Expert* • Valuation Expert responsible for valuation of all properties • Partake in public education/stakeholder consultations. • Lead in the preparation of the "Compensation Action Plan" Report.
Scott Mason	SRK SA	*Visual Impact Assessment* • Coordinate the preparation of the "Landscape and Visual Impact Assessment Report"

NAME	ORGANISATION	ROLE/STUDY TO BE UNDERTAKEN
Nicolette von Reiche	Airshed Planning Professionals	*Noise and Flicker Impact Assessment* • Baseline ambient noise study • Undertake noise impact evaluation • Undertake noise dispersion model and develop a Noise Monitoring Programme. • Shadow Flicker Modelling
Annick Walsdorff	CSIR	*Physical Studies coordinator and Project Leader* • Assist the CSIR Team leader in coordinating the preparation of project Environmental Scoping as well as detailed ESIA reports. • Environmental Management Expert • ESIA Specialist • Provide quality assurance in the preparation of project Environmental Scoping as well as detailed ESIA Reports.
Lydia Cape	CSIR	*Physical Studies coordinator* • Environmental Management Expert • ESIA Specialist
Abulele Adams	CSIR	*Project Manager* • Environmental Assessment Practitioner (Project Manager) • Execution of the contract • Develop project Background Information Document for distribution to stakeholders as part of the public consultation exercise • Compile Scoping and Detailed ESIA reports

PROJECT DESCRIPTION

As noted above, VRA is proposing to construct a 76.5 MW wind energy facility in the Wokumagbe and Goi communities. As determined by the outcomes of the feasibility study and the Scoping Report, the proposed facility will cover approximately 169.98 ha for the preferred layout and 186.08 ha for the alternative layout.

The proposed project will consist of the following main components:

- **Wind turbine area**
    - Wind turbines;
    - Hard standing areas

- **<u>Building Infrastructure:</u>**
  - Offices;
  - Operational and maintenance control centre;
  - Warehouse/workshop;
  - Ablution facilities;
  - Converter/Inverter stations;
  - On-site substation building; and
  - Guard Houses.

- **<u>Associated Infrastructure</u>**
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Stormwater channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

The project will additionally require the following associated infrastructure which is not part of the scope of work for this ESIA:

- Transmission lines;
- On-site substation;

A detailed project description (based on the conceptual design) is provided in Chapter 3 of this draft ESIA Report.

NEED FOR AN ESIA

As noted above, under the provisions of the Ghana Environmental Assessment Regulations, 1999 (LI 1652), power generation and transmission projects are categorized under environmentally critical projects for which an Environmental Permit is required from the Environmental Protection Agency (EPA). It is an offence under Regulation 29 of the Environmental Assessment Regulations LI 1652 of 1999 to start a project without an Environmental Permit.

Section 2.3 of the Environmental Impact Assessment (EIA) Guidelines for the Energy Sector, Volume 1, dated September 2011, indicates that all wind farms exceeding 20 hectares or exceeding an installed capacity of 15MW falls into the category for which an ESIA Study is required. The EPA has issued formal guidance on regulatory requirements and the ESIA process. The environmental assessment processes have been further outlined in Volume 2 of the EIA Guidelines for the Energy Sector. It is therefore a legal requirement in Ghana that development projects such as a 76 MW Wind Power Project 1 should be subjected to an ESIA.

IMPACT ASSESSMENT SUMMARY

This section provides a summary of the findings of the specialist studies (or inputs) that were sourced as part of this ESIA Process. Table-1 and Table -2 summarise the overall significance of these impacts following the implementation of the recommended mitigation and management measures. From this table it can be seen that there is one visual impact (altered Sense of Place and Visual Intrusion from the WEF) that will be of negative high significance as a result of the proposed project after all stipulated management actions are implemented effectively. The positive impacts generated by the project are associated with the economic benefits from employment opportunities, and potential positive archaeological gains.

Table-1: Comparative Assessment of Positive Direct and Indirect Impacts

Specialist Study	Overall Impact Significance Before Mitigation or Enhancement	Overall Impact Significance After Mitigation or Enhancement
Socio-economic Impact Assessment Study	High - Medium	High
Heritage Impact Assessment Study	Medium	Medium

Table -2: Comparative Assessment of Negative Direct and Indirect Impacts

Specialist Study	Overall Impact Significance Before Mitigation or Enhancement	Overall Impact Significance After Mitigation or Enhancement
Socio-economic Impact Assessment Study	High -Medium	Low – Very Low
Terrestrial Ecology Impact Assessment Study	Low	Low- Very Low
Bird Impact Assessment Study	Low - High	Low - Medium
Heritage Impact Assessment Study	Medium - Low	Medium- Very Low
Aviation & Communication Impact Assessment Study	Very Low	Very Low
Wetland Impact Assessment Study	High - Low	Medium-Very Low
Noise and Flicker Impact Assessment Study	Medium-Low	Low
Visual Impact Assessment Study	High-Medium	High-Low

OVERALL EVALUATION BY THE ENVIRONMENTAL ASSESSMENT PRACTITIONER

Based on the findings of the specialist studies, which all recommend that the proposed project can proceed and should be authorised by the EPA, the proposed project is considered to have an overall low to medium negative environmental impact and an overall medium positive socio-economic impact with the effective implementation of recommended mitigation and enhancement measures.

This ESIA considered the nature, scale and location of the development as well as the wise use of land (i.e. is this the right time and place for the development of this proposed project). With regards to the layout alternatives, based on specialist recommendations; the alternative layout will have slightly less impacts overall. However it must be noted that the difference in impacts is low for both layouts. All differences noted in most specialist studies are slightly low.

Ghana is currently facing considerable constraints in the availability and stability of electricity supply. The development of wind energy is important for Ghana to reduce its overall environmental footprint from power generation (including externality costs), and thereby to steer the country on a pathway towards sustainability. On a municipal planning level, the proposed project does not go against any of the objectives set within the districts. The proposed project will be in line with and will be supportive of the objective of creating more job opportunities. The proposed wind energy facility will assist in local job creation during the construction and operation phases of the project (if approved by the EPA). It should however be noted that employment during the construction phase will be temporary. During the operational phase of the project (estimated to be more 20 years), long-term employment opportunities will be created.

The locality of the proposed project will fall within an area that is a transformed and has fragments of sensitive environment however provided that the recommended management actions are implemented effectively, no residual negative impacts have been identified within the ambient of this EIA that, in the opinion of the Environmental Assessment Practitioner, should be considered "fatal flaws" from an environmental perspective, and thereby necessitate substantial re-design or termination of the project.

The findings of this ESIA show that all natural resources will be used in a sustainable manner (i.e. this project is a renewable energy project and the majority of the negative site specific and cumulative environmental impacts are considered to be of medium - low significance with mitigation measures implemented), while the benefits from the project will promote justifiable economic and social development.

In order to ensure the effective implementation of the mitigation and management actions, an EMP has been compiled as part of this ESIA Report. The mitigation measures necessary to ensure that the project is planned, constructed, operated and decommissioned in an environmentally responsible manner are listed in this EMP. The EMP is a dynamic document that should be updated regularly and provide clear and implementable measures for the establishment and operation of the proposed Wind Power facility.

Taking into consideration the findings of the ESIA Process and given the national and provincial strategic requirements for infrastructure development, it is the opinion of the EAP that the project benefits outweigh the costs and that the project will make a positive contribution to steering Ghana on a pathway towards sustainable infrastructure development. Provided that the specified mitigation measures are applied effectively, it is recommended that the project receive EP.

GLOSSARY

BID	Background Information Document
CITES	Convention on International Trade in Endangered Species
CA	Competent Authority
CEB	Communauté Electrique du Benin
CESAP	Constructional Environmental & Social Action Plan
CO2	Carbon Dioxide
CoP	Conference of Parties
CSIR	Council for Scientific and Industrial Research
DEA&DP	Western Cape Department of Environmental Affairs and Development Planning
DSR	Draft Scoping Report
EAP	Environmental Assessment Practitioner
EHS	Environmental health and Safety
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EMS	Environmental Management Services
EP	Environmental Permit
EPA	Environmental Permit Authority
EPFI	Equator Principle Financial Institutions
ESIA	Environmental & Social Impact Assessment
FSR	Final Scoping Report
GHG	greenhouse gases
GoG	Government of Ghana
Km	kilometer
I&AP	Interested and Affected Party
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Produce
kWh	Kilowatt Hours
LNG	Liquefied Natural Gas
MV	Medium Voltage
MW	Megawatts
NEDCo	Northern Electricity Distribution Company
NESRP	Northern Electrification & System Reinforcement Project
NREL	National Renewable Energy Lab
OECD	Organisation for Economic Corporation & Development
OESAP	Operational Environmental & Social Action Plan
OHS	Occupational Health & Safety

OPs	Operational Policies
RE	Renewable Energy
REDPP1	Renewable Energy Development Programme Phase 1
PAP	Project-Affected Persons
PPP	Public Participation Process
PS	Performance Standards
PURC	Public Utilities Regulatory Commission
S&EIR	Scoping and Environmental Impact Reporting
SSRs	Sensitive Shadow Receptors
ToR	Terms of Reference
TNC	Third National Communication
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WAPP	West Africa Power Pool
WEF	Wind Energy Facility
WPP	Wind Power Project
WTG	Wind Turbine Generator
VRA	Volta River Authority

Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 1:

Introduction

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TABLES

FIGURES

1 INTRODUCTION

The Republic of Ghana is currently facing considerable constraints in the availability and stability of electricity supply. Due to the inability to meet the increasing demand for electricity and instabilities in the national grid due to poor water inflows for hydro power, load shedding has been a prominent feature in the country. In 2013, a 1231.50 MW thermal plant has been constructed to alleviate these constraints. However, the increase in thermal generation capacity has led to an increasing exposure to the risk of fuel price escalations, fuel supply risks (in the case of pipeline gas), and an increase in carbon emissions. This has also meant that the Ghanaian electricity consumers have been exposed to high and volatile electricity prices linked to oil prices over the last ten years.

In view of the above as well as the limitations on national reserves of oil and gas, it is essential to broaden the outlook on the country energy mix and to increase the share of the renewable sources as alternative to crude oil and gas. As at September 2017, 63.4% of electricity in Ghana was generated from fossil fuels and 36.1% from hydro power with only 0.5% being generated from renewable sources, specifically solar power[1].

Within this context, the Government of Ghana (GoG) has launched an "energy economy" initiative, which forms part of the National Renewable Energy Law, with the mandate to increase renewable energy production, with particular attention to the electrification of rural communities by 2020, The Volta River Authority (VRA), in line with the National Renewable Energy Law, has in-turn set a 5-10 years' Renewable Energy (RE) generation capacity target, taking cognisance of the local and export demand and the system constraints. VRA's RE Development Programme Phase 1 (REDP1) aims at developing about 164.5 MW of installed renewable energy capacity and this program consists of three components, specifically (a) 152 MW Wind Power Phase 1 (which includes the proposed WPP1 and WPP2) (b) 14.5 MW Solar Power Phase 1 and (c) Renewable Energy Planning &

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[1] Source: (http://www.vra.com/resources/facts.php)

Development Integration. The proposed construction and operation of WPP2 is the focus of this ESIA report.

There are several advantages associated with the consideration of Wind Energy Facilities in Ghana:

- Responds to the national need to produce power from renewable energy sources that are alternatives to thermal and hydro power production systems.
- Reduction of Greenhouse gas emissions, including CO2, in Ghana through net energy gain, and
- Adding additional sources of energy generation to the energy mix.

In line with this initiative, the Volta River Authority (VRA) proposes to construct and operate two wind energy facilities (refer to Figure 1) namely:

- A 76 MW Wind Energy Facility (herewith referred to as Wind Power Project 1 (WPP1) (Anloga Extension)) located in the Anloga, Anyanui and Srogbe communities in the Keta Municipal in the Volta Region (Site A).
- A 76.5 MW Wind Energy Facility (referred to as Wind Power Project 2 (WPP 2) (Wokumagbe and Goi)) located in the Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region (Site B)

This report discusses WPP2, while that of WPP1 is discussed in a separate report namely, Environmental & Social Impact Assessment for the proposed development of a Wind Energy Facility in Anloga Extension (WPP1), 2017.

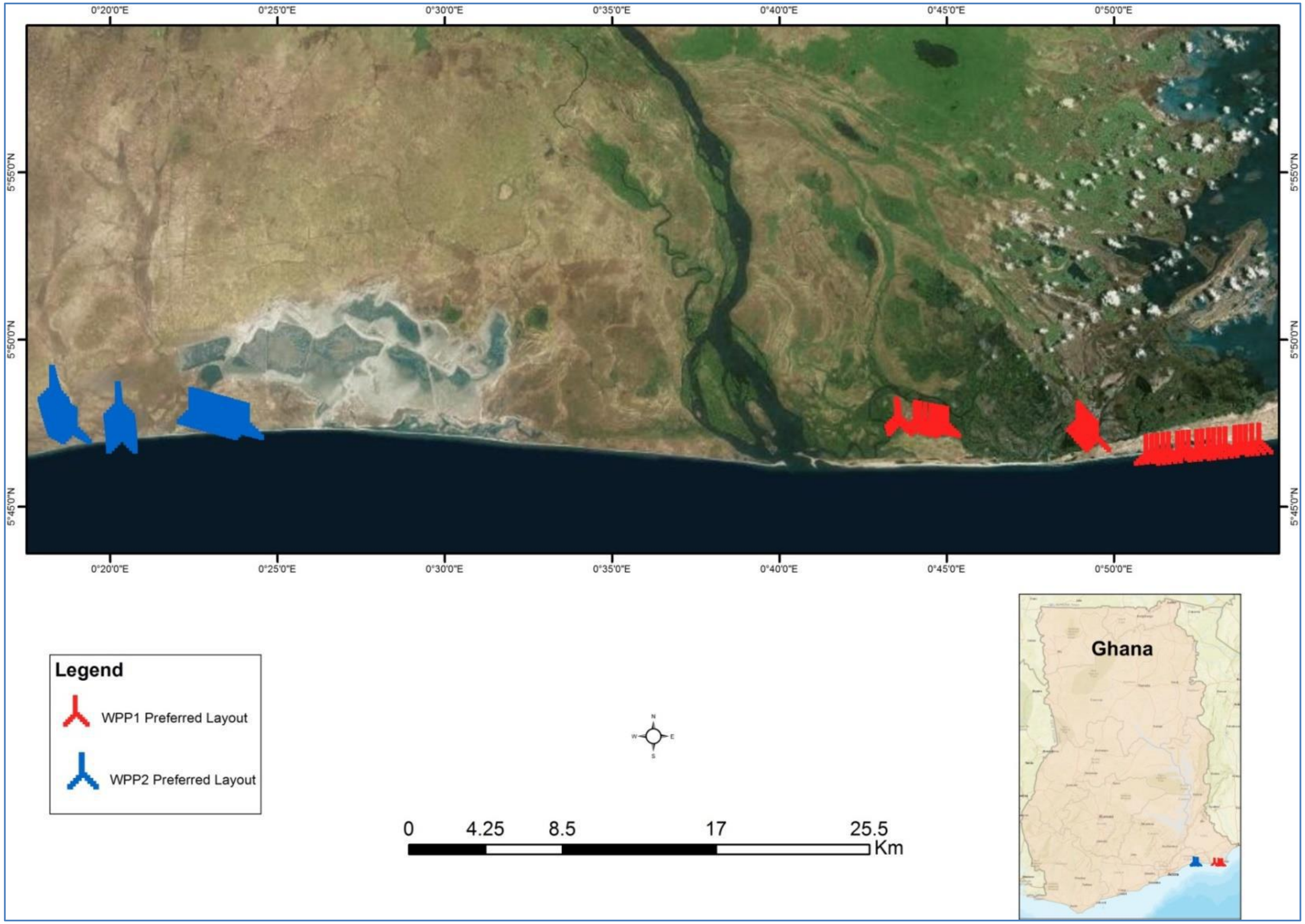

Figure 1-1: Locality map for the proposed WPP1 and WPP2

1.1 PROJECT APPLICANT

The Volta River Authority (VRA) was established in 1961 by an Act of Parliament (Act 46). It is the main power generation company in Ghana, solely owned by the Government of Ghana (GoG). VRA relies on hydro, thermal and solar plants to generate electricity for supply to the local and export markets. The local market consists of the Electricity Company of Ghana (61% of market consumption), as well as mines and industrial establishments who purchase electricity directly from VRA, and the export market comprises of the Communauté Electrique du Benin (CEB) (for the Republics of Togo and Benin) and SONABEL (Burkina Faso).

The VRA utilizes the Ghana Grid Company (GRIDCo) transmission system. This transmission system covers the entire country and is connected with the national electricity grids of Compagnie Ivoirienne d'Electricité (CIE) of La Cote d'lvoire, CEB of Togo and Benin, and SONABEL of Burkina Faso. These interconnections now serve as part of the arrangement under the West Africa Power Pool (WAPP).

Northern Electricity Distribution Company (NEDCo), a subsidiary of VRA, undertakes the distribution function in northern Ghana covering the Upper East, the Upper West, Northern and Brong Ahafo regions, as well as parts of the Ashanti and Volta Regions. NEDCo was developed as an integral part of a larger scheme, the Northern Electrification & System Reinforcement Project (NESRP), to extend the national electricity grid to northern Ghana.

Historically, the Electricity Supply Industry in Ghana has been dominated by hydro power, which accounted for all generation until the late 1990s. Thermal generation plants gained consistent prominence in VRA's power generation mix, since the mid 1990's when VRA commenced the diversification of its generation source beyond the Akosombo Hydro-electric plant. Since the end of 2010, Ghana's total installed thermal generating capacity has almost equalled the existing hydro generation capacity. VRA’s hydroelectric power generation plants, the Akosombo Hydroelectric Power Plant and Kpong Hydroelectric Power Plant are situated in the Eastern region. The thermal plants are situated mainly in Tema and Takoradi.

In addition to those owned by VRA, independent Power Producers (IPPs) support the electricity supply market.

As at close of September 2017, the total installed capacity in Ghana was 4381 MW and is generated by 19 power generation plants. VRA owns ten (10) of these power generation facilities in Ghana, as shown in Table 1-1 below, with a total installed generation capacity of 2456 MW, representing 54.74% of total installed capacity in the country, with a dependable capacity of 2107MW.

Table 1-1: VRA Generation Plants As at September 2017

VRA PLANTS	INSTALLED CAPACITY (MW)	INSTALLED CAPACITY (%)	DEPENDABLE CAPACITY (MW)
Akosombo Hydroelectric Power Plant	1020	41.53%	900
Kpong Hydroelectric Power Plant	160	6.51%	140
Takoradi Thermal Power Station (T1)	330	13.44%	300
Takoradi International Company (TICO/ T2)	330	13.44%	320
Takoradi 3 (T3)	132	5.37%	120
Mines Reserve Power Station	80	3.26%	70
Tema Thermal 1 Power Station (TT1PP)	110	4.48%	100
Tema Thermal 2 Power Station (TT2PP)	49.5	2.01%	45
Tema Thermal 2 Plant expansion (TT2PP-X)	22	0.89%	19
Kpone Thermal Power Plant	220	8.97%	200
Navrongo Solar Power Plant	2.5	0.10%	0
TOTAL VRA	**2456**	**100.0%**	**2214**

Source: (http://www.vra.com/resources/facts.php)

Based on VRA's capacity demand and supply balance (2013-2025), and in line with Ghana's power sector reform and major policy objectives, the country's current total installed generating capacity requires to be increased to 5175 MW by 2023 in order to address power shortages, to ensure an adequate supply of electricity, to meet the country's forecast growth in demand requirements and to improve the quality of service and reliability of the power system.

The projected shortfall in generation capacity is expected to be filled by both VRA and Independent Power Producer's (IPPs) who have both embarked on various activities to expand power supply and infrastructure. In this regard, VRA is focusing on a number of power expansion projects and new projects, designed to ensure electricity availability and accessibility in the short-to-medium term. These include renewable energy (wind, hydro and solar) and combined cycle power plants, as detailed below:

- Development of two wind projects with a total capacity of 100-150 MW;
- Development of 14.5 MW of solar energy;
- Commencement of feasibility studies for the development of 140 MW of hydro dams at Pwalugu and Juale in the Northern Region;
- Expansion of the Simple Cycle 220MW Thermal Plant located at Kpone, near Tema (Phase1-Stage1), to a 330MW Combine Cycle, by close of 2018 (Phase 1 – Stage 2);
- Development of 450MW Combine Cycle Plant at Kpone, near Tema.
- Expansion of the existing VRA 110 MW single cycle Tema Thermal Power Plant (TT1PP) with that of 110 MW CENIT Power Plant (an Independent Power Producer) into a 330 MW combined cycle plant though a Joint Venture arrangement.

1.2 PROJECT OVERVIEW

As noted above, VRA is proposing to construct a 76.5 MW wind energy facility in the Wokumagbe and Goi communities (Figure 1.2). As determined by the outcomes of the feasibility study and the Scoping Report, the proposed facility will cover approximately 169.98 ha for the preferred layout and 186.08 ha for the alternative layout.

The proposed project will consist of the following main components:

- **Wind turbine area**
    - Wind turbines;
    - Hard standing areas

- **Building Infrastructure:**
    - Offices;
    - Operational and maintenance control centre;
    - Warehouse/workshop;
    - Ablution facilities;
    - Converter/Inverter stations;
    - On-site substation building; and
    - Guard Houses.

- **Associated Infrastructure**
    - Access roads;
    - Internal gravel roads;
    - Fencing;
    - Stormwater channels; and
    - Temporary work area during the construction phase (i.e. laydown area).

The project will additionally require the following associated infrastructure, which is not part of the scope of work for this ESIA and will be undertaken under a separate study:

- Transmission lines;
- On-site substation;

A detailed project description (based on the conceptual design) is provided in Chapter 3 of this draft ESIA Report.

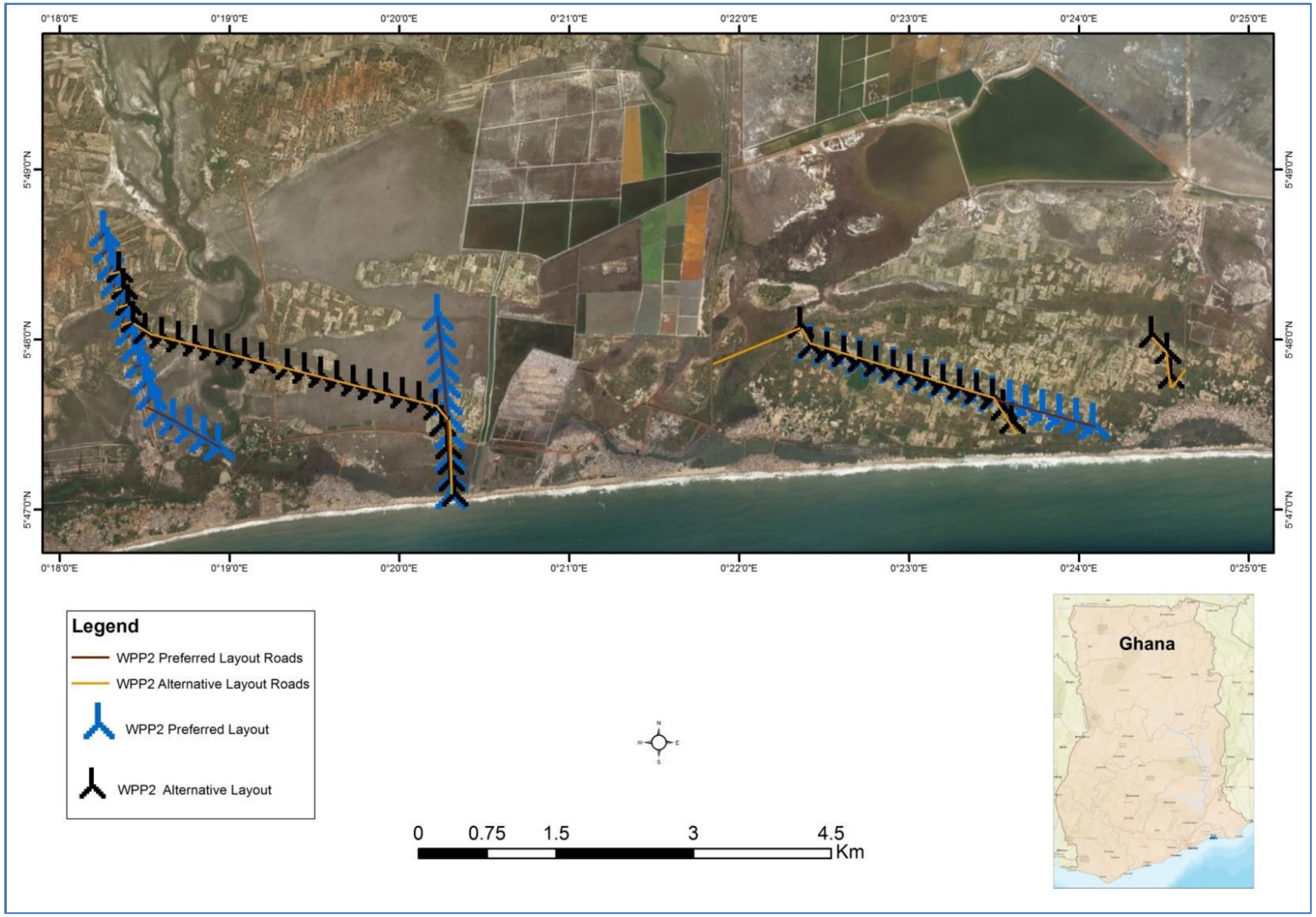

Figure 1-2: Preferred and Alternative Layout for WPP2

1.3 PROJECT MOTIVATION

Within the context of Ghana facing considerable constraints in the availability and stability of electricity supply and the prices of crude oil fluctuating, the Government of Ghana (GoG) has launched an “energy economy” initiative which mandates that 10% of Ghana’s electricity needs should come from RE by 2020, with particular attention to electrification of rural communities.

To contribute towards this target and to stimulate the renewable energy industry in Ghana, the Government passed a RE Law (Act 832 of 2011) which provides the necessary legal and regulatory framework to promote the provision of energy, including electricity from renewable sources. The object of this law is to promote the sustainable development and utilization of RE resources for electricity and heat generation. The goals of the renewable energy mix are to increase the proportion of renewable energy in the total national energy mix and ensure its efficient production and use.

The support for this renewable energy policy is also guided by the need to address climate change, as well as a rationale that Ghana has a range of renewable resources and that renewable applications are in fact the least-cost energy service in many cases - and more so when social and environmental costs are taken into account. The Ghana Renewable Energy Fund was created under the RE law to support renewable energy promotion, research and other activities.

This law provides for a feed-in tariff mechanism to encourage the adoption and use of renewable energy as well as creates a platform for the trading of renewable energy. An Executive Instrument was gazetted on November 12, 2014 by the Public Utilities Regulatory Commission (PURC) for the publication of feed-in-tariffs (FIT) for electricity generated from renewable energy sources in line with the electricity rate issuing guidelines to ensure return on investment for independent power providers.

Against this background, a number of wind developers are already active in Ghana. The following projects are currently underway:

a) A 140MW Amlakpo Wind Farm in Ada West District in the coastal region of Ghana about 80 - 85 km east of Accra. The Amlakpo Wind Farm will have a capacity of up to 140 MW and will supply around 300 000 MWh per year of electrical energy. Recent publication indicates that the construction of this project is not yet scheduled (http://upwindinternational.com/wind-energy/amlakpo-wind-farm/amlakpo-wind-farm.php)

b) A 225MW Ayitepa Wind Farm in the Ningo-Prampram District, around 50 - 60 km east of Accra. The wind farm will be supplemented by two 20 MW solar parks, together forming the first Hybrid Power Plant in Africa. The Ghana Civil Aviation Authority (GCAA) has granted Airspace Safety Permit for construction and maintenance of the wind farm. The final approval for the project was received in the fourth quarter of 2016. Upwind Ayitepa signed a power-purchase agreement (PPA) with the Electricity Company of Ghana in early-2017 to supply 225MW of electricity generated by the Ayitepa wind farm. Financial closure is expected to be achieved in the second half of 2017. Construction on the renewable power project is set to commence in late-2017 and is expected to be completed in 16 months with first power scheduled for 2018[2].

c) A 100MW Koluedor Wind Farm in the coastal region of Ghana about 70 - 75 km east of Accra, in the District of Ada West. The Koluedor Wind Farm will have a capacity of up to 100 MW and will supply around 200 000 MWh of clean, affordable and reliable electrical energy per year, which is produced locally, without need of any fuel or gas. Recent publication indicates that the construction of this project is not yet scheduled (http://upwindinternational.com/wind-energy/koluedor-wind-farm/koluedor-wind-farm.php).

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[2] http://www.power-technology.com/projects/ayitepa-wind-farm/

d) A 200MW Konikablo Wind Farm located in a very sparsely populated area in the Ningo-Prampram District, around 60 - 70 km east of Accra, between the Accra-Aflao-Road in the North and the Gulf of Guinea in the South. The Konikablo Wind Farm will have a capacity of up to 200 MW and will supply more than 350 000 MWh of electrical energy per year. Recent publication indicates that the construction of this project is not yet scheduled.[3]

e) The 86MW Prampram Wind Farm project is located on the south coast of Ghana in the Ningo-Prampram District in the Greater Accra Region, about 30 km east of Accra. The Prampram Wind Farm will supply up to 200 000 MWh of electrical energy per year. It is scheduled that construction of this project will commence in 2017.

1.3.1 Need and Desirability

It is an important requirement in the ESIA Process to review the need and desirability of the proposed project. The essential aim of this investigation revolves around determining suitability (i.e. is the activity proposed in the right location for the suggested land-use/activity) and timing (i.e. is it the right time to develop a given activity?).

1.3.1.1 Environmental sustainability

Carbon dioxide emissions from power plants, industry and the transport sector are by far the largest contributor to the build-up of greenhouse gases in the atmosphere. The Intergovernmental Panel on Climate Change (IPCC), in 2007, reported a 0.2 degrees Celsius increase over the course of 1990-2005 and further warming trends are predicted.

The environmental footprint of wind energy facilities is generally very small (i.e. emissions are estimated to range between 0.01 to 0.02 kg of CO_2 eq[4] /kWh) compared to natural gas and coal for which estimated emissions range from 0.6 to 2 pounds CO_2 eq/kWh and 0.64 to 1.63

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[3] www.upwindkoluedor.com

[4] Carbon dioxide equivalent per kilowatt-hour

kg of CO_2 eq/kWh respectively. Apart from dust and GHG emissions (e.g. transport) during construction, wind energy produces no atmospheric emissions. This will lead to a subsequent significant greenhouse gas reduction potential in the Ghanaian context.

Visual intrusion, noise and bird and bat mortalities are some of the impacts that can be associated with wind energy facilities. Research (Krohn & Damborg, 1999) suggests that the perception of the level of visual intrusion and noise are affected less by the actual amount of turbines and the noise it creates, than by individual feelings of positivity or animosity towards the erection of turbines. This by no means reduces the significance of these impacts, but rather illustrates its subjective nature. Wind energy related bird and bat mortalities, though regrettable, should be interpreted in the broader context of electricity generation's environmental impact. Research conducted in the USA indicates that wind turbines are responsible for 0.3 bird mortalities per GWh (7000 bird mortalities per annum) compared to 5.2 mortalities per GWh (14.5 million mortalities per annum) for fossil-fuelled power stations (Sovacool, 2009).

The development of a wind energy facility is therefore important for Ghana to reduce its overall environmental footprint from power generation.

1.3.1.2 Economic sustainability

The average price of crude oil increased by 60% (US$25 to approximately US$40 per barrel) between 2001 and 2004. During the next 4 years, the average price of crude more than doubled to a peak of around US$100 per barrel. Towards the end of 2008, crude oil prices dropped and continued to fall until early 2009, averaging approximately US$62 per barrel during 2009. From 2010 till 2013, annual average prices of crude oil ranged from between US$ 71 to US$ 89 per barrel. The trend for gas and light crude oil prices followed that of crude oil and led to high electricity rates. However, prices fluctuated from US$88.47 down to US$42.63 as at July 2017[5].

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[5] https://inflationdata.com/Inflation/Inflation_Rate/Historical_Oil_Prices_Table.asp

Crude oil/natural gas prices are expected to fluctuate over the years thus, developing electrical power facilities from renewable based projects will reduce Ghana's exposure to the fluctuating price of fuel, decrease its carbon footprint and place the country as a leader in small-grid connected renewable solar generation.

In addition, the increase in thermal generation capacity has led to an increasing exposure to the risk of fuel price escalations, fuel supply risks (in the case of pipeline gas), and an increase in carbon footprint. This has meant that the Ghanaian economy and electricity consumers have been exposed to high and volatile electricity prices linked to oil prices over the last ten years.

In comparison, wind power is not dependent on uncertain costs of key resource inputs such as oil. The current cost of wind-generated electricity is competitive and has decreased since the technology was first introduced. This reduction in cost is expected to continue as wind energy technology matures and economies of scale are established in the wind energy market.

1.3.1.3 Social sustainability

There may be over 50 employment opportunities created for the local labour force during construction, with the attendant invaluable up-skilling of both the local labourers and client's workers. Operational staff is expected to range from 14 to 21 employees. The key economic benefits associated with the construction and operation of a wind energy facility include a generated power price from the wind facility that is independent from the price of crude, the up-skilling of the Ghanaian labour force and the contracting of a local civil construction companies and labourers.

In view of the limitations on national reserves of oil and gas besides the unpredictable flow of water to meet the energy demands, and in consideration of the urgent need to normalize the commercial, industrial and agricultural activities, it is considered essential to broaden the outlook on the energy mix. There is a need to increase the share of the renewable sources as alternative to crude oil and gas that presently form 49.3% of the source of fuel for the country's generating plants.

Additional information regarding the project contextualisation is provided in Chapters 3 of this ESIA Report.

1.4 REQUIREMENTS FOR AN ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT

Under the provisions of the Ghana Environmental Assessment Regulations, 1999 (LI 1652), power generation and transmission projects are categorized under environmentally critical projects for which an Environmental Permit is required from the Environmental Protection Agency (EPA). It is an offence under Regulation 29 of the Environmental Assessment Regulations LI 1652 of 1999 to start a project without an Environmental Permit.

Section 2.3 of the Environmental Impact Assessment (EIA) Guidelines for the Energy Sector, Volume 1, dated September 2011, indicates that all wind farms exceeding 20 hectares or exceeding an installed capacity of 15MW falls into the category for which an ESIA Study is required. The EPA has issued formal guidance on regulatory requirements and the ESIA process. The environmental assessment processes have been further outlined in Volume 2 of the EIA Guidelines for the Energy Sector. It is therefore a legal requirement in Ghana that development projects such as a 76.5 MW Wind Power Project 2 should be subjected to an ESIA.

Further details on the relevant legislation can be found in Chapter 2 of this draft ESIA report.
The purpose of the ESIA is to identify, assess and report on any potential impacts the proposed project, if implemented, may have on the receiving environment. The environmental assessment therefore needs to show the Competent Authority and the project proponent, VRA, what are the potential impacts of the proposed activities on the biophysical and socio-economic environment and how such impacts can be, as far as possible, enhanced or mitigated and managed as the case may be. Chapter of the ESIA report contains further details of the methodology used to determine and rate impact significance.

1.5 ESIA TEAM

SELJEN Consult Limited has been appointed by VRA to undertake the ESIA required for the proposed project. The ESIA team involved in this Scoping and ESIA Process is listed in Table 1-2 below. This team includes a number of specialists which have been involved during the ESIA Process.

Table 1-2: The ESIA Management Team

NAME	ORGANISATION	ROLE/STUDY TO BE UNDERTAKEN
Kofi Gatu	Seljen Consult Limited	***ESIA Team Leader*** • Design and implementation of social surveys as part of baseline study • Sociologist for rapid socio-economic and environmental appraisal of project area • Lead expert responsible for data collection and literature review of socio-economic data environment. • Conduct of social impact assessment as contribution to the ESIA • Undertake the Public Consultation Process • Due diligence for quality project reporting • Drafting Reports and Quality Assurance
Paul Andrew Lochner	CSIR	***Project Advisor*** • Environmental Management Expert / ESIA Specialist • Execution of contract • Supervision and coordination for effective implementation of project activities • Due diligence for quality project reporting • Overall management of the wind power project • Review and assure timely compilation and submission of all reports. • Coordinate preparation of project Environmental Scoping as well as Detailed ESIA reports with support from his team
Dr. James Kojo Adomako	University of Ghana	***Terrestrial Ecologist*** • Responsible for supervision of data collection and literature review of biological environment • Identify floral species in the area of environmental influences of the project • Draw up a list of floral and faunal species in the study area and identifies environmental impacts. • Lead in the preparation of the "Ecological Survey & Habitat Assessment Study" Report.

NAME	ORGANISATION	ROLE/STUDY TO BE UNDERTAKEN
Dr. Erasmus Owusu Mr Patrick Morant Dr Andrews Agyekumhene	University of Ghana	***Ornithologist*** • Undertake Birds Impact Assessment • Rapid appraisal of avifaunal, including bats, in the project area to identify impact on these, • Provide inputs in the preparation of the "Ecological Survey & Habitat Assessment Study" Report.
Dr. Wazi Apoh	University of Ghana	***Heritage Impact Assessment Specialist*** • Assess the terrain to identify and map out prehistoric, Iron Age and historic archaeological and other heritage sites • Conduct interviews and collect relevant oral accounts, including migration and settlement histories of descendant communities in the project areas • Measure, describe and record vital ethnographic objects and surface archaeological materials in project areas • Undertake video and photographic documentation of sites, objects, landscape, the built environment, craft production processes, sacred ceremonies, and other tangible lifeways in the project areas • Lead in the preparation of the "Historical Resources & Cultural Heritage Assessment Study" Report.
Emmanuel Hayford	Ghana Civil Aviation Authority	***Aviation & Telecommunication Impact Assessment*** • Generate graphical overlays to determine proximity to key installations • Undertake aeronautical study regarding the wind turbines and effects on safety of air navigation • Prepare "Aviation & Communication Impact Analysis Study Report"
Charles Amankwah	Ghana Wildlife Division	***Wetland Impact Assessment Specialist*** • Assist in the desktop aquatic biodiversity assessment of the study area. • Provide inputs in the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of any ecological sensitive areas • Recommend buffer zones and No-go areas around any delineated aquatic areas based on the relevant legislation or best practice • Provide quality assurance in the wetlands impact assessment migratory measures development.
Alex Whitehead	Sustainable Development Planning	***Wetland Impact Assessment Specialist*** • Assist in the desktop aquatic biodiversity assessment of the study area. • Provide inputs in the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of any ecological sensitive areas • Recommend buffer zones and No-go areas around any

NAME	ORGANISATION	ROLE/STUDY TO BE UNDERTAKEN
		delineated aquatic areas based on the relevant legislation or best practice • Provide quality assurance in the wetlands impact assessment migratory measures development.
Frank Cudjoe	Home Select & Appraisers	***Property Valuation Expert*** • Valuation Expert responsible for valuation of all properties • Partake in public education/stakeholder consultations. • Lead in the preparation of the “Compensation Action Plan” Report.
Scott Mason	SRK SA	***Visual Impact Assessment*** • Coordinate the preparation of the “Landscape and Visual Impact Assessment Report”
Nicolette von Reiche	Airshed Planning Professionals	***Noise and Flicker Impact Assessment*** • Baseline ambient noise study • Undertake noise impact evaluation • Undertake noise dispersion model and develop a Noise Monitoring Programme. • Shadow Flicker Modelling
Annick Walsdorff	CSIR	***Project Leader and Physical Studies coordinator*** • Assist the CSIR Team leader in coordinating the preparation of project Environmental Scoping as well as detailed ESIA reports. • Environmental Management Expert • ESIA Specialist • Provide quality assurance in the preparation of project Environmental Scoping as well as detailed ESIA Reports.
Lydia Cape	CSIR	***Physical Studies coordinator*** • Environmental Management Expert • ESIA Specialist
Abulele Adams	CSIR	***Project Manager*** • Environmental Assessment Practitioner (Project Manager) • Execution of the contract • Develop project Background Information Document for distribution to stakeholders as part of the public consultation exercise • Compile Scoping and Detailed ESIA reports

1.6 DETAILS AND EXPERTISE OF THE EAP

SELJEN CONSULT (SC):

SELJEN Consult (SC) is an Environmental Management Consultancy firm which was formed between 1997 and 1998 but was only formerly registered on July 28, 2003. The main objective of SELJEN Consult is to offer Environmental Management Consultancy services in Social and Environmental Impact Assessment, Environmental Management Plan, Preliminary Environmental Report, Annual Reports, and De-Commission Plans among others.

SELJEN Consult has conducted Environmental Impact Assessments and Strategic Environmental Assessments for a number of organizations and companies which have had to comply with the Environmental Regulations and the World Bank requirements including facilitating the processes of acquiring statutory permits for their proposed undertakings such as Environmental Protection Agency permits and certificates.

Since 1998 SELJEN Consult and its Associates have been contracted as Environmental Consultants by many National and International Companies and Bodies and have been responsible for obtaining the relevant environmental clearance, approval and permits for their projects Nation-wide. SELJEN Consult has gained considerable experience in the preparation of Environmental Impact Assessment and Environmental Management Plans in a wide range of infrastructural development, housing, industrial activities such as Real Estate development, fuel stations construction and solid and liquid waste management, Mining, Tank Farm Construction etc. Among our cherished clients are The World Bank, International Finance Corporation, GRIDCo, DANIDA Private Sector Development Programme, Volta River Authority, PW Ghana Ltd, Ghana Oil Company Limited, Ghana Telecom Ltd, Reime Ghana Ltd, Tema Oil Refinery, FMC Technologies, West Africa Power Pool, USTDA-Funded Feasibility Studies and Rom Int Ltd among others.

CSIR:

Over the past 30 years the CSIR has been involved in a multitude of projects across Africa and South Africa, with experience in 32 sub-Saharan African and Indian Ocean Island countries. The Environmental Management Services (EMS) group within the CSIR has been involved in the management and execution of numerous environmental assessment and management studies in more than 15 countries in Africa, as well as the Middle East, South America and Russia. These studies have included both public and private sector clients. Consequently, the CSIR EMS team offers a wealth of experience and appreciation of the environmental and social priorities and national policies and regulations in South Africa.

The CSIR's consulting expertise in environmental assessment and management is housed within the Environmental Management Services (EMS) business unit. This group has over 20 years' experience in environmental management practices and research methodologies, as well as in conducting environmental assessment and management studies in more than 17 countries in Africa, in particular in southern and West Africa, and elsewhere in the world.

1.7 OBJECTIVES FOR THIS DRAFT ESIA REPORT

A comprehensive scoping process for the proposed project was undertaken prior to this draft ESIA report, which led to the submission of a Final Scoping Report to the authorities (EPA) for decision making. During the Scoping Phase, the Scoping Report was made available to Interested and Affected Parties (I&APs) and stakeholders for 30 days commenting period. All comments received from I&APs during the Scoping Phase are included in Chapter 5 of this draft ESIA Report. The EPA accepted the Scoping Report and Plan of Study for the ESIA in a letter dated September 14, 2016, which marked the end of the Scoping Phase. Thereafter the ESIA Process moved into the impact assessment and reporting phase. For background on the Scoping Process, the reader is referred to the Scoping Report for the proposed Wind Energy Facilities in Wokumagbe and Goi (WPP2), 2016, which is available at VRA's corporate website www.vra.com.

The primary objective of this ESIA Report is to present stakeholders, I&APs and the Competent Authority, with an overview of the predicted impacts and associated management actions required to avoid or mitigate the negative impacts (taking into account all issues flagged in the Scoping Phase); or to enhance the benefits of the proposed project (Figure 1-3).

In broad terms, the ESIA Process must be undertaken in line with the approved Plan of Study for the ESIA, and that it must include a description of the potential environmental impacts, mitigation and closure outcomes, as well as the residual risks of the proposed activity.

The objectives of the ESIA Process are to:

- Determine the policy and legislative context within which the activity is located and note how the proposed activity complies with and responds to the policy and legislative context;
- Identify the location of the development footprint within the preferred site based on an impact and risk assessment process inclusive of cumulative impacts and a ranking process of all the identified development footprint alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects of the environment;
- Determine the nature, significance, consequence, extent, duration and probability of the impacts occurring to inform identified preferred alternatives; and the degree to which these impacts (a) can be reversed; (b) may cause irreplaceable loss of resources, and (c) can be avoided, managed or mitigated;
- Identify the most ideal location for the activity within the preferred site based on the lowest level of environmental sensitivity identified during the assessment; and
- Identify suitable measures to avoid, manage or mitigate identified impacts.

In terms of legal requirements, a crucial objective of the ESIA Report is to satisfy the requirements of The EPA formal guidance on regulatory requirements and the ESIA. These regulate and prescribe the content of the ESIA Report and specify the type of supporting information that must accompany the submission of the report to the authorities. An overview of where the requirements are addressed in this report is presented in Table 1-3.

Table 1-3: Requirements of an ESIA Report

CONTENT CONTAINED IN THE DRAFT ESIA REPORT TO BE SUBMITTED TO EPA	LOCATION IN THIS ESIA REPORT
An Introduction which analysis the need for the undertaking	Chapter 1
A description of the undertaking	Chapter 3
An identification of existing environmental conditions including social, economic and other aspects of major environmental concern	Chapter 4
An indication whether any area outside Ghana is likely to be affected by the activities of the undertaking	
Approach to the ESIA Process including the legal context and Public participation	Chapter 2
Consultation with members of the public likely to be affected by the operations of the undertaking	Chapter 5
Alternatives to the undertaking including alternative situations where the undertaking is not proceeded with;	Chapter 3
Matters on site selection including a statement of the reasons for the choice of the proposed site and whether any other alternative site was considered	
Information on potential, positive and negative impacts of the proposed undertaking from the environmental, social, economic and cultural aspect in relation to the different phases of development of the undertaking	Chapter 6 and 7
The potential impact on the health of people	
Proposals to mitigate any potential negative socio-economic, cultural and public health impacts on the environment	
Proposals for payment of compensation for possible damage to land or property arising from the operation of the undertaking; and	
Proposals to be developed to monitor predictable environmental impact and proposed mitigating measures	Chapter 8
Contingency plans existing or to be evolved to address any unpredicted negative environmental impact and proposed mitigating measures	
An Environnemental Management Plan (EMP)	Chapter 8
Reference List	Chapter 10
Maps, plans, tables, graphs, diagrams and other illustrative material that will assist with comprehension of the contents of the environmental impact statement	Chapter 1, Chapter 2, Chapter 3, Chapter 4, Chapter 5, Chapter 6, Chapter 7, Chapter 8
Appendices	

Furthermore, this process is designed to satisfy the requirements relating to the public participation process and, specifically, the registration of I&APs and recording of submissions from interested and affected parties. The draft ESIA Report will be released to stakeholders for a 50 working day review period as per the requirement of the Ghana EIA Review Process as shown in Figure 1-4. All I&APs on the current database for this ESIA will be informed of the release of the Draft ESIA Report for comment. All comments on this Draft ESIA Report will be incorporated into the Final ESIA Report for submission to the EPA for decision-making.

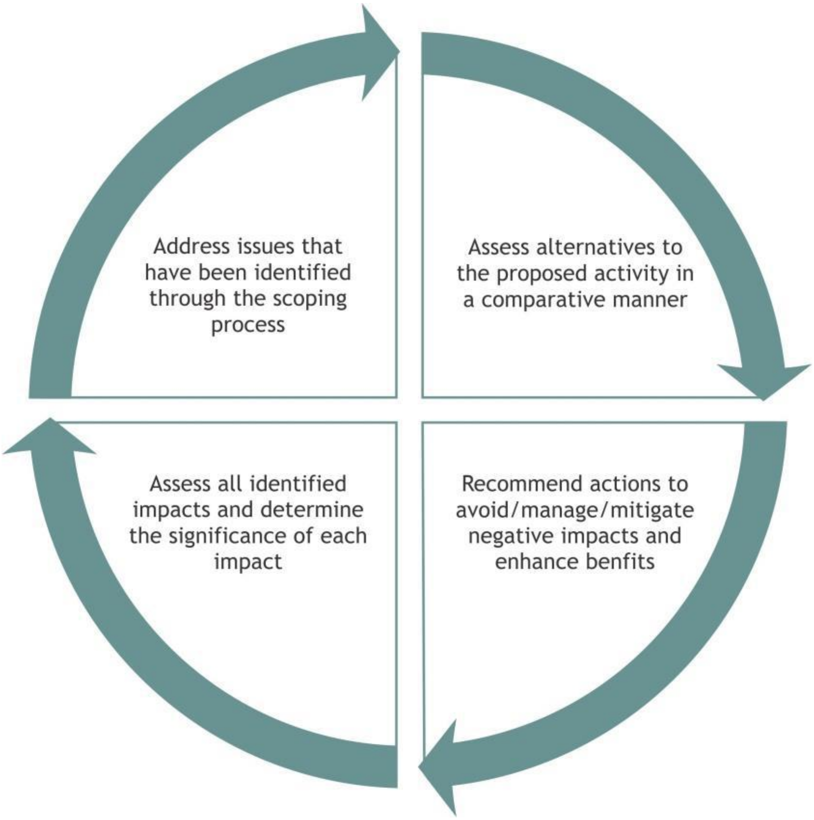


Figure 1-3: Purpose of the EIA Phase.

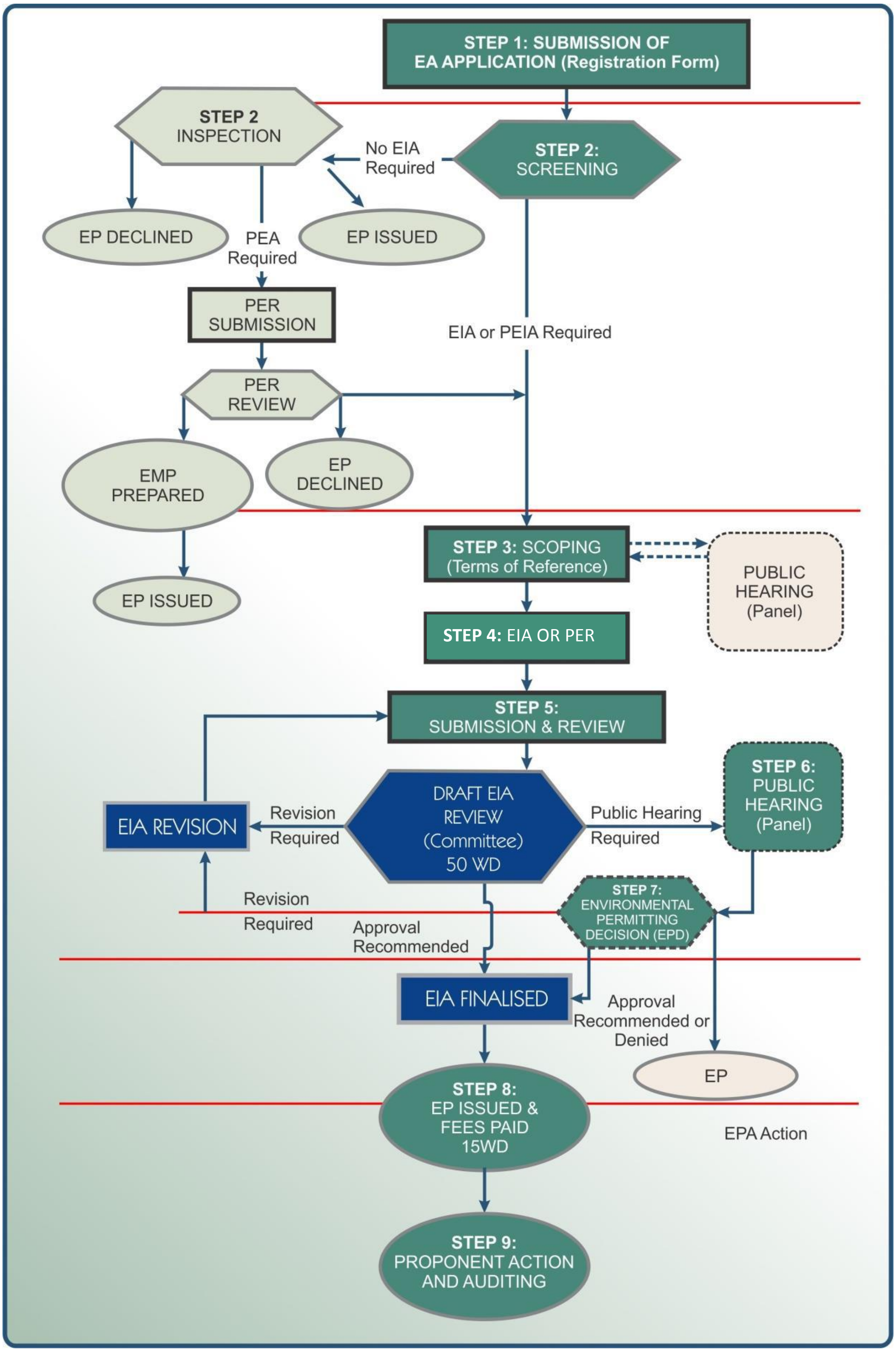


Figure 1-4: Ghana EIA Review Flow Chart

The Environmental Management Plan (EMP) that is required as part of the ESIA process is provided in Chapter 8 of this ESIA Report.

1.8 APPROACH/METHODOLOGY FOR THE ESIA STUDY

The approach and methodology adopted by the team of specialists for the study included:

- Field inspections and trekking;
- Physical & Biological Studies
- Archaeological & Heritage Impact Studies
- Aviation Impacts
- Bird Impact Studies
- Wetland Impacts
- Land use studies;
- Socio-economic studies;
- Stakeholder Consultations; and
- Review of available literature.

The TOR for the specialist studies essentially consist of the generic assessment requirements and the specific issues identified for each discipline and are summarised in Table 1-2. The detailed scope and methodology of the specialist studies, detailed impact assessments and impact statements are included in each relevant study, which are provided as Appendices to this ESIA Report as shown in Table 1-4.

Table 1-4: Specialists and Associated Specialist Studies

NAME	ORGANISATION	ROLE/STUDY TO BE UNDERTAKEN	LOCATION IN THIS ESIA REPORT
Kofi Gatu	Seljen Consult Limited	Socio-economic Impact Assessment Study	Appendix 1
Dr. James Kojo Adomako	University of Ghana	Terrestrial Ecology Impact Assessment Study	Appendix 2
Dr. Erasmus Owusu Mr Patrick Morant Dr Andrews Agyekumhene	University of Ghana CSIR Wildlife Division (Forestry Commission)	Bird Impact Assessment Study Bird Impact Assessment Study Review Bird Impact Assessment Survey and study Review	Appendix 3
Dr. Wazi Apoh	University of Ghana	Heritage Impact Assessment Study	Appendix 4
Emmanuel Hayford	Ghana Civil Aviation Authority	Aviation & Communication Impact Assessment Study	Appendix 5
Charles Amankwah	Ghana Wildlife Division	Wetland Impact Assessment Study	Appendix 6
Alex Whitehead	Sustainable Development Planning	Wetland Impact Assessment Study	Appendix 6
Nicolette von Reiche	Airshed Planning Professionals	Noise and Flicker Impact Assessment Study	Appendix 7
Scott Masson	SRK South Africa	Visual Impact Assessment Study	Appendix 8

The foremost step was to get the maximum information on physical aspects of the project, as well as construction and operation activities from the proponent. Surveys of the proposed site to be affected by the installation of the proposed wind turbines and related facilities were carried out from February 2016 – March 2017 to confirm the environmental and social issues and conditions to be affected or are likely to develop from the implementation of the project and to cover the dry/wet seasons within the project area. This involved visits by the environmental assessment team comprising group of experts to the project area and its vicinity to conduct reconnaissance survey and to collect baseline data in the context to environmental (physical and ecological) and social aspects. The survey included a focused group discussion with locals as part of information disclosure and public consultation.

The Study Team held one-on-one stakeholder consultations with key stakeholders to obtain their comments and concerns on the proposed project with respect to the potential environmental and socio-economic issues and impacts that have been addressed in the study. This included the Ada West District Assembly, District Health and Education Services, Ghana Wildlife Division, Ghana National Fire Service, Ghana Highway Authority, the Department of Urban Roads, Ghana EPA, Ghana Civil Aviation Authority, relevant Government Institutions and regulatory bodies, the project beneficiaries and engineers, local political authorities and interested and affected project persons (I&APs).

Field visits were also made to communities likely to be influenced by the construction and operations of the wind energy project, and these are Goi and Wokumagbe as well as nearby Omankope in the nearby Ningo Prampram District in the Greater Accra Region. Impacts on, inter alia, climate, topography, biodiversity, sites of archaeological, cultural and historical interest, as well as the social environment were identified by means of the site inspection, desk-top review of available information and relevant literature for the study area.

1.8.1 Information sources

The general method used in this environmental assessment for the development of the EIA Report involved an extensive review of baseline environmental data for the project area. In addition to this, field visits to the project site were also undertaken for an assessment of the existing environment. Most of the data on plant species, fauna, soils, water, geology, etc. were confirmed from interviews and existing documentations for the project area. This includes the following:

- 2014-17 Medium Term Development Plan for the Ada West District Assembly prepared within the context of the Ghana Shared Growth & Development Agenda.
- 2010 Population & Housing Census, District Analytical Report, Ada West District.
- Draft Feasibility Study for Lekpoguno/ Akplabanya Wind Farm , Lahmeyer International GmbH, 2015.
- Lekpogonu 1/2 Route Survey, Laso Transportes, 2015.
- Renewable Energy Development Programme, Ghana: Development Worksheet No. 05, September 2014.
- Renewable Energy Development Programme, Ghana: Manual for Ranking Model, June 2014.
- Renewable Energy Development Programme: 150MW Wind Power Project, Status Report, February 2015.

- Renewable Energy Development Programme: 150MW Wind Power Project, Ranking Model Manual, June 2014.
- "Anloga and Anyanui" Background Noise Level Assessment Report, March 2015.

Various technical guidelines for wind energy environmental assessments both within and outside Ghana as well as ESIA Reports for similar projects were also reviewed.

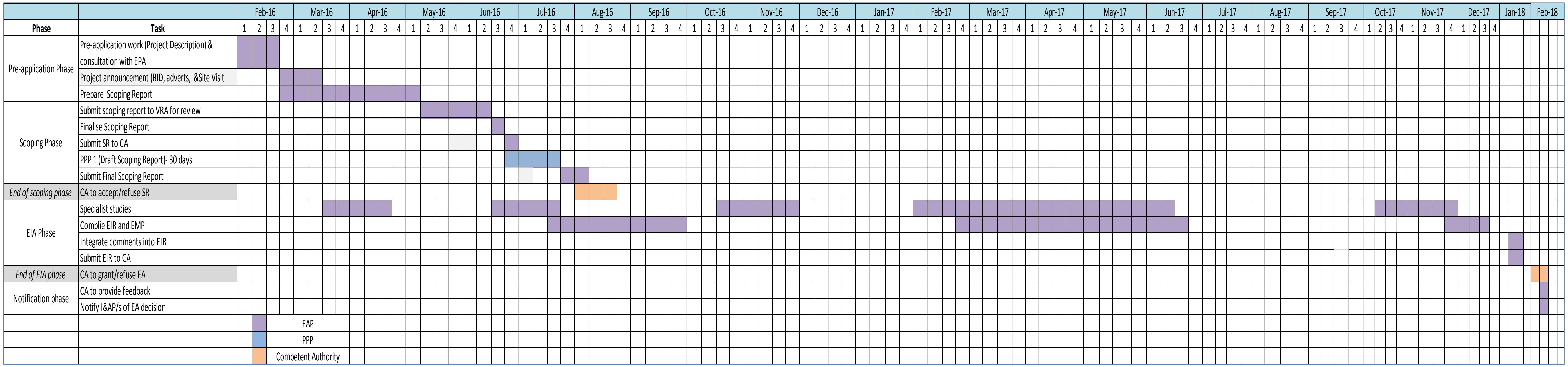
1.9 SCHEDULE FOR THE ESIA

The proposed activities and schedule for the ESIA, based on the legislated ESIA Process, is presented in Table 1-6. The key milestones for the process are summarised in Table 1-5 below. It should be noted that this schedule could be revised during the ESIA Process, depending on factors such as the time required for decisions from authorities.

Table 1-5: Key Milestones of the ESIA Process

KEY MILESTONES ACTIVITIES	PROPOSED TIMEFRAME
Submit Scoping Reports to the EPA for Decision-making.	August 2016
I&AP, Stakeholder and Authority Review of the Scoping Reports	August 2016
Review of the Scoping Reports by the EPA (i.e. accept or refuse EA):	August 2016 – September 2016
Submit Draft ESIA Reports to the EPA for Decision-making.	January 2018 (Current Stage)
Next steps: Notification to applicant	

Table 1-6: Schedule for the Proposed Project



		Feb-16				Mar-16				Apr-16				May-16				Jun-16				Jul-16				Aug-16				Sep-16				Oct-16				Nov-16				Dec-16				Jan-17				Feb-17				Mar-17				Apr-17				May-17				Jun-17				Jul-17				Aug-17				Sep-17				Oct-17				Nov-17				Dec-17				Jan-18				Feb-18			
Phase	**Task**	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4								
Pre-application Phase	Pre-application work (Project Description) & consultation with EPA	🟪	🟪	🟪																																																																																																		
	Project announcement (BID, adverts, &Site Visit				🟪	🟪	🟪																																																																																																	
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Scoping Phase	Submit scoping report to VRA for review														🟪	🟪	🟪	🟪	🟪																																																																																						
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End of scoping phase	CA to accept/refuse SR																									🟧	🟧	🟧																																																																						
EIA Phase	Specialist studies							🟪	🟪	🟪	🟪	🟪								🟪	🟪	🟪	🟪	🟪												🟪	🟪	🟪	🟪	🟪	🟪									🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪	🟪																🟪	🟪	🟪	🟪	🟪	🟪	🟪												
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Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 2:

Policy, Legislative and Administrative Requirements

CONTENTS

TABLES

2 POLICY, LEGISLATIVE AND ADMINISTRATIVE REQUIREMENTS

The VRA is committed to providing exemplary levels of care and safety for employees, the local populations and the environment in general. As such, VRA's environmental policy aims at conducting all its operations in such a manner that the safety, health and welfare of its workers and the integrity of the environment will be safeguarded at all times. To achieve these, VRA has developed corporate policies regarding environmental protection, health and safety of its workers as well as welfare of the affected population.

Key amongst them are:

- Corporate Environmental Policy Statement (2013)
- Community Development Programme (2012)
- Local Content Policy (2012)
- Corporate Social Responsibility Policy (2015)
- Corporate Health & Safety Policy (2015)
- Safety Policy Handbook (2001)
- Safety Rules & Standard Protection Code (2003)
- Safety Rules Book (2008)
- Health and Safety Training Manual (2009)
- Safety, Health & Environment Standards for Contractors (2013)
- Workplace HIV/AIDS Policy (2008)

It is the aim of this draft ESIA report to provide an overview of all legislation and international conventions/guidelines that may inform the ESIA Process in Ghana to ensure that the proposed project meets the highest possible standards of ESIA and the subsequent management policies. To that end, pertinent components of Ghana legislation and how they apply to the project are listed in this chapter. Moreover, international conventions that dictate 'best-practice' from an environmental and social impact perspective is outlined briefly along with guidelines that have thus far been developed for wind projects in the international community.

In addition to the applicable legal requirements and norms of the Government of Ghana and VRA's corporate policies, the proposed project has committed to align as far as possible with the requirements of the International Finance Company, Equator Principles and World Bank as required by international financiers. Within this context, this chapter also explains the environmental requirements of any co-financiers and identifies relevant international environmental agreements to which the country is a party.

The scope and content of this ESIA Report has been informed by the following legislation, guidelines and information series documents. It is important to note that the specialist studies included in the Appendices of this ESIA Report also include a description of the relevant applicable legislation.

2.1 INSTITUTIONAL & ADMINISTRATIVE FRAMEWORK

The governmental bodies in Ghana that will be responsible for various aspects of the proposed project are:

- Ministry of Energy
- Energy Commission
- Public Utilities and Regulatory Commission
- Volta River Authority
- Ghana Grid Company
- Electricity Company of Ghana
- Environmental Protection Agency
- Ghana Civil Aviation Authority.

The legal framework within which these institutions exist and their roles in the administration of the proposed wind power project are explained as follows:

2.1.1 Ministry of Energy

The Ministry of Energy (MOE) is responsible for formulating, monitoring and evaluating policies, programmes and projects in the power sector. It is also the institution charged with the implementation of the National Electrification Scheme (NES), which seeks to extend the reach of electricity to all communities in the long term. For achieving this, the National Energy Policy, 2010 includes a section on expansion of electricity production as well as its distribution and transmission. MOE is therefore the governmental ministry directly responsible for the project.

2.1.2 Energy Commission

With respect to oversight responsibilities of the energy sector, the ***Energy Commission Act (1997), Act 541*** established the Energy Commission and provided for its functions relating to the regulation, management, development and utilization of energy resources in Ghana; provide for the granting of licenses for the transmission, wholesale supply, distribution and sale of electricity and natural gas; refining, storage, bulk distribution, marketing and sale of petroleum products and to provide for related matters. The Commission performs these regulatory functions through elaboration and enforcement of technical rules.

Subsidiary legislations enacted under the authority of the Energy Commission Act for the proper management of the power sector of Ghana include:

- Electricity Transmission (Technical, Operational and Standards of Performance) Rules, 2008 (LI 1934).
- Electricity Supply and Distribution(Standards of Performance) Regulations,2008 (LI 1935).
- Electricity Regulations, 2008 (LI 1937).
- Electricity Supply and Distribution (Technical and Operational), 2005 (LI 1816).
- Layout-Designs (Topographies) of Integrated Circuits Act, 2004 (Act 667).
- National Electricity Grid Code, 2009.
- Renewable Energy Sub-Code for NITS connected Variable Renewable Energy Power Plants in Ghana, January 2015.
- Renewable Energy Sub-Code for Distribution Network connected Variable Renewable Energy Power Plants in Ghana, January 2015.
- Net Metering Sub-Code for Connecting Renewable Energy Generating Systems to the Distribution Network in Ghana, January 2015.

The rationale for passing the Ghana Renewable Energy Act, 2011 (Act 832) has been outlined under Section 1.3 of this report. Energy Commission is to provide technical regulation and licensing for RE electricity generation, transmission and distribution. By virtue of Section 11 of the Energy Commission Act, participation in any segment of the power sector, either for transmission, wholesale supply, distribution or sale of electricity, requires a license. A license may only be granted to (a) a citizen of Ghana, or (b) a body corporate registered under the Companies Act, 1963 (Act 179) or under any other law of Ghana, or to a partnership registered under the Incorporated Private Partnerships Act, 1962 (Act 152).

Thus, the development of the wind power project would require a license from the Energy Commission to supply and distribute electricity. Currently, VRA has obtained a provisional license from the EC for the project. Constructional license will be dependent on the project applicant receiving the Environmental Permit from the EPA.

2.1.3 Public Utilities and Regulatory Commission

The ***Public Utilities Regulatory Commission (PURC) 1997, Act*** 538 required the PURC to set up guidelines for pricing of power generated taking into consideration assurance of financial viability of power produced, investor interests and best use of natural resources. Under the PURC Act, the PURC, among other things, approves rates chargeable by public utilities, ensures competition among public utilities, monitors standards of performance of public utility service provision and ensures the protection of consumer rights. In seeking to achieve this, PURC has various legislations to support its work. This includes the Public Utilities (Termination of Service) Regulations, 1999 (L.I. 1651), the Public Utilities (Complaints Procedure) Regulations 1999 (LI 1665), the Public Utilities (Consumer Service Committee) Regulations 2002 (LI 1704A).

PURC in 1999 issued guidelines for electricity rate-setting in Ghana. It provides the key elements of electricity rate making methodology and contains the general guiding principles used as the basis for rate-setting. PURC is to provide economic regulation and setting tariffs for electricity including the Renewable Energy Feed-in-Tariff. As with all generating plants in Ghana, the PURC shall be responsible for setting prices for power generated from the wind power facility taking into consideration the generation mix at any particular time. PURC gazettes these tariffs as and when produced.

2.1.4 Volta River Authority

GoG established the Volta River Authority on April 26, 1961 under the Volta River Development Act, Act 46, as a body corporate with the mandate to operate mainly as a power generation, transmission and distribution utility. In 2005, following the promulgation of a major amendment to the VRA Act in the context of the Ghana Government Power Sector Reforms, the VRA's mandate has now been largely restricted to generation of electricity. VRA as a utility company is the developer for the proposed wind power project, and this is being done within the context of the Ghana Renewable Energy Act, 2011 (Act 832).

The following legislations are in place to assist the VRA in its power generation installations:

- ***Volta River Authority (Transmission Line Protection) Regulations, 1967 (LI 542)*** provide security for VRA Transmission Lines and ensure public safety. Define "transmission line right of way" and prohibit/restrict a number of activities in the RoW including farming, cultivation, mining and construction of buildings, which are only allowed with prior consent from the VRA.
- ***Volta River Authority (Transmission Line Protection) (Amendment) Regulation, 2004*** which provides for the right of way distances for 69 kV, 161 kV, 225kV, 330 kV transmission lines. The RoW for 225 kV and 330 kV transmission towers is 40 meters, whilst that of 69kV and 161 kV is 30 m. This regulation prohibits a number of activities in the RoW including mining, construction of buildings, and cultivation of some types of crops.

2.1.5 Ghana Grid Company

GRIDCo was established in accordance with the Energy Commission Act, 1997 (Act 541) and the Volta River Development (Amendment) Act, 2005 Act 692, which provides for the establishment and exclusive operation of the National Interconnected Transmission System

(NITS) by an independent Utility and the separation of the transmission functions of the VRA from its other activities within the framework of the Power Sector Reforms.

GRIDCo was incorporated on December 15, 2006 as a private limited liability company under the Companies Code, 1963, Act 179 and granted a certificate to commence business on December 18, 2006. The company became operational on August 1, 2008 following the transfer of the core staff and power transmission assets from VRA to GRIDCo.

The establishment of GRIDCo is intended to develop and promote competition in Ghana's wholesale power market by providing transparent, non-discriminatory and open access to the transmission grid for all the participants in the power market particularly, power generators and bulk consumers and thus bring about efficiency in power delivery. The amendment has a key function of creating the requisite environment to attract independent power producers (IPPs) onto the Ghana energy market. GRIDCo shall be responsible for the transmission component of the wind power facility, and the therefore the development of such associated infrastructure.

2.1.6 Electricity Company of Ghana

For electric power distribution, the Electricity Company of Ghana (ECG) was established by a decree ***(NLC Decree No.125)*** in 1967 and replaced the Electricity Department of the Ministry of Works and Housing. However, under the provisions of the Statutory Corporations (Conversions to Company) Act, 1993 (Act 461), ECG has since 1997 been converted into a limited liability company called Electricity Company of Ghana and is responsibility for electric power distribution is now limited to the Ashanti, Western, Central, Eastern, Greater Accra and Volta Regions. In pursuant of the Power Sector Reforms, VRA has also registered Northern Electricity Distribution Company as a wholly-owned VRA subsidiary and is responsible for distributing electricity in the Brong-Ahafo, Northern, Upper East, Upper West, and parts of Ashanti and Volta Regions of Ghana.

2.1.7 Ghana Civil Aviation Authority

The Ghana Civil Aviation Act 678, 2004 requires the Ghana Civil Aviation Authority (GCAA) to be responsible for

a) Ensuring safety of air navigation and aircraft;
b) Minimizing or preventing interference with the use or effectiveness of apparatus used in connection with air navigation and for prohibiting or regulating the use of that apparatus and display of signs and lights likely to endanger aircraft;

The Act provides for the efficient utilization of the navigable space, including the safe altitude of flights and the prevention of collision between aircraft, between aircraft and land or water, vehicles and any other objects and between aircraft airborne objects. The Ghana Civil Aviation Regulations (GCAR) part 1, LI 1818 establishes requirements for the construction of structures that may project high in the airspace for the protection navigable airspace. By the GCAA Policy, a structure is considered to have an adverse aeronautical effect if it first exceeds the obstruction standards of GCAR, and/or is found to have physical or electromagnetic radiation effect on the operation of air navigation facilities. It requires the proponent of a proposed structure to notify GCAA of their intention to erect any structure anywhere in the country and to provide the proposed height and location coordinates of the structure. If a structure is found to have a significant adverse impact, a "hazard" determination will be issued.

In accordance with GCAR Part 27, the Authority’s Safety Inspectors shall determine after conducting an aeronautical assessment that a high-rise structure is, or will not hazardous to aircraft operation, GCAA shall direct the proponent to light or mark the hazard in accordance with the Manual of Standards (MOS) – Aerodromes Advisory Circular Obstacle Marking and Lighting. GCAA is empowered to approve or refuse the erection of structures on or near an aerodrome as well as proposed future aerodrome through the issuance of an Airspace Safety Permit. If deemed necessary, GCAA in coordination with the Metropolitans, Municipals and District Assemblies (MMDAs) can order the removal of high-rise structures that is classified as an obstruction or hazardous to aircraft operations by the Authority.

Some documentations produced to guide the work of GCAA include:

- Guidelines for The Preparation of A "Plan of Construction Operations" Ghana Civil Aviation Authority, January 2009 (First Edition)
- Guidance On Lighting and Marking of Obstacles"; Ghana Civil Aviation Authority
- Evaluating Aeronautical Effects of Proposed Construction on Air Navigation & Airspace Permit Procedure, Ghana Civil Aviation Authority.
- Guidelines for the Deployment of Communications Towers, 2010

Subsequently, if a wind turbine is found to penetrate a defined airspace surrounding an airport, it will be defined as an obstacle and shall be dealt with in accordance with the requirements set out in GCAR Part 27 and that of the Manual of Standards (MOS), – Aerodromes. Ghana Civil Aviation Authority under the legislative instruments protecting civil aircraft safety also protects the interests of the Ghana Air Force (GAF) aircraft operations. This is done in coordination with GAF. VRA has subsequently applied for an Airspace Safety Permit for the project and officials of GCAA have conducted field assessments to enable them issue the permit.

2.2 OTHER NATIONAL LEGISLATION AND GUIDELINES OF RELEVANCE TO THE PROPOSED PROJECT

Other key national legislation, regulations and guidelines of relevance to the envisaged project and this ESIA report and relating to Environmental Protection, Occupational Health & Safety, Road Traffic Safety, Labour & Other Social Responsibility, Property Acquisition & Compensation, Land & Water Resource Protection and Biodiversity & Resource Protection are listed below.

2.2.1 Environmental Protection

The broad mandate for environmental protection and over-arching resources and sustainable development fall under the Environmental Protection Agency (EPA), as the Lead Regulator.

The EPA Act 490 defined environmental impact assessment as a method used to identify a project's probable impacts on the environment.

Under the EPA Act, 1994, (Act 490) and the Environmental Assessment Regulations, 1999 (LI 1652), the EPA has the mandate and power to request, assess and generate a record of decision through an environmental assessment for all developments which may be detrimental to the environment, including that in the energy sector. Proponents are to carry out environmental assessments in order to influence project design and the choice of project alternatives. Subsequently, every undertaking or project that may have an impact on the environment must register with the EPA. No licenses, permits or approvals required from other government departments relating to the project, will be issued unless a request for an EIA is complied with. Of relevance once the project is operational is that the EPA is also empowered to serve an enforcement notice on any person responsible for any project requesting him to prevent or cease any activity it considers harmful.

The EPA has issued formal guidance on regulatory requirements and the ESIA process. The following documents are relevant to the ESIA process and the project:

a) Environmental Impact Assessment Guidelines for the Energy Sector (2010), Volume 1 has been prepared to ensure the sustainable use of energy resources and also contribute towards sound environmental management in the energy sector. Volume 2 of the Guidelines provides systematic procedures on EIS preparations for the energy sector as well as guidelines on common potential impacts and mitigation measures. The implementation of the environmental assessment of WPP2, as a wind power project, has been guided by this guidelines document.

b) Environmental Assessment in Ghana, A Guide (1996) produced by the EPA provides detailed guidance on the procedures to be adhered to when undertaking an ESIA.

c) Environmental Impact Assessment Guidelines for the General Construction and Services Sector (2011), has been prepared to ensure the sustainable development of the general construction and services sector and also contribute towards sound environmental management in the general construction and services sector.

d) The EPA has published guidelines for industrial or facility effluents, air quality and noise levels. Relevant guidelines are outlined below and their permissible values would be indicated where relevant data is collected or are to be used in environmental quality monitoring.
   - *Schedule 1*: Ghana's EPA Guidelines for discharges into natural water bodies provide maximum permissible concentrations for a number of parameters. Sector specific guidelines for discharge into water bodies have also been developed.
   - *Schedule 2*: Waste Discharges into Air
   - *Schedule 3*: Ghana EPA Environmental Quality Guidelines for Ambient Air
   - *Schedule 4*: Environmental Quality Guidelines for Ambient Noise (EPA)

The EPA EIA Guidelines for the Energy Sector (Vol. 2) provides guidance on assessing the proposed project's potential environmental and social risks and impacts and addressing these through planning and mitigation. The following wind power developments are classified as mandatory for environmental impact assessment (Category C):

- All off- shore installations for wind power or farm.
- All wind farms exceeding 20 hectares.
- Wind farm exceeding a total installed capacity of 15 MW(e).
- Applicable also to all cases of retrofitting or upgrading as well as decommissioning of the stated or described plants.

Based on this legal requirement, the proposed wind power project has been subjected to an environmental assessment and permitting prior to construction leading to the prpeparation f this Draft ESIA Report. The Environmental Assessment Fees and Charges (Amendment) Instrument, 2015 LI 2228 applies for the purposes of the processing and Environmental Permit Fees charged by the EPA depending on the scale of the undertaken. VRA has so far paid various stipulated charges regarding the environmental assessments to the EPA.

The ***Pesticides Control and Management Act, 1996, Act 528*** that has been integrated into Act 490 as Part 2 was enacted to provide for the control, management and regulation of chemicals and pesticides in Ghana and to provide for related matters. It provides the EPA the powers to register and classify chemicals, to determine restricted and suspended chemicals, to license and approve dealers, and to ensure enforcement and penalties. It states that no person shall import, export, manufacture, distribute, advertise, sell or use any chemical in Ghana unless the chemical has been registered by the EPA in accordance with this Act.

2.2.2 Occupational Health & Safety

a) **Factories, Shops and Offices Act of 1970 (Act 328)** was enacted to promote and ensure the health, welfare and safety of persons employed in the country as well as the responsibilities of the employer. Under the Act, employers are required to ensure that a safe and healthy workplace is provided for the safety, health and welfare of all employees.

b) **Ghana National Fire Service Act, 1997 (537)** mandates that a Fire Certificate be required for premises used as a public place or place of work. The owner or occupier of the premises shall apply to the Chief Fire Officer for a Fire Certificate, which will be valid for 12 months from the date of issue and subject to renewal. Power facilities require a fire certificate. Subsequently, the Fire Precaution (Premises) Regulations, 2003, LI 1724 necessitates that adequate measures are taken to eradicate potential sources of fire outbreaks and that a fire certificate be acquired for any project or facility.

c) The **Control and Prevention of Bushfires Act, 1990 (PNDC Law 229)** was issued to prohibits any person from starting of bushfires which results in the uncontrolled burning of a farm, forest or grassland, and to provide for related matters. It repeals the Bush Fires Law, 1983 (P.N.D.C.L. 46).

d) **Workmen’s Compensation Law, 1986** recasts the law in relation to compensation awarded to workers for personal injuries arising out of and in the course of their employment. It governs, inter alia, the employer's liability in such cases, the distribution of compensation in the event of the worker's death (including a related schedule), degrees of partial incapacity set forth in a schedule, determination of claims, remedies against the employer and third parties, protection of compensation against attachment or assignment, payment of medical expenses and provision of medical aid, and occupational diseases (with 13 such diseases listed in an attached schedule).

The new enactment grew out of a study undertaken by the Tripartite National Advisory Committee on Labour. It repeals the Workmen's Compensation Act 1963 (No. 174) and the 1966, 1968 and 1969 amendments thereto. Statutory Instruments made under those Acts remain in force until amended, varied or revoked in accordance with the provisions of the new law.

e) **Persons with Disability Act, 2006, Act 715** Act provides for persons with disability, to establish a National Council on Persons with Disability and to provide for related matters. The law requires owners or occupiers of public structures to provide appropriate facilities to make them easily accessible by persons with disability. The Act deals with issues such as rights, employment, education, transportation, housing facilities, effective health care, adequate medical rehabilitation services, generation and dissemination of relevant information and participation of PWDs in cultural activities. Pursuant to the passage of the Disability Act 2006 (Act 715), the National Council on Persons with Disability was established in line with Article 41 of the Persons with Disability Act.

f) **The National HIV & AIDS STI Policy of 2004** and revised in Feb. 2013 has been developed to address the very serious health and developmental challenges posed by HIV/AIDS. The policy provides the framework for Ghana‘s strategy to reduce the spread of HIV infection. It provides the necessary statement of commitment around which a legislative framework will be built for an Expanded Multi-Sectorial Response to reduce further spread of the epidemic, and for the protection and support of people infected with HIV/AIDS in Ghana. Subsequently, a National HIV/AIDS Strategic Framework for Ghana has been formulated in recognition of the developmental relevance of the disease. Ghana, by this document has joined the global community in a united effort to combat the epidemic. The Strategic

Framework document is updated periodically and it provides for a Workplace HIV Policy. Ghana has now developed a National HIV/AIDS Strategic Plan 2016-20.

g) The **Ghana National Building Regulations, 1996, LI 1630** establishes a common set of baseline requirements for all structures erected in Ghana, enforce the regulations, and educate building contractors on building the safest buildings possible.

The building regulators of Ghana focus on the following:

- A builder must first apply for the proper development permits with the regulating body.
- A builder must then acquire and report on a suitable plot for development that meets the requirements of the regulations.
- Excavation of the plot must be done with accommodation for water tables, sub-soil drainage, and the surrounding environment.
- The building's design must be reviewed to ensure structural stability.
- The builder must include structural fire precautions in the design.
- Proper accommodations must be made for accessing the structure.
- The regulations enforce correct ventilation and air flow design and set up including the proper expulsion of gasses produced by heat producing appliances.
- Other regulations deal with the proper intake, usage, and disposal of water.

Within this framework, the **Ghana National Building Code, 2006** was enacted to minimise structural failures in the building construction industry, promote safety as well as ensure qualitative housing.

h) The **Ghana Seismic Code, November 1990** sets down the minimum design requirements to be met when dealing with seismic situations. It applies to among others, reinforced and pre-stressed concrete buildings for ordinary uses.

i) The **Ghana National Environmental Sanitation Policy** 2010, which was originally passed in 1999, seeks to develop a clear and nationally accepted vision of environmental sanitation as an essential social service and a major determinant for improving health and quality of life in Ghana. The policy is a necessary tool required to help shape all efforts in dealing with the overwhelming challenges of poor sanitation in Ghana.

j) The **"Health Care Waste Management Policy & Guidelines", 2006** was developed by the Ministry of Health to ensure that health care waste is managed effectively in compliance with existing laws and regulations and others to be passed in future in order to protect health care workers, their clients and the environment from potentially disease-causing waste materials. The Guidelines provide standards, procedures and processes for handling health care waste in the sector institutions and mechanisms for performance and performance monitoring.

Applicability to Project

The safety of the public as well as all workers is critical in project execution, and these legal requirements seek to ensure public safety and compensation in the event of injury. They laws seeks for projects to anticipate and avoid adverse impacts on health and safety of the affected communities during the project life from both routine and non-routine circumstances. Projects are to ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimises risks to the affected communities. Subsequently, risks associated to public health, safety and security is required to be assessed.

The tenets of the law place a large share of the burden of supporting workers injured at the workplace on the shoulders of the employers. The project and its contractors will be responsible for the health and safety of workers and the impacted communities as well as the public. The project shall be responsible for providing for the payment of compensation to workers for personal injuries caused by accidents arising out and in the course of their employment. In addition, developmental activities of the project will provide equal opportunities for all persons, including persons with disabilities and the project should not discriminate against a qualified applicant or employee because of the known disability. HIV&AIDS education for workers is key and must be adhered.

2.2.3 Road Traffic Safety

a) The **National Road Safety Commission Act, 1999 (Act 567)** established the National Road Safety Commission and provide for its functions relating to the development and promotion of road safety in the country and to provide for connected matters.

b) **The Road Traffic Acts, 2004, Act 683** deals with restrictions on road use in the interest of Road safety, registration and licensing of motor vehicles and trailers, licensing of drivers of motor vehicles, test of vehicles and issuance of road use certificates and licensing of drivers of commercial vehicles. It is supported by the Road Traffic Offences Regulations, 1974 (LI 952), which was amended by the Road Traffic (Amendment) Regulations (1995), LI 1605, and the Road Traffic (Amendment) Act 2008 (Act 761) as well as the Road Traffic Regulations, 2012, LI 2180.

c) **The Road Reservation Management: Manual for Coordination" (June 2001)** has been prepared form infrastructure and utilities to help promote coordination in the utilization of road reservation in the country.

d) **The National Road Safety Policy, 2007** was developed to underpin and validate road safety interventions that have been implemented in Ghana since 1999 till 2007. The Policy provides guideline for the design, implementation, monitoring and evaluation of national road safety programmes and activities from 2008 and beyond.

e) The **Truck Driver's Guide - Ghana, 2010** provides information on what a driver needs to know what the laws say and how the rules are implemented. This guide presents the most important information about Ghana's traffic laws and enforcement. It includes:

  - The rules for using Ghana's roads and highways
  - How customs and police officers enforce the law
  - What to do in case of an accident
  - What documents you must carry

- The new axle load rules
- Telephone numbers to call when you need help

Applicability to Project

Equipment, supplies and personnel will move in and out from the site using the access road and the Accra – Aflao NI Highway. Heavy vehicles carrying the wind turbines and necessary equipment will operate from the Tema Port and take the link road to the NI Highway for onward journey to project sites site by the dirt road which will be upgraded to take the heavy load of towers (~162 tons), rotor blades (~60 tons), turbines (Nacelle ~82 tons), machinery and equipment. These legal requirements provide guidelines for the Client and the EPC contractor to manage associated road safety issues.

2.2.4 Labour & Other Social Responsibility

a) **Labour Act 2003 (Act 651)** of 2003 consolidates and updates the various pieces of former legislation and introduces provisions to reflect International Labour Organisation (ILO) Conventions ratified by Ghana (see Section 3.5). The Labour Act covers all employers and employees except those in strategic positions such as the armed forces, police service, prisons service and the security intelligence agencies. It ensures employer and employee relationships. **The Labour Regulations, 2007 (LI 1833)** provide details regarding conditions of employment in the country.

Section 9(c) of the Act mandates an employer to take all practicable steps to ensure that the worker is safe from risk of personal injury or damage to his or her health during and in the course of the workers' health while lawfully on the employer's premises. Provisions specifically related with occupational health, safety and environment are included with the Part XV of the Labour Act. These include general health and safety conditions, exposure to imminent hazards, employer occupational accidents and diseases reporting.

The National Labour Commission in Ghana was established in 2005, under Section 135 of the Labour Act 2003 with the sole mandate to facilitate and settle industrial disputes using dialogue. Its law applies to all workers as well as employers with the exception of the Ghana Armed Forces. Police Service, Prison Service and other Security and Intelligence Agencies provided for under the Security and Intelligence Agencies Act 1996 (Act 526). Customs Excise and Preventive Service (CEPS) is also excluded by a Supreme Court decision. Its major mandate includes receiving labour-related complaints, facilitating the settlement of Industrial disputes, settling industrial disputes and promoting effective cooperation between labour and management.

b) **Children's Act No. 560 of 1998** defines a child as a person below the age of eighteen years. It is stated within the Sections 12 and 87 of the Act 560, that child must not be engaged in exploitative labour. Exploitative labour is defined by a labour depriving the child of its health, education or development.

c) **The Criminal Code, 1960 (Act 29)** provides for procedures for dealing with criminal activities in Ghana. Section 296(1) that whoever places or permits to be placed, any carrion, filth, dirt, refuse, or rubbish, or any offensive or otherwise unwholesome matter, on any street, yard, enclosure, or open space, except at such places as may be set apart by the local authority or health officer for that purpose commits a punishable offence.

d) **Commission on Human Rights and Administrative Justice Act (Act No. 456 of 1993)** establishes a Commission on Human Rights and Administrative Justice to investigate complaints of violations of fundamental human rights and freedoms, injustice and corruption, abuse of power and unfair treatment of persons by public officers in the exercise of their duties, with power to seek remedy in respect of such acts or omissions.

e) **National Vocational Training Act (Act No. 351 of 1970)** obliges all employers to provide training for their employees for the attainment of the level of competence required for the performance of their jobs and to enhance their career, according to the provisions of the National Vocational Training Act (Act 351) of 1970 and the National Vocational Training Regulations (Executive Instrument 15).

f) **Ghana Investment Promotion Centre ACT, 2013 Act 865**, is an Act that that provides for the Ghana Investment Promotion Centre as the agency of Government responsible for the encouragement and promotion of investment in Ghana. The aim is to provide for the creation of an attractive incentive framework and a transparent, predictable and facilitating environment for investment in Ghana and for related matters.

g) **The Ghana Business Code** is a set of principles introduced into the Ghanaian business environment through the initiative of three key business associations in Ghana – the Association of Ghana Industries (AGI), Ghana National Chamber of Commerce and Industry (GNCCI) and Ghana Employers Association (GEA) under the DANIDA funded project, Improving Business Practice (IBP), Sub-Component of the Business Sector Programme Support (BSPS). The GHBC is a series of prescriptions based on UN Global Compact relating to human rights, labour standards, the environment and transparency in business operations.

Applicability to Project

These legal requirements seeks to promote the fair treatment, non-discrimination and equal opportunity of workers. They aim to stablish, maintain and improve the worker management relationship and to promote compliance with national labour and employment laws. The project is therefore expected to protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the clients supply chain. In addition, the project is required to promote safe and healthy working conditions and health of workers and to avoid the use of forced labour.

2.2.5 Property Acquisition & Compensation

a) **The Constitution of Ghana** and the protection of individual property is outlined in Article 20 and this provides for the protection from deprivation of property unless such acquisition is made in the interest of defence, public safety, public order, public morality, town and country planning, or the development or utilisation of property to promote public interest.

Under the same Article 20 of the Constitution, such compulsory acquisition of property by the State should be made under a law which makes provision for prompt payment of fair and adequate compensation as well as a right of access to a High Court by any person who has interest in or right over the property for the determination of his interest or right and the amount of compensation to which he is entitled.

b) **Local Government Service Act, 2003 Act 656** was developed in accordance with the constitution and details the establishment and regulation of local government systems. The Act was created to establish and regulate the local government system in accordance with the Ghanaian constitution and outlines the stipulations and qualifications regarding local elections, provides requirements for the functioning of district assemblies and outlines the responsibility of each level of local government.

c) **Lands Commission Act, (2008), Act 767** was enacted to detail the management frameworks for public and other lands and which establishes a commission to assist and advise the government, local and traditional authorities on land related issues, usage and management concerns.

d) **New Lands Commission Act (2008) Act 76** provides for the management of public lands and other lands and for related matters. The Commission manages public lands and any other lands vested in the President by the Constitution or by any other enactment or the lands vested in the Commission. The act advises the Government, local authorities and traditional authorities on the policy framework for the development of particular areas to ensure that the development of individual pieces of land is co-ordinated with the relevant development plan for the area concerned. The commission formulate and submit to Government recommendations on national policy with respect to land use and capability; advice on, and assist in the execution of, a comprehensive programme for the registration of title to land throughout the Republic in consultation with the Title Registration Advisory Board established under section 10 of the Land Title Registration Act, 1986.

e) **State Lands (Amendment) Act (2005) Act 586** relates to compulsory acquisition in the country which has relied on State Lands Act, 1962 (Act 125) and State Lands (Amendment) 2005, Act 586. The two statutes are limited to the acquisition of private interest in real estate whiles stool lands are acquired drawing on Administration of Lands Act, 1962 (Act 123). States Lands (Act 125) also provide for lump sum of compensation payable to property owners affected by acquisition. Section 4 also spells out the procedure for making claims whiles section 11 also outlines mechanism for settlement of disputes generating from dissatisfaction of compensation.

f) The **State Lands Regulations (1962) LI 230** was passed for the purpose of inspecting and making a recommendation as to the suitability or otherwise of any land proposed to be acquired. The Regulation requires the setting up of a Site Advisory Committee for this function. After the submission of an application to acquire land, a Site Advisory Committee'' is set up in order to assess the application. The application is then assessed by the Ministry to a Land Commission, which prepare an executive instrument. Once this instrument is accepted and endorsed by the Minister, it is published in the newspapers and property owners can submit claims. The valuation board estimates the corresponding compensation. Compensation is then made to the property owners and sometimes resettlement is followed. Administration of Lands Act 1962 (Act 123) empowers the Minister responsible for lands to manage stool lands in accordance with the provision of the law.

g) **Stools Lands Act, 1994 (Act 481)** establishes the management and administrative processes applicable to Stool land and describes the appropriate distribution of any revenue accrued from stool lands.

h) **Concessions Act, 1962;** An Act to provide the provisions of the Concessions Ordinance which ceased to apply in respect of stool lands, to continue in force certain existing concessions subject to their terms and to provide for purposes connected therewith or incidental thereto.

i) **The Immovable Property Rate Regulations (1975) LI 1049** applies for the purposes of valuation of immovable property.

j) **Lands (Statutory Wayleaves) Act 1963 (Act 186)** provides for entry on any land for the purpose of the construction, installation and maintenance of works of public utility, and for the creation of rights of way for such works. The owner / occupier of the land must be formally notified at least a week in advance of the intent to enter, and be given at least 24 hours‘ notice before actual entry. An authorized person may enter at any time for the purpose of inspecting, maintaining, replacing or removing any specified works (Section 5). Any damage due to entry must be compensated in accordance with the established procedure, unless the land is restored or replaced. In the case of roads, not more than one-fifth of a plot may be taken and the remainder must be viable, or the entire plot must be taken; Section 6-3(b). The Act and its accompanying Regulation, **the Lands Statutory Wayleave Regulation 1964 (LI 334)** provides the modalities and procedures for the acquisition of the Statutory right of ways.

k) **National Museums Decree (1969) NLCD 387,** the Executive instrument (EI 42) of 1972 and the National Museums Regulation (EI 29) of 1973 provides for the management of any antiques and archaeological finds. This is the law governing the activities and operations of the Ghana Museums and Monuments Board (GMMB). Procedures to be followed on the discovery of any such artefacts are outlined in NLCD 387. Any archaeological finds during the construction activities shall be reported accordingly. Ghana ratified the World Heritage Convention in 1975. Therefore, GMMB is guided by the operational guidelines for the implementation of the World Heritage Convention.

l) **Survey Act 1962, Act 127** relates to geological, soil and land survey. Part II of the Act deals with demarcation and survey of lands. Under the law, the sector minister may appoint official surveyors and the Chief Survey Officer (Director of Surveys) may license private surveyors. It is the official surveyor or licensed surveyor that shall certify plans for attachments to instruments of conveyance, leases, assignment, charge or transfer. Under the law it is an offence to damage, destroy or alter any boundary mark.

The Act 127 with its amendments gave legal backing to the Director of Surveys to carryout cadastral and other surveys through official surveyors who work directly under him at the Survey Division of the Lands Commission. It also gave authority to the Director of Surveys to recommend from time to time experienced surveyors to the Minister responsible for Lands to be licensed to undertake surveys.

m) **Resettlement Policy Framework (RPF), 2011** document was developed in 2011 by the Ministry of Finance and Economic Planning as part of the Government of Ghana's Public-Private Partnership (PPP) programme. This programme was established to increase investment in public service delivery and infrastructure in support of the country's growing development needs. The developments and projects proposed by the PPP are likely to involve land acquisition and resettlement impacts, which are addressed by the RPF.

Applicability to Project

These legal requirements seeks to avoid, and when avoidance is not possible, minimise avoid forced eviction. It also expects to anticipate and avoid, or where avoidance is not possible, minimise adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. Projects are expected to improve, or restore, the livelihoods and standards of living of displaced persons as well as the living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites. They also seek to protect cultural heritage from the adverse impacts of project activities and support its preservation and to promote the equitable sharing of benefits from the use of cultural heritage.

Land is to be acquired under the project and this can lead to the possibility of land restrictions and economic displacement of the community members. The Project will need to adhere to the regulations previously mentioned and ensure the project is implemented according to the management structures in place in the region. This is particularly relevant if resettlement and livelihood restoration are needed. The project will need to ensure that they communicate and build relationships with the correct levels of local government in the region where the project site is located.

Although the project will take place in an area that has already been disturbed, the project will need to still take cognisance of tangible and intangible cultural heritage sites and items, including archaeological heritage within the Area of Influence. This will also need to include basic mitigation for the construction phase, such as a chance find procedure for the construction phase.

2.2.6 Land & Water Resource Protection

a) **Water Resources Commission Act, 1996, Act 552** establishes the Water Resources Commission. The mandate of the Commission is to formulate a comprehensive national policy on water resources management; to plan, coordinate and monitor water resources development, conservation and management; as well as control and regulate the utilization of Ghana’s water resources.

b) **The Water Use Regulations, 2001 (L.I. 1692),** outlines procedures for allocating permits for various water uses including domestic, commercial, municipal, industrial, agricultural, power generation, water transportation, fisheries (aquaculture), environmental, recreational, and under water (wood) harvesting. The Water Use Regulations enable the Water Resources Commission to grant rights for water use, and in the granting of these water use permits, the Commission must ensure that water allocations for various uses will be beneficial to the public interest and the greater good of society.

c) **The National Water Policy of Ghana, 2007** is intended to provide a framework for the sustainable development of Ghana’s water resources. It is targeted at all water users, water managers and practitioners, investors, decision- makers and policy makers within the central Governmental and decentralised (district assemblies) structures, non-Governmental organisations and international agencies.

d) **The National Land Policy, 1999** seeks to address some of the fundamental problems associated with land management in the country. It also aims to protect a variety of habitat types, and recognizes Forest reserves, National Parks and wildlife reserves and similar land categories including Ramsar Sites as fully protected ecosystem for biodiversity conservation. The Policy recognises wetlands as environmental conservation areas and precludes practices such as physical draining of wetland water; draining of streams and watercourses feeding the wetlands and human settlements and their related infrastructural developments in wetlands. The policy, however, seeks to promote the use of wetlands for farming, grazing, fishing, timber production and salt winning, if such uses serve to conserve the ecosystem, biodiversity and sustainable productivity of wetlands.

e) **Rivers Act, 1903 (Cap 226)** was passed to regulate the use of certain rivers and related matters. Activities considered included dredging, diverting and use of steam vessels. Inclusive in the list of rivers is the Volta River.

f) **Land Planning and Soil Conservation Act, 1957** provide for the better utilisation of land in designated areas by land planning and soil conservation and for the establishment of committees for purposes incidental to this. Government can therefore for the purposes of preserving land, reclaiming land and protecting water resources, by an executive instrument declare an area within a designated area to be a planning area.

g) **Drilling License And Groundwater Development Regulations, 2006, LI 1827** was enacted for the purpose of obtaining a drilling license from the Water Resources Commission for the construction of a well for the abstraction, or monitoring of groundwater or for research.

Applicability to Project

These legal requirements seeks to address some of the fundamental problems associated with land-use and water management and their impacts on such resources and means to ensure sustainable use of these resources in the country. They are targeted at all users, managers and practitioners, investors, decision-makers and policy makers within the central Governmental and decentralised (district assemblies) structures, non-Governmental organisations and international agencies. The policy also recognises the various cross-sectoral issues related to such uses and the links to other relevant sectoral policies such as those on sanitation, agriculture, transport, energy et cetera.

The project will have to recognise that the use of such resources would require permitting from relevant state agencies. For example, any use of underground water through abstraction will need to be regulated by the Water Resources Commission through a formal application for abstraction purposes.

2.2.7 Biodiversity Protection

a) **Wild Animals Preservation Act 1961 (Act 43)**; An Act to consolidate and amend the law relating to wild animals, birds and fish and to continue the observance of the Convention signed at London on nineteenth day of May, 1900.

b) **Wildlife Conservations Regulations, LI 685, 1971** (and Amendments), a legislative instrument for restrictions on wildlife destruction and hunting, game licencing and export of game and trophy. It provides a system of permits and certificates for regulating international trade in line with CITES regulations. It is the main instrument under which endangered species are legally protected through trade.

c) **Wildlife Reserves Regulations 1971 (LI 710**) empowers the government to establish wildlife Protected Areas, including Ramsar Sites (and Marine Protected Areas) and defines permissible and non-permissible activities within the Protected Area.

d) **Economic Plants Protection Act, 1979**; An Act to provide for the prohibition of the destruction of specified plants of economic value and for related matters.

e) **Biodiversity Strategies and Action Plan, 1998**, is an action plan to ensure sustainable use of the country's biological resources as enshrined in the Convention on Biological Diversity.

f) **National Biodiversity Strategy for Ghana, 2002**; The Strategy document seeks to ensure sustainable utilization of the country’s biological resources and the need to integrate biodiversity issues into national development planning programmes. Some of the actions that have been identified include capacity building to ensure an in-depth assessment of biological resources, promotion of community participation in sustainable management of biodiversity and the strengthening of the management of forests and protected areas as well as other off reserve biological resources.

g) **National Wildlife Management Policy, 2006:** The Policy seeks to give a more proactive, pragmatic and comprehensive framework to guide and determine government actions towards wildfire management. The policy is also to ensure consistency in formulation of legislation and bye-laws at all levels of governance to deal with the issues of wildfires in the country. In addition, by developing a national policy on wildfire, Ghana will be addressing global concerns for environmental quality management, and minimise risks from climate change.

h) **Fisheries Act, 2002 (Act 625)** that provides for the regulation and management of fisheries, the development of the fishing industry, and the sustainable exploitation of fishery resources.

i) **Wetland Management (Ramsar Site) Regulations 1999 (LI 1659)** regulates management of Ramsar Sites also defines wetland areas of environmental sensitivity and permissible and non-permissible activities within designated Ramsar site or wetlands of International Importance. The following areas the particulars of which are set out in the Schedule to these Regulations are hereby designed as Ramsar Sites: Muni-Pomadze; Densu Delta; Sakumo; Songor; Keta Lagoon Complex and; Owabi Wildlife Sanctuary; A District Assembly where a Ramsar Site is located may in consultation with the Minister by bye-law prescribes custody and traditional conservation practices which are compatible with the Ramsar Convention and permitted under these Regulations.

j) **Forest and Wildlife Policy, 2012** aims at the conservation and sustainable development of forest and wildlife resources for the maintenance of environmental stability and continuous flow of optimum benefits from the socio-cultural and economic goods and services that the forest environment provides to the present and future generations whilst fulfilling Ghana’s commitments under international agreements and conventions. This **policy** replaces **Ghana’s** first **forest** and wildlife **policy** formulated in 1994 which resulted in the merging of sector institutions into a corporate Forestry Commission and also introduced reforms to improve the **forest** and wildlife base.

k) **Wildlife Division Policy for Collaborative Community Based Wildlife Management, September 2000** aims to enable the devolution of management authority to defined user communities and encourage the participation of other stakeholders, to ensure the conservation and sustainable use of the nation’s wildlife for the maintenance of environmental quality and a perpetual flow of optimum benefits to all segments of society. It was prepared based on national convictions, current national policies and Ghana’s commitment to international conventions and guidelines. This policy seeks to incorporate where appropriate new ideas and approaches involving communities in wildlife management. In this respect, this policy recognises Ghana’s commitment under Articles 6, 10 and 11 of the Convention on Biological Diversity and the principles outlined in World Conservation Strategy.

Applicability to Project

Biodiversity provides tangible benefits for human health. Preserving intact ecosystems and their native biodiversity can sometimes reduce disease transmission by changing the abundance, behavior, and condition of the host or vector. These regulations turns to provide the legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities to ensure the protection and conservation of such biodiversity. They provide strategy for sustainable utilization of the country's biological resources and the need to integrate biodiversity issues into national development planning programmes.

The project installation process may affect some biodiversity. A review of available information and a preliminary site investigation indicated that the two project areas fall within an area of the Ghanaian coast characterized by extensive lagoons, estuarine habitat and freshwater wetlands, the most prominent being the Songhor Lagoon, a RAMSAR site. The lagoon and associated habitats support a diverse range of fauna and flora, but are known specifically for their importance for migratory birds. The potential issues of concern identified include the impact on birds/bats during the construction and operation phase of the project as well as the removal of natural vegetation containing threatened, protected and endemic species such as mangroves. Hence, any activity that would be undertaken would need to ensure that such species are not negatively impacted.

2.3 INTERNATIONAL INSTRUMENTS AND COMMITMENTS

2.3.1 World Bank International Finance Corporation (IFC)

The World Bank is an international institution, which provides financial and technical assistance to developing countries around the world. It is made up of two distinct development-related institutions owned by over 100 member countries; these are the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA), with affiliations in the International Finance Corporation (IFC). The IFC is a global investor and advisor and is committed to promoting sustainable projects in developing member countries that are economically beneficial, financially and commercially sound, and environmentally and socially sustainable.

IFC Performance Standards

To manage the social and environmental risks and impacts of IFC projects, the IFC has developed a number of environmental and social performance standards (PS). The IFC PS indicate that the party responsible for implementing and operating the project must comply with the applicable national laws, including those laws implementing host country obligations under international law. The project operator is also required to meet the requirements of the standards throughout the life of an investment by IFC or other relevant financial institution.

These are as follows:

- *Performance Standard 1*: Assessment and Management of Environmental and Social Risks and Impacts
- *Performance Standard 2*: Labour and Working Conditions
- *Performance Standard 3*: Resource Efficiency and Pollution Prevention
- *Performance Standard 4*: Community Health, Safety, and Security
- *Performance Standard 5*: Land Acquisition and Involuntary Resettlement
- *Performance Standard 6*: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- *Performance Standard 7*: Indigenous Peoples
- *Performance Standard 8*: Cultural Heritage

All the above Performance Standards are applicable for this Project other than PS 7 - Indigenous Peoples.

The IFC produces a number of Guidance Notes and other reference documents providing advice on undertaking ESIA. Specific guidance is contained in the Guidance Notes to the WB/IFC Performance Standards. The IFC's set of Guidance Notes provide guidance on the requirements contained in the WB/IFC Performance Standards, including reference materials on good sustainability practices to improve project performance. Those of relevance to this project include:

- Guidance Note A - Checklist of potential issues for an Environmental Assessment.
- Guidance Note B - Content of an ESIA Report
- Guidance Note C - Outline of an Environmental Action Plan.

The following IFC handbooks are also relevant to the Project:

a) *Stakeholder Engagement*: A Good Practice Handbook for Companies Doing Business in Emerging Markets.
b) *Strategic Community Investment*: A Good Practice Handbook for Companies Doing Business in Emerging Markets.
c) *Good Practice Handbook* - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets.
d) *Good Practice Note*: Addressing Grievances from Project-Affected Communities.

World Bank Group Operational Policies

The World Bank projects and activities are governed by Operational Policies, which are designed to ensure that the projects are economically, financially, socially and environmentally sound. The Bank's Operational Manual details these policies, and provides guidance on how to comply with them ("Bank Procedures" and "Good Practices"). The policies/procedures are to ensure the safe development of projects it is funding. That is to prevent and mitigate unintended adverse effects on third parties and the environment in the development process. The policies of relevance to this project are the safeguard policies.

The World Bank's Environmental & Social Safeguards Policies covering ten (10) key categories in the form of Operational Policies (OPs) are operationalised when triggered by the proposed project's scope. These policies, which include the Environmental Assessment policy, are designed to prevent unintended adverse effects on third parties and the environment (refer to Table 2-1).

Table 2-1: World Bank's Environmental & Social Safeguards Policies

OP	SAFEGUARD	REVISION DATE
OP 4.01	Environmental Assessment (Jan 1999)	April 2013
OP 4.04	Natural Habitats (June 2001)	April 2013
OP 4.09	Pest Management (December 1998)	
OP 4.10	Indigenous Peoples (July 2005)	April 2013
OP 4.11	Physical Cultural Resources (July 2006)	April 2013
OP 4.12	Involuntary Resettlement (December 2001)	April 2013
OP 4.36	Forests (November 2002)	April 2013
OP 4.37	Safety of Dams (October 2001)	April 2013
OP 7.50	Projects on International Waterways (June 2001)	March 2012
OP 7.60	Projects in Disputed Areas (June 2001)	March 2012

***(Source:** http://web.worldbank.org)*

World Bank Policy on Access to Information took effect from July 2013, and has since June 30, 2015 been revised. The Policy governs the public accessibility of information in the Bank's possession and describes how the World Bank makes information available to the public. Underlying the new policy is the principle that the World Bank will disclose any information in its possession that is not on a list of exceptions. The Access to Information Policy is based on the following five principles: 1) maximizing access to information; 2) setting out a clear list of exceptions; 3) safeguarding then deliberative process; 4) providing clear procedures for making information available; and 5) recognizing requesters' right to an appeals process.

The following operationally policies are relevant to this project:

OP	SAFEGUARD	REVISION DATE
OP 4.01	Environmental Assessment (Jan 1999)	April 2013
OP 4.04	Natural Habitats (June 2001)	April 2013
OP 4.09	Pest Management (December 1998)	
OP 4.11	Physical Cultural Resources (July 2006)	April 2013
OP 4.12	Involuntary Resettlement (December 2001)	April 2013
OP 4.36	Forests (November 2002)	April 2013
OP 7.60	Projects in Disputed Areas (June 2001)	March 2012

Where possible, the ESIA has follows national best practice and has followed the OP 4.01 on contents of the Environmental Assessment as far as possible. Specialists were contracted to conduct specialist studies which have assessed an element of the impacts regarding natural habitat, cultural resources and there has been a Compensation Action Plan by VRA to address the issue of possible removal of community members on land for the project. Throughout the project there have been a number of stakeholder engagements sessions to ensure transparency of the project.

World Bank Group EHS Guidelines

The EHS Guidelines produced by the World Bank Group are technical reference documents on cross-cutting environmental, health, and safety issues applicable to all industry sectors. They cover general and industry-specific examples of Good International Industry Practice, as defined in IFC's Performance Standard 3 on Resource efficiency and pollution prevention.

The General EHS Guidelines (April 2007) contain the performance levels and measures that are normally acceptable to the IFC and are generally considered to be achievable in new facilities at reasonable costs by existing technology.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

Resettlement

There are no physical settlements located directly on the land required for the project and therefore it is anticipated that there will be no physical displacement. However, transportation of project materials and equipment could result in the removal of certain physical structures and people along the target roads. The land is being used for agricultural purposes and there will therefore be some economic displacement.

The following documents from the World Bank Group Policies and Guidelines are therefore relevant to this project and will be considered by VRA:

a) The Operational Policy 4.12 Involuntary Resettlement issued on December 2001,
b) The IFC Performance Standard 5: Land Acquisition and Involuntary Resettlement
c) The IFC Guidance Note 5: Land Acquisition and Involuntary Resettlement which was lastly issued in 2007 but revised and updated in January 2012,
d) IFC's Handbook on Preparing a Resettlement Action Plan.

The main objective of these documents is to ensure that potential adverse impacts on the community are mitigated through planning and undertaking appropriate measures and that people displaced as a result of a specific project financed by the World Bank Group receive benefits from the project. Considering these core issues, the following policy objectives of OP 4.12 are taken into account:

a) Involuntary resettlement should be avoided when feasible, or minimized, exploring all viable alternative project designs.
b) Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in project benefits. Displaced persons should be meaningfully consulted and should have opportunities to participate in the planning and implementing of resettlement programs.
c) Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher." (WB, OP 4.12, p.1)

In agreement with these principles, the proposed wind power project was located such as to avoid involuntary resettlement. As mentioned above, local people would only be subjected to economic displacement as a result of the transport of components associated with the proposed project. Impacts associated with the displacement of people have been addressed in the relevant sections of the Report (refer to Chapter 6) and a separate Compensation Action Plan Report to be prepared to guide compensation payment.

2.3.2 Equator Principles

The Equator Principles, revised in June 2013, are a set of voluntary principles for financial institutions to ensure that the projects financed are developed in an environmentally and socially responsible manner. The principles are based on the IFC PS on social and environmental sustainability and on the World Bank Group EHS Guidelines, and are relevant for the purposes of this Project as they represent industry best practice (see Table 2-2). The financial institutions that have signed up the Equator Principles are called Equator Principle Financial Institutions (EPFIs) and the principles are intended to serve as a common baseline and framework for the implementation by each EPFI. The Principles apply to all new EPFI project financings globally with total project capital costs of US$10 million or more, and across all industry sectors.

Table 2-2: Summary of Equator Principles

PRINCIPLE	DESCRIPTION
Principle 1: Review and Categorisation	Relates to the categorisation of projects based on the magnitude of its potential impacts and risks in accordance with the environmental and social screening criteria of the IFC.
Principle 2: Social and Environmental Assessment	Requires a Social and Environmental Assessment. The Assessment should propose mitigation and management measures relevant and appropriate to the nature and scale of the Project.
Principle 3: Applicable Social and Environmental Standards	Establishes the IFC PS and EHS Guidelines to complement the host country legislation as the basis for social and environmental performance.
Principle 4: Action Plan and Management System	Requires preparation of an Action Plan which should describe and prioritise the actions needed to implement mitigation measures, corrective actions and monitoring measures.
Principle 5: Consultation and Disclosure	Requires consultation with project affected communities in a structured and culturally appropriate manner, ensuring free, prior and informed consultation and facilitate informed participation.
Principle 6: Grievance Mechanism	Requires the establishment of a grievance mechanism as part of the management system which addresses concerns promptly and transparently, in a culturally appropriate manner, and is readily accessible to all segments of the affected communities.
Principle 7: Independent Review	Requires an independent social or environmental review of the Assessment.
Principle 8: Covenants	Requires compliance with all relevant host country social and environmental laws, regulations and permits, Action Plan implementation commitments, periodic reviews of reports, and facility decommissioning in accordance with an agreed decommissioning plan.
Principle 9: Independent Monitoring and Reporting	Requires ongoing monitoring and reporting over the life of the loan through the appointment of an independent environmental and / or social expert.
Principle 10: EPFI Reporting	Commits the EPFIs to report publicly at least annually about its Equator Principles implementation processes and experience, taking into account appropriate confidentiality considerations.

In accordance to the Equator Principles, potential social and environmental issues to be addressed in Social and Environmental Assessments where applicable include the following:

- Assessment of the baseline social and environmental conditions;
- Consideration of the feasible environmentally and socially preferable alternatives;

- Requirement under the host country laws and regulations, applicable international
- treaties and agreements;
- Protection of human rights and community health, safety and security (including risks, impacts and management of project's use of security personnel);
- Protection of cultural property and heritage;
- Protection and conservation of biodiversity, including endangered species and sensitive ecosystems in modified, natural and critical habitats, and identification of legally protected areas;
- Sustainable management and use of renewable natural resources (including sustainable resource management through appropriate independent certification systems);
- Use and management of dangerous substances;
- Major hazards assessment and management;
- Labour issues and occupational health and safety;
- Socio-economic impacts;
- Fire prevention and life safety;
- Land acquisition and involuntary resettlement;
- Impacts on affected communities, and disadvantaged or vulnerable groups;
- Impacts on indigenous peoples, and their unique cultural systems and values;
- Cumulative impacts of existing projects, the proposed project, and anticipated future projects;
- Consultation and participation if affected parties in the design, review and implementation of the project;
- Efficient production, delivery and use of energy; and
- Pollution and prevention and waste minimisation, pollution controls (liquid effluents and air emissions) and solid and chemical waste management.

2.3.3 Organisation for Economic Corporation & Development

The Organisation for Economic Corporation & development (OECD) recommends that Members, before taking decisions on officially supported export credits, apply the "Common

Approaches" for addressing environmental and social issues relating to exports of capital goods and/or services and the locations to which these are destined.

Under "The Common Approaches", the proposed WPP2 falls under the Category A listed projects requiring ESIAs, as it is located near the Songor Lagoon Complex Ramsar Site. ESIAs are to be undertaken for "*Projects which are planned to be carried out in sensitive locations or are likely to have a perceptible impact on such locations, even if the project category does not appear in the above list. Such sensitive locations include National Parks and other protected areas identified by national or international law, and other sensitive locations of international, national or regional importance, such as wetlands, forests with high biodiversity value, areas of archaeological or cultural significance, and areas of importance for indigenous peoples or other vulnerable groups*".

The defined safeguard instruments under the Common Approaches that needs to be adhered to are the "World Bank Safeguard Policies" and "IFC Performance Standards" and these have been discussed in detail in previous sections in this report.

2.3.4 Industry Specific Guidelines

Specific industry Sector EHS guidelines relevant to the Project are:

a) Environmental, Health, and Safety Guidelines for Wind Energy (April 2007);
b) Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution (April 2007);
c) Environmental, Health and Safety Guidelines for Waste Management Facilities (December 2007)
d) Environmental, Health, and Safety Guidelines for Water and Sanitation, (December 2007)

The EHS Guidelines for wind energy include information relevant to environmental, health, and safety aspects of onshore and offshore wind energy facilities. Construction activities for wind energy projects typically include land clearing for site preparation and access routes; excavation, blasting, and filling; transportation of supply materials and fuels; construction of foundations involving excavations and placement of concrete; operating cranes for unloading and installation of equipment; and commissioning of new equipment. Decommissioning activities may include removal of project infrastructure and site rehabilitation.

Environmental issues associated with the construction and decommissioning activities may include, among others, noise and vibration, soil erosion, and threats to biodiversity, including habitat alteration and impacts to wildlife. Due to the typically remote location of wind energy conversion facilities, the transport of equipment and materials during construction and decommissioning may present logistical challenges.

Environmental issues specific to the operation of wind energy projects and facilities include the following:

a) Visual impacts
b) Noise
c) Species mortality or injury and disturbance
d) Light and illumination issues
e) Habitat alteration
f) Water quality
g) Electric Power Transmission and Distribution

The EHS Guidelines for Electric Power Transmission and Distribution include information relevant to power transmission between a generation facility and a substation located within an electricity grid, in addition to power distribution from a substation to consumers located in residential, commercial, and industrial areas. Examples of the impacts addressed in the General EHS Guidelines include:

a) Construction site waste generation;
b) Soil erosion and sediment control from materials sourcing areas and site preparation activities;
c) Fugitive dust and other emissions (e.g. from vehicle traffic, land clearing activities, and materials stockpiles);
d) Noise from heavy equipment and truck traffic;

e) Potential for hazardous materials and oil spills associated with heavy equipment operation and fuelling activities.

Environmental issues during the construction phase of power transmission and distribution projects specific to this industry sector include the following:

a) Terrestrial habitat alteration.
b) Aquatic habitat alteration.
c) Electric and magnetic fields.
d) Hazardous materials.

2.3.5 International Protocols & Conventions

In addition to national policies and laws, there are also statutory provisions with broad requirements for conservation and protection of certain species and habitats and prevention of pollution emanating from international conventions and agreements. The Republic of Ghana is a signatory to a number of international conventions on environmental protection and conservation as shown in *Table 2*-3, and those relevant to this project described in the subsequent sections:

Table 2-3: Treaties & Conventions

TREATIES AND CONVENTIONS	YEAR RATIFIED
African Convention on the Conservation of Nature and Natural Resources	1968
African Charter on Human and Peoples’ Rights	1989
Convention on Biological Diversity	1992
The Convention on Wetlands of International Importance Especially Waterfowl Habitat (RAMSAR Convention)	1971
The Convention Concerning the Protection of World Cultural and Natural Heritage	1972
The Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matters, London	1972
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington	1973
International Convention on Civil Liability for Oil Pollution Damage	1969
International Convention for the Conservation of Atlantic Tunas	1966
The United National Convention on Law of the Sea, Montego Bay	1982

TREATIES AND CONVENTIONS	YEAR RATIFIED
The Convention on the Prevention of Marine Pollution from Ships (MARPOL)	1973
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Intervention Convention)	1969
Convention on the International Regulations for Preventing Collisions at Sea (COLREGs)	1972
International Convention for the Safety of Life at Sea (SOLAS)	1974
Convention on Limitation of Liability for Maritime Claims (LLMC)	1976
International Convention on Standards of Training, Certification, and Watch keeping for Seafarers (STCW)	1978
International Convention of Oil Preparedness, Response and Co-operation (ORPC)	1990
International Convention on Civil Liability for Oil Pollution Damage	1969
International Convention on the Establishment of an International Fund for Compensation of Oil Pollution Damage	1971
International Covenant on Civil and Political Rights	2000
Montreal Protocol on Substances that Deplete the Ozone Layer	1993
International Covenant on Economic, Social and Cultural Rights	2000
Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movements of Hazardous Wastes within Africa	1990
The Vienna Convention on the Protection of Ozone Layer	1993
The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	2003
International Convention for the Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region-the Abidjan Convention	1981

African Convention on the Conservation of Nature and Natural Resources ("African Convention")

The African Convention on the Conservation of Nature and Natural Resources reaffirms the importance of natural resources both renewable and non-renewable, particularly the soil, water, flora and fauna. The main objective is to facilitate sustainable use the above resources. The above Convention was adopted in Algiers on 15th September, 1968 and came into force on 16th June 1969.

The convention was signed by Ghana in 1968. It obligates signatories to: "manage aquatic environments, whether in fresh, brackish, or coastal water, with a view to minimizing deleterious effects of any water and land use practice which might adversely affect aquatic habitats." (Art. VII, Sect. la).

"In the formulation of all development plans, full consideration shall be given to ecological, as well as economic and social factors." (Art. XIX, Sect. 3). "The Contracting States recognize that it is important and urgent to accord a special protection to those animal and plant species that are threatened with extinction, or which may become so, and to the habitat necessary to their survival." (Art. VIII, Sect. 1).

Convention on the Conservation of Migratory Species of Wild Animals ("Bonn Convention")

The convention was signed by Ghana in 1988. "The Parties acknowledge the need to take action to avoid and migratory species becoming endangered." (Art.I1, Sect.2). "Parties that are Range States of a migratory species listed in Appendix I [endangered] shall endeavor: (a) to conserve and where feasible and appropriate, restore those habitats of the species which are of importance in removing the species from danger of extinction." (Art. III, Sect. 4).

Ramsar Convention, 1971 (formerly Wetlands of International Importance, especially Waterfowl Habitats)

The Convention on Wetlands of International Importance as Waterfowl Habitats is also referred to as Ramsar Convention. Its main objective is to promote conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world. The Convention defines wetlands as areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

Member countries are to designate suitable wetlands within its territory for inclusion in a List of Wetlands of International Importance, hereinafter referred to as "the List" which is maintained by the bureau established under Article 8. The boundaries of each wetland shall be precisely described and also delimited on a map and they may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands, especially where these have importance as waterfowl habitat. The convention was signed by Ghana on March 1981 and ratified by Ghana on July 1989.

Ghana's coastal wetlands form an ecologically important unit, providing feeding, roosting and nesting sites for thousands of migratory and resident birds. Bight of the coastal wetlands: Keta lagoon, Songor lagoon, Sakumo lagoon, Kor1e lagoon, Densu delta, Huni lagoon, B1mins Salt Pans and Busia beach, qualify as internationally important wetlands under the Ramsar* criteria of supporting 20,000 waterfow1s or 1% of the population of a waterfowl species. Keta and songor each holds over 100,000 seashore birds, and supports internationally important numbers of seven species of waders. Sakumo, Densu delta, Kor1e and Huni each holds 23,000 -35,000 birds and supports internationally important populations of up to 6 wader species.

The Ghana coast is also important for marine turtles, providing nesting grounds for at least three species of turtles, all of which are listed in the IUCN Red Data list of Threatened\ Animals. Coastal wetlands provide nutrient rich habitats which are used for spawning and as nursery grounds by many species of fish. These wetlands therefore form a vital link for the survival of Ghana's declining marine fishery resource.

More importantly, Ghana's coastal wetlands provide resources such as, shell, salt, thatch and wood, which are major sources of income and play a significant role in the socio-economic and cultural life of the coastal communities. All the important coastal wetlands are threatened by pollution from both solid and liquid wastes from domestic and industrial sources and/or proposed urban/industrial developments. All the wetlands are situated in densely populated areas, and as human population in the country increases, the demands for wetland resources and the threats.

United Nations Convention on Biological Diversity

The three goals of the Convention are to promote the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources. Ghana being a signatory of this convention, it is supposed to work towards the achievement of the three goals. The convention calls for the adoption of national strategies, plans and programmes for the conservation and sustainable use of biological diversity into their relevant sectoral and cross-sectional plans, programmes and policies. One of the tools that are prescribed for the management of biodiversity is environmental assessment. Article 14 of the convention deals with impact assessment and minimization of adverse impacts. The convention was signed by Ghana on June 1992 and ratified on 1994.

As indicated, the WPP2 is to be located close to the Songor Wetlands, an environmentally sensitive area designated as a Ramsar Site, and comprising of a large expanse of open lagoon, floodplain, marsh land and extensive mangrove stands, stretching for about 40 km along the coast, was also noted. There is therefore the likelihood of possible impact on marine and wetland’s biodiversity during construction and operation of the project.

United Nations Framework Convention on Climate Change

The primary purpose of the Convention is to establish methods to minimize global warming and in particular the emission of the greenhouse gases (GHG). The United Nations Framework Convention on Climate Change (UNFCCC) was adopted on 9th May 1992and came into force on 21st March 1994. The Convention has been ratified by 189 states. The UNFCCC provides the basis for global action to protect the climate system for present and future generations. The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 189 countries having ratified.

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. Under the Convention, governments:

a) Gather and share information on greenhouse gas emissions, national policies and best practices.
b) Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and
c) Cooperate in preparing for adaptation to the impacts of climate change.

Ghana became a party to the United Nations Framework Convention on Climate Change (UNFCCC, hereinafter referred to as the Convention) after ratification in September 1995. Upon ratification, Ghana had committed itself to pursue coordinated actions to reduce greenhouse gas (GHG) emissions and climate change impacts on the most vulnerable people, while continuing to advance national economic development. As a party to the Convention, Ghana has an obligation under Article 4, paragraph 1, and Article 12, paragraph 1 of the Convention to regularly prepare, publish and report its national communication to the Conference of Parties (COP) to the UNFCCC.

In 2000 and 2011, the country submitted its first and second national communications respectively to the Conference of Parties (COP) to the UNFCCC. The Third National Communication (TNC) is prepared in compliance consistent with Ghana's obligations under the Convention. The main objective of the TNC was to prepare, update and communicate to the COP, policies and measures Ghana has taken and envisaged to implement the convention in the country and at the regional level. Components being reported on include Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use and Waste.
Ghana intends to Increase the contribution of RE source (including hydro, solar, biomass and wind) by 10% for grid, mini grid and off-grid applications; by 2020, thus the development of the wind power projects is one of the proposed carbon offsets projects in Ghana.

Kyoto Protocol

UNFCC has been identified as only the initial step in the international response to climate change. Climate prediction models showed that greater reductions in emissions will be needed to prevent serious interference with the climate. The Kyoto Protocol to the United Nations Framework Convention on Climate Change [5], agreed in December 1997, was designed to address this issue. The Protocol has since been ratified by over 150 countries, including Ghana, and entered into force (becoming legally binding) on 16th February 2005.

The 1997 Kyoto Protocol shares the Convention's objective, principles and institutions, but significantly strengthens the Convention by committing developed countries to individual, legally-binding targets to limit or reduce their overall greenhouse gas emissions (of carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, perfluorocarbons and sulphur hexafluoride). Developing countries are not required to reduce emissions of greenhouse gases to specific targets as yet on the basis that it is industrialised countries that produce most of the emissions and more urgently need to take corrective action.

Developing countries were asked to contribute as far as possible, but were not bound to take action, under the principle of 'shared but differentiated responsibility'. The Kyoto Protocol sets out how developing countries must monitor and report on their greenhouse gas emissions. There are also agreements on how the international community must help developing countries adapt to the impacts of climate change.

Developed countries must put in place domestic policies and measures to help mitigate climate change and promote sustainable development. A key mechanism is the Clean Development Mechanism (CDM) under Article 12 of the Kyoto Protocol. The Kyoto Protocol provisions allow for the use of the clean development mechanism (CDM), under which, beginning in 2000, greenhouse gas emissions from projects in non–Annex I countries that are certified by designated operating entities can be acquired by Annex I countries and credited against their emissions binding commitments. The CDM allows Annex I Parties to implement project activities that reduce emissions and contribute to sustainable development in non-Annex I Countries while claiming the resulting emissions reductions for themselves.

The availability of CDM financing may alter, in some cases, the choice of the least-cost project alternative.

Currently, VRA has initiated a Carbon Accounting Programme, with assistance from the Ghana EPA, and from 2016, will be reporting annually on its carbon emissions for the generating plants as well as carbon offsets projects.

Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan Convention).

This Convention was signed by Ghana on March 1981 and ratified on July 1989. The convention covers the marine environment, coastal zones and related inland waters falling within the jurisdiction of the States of the West and Central African Region, from Mauritania to Namibia inclusive, which have become Contracting Parties to this Convention under conditions set forth in article 27 and paragraph 1 of article 28 (hereinafter referred to as the Convention area).

The Contracting Parties shall, individually or jointly as the case may be, take all appropriate measures in accordance with the provisions of this Convention and its protocols in force to which they are parties to prevent, reduce, combat and control pollution of the Convention area and to ensure sound environmental management of natural resources, using for this purpose the best practicable means at their disposal, and in accordance with their capabilities.

As noted above, other Acts, standards and/or guidelines which may also be applicable have been reviewed in more detail as part of the specialist studies (Refer to Appendices 1 to 10 of this ESIA Report).

Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 3:

Project Description and Alternatives

CONTENTS

TABLES

FIGURES

3 PROJECT DESCRIPTION

This chapter provides an overview of the conceptual project design as well as a description of the alternatives considered, as required by the Ghanaian EIA Regulations LI 1652 of 1999. This includes details on the proposed preferred and alternative layout, technology, site, and location within the project site.

The purpose of this chapter is to present sufficient project information to inform the ESIA Process in terms of design parameters applicable to the project. It is important to note at the outset that the exact specifications of the proposed project components will be determined during the detailed engineering phase (subsequent to the issuing of an environmental permit). Specialist assessments were based on the project specifications presented in this Chapter.

3.1 SITE LOCATION

The proposed 76.5 MW Wind Power Project 2 (WPP2) is located in the Wokumagbe and Goi communities in the Ada West District of the Greater Accra Region. The predominant land use associated with the study area is agriculture, in particular subsistence farming. The Songoor Lagoon is also one of the main features of the area. VRA is in the process of acquiring and reaching land agreements with the relevant landowners to enable the development and operation of the proposed Wind Energy Facility.

The regional location of WPP 2 is shown in Figure 3.1 and the geographical coordinates for the proposed layouts are provided in Table 3.1. The detailed micro-siting of the turbines will be continued during the ESIA process and taking into account the findings of the ESIA. WPP2 will cover an area of approximately 169.98 ha (refer to Table 3.2) for the preferred layout and 186.08 ha for the alternative layout.

Figure 3-1: **Proposed new project location**

Table 3-1: Geographical Coordinates for WPP2

SITE	COORDINATES FOR THE PREFERRED LAYOUT	COORDINATES FOR ALTERNATIVE SITES
Goi	5º 48’ 02.35”N /0º 22’ 23.26”E 5º 47’ 56.31”N / 0º 22’ 20.24”E 5º 47’ 32.96”N / 0º 24’ 09.40”E 5º 47’ 28.83”N / 0º 24’ 07.82”E	5°48'7.01"N / 0°22'24.70"E 5°48'1.24"N / 0°22'26.45"E 5°47'45.58"N / 0°23'26.49"E 5°47'37.45"N / 0°23'39.53"E 5°47'26.27"N / 0°23'41.81"E 5°47'26.09"N / 0°23'33.34"E 5°47'38.25"N/ 0°23'25.54"E 5°47'56.68"N / 0°22'20.57"E 5°48'6.10"N / 0°22'17.23"E
Wokumagbe 1	5º 48’ 12.48”N / 0º 20’ 16.22”E 5º 48’ 11.02”N / 0º 20’ 09.46”E 5º 47’ 05.88”N / 0º 20’ 20.53”E 5º 47’ 04.76”N / 0º 20’ 14.72”E	5°48'25.53"N/ 0°18'17.04"E 5°48'26.47"N / 0°18'21.73"E 5°48'7.58"N / 0°18'26.67"E 5°48'3.88"N / 0°18'32.56"E 5°47'41.37"N / 0°20'8.33"E 5°47'37.78"N / 0°20'14.81"E 5°47'25.73"N / 0°20'18.71"E 5°47'4.43"N / 0°20'22.91"E 5°47'3.77"N / 0°20'16.22"E 5°47'24.21"N / 0°20'13.02"E 5°47'34.97"N / 0°20'4.23"E 5°47'59.79"N / 0°18'23.89"E
Wokumagbe 2	5º 47’ 24.20”N / 0º 19’ 01.30”E 5º 47’ 19.57”N / 0º 18’ 56.32”E 5º 48’ 42.75”N / 0º 18’ 13.30”E 5º 47’ 34.07”N / 0º 18’ 31.21”E 5º 48’ 42.75”N / 0º 18’ 17.61”E 5º 48’ 42.04”N / 0º 18’ 13.30”E	

Table 3-2: Land Requirements for the preferred and alternative layout for WPP2

SITE	LAND REQUIRED FOR PREFERRED LAYOUT		LAND REQUIRED FOR ALTERNATIVE LAYOUT
Wokumagbe 1	2.153km x 0.2km 0.879km x 0.2km	60.64 Ha	98.8Ha
Wokumagbe 2	2.083km x 0.2km	41.66 Ha	N/A
Goi	3.384km x 0.2km	67.68 Ha	87.22 Ha
Total		**169.98 Ha**	**211.18**

Site Selection

It is recognized that in order to achieve the Ghana Government's challenging targets for renewable energy generation, a greater number of renewable energy schemes, such as this project, are required. Such infrastructure should however be appropriately located and designed so as to avoid significant technical and environmental constraints. The site selection process is the initial stage of the Project development process. It is undertaken because of screening against a number of variables to include land availability, wind resource, grid connection and identification of key environmental constraints. Having identified a wind farm site, a more detailed analysis is carried out as part of feasibility process, which identifies initial WTG locations. Following this, the ESIA process informs the location of the WTGs and associated infrastructure which have been designed and amended in response to the EIA process ('dynamic design process'). These layout iterations and refinements have contributed to reducing the potential effects of the proposals to an acceptable level.

The selection of a wind farm site is a complex process and involves the assessment of technical, commercial, environmental and planning criteria. One of the key variables in site selection is analysing the regional wind speed of the site. Other criterion includes the analysis of and effects on:

- Land availability.
- Site size.
- Landscape and visual impact assessment.
- Residents in the vicinity.
- Aviation.
- Telecommunications.
- Proximity to grid connection.
- Good transport access to the site from point of WTG manufacture or delivery.
- Archaeology issues.
- Hydrology.
- Relevant planning considerations.
- General environmental considerations.

Once a site is deemed suitable for wind farm development from the initial site selection criteria it is then progressed further to a detailed feasibility assessment. Technical Consultants review the site and its merits from a technical, planning and environmental standpoint. In principle, the selection of any preferred alternative system and site for establishment of wind farm needs to be based on:

a) Current status of energy production system,
b) Strategic needs of energy production, conservation and environmental protection,
c) Urgent need to provide better level of service in power production to meet the current and future demand.

VRA has undertaken a rigorous analysis of potential sites in order to minimise the effects on local people, the environment and the landscape. Based on national data obtained from the above studies, VRA identified eight (8) potential candidate sites (located in various regions of the country as listed in Table 3.3), where based on general knowledge favourable wind conditions were expected. VRA subsequently engaged the services of consultancy company Barlovento Recursos Naturales to carry out 8-wind measurement campaign prior to the development of the wind farm.

Table 3-3: Locations of selected sites for Wind Measurements

SITE	EASTING	NORTHING	LATITUDE	LONGITUDE
Anloga	31267054	639704	5º 47’ 0.606”N	0º 53’ 47.041”E
Lekpogunu Goi	31204880	641019	5º47’ 34.873”N	0º 20’ 6.921”E
Akplabanya/Wokumagbe	31211343	641192	5º47’41.482”N	0º 23’ 36.830”E
Amoama South	30620093	857865	7º45’34.216”N	1º54’39.280”W
Gambaga	30795913	1170509	10º34’37.703”N	0º 17’45.551”E
Anloga West 2	31248499	641046	5º47’41.946”N	0º 43’43.962”E
Nsutapong	30803402	697905	6º18’24.037”N	0º 15’28.588”E
Amoama North	30621174	865262	7º 49’ 34.958”N	1º 54’ 3.365”W

Source: VRA, 2014

On these eight (8) sites a wind measurement campaign over a complete year had been performed. Factors considered in the selection of the sites included energy yield (wind conditions), accessibility to national grid, road access, basic soil conditions, environmental aspects as follows:

- Environmental considerations: hydrology, visual and noise sensitivities, impacts on cultural heritage, etc.
- Favourable wind conditions: sites were selected in areas with a superior wind regime
- Accessibility: the sites need to be accessible for large vehicles such as cranes and delivery vehicles (turbine components).
- Proximity to grid: sites, where possible, should be selected based on their proximity to existing substations, in order to avoid the need for extensive additional transmission lines and associated financial costs and environmental impacts (e.g. risk of bird collisions and visual intrusion).
- Transformed habitat: The site selection focused on areas where the natural habitat has already been transformed, so that the footprint of the wind energy facility (although small) would not contribute to extensive loss of natural habitat.
- Willing participation of landowners: Land negotiations should be in place before commencing the ESIA.

Subsequently, the six (6) most interesting sites had been further analysed. The six (6) sites were grouped into four (4) areas as listed below.

a) Anloga/Anloga West 2
b) Lekpogun/Akplabanya
c) Gambaga
d) Amoama North/Amoama South

Assessing the energy yield of the four (4) areas as shown in Table 3-4, Anloga/Anloga West 2 (now Wind Power Project 1 - Anloga Extension) and Lekpogunu/Akplabanya (now Wind Power Project 2 - Workumagbe/Goi) have been selected as the two (2) candidate sites for the development of the wind farms by the VRA. Based on feedback during the public consultations, VRA changed the name for the Lekpogunu/Akplabanya site to Workumagbe/Goi site, which are the actual names of the communities that the project will situate.

Table 3-4: Results of site assessments for candidate site selection based on energy yield

SITE	**GAMBAGA**	**AMOAMA**	**ANLOGA EXTENSION-WPP1**	**WORKUMAGBE/GOI - WPP2**
Energy Yield	Good wind conditions for VESTAS	Good wind conditions for VESTAS	Good wind conditions for TWT & VESTAS	Good wind conditions for TWT & VESTAS
Site complexity	Complex and uncertain flow model (Uncertain yield calculation / Turbulences WTG aging)	Low Complex Feasible flow model	Flat terrain trustable flow model	Flat terrain trustable flow model
Access road	Extreme long transport way to site. The sum of all defects may effect high costs	High frequent of defects between Accra and Kumasi resulting in long distance and roads to care	Short roads access but a critical bridge (Sogakofe Bridge)	-Short roads access
Grid Connection	Grid Far	Grid near	Grid in feasible distance	Grid in feasible distance
Extendability	Wind farm extendable along the scarp/cliff	Wind farm extendable	Restricted space (noise)	Restricted space (noise)
Environmental aspects	Possible conflict with inhabited houses	Potential conflict with Anlo-Keta Wetlands (Ramsar site) as WTG is planned within it	Potential conflict with Anlo-Keta Wetlands (Ramsar site)	Potential conflict with Songor Lagoon (Ramsar site) as WTG is planned within the buffer and transition zone of the biosphere reserve.
		Scattered houses (More persons to support)	Scattered houses (More persons to support)	Scattered houses (More persons to support)
TWT Yield gross[MWh/a]	**151,073**	**145,384**	**170,533**	**147,931**
Cap (gross)	23%	22%	26%	23%
MWh/MW (gross)	2035	1958	2297	1992
V110 Yield gross [MWh/a]	**209,634**	**211,405**	**246,812**	**219,770**
Cap (gross)	31%	32%	37%	33%
MWh/MW (gross)	**2758**	**2782**	**3248**	**2892**

3.2 KEY COMPONENTS OF A WIND ENERGY FACILITY

The key components of the proposed wind power project (WPP2) are briefly described in the sections below and a summary of the project components are shown in Table 3.5 below.

Table 3-5: Specifications of the Project Components

COMPONENT	DESCRIPTION
WPP2	
Type of Technology	Wind Technology
Generation Capacity	76.5 MW for both the preferred layout alternative layout
Wind turbines	Height: 80 m for both the preferred layout and alternative layout
Area	Footprint: 169.98 ha for preferred 186.08 ha for alternative layout both areas excluding the area required for associated infrastructure
Building Infrastructure	
Total Area occupied by buildings	
Offices	
Operational and Maintenance Control Centre	
Warehouse/Workshop	
Ablution Facilities	
On-site Substation and Building	
Associated Infrastructure	
Main Access Roads:	Existing
Internal gravel roads (Widening)	Length and Width: To be confirmed
Fencing	Length:140 m around each turbine
Stormwater channels	Length: To be confirmed
Temporary work area during the construction phase (i.e. laydown area)	Approximately 45 m x 25 m per turbine
Area occupied by both permanent and construction laydown areas	During construction each turbine would require 2,950 m2 (crane pad , turbine foundation + equipment laydown and assembly area), whilst 1400 m2 would be required permanently
Proximity to Grid Connection	Approximately 4 km (Maximum 8 km)

3.2.1 Wind turbines and associated infrastructures

Wind turbines generate electricity by converting movement, or kinetic energy, into electricity. In conventional/geared wind turbines, which VRA has opted to use (Figure 3.2 below), the kinetic energy of the wind rotates the rotor blades of the wind turbine around a horizontal hub (7 - 19 rpm), which is connected to a low speed shaft situated inside the hub, a gearbox and a generator located in the nacelle (turbine housing). Direct drive turbines however do not use a gearbox, and as a result their alternators are able to generate electricity at a low speed by making use of a larger stator/rotor diameter when compared to conventional/geared wind turbines. Due to the small alternator size in comparison to the external rotor blades in geared wind turbine systems, the gearbox turns at a much faster speed (about 1000 – 1800 rpm) than the external rotor blades. VRA has opted to use conventional/geared wind turbines for the proposed project.

The shaft is connected to an electrical generator at its other end. The generator is an assembly of permanent magnets that surrounds a coil of wire. When the rotor spins the shaft, the latter spins the assembly of magnets which generate voltage in the coil of wire. This voltage provides alternating electrical current which can then be distributed through power lines. The wind turbine tower supports the rotor and nacelle and provides the height for the rotor blades to clear the ground safely, and to capitalise on atmospheric wind resources which occur approximately 100 m above the earth’s surface. The energy output of a wind turbine ultimately depends on the velocity of the wind, the height of the hub, and the length of the rotor blades.

Wind turbines can operate at a range of wind speeds but are designed to deliver peak efficiency at a specific wind speed. Turbine manufacturers therefore provide power curves that show how output varies with wind speed. Turbines have a start-up speed, which is the speed at which the blades and rotor start to rotate, and a cut-in speed, which reflects the minimum wind speed at which usable power is generated. This is typically about 3 - 4 m/s with full power output occurring at higher wind speeds of approximately 10 to 12 m/s. The rated speed is the minimum wind speed at which the turbine delivers peak efficiency to generate its designated rated power.

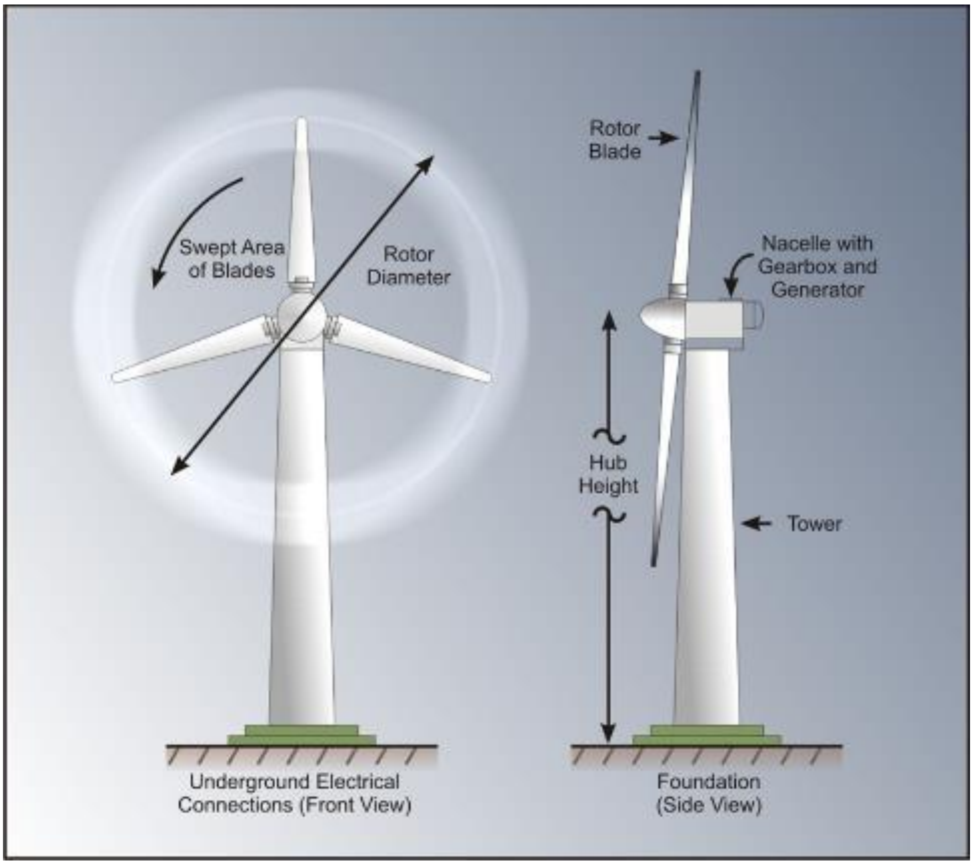

Figure 3-2: Generic design for a horizontal axis wind turbine

(Source: Encyclopaedia of Renewable Energy and Sustainable Living)

The rated speed of the 3.3 MW turbines is approximately 10 to 12 m/s. Power output from a wind turbine increases as the wind increases, and usually levels off above the rated speed. This is the furling speed, which is the amount of wind required to produce the maximum power that a turbine is capable of generating; any wind in excess of that speed will not generate more than this maximum power generation capacity. Wind turbines are also equipped with a cut-out speed as a safety feature to prevent mechanical damage. The cut-out speed is therefore the highest wind speed at which a wind turbine will stop producing power. This is typically between 25 and 28 m/s depending on the manufacturer and type of turbine selected for implementation. Once the wind drops below the cut-out speed back to a safe level, the turbine can resume normal operation. An illustration of a typical wind turbine can be seen in Figure 3.3.

Figure 3-3: Illustration of typical wind turbines

3.2.1.1 Turbine technology

The implementation of the proposed project will result in the establishment of 45 individual wind turbines with an approximate generation capacity of 1.7 MW each for both the proposed and alternative layout. At this stage of the project planning, the turbine technology has been selected by VRA. The preferred technology provider will be GE Energy. The wind turbine is a pitch-regulated upwind turbine with active yaw, gearbox, and a three-blade rotor. The turbines will have a hub height of up to 80 m and a rotor diameter of 103 m.

3.2.1.2 Hard Standing Areas

A hard standing area of up to 45 m x 25 m will be established next to each wind turbine. These hard standing areas will be utilised by cranes during the construction (and also possible maintenance) processes. Hard standing areas will be maintained and utilised for maintenance works during the operational phase. In the event that the turbine technology selected for implementation does not incorporate transformers into the turbine tower or nacelle, each wind turbine may also require that a transformer of up to 5 m x 5 m be installed within the hard standing area.

A number of additional laydown areas of approximately 150 m x 60 m will be required during the construction phase. These areas will be compacted and levelled to be used as blade lay down areas and for the initial storage of wind turbine components. These laydown areas will also accommodate cranes required for tower/turbine assembly. Foundations would comprise a 17 m diameter reinforced concrete slab buried at a depth of approximately 1.8 m. Topsoil and vegetation will be stripped for construction of the foundations, stored and reinstated once Wind Turbine Generator (WTG) construction is completed. Material won from foundation excavations will, if suitable, be utilised in the construction of site infrastructure. For the construction of the WTG foundations and for further civil works (O&M and administration building, sub-station foundations and building, etc.) big quantities (>500m^3 per foundation) of high quality concrete are needed. Quality management according to international standards - such as for instance EUROCODE - is strongly recommended to avoid doubts on the quality of the concrete during installation. It has to be expected that any international turbine supplier will also insist on such quality procedures for the production and use of concrete at the wind farm site.

3.2.2 Ancillary infrastructures

3.2.2.1 Building Infrastructure

The wind energy facility will require on-site buildings, including an operational and maintenance control centre, offices, warehouse/workshop (for storage of equipment), ablution facilities, converter stations, on-site substation and substation building, laydown areas and security enclosures. Ablution facilities are likely to be incorporated into the office structures.

3.2.2.2 Substation, auxiliary power and grid connection

The following section discusses the substation, auxiliary power supply and grid connection as part of associated infrastructure for information purposes only. The substation and transmission lines do not form part of the scope of work for the ESIA.

Substation

The electricity generated at the proposed Wind Power Project 2 would be evacuated via a newly constructed 161/33 kV substation onsite and would be connected to the grid via a new 330 kV overhead transmission line of approximately 40 km from the onsite substation to the Dawa Substation. In principle, a single transformer would be sufficient for the transmission of the maximum wind farm capacity of 76.5 MW. However, in order to increase the reliability of wind farm operation and to allow maintenance on the transformer, a two transformer setup is more plausible. Therefore, two 50 MVA Oil Natural Air Forced (ONAF) 161/33 kV power transformers, operating in parallel, are considered for stepping up the internal wind farm voltage to the external voltage of 161 kV. The main reason for using two transformers in parallel operation, for this case, is to in-crease the reliability of the system. In case a fault occurs in one of the transformers, the other transformer will continue with the transmission of the power. Under the dominating wind conditions (at wind speeds below 13 m/s the wind farm will not reach its rated power), one transformer might even be able to transmit all the power generated by the wind farm. Additionally, the costs related to maintenance and spare parts are typically lower for smaller transformers than for a single bigger transformer of equivalent capacity.

The proposed wind farm substation will be a gas insulated substation (GIS) indoor substation foreseen to be located almost at the middle part of the wind farm. Compared to an air-insulated system the proposed gas-insulation is resulting in higher costs, but is giving also higher reliability. Considering that the wind farm substation is located quite close to the sea, the air at the site will be salty and requires to be taken into account suitably for the substation design. However, again the GIS layout is just a preliminary assumption and may be modified in the further planning of the wind farm.

The electrical equipment shall be designed for 50 Hertz operation according to the relevant standards applicable in Ghana.

The proposed substation will be located on a graveled area of approximately two to four acres surrounded most likely by a chain linked perimeter fence and provided with an outdoor lighting system.

The high and medium voltage equipment will be installed in separate areas / rooms with lockable doors.

The position of the substation will be informed by the final micro-siting/positioning of the wind turbines. Currently, this new substation is preliminary assumed to be constructed in the centre section of the wind farm. The final design and layout shall comply with common engineering practice and the latest edition of the relevant IEC Standards or Ghanaian standards as applicable.

Auxiliary Power Supply

One of the necessary components in the HV/MV substation is the auxiliary power supply station. The auxiliary power supply should be rated 400/230 V. It will be supplied via auxiliary transformers and a backup uninterruptible power source (UPS) via batteries or eventually an additional emergency diesel generator may be included as alternative supply. The auxiliary power supply equipment will provide power to the control system, protection system, SCADA system, station illuminating system, socket outlets and other consumers situated in the station.

Grid Connection

As the wind farm is an electricity generation facility, its connection to consumers is essential for providing its function. Although no detailed grid study (load-flow, voltage and frequency management, etc.) has been done, it is obvious that with a distance to the Ghanaian load centre in Accra of around 60-100 km, the transport of the electricity to the customers is possible. It has been proposed that the integration of the wind farm to the existing grid will be done via the construction of a 161 kV overhead transmission line (OHL) of approximately 40 km to the existing grid. The nearest existing sub-station to interconnect the new HV transmission line to the existing grid is located at Tema substation, which is located approximately 40 km southwest from the wind farm site.

3.2.2.3 Telecommunication and SCADA

As a standard today, wind farms are equipped with SCADA systems for the continuous supervision of the operation. Typically, they consist of 2 systems, which are frequently interconnected. One system is dedicated to the WTGs (related to all operational data of the WTGs) and the other to the substation (related to all relevant data for the operation of the substation and for the grid dispatch). An interconnection between both systems can be realized by standard protocols (for example according to IEC 60870-5-101 and via OPC) with the substation SCADA being at higher hierarchical level.

Via this interconnection the grid dispatch can have access to WTG related data, which may be of interest for the grid operation (like wind speed or availability/faults of WTGs). The substation SCADA system will connect all installed main components in the substation in order to ensure proper communication and monitoring of these components. These components are in particular the main transformers, protection and switches on the HV side and metering systems.

The system for the surveillance and control of the wind farm and its components is normally supplied by the WTG manufacturer and its functionality is varying a bit from one manufacturer to the other. Within the wind farm the necessary data connections are today usually done via optical fiber (F/O) cables between all the turbines and up to the substation and control building. A central computer SCADA system shall be installed in the substation building.

The necessary cables can run in the wind farm in parallel to the underground power cabling in the same trenches. When parts of the MV grid are realised by overhead lines, also adequate F/O cables can be put on the same masts. For the data communication to the external grid and to the national dispatch center of GRIDCo, as well as to a central control room from VRA, it needs to be defined in a later stage of project development, if this can be done by power-line communication (PLC) over the external HV transmission-line to the existing grid or via

OPGW (optical ground wire) on this line or as last alternative via radio frequency/GSM or satellite transmissions.

The choice of telecom type depends on the availability of the necessary infrastructure on the existing grids and further strategic decision by VRA and GRIDCo. Anyway it has no impact on the general feasibility of the project and also the impact on costs of the wind farm construction (CAPEX) and operation (OPEX) is of a minor nature. In many cases, even two different channels (for example via PLC and as back-up by radio frequency) are being used for getting maximum reliability of the communication system.

As mentioned above, the wind turbine SCADA system can be integrated in the system of the grid operator. More detailed real-time information, including for example the positions of the main switches in each WTG as well as metering data can be remotely read out and automatically forwarded to the grid operator's system. It must, however, be agreed with the grid operator what protocols to use and what data to transmit. All this must be discussed and designed in the detailed planning phase of the wind farm, normally within the scope of the EPC Contractor(s).

3.2.3 Access road

Access to the proposed WPP2 Wind Energy Facilities will be obtained via a number of gravel roads. A gravel surface road will be required from the nearest public road onto the site and an internal site road network will also be required to provide access to each of the individual turbine locations. For this purpose, existing roads and access tracks will be used as far as possible.

During construction the majority of internal access roads will need to be up to 6 m wide, however, in some limited locations, they may need to be up to 9 m wide. Civil design studies have indicated that this additional width is required where internal access roads turn a corner. This is necessary to allow for the safe movement of vehicles on site during the construction process. By increasing the width of the road on corners damage to storm drains and road-side vegetation is avoided and health and safety risks are reduced.

During operation, the internal access roads can be reduced to 3 – 4 m in width. The layout of the internal road network will only be finalised once the final turbine layout has been confirmed, however preliminary new roads can be seen in Figure 3.4. This will be informed by the findings of the ESIA as well as the botany and heritage specialist studies. Routing will occur in such a way to minimize the number of watercourse crossings as far as possible.

Figure 3-4: Proposed new roads for WPP2 preferred and alternative layout

3.2.4 Fencing

For various reasons (such as security, public protection and lawful requirements), the proposed facility will be secured via the installation of boundary fencing. Currently fencing is expected to be non-invasive and thus would be done around the turbine pads and foundations. The fences would be around each turbine with a perimeter of 140 meters for WPP2.

3.2.5 Stormwater, Sewage, Waste and Water Requirements

Stormwater channels will be constructed on site to ensure that stormwater run-off from site is appropriately managed. Water from these channels will not contain any chemicals or hazardous substances, and will be released into the surrounding environment based on the natural drainage contours.

The proposed project may also entail the construction of drainage structures (i.e. French drains) for the transfer of waste water generated by the proposed facility.

The project will require sewage services during the construction and operational phases. Low volumes of sewage or liquid effluent are estimated during both phases. Liquid effluent will be limited to the ablution facilities during the construction and operational phases. Portable sanitation facilities (i.e. chemical toilets) will be used during the construction and operational phases, which will be regularly serviced and emptied by a suitable (private) contractor on a weekly basis. The site office is expected to have a conventional septic tank treatment for sewage. The waste water will be transported to a nearby Waste Water Treatment Works for treatment. Due to the remote location of the project site; a conservancy tank or septic tank system could be used on site.

During the operational phase after construction, the facility will produce minor amounts of general waste (as a result of the offices). Waste management is discussed in the EMP Chapter 8 this ESIA Report.

3.3 PRELIMINARY SITE LAYOUT

The selected layout designed by Lahmeyer International GmbH intends to optimize the siting for maximum yield, minimum load and harm for the WTG and minimum disturbance to residence, environment and visual intrusion.

Figure 3.5 below above indicates the preliminary location of the proposed wind turbines for the preferred and alternative layouts. This preliminary layout is iterative in nature and has already undergone a number of revisions to date. The layout presented in this ESIA Report therefore represents an updated layout from that which was contained in the feasibility studies. Due to its iterative nature, the site layout will continue to evolve throughout the remainder of the ESIA process and subsequent detailed project design and planning processes as additional information becomes available. Furthermore, it is expected that following the completion of the ESIA process, during the detail design phase and upon completion of additional technical studies (e.g. geotechnical investigations), additional changes to the site layout will occur.

The site layout plan is dependent on a number of environmental and technical factors and will be largely influenced by both the findings of the independent specialist studies to be completed during the Impact Assessment phase of ESIA, and the turbine technology selected for implementation. There are various factors which may influence the placement of wind turbines within a wind energy facility. Different turbine suppliers and turbine technologies have differing requirements with regards to the placement of wind turbines. For example, the tower height and rotor blade length associated with different turbine models may impact on the separation distances required between individual turbines. While some turbine suppliers may provide taller turbines these would require greater separation distances between individual turbines. Separation distances therefore have the ability to influence the location, spacing and overall number of individual wind turbines which may be implemented, thus impacting on the overall project layout. The separation distances required between individual wind turbines would therefore be dependent on the final turbine technology selected for implementation, and this would have an impact on the total number of turbines which may "fit" within a particular development area.

Similarly, the generation capacity of different wind turbines has an influence on the total number of turbines which may be installed. For WPP2, VRA has selected the use of 45 GE, each of 1.7 MW nominal power and on a hub height of 80 m above ground level. The high number of turbines and the relatively small areas has resulted in splitting the turbines into the three sub-sites for the preferred and alternative layouts.

The routing of onsite infrastructure such as roads and electrical reticulation would also be ultimately dependent on the final turbine placement, and as such this infrastructure has been omitted from the provisional site layout.

Independent specialist studies were as part of the Environmental Impact Assessment phase which assessed the total number of turbines proposed, while the findings and recommendations provided by the specialist studies may influence the final project layout through modifications in the micro siting of the turbines.

A final site layout plan depicting the location of the individual turbines and associated infrastructure will be developed during the micro-siting process, and this would need to be approved by the relevant authorities prior to any construction commencing on site.

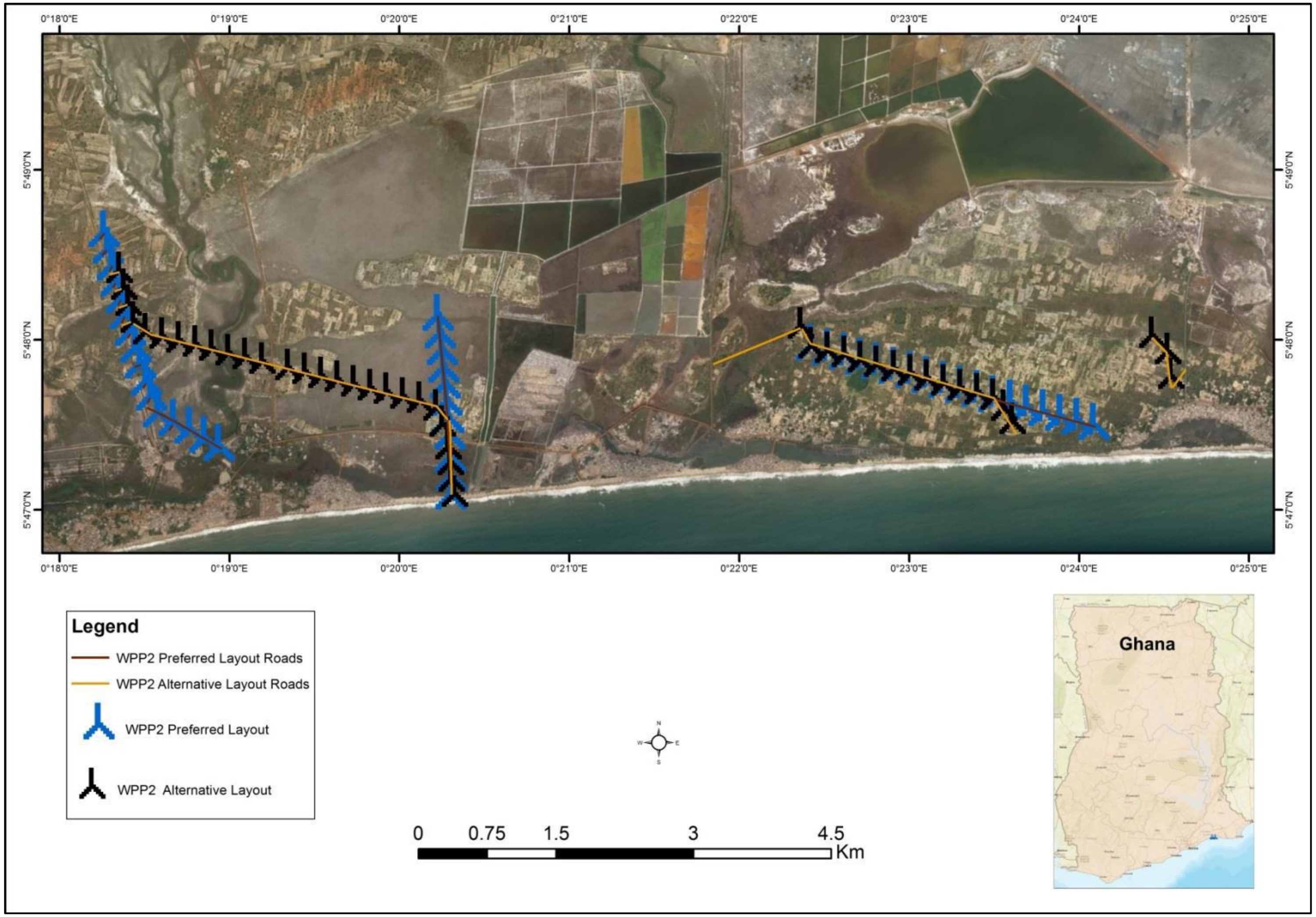

Figure 3-5: Location of WPP2 preferred and alternative layouts

(Source: Renewable Energy Development Training, 150MW Wind Farm Development Project, VRA, February 2015)

3.4 OVERVIEW OF THE WPP2 DEVELOPMENT CYCLE

Various aspects of the planning and design phase of the WPP2 still need to be finalised pending the result of the ESIA. Most notably, the micro-siting of each individual turbine needs to be determined as well as the subsequent routes of the proposed access roads and servitudes. The following activities have/will need to be undertaken in the various phases of the proposed project.

3.4.1 Pre-construction phase

Wind Resources Measurement

Several preliminary project activities have already been carried out. Having identified the most feasible locations based on national data, one of the first priorities of the VRA was to undertake wind measurements to access the wind resource and determine its economic viability. Subsequently, VRA in December 2013 commenced a qualitative high level wind measurement at the eight sites in Ghana. The measurement campaign was carried out under Barlovento Company supervision, following MEASNET [13] standard and indications.

Under this project, the wind measurement systems consisted of two-time series of about one year collected by two measurement systems named Lekpogonu for the Wokumagbe site and Met system Akplabanya for the Goi site. All sensors were calibrated according international standards, mast set up and devices specifications are described in Table 3.6.

Table 3-6: Mast Specifications for Wind Measurements

(Source: Study for Wokumagbe and Goi, August 2015)

MAST NAME	LEKPOGONU	AKPLABANYA
Mast Type	Lattice	Lattice
Mast height (m)	80m	80m
Projection	UTM	UTM
Reference Ellipsoid	WGS84	WGS84
Zone	31N	31N
E / Longitude	0204 847	0211 339
W / Longitude	0640 693	0641 190
Z a.s.l [m]	3	8
Reference of directions in Logger and Installation Report	Magnetic / True North	Magnetic / True North
Duration of Measurement Campaign for feasibility study	Nov. 06, 2013 to November 3, 2014	Oct. 13, 2013 to December 1, 2014
Model	CR 3000	CR 3000
Manufacturer	Campbell Scientific	Campbell Scientific
Serial Number	7106	7107
Firmware	LoggerNet	LoggerNet
Time Zone Offset	UTC + 0 hours	UTC + 0 hours
Sampling Interval	1s	1s
Averaging Interval	10 min	10 min

Technical & Economic Feasibility Studies

The feasibility studies undertaken for the proposed sites (Lahmeyer International GmbH, 2015) will assist the VRA in defining the requirements for the project for the necessary funding and for EPC Contracting. Lahmeyer International GmbH of Germany is therefore also responsible for providing architectural and engineering services for the works. Site survey and relevant maps and initial drawings for the project are to be developed by Lahmeyer. The schematic drawings are to be endorsed and finalised by the Contractor for approval by the relevant agencies prior to commencement of constructional activities.

Route Survey Study

In addition, a route survey has been undertaken by Laso Transportes of Portugal to evaluate access to the project sites from the Tema harbor, where the equipment for the wind power projects are expected to be delivered in Ghana and transported to the project sites. Reports on this assignment, dated March 2015 are also available.

Geotechnical Survey

The ground and soil conditions at the project site have not yet been analysed. However, the first visual impression of the sites shows in general stable grounds and for the overall feasibility of executing the civil works at the site no major obstacles are seen. A geotechnical survey inclusive drillings at each Wind Turbine Generator location is necessary to determine details of foundations, roads, crane pads, etc. However, in the current feasibility stage of the project, flat foundations are assumed to be acceptable for buoyancy conditions; additional costs for pile foundations will then be proposed to be included in contingencies.

A geotechnical survey inclusive drillings at each Wind Turbine Generator location is necessary to determine details of foundations, roads, crane pads, etc.

Land Acquisition/Compensation Issues

The project requires the acquisition of land for the development of the wind power projects in the various areas. For the project under study, a total of 169.98 Hectares land is required for the 3 identified subsites and a total of 193.31 ha including the addition of associated overhead internal grid connection. There is therefore the need to consult with project-affected persons (PAPs) in a meaningful manner, and to provide opportunity for their participation in the planning and execution of resettlement programs. In view of this, VRA has considered involuntary compensation as an integral part of the project design, and subsequently it is planned to deal with resettlement issues from the earliest stages of the project preparation.

As part of the ESIA Study, VRA is developing a “Compensation Action Plan Report” for the project. Consultations are now ongoing with identified affected persons to obtain information on affected individual and community properties, and compensation packages that may be required for the acquisition of the land and any impacts due to the project. The land acquisition procedures is being carried out in accordance with national regulations.

Acquisition of Approvals

The VRA has now embarked on relevant activities to ensure all required permits will be obtained. The acquisition of an Environmental Permit (EP) is mandatory to allow for the commencement of the physical construction for such a project. As such, the VRA has registered the project with the EPA and the preparation of this Scoping Report is the first step towards Environmental approval by the EPA and the issuance of an Environmental permit. The Permit, if granted, will outline various conditions that must be adhered to in the project implementation. The VRA will be responsible for implementing the conditions of the EP.

VRA obtained a Provisional License, dated 27 July 2015, from the Energy Commission to allow the company to generate and Supply Electricity from wind energy at Ada West Distract of the Greater Accra region. Power generated is to feed into the national grid, which is being operated by the Ghana Grid Company.

It must also be noted that a Developmental permit is required from the Local Government Administration, in this case the Ada West District for infrastructural development, whilst the Ghana Highway Department / Department of Urban Roads will need to be consulted for approval for crossing of highways and roads and public property with the heavy plant equipment.

The wind turbines would be at the hub height of above 80m, which would necessitate adequate provision of warning lights and signals necessary for elevated structures. This would require obtaining clearance from the Ghana Civil Aviation Authority and the National Communication Authority, which are yet to be obtained.

Micro-siting

Micro-siting would be undertaken to minimise potential environmental and social impacts following findings and recommendations of specialist studies, for example to reflect findings of pre-construction survey works or to further refine the site layout to avoid areas of deep peat prior to construction. No micro-siting will be undertaken that would increase the potential level of effect on sensitive receptors. In addition, micro-siting would only be undertaken where achievable within the application boundary taking into account blade over-sail. Table 3.7 below outlines the number of turbines in each area within study area of WPP2.

Table 3-7: Wind Turbine Distribution of WPP 2

SITE	INSTALL CAPACITY FOR PREFERRED LAYOUT	INSTALL CAPACITY FOR ALTERNATIVE LAYOUT
Goi	27.4MW - Sixteen (16) Wind Turbines	N/A
Wokumagbe 1	18.7MW- Eleven (11) Wind Turbines	45.9MW- Twenty seven (27) Wind Turbines
Wokumagbe 2	30.6MW - Eighteen (18) Wind Turbines	25.5MW- Fifteen (15) Wind Turbines
Wokumagbe 3	N/A	5.1MW- Three (3) Wind Turbines
Total	**76.5 MW**	**76.5MW**

Stakeholder Engagements with State Agencies

The following state agencies are to be taken on-board before commencement of associated physical works for the project:

- Ghana Wildlife Division of the Forestry Commission, for working close or within the Songor Ramsar site in Ghana.
- Ghana Highway Authority for associated impacts in the transportation of equipment on the Accra-Aflao NI Highway.
- Department of Urban Roads for any access road development or road diversion within the project sites in line with the “Road Reservation Management: Manual for Coordination” (June 2001).
- Ghana Police Service to assist in safeguarding the transportation of project equipment from the Tema Harbour and along the NI Highway to the project site.
- Ghana Water Company, to identify water pipelines in order to avoid destruction of such infrastructure.
- Electricity Company of Ghana, to identify if any distribution electric lines would be impacted and to arrange for smooth disconnections and connections as appropriate in order to avoid destruction of such infrastructure.
- Ghana Civil Aviation Authority on aviation impacts issues.
- Telecommunication Companies, if their communication mast is identified within the project sites.
- Ghana National Fire Service for the issuance of a fire permit for the project.
- Ghana Ports & Harbours Authority for modalities for the clearing of heavy equipment from the Tema Port.

- Physical Planning Department of the Ada West for Developmental permit for the WEF.

3.4.2 Construction phase

The duration of the construction phase for the proposed Wind Energy Facility (WPP2) is ultimately dependent on the total number of turbines to be erected; however, this process is expected to take between 15 and 24 months to complete.

The main activities that will form part of the construction phase are:

- Removal of trees and large bushes and ground-vegetation clearance for buildings and substations;
- Excavations for infrastructure and associated infrastructure;
- Establishment of a laydown area for equipment;
- Construction of internal access roads where required;
- Stockpiling of topsoil and cleared vegetation;
- Transportation of material and equipment to site; and
- Construction of the wind energy facility and additional infrastructure.

The first stages of construction are anticipated to be the establishment of site access and the construction of access roads. Following this, vegetation and site clearance would need to occur at the footprint of each individual turbine. Excavations will then be dug for turbine foundations, followed by the construction of concrete foundations and the establishment of laydown areas adjacent to each turbine location. When the Project is completed, the areas surrounding this new installation will be reinstated to their former state.

GE which has been selected for the construction of the turbines would be responsible for the transportation of wind turbine components, including the wind turbine towers. This will be done by making use of flatbed trucks. Construction and lifting equipment such as cranes, as well as components of onsite infrastructure including substation transformers will also be transported to site by road.

Each wind turbine will take approximately 2 days to erect, however this will be dependent on local weather conditions.

Wind turbines will be connected to the optimally positioned onsite substation by means of electrical cables which will typically have a rating of 33 kV. Where practical and where site conditions allow, these electrical cables will be routed underground. The installation of any underground cabling will require the excavation of trenches, approximately 1 m in depth within which the cables can then be laid. Where possible; underground cabling will follow the routing of internal access roads to be constructed on site in order to as far as possible confine the project footprint.

The Contractor shall implement all measures necessary to restore the sites to acceptable standards and abide by environmental performance indicators specified in the Project's EIS/EMP to measure progress towards achieving objectives during execution or upon completion of any works. Furthermore, VRA will undertake environmental monitoring programs during the various stages of the project to assess the effectiveness of the mitigation measures. Further details shall be contained the ESIA - Environmental & Social Management Plan.

Staff Requirement during Construction Phase

This project will bring in employment opportunities for the local inhabitants. It is expected that the project will create approximately 50 direct construction employment opportunities over this period (i.e. 8 skilled, 18 semi-skilled, and 24 low skilled). About 10 VRA support staff will be present in addition to the above. About 5 expatriate workers are expected to be on site. No on-site labour camps are envisaged as construction workers will be accommodated in the nearby communities of Wokumagbe and Goi and transported to and from site on a daily basis. Thus, no employees will reside on the site at any time during the construction phase. Overnight on-site worker presence would be limited to security staff.

It is expected that there will be between 6 and 15 people in a construction crew, depending on the construction phase of project and the nature of activities being undertaken. There may be more than one crew operating on the site at any one time. Construction crews will constitute mainly skilled and semi-skilled workers. Unskilled jobs will be offered mainly to the local people particularly during the construction phase.

Logistics

Equipment, supplies and personnel will move in and out from the site using the access road and the Accra – Aflao NI Highway. Heavy vehicles carrying the wind turbines and necessary equipment will operate from the Tema Port and take the link road to the NI Highway for onward journey to project sites site by the dirt road which will be upgraded to take the heavy load of towers (~162 tons), rotor blades (~60 tons), turbines (Nacelle ~82 tons), machinery and equipment.

Concrete and some material (cabling, cement etc.) will be transported to the site via normal articulated heavy goods vehicles. WTG components will require delivery via specialised heavy goods vehicles which would be escorted along the public highway and upgraded access tracks. Aggregate for tracks and foundations will be sourced from off-site quarries in proximity to the Project therefore no borrow pits are proposed.

Access Road

The shipping port would be Tema and the transport distance from the port to the sites would be around 70 km for Goi and Wokumagbe. The main part of the route is on the N1 (Accra - Aflao road). The main part of the route is on the N1 (Accra – Aflao road). The routes are shown in Figure 3.6. The existing road network reaches close to the selected sites and only a few kilometres of new access roads will have to be built to reach the selected sites.

Where required, existing public roads may need to be upgraded along the proposed equipment transport route to allow for the transportation and delivery of wind turbine components and other associated infrastructure components (refer to Figures 3.7 to 3.9). Laso Transportes of Portugal conducted a road survey (Laso Transportes, 2015) to evaluate access to the project sites from the Tema harbor, where the equipment for the wind power projects are expected to be delivered in Ghana. As recommended by Laso Transportes, the terrain of the area under consideration would require a number of road works for the establishment of a wind energy facility.

Figure 3-1: Project Transport Route

(Source: Draft Feasibility Study for Anloga Wind Farm, August 2015)

The access to the site along the N1 shows no major obstacles, only small works are necessary at roundabouts and turnings to assure sufficient space without electricity poles, traffic signs, etc.

A truck test is to be performed after the road works are done. All roads are to be reviewed 4 months before the start of the project. Due to local movements/traffic inside villages, the proposed roads are to be crossed during night time and all access roads within villages must be clear to allow the transports.

Work will commence with improvement of the access road connecting the site with the national Accra – Aflao Highway N1. Any dirt road to the identified sites will require widening, spreading gravel and compaction to upgrade/ build to a standard that is suitable for the 60-foot flat-bed trucks in good weather conditions. Lay-bys will be built at suitable points for ease of crossing. The roads within the project area shall be suitably compacted / strengthened to withstand the onset of torrential surface flow and land submergence/inundation. Since the entire project area is flat, road gradient will not be an issue.

Figure 3-2: **Transportation of a Tower section**

Figure 3-3: **Transportation of a Rotor blade.**

Figure 3-4: **Transportation of a Nacelle**

Transport Vehicles and Requirements

The road specifications must be related to the wind turbine types, due to different length and weight of the components.

The wind turbine, including tower, will be brought on site by the supplier in sections on flatbed trucks. Turbine units which must be transported to site consist of a tower comprised of four segments of approximately 20 m in length, a nacelle weighing approximately 83 tons, and three rotor blades.

The Truck Drivers’ Guide, 2013 requires that trucks weighing 3.5 MT or more must have reflective tape (yellow in color and 50 mm wide) on the side and back of the truck and trailer. Trailers carrying loads exceeding 2.5 m wide or 4.5 m high require a special permit from the Ghana Highway Authority. In addition to the specialised lifting equipment, the normal civil engineering construction equipment will need to be brought to the site for the civil works (e.g. excavators, trucks, graders, compaction equipment, cement mixers, etc.). The components required for the establishment of the substation (including transformers) as well as the powerlines (including towers and cabling) will also be transported to site as required. The dimensional requirements of the load during the construction phase (length/height) may require alterations to the existing road infrastructure (widening on corners, removal of traffic islands), accommodation of street furniture (electricity, street lighting, traffic signals, telephone lines, etc.) and protection of road-related structures (bridges, culverts, portal culverts, retaining walls, etc.) as a result of abnormal loading. The equipment will be transported to the site using appropriate national and urban routes, and the dedicated access/haul road to the site itself.

3.4.3 Operational Phase

The operational lifespan of the proposed Wind Energy Facility (WPP2) is expected to be approximately 20 to 30 years. Wind turbines will be operational for this entire period except under circumstances of mechanical breakdown, extreme weather conditions and/or maintenance activities. Wind turbines will be subject to regular maintenance and inspection to ensure the continued optimal functioning of the turbine components. The Project will be operational 24 hours a day, seven days a week. There will be regular monitoring of the performance of the WTGs and minor maintenance carried out when required. Annual maintenance of the WTGs will also be carried out.

Operation and maintenance (O&M) of wind farms is different from O&M of conventional power plants. To run conventional power plants, the purchase of fuel (or coal or gas etc.) is necessary. In case of failures, the machines will stop and do not produce energy - but do also not consume fuel anymore; therefore, the loss of revenue is limited. It is different with wind farms as the “fuel” is the wind. It is free of charge, but is fluctuating; therefore, the aim is to run the WTG as much as the wind speed is in a meaningful level. Hence every stop of the WTG, especially in high wind season is a loss of revenue.

O&M presents different challenges for utilities, including decisions on conducting activities with existing utility staff or outsourcing these activities or a blend of the two scenarios. The operating and maintenance requirements and costs for the wind farm are described in the Draft Feasibility Study for Anloga Wind Farm (LI, 2015). Wind turbines can provide large amounts of electricity, cleanly and reliably, at prices competitive with any other new electricity source, provided they are properly operated and maintained. Standard maintenance of the WTG components can be schedule by VRA with technicians. When scheduling maintenance occurs, the operation of the WTG will need to stop.

There are three basic O&M concepts:

a. Many turbine suppliers (TS) offer their clients a 100% full service contract. This can start from installation to almost for the whole lifetime of the wind turbines.

   Concerning balance of plant (BOP) – although it is not common that all equipment other than the turbines such as civil devices (e.g. roads, foundations, crane pads) or electrical devices (e.g. cables, transformers, substation)– are taken care of by the TS, it has been practiced e.g. for smaller wind farms with only a few wind turbines. For larger wind farms this is a matter of negotiation with the TS, otherwise consequently the owner or another company have to be engaged for the O&M of BOP.

b. The most common way of O&M is to share the tasks between the operator (owner) and the turbine supplier. Usually the first few years (in common 2 to 5 years, which is the usual warranty time) the TS will play the main role in monitoring, maintenance and repair of the wind turbines. The owner usually accompanies this process, having own devices for monitoring and setting up own maintenance teams time by time until the handover of the turbines, which is usually after the warranty period. It is also common practice that the owner undertakes the task of O&M of BOP; especially in the case, the owner has already experience with power plants.

c. A seldom case is the complete own O&M by the owner right after installation and commissioning of the turbines. This is e.g. the case often found in China, where they sometimes follow other strategies driven by own policies. But also in this case a training of personnel is necessary and the accompanying support of an experienced consultant is recommended. The staffing is similar to the one mentioned under b).

For the long-term success of the wind farm project, assuring the optimal utilisation of the given wind potential and the optimal electricity generation, good operation and maintenance procedures have to be established. The expertise and experiences of the personal is the key property which is to be established and maintained.

The main aim of the periodical maintenance of the WTGs is to verify and assure the good state of all components. It includes amongst others visual inspections, greasing of moving parts and replacement of wear and tear parts. Furthermore, the repair and/or replacement of damaged components need to be done; this is also referred to with the term “unscheduled maintenance”.

With regards to the operation of the wind farm, the continuous control of electricity generation of the individual WTGs and the complete wind farm and commercial issues related to invoicing the generated electricity to the off-taker and paying received invoices are key activities. For the remote control of the wind farm the team should be capable to handle complex software and data bases of immense extension and information density. Incoming SCADA data demands monthly analyses of the production, income and costs as economic data set. Also deep analyses and elaborations of the SCADA data allow the indication of potential optimisation, pinpoint instruction of maintenance hot spots and/or arising defects (CMS). With meteorological input the target-performance comparison is to be performed.

As a general standard, the maintenance is done by the lead of the manufacturer of the WTGs for the first operational years and in particular during the defects liability or warranty period. Afterwards VRA may decide to do the maintenance (at least major share of these works) with its own staff. The staff should therefore be trained during the first operational years, amongst others by working jointly with the manufacturer's staff. The VRA staff can take over more and more of the work until the manufactures staff effort is reduced to consultancy.

Spare part storage

One of the most essential tasks to ensure a smooth operation of a plant is the availability of spares. The usual manufacturing time for components is quite high and the lead-time for some of the spares is up to one year. VRA plant management should be aware of this fact and a fully computerized inventory management system should be developed right at the start, to eliminate shortages of spares.

Regarding small parts and components, the TS should deliver an inventory plan of spares. Regarding large components which have a high impact on the revenue and profit of the wind farm, it is advisable to have the following spares:

Sets of rotor blades	1 - 2
Generators	1 - 2
Gear boxes	1 - 2
Main converters	1 - 2
Transformers (step up from WEC to WF)	2 - 3

For rotor blades it is recommended using the transport cages for rotor blades as storage. These cages have to be covered by a roof to protect the blades from sun, dirt and rain. This system has the advantage that the blades can be transported safely according to the manufacturer's instructions in case of a rotor blade change.

The instructions for the handling and storage of major components like gearboxes, generators and cabinets have to be followed carefully. Generally, protection against sun, rain, dust and small animals is recommended. For some equipment the storage should stay below a maximum temperatures e.g. specific pint.

The above mentioned large components sum up to an investment of approximately 1 to 1.5 wind turbine equivalents. These values are derived from the experience of the Consultant and are rather rough, but reliable values. With a broad basis of European wind farm data, it would be possible to prepare a more detailed evaluation, but the question is if this is possible and even sensible at present stage, lacking of data and experience of wind energy in Ghana.
Due to fact that repairing is always a challenge against time, the storage should be located at a place with sufficient infrastructure to transport spares and equipment to the wind farm.

Employment

Approximately 20 technical persons on shift basis shall be hired for the operation of the wind farm and during operational phase. This number will be in addition to those engaged at site for security and administrative duties expected.

3.4.4 Decommissioning Phase

Decommissioning refers to the planned shut down or removal of a facility, buildings and/or equipment from operation or use. It is anticipated that the WPP2 Wind Energy Facility will only be decommissioned once it has reached the end of its economic life span. The main aim of decommissioning is to return the land to its original, pre-construction condition. Should the unlikely need for decommissioning arise (i.e. if the facility becomes outdated or the land needs to be used for other purposes), the decommissioning procedures will be undertaken in line with the EMP and the site will be rehabilitated and returned to its pre-construction state.

If the site is not decommissioned, it is possible that a lease extension could be granted based on agreements with the landowner. If this occurs, the site and technologies could possibly be advanced and upgraded, subject to the legislative requirements at that point in time.

Should it be deemed feasible at the time to continue the economic life of the project then wind turbines and associated infrastructure may be disassembled and replaced with more appropriate technology and infrastructure which may be available at the time, alternatively the disassembled turbines and infrastructure will be removed and not replaced. Various components of the proposed Wind Energy Facility which would be decommissioned can be reused, recycled or disposed of in accordance with the relevant regulatory requirements. All of the components of the wind turbines are considered to be reusable or recyclable except for the turbine blades.

3.5 ASSESSMENT OF ALTERNATIVES

The Ghanaian EIA Regulations LI 1652 of 1999 require the provision of an outline of the main alternatives considered with the main reasons for the choice selected. This section provides a full description of the process followed to select the proposed preferred activity, technology, site and location within the project site, including details of all the alternatives considered and the outcome of the site selection matrix, taking into account environmental, social and economic variables. This analysis is aimed at comparing, based on a set of previously established criteria, the best feasible alternatives in order to identify the one causing the least impact and allowing to determine the optimal option for the Project location.

The alternatives considered are as follows:

- No Go Alternative
- Alternatives for the Generation of Electricity from a Non-Renewable Resource
- Site Location Alternatives
- Technology Alternatives
- Layout Alternatives

3.5.1 No-Go Alternative

The no-go alternative assumes that the proposed project will not go ahead i.e. the proposed project is not constructed and developed into an operational energy facility. This alternative entails that the development of the proposed facility would not drive any environmental change and results in no environmental impacts on the site or surrounding local area. It provides the status quo or baseline against which other alternatives are compared and will be considered throughout the report.

The costs/implications and benefits of implementing the ‘no-go’ alternative is presented in Table 3-8. Implementing the ‘no-go’ alternative entails that this WEF facility will not be contributing to environmental, social and economic change (positive/negative) in the area proposed at the project site.

Table 3-8: Costs and benefits of implementing the ‘no-go’ alternative

COSTS	BENEFITS
• No additional power will be generated or supplied through means of wind energy generation by this project at this location. • A WEF is not present to assist Government in achieving its energy generation targets. • Electricity generation sources will remain unchanged. • Electricity generation will remain constant (i.e. no additional energy generation will occur on the proposed site) entailing that the local economy will not be diversified. • The local municipality’s vulnerability to economic downturns will increase because of limited access to capital. • No additional employment opportunities will be created. Both skilled and unskilled employment opportunities are anticipated to be created for the construction and operation of the WEF. • No additional opportunities for skills transfer and education/training of local communities created. • Potential positive socio-economic impacts likely to result from the project, such as increased local spending and the creation of local employment opportunities, will not be realised.	• No threatened vegetation will be disturbed or removed. • The current landscape character will not be altered. • No influx of people (mainly job-seekers), driven by the development of a facility will occur, which entails that there would not be additional pressures on the infrastructure and service delivery of local municipalities and towns in the area. • No fragmentation of habitat or disturbance to faunal species.

Ghana faces a critical energy challenge, unmet demand and an unreliable energy supply. According to Essah, 2011, electricity consumption in Ghana is estimated to be increasing by 10% per annum due to the demand from the growing population. It is estimated that between 200MW and 250MW is expected to be added to the installed capacity each year to keep up with the demands of a growing economy and improve the reserve margin. The country in 2014/15 was shedding between 400 and 700 Megawatts of power during off-peak and peak periods, respectively due to a shortfall in production. The crisis was because of poor water levels in the three hydropower dams, lack of gas flow from the West Africa Gas Pipeline in Nigeria to thermal plants in Ghana for production as well as the breakdown of some of the thermal power plants. Thus, the need for a stable, adequate, and regular power supply in stimulating the country's development cannot be underestimated. Solving the energy crisis requires the highest priority given the damaging cost it poses to the growth of Ghana's economy.

In spite of the fact that the "No Go Alternative" does not relocate anybody, it does not guarantee that the existing environmental quality will continue to be maintained. At the same time, the large society of people in the local area as well as Ghana in general would not derive the associated socio-economic benefit rather they are going to lose in terms of development, improved quality of life through access to cheap electricity, increased pollution and deforestation in some areas for fuel wood.

In summary, whilst the "no-go" alternative will not necessarily directly drive any negative environmental and social impacts; it will also not result in any positive community development or socio-economic benefits. Furthermore, it will also not assist government in addressing electricity shortages and electricity demand within the country. Based on the above, the "no-go" alternative is not deemed to be the preferred alternative but will be taken forward and indirectly considered within the ESIA Phase as this alternative will serve as the baseline against which the potential impacts associated with the project are assessed.

3.5.2 Alternatives for the Generation of Electricity from a Non-Renewable Resource

VRA is undertaking more generation projects and is planning to add about 1,000 MW of generation capacity by 2020. This includes upgrading simple cycle plants to combine cycle to reduce cost of supply, pursuing Solar and Wind energy projects as well as pursuing the use of Liquefied Natural Gas (LNG) to generate electricity as a measure to secure future gas supply reliability. The proposed 75MW Power project could be obtained through the use of fossil fuels to generate electricity. However, by so doing, VRA will not be responding to the requirement of slowing down on fossil fuel consumption that is adding to global warming on the one hand and on the other hand depleting the resources.

As indicated, the Government of Ghana has formulated a Renewable Energy (RE) policy that projects that 10% of Ghana's electricity needs should come from RE by 2020. The RE Law is to provide for the management, development and utilization of renewable energy (RE); to provide for the sustainable and adequate supply of renewable energy; and to provide for related matters. The object of this Act is to promote the sustainable development and utilization of RE resources for electricity and heat generation.

The uptake of renewable energy offers the opportunity to address energy needs in an environmentally responsible manner and thereby allows Ghana to contribute towards mitigating climate change through the reduction of greenhouse gas (GHG) emissions. According to the National GHG Inventory Report (2014), Ghana generated 3 955.9 GWh of thermal-based electricity to the economy in 2012. Out of this, 64.14%, 35.17% and 0.68% of thermal electricity were produced from LCO, natural gas and diesel fuels. This resulted in a total of 3.2MtCO2e greenhouse gas emissions, which was about 85% higher than the 2000 emission levels. This translated into CO2 intensity of 0.07 GgCO2e/GWh in 2000 to 0.26 GgCO2e/GWh in 2012.

The 10% Renewable Energy into the electricity mix targeted by 2020 means 500MW of RE and this project is helping achieve the national target. Thus the use of other forms of energy like fossil fuels (Light crude oil, diesel fuel oil, heavy fuel oil, natural gas) as an alternative power generation with high impact on climate change will not assist the Ghanaian government in addressing climate change, in reaching the set targets for renewable energy, nor will it assist in supplying the increasing electricity demand within the country.

3.5.3 Site Location Alternatives

Section 3.1 provides detailed information on the various alternatives considered in the site selection for the project.

3.5.4 Technology Alternatives

There is a limited range of alternative technologies (turbines) for commercial scale wind energy facilities. In addition, the technology is constantly evolving and there are currently no significant differences from an environmental perspective between technologies. As indicated earlier, VRA has engaged the services of two wind developers, Vestas Eolica and Elsewedy/EYRA (Energia y Recursos Ambientales S.A.). The WPP2 site is proposed to be equipped with WTGs manufactured by general Electric and would comprise 45 General Electric GE1.7-103, each of 1.7 MW nominal power on a hub height of 80 m above ground level.

General Electric (GE) is an American corporation incorporated in New York and headquartered in Fairfield, Connecticut. It is ranking within the 30 largest companies in the world. It has its roots in companies founded by Thomas Edison at the end of the 19th century and back in 1889 the “Edison General Electric Company” was incorporated, growing over the decades to the actual GE conglomerate. GE moved into the wind energy business in 2002 by acquiring bankrupt Enron Wind, which had been formed from mainly two companies, Zond (established in 1980 in the US) and Tacke Windtechnik (established in 1990 in Germany). Under the GE brand, at the beginning the only WTG model was a 1.5 MW machine, which evolved over the years in the actually produced models of 1.6 - 1.85 MW. In 2004 additionally a 2.5 MW model was introduced and led to actually produced models of 2.0-2.4 MW. Building on this base, also models around 3 MW of rated power have been introduced.

The GE 1.7 is a WTG following one of the main concepts in wind industry, based on the initial simple three bladed, upwind positioned, horizontal-axis rotor and using a distributed drive train design with the major drive train components (main shaft, bearings, gearbox, generator). The auxiliary components (yaw drives and control panel) are attached to a bedplate. The generator is a doubly-fed induction generator (DFIG) design. The control system allows several machine features such as: active and reactive power control, optimized aero-dynamic efficiency to maximize power output while minimizing the wind loads, increasing power quality and reliability. For the rotor blades, GE is offering the "low-noise trailing edge" option (vortex generators applied to the surface) for lowering the acoustic emission from 107 to 105 dB(A).

3.5.5 Layout Alternatives

This section provides a description of the three site locations which form part of WPP2 for the preferred and alternative layout. The conceptual layout for each of the three sites is shown in Figures 3.9 to 3.14 below.

3.5.5.1 Goi

The site encompasses 67.68 ha properties, where it is planned to install 16 turbines of 1.7 MW each for the preferred layout and no turbines for the alternative layout.

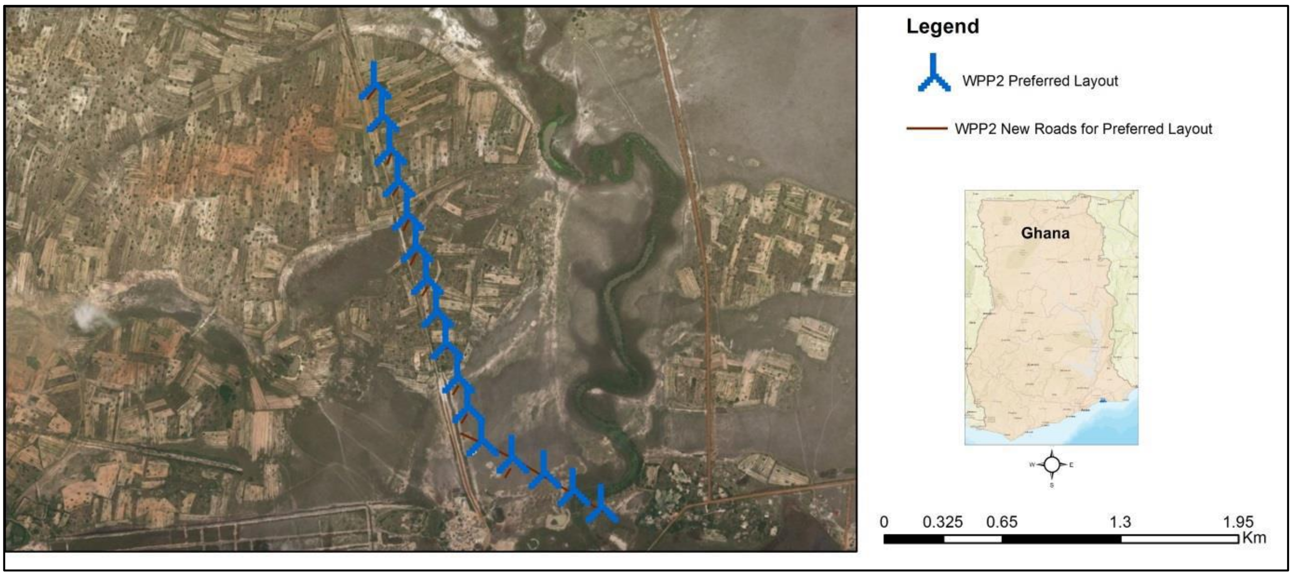

Figure 3-5: Location of Goi preferred location

3.5.5.2 Wokumagbe 1

The site encompasses 60.64 ha properties, where it is planned to install 11 turbines of 1.7 MW each for the preferred layout and 27 turbines of 1.7 MW each for the alternative layout.

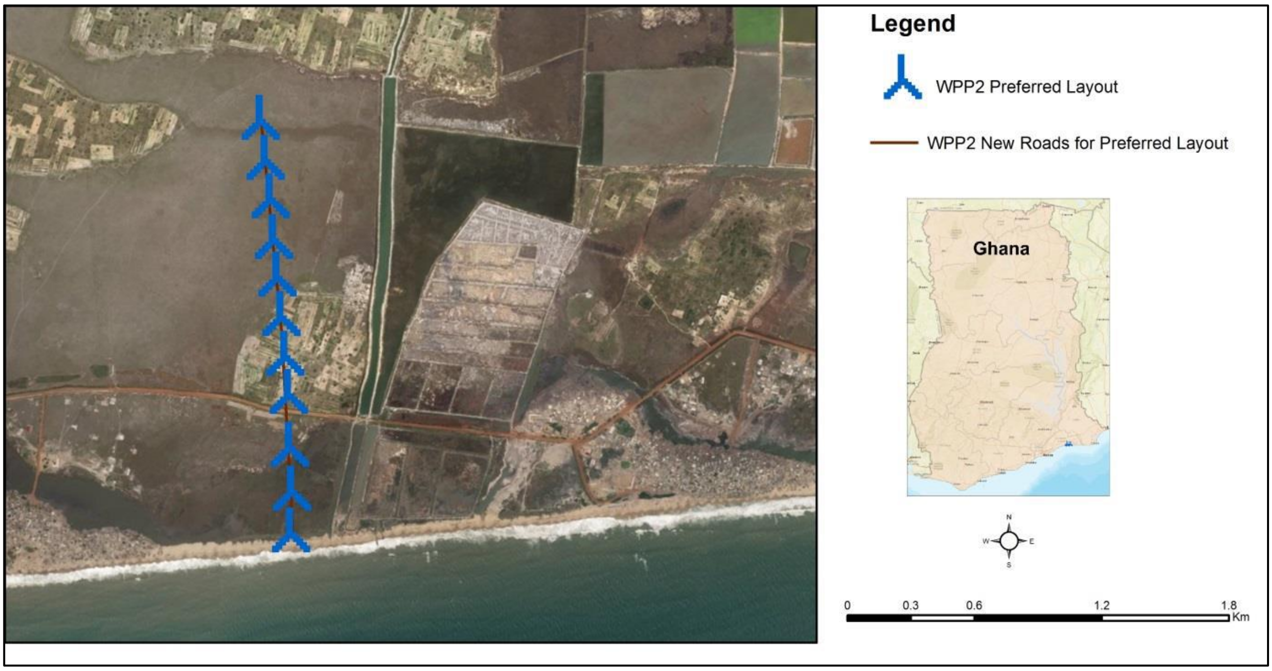

Figure 3-6: Location of Wokumagbe 1 preferred layout

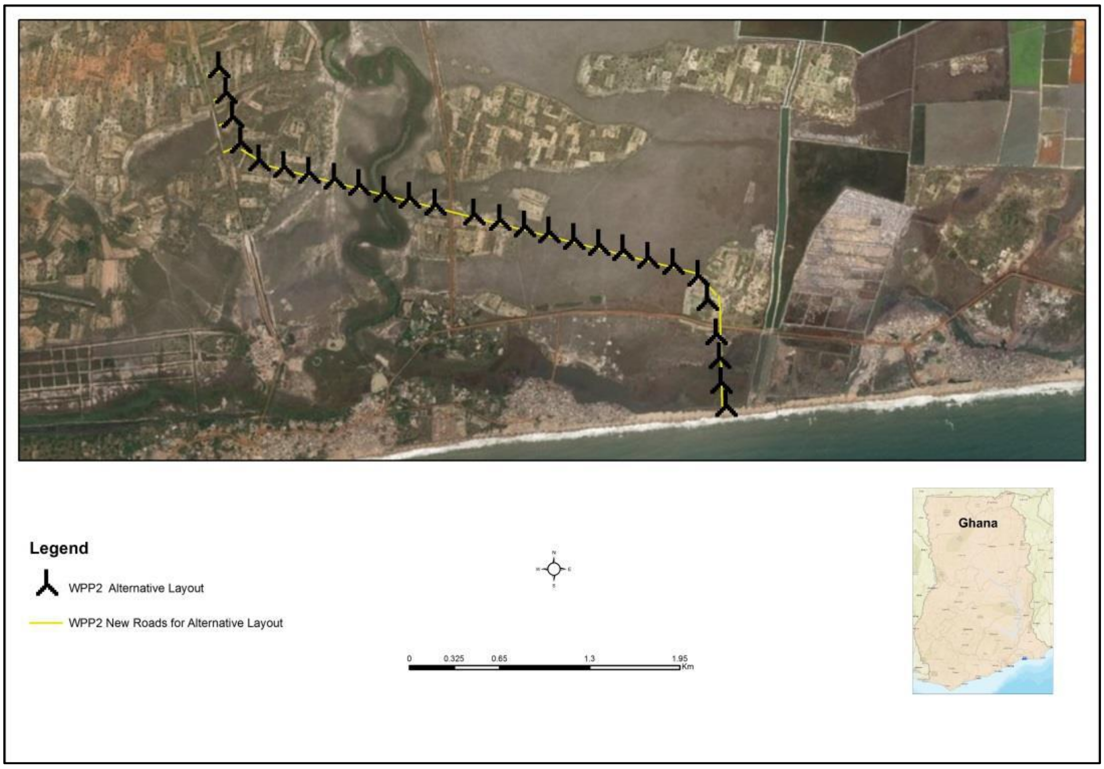

Figure 3-7: Wokumagbe 1 alternative layout

3.5.5.3 Wokumagbe 2

The site encompasses 94.38 ha properties, where it is planned to install 18 turbines of 1.7 MW each and 15 turbines of 1.7 MW each for the alternative layout.

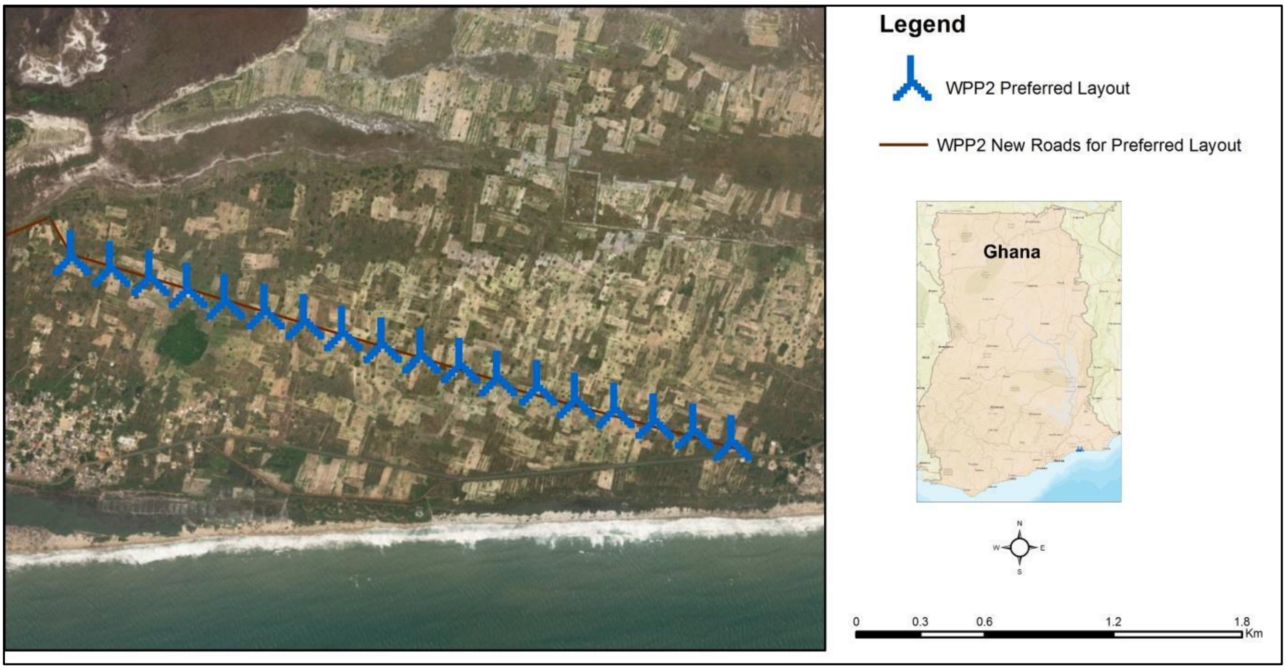

Figure 3-8: Location of Wokumagbe 2 preferred layout

Figure 3-9: Location of Wokumagbe 2 alternative layout

3.5.5.4 Wokumagbe 3

The site encompasses 56.16 ha properties, where it is planned to install 3 turbines of 1.7 MW each for the alternative layout and no turbines for the preferred layout.

Figure 3-10: Location of Wokumagbe 3 alternative layout

3.5.6 Concluding Statement of Preferred Alternatives

Based on the aspects considered in this chapter, the following concluding statement is provided in terms of the preferred alternatives that have been considered in the ESIA Phase.

- **No-go Alternative:**
  - The no-go alternative assumes that the proposed project will not go ahead. This alternative would result in no environmental impacts on the site or surrounding local area, because of the facility. However, there would be shortfall in generation capacity, constraints in the availability and stability of electricity supply, no additional people employed and no skills transfer. It provides a baseline against which other alternatives can be compared to and considered during the ESIA Phase.

- **Alternatives for the Generation of Electricity from a Non-Renewable Resource**
    - The use of other forms of energy like fossil fuels (Light crude oil, diesel fuel oil, heavy fuel oil, natural gas) as an alternative power generation with high impact on climate change will not assist the Ghanaian government in addressing climate change, in reaching the set targets for renewable energy, nor will it assist in supplying the increasing electricity demand within the country. Generation from renewables, such as this wind power facility, are therefore high on the sustainable development agenda of Ghana.

- **Site Location:**
    - The preferred site for the project is the sites of Goi, Wokumagbe 1 and Wokumagbe 2 for the preferred layout with the addition of Wokumagbe 3 for the alternative layout; and
    - The available developable areas at each of the above locations exceed the required area for the proposed development.

- **Technology Alternatives**
    - There is a limited range of alternative technologies (turbines) for commercial scale wind energy facilities. In addition, the technology is constantly evolving and there are currently no significant differences from an environmental perspective between technologies.
    - VRA has engaged the services of Elsewedy/EYRA (Energia y Recursos Ambientales S.A.).
    - 45 General Electric GE1.7-103, each of 1.7 MW nominal power on a hub height of 80 m above ground level has been selected for installation.

- **Layout Alternatives:**
    - The preferred layout comprises 1.7MW turbines and consists of 45 turbines covering an area of approximately 169.98 ha.
    - The alternative layout comprises 45 turbines with an individual capacity of 1.7 MW and covers an area of approximately 186.08ha.

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for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 4:

Description of Affected Environment

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TABLES

FIGURES

4 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This chapter of the ESIA Report provides a broad overview of the affected environment for the proposed project region. The receiving environment is understood to include biophysical, socio-economic and heritage aspects which could be affected by the proposed development or which in turn might impact on the proposed development.

This information is provided to identify the potential issues and impacts of the proposed project on the environment. The information presented within this chapter has been sourced from:

- Preliminary scoping input from the specialists that form part of the project team;
- Review of information available information.

It is important to note that this chapter intends to provide a broad overview and does not represent a detailed environmental study. Detailed descriptions of the project sites are provided in the relevant specialist studies which are included as Appendices to this ESIA Report.

4.1 LOCATION

Ghana lies in the centre of the West African coast and shares borders with the three French-speaking nations of Cote d’Ivoire to the west, Togo to the east, and Burkina Faso (formerly Upper Volta) to the north (Figure 4.1). To the south are the Gulf of Guinea and the Atlantic Ocean. The country lies just above the equator and is on the Greenwich Meridian which passes through the seaport of Tema, about 24 km east of Accra, the capital.

Figure 4-1: Location of Ghana in West Africa

The Wokumagbe and Goi WEF is located in the Ada West District. The District lies between Latitudes 5°45'S and 6°00'N and Longitude 0°20'W and 0°35'E. The total land area of the District is approximately 323.72 km^2, which is about 10% of the total land size of the Greater Accra Region. The District shares common boundary with the North Tongu District of the Volta Region to the North, Ada East to the East, Ningo Prampram District to the West and to the South by the Gulf of Guinea, which stretches over 45 km from Wokumagbe through Goi to Kablevu. Sege is the District capital, and it lies about 80 km from Accra on the Accra - Aflao road (Figure 4.2).

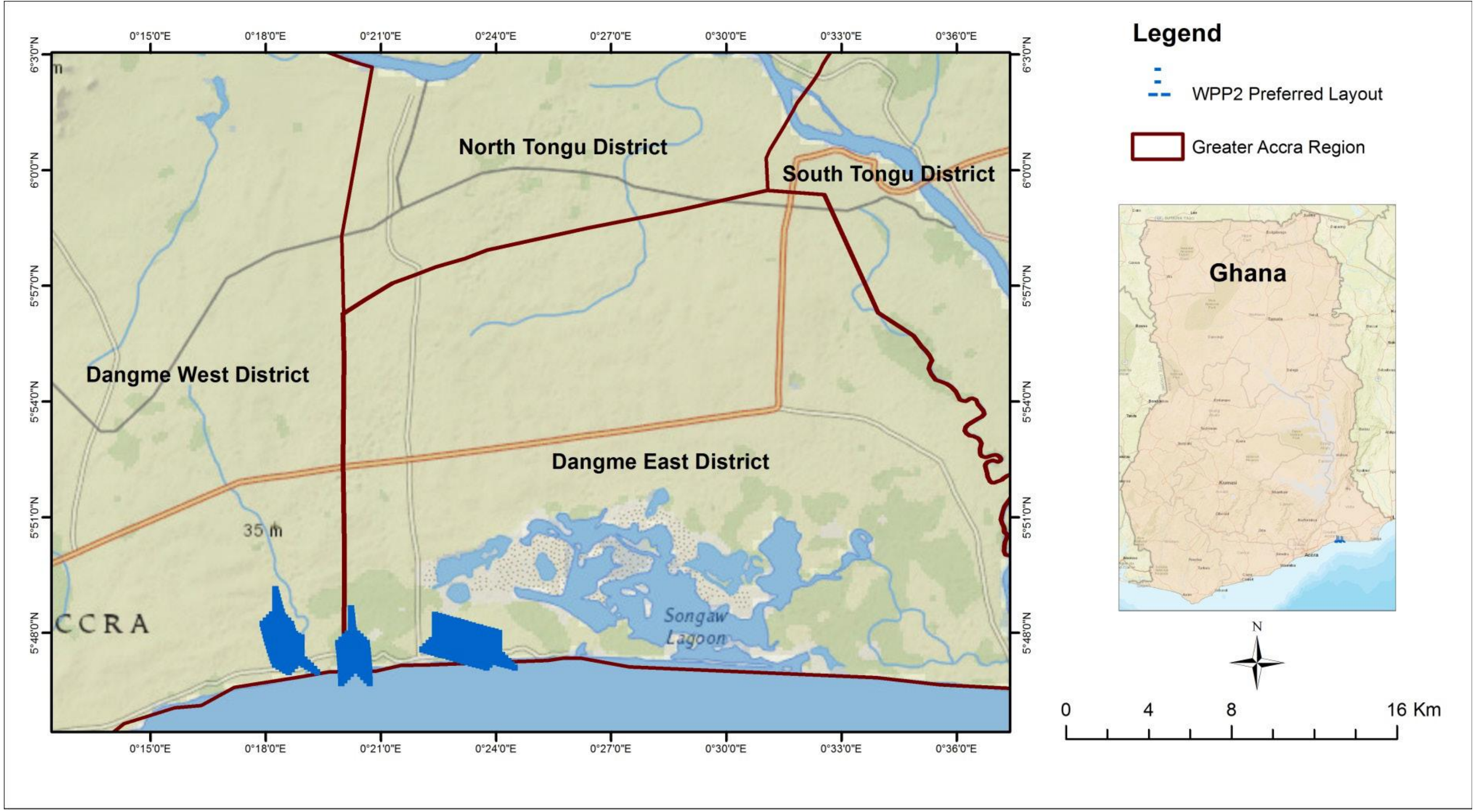

Figure 4-2: Regional Context of WPP2 site

4.2 BIOPHYSICAL ENVIRONMENT

4.2.1 Climatic Conditions

The climate of Ghana is tropical, warm and comparatively dry along the southeast coast; hot and humid in the southwest of Ghana and hot and dry in the north, with temperatures varying with season and elevation. The majority of the country’s average rainfall falls 1 000 – 1 250 mm between the years 1981-2010 (Figure 4.3). The weather in Ghana is controlled by the position and intensity of the Azores anticyclone (high pressure centre) in the North Atlantic and the St Helena anticyclone in the South Atlantic. Rainfall throughout Ghana is determined by two prevailing air masses: the hot and dry Tropical Continental Air Mass (NE trade winds) and the warm and humid Tropical Maritime Air Mass (SW trade winds).

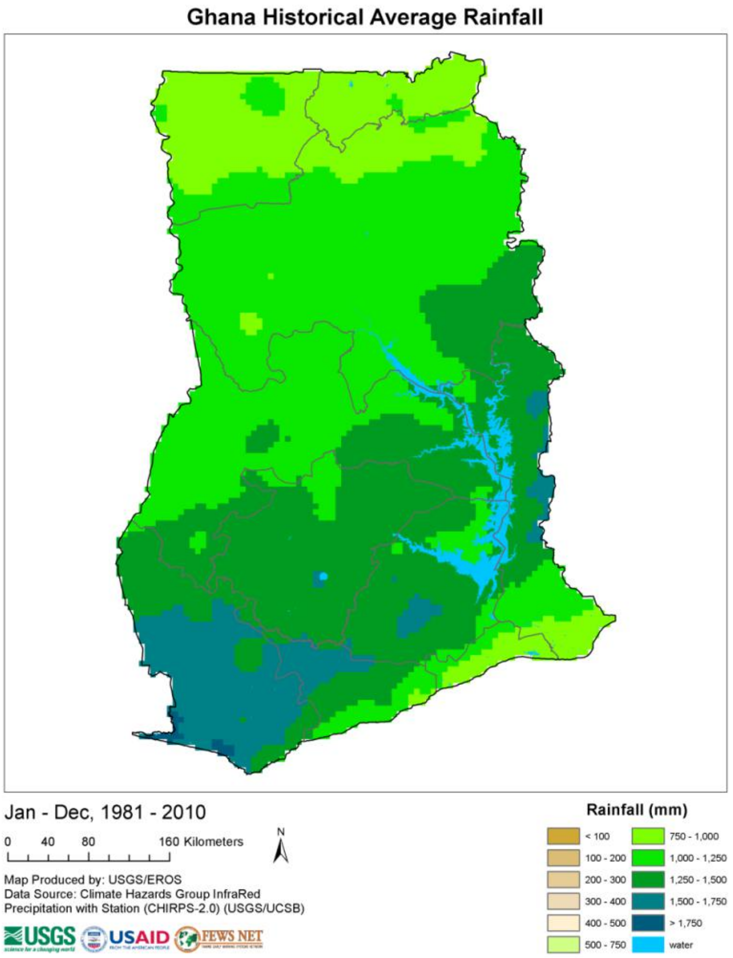

Figure 4-3: Mean Annual Rainfall Levels of Ghana (Source: Climate Hazards Group InfraRed, 2017)

The mean annual temperature in Ghana ranges from 25.9 °C to 29.7 °C due to the low latitude of Ghana (Figure 4.4).

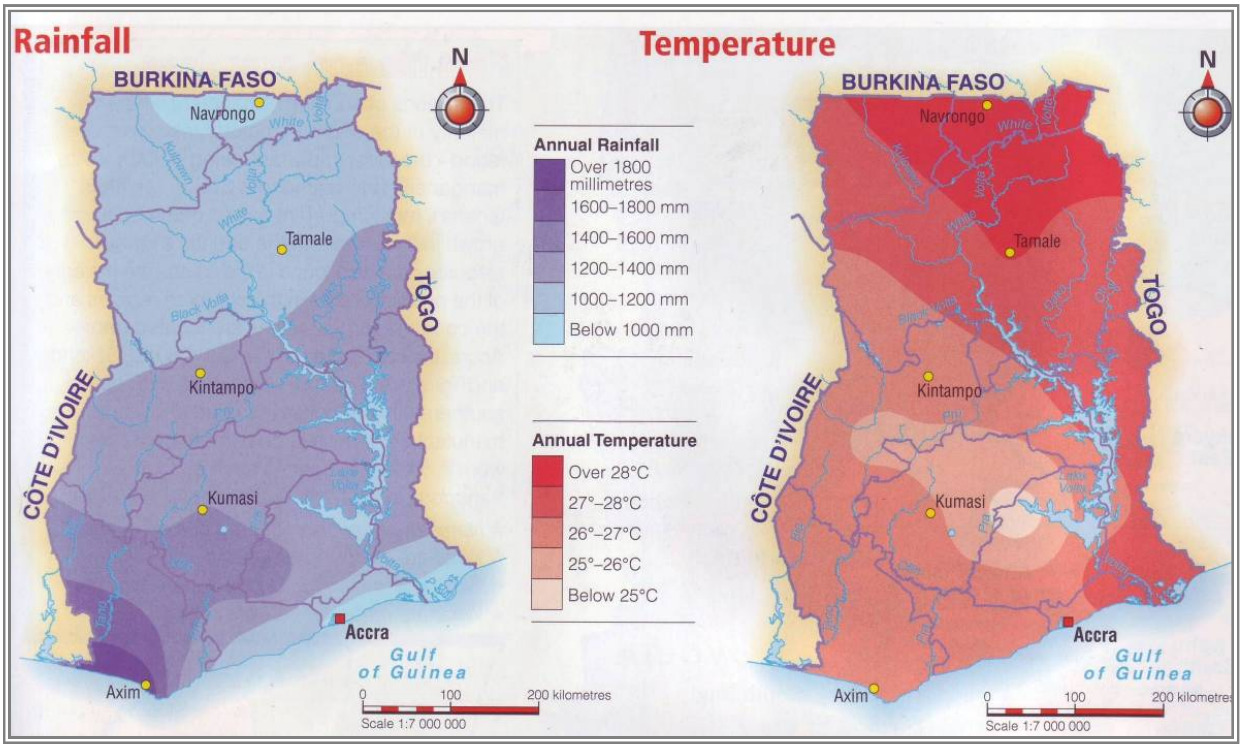

Figure 4-4: Average annual rainfall and temperatures in Ghana (MacMillan, 2007)

The Ada West District is located on the south-eastern coastal plains of Ghana which form one of the hottest parts of the country. Temperature is generally high throughout the year. The minimum temperature ranges between 20°C and 29°C while the maximum temperature also ranges between 290 C to 33°C which is normally attainable during the hot seasons. Though the coastal savannah experiences a bimodal rainfall regime, annual rainfalls are very variable and range from 750-1000mm. Rainfall is generally low along the coast but increases towards the inland area. The first and major season starts from March or sometime in April to mid-July while the second season begins from September and ends in early December. The second season is highly unreliable. The average annual rainfall is about 850 millimeters. The erratic rainfall in the district affects the agricultural productivity since most farmers depend solely on it for their crop and animal production (Table 4-1).

Table 4-1: Temperature, Humidity, Rainfall and Wind Speed in Project Area for 2006 - 2015

PERIOD	TEMP (^{O}C)			RAINFALL	WIND SPEED (KM/HR)		MEAN HUMIDITY
Month	*Min*	*Mean*	*Max.*	*mm*	*Mean*	*Max*	*%*
January	25.0	28.6	33.4	8.6	3.7	8.0	70.8
February	25.6	29.0	33.9	9.0	4.6	9.8	72.7
March	21.2	23.3	26.1	2.9	9.2	14.1	77.5
April	19.8	21.4	23.4	12.8	10.9	16.2	79.3
May	22.7	24.5	26.8	13.2	12.0	18.1	79.3
June	20.0	21.6	23.5	20.2	9.9	15.6	79.5
July	23.8	26.2	28.5	53.6	10.3	18.1	80.6
August	23.3	25.1	26.9	45.3	11.8	19.3	83.6
September	22.3	23.9	25.7	21.6	13.1	19.4	86.1
October	21.5	23.0	25.1	30.0	12.2	18.4	87.7
November	22.4	24.0	26.3	22.8	13.8	19.8	86.2
December	21.0	22.8	25.0	29.6	11.4	17.2	82.0

A noteworthy climatic phenomenon in Ghana is the harmattan winds which blow in from the northeast from December to March, bringing dust from the Sahara and reducing visibility to as little as 1 km. This dry desert wind lowers the humidity and creates hot days and cool nights in the north. In the south, the effects of this wind are felt in January.

4.2.2 Regional Geology

About two thirds of the land surface of Ghana is covered by Birimian rocks that are of paleoproterozoic age. These rocks form the easternmost component of the Man Shield of West African craton that has remained stable since 1.7 Ga. The eastern portion of the country is predominantly underlain by middle to late Proterozoic rock units, namely; Dahomeyan, Togo, Buem and Voltain belts (Leube, et al., 1990).

The Volta River has a dominant influence on the geomorphology of this coast. The project sites are mostly sandy and characterized by the deltaic features of the Volta River. Fluvial sediments from the river, as well as, marine and fluvial-marine sediment make up the surface geology of the area. The beaches comprise medium to coarse sand and rise steeply (a slope of about 1:10) in elevation to about 2m above Mean Sea Level (MSL).

A large portion of the District is underlain by tertiary and recent alluvial deposits. A small section of the northern and eastern parts (between Afiadenyigba and Sege) fall under the Dahomeyan complex rocks of Precambrian age. Unconsolidated sand, clay and gravel occur in the deltaic areas surrounding the Songor Lagoon. The suitable soil formed from these soil associations is the Tojeh and Koloidaw series. These soil types vary from red to brown deep (120-150cm) to very deep (>150cm) well to moderately drained fine sandy clay loams to sandy clay. The soil formed under these rocks supports a variety of tropical crops which sustain the agricultural activities in the district.

Ghana has been known to be seismically active for centuries. Earthquakes of magnitude greater than 6.0 have been recorded; however, current seismic activities have been confined to local tremors of 4.8 or less on the Richter Scale. The earthquakes have mostly occurred west of Accra in the area where the Coastal boundary fault and Akwapim fault zone meet. A review of geological and instrumental recordings by Amponsah (2002) shows that earthquakes are still can occur in this area. The Seismic activities of southern Ghana have been linked to the St. Paul’s (Axim area earthquakes) and Romanche (Accra area earthquakes) transform-fracture zone systems offshore in the Gulf of Guinea to onshore. The St. Paul’s has been inactive for some time but movement along the Romanche Transform fault and Fracture zone is active.

According to Bacon and Quaah, 1981, most of the epicentres are located south of Weija suggesting that there is little activity north-eastward along the Akwapim range and westward along the Coastal boundary fault. It is evident from their results that there is a low level of seismic activity scattered along the Akwapim fault zone that could be due to normal faulting (Burke, 1969).

Microseismic studies in southern Ghana indicated that the seismicity is associated with active faulting (Essel, 1997) between the east-west trending Coastal boundary fault and a northeast-southwest trending Akwapim fault zone, defined by a number of active faults. A geophysical study by Essel (1997) indicated that the seismic activity is related to deep-seated faults.

The project area in south eastern Ghana is not likely to be impacted by a major earthquake in the Accra region. It is important that all foundation structures adhere to the "Code for Seismic design for Concrete Structures" (Nov. 1990) as well as the National Building Regulations, 1996, LI 1630.

Environmental risks like earthquakes and landslides are not considered as major risks and have not to be taken into account.

4.2.3 Agricultural Capability and Sensitivity

Agriculture constitutes the main economic activity and a major source of livelihood for the majority of the rural dwellers. According to the 2010 Population and Housing Census, the agriculture sector provides employment for about 42.5% of household heads in the District. This include livelihood for the people through direct farming, distribution and marketing of farm produce and other service to the agricultural sector. It forms the basis of successful operation of the thriving market in the district.

The main agricultural activities considered here include crop farming (48.1%) livestock rearing (36.5%), and fishing and agro-forestry. Agriculture in the district contributes to food security, provides raw materials for local industries, generates foreign exchange, and provide employment and incomes for most of the population (especially those living in the rural areas), thereby contributing to poverty reduction. The dominant agricultural in the region is crop farming (48.1%).

The Ada West District is noted for the cultivation of cassava, maize, legumes, fruits and variety of other vegetables. With the exception of maize and cassava, the district accounts for more than 50% of the regional output for these crops. Livestock rearing is another important agricultural activity in the district. The livestock identified in the district are cattle, sheep and goats, pig, poultry (fowls, turkey, duck, and guinea fowl.). The Ada West is noted for marine fishing activities. The major fishes harvested are King Fish, Anchovy, Mackerel, Tuna Spp, Shrimp, Herrings and Baracuda.

4.2.4 Regional Hydrogeology

Coastal erosion, flooding and shoreline retreat are serious problems along the coast of Ghana. Past human impacts, inappropriate management interventions, climate change and sea-level rise have been identified as major contributing factors with the soft geology and extremely low-lying nature of the coastline also being major contributing factors. Coastal erosion and flood risk to the region was aggravated due to the shortage of littoral sediment which was created by the Akosombo dam built on the Volta River in 1964.

The flat nature of the topography of Ada West District exposes it to serious threat of flood accounting for majority of cases of disasters. The most affected areas of flooding in the district are Akplabanya, Wokumagbe, Goi, Matsekope and Addokope.

4.2.5 Aquatic and Terrestrial Environment

Details pertaining to the aquatic and terrestrial environment are provided in more detail in the Ecological Impact Assessment and Wetland specialist studies ESIA Report (refer to Appendices 3 and 7 respectively).

4.2.5.1 Protected and environmentally sensitive areas

The proposed project site is located close to the designated Songor Ramsar Site (Figure 4.5). This Ramsar Site shares boundaries with the West Bank of the Lower Volta River Estuary and the Songor Lagoon. The Ramsar site is the second largest wetland along the coast of Ghana and was listed as a Ramsar site in 1992. It covers and estimated area of 53,333.3 hectares (representing 5.6 km^2 of the total land size of the district) and lies in the south-eastern coastal plains. The open water covers an area of 115 km and extends 20 km along the coast and 8 km inland behind a narrow sand dune on which fishing communities like Pute, Totope, Lolonya, Kablevu, Goi, Anyamam are situated. The coast is generally smooth without cliff.

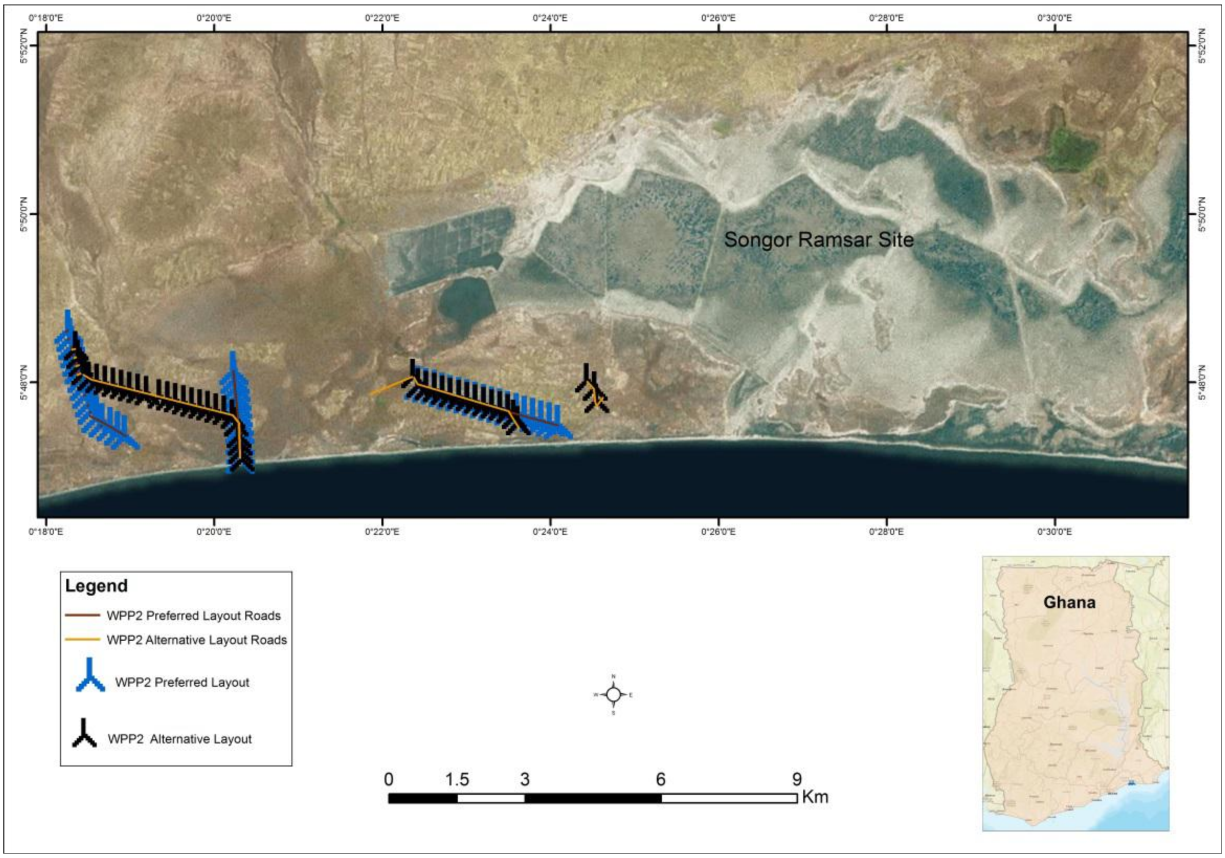

Figure 4-5: WPP2 site in relation to the Songor Ramsar Site.

The vegetation of the Songor wetland may be classified into five main types:

a) Saline marshes in the mud and salt flats depicted by *Sesuvium portulacastrum*, *Paspalum vaginatum*, *Ipomoea pescaprae*; *Sesbania sesban* and *Opuntia* species.

b) Waterlogged grassland dominated by *Vetiveria fulvibarbis*, *Andropogon gayanus*, *Brachiaria yalcifera*, *Imperata cylindrica* (Lalang grass), *Sporobolus pyramidalis*, *Fimbristylis pilosa*, with a few dicots like *Cassia mimosoides* and *Polygala arenaria*.

c) Scattered thickets of shrubs, climbers and small trees on higher ground. The thicket population being composed principally of *Allophylus africanus*, *Flacourtia indica*, *Griffonia simplicifolia*, *Grewia carpinifolia*, *G. mollis*, *Capparis grythrocarpos*, *Securinega virosa*, *Uvaria globosa*, *U. chamae*, and *Zanthoxylum xanthoxyloides*.

d) Riverain woodland along the streams where *Baphia nitida* Camwood, *Lonchocarpus cyanescens* (west African or Yoruba Indigo), *Pialium guineense* (Velvet Tamarind) and *Millettia thonningii* are found;

e) Low mangroves along the margins of the lagoon characterised by *Avicinnia africana*. The plants growing in or around the water are *Cyperus articulatus* (sometimes cultivated for matting and for the aromatic rhizomes), *Borreria* species, *Lemna purpusilla*, *Nymphaea lotus*, *N. micrantha* (both called water Lily), *Ludwigia* species, *Ipomoea aguatica* and *Abutilon mauritianum.*

There has been considerable damage to the vegetation in the areas as a result of traditional slash and burn farming method, cultivation and cutting for fuelwood and charcoal

The Songor wetland supports a number of seashore birds such as terns, waders, herons and ducks. There is evidence that the area serves as a stop-over point and has a high rate of shorebird population turn over. The Songor wetland supports the following internationally important populations of species of waders: spotted redshank, greenshank, ringed curlew sandpiper, little stint, avocet and black-tailed godit. The site has the highest total tern count on Ghana coast and supports nationally important populations 10% of the total coastal count of at least 32 species of birds.

4.2.5.2 Vegetation

The project area lies in the coastal guinea savanna zone, which stretches from the east of Accra to the Western tip of Nigeria. The extent and quality of the Upper Guinea forest have declined considerably as a result of urbanisation. The existing natural vegetation of the project area is a mosaic of Coastal Thicket and Grassland as well as Lagoon margin and Estuarine Mangrove. The sand bar above the high water mark has a narrow stretch of Coastal Strand Vegetation.

The existing vegetation at Wokumagbe (Omankope) is seasonally flooded grassland vegetation which is heavily grazed, farm re-growth and isolated thicket clumps. The seasonally flooded grassland is dominated by *Cyperus articulatus, Typha domingensis, Chloris pilosa, Eluesine indica, Sporobolus pyramidalis* and Cynodon dactylon. The farm re-growths and thickets have species such as *Hygrophila auriculata, Dichrostachys cinerea, Croton lobatus, Securinega virosa, Capparis erythrocarpos, Zanthoxylum xanthoxyloides and Elaeis guineensis*.

The existing vegetation at Goi is composed of stunted *Avicennia germinans, Sesuvium portulacastrum, Cyperus maritimus, Opuntia vulgaris* and *Cocos nucifera*. The Thicket vegetation has largely been cultivated, the main crop being Cassava (*Manihot esculenta*). It occurs in a mosaic with farms and farm re-growths. Some of the common species of the thicket are *Azadirachta indica, Chassalia kholly, Millettia thonningii, Paullinia pinnata, Schrankia leptocarpa*, and *indigofera hirsuta*.

4.2.5.3 Fauna

The coastal savannah vegetation is known to support a diversity of animals including birds, small mammals and reptiles. These animals are not restricted to specific areas within the proposed area.

The Togo hare (Lepus zechi) and the common rat (*Rattus rattus*) are the most common mammals occurring widely in the area. Reptiles that are prevalent in the proposed project area include the Agama lizard (*Agama agama*), the Nile monitor (*Varanus niloticus*), Orange flanked skink (*Matugu perotteltii*) and the Puff adder (*Bitis arietans*) all perform functions vital to the maintenance of the ecological set-up of this type of vegetation.

Detailed reports on the types of flora and fauna in the project area can be found in the Ecological specialist assessment in this ESIA report (refer to Appendix 2).

4.2.5.4 Avifauna

Ornithological monitoring is vital towards ascertaining the likely impacts of the proposed wind farms on avifauna within the project site. The development will potentially pose a risk to avifauna hence such monitoring is in line with best practices of the industry as prescribed by Birdlife International, IFC Performance standards and the Equator Principles.

During the scoping phase, the behaviour and biology of observed species formed the basis of highlighting birds that may be at risk during and post construction of the proposed wind farm. A total of 101 bird species were recorded at the three sites during the study. The ten (10) most abundant species recorded were the Common Bulbul, Vinaceous dove, Laughing dove, Village weaver and the Yellow-crowned Gonolek Black-crowned Tchagra, Zitting Cisticola, Black billed Wood-dove, Yellow-billed Kite, Tawny-flanked Prinia and Western Grey Plantain-eater. All the species recorded are categorised as ' Least Concern' based on the IUCN Red list.

With the exception of 13 migrants (Palaearctic and intra-African) constituting 13% of all species, all the other species observed were endemic to the area. Raptors are a group of species of concern with regards to wind farms in that they fly at heights that potentially put them at collision risk with the wind mills. Only five raptor species were observed during the study. These were the African Hobby, Black Shouldered Kite, Grey Kestrel, Gabar Goshawk and the Yellow-billed kite. All of which are listed under Schedule I of the Wildlife Conservation Regulation as wholly protected in Ghana. The Yellow-billed Kite was only raptor found among the top 10 most abundant species recorded at all the sites.

Special attention has been paid to the Goi site which is in close proximity to the Songor Ramsar site, an area of high concentration of migrant waterfowls. This was to ascertain the potential risks with regard to flight over the study area. Because of the importance of the interphase between the lagoon and Goi site some effort was put into assessing the waterfowls occurring at the Songor Lagoon and how their flight path could be impacted on by any future development. Few waterfowls, which are also migrants, were recorded at the lagoon. However, the most abundant migrants observed within the study area is the Barn Swallow which is not under threat.

Details of the results of the avifaunal stud can be found in the Avifaunal Specials Assessment of this ESIA report.

Details of the results of the avifaunal stud can be found in the Avifaunal Specials Assessment of this ESIA report (refer to Appendix 3).

4.2.5.5 Bats

Local knowledge suggests that there have been sightings of bat species in the area however the avifaunal specialist team did not identify any species during the scoping phase. There needs to be ongoing monitoring in the project area to determine the presence of bats. (Refer to Appendix 3).

4.2.6 Heritage Profile

The people of Ada West have a very rich history of culture and heritage. The celebration of Asafotufiami is one of the prominent festivals celebrated every year in August. Asafotufiami simple connotes "the firing of musketeers". It is celebrated in commemoration of the death of freedom fighters and as form of recognition to the war heroes who defended the land of Adas during the wars against the Asante.

The land at Wokumangbe belongs to the Kuogbo clan. 'Osuola' is the deity of the land and the shrine of the 'Buokumaa' deity (See figure 4.6) is also situated on their land. The deity forbids chaos and murder hence its isolation from the community. A reconnaissance survey conducted during the scoping phase over the Wokumagbe project area did not reveal any archaeological site of significance. It is mainly flood zone and grazing fields. A reconnaissance survey was conducted over the Goi project area. An abandoned local building and associated cultural remains were identified on the site (See Figure 4.7). This archaeological site will need further archaeological testing to salvage heritage remains from the site in the next phase of work.

Figure 4-6: The Shrine of Buokumaa deity at Wokumagbe Source: Cultural Heritage Impact Assessment at VRA Wind Mill Sites, Ghana (Wokumagbe & Goi Sites), March 2016

Figure 4-7: Possible archaeological site in the Goi project area

A detailed description of the heritage features within the study area, along with associated potential impacts of the proposed project, is included in the Heritage Impact Assessment of this ESIA Report (refer to Appendix 4).

4.2.7 Socio-Economic Environment

The following section details the socio economic aspects of the project area.

4.2.7.1 Land ownership

The project area is traditionally the home of the Ningo people in the west and the Ada people in the east. Land is owned by kinship groups or families and is administered by the elders of the group. The Wokumagbe site is located along the Wokumagbe - Akplabanya road. Wokumagbe means the “land of buffalos”. According to the oral history, one of their ancestor who was a hunter called Nene Tei Sowu discovered the place on one of his usual hunting adventures. After conquering and mastering the environment, he settled there and named the place Wokumagbe. The people of Wokumagbe are Adas. They share boundaries with Akplabanya and Omankofe. Wokumangbe is ruled by two brothers who are both chiefs namely Nene Appedo Charwe-Narh II who is the youngest and Nene Tei Sowu II, the eldest, all still alive.

Land ownership of the project area is being contested by both the Kabiawe Clan of Omankope and Sowu & Tsawena clan from Workumagbe. According to the Wokumagbe elders, the project site land is owned by the Sowu and Charwe-Narh families. The land at Wokumangbe belongs to the Kuogbo cla and the administration and transfer of land is done by the Chief, Stool Father, and the elders of their clans. According to Nene Kano Ateipa (V) of Omakopee, lands in the community belong to the clans (e.g.Kabiawe) in the community but not owned by individuals.

The project site at Goi is located along the road linking Akplabanya to the Goi township. The name Goi came about as a result of the abundance of the *Borassus sp* (Emaa kube) on the land. Nene Osibli Sebi is the paramount chief of the land and he hails from the Tekpebiawe clan. Members of the Tekpebiawe clan are the land owners in Goi , however, sections have been given out to some individuals within the clan. The chief and elders of the clan are responsible for administration and transfer of the clan land while those that have been acquired by the individuals are handled by the individuals.

4.2.7.2 Demographic Profile

The total population of Ada West District according to the 2010 Population and Housing Census was 59 124 representing. Males constitute 48.3% and females represent 51.7% of the population (See Table 4-2). About 70.3 % of the population resides in rural areas. The youth population (population less than 15 years) in the district account for 42.8% of the population depicting a broad base population pyramid which tapers off with a small number of elderly persons (population aged 60 years and older). The total age dependency ratio (dependent population to population in the working age) for the District is 90.6, the age dependency ratio for males is higher (95.4) than that of females (86.3).

Table 4-2: Population By Cohort By Sex (Source: Ghana Statistical Service, 2010 Population and Housing Census)

AGE COHORT	BOTH SEXES		SEX				TYPE BY LOCALITY	
	Total	**%**	**Male**	**%**	**Female**	**%**	**Urban**	**Rural**
0-14	25,298	42.8	12,868	45.0	12,430	40.7	30.3%	69.7%
15-64	31,016	52.4	14,622	51.8	16,392	53.7	29.8%	70.2%
65 and above	2,810	4.8	1,089	3.8	1,723	5.6	23.5%	76.5%
Total	**59,124**	**100**	**28,579**	**100**	**30,545**	**100**	**29.7%**	**70.3%**

4.2.7.3 Education

While significant efforts have been made by central government and other agencies to improve access through the provision of infrastructure and facilities, issues of financing quality education and management remain big concerns in the District. Universal enrolment in basic schools has not been achieved and adult literacy is estimated at 68.5% of the population (11 years and above) but varies considerably between men and women, with their respective rates being 54.1% and 45.9%.

Of the population 11 years and above, 68.5% are literate and 31.5% illiterate. The proportion of literate males is higher (78.6 %) than that of females (59.5 %). About five out of ten people (58.6%) indicated they could read and write both English and a Ghanaian language (s). Of the population aged 3 years and above (23 354) in the district, 29.9 % have never attended school, 40.3% are currently attending and 29.7% have attended in the past.

4.2.7.4 Employment and Income Profile

Of the total population which is 15 years and older, 60.5% are self-employed without employees, 1.8% is apprentice worker and 4.4% are casual workers. Overall, men constitute the highest proportion in most employment categories. The private informal sector is the largest employer in the district, employing 89.6 % of the population followed by the private formal with 5.7 %.

Of the employed population, about 42.1% are engaged as skilled agricultural, forestry and fishery workers, 18.6 % in craft and related trade and 17.4 % are engaged as service and sales workers whiles 8.3 % are engaged as assemblers. One remarkable feature of the district economy is that it is dominated by the private informal sector. The private informal sectors employed 89.6% of person aged 15 years and above, while the private formal sector accounts for only 5.7% and the public (government) sector for 4.1%. The employment status and sector in the project communities of Wokumagbe and Goi is shown in Table 4-3.

Table 4-3: Employment status of persons 15 years and older by sex Wokumagbe and Goi (Source: Ghana Statistical Service, 2010)

	WOKUMAGBE			**GOI**		
Employment status	***Male***	***Female***	***Total***	***Male***	***Female***	***Total***
Employee	110	42	152	272	129	401
Self-employed without employee(s)	101	204	305	197	453	650
Self-employed with employee(s)	21	20	41	78	51	129
Casual worker	25	18	43	64	39	103
Contributing family worker	15	24	39	63	96	159
Apprentice	2	3	5	11	29	40
Domestic employee (Househelp)				10	22	32
Other				5	6	11
Total	**274**	**311**	**585**	**700**	**825**	**1,525**

A detailed description of the socio-economic environment within the study area, along with associated potential impacts of the proposed project, is included in the Socio-economic Impact Assessment of this ESIA Report (refer to Appendix 1).

4.2.8 Distance from nearest airports

Wind turbines potentially can have a variety of negative impacts on civil aviation. Key potential impacts include turbines presenting a physical obstacle to Air Navigation, interference with Communication, Navigation and Surveillance (CNS) signals and impact on Air Traffic Control Operations. Moreover, the greatest risk to aviation is linked to the cumulative effects of large-scale developments in areas that are sensitive in terms of aviation. Subsequently, as these proposed wind turbines could cause hazard to aircraft navigable airspace, the Ghana Civil Aviation Authority (GCAA) are to be notified for assessment of the risk this proposed structure may pose to civil aircraft operation. VRA has accordingly notified GCAA and this is discussed under Chapter 5 of this ESIA Report.

As indicated, an assessment of the potential impacts on aviation associated with the proposed construction, operation and decommissioning of the wind energy facility has been conducted in order to identify various cross sectional issues that are likely to impinge on aviation safety and efficiency, as well as, recommending appropriate interventions to mitigate potential issues, if any. The nearest airport to WPP2 is the existing Kotoka International Airport in Accra. A new airport is also proposed to be located at Prampram in the Dangbe West District of the Greater Accra Region and is one of the projects earmarked by the Ghana Airports Company Limited to make the country the aviation hub in the West African sub-region. The coordinates of the two (2) airports are:

a) KIA	05 36 15.89N, 000 10 03.16W
b) Prampram Airport	05 53 33.27N, 000 09 52.79E

The current aviation infrastructures available at KIA include but not limited to very wide omnidirectional range (VOR), radar, outer marker beacon, middle maker beacon, inner marker beacon, localizer and glideslope. An airport master plan, showing a comprehensive study of the Prampram airport and usually describing the short, medium, and long-term development plans is not available, as such technical decisions concerning siting of airport infrastructure like radar is not certain.

A 15 km distance has been defined for Airport protection boundaries and this applies to these two (2) airports. The proposed wind farm project site is on a south-eastern portion of Kokota International Airport (KIA) and the proposed Prampram Airport. The distance of locations of WPP2 from the 15 km airport protection boundaries of KIA and that for the proposed future Prampram Airport are 100 km and 80 km respectively.

Figure 4-8/...

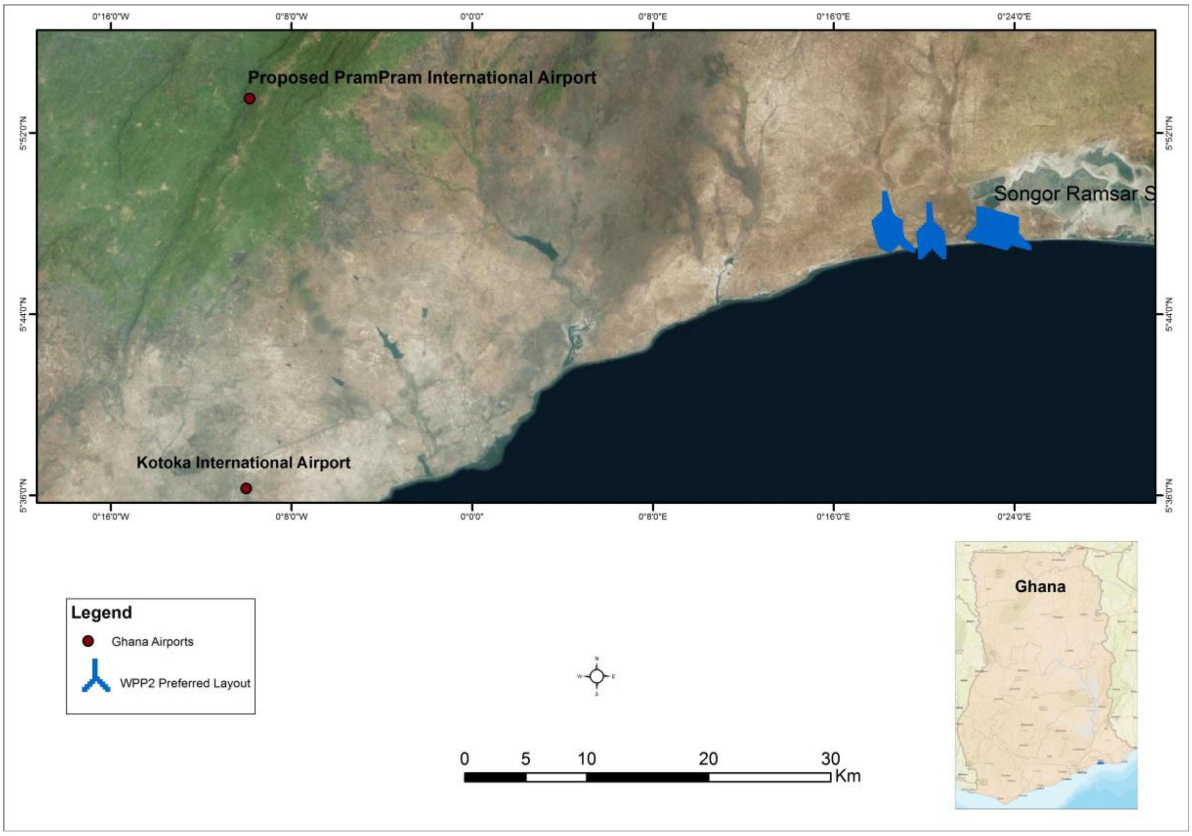

Figure 4-8: Location of the KIA and the proposed PramPram airports in relation to the study sites.

Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 5:

Stakeholder Consultation

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5 STAKEHOLDER CONSULTATION

A stakeholder to the project refers to any individual or group which is potentially affected directly or indirectly by the proposed project or who has an interest in the proposed Project and its potential impacts. Subsequently, the rationale for any stakeholder engagement is to help to identify potential points of disagreements between stakeholders, ethnic / gender / religious / political based tensions, raised expectations by the project and emerging social problems that require attention and with which the project developer may be able to assist.

Stakeholder engagement is an ongoing process that may involve, in varying degrees, the following elements: stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism, and ongoing reporting to Affected Communities. The nature, frequency, and level of effort of stakeholder engagement may vary considerably and will be commensurate with the project's risks and adverse impacts, and the project's phase of development.

The engagement process has been designed to meet Ghanaian legal requirements for public participation and to align as far as practically possible with good international industry best practice (GIIP), based on the project timing and budget.

The Principles for Public Participation (PPP) for this ESIA Process is being driven by a stakeholder engagement process that will include inputs from authorities, Interested &Affected Parties (I&APs), technical specialists and the project proponent. This chapter presents a summary of the engagement activities undertaken as well as future engagement activities planned as part of the ESIA process for the wind power project.

5.1 PRINCIPLES FOR PUBLIC PARTICIPATION

Effective public participation improves the ability of the Competent Authority (CA) to make informed decisions and results in improved decision-making as the views of all parties are considered. Effective PPP has the following benefits:

- It provides an opportunity for I&APs, consultants and the CA to obtain clear, accurate and understandable information about the environmental impacts of the proposed activity or implications of a decision;
- Provides I&APs with an opportunity to voice their support, concern and question regarding the project, application or decision;
- Enables an applicant to incorporate the needs, preferences and values of affected parties into its application;
- Provides opportunities for clearing up misunderstanding about technical issues, resolving disputes and reconciling conflicting interests;
- Is an important aspect of securing transparency and accountability in decision-making; and
- Contributes toward maintaining a health, vibrant democracy.

To the above, one can add the following universally recognised principles for public participation:

- Inclusive consultation that enables all sectors of society to participate in the consultation and assessment processes;
- Provision of accurate and easily accessible information in a language that is clear and sufficiently non-technical for I&APs to understand, and that is sufficient to enable meaningful participation;
- Active empowerment of grassroots people to understand concepts and information with a view to active and meaningful participation;
- Use of a variety of methods for information dissemination in order to improve accessibility, for example, by way of discussion documents, meetings, workshops, focus group discussions, and the printed and broadcast media;
- Affording I&APs sufficient time to study material, to exchange information, and to make contributions at various stages during the assessment process;
- Provision of opportunities for I&APs to provide their inputs via a range of methods, for example, via briefing sessions, public meetings, written submissions or direct contact with members of the ESIA team.

- Public participation is a process and vehicle to provide sufficient and accessible information to I&APs in an objective manner to assist I&APs to identify issues of concern, to identify alternatives, to suggest opportunities to reduce potentially negative or enhance potentially positive impacts, and to verify that issues and/or inputs have been captured and addressed during the assessment process.

At the outset, it is important to highlight two key aspects of public participation:

- There are practical and financial limitations to the involvement of all individuals within a PPP. Hence, public participation aims to generate issues that are representative of societal sectors, not each individual. Hence, the PPP will be designed to be inclusive of a broad range of sectors relevant to the proposed project.
- The PPP will aim to raise a diversity of perspectives and will not be designed to force consensus amongst I&APs. Indeed, diversity of opinion rather than consensus building is likely to enrich ultimate decision-making.

5.2 STRATEGIES USED FOR PROJECT BRIEFING

The key steps undertaken in the PPP for this ESIA thus far are described are described below:

5.2.1 Background Information Document

As part of project briefing to the public, a Background Information Document (BID) was prepared for the project and distributed to stakeholders during the various engagements. The rationale for the BID is to allow I&APs to register their interest in the project in order to get the opportunity to be involved in the Scoping and ESIA Processes through receiving information, raising issues of concern and commenting on reports. Inputs from I&APs, together with the information and assessment provided by the ESIA Specialists is expected to assist the Environmental Protection Agency with their decision-making in terms of whether to grant or refuse an environmental permit for the proposed projects.

5.2.2 Verbal Communication

Verbal brief, in Akan/Ada (local language) or in English language as may be appropriate, on project information provided to the stakeholders during various individual and group meetings were as follows:

a) Increased electricity demand requires that other sources of generation are developed to meet the demand.

b) VRA's REDP intends to develop a mixed Renewable Energy portfolio in various potential locations noted/established to have available RE resources

c) VRA has since 2014 undertaken a one-year wind measurement at 8 locations in Ghana for the development of the first 152.5MW of Wind Energy.

d) Various sites have been identified within the Anloga Beach, Anyanui and the road leading to Saviotula Junction at Srogbe within the Keta Municipality as potential sites for a 76MW.

e) Again, sites have been identified at Goi and Workumagbe in the Ada West District as potential sites for a 76.5MW.

f) Feasibility studies are now ongoing to finalise the design for the project at the various sites.

g) Project development will entail the following:

    - Construction of Access and Internal road network linking all wind turbines
    - Procurement and Installation of the finally selected Wind turbines, made up of 76.5 MW, 45 VESTAS each with 1.7 MW nominal power and on a hub height of 80 m.
    - Installation of corresponding number of step-up transformers mounted at the foot of each turbine tower
    - Construction of operations and control building; substation and grid connection and the integration of the wind farm to the existing grid will be done by a new to be built sub-station 161/33 kV in the north-west area of the Wokumagbe. Construction of underground electrical collection system leading to the project substation. Note that these components are not part of the scope of work for this ESIA and will be assessed separately.
    - Within the wind farm, all 45 WTGs will be connected on MV level to the sub-station.
    - Impact during Construction phase

h) Operation of the wind farm will require the following environmental issues to be addressed:
    - Land Use Changes
    - Visual Effects
    - Noise Effect
    - Flicker Effects
    - Cultural Heritage and Archaeological Issues
    - Flora
    - Fauna (Wildlife, Birds)
    - Wetland Impacts
    - Aviation & Telecommunications Impact
    - Wind Farm Development Advantages (positive effects)
    - Recreational and Tourism Issues

i) VRA has contracted SCL and CSIR-SA to undertake the ESIA for the study.
j) The scoping phase of the ESIA is on-going and relevant health, safety, environmental, social and economic issues are being identified for input into the ESIA study report.
k) Studies being undertaken include Flora & Faunal Assessment, Bird Assessment, Heritage and Archaeological Assessment, Wetland Impact Assessment, Aviation & Communication Impact, Property Valuation, Noise and Flicker Impact, Socio-Economic Evaluation & Assessment.
l) As part of the Scoping phase, SCL is mandated to undertake stakeholder engagement and issues raised by stakeholders are to inform the terms of reference for the study which will guide the client in the finalisation of the project design.
m) It is expected that the ESIA Studies for the 2 projects are to be completed by June 2017 for which an Environmental permit is to be issued to allow for physical construction to commence.
n) Physical construction could commence by close of 2017.

5.2.3 Power Point Presentation Meeting with Project Affected Communities

Project Affected Communities were provided all relevant information about siting of, construction at and operation of the WPP and the Consultants' experience on projects similar to the one that is being proposed. The community representatives consulted were:

- Chief and Elders of the project affected community of Goi
- Chief and Elders of the project affected community of Wokumagbe
- Chief and Elders of the project affected community of Omankope, who were contesting the project land at Wokumagbe

Some of the resident communities already knew about the project, but did not know the specific details, particularly about the environmental issues involved.

On October 20, 2016, the study team organised formal consultations involving both the public, traditional authorities and state agencies in the Ada West District[1]. At these consultations, the outcomes from the Scoping Phase and the opportunity to make inputs into the ESIA report were presented to attendees.

5.2.4 Consultation with State Agencies

VRA has formally registered the project with the EPA as part of project consultations process. The EPA has confirmed (letter dated February 26, 2016) that the project falls under the category for which an ESIA and an Environmental Scoping Study is required. It was further indicated that the scoping phase is meant to focus on the key issues, concerns and decision areas and solicit input and guidance of all relevant stakeholders on the TOR. EPA's Response to the Project Registration is attached as Appendix1.2. Based on the latter, the Scoping Report for WPP2 was prepared for review by both the EPA and the public. The EPA submitted review comments on the scoping report in September 2016.

The Energy Commission has issued a Provisional License, dated 27 July 2015, to VRA allowing them to generate and Supply Electricity from wind energy at Wokumagbe and Goi in the Ga West District of the Greater Accra Region (Appendix 1.3).

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[1] See Appendix 1.1 for list of participants at the public forum

Ongoing consultations with the Ghana Highway Authority (GHA) are held regarding the possible impact of the project on road infrastructure. On request, VRA submitted additional project details to the GHA and indicated that they will revert to them at the appropriate time with the required details for their contractor to undertake the relevant assessments as required in letter dated March 3, 2017. Copies of the correspondences between VRA and GHA are included in Appendix 1.5.

Approvals will also be needed from the Ghana Civil Aviation Authority (GCAA) as well as the National Communication Authority (NCA) in case the project is sited near or under the aircraft flyway zone and telecommunication masts. Each of these departments has individual requirements for grant of approvals. VRA has formally notified the Ghana Civil Aviation Authority (GCAA) of its intention to construct the wind power facilities. The GCAA per letter, dated February 3rd 2014, requested the VRA to complete a Form GCAA/SRD/ASAS - 01 to enable its safety inspectors to conduct the aeronautical assessment of the proposed site(s). Mrs. Anita Adjei Nmasie, Manager, Aerodrome Safety & Standards during an initial consultation with GCAA confirmed this requirement for the project.

Completed forms with associated cadastral maps were sent to GCAA in March 2014. In June 2015, VRA formally requested GCAA to advise on regulations on lighting and painting requirements for the wind turbines as well as any other regulations that are relevant to the wind farms. GCAA is yet to response to these requests. On September 1, 2016, GCAA requested the VRA to effect payment towards the issuance of an airspace safety permit. VRA and GCAA also undertook a joint site visit to the project area in April 2017. Meanwhile, Aviation Impacts Experts were contracted to conduct the relevant assessment to determine possible aviation impacts and results have been incorporated in the ESIA report. Copies of the correspondences between VRA and GCAA are attached as Appendix1.6.

Although no major impact is anticipated, communications operators may need to be contacted, during the initial stages of development. In May 2016, SCL formally notified the NCA of the project, and made a copy of the Background Information document available for their review. The NCA is yet to respond to this formal notification despite persistent follow-ups.

Upwind Konikablo Limited and Upwind Akplanya Limited in response to VRA's Scoping Notice per letter dated September 07, 2016 formally raised concerns with WPP2 on issues of a) Overlap of Project Area; b) Yield losses to Wake Effects; and c) Cumulative Environmental Effects on their project located within the area. The EPA after receiving a similar concern from the company also per letter October 19, 2016 informed VRA of the issues of possible site layout overlaps and requested VRA to take the necessary steps to resolve the issue. VRA has since consulted with the Energy Commission to discuss the site overlay issue. In addition, VRA per letter dated October 18, 2016[2] formally communicated to the company regarding the concern about the potential impact of our WPP2, and the possible overlap of the wind farms. VRA in the letter informed Upwind that it was investigating the concern and will in due course schedule a meeting to discuss the issues.

The General Assembly of the Ada West District Assembly was engaged on March 31, 2016 at the Ada West District Assembly hall to brief them on the project. The Presiding Member of the General Assembly, Member of Parliament of the Ada West Constituency, Assemblypersons of the various communities within the district including that of Goi and Wokumagbe and representatives of the under-listed state agencies participated in the meeting:

- Ada West District Assembly
- Ghana Education Service
- Physical Planning Department
- Department of Social Welfare
- Department of Community Development
- Environmental health & Sanitation Department
- National Disaster Management Organization
- Information Services Department
- Works Department

From February to March 2016, initial one-on-one meetings were held with key officials of various state agencies within the Ada West District. A major formal consultation was held with relevant state agencies within the Ada West District on April 13, 2016 at the District

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[2] See Appendix 1.13 for correspondences between VRA and Upwind International

Assembly to brief them on the project to allow for the relevant issues of concern to be discussed. At this forum, the purpose of the EIA and the steps to be followed was presented. State agencies within the Ada West District consulted are listed below:

- Town & Country Planning Department
- Information Services Department
- Physical Planning Department
- Department of Agriculture
- Department of Community Development
- National Commission for Civic Education
- National Disaster Management Organization
- Works Department
- Ghana National Fire & Rescue Services
- Ghana Wildlife Department
- Department of Urban Roads
- Department of Agriculture
- Department of Social Welfare
- National Commission of Civic Education

In October 2016, the study team organised a major formal consultations involving both the public and state agencies in the Ada West District. At these consultations, the outcomes from the EIA study as well as the way forward and opportunity to comments on the ESIA report was presented to attendees.

The correspondence sent to I&APs during the Scoping Phase (including the submission of the finalised Scoping Reports to the EPA) and the ESIA Phase is included in Appendix 1.8 of this ESIA Report. Table 5.1 contains all the comments and correspondence received from I&APs during the Scoping Phase (i.e. during the Project Initiation Phase and review of the Scoping Reports).

5.3 PUBLIC PARTICIPATION STEPS FOR ESIA PHASE

The key steps undertaken during the PPP for the ESIA Phase are described below. As previously mentioned, a Scoping Report was compiled for the WPP2 and submitted to the EPA, and copied to the Ada West District for review in July 2016[3]. VRA has made available the Scoping Report to the public through posting at the corporate website at www.vra.com.

In addition, VRA placed a Scoping Notice of the proposed wind energy facility in the national newspapers to notify the public of the release of the Scoping Report, as required under Regulation 15 (1) of LI. 1652. The Scoping Notice was publicly disclosed in the August 9, 2016 and September 15, 2016 editions of the Daily Graphic as well as the August 24, 2016 edition of the Ghanaian Times[4]. Any person(s) with an interest, concern, or special knowledge relating to potential environmental effects of the proposed undertaking was required to contact or submit such concerns to the VRA and the EPA. The Scoping Notice was also placed at the Ada West District to inform locals. Comments from the EPA have been included in Appendix 1.10 (letter dated September 14, 2016).

The following tasks outline the key proceedings for the PPP for the ESIA phase:

TASK 1: Compilation of Draft ESIA Report for Submission to the EPA (Current Stage)

VRA has contracted Seljen Consult to compile the draft ESIA Report, incorporating issues raised in the review comments. VRA will submit eight (8) hard copies of the Draft ESIA Report, as well as the electronic copy on **CD,** to the EPA (Head office and regional office at Tema) for review**.**

TASK 2: I&AP review of the ESIA Report and EMP

The first stage of the process entails the release of the draft ESIA Report to I&APs and stakeholders for review for at least ninety (90) days. Relevant organs of state and I&APs will be informed of the review process in the following manner:

- Placement of the e-copy of the Draft ESIA report on VRA’s corporate website (www.vra.com) for easy access by the public to ensure access to information on the project and to communicate the outcome of specialist studies.

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[3] See Appendix 1.9 for VRA submission letter of Scoping Report to the EPA

[4] See Appendix 1.11 for Scoping Notice

- Publication of an ***"Advertisers' Announcement"*** in the Daily Graphic as well as the Ghanaian Times, the most widely distributed national newspapers to notify potential I&APs of the availability of the ESIA Reports.

- Formal notification of relevant state actors, the Energy Commission, Ghana National Petroleum Corporation, Ghana Armed Force as well as the Ghana Civil Aviation Authority of the ***"Advertisers' Announcement"*** and the availability of the Draft ESIA Report at the corporate website for their review.

- Distribution of Draft ESIA Reports to Ada West District and traditional authorities of affected communities, namely Wokumage and Goi.

- Meeting(s) with key authorities involved in decision-making for this ESIA (if required and requested).

TASK 3: Comments and Responses Trail

A key component of the ESIA Process is documenting and responding to the comments received from I&APs and the authorities. The following comments on the draft ESIA Reports shall be documented:

- Written and emailed comments (e.g. letters and completed comment and registration forms);
- Telephonic communication with project team
- Comments raise at stakeholder engagement sessions

TASK 4: EP and Appeal Period

Subsequent to the decision-making phase, if an Environmental Permit (EP) is granted by the EPA for the proposed projects, all registered I&APs and stakeholders on the project database will receive notification of the issuing of the EP and the appeal period. All registered I&APs will be informed of the outcome of the EP and the appeal procedure and its respective timelines.

5.4 PUBLIC DISCLOSURE

According to the requirements under the Ghana EIA process (Regulation 15 (1) of LI 1652), the Administrative procedure for the scoping exercise requires that the public is adequately and appropriately informed. The IFC Disclosure Policy (1998) highlights the importance of accountability and transparency in the development process of projects. Under the "**Equator Principle 10: Reporting & Transparency**", clients are committed to ensure that, at a minimum, a summary of the ESIA is accessible and available online. From these, it is recognised that disclosure of information throughout the project will help to ensure accountability and transparency and this has been reiterated at the various stakeholder engagements that the project has conducted so far.

Following the preparation of the Draft ESIA Report, an advertisers' Announcement will be made in a widely circulating national dailies for the general public to assess and make inputs into the Draft ESIA Report. Copies of the Draft ESIA Report will be made available at the following locations:

- ✓ VRA Corporate website
- ✓ VRA Head Office Library in Accra
- ✓ VRA Environment & Sustainable Development Department Library in Akosombo
- ✓ EPA Head office in Accra
- ✓ EPA Accra East Regional Office in Tema
- ✓ Ada West District

As part of the disclosure processes, VRA will also give approval for potential funding agencies to publicly disclose the Draft ESIA report on their online portal. The Final ESIA Report shall also be available in the offices of VRA and the website as well as the EPA for public disclosure purposes.

5.5 IDENTIFICATION OF ISSUES

An important element of the ESIA Process is to evaluate the issues raised through the interactions with authorities, the public, the specialists on the ESIA team and the project proponent. In accordance with the philosophy of Integrated Environmental Management, it is important to focus the ESIA on the key issues, such as those issues that are considered critical for decision-making on the EA.

To assist in the identification of key issues, a decision-making process is applied to the issues raised, based on the following criteria (Refer to Figure 5-1):

- Whether or not the issue falls within the scope and responsibility of the proposed project;
- Whether or not sufficient information is available to respond to the issue raised without further specialist investigation.

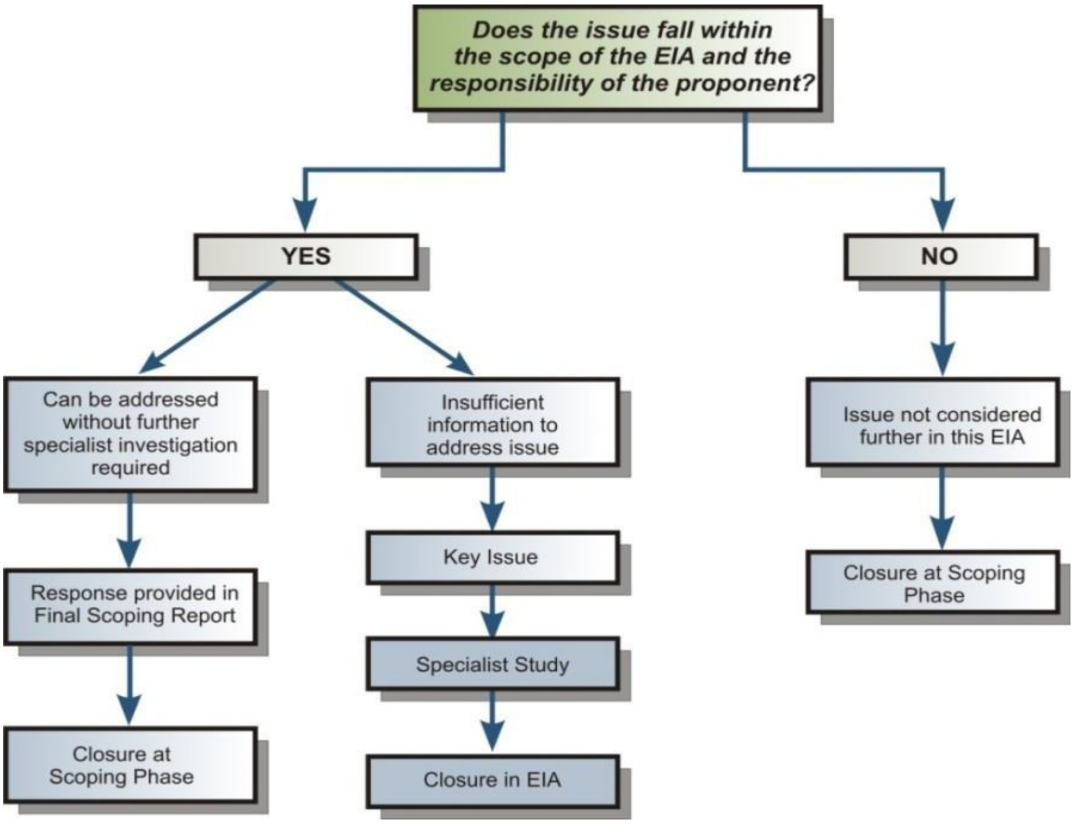

Figure 5-1: Decision-making framework for identifying key issues for the ESIA

All comments received during the review of the BID and the Scoping Report are included in Appendix 1.12 of this ESIA Report and summaries of the Comments together with responses from VRA, Seljen and CSIR are included in the comments and issues trail below. Section 5.6 below provides a summary of the comments received prior to the release of the Scoping

Report, and Section 5.7 below provides a summary of the comments received during the review of the Scoping Report.

5.6 ISSUES AND RESPONSES TRAIL (PRIOR TO THE 30-DAY REVIEW OF THE SCOPING REPORT)

Table 5-1: Issues & Responses Trail prior to Scoping

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
February 17, 2016	Chief and Elders of Wokumagbe	Regent House	1) They have been briefed on the project by the personnel from the VRA	No Response needed.
			2) They are glad that their community has been chosen for such a project	No Response needed.
			3) They want the negotiation for the acquisition of their land done quickly and the payment done promptly	This will be done after the project site has been properly demarcated and the total area clearly determined. VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.
			4) They expect the other packages such as scholarships and provision other social amenities for the people	The community will benefit from the VRA’s Community Development programme which provides among others, educational scholarships to needy students in project impacted communities.

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
			5) They want workers to be recruited from the community	This is dependent on the skill set available within the community and what is required to successfully execute the project. Meanwhile, the Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment
			6) They want workers to respect their traditions and observe festivals	These issues are being captured during the ESIA study and will be made known to the contractor for adherence. The workers and the entire team will be adequately briefed on these traditional rights and festivals.
February 18, 2016	Ada West District Education Directorate	Office of the Assistant Director, In Charge of Supervision	1) The request that VRA provide additional educational facilities such as School blocks and furniture, District Education Office, and other material such as text books, balls and jerseys, among others.	The community will benefit from the VRA's Community Development programme which provides among others, educational scholarships to needy students in project impacted communities.
17th and 19th February, 2016	Chief and Elders of Goi	Under coconut trees at the beach	1) They are aware of the choice of their community for the project	No Response needed.
			2) They indicated that the presence of the project will lead to an influx of people for jobs and related activities	They were urged to take advantage of this positive economic effect. Meanwhile, the Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
			3) They demanded an immediate meeting with the VRA Real Estates Department concerning the size of the land they require, its location among others	This will be done after the project site has been properly demarcated and the total area clearly determined
			4) They will not corporate with any consultant(s) or land demarcation until VRA arrange a meeting with them.	This was noted and the information will be conveyed to the VRA. However, any grievance should be communicated formally using the BID.
February 17, 2016	Chief and Elders of Omankope	Pentecost Church, Omankope	1) They are aware of the choice of their community for the project	No Response needed.
			2) They are of the view that the land at Wokumagbe belong to them. The people of Wokumagbe are only settlers on their land	VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.
			3) They will not corporate with any consultant(s) or land demarcation until VRA arrange a meeting with them.	This was noted and the information will be conveyed to the VRA. However, any grievance should be communicated formally using the BID.
February 18, 2016	Ada West District	District Finance Office,	1) They are aware of the project's location within the district	No Response needed.

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
	Assembly	Sege Ada	2) They don't know the sites selected to host the project	Details of the project was explained to them
			3) They are prepared to offer every support towards the successful execution of the project	VRA was grateful for that.
			4) They will ask the VRA to improve some of the road networks within the communities	By the scope of the project, ancillary developments such as roads will be required
February 18, 2016	Ada West District Health Directorate	Office of the District Health Information Office	1) They are not aware of the project	Details of the project were explained to them. Background information to the project will be made available to them in due course. This document contains all issues there is to the project.
			2) The consultants should critically examine every health hazards likely to be caused by the project to the indigenes within the communities	Associated impacts like noise and shadow flicker are being investigated and the siting of the turbines will be done in order to mitigate these.
			3) They should examine whether the land taken will not affect the nutritional needs of the people	This issue is well noted and there will be a health assessment and potential impact to the capability of agricultural to determine mitigative measures to be employed on the project.
March 31, 2016	General assembly of	Ada West District	1) The physical construction of the project is taking too long to	Projects development in the power sector is quite laborious and requires very forms of studies to come to

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
	the Ada West District Assembly	Assembly	commence.	a final decision on exactly what is to be done. It is therefore important that land owners and the municipality in general to exercise some patience since a project of such magnitude requires several processes including the Wind Measurement and ESIA before actual construction
			2) The road between Anyamam and Wokumagbe is very bad and therefore needs to be done before the project commences	By the scope of the project, ancillary developments such as roads will be required
			3) How will the salt mining activities be affected by the project?	This issue is well noted and there will be a flood risk assessment as well as wetland assessment to determine mitigative measures to be employed on the project
			4) How soon will compensation be paid to those whose livelihoods are negatively affected by the project.	Property evaluation will be done and payment effected in line with requirements of the Lands Commission. VRA recognises that compensation issues are key to the success of the project. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.
April 13, 2016	Ada West District	District Assembly Hall	1) Land in the project area belongs to individuals so the developers will have to identify the individual	Detailed property valuation will be done leading to the development of the Compensation Action Plan which is expected to adequately address this concern.

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
			landowners and ensure compensation is paid directly to such people.	
			2) The project should consider the impact of the wind turbines on birds as well as the transmission component within the Songor Ramsar Site.	A birds study is underway to assess the impact and provide mitigative measures as required.
			3) As the project may involve the construction of roads, the project developer should also consider paying compensation for properties destroyed during this development.	As indicated, a detailed property valuation will be done leading to the development of the Compensation Action Plan which is expected to adequately address the concern of any property to be affected by the project.
			4) It is understood that there are challenges with the resettlement programme under the recently constructed Bui dam, which VRA was involved. How assured are they that such challenges will also not prevail under this project?	There are no resettlement issues regarding the current project. However, livelihoods would be affected and plans are in place to develop a plan for compensation such losses.
			5) Employment of local labour should be of key consideration under this project.	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will subsequently be advised to consider this proposal from

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
				the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project.
			6) The developers should ensure that geotechnical studies are performed before the district assembly can provide them with developmental permit for the project.	Geotechnical studies are to be performed to determine the foundation requirements. VRA will make the geo tech data available if required by the district assembly.
			7) What will be the associated social projects to the development?	The community will benefit from the VRA's Community Development programme which provides among others, educational scholarships to needy students in project impacted communities.
			8) What's is the lifespan of the wind power project?	About 25 years but they facilities will undergo continuous maintenance and retrofitting and there could last for more than the said period.

5.7 ISSUES AND RESPONSES TRAIL
(REVIEW OF THE SCOPING REPORT FOLLOWING PUBLIC MEETINGS)

Table 5-2: Issues & Responses Trail following the review of the Scoping report

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
October 20, 2016	General Public	Ada West District Assembly Conference Hall	1) As land in the Ada area belongs to individuals, there is the need to identify the true landowners for compensation purposes.	VRA recognises that compensation issues are key to the success of the project. The "Compensation Action Plan" being prepared involves survey to identify lands and its owners. To facilitate compensation payments, Land owners are urged to have a proper land title document to their property. VRA will also conduct further checks to determine the true owners of the land before compensations are paid.
			2) The project should consider the impact of the wind turbines on birds as well as the transmission component within the Songor Ramsar Site.	A birds study is underway to assess the impact and provide mitigative measures as required.
			3) VRA should compensate for lands affected by roads construction.	VRA shall pay compensation for all project-affected lands.
			4) How was the project affected persons resettled under the Bui Hydropower Project?	There are no resettlement issues regarding the current project as was done for the Bui Project. Under Bui, the project constructed houses for the affected persons

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
				because their accommodation was to be flooded from the creation of the Lake.
			5) The contractor should consider the locals for employment especially in menial jobs.	The Local content policy of VRA will be applicable to the project and the contractor will be required to consider locals for recruitment. The contractor will subsequently be advised to consider this proposal from the community. However, this will be dependent on the skill set available within the community and what is required to successfully execute the project
			6) Compensation must be done very well as its key to the landowners.	Property evaluation will be done and payment effected in line with requirements of the Lands Commission.
			7) VRA must undertake geotechnical studies to determine the soil quality for the installation of the foundations of the turbines	Geotechnical studies are part of the feasibility studies for the project; however, the contractor during construction will also study the soil quality prior to determining the foundation types.
			8) There is the need for VRA to acquire a developmental permit from the District Assembly prior to physical construction.	VRA will acquire all necessary permits for the project as required by law.
			9) What will be the lifespan of the project?	For now, the project lifespan is determined at 25 years. However, various maintenance activities including retrofitting could allow for a longer time prior to decommissioning.

Date	**Stakeholder**	**Location**	**Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders**	**Response**
			10) VRA should improve the road network within the communities as part of the project.	The road network will definitely be improved to allow for maintenance activities for the wind project. VRA will also do its best to improve on any social infrastructure that is required for the community.
			11) What are the associated social developments as part of this project?	The Compensation Action Plan and the VRA's Social Responsibility Program will adequately address this concern
			12) The project should consider impacts on the Songoor lagoon and salt mining in the communities. In this regard, VRA should consult with the Ministry of Lands & Natural Resources on the acquisition of lands within these areas	This issue is under consideration and VRA will make necessary arrangements to liaise with the Ministry to ensure smooth project implementations.

Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 6:

Impacts identification and Significance

CONTENTS

TABLES

6 IMPACT IDENTIFICATION AND SIGNIFICANCE

This chapter gives a description of the impacts assessment methodology. A detailed description of the proposed project can be found in Chapter 3 of this ESIA report.

6.1 APPROACH TO IMPACT ASSESSMENT AND SPECIALIST STUDIES

The section below outlines the assessment methodology.

6.1.1 Generic TOR for the Assessment of Potential Impacts

The identification of potential impacts included impacts that may occur during the construction, operational and decommissioning phases of the development. In order to identify potential impacts (both positive and negative), it is important that the nature of the proposed project is well understood so that the impacts associated with the projects can be assessed. The process of identification and assessment of impacts includes:

- Determining the current environmental conditions in sufficient detail so that there is a baseline against which impacts can be identified and measured;
- Determining future changes to the environment that will occur if the activity does not proceed;
- Develop an understanding of the activity in sufficient detail to understand its consequences; and
- The identification of significant impacts which are likely to occur if the activity is undertaken.

The assessment of impacts is to include direct, indirect as well as cumulative impacts as directed by the EPA’s guidelines for the preparation of Environmental Impact Statement. The following methodology is applied to the predication and assessment of impacts and risks:

- **Nature of impact** - this reviews the type of effect that a proposed activity will have on the environment and should include “what will be affected and how?”

- **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.

- **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.

- **Cumulative impacts** are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. The cumulative impacts will be assessed by identifying other applicable projects, such as construction and upgrade of electricity generation, and transmission or distribution facilities in the local area (i.e. within 20 km of the proposed WPP2 project) that have been approved (i.e. positive EP has been issued) or is currently underway.

- **Status** - Whether the impact on the overall environment (social, biophysical and economic) will be:
  - Positive - environment overall will benefit from the impact;
  - Negative - environment overall will be adversely affected by the impact; or
  - Neutral - environment overall will not be affected.

- **Potential Intensity**

Potential Intensity Description (negative)	Rating	Score
Potential to severely impact Human Health (morbidity/mortality); or to lead to Loss of species[1] (fauna and/or flora)	Very High/Fatal Flaw	16
Potential to reduce faunal/flora population or to lead	High	8

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[1] Note that a Loss of species is a global issue and is differentiated from a loss of “flora/fauna” population

to severe reduction/alteration of natural process, loss of livelihoods or sever impact on quality of life[2], individual economic loss		
Potential to reduce environmental quality – air, soil, water. Potential Loss of habitat, loss of heritage, reduced amenity	Medium	4
Nuisance	Medium-Low	2
Negative change – with no other consequence	Low	1
Potential Intensity Description (positive)	**Rating**	**Score**
Potential Net improvement in human welfare	High	8
Potential to improve environmental quality – air, soil, water. Improved individual livelihoods	Medium	4
Potential to lead to Economic Development	Medium-Low	2
Potential positive change – with no other consequence	Low	1

Note that the concept of “**irreplaceable loss of a resource**” is to be taken into account in the Potential Intensity score of an impact.

- **Irreplaceability of resource** loss caused by impacts –
  - High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment. For example, if the project will destroy unique wetland systems, these may be irreplaceable);
  - Moderate irreplaceability of resources;
  - Low irreplaceability of resources; or
  - Resources are replaceable (the affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment).

- **Spatial extent** – The size of the area that will be affected by the risk/impact:

Extent Description	**Score**
Site specific	1
Local (<10 km from site)	2
Regional (within 100 km of site)	3

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[2] Note that a visual impact or air emissions for example could be considered as severely impacting on quality of life should it constitute more than a nuisance but not being life threatening.

National	4
International/Global (e.g. Greenhouse Gas emissions or migrant birds).	5

- **Duration –** The timeframe during which the risk/impact will be experienced:

Duration Description	**Score**
Temporary (less than 2 year) or duration of the construction period. This impact is fully reversible. ***E.g. the construction noise temporary impact that is highly reversible as it will stop at the end of the construction period***	1
Short term (2 to 5 years). This impact is reversible.	2
Medium term (5 to 15 years). The impact is reversible with the implementation of appropriate mitigation and management actions.	3
Long term (> 15 years but where the impact will cease after the operational life of the activity). The impact is reversible with the implementation of appropriate mitigation and management actions. ***E.g. the noise impact caused by the desalination plant is a long term impact but can be considered to be highly reversible at the end of the project life, when the project is decommissioned***	4
Permanent (mitigation will not occur in such a way or in such a time span that the impact can be considered transient). This impact is irreversible. ***E.g. The loss of a palaeontological resource on site caused by construction activities is permanent and would be irreversible.***	5

The concept of "reversibility" is reflected in the duration scoring. i.e. the longer the impact endures the less likely it will be reversible.

- **Reversibility of impacts -**
  - High reversibility of impacts (impact is highly reversible at end of project life, i.e. this is the most favourable assessment for the environment. For example, the nuisance factor caused by noise impacts associated with the operational phase of an exporting terminal can be considered to be highly reversible at the end of the project life);
  - Moderate reversibility of impacts;
  - Low reversibility of impacts; or
  - Impacts are non-reversible (impact is permanent, i.e. this is the least favourable assessment for the environment. The impact is permanent. For example, the loss

of a palaeontological resource on the site caused by building foundations could be non-reversible).

Using the criteria above, the impacts will further be assessed in terms of the following:

- **Probability** – The probability of the impact/risk occurring:

Probability Description	Score
Improbable (little or no chance of occurring <10%)	0.1
Low Probability (10 - 25% chance of occurring)	0.25
Probable (25 - 50% chance of occurring)	0.5
Highly probable (50 – 90% chance of occurring)	0.75
Definite (>90% chance of occurring).	1

- **Magnitude**–The anticipated severity of the impact (Potential intensity + Extent + Duration):
    - Extreme (extreme alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they permanently cease);
    - Severe (severe alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);
    - Substantial (substantial alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);
    - Moderate (notable alteration of natural systems, patterns or processes, i.e. where the environment continues to function but in a modified manner); or
    - Slight (negligible alteration of natural systems, patterns or processes, i.e. where no natural systems/environmental functions, patterns, or processes are affected).

- **Significance** – Will the impact cause a notable alteration of the environment? To determine the significance of an identified impact/risk, the consequence is multiplied by the probability (as shown below).

Significance rating = Impact magnitude * Probability

Impact Magnitude = Potential Intensity + duration + extent

Table 6-1: Guide to assessing risk/impact significance as a result of consequence and probability.

Scoring	Significance rating	Description
18-26	Fatally flawed	The project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating.
10 - < 18	High	The impacts will result in major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making.
5 - <10	Medium	The impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures, and will only have an influence on the decision-making if not mitigated.
2 - <5	Low	The impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making.
<2	Very Low	The impact may result in very minor alterations of the environment and can be avoided through the implementation of mitigation measures.

- **Confidence –** The degree of confidence in predictions based on available information and specialist knowledge:
  - Low;
  - Medium; or
  - High.

Where appropriate, national standards will be used as a measure of the level of impact. Table 6.1 has been used by specialists for the rating of impacts.

- **Management actions and Assessing Residual Impacts**

As specified in Section 12 of part II of the ESIA Regulations, appropriate management actions will be identified to eliminate, minimise or manage identified potential significant environmental effects and to enhance positive impacts. The following will be considered:

  - Embedded or inherent mitigation - mitigation which is built in to the project during the design process.
  - Mitigation of significant effects or key mitigation (pertinent measures that will be written into, and enforced through the EMP for implementation to ensure that the significance of the associated impact is acceptable).
  - Mitigation of non-significant effects or additional mitigation (management actions to be considered by proponent and authority).
  - Enhancement measures.

Impacts will be described both before and after the implementation of the proposed mitigation and management measures. In Table 6.2 below, the scenario “without mitigation” considers all management actions already proposed by the proponent as part of the project description. “With mitigation” assesses the significance rating of the potential impact, taking into account any key mitigation or additional management actions recommended by the specialist (i.e. residual impact).

It is expected that for the identified significant impacts, the project team will work with the client in identifying suitable and practical mitigation measures that are implementable. Management actions that can be incorporated into the Project design in order to avoid or reduce the negative impacts or enhance the positive impacts will be developed. A description of these management actions will also be included within the Environmental Management Plan (EMP).

- **Proposed Monitoring**

Subsequent to the completion of the assessment, proposals for monitoring requirements will be put forward where relevant. Proposals for monitoring will be designed to evaluate the accuracy of the impact prediction and the success of any implemented mitigation measures.

- **Dealing with Uncertainty**

Even with a final design and an unchanging environment, impacts are difficult to predict with certainty, but in projects such as the proposed wind power project, where the design process is currently in progress, uncertainty stemming from on-going development of the Project design is inevitable, and the environment is typically variable from season to season and year to year. Where such uncertainties are material to the ESIA findings, they are clearly stated and are approached conservatively (‘the precautionary approach’) in order to identify the broadest range of likely residual impacts and necessary mitigation measures.

Potential impacts may be assessed using tools ranging from quantitative techniques such as modelling to qualitative techniques based on expert judgment and historical information. The accuracy of these assessment tools depends on the quality of the input data and available information. Where assumptions have been made, the nature of any uncertainties associated with the assumption is discussed. For qualitative predictions/assessments, some uncertainty is removed through consultation. These uncertainties are reflected in the Confidence level scoring.

Table 6-2: Example of Table for Assessment of Impacts

Aspect/Impact Pathway	**Nature of impact**	**Status**	**Spatial Extent**	**Duration**	**Consequence**	**Probability**	**Reversibility**	**Irreplaceability**	**Mitigation Measures**	**Significance of Impact/Risk = Consequence x Probability**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
CONSTRUCTION PHASE (EXAMPLE)												
Clearing of 150 ha of vegetation	Loss of Habitat and Species	Negative	Site Specific	Long term	Substantial	Very Likely	Yes	Moderate	Undertake Plant Search and Rescue prior to the commencement of construction	Moderate	Low	Medium
	Susceptibility of soil erosion on exposed surfaces	Negative	Site Specific	Medium term	Moderate	Likely	Yes	Moderate	Implement an Erosion Management Plan throughout the construction Phase	Moderate	Low	High

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for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 7:

Mitigation and Enhancement Measures

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7 IMPACT IDENTIFICATION AND SIGNIFICANCE

The issues and impacts presented in this chapter have been identified via the environmental status quo of the receiving environment, a review of environmental impacts from other similar projects and inputs from specialists that form part of the project team. This chapter gives a summary of the detailed and original specialist studies as contained in the relevant appendices to this report. The current summary of specialist findings and recommended management actions is provided in the interest of adhering to the EPA guidelines on ESIA reports and with a view to facilitating public participation. The EPA, with its mandate of substantive review of the ESIA report, is therefore urged to also read the original specialist studies in the relevant appendices to this report with the aim of discharging its decision-making function.

A detailed description of the proposed project can be found in Chapter 3 of this ESIA report.

7.1 SOCIO ECONOMIC IMPACTS

An assessment of the socio economic impacts associated with the proposed development was conducted by Mr Kofi Gatu from Seljen Consult (refer to Appendix 1). The findings of this study are discussed below.

7.1.1 Identification of Key Issues

The socio-economic impact assessment has involved a series of stakeholder consultations including that with community members and elders, landowners, traditional authorities and heads of key governmental agencies. In addition to this, a stakeholder forum was organised in October 2016 where members of the public and state agencies were invited for a briefing on the project.

Based on the issues raised at the project briefings, status quo conditions of the study area and the nature of the proposed development, the key socio-economic issues of concern can be summarised as follows:

- Employment Opportunities;
- Changes in Land Use
- Compensation for Loss Property
- Risk to Public Safety and Health
- Ecotourism Potential
- Improvement in Infrastructure
- Environmental Challenges
- Change Management

7.1.2 Assessment of Impacts

The potential social, economic, health and public safety related impacts likely to be associated with the proposed project from site preparation to its operational phase are listed and detailed out in the following sections. The significance rating of those impacts will be the same for the preferred and the alternative layouts.

7.1.2.1 Positive Impacts of Proposed Project

The support for renewable energy projects is guided by the need to address climate change as well as a rationale that Ghana has a very attractive range of renewable resources, particularly solar and wind, and that renewable applications are in fact the least-cost energy service in many cases - and more so when social and environmental costs are taken into account. The proposed project will have significance positive environment impacts when compared to other forms of power production, including the thermal power production which involves the burning of fossil fuel.

The major positive impacts of the project will include stabilization of electricity in Ghana, potential for carbon market, promotion of economic growth in the country, increased employment in the project area among other positive benefits. The ratings of the significance of these positive impacts are outlined in Table 7-1 and the rationale for arriving at these ratings provided in the corresponding texts below.

7.1.2.1.1 Stabilization of Electricity

Operational Phase

Developing the wind power facility to feed the national grid with approximately 76MW of power will contribute to creating a stable and reliable power supply base and solving the serious domestic power supply volatility experienced in Ghana over recent years. The current primary energy generation sources in Ghana have experienced serious limitations due to low water levels and oil and gas supply constraints. Consequently, wind facility coming on stream by 2020 will provide broader electricity supply market space as well as optimize the power generation portfolio and improving generation mix and power supply stability and reliability in Ghana.

The wind facility is envisaged to contribute significantly to addressing potential power demand and supply growth in-balance and deficit in the near future, as it will play a significant role in the stabilization of power situation in the country during the operational phase. Stabilisation of electricity can be described to be definite and has a **high** positive impact on the country as it will lead to improvement of environment and individual livelihoods for the entire country during the 25 years of its operations.

Enhancement Measures

To ensure continuous availability of electricity, the following enhancement measures are proposed:

- Regular and routine maintenance of wind power facilities.
- Capacity building of operational and maintenance staff for the purposes of developing their efficiency.
- Development of policy options that supports competitive markets with equitable rate structures.
- Provide reliable electricity supply with a socially acceptable level of local or large-scale outages;
- Develop a system to allow a smooth transition in the architecture and operation of the present power system;
- Operations and maintenance activities are environmentally benign; and socially equitable.

7.1.2.1.2 Inclusion in Ghana's National Determined Commitments

Operational Phase

Developing a renewable energy resource will lessen the need to use fossil fuels such as coal. Wind power generation does not require fuel for turbine operation, and has no emissions directly related to electricity production. As such, operations of wind turbines does not produce CO_2, SO_2, NOx or particulate matter or any other form of air pollutant. Thus, one of the direct benefits that Ghana will enjoy by developing its renewable energy resources is the avoidance of Greenhouse Gases emissions (GHG). In June 2015, VRA notified the UNFCCC of this wind power facility and plans taken to prepare a Project Design Document to identify its carbon savings for carbon trading under the Clean Development Mechanism (CDM). However, the process stalled due to suspension of CDM application. Currently, the proposed wind power projects have been included as part of the Ghana's Nationally Determined Commitments to help the country achieve its legally-binding targets of reducing greenhouse gases for the period 2020 - 2030 following the signing and ratification of the Paris Agreement by the country. The inclusion of the project as part of the nationally determined commitments can be described as definite and has a **high** positive impact as it will lead to improvement of environment due to low carbon emissions and individual livelihoods for the entire country during the 25 years of its operations.

Enhancement Measures

It is important that to enhance the contribution of the wind power project to reduction of greenhouse gases and its contribution to climate change impacts, there should be regular and routine maintenance of wind power facilities for continuous operations of the plant to ensure it displaces energy sources from fossil fuels.

7.1.2.1.3 Promotion of Economic Growth

Operational Phase

This project will play a significant role in stimulating economic growth in Ghana. The power input will contribute significantly to the Ghana's Electrification Programme, which has potential to promote spin-off effects on rural economy. The project also has power export potential to the neighbouring countries, particularly Togo. Today the energy situation in Ghana is unsatisfactory as evidenced by the frequent unplanned power outages, an important circumstance which slows down the economic development in the country. Power produced by this project will largely change this situation.

Currently, nearly 43% of the power capacity in Ghana is based on hydropower at Akosombo, Akuse and Bui, with about 56% being thermal based[1]. Over the last ten years or so, the country has paid a heavy price for over reliance on hydropower. The country from 2011 to 2015 undertook load shedding between 400 and 700 Megawatts of power during off-peak and peak periods, respectively due to a shortfall in production. The crisis came about because of poor water levels in the three dams (Akosombo, Kpong and Bui), the lack of gas flow from the West Africa Gas Pipeline in Nigeria to thermal plants in Ghana for production as well as the breakdown of some plants. The crisis took a toll on industry, businesses and domestic consumers. In the 2013 World Bank Enterprise Survey on Africa, the widespread, poor electricity supply was mentioned as one of the biggest barriers to growth in Ghana's economies, and a hindrance to many multinational investors. The World Bank[2] has indicated that electricity is the second most important constraint to business activities in the country and that Ghana lost about 1.8% of GDP during the 2007 power crisis.

Reduction of hydropower production during the dry spells was compensated by increasing the power production of the diesel plants and of course rationing of power. This increased the cost of power production. ISSER[3], in its 2014 study[4] also indicates that on the average, the country is losing production worth about US$ 2.1 million per day (or, US$ 55.8 million per month) just being caused by the power crisis alone and that the country lost about US$680 million in 2014 translating into about 2% of GDP due to the power crisis. It further indicated that firms that do not have access to sufficient electricity have lower output/sales, and that not having sufficient electricity lowers firm's annual sales by about 37-48%. These experiences have underscored the need to diversify the power sources in Ghana and this is what the project will achieve during its operations.

The project has the potential of reducing the cost of the power because the power generated from the project will in the long-term cost less than any other existing sources as its production cost will not increase thereafter. In effect, this implies that the project has the

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[1] National Energy Statistics, 2006-2015, Energy Commission, April 2016

[2] World Bank, Energizing Economic Growth in Ghana: Making the Power and the Petroleum Sectors Rise to the Challenge, February, 2013

[3] ISSER is Institute of Statistical Social and Economic Research

[4] Electricity Insecurity and its impact on Micro and Small Businesses in Ghana, Charles Ackah, Senior Research fellow, ISSER, University of Ghana, 2015.

potential to usher the country into a low-power tariff regime. This has not only a positive effect on the cost of the energy production but will also lead to economic gains through improved competitiveness.

The impact of the project in the promotion of economic growth during the 25 years of its operations can be said to be **medium positive** as it is national and of long term in nature and definite.

Enhancement Measures

The following enhancement measures are proposed:

- Ensure stably priced electricity for consumers to promote local businesses.
- Payment of taxes to Government for national developments.
- Provide job opportunities for locals and nationals to enhance their economic development.
- Landowner lease and project revenue payments as part of Corporate Social Responsibilities to enhance local economy.
- Promote ecotourism potential of the wind power project to enhance local development and revenue generation.

7.1.2.1.4 Increased Employment Opportunities

Constructional Phase

The proposed project has the potential to create jobs in the local area both directly and indirectly during the construction phase. As indicated, this project will bring in employment opportunities for the local inhabitants. Direct job opportunities will be available for high calibre professionals including engineers, mechanics and consultants. It is, however, unlikely that the local community will benefit from this calibre of specialised job market. Of greater relevance to the local community will be job opportunities involving unskilled and semi-skilled labour especially during the rehabilitation of the roads and the construction of the wind park and staff buildings.

It is expected that the project will create approximately 50 direct construction employment opportunities over this period (i.e. 8 skilled, 18 semi-skilled, and 24 low skilled). Construction crews will constitute mainly skilled and semi-skilled workers. Unskilled jobs will be offered mainly to the local people particularly during the construction phase. About 10 VRA support staff will be present in addition to the above. About 5 expatriate workers are expected to be on site.

During the road rehabilitation and construction phases of the project, over 50 members of local communities in the project area will be hired by the project as drivers, masons, loaders, carpenters, cooks, security personnel and other assorted personnel. Indirectly the project will create opportunities for self-employment in the project area especially during the rehabilitation of the roads and the construction of the wind park facility. Since the project will require local materials for the above project activities, the local community stand to benefit from their engagement in several activities including the making of ballast, collection of sand, cutting of building stones, making of concrete blocks and transportation of goods and building materials. Other employment opportunities in the project area will spring from spin-off activities including trade, accommodation, and supply of goods and services to both the skilled and unskilled labour.

In addition to direct benefits from the employment of local residents, the proposed project may also offer potential economic benefits through the procurement of goods and services. It is assumed that the majority of this procurement will be at a regional or national level due to shortages in suitable industry and service providers in the study area. Some local businesses' will benefit from the influx of migrant workers due to an increase in trade of a variety of products, including agricultural, fishing, services, recreational activities, amongst others. Nonetheless, the price of food and other goods sold in the surroundings of the site may increase due to this influx of workers. It is expected that this impact will however be limited to the construction phase.

Increased income generating opportunities will be experienced at a national, regional and more local level to varying scales, causing different degrees of economic growth. However, the majority of employment during construction is likely to be relatively short-term and significant employment opportunities for local communities may be limited due to the low levels of education, skills and limited experience and training opportunities that the local people have. This can result in a large percentage of skilled and semi-skilled workforce being sourced on a temporary or permanent basis from outside of the local community.

Receptors in the Social Area of Influence (AoI) that may be able to make the most of these opportunities are those who have received some experience of formal employment, gained basic education or learned English language skills. Typically this may be youthful males who have received some education, have experience working for the government or other international companies, or who have learnt some English. It should be noted that at the local level the overall lack of education, skills and capacity means that vulnerability is high, meaning a large majority would be ill equipped to maximise benefits.

Construction of the project will lead to a positive impact on the employment of the area and region. During the constructional phase, this project will create job opportunities in the project area and beyond, including the international community. Local labour sources and local resources will be utilised where possible. It is expected that many of the workers will either originate from the neighbouring area or be staying in houses and apartments in nearby communities. The impact of employment created during construction will be definite and is considered a positive effect from the project. The local community will benefit from job opportunities for the semi-skilled and unskilled cadres who will form the bulk of the labour force, thus the project has the potential to lead to economic development and therefore of **medium positive** impact.

Enhancement Measures

- Measures are to be designed and adhered to regarding employment and workforce policies to mitigate environmental, health and social impacts that are associated with the influx of formal and informal workers by the Contractor.
- Design and adhere to employment and workforce policies
- Local employment and sourcing policies are to be used to give priorities to people within the three project communities and the Ada District and this must be done in line with VRA Local Content Policy.

- Announcement of job opportunities must be made via both the electronic and print media. Announcements must be in English and the local dialects since a large proportion of the populace in the project area have no formal education.
- Food vendors from the local communities must be encouraged to sell their food to workers at designated place at within the project site.
- The Contractors' workforce should procure food stuff and fish from the local communities, thus providing a source of income for such communities.
- The local communities therefore must be encouraged to earn their income through the sale of cooked food to workers.
- Apply relevant national policies, labour laws and codes concerning employment conduct
- Institute appropriate grievance mechanisms to address concerns of both workers and the public
- Appoint a Community Liaison Officer as a designated point of contact for the community.
- Prepare Labour Management Plan as part of HSE Plan for the construction phase.
- Supply the workers with STD prevention devices including the male and female condoms
- Put in place a worker grievance mechanism including monitoring and resolving of such concerns.
- Put in place mechanisms to deter the work force from engaging in activities which has the potential of causing conflict with the communities
- Put in place suitable measures to maintain a healthy environment for the labour force.

Operational Phase

Approximately 20 technical persons on shift basis shall be hired for operations at the wind farm and power plant during operational phase. This number will be in addition to those engaged at site for security and administrative duties expected. At this stage in the project development, the origin of these workers is unknown. Other employment opportunities in the project area will spring from spin-off activities including trade, accommodation, and supply of goods and services to both the skilled and unskilled labour and those to be associated with the tourism potential of the project.

The socio-economic environment of the social study area is characterised by a low degree of livelihood productivity with some degree of diversity. The study showed low levels of educational achievement and capacity within the project area. From the household survey it is determined that majority of household respondents have only reached 2nd cycle and primary school. During the operational phase, It is assumed that the majority of beneficiaries for employment will be educated Ghanaians with experience in the power sector who can provide a swift response to labour requirements with minimum training. Based on the baseline conditions it is assumed that very few of these types of candidates will be available from within the local area. As a result, employment benefit is expected to be experienced mainly by beneficiaries from nearby urban centres such as Accra and Tema. Looking at the numbers involved, the potential intensity on employment is low, national and of long-term duration and definite and is described as **medium positive** in nature.

Enhancement Measures

The enhancement measures outlined under the constructional phase is also very pertinent to the operational phase. In addition, eensuring continuous electricity availability will help manufacturing sectors which are often constrained by a lack of reliable power to produce more, consume more inputs from other sectors, and hence create additional employment.

7.1.2.2 Negative Impacts associated with the Proposed Project

Although this project will realise tremendous economic benefits and other positive impacts as outlined above, it will also have negative effects on the socio-economic environment. The socio-economic negative impacts of the project will be triggered mainly by challenges in land acquisition and compensation issues, land use and quality as well as the increased population in the project area following the commencement of the installation of the proposed wind power project. As the local community and other people from outside the project area respond to employment opportunities, the project area will witness an increase in human population in this remote area. This influx of people is likely to lead to a number of negative socio-economic impacts including cultural contamination, health issues, increased insecurity and community conflicts, challenges of labour force management, increased accidents from traffic and transport and occupational hazards. The ratings of the significance of these negative impacts are outlined in Table 7-1 and the rationale for arriving at these ratings provided in the subsequent texts.

7.1.2.2.1 Impact on Land Use

Construction Phase

The project is situated within two areas within the Ada west District; Wokumagbe and Akplabanya-Goi sites. Land requirements for the wind turbines and related grid system is approximately 193.31 ha (1.9331 square km). The proposed site at Wokumagbe is marshy with open grass land. The Akplabanya-Goi site is predominantly farmlands. Land use in the project area includes farming, animal rearing, fishing, salt collection, recreation, settlement and associated constructions such as roads. On elevated land where the rooting zone is above the saline water table the following crops can be farmed; cassava, maize and vegetables (particularly okro, pepper and tomatoes). Cultivation is particularly intense west of Ada and between Goi and Anyaman. The mud-flats and the saline marshes, in the east are not extensively cultivated. Because of the scarcity of arable land, the same plots are cultivated continuously with heavy use of fertilizer. Small scale free range livestock production is widespread in all the villages.

Fishing is undertaken in both the Songor lagoon and the sea, the latter being a major commercial activity. Lagoon fishing is particularly important to older people who cannot go out to sea. The main species caught were tilapia and lagoon crabs. Salt winning is a major commercial activity in villages around the lagoon and majority of the people derive their livelihood from salt collection. Ownership of the lagoon and salt winning rights have in the past, been a source of serious conflict between the, local people and external private salt mining companies.

The Town & Country Planning will have to demarcate the area and map out accordingly. The land to be affected by the implementation of the proposed project has the following categories of land-uses, agricultural lands, potential agricultural lands or fallow agricultural lands. Land for the project site has been surveyed and is to be acquired. The demarcation of the land for the project would result in some potential effects on land-use characteristics such as hunting as well on the fauna within the project environment, however, on a very minimal basis. The major activity requiring mitigation is the land-use as this ultimately leads to loss of land for hunting and possible land-use conflicts.

Constructional activities could lead to a direct impact of physical displacement of residential communities (with or without legal entitlement) or economic displacement from key activities such as fishing or farming, because of the development and associated infrastructure and this can plunge households into poverty and / or dislocate communities severing extended support networks such as childcare. If located on land impacted by the project, the people and houses will need to be relocated to make way for the project and new land or alternative means of subsidence or livelihood generating activities may be required; however, this is not expected under this project as the alignment of the project infrastructure is being done in such a way to avoid these.

The significance rating of the impact on land use is said to be high. The potential intensity of this impact is high and negative as various people will lose their lands and livelihood. The spatial extent of the impact will be specific only to the project site, however, the duration of the impact will be long term but irreversible as the land will be acquired and its uses will be restricted from then on.

<u>The following mitigations are recommended:</u>

- Appropriate consultations with all stakeholders to raise awareness about the project. Of special importance is awareness with regard to project benefits that different communities stand to gain
- Effective zoning of project area by the Town and Country Planning Department
- Minimise impact on land acquisition through alternative site selection
- Utilise existing right of way to minimise land acquisition
- Institute appropriate grievance mechanisms to address concerns of the public
- Appoint a Community Liaison Officer as a designated point of contact for the community

With the successful implementation of the above recommended mitigation, the high negative significance of this impact is expected to decrease to **low.**

Most households within the social study area have high level of dependency and communal use of lands where families and individuals are engaged in subsistence farming. Subsistence cropping is not a controlled activity by any authority. Farmers with authority from landowners use portions of lands for farming. As indicated, the land to be affected by the implementation of the proposed project has the following categories of land-uses: agricultural lands, potential agricultural lands or fallow agricultural lands as well as grazing if animals, at the Anynui site. Due to land acquisition, farming activities may now be restricted during the operational phase, as the acquired land will be fenced off and now be used for wind power operations involving regular monitoring of the performance of the wind turbine generators (WTGs) and minor maintenance carried out when required as well as annual maintenance of the WTGs. The Project will be operational 24 hours a day, seven days a week with the proposed operational period of the Project being 25 years.

This impact to land access is definite and of medium term duration as farmers may return to use the lands once wind turbines are installed. The loss to access of lands for subsistence farming will also affect income generation ability by local residents. The impact of loss of income or lowered income generation is definite and will occur in the medium term. Roads in the study area will also be enhanced because of the project development and thus may enhance the landscape and enhance investments.

All degraded areas resulting from the road rehabilitation and wind facility construction activities including the quarries, cuts and fills and other disfigured surfaces in the project area and environs, need to be landscaped and suitable grass, shrubs and trees planted to blend with the environment. The presence of the wind facility in otherwise an unspoilt natural environment is likely to be visually intrusive to some people. As discussed during the stakeholder consultations, the wind facility has the potential to attract observers from the normal scenery. It may, however, be noted that the wind facility is not an ordinary sight and being a novelty, could be appealing to a wide cross- section of local community, other Ghanaians and even foreign visitors. Indeed, it could as well be a local attraction drawing many observers from beyond the project area. The area could however become a tourist attraction due to the physical presence of the wind turbines infrastructure. This provides opportunity for establishment of recreational and entertainment facilities in the project area to support this new development.

The significance rating of the impact on land use is said to be medium negative. Land use restrictions will be definite during operations will be definite. However, the land acquired may be available for limited farming activities. The potential intensity of this impact is medium and negative. The spatial extent of the impact will be specific only to the project site. The duration of the impact will be long term and irreversible as the land will be acquired and its uses will be restricted from then on.

The following mitigation measures are recommended:

- Formulate resettlement and livelihood restoration activities to improve the standards of living and long-term wellbeing of the affected persons

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to **low**.

7.1.2.2.2 Impacts on Land Quality

Constructional Phase

Contamination of ground and groundwater at the development site may be present during the construction phase. However, these risks are considered low. Possible sources of contamination associated with construction work may include spills, leaks, or deliberate discharges of oil or fuel. Other substances may include raw materials, fluids, intermediate produces, wastes and effluents. Dredged material may contain contaminants. As such, substances will be in small quantities, the intensity of any such contamination may be direct, low, and reversible.

The significance rating of the impact of the project on land quality during the constructional phase can be described as very low. Substances that will have the potential for ground and groundwater contamination will be small quantities, the intensity of any such contamination may be direct, negative and low and reversible. The spatial extent of the impact will be specific only to the project site. The duration of the impact will be temporal and reversible. The probability of the impact on land quality is low.

The following mitigation measures are recommended:

- Design facility to good practice standards in line with IFC EHS Guidelines For Wind Power Projects and General IFC EHS Guidelines to minimise contamination of soil and ground water
- Limit clearing and grading of access and corridor tracks of the wind turbines to the minimum area requirements
- Implement measures to minimize erosion

With the successful implementation of the above recommended mitigation, the very low negative significance of this impact is expected to remain **very low**.

Operational Phase

Substances that will have the potential for ground and groundwater contamination will be small quantities, the intensity of any such contamination may be direct, negative and low and reversible. The spatial extent of the impact will be specific only to the project site. The duration of the impact will be temporal and reversible. The probability of the impact on land quality is low. The significance rating of the impact of the project on land quality during the operational phase is therefore anticipated to be very low.

The following mitigation measures are recommended:

- Design facility to good practice standards to minimise contamination of soil and ground water

With the successful implementation of the above recommended mitigation, the very low negative significance of this impact is expected to remain **very low**.

7.1.2.2.3 Impacts on Land Acquisition

The project will necessitate land acquisition and both physical and economic displacement of. It is hoped that physical displacement for associated facilities can be avoided as much as possible. Again, some land acquisition and economic displacement is anticipated for the Rights of Way (ROW) for the access roads and associated transmission lines. Vegetables and cassava are the main farming activities taking place on some parts of the proposed project sites. During the study, some legitimate representatives for the acquisition of community lands especially at Omankope and Wokumagbe have been identified. However, ownership of the affected lands at Wokumagbe is being contested between the people of Omankope and Wokumagbe.

There will be no physical displacement of residential communities (with or without legal entitlement) because of project activities. However, economic displacement from key activities because of the development and associated infrastructure can plunge households into poverty and / or dislocate communities severing extended support networks such as childcare. If not mitigated appropriately and early, resettlement impacts can cause great controversy and result in significant public objections, time delays and considerable cost overruns for the project.

It is expected that project activities connected with the road rehabilitation will not displace local communities in the project area or any section traversed by the earmarked access roads. The proposed road rehabilitation will follow the current Right of Way (ROW) for the existing road and therefore, there will virtually be no displacement of local people and destruction of property.

The significance rating of the impact of the project on compensation during the constructional phase can be described as high negative . Land acquisition and economic displacement will require compensation, and this is definite. PAPs to be impacted are currently being enumerated and the property cost under valuation in collaboration with the Lands Commission. The intensity of this impact can be said to be high, negative and direct. The spatial extent of the impact will be specific to the people within the project site. The duration of the impact will be long term and irreversible and will last during the lifetime of the project. There is a definite probability of the impact on occurring.

<u>The following mitigation measures are recommended:</u>

- Institute appropriate grievance mechanisms to address concerns of the public
- Appoint a Community Liaison Officer as a designated point of contact for the community

- Undertake detailed survey of project-affected persons for the purposes of compensation payment
- Prepare a "Compensation Action Plan" to guide compensation payment
- Pay prompt, adequate and fair compensation to all project-affected persons before the start of constructional activities
- Utilise existing right of way to minimise land acquisition

With the successful implementation of the above recommended mitigation, the high negative significance of this impact is expected to decrease to **low**.

Operational Phase

As indicated, a "Compensation Action Plan" report is under preparation to ensure that the PAPs are compensated properly prior to project development. From experience, land ownership issues are expected to persist during the operational phase of the project. In cases, where property owners could not be traced after all efforts have been made during the constructional phase additional efforts will be made during the operational phase to locate such people.

Outstanding payments will be effected during this phase. The significance rating of the impact of the project on compensation during the operational phase can be described as medium negative. Land acquisition and economic displacement will require compensation. PAPs to be impacted are to be paid prior to project development. This impact can be said to be of medium low intensity, negative, direct and irreversible. The spatial extent of the impact will be specific to the people within the project site.

The following mitigation measures are recommended:

- Institute appropriate grievance mechanisms to address concerns of the public
- Appoint a Community Liaison Officer as a designated point of contact for the community
- Pay prompt, adequate and fair compensation to all project-affected persons

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to **very low**.

7.1.2.2.4 Impacts on Labour and Working Conditions

Constructional Phase

It is envisaged that the client will employ as many people as possible from the surrounding local villages and towns. Workers will be hired for periods lasting from a few days (for specific construction tasks) to the full extent of the construction period. Peak employment is estimated to be 6 months. Temporary camps will not be required to house the workforce. The Client is advised to hold discussions with the house owners in order to determine if the facilities will be suitable for senior level workers.

Productivity has been known to deteriorate on construction sites due to labour unrest, leading to a negative impact on the cost and quality of construction as well as the livelihood and morale of workers. Wages, bonus and other compensation disputes remains the main reason for work stoppages and accounting for working days lost. Given the important role of labour productivity and industrial action to workers and to the economy, there is the need for the client to play an increasingly active role in mitigating the damages resulting from industrial action.

EPC companies, contractors, and subcontractors usually have contracts with a defined work scope, duration, start date, and other parameters to base their estimate. A change in a project scope of any kind usually means there will be associated productivity impacts that can be attributed to inefficiencies as well. Often, the design is incomplete or changes are made that will impact the original estimate. The original project may have been planned for partial execution in wet weather and other inefficiencies; however, the changes will probably constitute additional impacts and inefficiencies.

A key example is the request from owners to keep the same completion date, despite the added scope of work. This may require overtime, second shift work, rework, additional crafts, and many other impacts to the original plan and estimate. This increase in person-hours, constraints, and other resources would affect the cost and schedule. Another impact that may occur is the need for new or additional material, constraints, and equipment, which affect the sequence, duration, and schedule of work packages. There could also be an increase in idle time of workers waiting on material. Such changes may cause work force increases and work areas to be overcrowded with workers who now need to share and occupy the same workspace, scaffolding, or equipment with other crafts, causing a further drop in productivity.

The significance of the impact on labour and working conditions during constructional phase is **low** negative. The potential intensity if this impact occurs is described as medium negative, site specific and temporal in nature and probable to occur, if relevant measures are not put in place.

<u>The following mitigation measures are recommended:</u>

- Apply relevant national policies, labour laws and codes concerning employment conduct
- Design and adhere to employment and workforce policies
- Institute appropriate grievance mechanisms to address concerns of both workers and the public
- Appoint a Community Liaison Officer as a designated point of contact for the community
- Prepare Labour Management Plan as part of HSE Plan for the construction phase
- If required, design and operate work camps in accordance with the requirements set by IFC PS2 and the relevant guidelines within the guidance document Workers' Accommodation: Processes and Standards: A Guidance Note by IFC and EBRD.

With the successful implementation of the above recommended mitigation, the low negative significance of this impact is expected to decrease to **very low**.

<u>Operational Phase</u>

Approximately 20 technical persons on shift basis shall be hired for operations at the wind farm and power plant during operational phase. This number will be in addition to those engaged at site for security and administrative duties expected. Other employment opportunities in the project area will spring from spin-off activities including trade, accommodation, and supply of goods and services to both the skilled and unskilled labour. Increased income generating opportunities will be experienced at a national, regional and more local level to varying scales, causing different degrees of economic growth. It is assumed that the majority of beneficiaries will be educated Ghanaians with some experience in the power sector who can provide a swift response to labour requirements with minimum training. Based on the baseline conditions it is assumed that very few of these types of candidates will be available from within the local area.

The socio-economic environment of the social study area is characterised by a low degree of livelihood productivity with some degree of diversity. The study showed low levels of educational achievement and capacity within the project area. From the household survey it is determined that majority of household respondents have only reached 2nd cycle and primary school. As a result, this benefit is expected to be experienced mainly by beneficiaries in urban centres such as Accra.

Receptors in the Social Area of Influence (AoI) that may be able to make the most of these opportunities are those who have received experience of formal employment, gained basic education or learned English language skills. Typically this may be youthful males who have received some education, have experience working for the government or other international companies. It should be noted that at the local level the overall lack of education, skills and capacity means that vulnerability is high, meaning a large majority would be ill equipped to maximise benefits. Experience has shown that such situations usually cause the community members to be peeved that others have been successful, with its subsequent negative attitudes to the project and the workers that have been engaged. Vandalism sometimes results from such ill feelings.

The significance of the impact on labour and working conditions during operational phase is medium negative. The potential intensity if this impact occurs is described as medium negative, national and temporal in nature and probable to occur, if relevant measures are not put in place. Mitigation measures proposed for the constructional phase will be same for the operational phase.

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to **very low**.

7.1.2.2.5 Impacts on Community, Health, Safety and Security

Constructional Phase

Health and safety requirements are key aspects for any developmental project which is seeking for international lending or loan financing. According to IFC performance standard 2, "*economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers"*. Occupational health and safety is contained under Section 23 of the IFC PS 2 and requires that, "*the client will provide safe and healthy work environment, taking into account inherent risk in this particular sector and specific classes of hazards in the clients works areas including physical, chemical, biological and radiological hazards"*. The requirements and conditions of this standard are applied to the development of this project.

In Ghana, there is not an abundance of health and safety regulations, however, the practice is promoted under the Factories, Shops and Offices Act of 1970 (Act 328), the Ghana National Fire Service Act, 1997 (537) and the Workmen Compensation Act, 1987 (PNDL 187). Nevertheless, the promotion of health and safety practices on projects of this nature is discussed in a number of government document and national guidelines. These standards, laws and guidelines, will protect workers during the project construction and operation period.

Implementation of the project will definitely increase volume of human and motor traffic. Increases in human and motor traffic will be aggravated by the transportation of construction materials and proposed wind plant accessories and other equipment required to install the wind facility from the Port of Tema. This is likely to result in a higher risk of accidents occurring, and relocation of facilities to allow for smooth transportation.

During the road rehabilitation and wind farm construction phases, several activities including vehicular transport, operation of heavy machineries and blasting of hard rock in quarries have potential for accidents risks among both the project workers and the local community. Factors that may exacerbate this situation are inadequate appropriate working gear for project workers including the helmets, overalls, boots and gloves.

The road rehabilitation, construction of the wind power facilities, and other project activities may lead to creation of stagnant water bodies in quarries and depressions created during the construction works. Although water collected in the depressions may be a respite for pastoral animals, the resultant stagnant water bodies are likely to be suitable habitats for the breeding of mosquitoes that is the disease vector for malaria.

There will be the potential for increased road traffic accidents from increased construction traffic. The risks of accidents and injury will mainly concern the construction workers. During construction, non-local employees are typically employed on a 'single' basis, they will not come with their families. Often, they can be housed close to the construction sites either in purpose built accommodation of within the nearby communities, which will most be likely in this case.

From the social surveys conducted, most common illness in the various communities are; malaria, cholera, diarrhoea and headaches. Except for headaches, significant number of persons in household has suffered the effect from one of these diseases illness. Except for headaches, significant number of persons in household has suffered the effect from one of these diseases illness. Malaria is spread by the Anopheles mosquito, which breeds in water spools and chocked gutters. Cholera is an acute illness caused by the ingestion of food and water contaminated with bacterium. The prevalence of these diseases is because of poor sanitary conditions within the areas. From the study, it was identified that sanitation conditions are poor and in some areas, no proper waste management system was identified. With the significant potential influx of workers to the project area, it is expected that communicable diseases will increase among workers through interaction with local communities and vice versa.

Migration will occur to the surrounding areas as there is an opportunity for employment. Coinciding with the influx of migrant workers is typically a raise in demand for goods and services during the construction period which can result in a rapid expansion in supply chain businesses operating in the area. This will result in increases in formal employment and informal labour. This expansion may result in migration into the area. The impacts that may arise from the presence of migrant and/or expatriate employees largely comprise the following:

a) Inappropriate behaviour and lack of respect for local leadership and cultural norms on the part of expatriate workers;
b) Conflict resulting in part from resentment by skilled nationals and local residents if they perceive that expatriates have been hired into jobs for which they are suitably qualified;
c) Disruption of local communities with an increase in crime and anti-social behaviour;
d) Spread of transmissible diseases including HIV/AIDS both within the workforce and between the workforce and the local community;
e) Resentment of non-local nationals by local residents if they are perceived to have taken jobs that could be successfully filled by local people, or due to non-integration with the local community; and
f) Increased local demand for consumer goods and housing with resulting encouragement for improved supply resulting in financial hardship and benefits for local people; and,
g) Increased pressure on infrastructure, services (such as healthcare) and roads, particularly with the establishment of informal settlements.

The significance rating of the impact of the project on community health, safety and security can be described as medium negative. The intensity of this impact can be said to be high with local to regional influence. The duration is temporal and reversible with a high probability to occur.

<u>The following mitigation measures are recommended:</u>

- Develop Health and safety measures related to the working conditions as part of the Health and Safety Plan
- Undertake health education with regard to communicable diseases as part of the induction training for workforce members
- Organize and support education programmes to increase awareness and change public attitudes towards HIV/AIDS and other sexually transmitted diseases.

- Supply the workers with STD prevention devices including the male and female condoms
- Put in place a worker grievance mechanism including monitoring and resolving of such concerns.
- Put in place suitable measures to maintain a healthy environment for the labour force
- Prepare Labour Management Plan as part of HSE Plan for the construction phase.
- Complaint redress committee should be formed to receive and facilitate resolution of concerns and grievances about the socioeconomic concerns raised by individuals or groups from the project affected communities. To ensure that the committee provides a solution to the grievances, the committee should be headed by the Project Engineer with representation from professionals with background in Social Work, Economics, Land Administration and Law. The community should also involve an impartial representative from the communities, district or municipal officers, traditional, religious and community leaders.
    - The main functions of the committee will be as follows:
        - To provide a mechanism for aggrieved persons to report on problems arising because of project activities.
        - To facilitate and prioritize the grievances of project affected persons that needs to be resolved.
        - To ensure reporting to the aggrieved parties about the developments regarding their grievances and the decision of the project authorities.
- Put in place mechanisms to deter the work force from engaging in cutting of trees for fuel wood, charcoal burning, and building material and for any other purposes, which has the potential of causing conflict with the communities
- VRA needs to put in place mechanisms for the collection of all wastes generated (solid wastes, organic wastes, food remains, garbage etc.), in the labour camps, segregate the various wastes and arrange for subsequent disposal through either efficient incineration or disposal in a sanitary landfill.

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to **very low**.

Operational Phase

Health and occupational hazards associated with the proposed project are cross cutting issues, which may occur in the project area due to a combination of several project processes including influx of workers, creation of ponding conditions, increased human and motor vehicle traffic and operations of the installed wind park facility. Public safety, Occupational safety and health hazards associated with the project are extremely significant and must be the first priority of site management as they pose potential threat to the safety and health of the workers. These hazards could be from falling and/or swinging objects, potential collapse of towers due to rainstorms or vandalism, falling from heights and snakebites.

Due to the nature of technology involved, the wind farm operation and maintenance activities will be minimal. Nevertheless, there are potential occupational hazards with regard to work force engagement in both daytime and/or night-time activities albeit on a small scale. The nature of occupational hazards will include:

- ✓ Machine/equipment injury risk;
- ✓ Occupational noise and vibration;
- ✓ Fire risk;
- ✓ Risk of exposure to electro-magnetic radiation;
- ✓ The risk of electrical shock; and
- ✓ Miscellaneous hazards.

The significance rating of the impact of the project on community health, safety and security can be described as low negative. Considering the number of workers involved at this stage, the intensity of this impact is anticipated to be medium, the spatial extent of the impact will be local, and the duration of the impact will be long term and reversible. There is a low probability of the impact occurring.

The following mitigation measures are recommended:

- Adopt the IFC Occupational Health and Safety (OHS) Guidelines for wind energy projects
- Take precautions to beef up the security of the wind park and the staff quarters.
- Appropriate warning signs will also be provided at the site where there is a risk to health and safety

- Project management should cultivate harmonious co-existence between itself and the local communities in the project area.
- Provide alternative source of energy during the implementation of the project to ensure that uncontrolled utilization woody resources do not take place in the project area.
- Support relevant local CBOs to conserve the plant resources including participation in planting of trees and mangrove rehabilitation in the project area.
- A comprehensive fire detection and protection system will be installed to cover all equipment on site that could constitute a fire risk.

With the successful implementation of the above recommended mitigation, the low negative significance of this impact is expected to decrease to **very low**.

7.1.2.2.6 Traffic and Transport Impacts

Constructional Phase

The shipping port would be Tema and from there the transport distance to the sites would be around 70 km to the Goi and Wokumagbe sites. The main part of the route is on the N1 (Accra - Aflao road) to Sege and then off to the project sites. The routes are shown in Figure 7-1[5]. The existing road network reaches close to the selected sites and only very few kilometres of access roads have to be built new for reaching the selected sites. A 1km x 0.03km (3Ha) road access will be required and subsequently developed.

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[5] *Source:* Draft Feasibility Study for Lekpoguno/Aklabanya Wind Farm, August 2015

Figure 7-1: Project Transport Route

All roads are to be reviewed four (4) months before the start of the project. Work will commence with improvement of the access road connecting the site with the national Accra – Aflao Highway N1. Any dirt road to the identified sites will require widening, spreading gravel and compaction to upgrade/ build to a standard that is suitable for the 60-foot flat-bed trucks in good weather conditions. Lay-bys will be built at suitable points for ease of crossing. The roads within the project area shall be suitably compacted / strengthened to withstand the onset of torrential surface flow and land submergence/inundation. Since the entire project area is flat, road gradient will not be an issue. A truck test is to be performed after the road works are done.

The proposed sites are well served by public transport; the local bus service known as the Metro Mass, as well as short-hub transport, popularly known as “Tro-tro”, as well as taxis runs several times on the route. However, encroachment and traffic load on the designated road are not considerably heavy. Hence, traffic congestion during the construction phase will not be a major issue. However, suitable temporal segregation of traffic will be undertaken, to ease the load of traffic in the project area. Due to local movements/traffic inside villages, the proposed roads are to be crossed during night-time and all access roads within villages must be clear to allow the transports.

Equipment, supplies and personnel will move in and out from the site using the access road and the Accra – Aflao NI Highway. WTG components will require delivery via specialised heavy goods vehicles, which would be escorted along the public highway and upgraded access tracks. Heavy vehicles carrying the wind turbines and necessary equipment will operate from the Tema Port and take the link road to the NI Highway for onward journey to project sites site by the dirt road which will be upgraded to take the heavy load of towers (~162 tons), rotor blades (~60 tons), turbines (Nacelle ~82 tons), machinery and equipment. Analysis of the difficulties to be encountered on these routes has been performed and recommendations have been made on how to overcome them. Within this context, the access to the site of along the N1 shows no major obstacles, only small works are necessary at roundabouts and turnings to assure sufficient space without electricity poles, traffic signs, etc.

The site will receive many truckloads of fill material, construction materials daily for the constructional period. Concrete plant and some material (cabling, cement etc.) will be transported to the site via normal articulated heavy goods vehicles. Aggregate for tracks and foundations will be sourced from off-site quarries in proximity to the Project therefore no borrow pits are proposed. Building materials supply to the site would be frequent for sand, stones, cement, and blocks, especially during early stages of the construction period. In addition to this are the equipment and machinery, and this would be delivered to be project site, via road to the project sites.

The roadway and entrance/exit design, driver safety, and roadworthiness of the trucks are all important issues, as is the need to contain all garbage, trash and fluids in the load. In terms of total traffic generated by the construction phase, daily movements will be low. Transport of equipment and material would not require any specialised vehicles and would be highly minimal and therefore and does not have any impacts on the project. Administrative measures would have to be put in place to stagger the delivery of construction equipment and materials to the port sites.

There will also be traffic created by many of the workers who will drive to the site each day to work. The requirement will only be for the delivery of workers at the start and end of each day and the construction materials during the working day, both to the depots and to the construction sites.

There can be serious disruptions to local traffic and accidents during the construction period. The significance rating of the impact of the project on community health, safety and security can be described as Medium Negative. This may be as a result from the transportation of machinery and materials from Tema to the project site and the intensity of this impact can be described as high with both local and regional influence. It will be temporal and reversible in nature with a high probability of occurring.

<u>The following mitigation measures are recommended:</u>

The Client should develop a Traffic Method Statement (TMS) for the construction phase with the aim of minimizing disturbance to the nearby residents, industrial workers and general road users. The TMS will govern vehicle movements in and out of the site. The TMS will include, amongst other things details of signage requirements, transportation times etc. In addition, a health and safety management plan for all operating vehicles and machines.

In order to reduce/avoid any potential impacts in relation to traffic, the Client should ensure that:

- Local authorities are involved in defining optimum project traffic routes and times for transit;
- Defensive driving training will be provided to drivers;
- Speed limits will be enforced for heavy good vehicles and workforce transportation vehicles;
- The provision of site vehicle maintenance in order to ensure technical failures do not occur;
- Avoid densest areas of traffic, if possible, through planning and channelling of traffic.
- Install traffic safety signage at vantage points along access routes with the project sites. Install traffic calming measures (speed bumps and rumble strips) to slow traffic down where heavy vehicles cross or enter busy roads. Install traffic calming

measures (speed bumps and rumble strips) to slow traffic down where heavy vehicles cross or enter busy roads.

- Engage communities on road risk and educate them through constant communications, road signals as well as with communications with the local authorities and community leaders
- Improve and enhance community sensitization on road traffic accidents within the project area.
- Install speed control limits for the project and ensure all vehicles comply with the site driving regulations.
- Develop and implement a "No Drinking" "No Alcohol" policy on site during both construction and operation. Monitor all vehicles and ensure they have a "No Alcohol" sticker. The same must be done for all construction equipment and machines. Monitor all vehicles and ensure they have a "No Alcohol" sticker. The same must be done for all construction equipment and machines.
- Conduct periodic and routine alcohol checks for all site drivers and site workers.

The Client should ensure coordination with the Ghana Highway Authority and Department of Urban Roads to minimise interference between installation and operation following guidelines of the "Road Reservation Management: Manual for Coordination" (June 2001). The Client should give a Notice of Work as outlined in Appendix 1 of the manual and this should be accompanied by a sketch of the location plan. Thus in all cases, where the project will affect public roads due notification to the public and appropriate authorities (GHA, Urban Roads and/or Keta Municipality) will be given as required.

With the successful implementation of the above recommended mitigation, the medium negative significance of this impact is expected to decrease to **very low**.

Operational Phase

Currently, the road conditions of project area are in a very poor state. In order to facilitate smooth transportation of wind power equipment, the project will improve access roads to the wind turbines at the project site. The rehabilitated road will improve communication in the project area and promote economic activities. There may be some alterations in the existing road traffic movements associated with the operational phase of the project, however, in the long term, once the proposed power station is operational, the traffic generated will be small, and will not contribute significantly to the existing traffic volumes in the area. The additional traffic generated by the development can be accommodated by spare capacity in the existing highway network.

Approximately 20 technical persons on shift basis shall be hired for operations at the wind farm and power plant during operational phase. These staff will work a shift pattern, which combined with car sharing would result in a small increase of the order of about 5 vehicles arriving in any day. The increase in traffic would therefore be barely detectable within the day-to-day variation in the project area. As such, the operation of the wind power plant will not have a material impact on the operation of the existing roads. The operational phase of the scheme is not expected to have any significant impact on road safety. Severance, vibration, visual intrusion, driver delay will not be a significant impact. Nor will the operational phase of the project have a detrimental effect on pedestrian amenity.

The significance rating of the impact of the project on traffic and transport during project operations can be described as very low. Taking account of the low overall total traffic movement that will occur, impacts are predicted to be low. The spatial extent of the impact will be local. The duration of the impact will be during the operational duration and long term and there is a low probability of the impact on occurring.

<u>The following mitigation measures are recommended:</u>

The Traffic Method Statement (TMS) developed for the construction phase will continue to be used for the operational phase. The TMS aims at minimizing disturbance to the nearby residents, industrial workers and general road users. In the long term, once the proposed power station is operational, the traffic generated will be small, and will not contribute significantly to the existing traffic volumes in the area Due to the reliability of such new plant, requirements for maintenance will be minimised, limiting the number of site visits necessary by maintenance staff. Car sharing will be encouraged. The additional traffic generated by the development can be accommodated by spare capacity in the existing highway network.

With the successful implementation of the above recommended mitigation, the very low negative significance of this impact is expected to remain **very low**.

7.1.2.3 Potential Cumulative Impacts

Currently there are no wind power projects in Ghana. However, in future the coastal area in the Volta and Greater Accra Regions are likely to be associated with the establishment of other wind power projects. There is the potential for cumulative effects to occur when considering the Project in conjunction with other operational wind farms in the area or those consented or in planning. The nearest for a similar wind power project will be the 76MW Wind Power Project 2 (Wokumagbe and Goi) to be in Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region also belonging to the Client and those being implemented by Upwind International AG in different stages of development within the same vicinity. Cumulative impacts from operation of project will need to be considered in relation to the proposed developments.

At a national level, the impacts of the project must be considered in the context of effects on the national economy and compliance with national policy. The project will make a significant contribution to national energy policy by moderating Ghana's dependence on fuel-based energy. It will also provide stable and economic energy supplies, enhancing the sustainability of existing industry in the country.

None of the wind farms is yet to be built and hence the socio-economic effects of each at the regional level are yet to be realised. Cumulative benefits are likely to result through land rent, community funding, and employment and associated indirect impacts. When considering the proposed developments in conjunction with the Project, there is the potential for further benefits resulting from local employment and community funding. Should construction occur concurrently then temporary effects on recreational activities may be noted. As identified previously, measures will be employed during construction to minimise nuisance caused to users of local roads, for example cyclists and walkers. With mitigation in place, it is envisaged that cumulative impacts would be overall of low and of negligible significance.
From the wind feasibility studies for the project, the prevailing suitable wind attributes in the area are likely to attract other developers to install wind park facilities near the project area. A situation where other wind development projects are established close to the project area,

will lead to cumulative and long-term impacts in the project area, far beyond what has been predicted for this project. If this happens, the country in general and the project area are likely to be beneficiaries of cumulative positive impacts of the additional wind park facilities including further improvement in transportation, provision of employment and social benefits and enhancement of economic growth. However, increased projects close to the project area may enhance the negative impacts including loss habitats and biodiversity, increased pressure on natural resources, increased insecurity and unplanned settlements, visual intrusion and increased pollution among other negative impacts. In addition, the likely increase in incidences of HIV/AIDS and increased cultural contamination among the local community in the impacted area are likely to cause long-term and cumulative social impacts if no attempts are carried out to contain the situation at an early stage of project development.

7.1.2.4 Impacts of Project De-commissioning

The project is expected to have similar impacts as the construction phase during decommissioning phase. Key negative impacts will be on Land Quality, Community, Health, Safety and Security as well as Traffic & Transport and the ratings of these impacts are outlined under Section 7.1.2.1 and 7.1.2.2. Mitigative measures proposed for the constructional phase for these impacts also pertains to the decommissioning phase.

7.1.3 Impact Assessment Summary

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Table 7-1 and Table 7-2 below.

Table 7-1: Ratings of Project Associated Positive Impacts

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence/ Intensity	Probability	Reversibility	Irreplaceability	Significance		Confidence Level
									Without Enhancement	*With Enhancement*	
CONSTRUCTIONAL PHASE											
Job Creation	Increase in Employment Opportunities	Positive	International	Temporal	Medium	Definite	High	Replaceable	Medium	High	High
OPERATIONAL PHASE											
Electricity Availability	Stabilization of Electricity	Positive	National	Long Term	High	Definite	Low	Moderate	High	High	High
Climate Change	Contribution Towards National Determined Commitments	Positive	National	Long Term	High	Definite	Low	High	High	High	High
Economic Growth	Promotion of Economic Growth	Positive	National	Long Term	Medium	High	Low	Moderate	Medium	Medium	Medium
Job Creation	Increase in Employment Opportunities	Positive	National	Long Term	Low	Definite	Low	Moderate	Medium	Medium	Medium

Table 7-2: Ratings of Project Associated Negative Impacts

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
CONSTRUCTIONAL PHASE											
Land Use	Loss of land for personal and commercial use	Negative	Site Specific	Long Term	High	Definite	Low	Moderate	High	Low	Medium
Land Quality	Land pollution	Negative	Site Specific	Temporal	Low	Low	High	Low	Very Low	Very Low	Medium
Land Acquisition	Loss of Properties	Negative	Site Specific	Long Term	High	Definite	Non-reversible	High	High	Low	High
Labour & Working Conditions	Reduction in productivity	Negative	Local	Temporal	Medium	Probable	High	Low	Low	Very Low	Medium
Historical & Cultural Heritage Resources	Destruction / loss of Historical & Cultural Heritage Resources	Negative	Local	Temporal	Medium Low	Probable	High	Low	Low	Very Low	Medium
Community, Health, Safety and Security	Injury to public	Negative	Regional	Temporal	High	High Probable	High	Low	Medium	Very Low	Medium
Traffic & Transport	Increase in traffic and road accidents	Negative	Regional	Temporal	High	High Probable	High	Low	Medium	Very Low	Medium
OPERATIONAL PHASE											
Land Use	Permanent loss of land for personal and commercial use	Negative	Site Specific	Long Term	Medium	Definite	Low	High	Medium	Very Low	Medium
Land Quality	Land pollution	Negative	Site Specific	Temporal	Low	Low probable	High	Low	Very Low	Very Low	Medium
Land Acquisition	Loss of Properties	Negative	Site Specific	Long Term	Medium Low	Definite	Non-reversible	High	Medium	Very Low	High
Labour & Working Conditions	Reduction in productivity	Negative	National	Temporal	High	Probable	High	Low	Medium	Very Low	Medium
Historical & Cultural Heritage	Destruction / loss of Historical & Cultural	Negative	Site Specific	Temporal	Low	Low	Low	Moderate	Very Low	Very Low	High

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
Resources	Heritage Resources										
Community, Health, Safety and Security	Injury to public	Negative	Local	Medium	Medium	Low	High	Low	Low	Very Low	Medium
Traffic & Transport	Increase in traffic and road accidents	Negative	Local	Long	Low	Low	High	Low	Very Low	Very Low	High
DECOMMISSIONING PHASE											
Labour & Working Conditions	Reduction in productivity	Negative	Local	Temporal	Medium	Probable	High	Low	Low	Very Low	Medium
Community, Health, Safety and Security	Injury to public	Negative	Regional	Temporal	High	High Probable	High	Low	Medium	Very Low	Medium
Traffic & Transport	Increase in traffic and road accidents	Negative	Regional	Temporal	High	High Probable	High	Low	Medium	Very Low	Medium
Land Quality	Land pollution	Negative	Site Specific	Temporal	Low	Low	High	Low	Very Low	Very Low	Medium

7.2 TERRESTRIAL ECOLOGY IMPACTS

An assessment of the terrestrial ecology impacts associated with the proposed project was conducted by Dr James Kojo Adomako from The University of Ghana (refer to Appendix 2). The findings of this study are discussed below.

7.2.1 Identification of Key Issues

The key potential issues identified during the study are as follows:

Construction phase

- Permanent loss of vegetation cover and potential loss of listed/rare plant species associated with the turbines footprint and new access roads during construction is expected.
- In swampy areas, there may be the need to pump out water from the excavations and this would further increase erosion from surface runoff and increase sediment flow into nearby water bodies. Increased erosion risk would be likely to result due to the loss of plant cover and soil disturbance created during the construction phase. This may impact downstream riparian and wetland habitats if a lot of silt enters the drainage systems.
- Removal of mangrove vegetation will cause the exposure of water bodies to direct sunlight thus increasing the rate of evaporation.
- Clearing of vegetation and compaction of soils could lead to death and displacement of some faunal species.
- Impact on plants due to the release of fine particulate matter or sediment into the environment
- Harsh chemical control measures for weed and pest control may be used which might have negative impacts on non-target plant species and the environment
- Introduction of alien (sometimes invasive) species of biodiversity to the area in and around the wind facility
- Presence and operation of construction machinery on site. This will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.

Operational Phase

- Alteration of micro-climate.
- The operation of the facility may generate noise and disturbance which may deter some fauna from the site as well as impact the activities of others within the site.
- Maintenance activities such as vegetation clearing may impact the biodiversity of the site if not conducted in a sensitive manner.
- Loss of connectivity and habitat fragmentation may result if fauna avoid the area or cannot move through the area on account of the presence of the facility.

Decommissioning

Decommissioning is assumed to entail the removal of the hard infrastructure from the facility and the rehabilitation of the cleared and disturbed areas. The following impacts are likely to be associated with this phase of the development:

- Increased erosion risk due to the loss of plant cover and soil disturbance created during the decommissioning phase. This may impact downstream riparian and wetland habitats if a lot of silt enters the drainage systems. The disturbance would also be likely to increase the vulnerability of the area to alien plant invasion.
- Presence and operation of machinery on site. This will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.
- Impacts on fauna during decommissioning activities.

7.2.2 Assessment of Impacts

7.2.2.1 Construction Phase

A high level of disturbance is likely to occur for the duration of the construction phase. Such disturbance will relate to vegetation clearing, excavation, noise and general anthropogenic influences associated with the building of the facility on site. This may include the cutting and removal of vegetation for the establishment of new internal gravel roads (a permanent transformation) and the cutting and trampling of vegetation at the proposed location for the wind turbines and laydown areas.

7.2.2.1.1 Loss of vegetation and protected/listed species due to the clearing of vegetation

The clearing of vegetation for roads, turbine foundations and crane pads will lead to disturbance of the area and loss of biological diversity, including the potential loss of globally/locally rare species. Although the total footprint is estimated at about 100 ha, this is distributed across a wide area, and a variety of different vegetation types and habitats are likely to be affected. The Gold star species (Fairly rare internationally and/or locally) encountered at Workumagbe was *Ritchea reflexa*. On the other hand, Goi recorded GHI value of 0.00 thus raising no conservation concerns. Increased human presence can lead to poaching, illegal plant harvesting and other forms of disturbance such as fire.

The impact of the project on vegetation is of high intensity for the preferred layout given the sensitivity of the sites and the presence of rare species. The impact is assessed to be long-term as the majority of cleared areas are required for roads and other infrastructure and will not be rehabilitated. The probability of the loss of vegetation is definite as clearing of the vegetation is required ahead of construction and the probability of impacting a protected/listed or rare species is rated as probable.

Given the above, the loss of vegetation and protected/listed or rare species due to the clearing of vegetation is anticipated to be of medium significance without mitigation for both, the Preferred layout and for the alternative layout.

Although the WPP2 site is poor in species richness, the following key mitigation measures are recommended to be implemented by the project applicant:

- Undertake a walk through the site while doing micro-sitting of the turbines to avoid species of concern as much as possible.
- Undertake a pre-construction walk through the site to identify species of concern that can be translocated if necessary
- Ensure that construction staff has attended an environmental awareness training to ensure that basic environmental principles are adhered to.
- Demarcate areas that will need to be cleared and keep clearing areas to a minimum.
- Demarcating and labelling no-go areas in proximity to the development footprint, such as sensitive areas

- No listed/protected or rare plant may be dislocated or disturbed without the permission of the environmental manager
- Ensure that camp sites, lay down areas and other temporary areas are located in areas of low sensitivity and that they are clearly demarcated
- Mangrove revegetation and tree planting should be undertaken to reverse the decline in the vegetation cover of the project footprint.
- Any unwarranted destruction of vegetation and habitats beyond the designed wind facility should is prohibited.
- Lost biodiversity on the disturbed area should be restored through planting of appropriate trees and shrubs and protection of fauna species and their habitat.
- The GoG quarantine inspection and procedures should be followed to ensure that invasive or alien species do not enter the area.
- Construction of new tracks should be kept to the barest minimum and the use of existing roads should be encouraged. Track routes should be selected in such a way as to minimize any damage to farms and crops.
- Mechanical control should be used for all vegetation clearing.
- Removal of stream bank vegetation (especially bamboo/mangrove) must be avoided as much as possible.
- Cutting of trees must be done by a certified timber contractor, and strictly in line with the prescribed safety guidelines. The landing area of falling trees should be carefully selected to minimize damage to farms. Adequate warning should be given to ensure that public safety is not compromised.

With the successful implementation of the above recommended mitigation, the medium significance of this impact is expected to decrease to **low** for both preferred and alternative layouts.

7.2.2.1.2 Increase in potential erosion during the clearing of vegetation

Vegetation clearing and soil disturbance will lead to an increase in soil being exposed, which may leave the disturbed areas vulnerable to erosion. This may impact downstream wetland habitats if a lot of fine particulate matter or sediment enters into the environment. In addition, the construction of many hard surface areas for roads, laydowns, etc. will generate water run offs which can also increase erosion risks of surrounding areas. However, most parts of the site contain a high proportion of grass within the vegetation and grasses should increase in density rapidly within wetter areas and should in most instances help to prevent erosion in areas receiving runoff.

Given the above, impacts associated with erosion have been assessed to be of local extent, short term duration and medium intensity for both preferred and alternative layouts. The probability that erosion and associated impacts do occur is probable and the significance is therefore anticipated to be low, without mitigation.

The following mitigation measures are recommended:

- A rehabilitation and re-vegetation plan should be developed prior to construction.
- Regular monitoring of the site during construction for erosion problems.
- Topsoil should be removed and stored separately and should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.
- Establishment of revegetation in exposed areas
- Erosion management plan should be considered right from construction phase.

With the successful implementation of the above recommended mitigation, the low significance is expected to decrease to **very low** for the preferred and the alternative layout.

7.2.2.1.3 Removal of mangrove vegetation and brackish water swamp vegetation can cause intense evaporation of water body and destruction of habitats

The mangrove vegetation and brackish water swamp is composed of species such as Typha doimngensis, Acrostichum aureum, Avicennia germinans, Rhizophora sp., Paspalum vaginatum, Cyperus ariculatus and Sesuvium portulacastrum. The mangrove swamps are sensitive habitats that require conservation action. Aside protecting water bodies from intense evaporation, mangrove vegetation serves as habitats and brooding sites for brackish and freshwater organisms. This medium rated impact is expected to affect footprint of local extent. Mangrove forest can be replaced through replanting. There is only 25% chance of removing a few mangroves in the proposed wind power project site. Mangroves may also be impacted by runoffs from construction activities.

The duration of this impact of removing the mangrove vegetation is expected to be long term unless mitigation strategies are adopted.

Without mitigation, the negative impact is anticipated to be of medium significance for both preferred and alternative layouts.

The following mitigation measures are recommended:

- Mangrove revegetation
- Avoiding destruction of mangrove swamp where possible
- Adequate management of construction runoffs

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to **low** for both preferred and alternative layouts.

7.2.2.1.4 Impacts on fauna and flora due to compaction of soils by traffic and through the use of compactors

Depending upon the nature of soils (particle size, clay and mineral content etc.) changes in habitat form may arise within the site in the long term as plant species that are tolerant of or prefer particular soils benefit at the expense of other species which are less tolerant. The intensity of this impact has been rated as high due to the fact that the impact will eventually lead to reduction in biodiversity. Moreover, in the situation where invasive alien species benefit, they will enjoy rapid growth at the expense of economic and rare plants in the project footprint.

Soil compaction can also lead to the death and displacement of some faunal and microbial species. This probable impact is expected to be long term and spread to about 10 km away from the project site.

Without mitigation, this negative impact is anticipated to be of medium significance for both preferred and alternative layouts.

The following mitigation measures are recommended:

- The number of passes of heavy trucks to and from the project sites should be regulated and minimised.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to **low** for both preferred and alternative layout.

7.2.2.1.5 Impact on plants due to the release of fine particulate matter or sediment into the environment

The clearing of vegetation for roads, turbine foundations and crane pads during the construction phase will result in the release of fine particulate matter which are likely to settle on plant surfaces. The particles impair respiration by blocking the stomata through which gaseous exchange occur. Furthermore, the particles reduce the surface area available for chlorophyll to trap solar energy for photosynthesis. The intensity of this impact is rated medium due to the fact that inefficiencies in respiration and photosynthesis can result in weakening and death of plants. Moreover, microorganisms and fauna that survive on such plant leaves will be displaced. There is also the likelihood of changing the visual morphology of plants in the project footprint.

However, this is a temporal impact that which can be reversed by rainfall as long as excavation activities ceases.

The impact of the settlement of particulate matter on the leaf surfaces of plants would be of local extent (<10 km), the probability of particulate matter settling on plant surfaces is probable. Without mitigation, the negative impact is anticipated to be of low significance for both preferred and alternate layouts.

The following additional mitigation measures are recommended:

- Excavation activities should not be carried out during high wind speed moment of the day. This will reduce the extend of spread of the particulate matter in the project footprint. Minor trenches and holes should be dug manually to reduce the release of particulate matter.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to **very low** for the preferred and the alternative layout.

7.2.2.1.6 Weed and pest control

Harsh chemical control measures may be used which might have negative impacts on non-target plant species and the environment.

Weed and pest control chemicals are usually in sprayable form, making them easier to soak into undesired plant foliage and animals. The intensity of this impact is rated medium due to the fact that chemical drift can result in damage to none target economical or rare plants and animals. Over time, the vegetation of the project site and its footprint will change as a result of residual chemicals in the soil. Chemical usage in weed and pest control is probable and long term activity that will last throughout the construction and operation phases of the project. The damage caused by chemicals usually has low reversibility.

Without mitigation, the negative impact of chemical weed and pest control is anticipated to be of medium significance for the preferred and alternative layout.

The following mitigation measures are recommended:

- Mechanical weed control should be used instead of chemical weed control
- Avoid the use of chemicals in the control of pests, rodents, snakes etc. around the project site and settlement areas.
- In situations where chemical control is inevitable, adopt spot application strategy in chemical application instead of the broadcast method in other to minimize exposure to non-targeted plants and animals.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to **very low** for the preferred and the alternative layout.

7.2.2.1.7 Introduction of alien (sometimes invasive) species of biodiversity to the area in and around the wind facility

During the construction phase, the introduction of exotic vegetation or the invasion of disturbed areas by exotic vegetation through either a physical vector (e.g. machinery, vehicles etc.) or more “natural” dispersion vectors (e.g. wind, avian dispersion) is probable.

The changes in vegetation as a result of the introduction of invasive alien species will last for long. However, the impact is expected to be contained within 10 km off the project site. The intensity is rated low due to the fact that the area is already degraded. Only a few native plants were identified during the survey. Pioneer index ranged between 126.0 and 133.8 respectively (Table 7). Such high PI values indicate that the sites are well populated with pioneer species. During secondary succession, pioneer species are first to arise. This implies that the area has been disturbed and thus has few or no primary species.

Without mitigation, the negative impact is anticipated to be of low significance for the preferred layout and low significance for the alternative layout.

The following mitigation measures are recommended:

- Inspection of all persons and machinery before entry to the site
- Quarantine and elimination of all suspected carriers of invasive alien species
- Use only plants and seed collected on-site for revegetation.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to remain **low** for both preferred and the alternative layout.

7.2.2.1.8 Impacts on fauna during construction activities

The intensity of the negative impact on fauna during the construction phase is rated as medium. This is because there is high probability of ousting of fauna through disturbance and human presence. Opportunistic animal species may benefit from the construction activities; in particular the exclusion of predators from the site may benefit former prey species which will take refuge within the area, skewing populations and predator – prey relations.

Another impact on fauna during the construction phase is that of lighting during late and early hours during construction. This may result in the death, injury and relocation of several animals inhabiting the project area. Increased human presence can also lead to poaching, illegal plant harvesting and other forms of disturbance such as fire.

The short term effect of the impacts is expected to be localized extent with a low chance of reversibility.

Without mitigation, the negative impact is anticipated to be of medium significance for the preferred and alternative layout. This phase is however transient and during the operational phase, levels of disturbance and activity will be considerably reduced.

The following mitigation measures are recommended:

- Faunal rescue plan should be adopted
- Hunting activities should follow the Wildlife Act
- All vehicles at the site should adhere to a low speed limit.
- No litter, food or other foreign material should be thrown or left around the site and should be placed in demarcated and fenced rubbish and litter areas.

With the successful implementation of the above recommended mitigation, the medium significance of this impact is expected to decrease to **low** for the preferred and alternative layout.

7.2.2.2 Operation Phase

The Operation phase is less impactful on the flora and fauna. Access roads to turbines would be maintained as well as vegetation controlled in the immediate vicinity of the turbines.

7.2.2.2.1 Alteration of micro-climate

Changes in wind speed and wind direction during operation may affect the flight of migratory birds. Dispersion of fruits and seeds, photoperiod, pollination, fruit formation and morphology of plants may be affected by the changes in micro-climate induced by the wind turbines during operation.

The status of the indirect impact is rated as neutral with a local spatial extent and long-term duration. The intensity of the impact is rated as low. The probability of the impact is assessed as probable. Without mitigation, the indirect impact is anticipated to be of low significance for the preferred layout and very low significance for the alternative layout.

The following mitigation measures are recommended:

- Monitoring plan for native plants the project footprint.
- Relocation of affected rare species.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to remain to **very low** for the preferred and the alternative layout.

7.2.2.2.2 Impact on fauna during the operation of the wind turbines

Although activity at the site is likely to be relatively low during operation, some impact on fauna may still occur as a result of personnel present on site as well as the operation of maintenance vehicles. Direct interactions between the turbines and terrestrial fauna are likely to be low. The operation of the facility will generate noise and disturbance which may deter some fauna from the site as well as impact the activities of others within the site. The operation of turbines and wind blades can cause injuries and deaths to flying mammals (birds and bats) in the vicinity (refer to Appendix 3 Birds Impact Assessment study). This localized impact will persist as long as the project is in operation with probability of 50%. Hence the intensity of this impact is rated as high. The reversibility of this impact is very low.

Without mitigation, the negative impact is anticipated to be of medium significance for both preferred and alternative layouts.

The following mitigation measures are recommended:

- Provision of critter paths within the fencing should be considered in the design.
- Promote and support faunal presence and activities within the proposed PV facility by prohibiting hunting, trading and consumption of bushmeat on the project site.
- Access to the site should be strictly controlled.

- All vehicles at the site should adhere to a low speed limit and any fauna on roads should receive right or way or can be moved off the road in the direction that the animal was moving in the case of slow-moving fauna such as tortoises.
- Any chemical spills at the site should be handled in the appropriate manner as determined by the nature of the spill.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to **low** for both, the preferred and alternative layouts.

7.2.2.2.3 Impact on flora during maintenance activities.

Maintenance activities such as vegetation clearing will impact the biodiversity of the site if not conducted in a sensitive manner. This is a site-specific impact with long term duration. Probability of occurrence is 75%, however, lost species can be replaced through replanting. The intensity is rated as medium since it involves the possible loss of species and habitats.

Without mitigation, the negative impact is anticipated to be of low significance for both preferred layout and alternative layouts.

The following mitigation measures are recommended:

- Avoid broadcast spraying of chemical herbicides during vegetation clearance
- Uproot and burn invasive alien species ones spotted
- Replant native rare plants in buffer zones to prevent extinction.
- Minor vegetation clearance should be done manually.

With the successful implementation of the above recommended mitigation, the significance of this impact is expected to decrease to **very low** for both preferred and alternative layouts.

7.2.2.2.4 Loss of connectivity and habitat fragmentation may result if fauna avoid the area or cannot move through the area on account of the presence of the facility.

The presence of the facility and the associated transformation of intact vegetation, would pose a threat to the connectivity of the landscape and the ability of fauna and flora to respond to environmental change. The potential severity of the disruption is to a large extent related to the surrounding vegetation and the contrast between the natural vegetation and the hardened surfaces of the facility. In the current context, the extent of disruption of landscape connectivity is likely to be low as the site is disturbed.

In the long-term the facility is not likely to create significant local or regional population-level impact as it is likely that sufficient numbers of individuals would be successfully moving about the landscape to prevent spatial fragmentation of their populations. The impact of the facility on the fragmentation of the landscape is likely to be of local extent, low intensity and **low** significance.

The following mitigation measures are recommended:

- Minimising the development footprint wherever possible.
- Revegetation of all cleared and bare areas created by the facility with local species.
- Key mitigation measures proposed by the specialist include:
- Fences and other structures which impede faunal movement should be avoided where possible.

7.2.2.3 Decommissioning Phase

7.2.2.3.1 Exotic weed invasion as a consequence of abandonment of site and cessation of weed control measures

Exotic weed invasion is a likely consequence the removal of wind turbines. Decommissioning of site will see increased disturbance of the land and therefore increased susceptibility to exotic weed invasion.

The spatial extent of this impact is local with medium-term duration. The consequence and probability of the impact are respectively rated as moderate and probable. The reversibility and irreplaceability of the impact are respectively rated as high and low. The significance of the impact without mitigation is rated as low. Significance without mitigation is low. Significance with mitigation is low.

Mitigation:

- Lost biodiversity on the disturbed area should be restored through planting of appropriate trees and shrubs.
- The GoG quarantine inspection and procedures should be followed to ensure that invasive or alien species do not enter the area.
- The landing area of falling turbines should be carefully selected to minimize damage to vulnerable plants and human lives. Adequate warning should be given to ensure that public safety is not compromised.
- Mitigation would include monitoring of the land and redress of exotic weeds found present on site.

With the successful implementation of recommended mitigations, the significance of this impact is anticipated to be **low**.

7.2.2.3.2 Exposed soil increases erosion risks

Increased erosion risk due to the loss of plant cover and soil disturbance created during the decommissioning phase. This may impact downstream riparian and wetland habitats if a lot of silt enters the drainage systems. The disturbance would also be likely to increase the vulnerability of the area to alien plant invasion.

Given the above, impacts associated with erosion have been assessed to be of local extent, short term duration and medium intensity for both preferred and alternative layouts. The probability that erosion and associated impacts does occur is probable and the significance is therefore anticipated to be low, without mitigation.

The following mitigation measures are recommended:

- Establishment of revegetation in exposed areas
- Construction of proper permanent drainage system

With the successful implementation of the above recommended mitigation, the low significance is expected to decrease to **very low** for the preferred and the alternative layout.

7.2.2.3.3 Impacts on fauna

The presence and operation of machinery on site will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.

In addition, increased human presence can lead to poaching, illegal plant harvesting and other forms of disturbance such as fire.

The short term effect of the impacts is expected to be localized extent with a low chance of reversibility.

Without mitigation, the negative impact is anticipated to be of low significance for both preferred and alternative layouts.

The following mitigation measures are recommended:

- Faunal rescue plan should be adopted
- Hunting activities should follow the Wildlife Act
- All vehicles at the site should adhere to a low speed limit.
- No litter, food or other foreign material should be thrown or left around the site and should be placed in demarcated and fenced rubbish and litter areas.

With the successful implementation of the recommended mitigation measures, the low significance is expected to decrease to **very low** for the preferred and the alternative layout.

7.2.2.4 Cumulative Impacts

Cumulative impacts on the flora and fauna, if other projects of similar nature are constructed in the area, would be significant. UpWind is proposing to construct a 300 MW WEF north of Lekpoguno, extending to the N1 (a distance of approximately 9.5 km), and to the north of Goi and Akplabnya, extending to the southern boundary of the Songor Lagoon (Figure 7.1). UpWind proposes to construct 90 to 100 turbines.

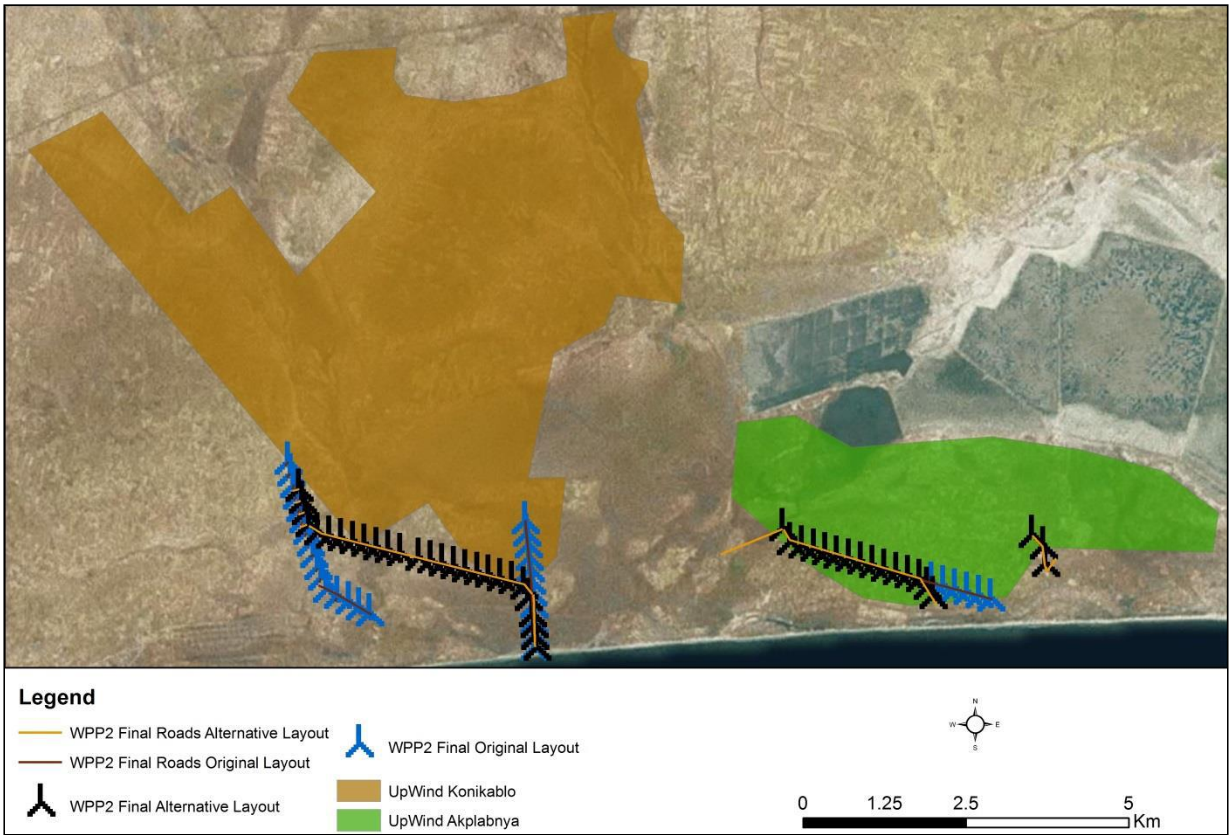

Figure 7-2: WPP2 in relation to the extent of the proposed Upwind WEF

Due to the close proximity of the two WEFs to each other, WPP2 and the UpWind WEF are likely to be viewed as a single WEF. The high number of turbines proposed for the UpWind WEF across a broad area will impact the terrestrial fauna and flora.

7.2.2.4.1 Cumulative impact 1: Reduced ability to meet conservation obligations & targets

The loss of unprotected vegetation types on a cumulative basis from the broad area may impact the countries' ability to meet its conservation targets, particularly the Gold Star index vegetation.

Mitigation measures inherent to the project design include:

- Preconstruction walk-through of the facility, especially the roads and turbine locations to ensure that sensitive habitats are avoided.
- Minimise the development footprint as far as possible.

As a result of the UpWind development, the cumulative impact for both alternatives is thus assessed to be of **high** significance.

7.2.2.4.2 Cumulative Impact 2: Impact on the disruption of broad-scale ecological processes

The presence of the facility and associated infrastructure could potentially contribute to the disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions.

Mitigation measures inherent to the project design include:

- Preconstruction walk-through of the facility, especially the roads and turbine locations to ensure that sensitive habitats are avoided.
- Minimise the development footprint as far as possible.

Key mitigation measures proposed by the specialist include:

- Stringent construction-phase monitoring of activities at the site to ensure that mitigation measures are adhered to and that the overall ecological impact of the development is maintained at a low level.
- The use of structures which may inhibit movement of fauna, such as mesh and electric fencing should be avoided as far as possible.

As a result of the UpWind development, the cumulative impact for both alternatives is thus assessed to be of **high** significance.

7.2.3 Impact Assessment Summary

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Table 7-3 to Table 7-5 below.

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Table 7-3: Direct impacts assessment summary table for the Construction Phase for the preferred and alternative layout

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
CONSTRUCTION PHASE											
Vegetation clearance	Loss of habitat and listed/rare species	Negative	Site and Local	Long-Term	High	Probable	Low	Low	Medium	Low	High
	Increase in potential erosion during the clearing of vegetation	Negative	Local	Short term	Medium	Probable	Moderate	Moderate	Low	Very low	High
	Removal of mangrove vegetation and brackish water swamp vegetation lagoon margin can cause intense evaporation of water body and destruction of habitats.	Negative	Local	Long-Term	Medium	Highly Probable	Moderate	Low	Medium	Low	High
Movement of Heavy Trucks and laying of concrete floors	Compacting of soils leading to death and displacement of some faunal and microbial species as well as to the competition of some plant species	Negative	Site specific	Long-term	Medium	Highly Probable	High	Low	Medium	Low	Medium

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
	Impact on plants due to the release of fine particulate matter or sediment into the environment	Negative	Local	Short-term	Medium	Probable	High reversibility	Moderate	Low	Very low	High
Weed and Pest control	Harsh chemical control measures may be used which might have negative impacts on non-target plant species and the environment.	Negative	Site specific	Long-term	Medium	Low probability	Low	Moderate	Medium	Very low	High
Transportation of people, materials and equipment	Introduction of alien (sometimes invasive) species of biodiversity to the area in and around the wind facility	Negative	Local	Long-term	Low	Probable	Low	Moderate	Low	Low	High
The clearing of vegetation and ousting of fauna through construction activities	Disturbance of fauna and opportunistic animal species may benefit from the construction activities	Negative	Local	Long-Term	High	Probable	Low	Low	Medium	Low	High

Table 7-4: Impact assessment summary table for the Operational Phase for preferred and alternative layout

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
OPERATIONAL PHASE											
Alteration of micro-climate	Changes in temperature, wind direction and speed	Neutral	Local	Long-Term	Medium	Probable	High	Low	Low	Very low	Medium
Impact on fauna during the operation of the wind turbines.	Noise, Accidents and Disturbance	Negative	Local	Long-Term	High	Probable	Low	Very Low	Medium	Low	High
Impact on flora during maintenance activities.	Loss of biodiversity and habitats	Negative	Site-specific	Long-Term	Medium	Probable	Low	Moderate	Low	Very low	High
Operation of the wind turbines	Loss of connectivity and habitat fragmentation may result if fauna avoid the area or cannot move through the area on account of the presence of the facility	Negative	Local	Long-term	Low	Probable	Low	Low	Low	Low	

Table 7-5: Decommissioning Phase Impact assessment summary table for preferred and alternative layout

DECOMMISSIONING PHASE											
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence / Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
Exotic weed invasion as a consequence of abandonment of site and cessation of weed control measures	Habitat and species change	Negative	Local	Medium-Term	High	Probable	Low	Low	Low	Low	High
Exposed soil increase in erosion	Habitat and species population change	Negative	Local	Short-term	Medium	Probable	Medium	Low	Low	Very low	Medium
	Impacts on fauna during construction decommissioning activities	Negative	Local	Short term	Medium	Probable	Low	Low	Low	Very Low	Medium

7.3 AVIFAUNAL IMPACTS

Dr. Erasmus Owusu from The University of Ghana and Mr Patrick Morant from the Council for Scientific and Industrial Research were appointed to conduct an assessment of the potential impacts on avifauna associated with the proposed construction, operation and decommissioning of a 76 Megawatt (MW) Wind Energy Facility (WEF) ("WPP1") in Anloga Extension areas in the Volta Region, Ghana with inputs from Dr Andrews Agyekumhene (Site Manager of the Muni-Pomadze Ramsar Site, Wildlife Division, Forestry Commission) (Appendix 3). The results of the study are discussed below.

7.3.1 Identification of Key Issues

The following key issues related to avifauna have been identified during the ESIA process:

Construction phase

- *Habitat Destruction:*

A certain amount of natural habitat will be altered and removed during the construction of the proposed facility. Building a new wind farm can therefore affect birds if the turbines are put up in an area that is frequently used directly by the birds. This may lead to the displacement of birds from the proposed site. However, the magnitude of the impact will depend on the conservation status of the species concern.

- *Disturbance and Displacement:*

Noise and human presence associated with construction activities may disturb birds in the surrounding areas. Other disturbances include burning and flashing of birds in an attempt by local community members to prevent them from destroying grain and pepper farms. New wind farms can act as a barrier for birds and lead to behaviour and flight pattern changes. For example, some wind farms could create a barrier between feeding areas and breeding areas, thus affecting productivity and populations. Equally, wind farms can also fragment habitats used by one bird species, making the two smaller pieces of habitat less useful. Regular maintenance of access routes and associated clearing of vegetation may also cause habitat fragmentation.

Operation phase

- *Disturbance and Displacement:*

Wind turbine blades create noise that can affect the ability of birds to communicate with one another. According to the U.S. Fish and Wildlife Service, a 3 decibel (dB) increase in sound from turbines can reduce the distance across which birds are able to communicate by 30 %. An increase in 10 dB reduces the distance by 90 %. The turbine noise can also cause long-term hearing damage in some bird species.

- *Disruption of bird movements:*

Wind turbines may also pose a physical barrier to the movement of birds across the landscape, which may induce alterations to their migration paths, and it may cause an increase in the distances that birds have to traverse, as well as increase their energy expenditure and potentially prevent movement of birds to ecologically important areas such as ephemeral wetlands.

- *Collision with wind turbines:*

This involves the direct strike of birds with wind turbine, killing them instantly. It is on record that songbirds/passerines, which are common in the project area, are susceptible to collisions. Birds are most susceptible to being hit by a wind turbine blade when the wind farm is in their migration corridor and when the bird is flying at low elevations, which can happen during bad weather. Large birds with poor manoeuvrability are generally at greater risk of collision with structures, and species that habitually fly at dawn and dusk or at night are perhaps less likely to detect and avoid turbines (e.g. cranes arriving at a roost site after sunset, or flamingos flying at night) (Jenkins *et al*. 2015). Collision risk may also vary for a particular species, depending on age, behaviour and stage of annual cycle (Drewitt & Langston 2006).

The number of birds impacted by collision is influenced by a number of factors, including:

- Number of birds in the vicinity of the WEF;
- The species of birds present and their flying patterns and behaviour; and
- The turbine layout, height and size of the rotor swept area.

Decommissioning Phase

- *Disturbance and Displacement:*

Activities occurring during the decommissioning phase, such as traffic and noise, may have similar impacts on avifauna as in the construction phase. Birds that may have utilised the electrical infrastructure for nesting may be vulnerable to disturbance impacts, particularly if the nests are disturbed or removed during the dismantling of infrastructure.

Key Issues Identified during the Public Consultation Process

Based on the comments raised by Interested and Affected Parties (I&APs) during the presentation of the scoping report on April 13, 2016, the Bird Impact Assessment also needed to address the impacts of the WEF at the location of the Keta Lagoon Ramsar site known to harbour significant number of birds and important migratory birds.

7.3.2 Assessment of Impacts

7.3.2.1 Construction Phase

The disturbance normally associated with the construction of a wind farm is temporary. However, this depends on the time taken to construct a wind farm and many other factors, including the scale of the project, the terrain and climate. In the project area, a key activity likely to impact on bird species includes the clearing of vegetation associated with the construction of proposed wind turbines and associated infrastructure, particularly roads, which can adversely alter the habitat quality of birds, but only for short periods, depending on the intensity of other anthropogenic activities that may be stimulated as a result of the creation of access routes. The clearing of vegetation will lead to two main impacts on avifauna in the project:

- Habitat Destruction,
- Disturbance and Displacement

7.3.2.1.1 Habitat Destruction

Construction typically takes 9 - 18 months (Kingsley & Whittam, 2005), which is likely to coincide with periods of bird breeding. Construction usually begins with the development of roads, followed by the excavation and pouring of the concrete foundations for the towers. This is followed by digging trenches and the burial of underground electrical cables.

Substations and any other buildings are then built; followed lastly by the assembly and testing of the turbines. The erection of a turbine usually takes 1 day. It is envisaged that during the construction phase, clearing of habitat used by birds for food and roosting within the site would result in the displacement of birds (Owusu & Roberts, 2016).

The scale of habitat loss resulting from the construction of a WEF and associated infrastructure depends on the size of the project, but is likely to be small per turbine base i.e. 2 – 5 % of the total development area (Drewitt & Langston, 2006) of a WEF. Therefore, due to the relatively small footprint of the WEF and degraded and altered state of the vegetation in the affected area, in most cases, habitat destruction or alteration due to clearing of natural vegetation is unlikely to be of much significance. Fragmentation of habitat can be an important factor for some smaller bird species. This disturbance could cause certain birds to avoid the entire site, thereby losing a significant amount of habitat effectively. In addition, the aerial habitat which will be lost by birds should be considered.

The destructive impact of the development on bird habitat would be of direct local extent for both alternative and preferred layouts, and permanent as the majority of cleared areas are required for roads and other infrastructure and will not be rehabilitated. The potential intensity of the impact on birds is expected to be Medium for the preferred and alternative layouts, given that there are species of Least Concern in the project area, and the development has the potential to reduce the quality of the environment and result in habitat loss. The probability of the impact on birds is rated as highly probable because of the previously- and currently cultivated nature of different sites within the project area, which attracts birds.

Given the above, the destruction of bird habit due to the clearing of vegetation is anticipated to be of medium significance for the preferred and alternative layout, without mitigation. The significance is predicated to be medium with mitigation for both proposed layouts.

The following mitigation measures are recommended:
Disturbance distances of up to 850 m have been recorded for wintering waterfowl and waders for onshore wind turbines (the distance from wind turbines in which birds are either absent or

the population density is less than expected) (e.g. Pedersen and Poulsen, 1991; Kruckenberg & Jaene, 1999; Larsen & Madsen, 2000; Kowallik & Borbach-Jaene, 2001; Hötker, *et al*., 2006; Madsen & Boertmann, 2008). A distance of 600 m is the maximum reliably recorded distance for the majority of species (Langston & Pullan, 2003; Drewitt & Langston, 2006). Assuming an absence of habituation, a precautionary complete avoidance distance would be in the region of 300 m for wintering waders and wildfowl, with a precautionary displacement distance of 600 m; the expected population reductions would be in the region of 100% within 0 - 300 m and 50% within 300 - 600 m (Owusu & Roberts, 2016). Specific mitigation actions include:

- Buildings (e.g. offices, storage areas etc.) and high traffic areas should be situated in areas that are already disturbed, where possible.
- Minimizing the footprint areas of infrastructure wherever possible, i.e. length and width of roads and the size of hard standing areas, laydown areas, and vehicle turning areas.
- Avoid wholesale clearing of the landscape and only clear areas critical to the project.
- Avoid prolonged disturbance by phasing clearing and ground work activities.
- Utilize existing roads and farm tracks, where possible, and keep road lengths to an absolute minimum. Ring and alternate roads to turbines should be avoided.
- Avoid any off-road driving and unnecessary earth moving, or vegetation damage or removal.
- Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist, since certain raptor species breed in these areas and should not be impacted.
- Any site rehabilitation should use only indigenous plant species.
- Minimise the impact on natural vegetation by keeping staff numbers to a minimum, as well as the number of large vehicles and general vehicular traffic.
- Avoid any development in sensitive zones and no-go areas.
- Environmental Control Officers (ECOs) must oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced;
- The avifaunal specialist should conduct a site walkthrough prior to construction, confirming the final road as well as the final turbine positions, to identify any

nests/breeding activity of sensitive species, as well as any additional sensitive habitats within which construction activities may need to be excluded.

- Rehabilitation of all disturbed areas (e.g. temporary access tracks and laydown areas) must be undertaken following construction; and a habitat restoration plan must be developed by a specialist and included within the CEMP.
- Providing wide corridors between clusters of closely spaced turbines, as recommended by Langston & Pullan (2003).
- According to Winkelman (1992), the layout of a wind farm is an important determinant of collision risk, with dense clusters of turbines potentially being less damaging for wintering, feeding and possibly breeding birds, in that it dissuades them from flying amongst the turbines.

7.3.2.1.2 Disturbance and Displacement

Certain sensitive species can be impacted by disturbances and noise from staff and construction activities, especially during feeding and breeding periods, which can result in effective habitat loss through a perceived increase in predation risk (Frid & Dill, 2002; Percival, 2005). There are various Species of Concern occurring on the WEF site (see Table 2), which may become displaced, either temporarily (i.e. for some period during the construction activity) or permanently (i.e. never returning to the site). This displacement into less suitable habitat may reduce their ability to survive and reproduce.

This is a negative impact restricted to the construction site (local) and duration is temporary (~1.5 years), limited to the duration of the construction phase. The irreplaceability of the receiving environment is low. The severity of the impact can be mitigated partially, but some disturbance is likely to occur. The consequence of this impact is medium as the environment will continue to function in a modified manner. The significance of the impact is rated as Low for the preferred and alternative layout prior to the application of mitigation measures, and is Low following mitigation.

Impacts on breeding success are anticipated to be of medium intensity on a short term duration. The impact would be highly probable and is therefore rated as medium before mitigation. With the effective implementation of mitigation actions, the impact on breeding success is anticipated to be of low significance.

The following mitigation measures are recommended:
Generally, the spacing between turbines should be greater than 200 m in order to avoid inhibiting bird movement (barrier effect). This recommended distance is also often the amount of spacing required by industry to reduce wake effects of large turbines on neighbouring turbines (Kingsley & Whittam, 2005). However, the wide spacing of turbines, in an attempt to reduce the likelihood of inhibiting bird movement, may potentially increase the area of displacement due to disturbance (Percival, 2001).

Given the open nature of the habitat in this project, with predominantly widespread and common species (of no or least conservation concern), the displacement of such bird species from portions of a wind farm is unlikely to have population consequences. However, the following specific actions are recommended:

- The implementation of a site specific CEMP is required, which must provide an appropriate and detailed description of how construction activities must be conducted. During construction, all contractors are to adhere to the CEMP and should apply good environmental practice.
- The avifaunal specialist should conduct a site walkthrough prior to construction, confirming the final road alignment, as well as the final turbine positions, to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats and no go areas. These results may inform the final construction schedule, including reducing the construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise.
- Where necessary and under the supervision of an avifauna specialist, nests and roost sites should be removed from the turbine cluster area prior to construction.
- Access routes and layout areas should, as much as possible, be devoid of farmlands which serve as feeding grounds for most of the bird species encountered.

- A precautionary disturbance distance of 1 km should be implemented around wader habitat.
- Minimise the number of staff on site, as well as the number of large vehicles and general vehicular traffic.
- Sensitive zones and no-go areas (e.g. nesting sites) which must be avoided must be demarcated.

7.3.2.2 Operational Phase

The development of new wind farms can affect birds because of the "barrier effect" it has on birds. This happens when the new wind farm causes birds to change their behaviour to avoid flying through the developed area. This affects bird movement patterns and, potentially, their eventual displacement. For example, some wind farms could create a barrier between feeding areas and breeding areas, thus affecting productivity and populations. Obstruction of the flight path for certain bird species, particularly raptors and large flocks, is therefore a major concern in the industry. Other impact sources include the regular maintenance of access routes through clearing of vegetation, thereby causing habitat fragmentation. This can also affect birds if the turbines are put up in an area that is frequently used directly by the birds. However, the magnitude of the impact depends on the rarity of the habitat type. During the operational phase, the main impacts on avifauna include:

- Collision with turbines
- Disturbance and displacement
- Disruption of bird movements

7.3.2.2.1 Collision with Wind Turbines

The average mortality rate from turbines in Europe fall within the average range of 6.5 and 1.6 bird per turbine per year in North America 1.6 (Rydell *et al*. 2012). Not all birds that fly through a WEF at heights swept by rotors automatically collide with blades. Certain bird species have extremely high avoidance rates. A radar study conducted for an off-shore WEF in Denmark showed that less than 1% of bird flights were at risk due to close proximity to the turbines, and it was clear that the birds (in this case; ducks and geese) effectively avoided the turbines (Desholm and Kahlert, 2005). Whilst a lack of data makes current avoidance rates for Ghanaian species unknown, comparisons can be drawn between functionally similar species in order to inform an assessment, for example Verreaux's Eagle with Golden Eagle.

The majority of studies on collisions caused by wind turbines have recorded relatively low mortality levels (Madders & Whitfield, 2006); however this may largely be a reflection of the fact that many of the studied wind farms are located away from large concentrations of birds. It is also noteworthy that many records are based only on finding carcasses, with no correction for carcasses that were overlooked or removed by scavengers (Drewitt & Langston, 2006).

The cautionary approach to assessing this impact is due to the lack of monitoring data as well as the location of the proposed WEF near a designated Ramsar Site.

Bird mortality is a direct, negative impact that can occur over the full duration of the project's lifespan (long-term). It can affect regional populations if, for example, dispersing eagles continue to collide with turbines as they attempt to populate an available territory (sinkhole effect). The consequence of this impact is potentially severe and recent data from wind farms in South Africa (Ralston Paton *et al*., 2017) demonstrates that mortalities are very likely to occur, and irreversible in terms of the deceased individuals and possibly also irreversible at a population level. The significance of the impact is rated as High prior to the application of mitigation measures, in particular due to the lack of detailed monitoring. With the effective implementation of the recommended management actions, this impact is anticipated to be of medium significance.

The following mitigation measures are recommended:

- Additional pre construction monitoring is recommended, particularly during the migration months where higher bird activity would be recorded. 24 hour-a-day monitoring during the three months September, October and November should be undertaken. Such real-time monitoring should be continued throughout the life of the facility to allow modification of the wind turbine operational regime in response to the presence of significant numbers of these birds.

- Develop and implement a carcass search programme for birds during the first 24 months of operation (at the start of operations at the wind farm). It is recommended to make use of webcams.
- Develop and implement a 24 month post-construction bird activity monitoring programme, including thorough and ongoing nest searches and nest monitoring, which mimics the pre-construction monitoring surveys/ walkthroughs as described in the Bird Impact Assessment Specialist Report.
- Frequent and regular review of monitoring data (activity and carcass) and results by an avifaunal specialist to establish the requirement for continued monitoring studies (activity and carcass) throughout the operational and decommissioning phases of the development, i.e. the frequency and scope of surveys can be adjusted as a result of experience gained during the first 2 years (e.g. focus the monitoring programme during the migration period).
- The review of monitoring data and results should strive to identify sensitive locations, including turbines that may require additional mitigation. If unacceptable impacts are observed (in the opinion of the bird specialist and independent review), the specialist should conduct a literature review specific to the impact (e.g. collision and/or electrocution) and provide updated and relevant mitigation options to be implemented. As a starting point for the review of possible mitigations, the following may need to be considered:
  - Assess the suitability of using deterrent devices to reduce collision risk (e.g. DTBird© and ultrasonic/radar/electromagnetic deterrents for bats)
  - Identify modification options to turbine operation to reduce collision risk if absolutely necessary and if other methods are not achieving the desired results (e.g. temporary curtailment or shut-down on demand).
- Nests and roost sites should be removed from the turbine cluster area to reduce raptor flight activity and subsequent possible collisions.
- As much as possible the ponds and pools in close proximity of turbines should be avoided as these serve as water sources for most bird species.
- Turbines should be placed outside of high sensitivity areas, such as ridge edges and nest buffers.

- If it becomes necessary, based on outcomes of the operation monitoring results, regulation of the operation of the turbines so as to reduce collision risks must be employed. If the real-time assessment proves that more collisions are occurring, turbines can be regulated during operations by reducing speed or stopping them of during certain months when we know (from the surveys) that significant numbers of birds move through the project area.
- If permissible by the Ghana Civil Aviation Authority (GCAA), the use of constant lighting on top of turbines should be avoided, as this may disorientate birds in flight. Intermittent lighting should rather be used.

7.3.2.2.2 Disturbance and Displacement

Operational activities such as turbine and road maintenance, fencing, etc. and associated noise can lead to the disturbance and displacement of birds, by effectively avoiding the area for feeding or breeding which could result in habitat loss, and ultimately a potential reduction in breeding success (Larsen & Madsen, 2000;Percival, 2005). Turbines may also disrupt bird flight paths, whereby some species may alter their routes to avoid them (Dirksen *et al*., 1998; Tulp *et al*., 1999; Pettersson & Stalin, 2003). While this reduces the chance of collisions it can also create a displacement or barrier effect, as discussed in the Bird Impact Assessment Specialist Report, which could result in an increased energy expenditure and lower breeding success (Percival, 2005).

Raptors are generally fairly tolerant of wind farms, and continue to use the areas for foraging (Thelander *et al*., 2003; Madders & Whitfield, 2006; Ralston Paton *et al*., 2017), and may therefore not be affected by displacement, however this subsequently increases their risk of collision. Maintenance activities can disturb sensitive species occurring on site. Furthermore, species nesting on the project site may be disturbed during routine maintenance.

This negative impact is of potentially Low consequence and has a long-term duration (will continue throughout the operational phase of the project). The Likely disturbance is restricted to local populations and is moderately reversible once the activity ceases. The significance of the impact is rated as low prior to the application of mitigation measures, and as low following mitigation.

The following mitigation measures are recommended:

- The on-site WEF manager (or a suitably appointed Environmental Manager) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possible breeding by these species. If a priority species or Red Data species is found to be breeding (e.g. a nest site is located) on the operational WEF, the nest/breeding site must not be disturbed and an avifaunal specialist must be contacted for further instruction.

7.3.2.2.3 Disruption of Bird Movements/ Patterns

The movement of birds across the landscape may be physically disrupted by WEFs, which may alter migration routes, increase distances travelled and energy expenditure, and/or block movement to important areas such as ephemeral wetlands or prey sources. The disruption of bird movements is likely to be more significant as a cumulative impact with surrounding developments, and it is difficult to measure and assess; making it difficult to identify appropriate mitigation measures. Although some mitigation may be possible by avoiding placing turbines in obvious flyways and making turbines more visible through lighting; the significance of this impact will remain unchanged.

The disruption of bird movements constitutes a direct, potentially negative regional impact, with long-term effects. However, the impacts will cease as soon as the turbines are removed (highly reversible). The consequence of this impact is considered medium. The significance of the impact is rated as medium prior to the application of mitigation measures, and as medium following mitigation.

The following mitigation measures are recommended:

- The construction of turbines must be avoided within any high sensitivity zones identified through pre-construction monitoring, and
- In order to reduce the possible impact on the movement patterns of nocturnal migratory species, an intermittent and coloured lighting on turbines is preferred, rather than constant white light. (to be confirmed by the Ghana Civil Aviation Authority (GCAA))

- A precautionary disturbance distance of 1km should be implemented around wader habitat.
- As much as possible the ponds and pools in close proximity of turbines should be avoided as these serve as water source for most bird species.

7.3.2.3 Decommissioning Phase

7.3.2.3.1 Disturbance and Displacement

Activities associated with the decommissioning phase, such as traffic and noise, may have similar impacts on avifauna as in the construction phase. Rehabilitation across the whole area affected by the project footprint must be conducted during decommissioning, with special emphasis on managing hazardous areas and the proper disposal of waste materials. This direct impact is site restricted (local) and will last for the length of the decommissioning phase (medium-term). The likely occurrence of this impact can however be mitigated. The impact holds a medium consequence, while the significance is rated as low prior to the application of mitigation measures, and as low following mitigation.

The following mitigation measures are recommended:

- A site specific EMP must provide an appropriate and detailed description of how decommissioning activities must be conducted during this phase. All contractors are to adhere to the EMP and should apply good environmental practice during decommissioning.
- The appointed ECO must be trained by an avifaunal specialist to identify the potential priority species and Red Data species, including any signs that could indicate possible breeding by these species. During audits/site visits, the ECO must pay careful attention to such breeding activities of Red Data species, and should train the construction staff to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species. If breeding of any of the Red Data species is confirmed (e.g. if a nest site is found), decommissioning activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed.

- Prior to decommissioning, an avifaunal specialist should conduct a site walkthrough, covering the turbine areas to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats. The results may inform the final decommissioning schedule within the proximity of that specific area, including shortening activity times, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise.

7.3.2.4 Cumulative Impacts

According to Kingsley & Whittam (2005) and Percival (2005) there is little relationship between the scale of a wind farm and the amount of bird mortality that occurs. For examples a large, appropriately sited wind farm may kill fewer birds than a small, poorly sited one. However, in isolation, it is unlikely that small numbers of fatalities per year at a wind farm would be considered significant, unless some of those fatalities were of threatened species, in which case impacts might occur at the population level. It should also be noted that cumulative effects of small numbers of fatalities at two or more wind farms may be sufficient to result in population impacts. As a result when considering potential impact, it is important to consider the average effect of each turbine, the cumulative effect of the total number of turbines and associated structures such as overhead power lines, meteorological masts on a farm, and even the cumulative impact of other wind farms in the range of a bird population, particularly where rare or threatened species occur. (Australian Wind Energy Association 2002; Everaert & Stienen 2007).

With regards to the proposed development at Wokumagbe and Goi, it is unlikely there will be any disruption to the wetland hydrology. Furthermore, the birds observed in the area are species of no conservation concern as there is the wider landscape with several options available for species to adapt. In general given that the habitat is an open modified one with predominantly widespread and common species of no conservation concern, the displacement of such bird species from portions of a wind farm is unlikely to have population consequences.

7.3.3 Impact Assessment Summary

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Table 7-6 below.

Table 7-6: Summary table of the direct impacts identified for the Construction, Operational and Decommissioning Phases for the preferred and alternative layouts

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequences/ Intensity**	**Probability**	**Reversibility (of impact)**	**Irreplaceability (of resource)**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
CONSTRUCTION PHASE											
Clearing of vegetation	Habitat Destruction	Negative	Local	Permanent	Medium	Highly probable	Moderate	Moderate	Medium	Medium	Medium
Noise and disturbance from construction activities Noise and disturbance from construction activities	Habitat loss and displacement through perceived increased predation risk	Negative	Local	Temporary	Medium	Probable	Moderate	Low	Low	Low	Medium
	Reduced breeding success	Negative	Local	Short term	Medium	Highly Probable	Moderate	Low	Medium	Low	Medium
OPERATIONAL PHASE											
Collisions with wind turbines during operation	Bird mortality	Negative	Regional	Long-term	Very high	Highly probable	Irreversible	Moderate	High due to the low level of confidence	Medium	Low
Disturbance (incl. noise) from maintenance activities	Habitat loss and displacement through perceived increased predation risk	Negative	Local	Long-term	Low	Probable	Moderate	Moderate	Low	Low	Medium
Turbine avoidance	Disruption and alteration of local bird movement patterns	Negative	Regional	Long-term	Medium	Probable	High	Moderate	Medium	Medium	Low

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequences/ Intensity**	**Probability**	**Reversibility (of impact)**	**Irreplaceability (of resource)**	**Significance**		**Confidence Level**
									Without Mitigation	***With Mitigation***	
DECOMMISSIONING PHASE											
Disturbance (incl. noise) from decommissioning and rehabilitation activities	Habitat loss and displacement through perceived increased predation risk	Negative	Local	Medium-term	Medium	Probable	High	Moderate	Low	Low	Medium
	Reduced breeding success	Negative	Local	Medium-term	Medium	Probable	High	Moderate	Low	Low	Medium
CUMULATIVE IMPACTS											
Clearing of vegetation	Disturbance of avifauna due to habitat Destruction	Negative	Local	Long-term	Medium	Probable	Moderate	Moderate	Medium	Low	Medium

7.4 HERITAGE IMPACTS

An assessment of the cultural heritage impacts associated with the proposed project was conducted by Dr Apoh Wazi from the University of Ghana (refer to Appendix 4). The findings of this study are discussed below.

7.4.1 Identification of Key Issues

Cultural resources and heritage comprise tangible historical/archaeological sites, documents and artefacts together with religious/spiritual sites (sacred sites) and activities important to local communities, customary law, traditional beliefs, values and practices. It should be noted that the assessment of impacts and development of mitigation actions for some cultural features cannot be wholly segregated from other social impact assessments and there will be overlap in some mitigation actions.

Potential impacts on heritage resources may relate to the possibility for disturbance, removal or destruction of archaeological deposits or cultural heritage features during construction activities, including ground excavations (foundations and piling) required for lay down areas of work camps, new access roads, etc.

As with any project, there is a potential for previously unrecorded cultural sites to lie within the project site. This is high priority only during the initial phase of the project. Disturbance within the project area following operation could potentially occur during the excavation works of additional building facilities, infrastructure, pipelines, cable lines and the installation of fencing for other works.

As the value of archaeological resources is predicated on their discovery within a specific geological host unit, construction of the proposed project could result in a net gain to the science of palaeontology by allowing fossils that would not otherwise have been found to be recovered, identified, studied, and preserved.

The project site is not located in a designated archaeological priority area nor contains any scheduled ancient monuments, listed buildings or locally listed buildings. There are no listed heritage sites located within the area of the property proposed for the project site. As indicated, further archaeological, heritage and cultural studies undertaken by experts from the Department of Archaeology & Heritage studies from the University of Ghana did not reveal any significant archaeological remains that could be directly impacted on by the project.

The identified heritage remains on the project site was an abandoned clay house measuring 12 x 20m that was in ruins. It was probably built and used as a farm house in the past 20 years and abandoned about a couple of years ago. It may have been used or belonged to a farmer in the Goi community. A test excavation conducted around the structure did not reveal any cultural artefacts. It has only remaining short walls and no roof.

The other identified heritage remain is the Buokumaa Shrine located near Wokumagbe.

Table 7-7 lists the archaeological and heritage resources that have been recorded in the study area during the course of the project.

Table 7-7: List of cultural heritage resources found during the survey for WPP2 preferred and alternative layouts.

Location	Co-ordinates	Description	Heritage Significance	Suggested Mitigation
1	N05˚ 47.601 E000˚ 23.672	An abandoned clay house measuring 12 x 20m that was in ruins. It has only remaining short walls and no roof.	High	Compensation must be paid to the owner and destroyed to pave way for the project
2	N05˚ 47.127 E000˚ 19.679	The Buokomaa Shrine is an active shrine of the people of Wokumagbe	Medium	This shrine cannot be relocated. A buffer of 100m must be demarcated around it. The custodian must be consulted to observe the appropriate ritual.

7.4.2 Assessment of Impacts

The direct archaeological and cultural heritage impacts identified for the construction / decommissioning and operation phases are described below:

The impacts on archaeological and cultural resources, associated with the construction and operation of the proposed wind facility will be similar for both the preferred and the alternative layout. The significance of the cultural heritage impacts for the alternative layout will be marginally lower.

7.4.2.1 Construction Phase

7.4.2.1.1 Disturbance, Damage to and Destruction of Heritage Resources

It is anticipated that any known heritage sites located within the final development footprint (refer to Table 7.7) would be relocated to minimise impacts and any unknown heritage site could possibly be physically damaged or, more likely, destroyed when the surface is levelled in preparation for construction. The potential impact or damage to and destruction of heritage resources are predicted to be a negative, direct impact. The impact is rated with a site specific spatial extent and a permanent duration. The intensity and probability of the impacts are respectively rated as medium given the absence of significant archaeological resources identified on the site. The reversibility of the impact and irreplaceability of the resource are respectively rated as non-reversible and high. As a result of low archaeological importance in the area, the significance of any impact is likely to be medium. It should, however, be ensured that all works take place within the authorised footprint so as to avoid impacts to any nearby tangible and intangible heritage resources.

The following mitigation measures are recommended:

- all works take place within the authorised footprint so as to avoid impacts to any nearby tangible and intangible heritage resources.
- dialogue with community members and compensation and moving the shrines

With effective mitigation including dialogue with community members and compensation and moving the shrines, the impact is anticipated to be of **low** significance.

7.4.2.1.2 Impacts to the Cultural Landscape

The proposed project has the potential to impact directly and indirectly on the cultural landscape. Some customary taboos could be directly impacted.

Some notable cultural taboos were documented in the project that need to be observed to minimize its impact. Those that apply to Wokumagbe and Omankope include

a) no weeding on the land on Mondays and Fridays,

b) no hunting on Thursdays and

c) no cooking of Kenkey (local corn meal) on Wednesdays.

The Buokomaa Deity is expected to be placated with these ritual items before commencement of the project: One black male goat; one white sheep; a piece of red calico; one carton of Schnapps and an undisclosed amount of money.

These potential impacts are predicted to be negative and direct, with a local spatial extent, and long-term. The proposed project will result in the identified shrine being moved and thus affecting the community's ability to observe cultural rites in the project area. Figure 7.3 is an illustration of the heritage sites in relation to the proposed project area.

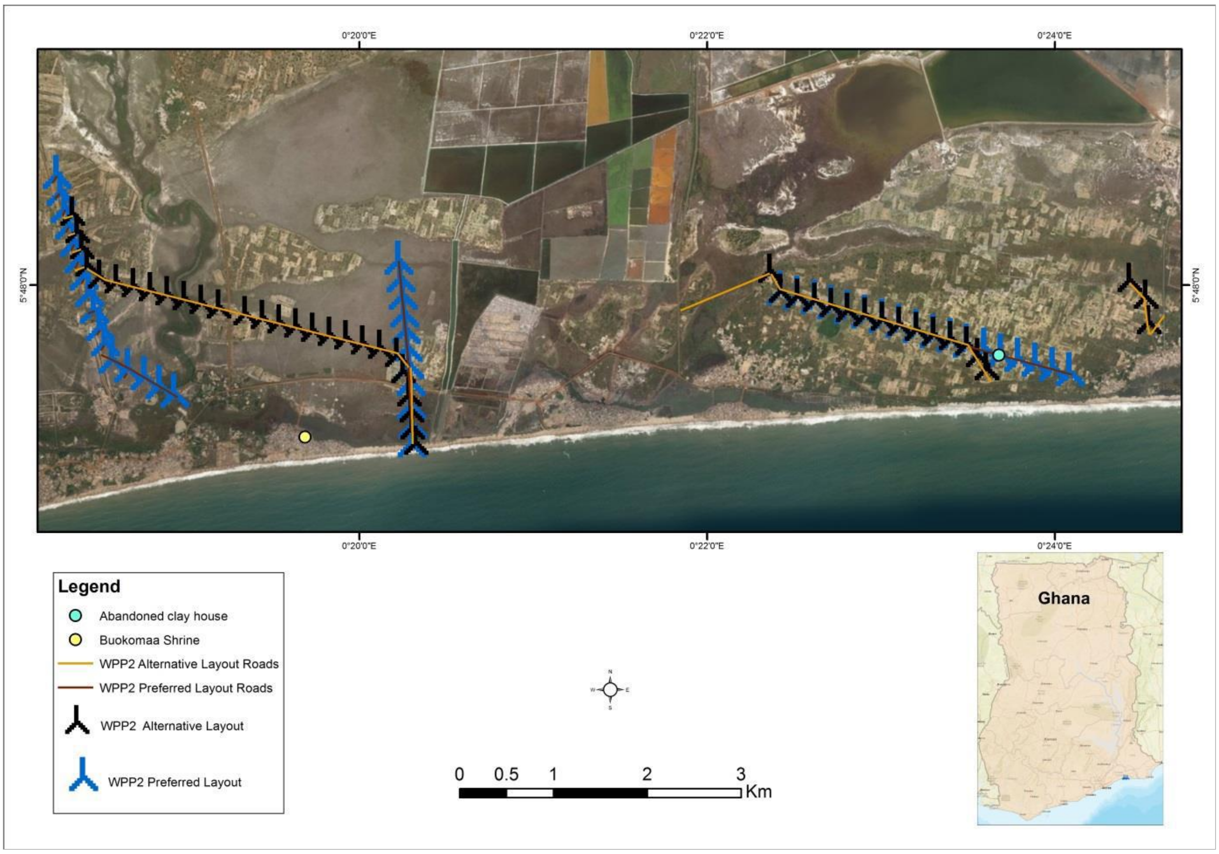

Figure 7-3: Heritage sites in relation to the proposed project area

The impacts of the proposed project on cultural landscape are anticipated to be of medium significance before mitigation and **low** after mitigation, if the shrine and the clay house are relocated. Effective mitigation measures include dialogue with community members and compensation and moving the shrines.

7.4.2.1.3 Gain to the science of archaeology

Any unknown archaeological resources could be uncovered during the excavation works during construction phase of the project. This would be a **positive impact** as it would be a gain to the science of archaeology. The impact is rated with a site specific spatial extent and a permanent duration. The intensity is rated as medium and the probability of the impacts are respectively rated as definite.

An essential mitigation measure would be proper documentation and reporting of chance finds and submission to Ghana Museum in Accra.

7.4.2.2 Operational Phase

7.4.2.2.1 Impacts to the Cultural Landscape

During the operational phase shrines in the designated project area will have to be buffered and the operation may result in the observed taboos and customs in the area being impacted on. The addition of wind turbines to the landscape will result in a marked change in its character from a rural landscape to one characterized by electrical infrastructure. Given that the Government of Ghana has commissioned the National Renewable Energy Law which calls for a mix in energy generation sources in Ghana and increase use of renewables, precedent has already been set for electrical development. The intensity of the impact of the proposed project on the cultural landscape is anticipated to be medium. The probability of the impact is rated as unlikely given the absence of significant cultural resources identified on the site. The reversibility of the impact and irreplaceability of the resource are respectively rated as high and moderate.

Given the above, the significance of the potential impact of the proposed development on the cultural landscape is considered to be medium and very low with mitigation.

The key recommendation associated with this impact is that though the shrines and their current locations are very important to the people, they are prepared to negotiate for their relocation to a new environment for the greater good of Ghana. However, the project must consistently ensure strict observation of the cultural taboos.

7.4.2.3 Decommissioning Phase

7.4.2.3.1 Impacts to the Cultural Landscape

The impact of the proposed project on the cultural landscape is expected to occur during the decommissioning phases. These potential impacts are predicted to be negative, direct and indirect with a local spatial extent, and a short-term duration. The reversibility of the impact and irreplaceability of the resource are respectively rated as highly reversible and moderate. As a result of low archaeological importance in the area, the significance of any impact is likely to be **low.** It should, however, be ensured that all works take place within the authorised footprint so as to avoid impacts to any nearby tangible and intangible heritage resources.

Mitigation measures are for the project applicant to ensure strict observation of cultural taboos and all development occurs in the development footprint.

7.4.2.3.2 Damage to and Destruction of Heritage Resources

Removal of infrastructure during decommission activities has the potential to impact on undiscovered archaeological resources. Potential impacts that may disturb or damage archaeological resources often arise from ground excavation required for decommissioning purposes; e.g. laying down areas of work camps, new access roads, etc. These potential impacts are predicted to be negative, direct and indirect with a local spatial extent, and a long-term duration for all phases. The reversibility of the impact and irreplaceability of the resource are respectively rated as non-reversible and high. As a result of low archaeological importance in the area, the significance of any impact is likely to be **very low**. It should, however, be ensured that all works take place within the authorised footprint so as to avoid impacts to any nearby tangible and intangible heritage resources.

Mitigation measures are for the project applicant to ensure all development occurs in the development footprint.

7.4.2.4 Cumulative Impacts

Because no sites of high archaeological significance were found within the present study area, the cumulative impact consequence is rated as slight with the probability of impacts being unlikely. These combine to provide a significance rating of medium for this project. However, the development of multiple wind energy facilities in the area, such as the proposed 300MW UpWind WEF which is in close proximity to the WPP2 site (Figure 7-4), could result in many unidentified buried archaeological artefacts and sites being disturbed and /or destroyed over a wide area. Cumulative impacts would be negative and direct in nature. They would occur at the local level. The impacts would be permanent. The impacts are irreversible and the irreplaceability of archaeological resources is high.

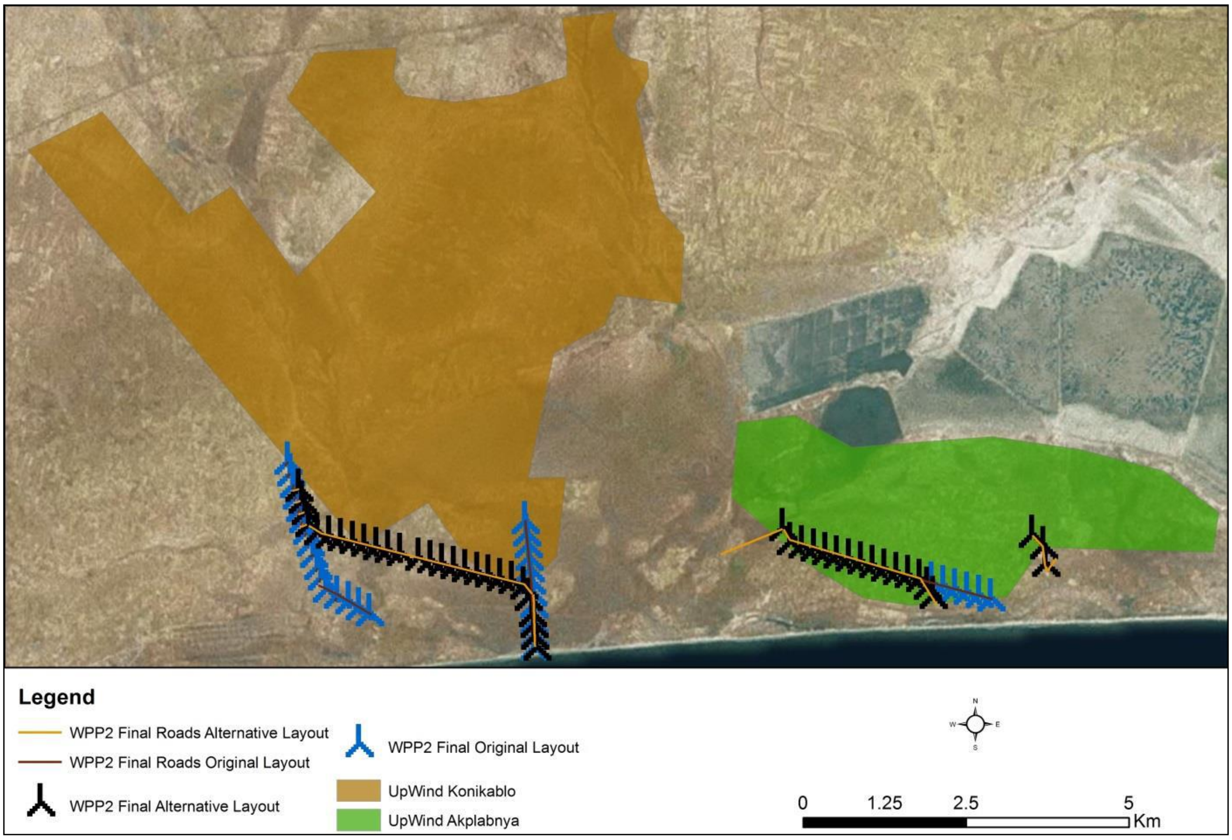

Figure 7-4: WPP2 in relation to the extent of the proposed Upwind WEF

7.4.3 Impact Assessment Summary

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Table 7-8 to Table 7-10 below.

Table 7-8: Impact assessment summary table for the Construction Phase for preferred and alternative layout

CONSTRUCTION PHASE											
Direct Impacts											
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Significance of Impact and Risk**		**Specialist Confidence Level in Assessment**
									Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Clearing of site and excavation works	Damage or destruction of archaeological resources at Goi	Negative	Site	Permanent	Medium	likely	Non-reversible	High	Medium	Low	High
Clearing of site and construction of the proposed facility	Impacts to the cultural landscape of Wokumagbe Shrine	Negative	Local	Long term	Medium	Likely	High	Moderate	Medium	Low	High
Clearing of site and excavation works	Gain to the science of palaeontology	Positive	Site	Permanent	Medium	Definite	-	-	Medium	Medium	High

Table 7-9: Impact assessment summary table for the Operational Phase for preferred and alternative layout

<table>
<tr><th colspan="12">OPERATIONAL PHASE</th></tr>
<tr><th colspan="12">Direct Impacts</th></tr>
<tr><th rowspan="2">Aspect/ Impact Pathway</th><th rowspan="2">Nature of Potential Impact/ Risk</th><th rowspan="2">Status</th><th rowspan="2">Spatial Extent</th><th rowspan="2">Duration</th><th rowspan="2">Intensity</th><th rowspan="2">Probability</th><th rowspan="2">Reversibility of Impact</th><th rowspan="2">Irreplaceability</th><th colspan="2">Significance of Impact and Risk</th><th rowspan="2">Specialist Confidence Level in Assessment</th></tr>
<tr><th>Without Mitigation/ Management</th><th>With Mitigation/ Management (Residual Impact/ Risk)</th></tr>
<tr><td>The presence of the proposed facility</td><td>Impacts to the cultural landscape</td><td>Negative</td><td>Local</td><td>Long term</td><td>Medium</td><td>unlikely</td><td>High</td><td>Moderate</td><td>Medium</td><td>Very Low</td><td>High</td></tr>
</table>

Table 7-10: Impact assessment summary table for the Decommissioning Phase for preferred and alternative layout

DECOMMISSIONING PHASE											
Direct Impacts											
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Significance of Impact and Risk**		**Confidence Level**
									Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
The presence of construction vehicles	Impacts to the cultural landscape	Negative	Local	Short term	Medium	Very likely	High	Moderate	Low	Low	High
Removal of infrastructure	Damage or destruction of archaeological resources	Negative	Local	Long-term	Medium	Unlikely	Non-reversible	High	Very low	Very low	High

7.5 AVIATION AND COMMUNICATION IMPACTS

An assessment of the aviation and telecommunication impacts associated with the proposed site was conducted by Emmanuel Hayford (refer to Appendix 5). The findings of this study are discussed below.

7.5.1 Identification of Key Issues

Potential key issues related to civil aviation include turbines presenting a physical obstacle to Air Navigation, interference with Communication as well as Navigation and Surveillance (CNS) signals and impact on Air Traffic Control Operations. Moreover, the greatest risk to aviation is linked to the cumulative effects of large scale developments in areas that are sensitive in terms of aviation.

The potential impacts of wind turbines on surveillance and navigation equipment are predominantly caused by the energy transmitted by the radar and returned by the turbines. The returned energy can result in the false detection of aircraft (i.e. clutter) or create blind spots behind wind facilities. In severe cases, the amount of returned energy can saturate the radar receiver and result in the radar system not being able to make any further detection. In terms of civil aviation this impact is most pronounced on the primary radar systems at major aerodromes. Such systems can be affected by any development in radio line of sight (which is generally 20% further than optical line of sight) and is thus dependent on the height of the turbine and the terrain. The size (i.e. rotor diameter) and distance from the radar station further determines the magnitude of the impact. It is generally unlikely for this impact to occur if development is further than 35 km from the radar station.

The key potential aviation issues identified during the study regarding the impacts are described below:

Navigation facilities (radar)

The wind farm would have no effect on navigation facility installations of the KIA and the proposed Prampram International Airport, since the proposed wind turbine site is beyond 15 km from the KIA and from the general proposed airport location in accordance with the recommendations provided in ICAO's Guidance Material on Managing Building Restricted Areas, which is applicable to any obstacle.

Experiences from other airports across the globe can be assessed and adopted to manage this issue, should any navigation systems be constructed near the project in future.

Effects on radio navigation aids (Communication, Navigation and Surveillance)

Ground based radio navigation aids could suffer from similar reflection and deflection effects as with radar. The effect of this may be that an aircraft is not be tracked accurately towards the aid on the designated air route. This false tracking can cause the aircraft to deviate too far from the intended flight track and expose it to obstacles which infringe on the clearances defined in the design of the particular flight procedure in instrument conditions.

Similarly, visually navigated aircraft may be tracked erroneously due to a conflict of navigation data available from maps and navigation aids. Line of sight (LOS) principles apply but this type of facility will normally be protected by preventing new structures if they will extend above an elevation angle of one (1°) degree as seen from the site of the radio navigation aid. This means that, at ground level, a 150 m high wind turbine should be located at a minimum of 8 km from the radio navigation aid to avoid any impacts.

Impacts on radio navigation aids are assessed and it does not fall within 15 km from both KIA and Prampram airport. There is however a possibility that CNS may be affected thus the impact has been rated as very low in the impact assessment section.

Instrument Flight Procedures (IFP)

Instrument Flight Procedures can be affected by tall structures in their vicinity. The wind farm would have no effect on IFP for the KIA and the proposed Prampram International Airport. Hence, there will be no significant on CNS because it is further than 15 km radius and also not in the radar line of sight.

The Instrument Flight Procedures for the proposed Prampram airport have not, to the author's knowledge, been designed yet. The wind farm will not lie on the proposed extended runway centre line and it is anticipated that it will be possible to design any required procedures to accommodate the wind farm safely.

Instrument Flight Rules (IFP)

Aircraft operating under the IFR are navigated by reference to cockpit instruments which process data from aircraft systems, ground-based NAVAIDS or satellites. All regular public transport (RPT) jet aircraft operating into Ghana operates under the IFR within controlled airspace. The proposed wind farm location is a low lying area and en route aircraft with reference to KIA are always at high altitude in that area. In addition, the proposed wind facility (preferred and alternative layout) is located beyond 15 km radius from both airports. It is therefore not anticipated that the proposed wind facility will have any impact on the operation of the KIA.

The complete airport master plan for the proposed future airport was not available at the time of this study. However, it is not anticipate that the proposed wind turbine site will have any negative impact on the operation of the proposed aerodrome.

Visual Flight Rules (VFR)

Aircraft operating under VFR may do so only in visual meteorological conditions (VMC) defined as an average range of visibility of 5,000 m forward of the cockpit, horizontal cloud clearance of 1,500m and vertical cloud clearance of 3,500 m. At the moment there is no prescribed or designated VFR traffic operation around this area. The entire Ghana airspace is a designated controlled airspace and pilots are to fly with reference to Air Traffic Control (ATC) clearance.

VFR traffic in daylight hours is not confined to air routes and these aircraft may operate anywhere provided they do so in VMC and observe the same rules from ATC for selecting their cruising altitude.

In these conditions wind farms should be easily visible and have no impact on VFR flying activity, if applicable.

Military pilots periodically conduct low level flying training at that location. However, the training may not veer off to the proposed wind farm areas. Special use airspace, extending to varying heights, is defined on air navigation charts and identified as Prohibited, Restricted or Danger. For safety reasons flight into this airspace may be prohibited or restricted or the airspace may be designated as a danger area to warn pilots to take additional care. The proposed wind turbine projects do not fall within any of this special use airspace.

Minimum Safe Altitudes

A pilot must maintain a safety margin between their aircraft and any obstacles beneath them. This defines a minimum safe altitude at which an aircraft can fly in any particular region. Introducing tall structures in an area can, therefore, increase the minimum safe level accordingly. The turbines would be the tallest structure in their immediate vicinity, and this may affect the minimum safe level in the area. Any restrictions imposed by the turbines will be relevant for the surveillance minimum altitude charts associated with the proposed Prampram airport. It is important to note that any increase in the minimum safe altitude due to the turbines will be modest. There are no anticipated impacts.

It should be noted that the maximum turbine altitude above mean sea level would be comparable to the terrain altitude approximately 10.5km to the west of the proposed airport location. The Prampram Airport is proposed to be located approximately 80 km from the proposed wind turbine project site (WPP2).

Impact on airspace around aerodromes

There are two key airspace surfaces surrounding the aerodrome airspaces:

- Obstacle Limitation Surface (OLS)
- Procedures for Air Navigation Services – Operations Surfaces (PANS-OPS surfaces)

Obstacle Limitation Surface (OLS)

An Obstacle Limitation Surface (OLS) is an imaginary three-dimensional plane around an airport that should not be breached by a physical structure. They define the volume of airspace that should ideally be kept free from obstacles in order to minimize the danger to aircraft during an entirely visual approach or during the final visual segment of an instrument approach procedure.

The purpose is to ensure that the airspace around aerodromes is free from obstacles so as to permit the intended aircraft operations at the aerodrome to be conducted safely. It is also to prevent the aerodrome from becoming unusable by the growth of obstacles around the aerodrome.

These surfaces are of a permanent nature and comprise the reference datum which defines an obstacle. Anything above the vertical limits of the OLS is regarded as an obstacle. Obstacles are reported so that GCAA can determine if they are “hazardous” and therefore need to be marked and/or lit to ensure they are prominently identified.

Airspace requirements will depend on the nature and scale of activities at an aerodrome but could extend to a radius of 15 km. The OLS also need to be considered in relation to both current and future aerodrome developments and activities.

Wind turbines may be acceptable in the areas covered by the OLS but will need to be assessed in relation to critical manoeuvres such as the approach to land and possible low level missed approaches, and a reduced power take-off following an engine failure.

The obstruction evaluation assessment of the proposed project, against the KIA and Prampram airport as depicted in Figure 7-5 and Figure 7-6 below shows that the wind turbine project is further away from the airport safeguarding protection zones and as such the wind turbine’s operation phase will have no impact on both airports given that the proposed project falls outside the OLS defined by the GCAA and the International Civil Aviation Organisation (ICAO) for both airports. Therefore, no breach would occur.

Figure 7-5: **Protection Zones of Kotoka international Airport (KIA)**

Figure 7-6: **Proposed Protection Zones of future Prampram international Airport on 1:50,000 topographic map**

Procedures for air navigation services - aircraft operations (pans-ops surfaces)

Airspace associated with aircraft instrument approach and departure procedures is defined by the PANS-OPS surfaces for an aerodrome. These surfaces are ascertained in accordance with the criteria specified in the International Civil Aviation Organization (ICAO) Procedures for Air Navigation Services - Aircraft Operations (Doc 8168, PANS-OPS).

The PANS-OPS surfaces are intended to safeguard an aircraft from collision with obstacles when the pilot is flying by reference to instruments. The designer of an instrument procedure determines the lateral extent of areas needed for an aircraft to execute a particular manoeuvre. The designer then applies minimum obstacle clearance to structures, terrain and vegetation within that area to determine the lowest altitude at which the manoeuvre can be safely executed.

As a result, PANS-OPS surfaces cannot be infringed on any circumstances. These airspace requirements will depend on the nature and scale of activities at an aerodrome but could determine the acceptable obstacle heights to a radius of 10 - 20 km from the aerodrome.

There are no anticipated impacts on procedures for air navigation services – PANS-OPS Surfaces.

Aviation lighting

In order to prevent any adverse effect from the proposed wind turbine project, all tall structures as well as other high-rise objects during the constructional phase should have obstruction lights in accordance with Ghana Civil Aviation Authority (GCAA) standards. The Ghana Civil Aviation Authority (GCAA) has produced and published guidance with regard to aviation lighting for tall structures. Wind turbines are listed as structures that require lighting and marking. Lighting will be in accordance with GCARs Obstacle Marking and Lighting and be operated in a manner consistent with a general duty of care towards aviation.

The guidance states that lights should be positioned to ensure that a pilot has an unobstructed view of at least one light at each level. The guidance states that structures above 45 metres require intermediate lights spaced equally between the top lights and ground level. The spacing between lights should not exceed 45 metres.

For structures that exceed 150 metres in height, the obstruction lighting should be of high intensity, which means flashing white lights (40-60 flashes per minute). The intensity requirements are:

- Minimum of 200,000 candela during the day.
- Minimum of 20,000 candela during twilight.
- Minimum of 2,000 candela during the night.

It is recommended that the lighting and marking requirements for the development are discussed with the GCAA. In practice, wind turbines are often not fitted with markings or intermediate lights. This can vary from one country to another.

7.5.2 Assessment of Impacts

The Aviation Impacts during Construction, Operation and Decommissioning Phases of the proposed WPP2 are discussed below.

7.5.2.1 Construction Phase

The aviation impacts on the proposed wind turbine development have been assessed in this study and there are no anticipated impacts during the construction phase.

7.5.2.2 Operational Phase

The potential impacts of a WEF on aviation during the operational phase include Interference with Communication, Navigation and Surveillance (CNS) signals.

7.5.2.2.1 Interference with Communication, Navigation and Surveillance (CNS) signals

During the operational phase of the project, tall structures may interfere with electromagnetic transmissions. Steel towers and rotating turbine blades can cause reflection and/or deflection of radiated waves and cause interference with aviation communication, navigation and surveillance (CNS) systems established for air traffic management. The CNS system includes aerodrome based and en-route navigation aids (NAVAIDS) and radar used for air traffic control at aerodrome and/or en-route surveillance. Two types of radar are used for air traffic control (ATC) and surveillance primary radar and secondary surveillance radar (SSR).

Primary radar works by radiating electromagnetic energy and detecting a return signal from reflecting objects. Comparison of the return signal with the original transmission provides information such as the direction and range of the target from the radar site. ATC radars are designed to filter returns from stationary objects to avoid moving targets, primarily aircraft, being obscured by radar clutter.

Other than this means of differentiating between stationary and moving targets, primary radar cannot determine the type of object detected and has no means of determining the height of the object. Secondary Surveillance Radar (SSR) emits radio frequency (RF) interrogation messages that trigger automatic responses from a transponder on board an aircraft. The transponder reports aircraft identification and altitude.

Primary radar can detect aircraft up to 50 NM from the radar sensor while Secondary Surveillance Radar (SSR) can detect aircraft up to 250 NM. This is referred to as the radar coverage. Despite that, KIA Radar coverage extends as far as the proposed wind farm project location, the proposed wind farm project will not pose any significant hazard to aircraft navigation in that environment.

The study assessed all the available documents/literature per the proposed types of flying activities that could be conducted in this area in close proximity to the proposed wind farm. An assessment of the impact of the wind farm on the proposed future aerodrome has concerns that will have to be operationally addressed. Given that the detailed design of the Prampram airport (planning, design, and construction of terminals, runways and navigational aids like radar) have not yet been finalised, potential impacts of the proposed project on the proposed airport cannot be assessed.

Impacts on Interference with Communication, Navigation and Surveillance (CNS) signals for KIA are assessed to be of local extent and long-term duration (i.e. the impact and risk will occur for the project duration). The probability of the impact is rated as improbable. Given the above, the significance of the impact is rated as very low for the preferred and the alternative sites. Mitigation measures are not applicable as this impact has a **very low** significance and an improbable rating.

7.5.2.3 Decommissioning Phase

The decommissioning of the proposed wind turbine project would have no impact on aviation, hence a written notification to the GCAA on the decommissioning should be enough.

7.5.2.4 Cumulative Impacts

At this stage, it is premature to provide a systematic analysis of how the concentration of two or more wind energy facilities is going to impact on aviation activities and the aviation community, as the existing information on the potential cumulative impacts of these wind farm projects is inadequate.

Despite the inadequate information, on-going studies have made some references to possible cumulative impacts as a result of the number of wind turbine generators proposed in specific geographic area. This would be a good area for research in future. Going forward, the aviation industry should partner with industry stakeholders and researchers to discuss issues of potential impacts associated with concentrated wind turbines in a particular geographic location As there are no other large development projects in the project’s area of influence, the cumulative impact for both alternatives is thus assessed to be of very low significance

7.5.3 Impact Assessment Summary

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Table 7-11 below.

Table 7-11: Impact assessment summary table for the Operational Phase for the preferred and alternative layout

OPERATIONAL PHASE											
Direct Impacts											
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility**	**Irreplaceability**	**Significance of Impact**		**Specialist Confidence Level in Assessment**
									Without Mitigation	***With Mitigation***	
Impact of Radar	Interference with Communication Navigation and Surveillance (CNS) signals	Negative	Local	Long term	Low	Improbable	High	Low	Very Low	Very Low	High

7.6 WETLAND IMPACTS

An assessment of the impacts on wetlands associated with the proposed project was conducted by Charles Amankwah from Wildlife Division (Forestry Commission) and Alexander Whitehead from SDP Ecological and Environmental Services (refer to Appendix 6). The findings of this study are discussed below.

7.6.1 Identification of Key Issues

Overview

Wetlands are dynamic areas, open to influence from natural and human factors. In order to maintain their biological diversity and productivity and to allow wise use of their resources by human beings, an agreement and understanding is needed between the various owners, occupiers and interested parties.

The wetland system (floodplain wetland and smaller freshwater wetlands embedded therein) and estuarine system (estuarine channels and lagoons) are valuable ecological assets and highly functional systems supporting a number of important habitats and faunal communities.

The wetland system present at Wokumagbe was found to be largely natural in condition and found to be a functional system providing a number of valuable ecoservices, both biophysical and social. The Goi wetland areas were more disturbed and lacked functionality as a result. The saline lagoons and salt marsh areas present between the inland wetland systems and the sandy beach environment were segmented, disturbed and not true estuarine systems. Their ecosystem functioning was limited as was their ecological importance. Based on the observation and findings, the freshwater wetland units associated with the Wokumagbe project area are the most valuable aquatic/wetland ecosystems within the WPP 2 project extent.

Key issues

The potential issues of concern identified during the scoping phase include:

- Impact on birds/bats during the construction and operation phase of the project.
- The removal of natural vegetation containing threatened, protected and endemic species such as mangroves;

- Common to the lower Volta River estuary is an increased exotic infestation due to disturbances of the wetland ecosystem. There are a number of invasive plant species in the Songor lagoon and the catchment areas. Invasive terrestrial plants common in the area include *Parkinsonia aculeata, Azadirachta, Prosopis julifora, Mimosa pigra, Zanthoxylum xanthoxyloides*. Also common are aquatic and semi-aquatics such as *Pistia stratiotes, Typha domingensis, Ceratophyllum demersum, Vossia cuspidata, Azolla filiculoides, A. pinnata, Oxycarium cubense.* There is the high tendency for these non-native plants to increase and spread from disturbance during the construction phase of the project.
- Increased dust deposition during construction, particularly if construction is undertaken during the dry season.
- High risk of coastal flooding and erosion: The main environmental hazard to be expected at the project sites is flooding. The flat nature of the topography of Keta Municipality coupled with climate change impacts exposes the area to serious threat of flood. The project area consists of approximately 25 km of coastline which is fast eroding posing a great threat to human life, property, infrastructure, tourism and marine turtle nesting sites.

Species of marine turtles listed on the IUCN list of endangered species as "Vulnerable" and "Endangered" are known to utilise the nearby sandy beach fronts as nesting grounds (See Section 6.2.4.3.1 in the Specialist Report found in Appendix 6). However, the marine turtles do not utilise the beaches beyond the high steep cliffs resulting from erosion by sea waves. The turtle nesting grounds will not be significantly impacted during the construction or operational phases of the project as the Wokumagbe and Goi project sites are well above areas utilised for turtle nesting.

There will be no impact on freshwater mammals, such as the Sitatunga considering the absence of their preferred habitats (within deep fresh water lagoons) and the human disturbances in close proximity to the project sites.

7.6.2 Assessment of Impacts

7.6.2.1 Wetland Birds

The wetland and estuarine habitats within the Songor Ramsar Site and Biosphere Reserve serve as a wintering ground for resident, migratory birds (en route the East Atlantic flyway) and other wildlife species and need to be preserved. Presently, terns, waders and herons in particular, are not seriously threatened by human activities. There was no evidence of bat hibernation areas and roosts within the period of visit. However, the presence of houses and human settlements presents the possibility of bats utilisation of the environment.

Construction phase

The footprint and potential area of disturbance is relatively small compared to the available area which birds have to forage and nest. Although habitat loss will occur and while having some influence on birds, this is considered to be a minor impact from an avian perspective given the availability of vast areas of similar or better habitat.

Nesting sites may be disturbed, however, mortality is expected to be very low as the footprint of disturbance and the probability of encountering a high density nesting site is considered very low, particularly near Goi (within a densely populated area with extensive and active agriculture).

Construction related disturbances that may interfere with bird foraging or nesting (with the exception of habitat loss) will be temporary in nature.

The following management actions must be undertaken prior to the commencement of construction:

- The construction zone must be inspected for active nesting sites by an ornithologist. The ornithologist must make a recommendation regarding the need to relocate the nests.
- During construction, should any birds become trapped within the construction area, they must be relocated safely.

For the significance rating of the impact on birds during construction phase please refer to the Bird Impact Assessment results found in section 7.3 of this chapter and found in Appendix 3 of the ESIA report.

Operation

From available information, the scale and the spread of the project facilities and the biologically important nature of the broad project area, including areas of estuaries, open lagoons and the sea (Gulf of Guinea) demonstrate that the project may have the potential for direct and indirect adverse impacts on the avifaunal and potentially bat biodiversity during the operation phase.

There is clear evidence that active wind turbines present a threat to the lives of birds and bats. The risk appears to be much greater in some areas than in others. The presence of large wind turbines may cause birds to avoid the site, thus losing a foraging resource and requiring extra energy to fly around it.

The key ornithological issues to be considered with respect to the proposed wind energy development are likely to include the following:

- Potential impacts on migratory bird species due to the risk of collision with turbines.
- Non-breeding, wintering birds within or adjacent to the site may be disturbed and/or displaced as a result of the functioning of the turbines. Individuals may also collide with the turbines.

The project may have a significant additional influence on birds through collision with the associated infrastructure, including overhead transmission lines, meteorological masts, substations and lighting.

The probability of the active turbines resulting in collisions and other disturbance related impacts as described is theoretically high. The habitat presented by the Songor Lagoon Ramsar Site and Biosphere Reserve is moderately to highly irreplaceable and a wind power facility that obstructs or deters birds from accessing or using the habitat will have a highly significant influence on the bird population. On the contrary, bird populations may adjust their flight paths, in which case the turbines will be of no influence. For the significance rating of the impact on birds during operational phase please refer to the Bird Impact Assessment results found in Section 7.3 of this chapter and found in Appendix 3 of the ESIA report.

The following mitigation measures are recommended:
Given the low confidence and uncertainty surrounding the likelihood of collisions during the operational phase, it is highly recommended that a bird strike monitoring programme be implemented during the first 24 months of operation. The programme should involve regular site inspections around the base of each turbine with the intention of recording the number and species of dead birds (if any) found.

Review of Alternatives

The Preferred and Alternative layout involves the establishment of wind turbines within 2 zones (Wokumagbe and Goi). The difference between the two layout options is the layout of the turbines at the Wokumagbe site. The preferred layout proposes the establishment of 2 separate turbine clusters at Wokumagbe, while the alternative layout proposes a continuous single cluster that stretches from the north-west to south-east. The latter crosses an extensive seasonal and temporary wetland area. The affected wetland area may potentially harbour many water birds during the wet season. The positioning of turbines within the wetland footprint may discourage use of the area by these birds, forcing them to forage elsewhere. The position of the Wokumagbe and Goi turbine clusters (both the preferred and alternative layout) are unlikely to affect migratory birds as the project area is situated to the extreme west of the transitional zone of the Songor Ramsar Site and Biosphere Reserve, well away form the core use zone.

Refer to the specialist avian assessment for further detailed assessment of bird related impacts and additional management action.

7.6.2.2 Other fauna

Construction

The installation of such large structures, along with supporting roads, and the associated clearing of wetland vegetation, will have a negative effect because of the loss, degradation, and fragmentation of habitat. The project is expected to cause displacement of wildlife through habitat conversion/degradation from land clearing activities. Although no endangered species of fauna were encountered during the visit, members of nearby communities confirm the presence of a variety of smaller wildlife including amphibians, reptiles, small mammals and invertebrates.

Apart from the marine turtles that utilise the sandy beach fronts as nesting grounds, low densities of some common terrestrial reptiles including the Royal python *Python regae*, the common lizard *Agama agama* and the Monitor lizard *Varanus niloticus* are reported to be present in the project area. The waterlogged grassland, riverine woodland and scattered thickets of shrubs, climbers and small trees on higher ground serve as suitable habitat for these reptiles. The habitat and its associated fauna will be directly impacted by the construction of the wind energy infrastructure, however once complete the operation of the turbines offers little threat to terrestrial fauna.

Given the above, the impact of the proposed wind facility on other fauna during the construction phase is assessed to be temporary, site specific and of medium-low to low intensity for the preferred and alternative layout respectively. This impact is therefore anticipated to be of low significance without mitigation for both the preferred and the alternative layout.

<u>The following mitigation measures are recommended:</u>

Terrestrial and semi aquatic fauna are mobile and are likely to move away from the site to the nearest refuge once construction commences. Should fauna become trapped within the construction site or become threatened by activities, a capture and relocation programme should be implemented. Ad hoc removals during construction should also be effected. The pre-construction capture and relocation programme will ensure that vulnerable terrestrial or semi aquatic fauna can be captured and relocated prior to disturbance and potential loss.

Candidates for removal include amphibian species that utilise a particular isolated depression which has been identified for infilling. The details of the capture and relocation programme will have to be finalised during the planning phase.

With the effective implementation of the recommended management actions the significance of the impacts of the proposed wind facility on other fauna during the construction phase is anticipated to be **very low** for the preferred and the alternative layout.

Operation

If fenced, fauna may become trapped within the fenced area. No other threat to terrestrial fauna has been identified for the operational phase. As such, the impact significance of the operation of turbines for both the Preferred and Alternative layouts is considered to be low.

The following mitigation measures are recommended:
Should the sites be fenced, the implementation of “critter paths” can be used to allow either the escape of any trapped fauna or allow the free movement of small fauna, and should total exclusion not be an option. The latter has been successfully implemented at photovoltaic solar plants in South Africa. Additional input may be required from a herpetologist.

Review of Alternatives

None of the alternatives will affect marine turtles due to the positioning of the turbines landward of the dune and dune slack area.

The position of the alternative layout option at Wokumagbe, which traverses the large floodplain wetland, is highly likely to affect semi aquatic fauna during construction, particularly if the area is inundated.

The Goi site (both layout options) poses no threat to semi aquatic fauna due to the transformed nature of the project site and surrounding environment.

The preferred layout at Wokumagbe is recommended due to the lack of turbines within the seasonal portion of the floodplain.

7.6.2.3 Disturbance of Salt Marsh and Coastal Habitat

Construction

The eastern cluster at Wokumagbe is proposed to be positioned within a section of salt marsh and lagoon habitat. Construction related activities will result in localised infilling to provide access and the turbine foundations. This infilling will result in habitat loss, although the habitat that will be lost is considered to be of limited ecological value based on the findings of the PES and EIS assessments.

The construction activities will create localised disturbance and the resultant impact thereof is likely to be of moderate significance, prior to mitigation.

The following mitigation measures are recommended:

No relocation of project components is proposed. The following management measures must be implemented to mitigate and reduce the resultant impacts:

- Clearing of vegetation to be kept to a minimum, keeping the width and length of the earth works to a minimum
- Land reclamation must be limited to essential areas only
- Effective site management and proper disposal of hydrocarbon fluids will alleviate concerns of contamination
- All services must be coupled to the access roads thus minimising the development footprint
- Chemicals used must be stored safely on site and surrounded by bunds. Chemical storage containers must be regularly inspected so that any leaks are detected early.
- No stockpiling should take place within the salt marsh area.
- All stockpiles must be protected from erosion

The resultant impacts for both alternatives are assessed to be of **low significance** with the effective implementation of the recommended mitigations.

Operation

Foundations within and adjacent to the lagoonal and salt marsh zones are unlikely to interfere with the system hydrology and general dynamics. The systems are fed and maintained primarily by lateral fresh water inputs, wave overtopping and salt water intrusions through the sandy beach. None of the proposed turbine clusters are believed to significantly influence any one of these system drivers. Impacts that may arise are associated with maintenance activities – changing of lubricants, minor repairs, etc. It is anticipated that impacts arising from operation will be of low significance without mitigation for both the preferred layout and the alternative layout.

The following must be implemented during the operational phase:

- During operational maintenance, drip trays must be utilised to prevent lubricant spillages. All lubricants must be stored correctly if kept on site. Alternatively all lubricants and other hazardous substances must be stored off site between maintenance operations.
- Hydrocarbon spill kits must be kept on site
- Any spills must be cleaned up rapidly to avoid prolonged exposure and to contain the extent of the spill.
- Where land reclamation has taken place, maintaining the hydrology through adequate drainage/system connectivity is considered important. An example includes incorporating culverts beneath access roads to maintain connectivity and flow between sections of salt marsh that have been segmented by infill.

The impact for both alternatives is assessed to be of **very low** significance with the effective implementation of the recommended mitigation measures.

Review of Alternatives

The only turbines situated within intact salt marsh are situated at Wokumagbe. With reference to Figure 7-7, the preferred and alternative layout options indicate 2 and 3 turbines within the salt marsh habitat respectively. Although the preferred layout option indicates 1 less turbine within the salt marsh area, the infrastructure needs and extent of the access roads will be the same. No change in the location of the proposed turbines is recommended based on the following;

1. the salt marsh area in question is not ecologically significant

2. the proposed mitigation and management measures are believed to adequately address the resultant impacts.

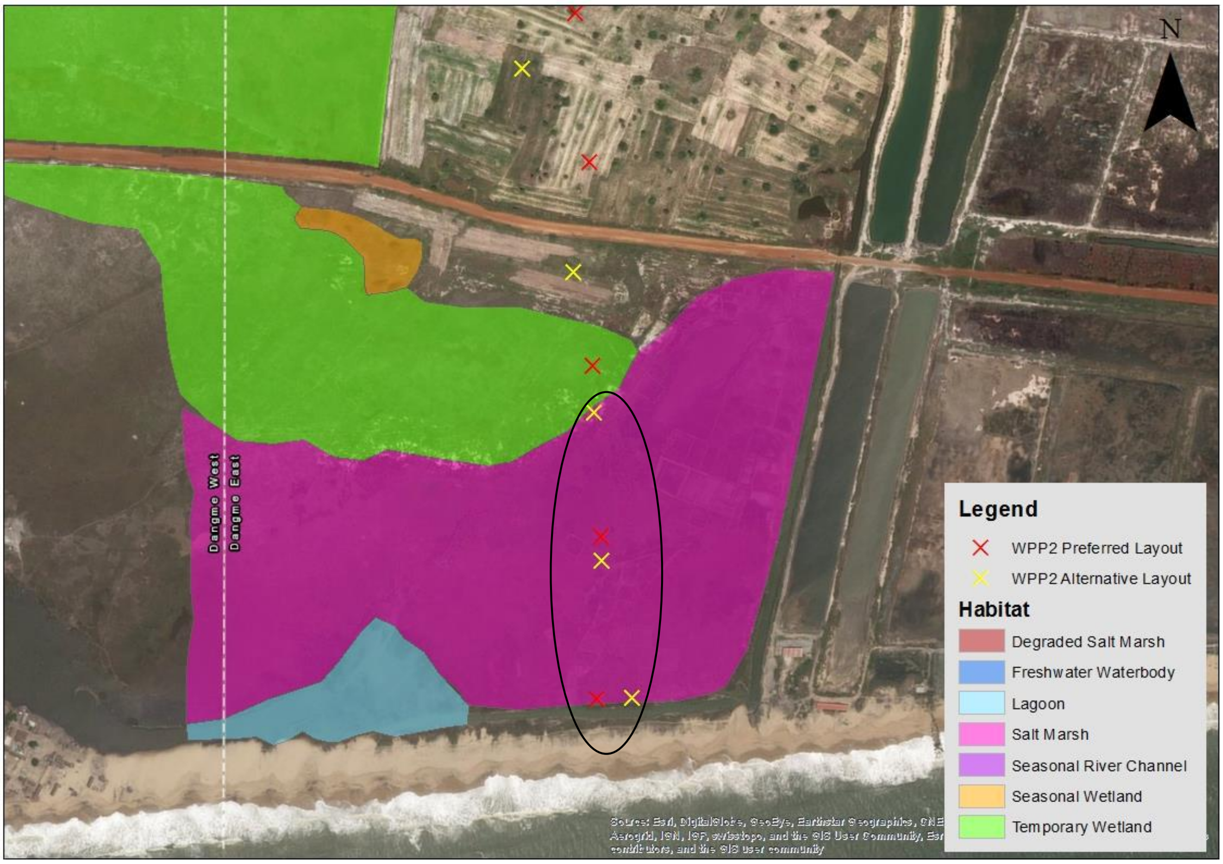

Figure 7-7: Location of the turbines within the salt marsh habitat near Wokumagbe

7.6.2.4 Coastal Impacts

Construction

No construction activities will take place within the frontal dune and sand beach environments. All construction will be situated landward of the dune slack/lagoon/salt marsh habitats.

No impacts or influence on the coastal dynamic is expected.

Operation

No turbines of foundations will be situated within the dynamic coastal zone. No impacts are foreseen as a result of the operation of the turbines.

Review of Alternatives

Neither of the proposed layout options poses an identifiable threat to the coastal dynamics of the Wokumabge or Goi areas, given the positioning of the turbine clusters.

7.6.2.5 Freshwater Wetland Impacts

Construction

Freshwater ecology would be impacted primarily from the raising of land to erect wind turbines and construction of access routes through the wetlands. Fish and fish spawning as well as breeding areas could be impacted during construction (and operation), particularly as access routes are constructed through open pools or seasonally wet habitats (Wokumagbe).

The displacement of freshwater fish due to land reclamation is likely to be a permanent impact as this will permanently alter the character of the project core areas. Land reclamation may have additional impacts on water quality as the increased vehicular activity and dumping of fill material will create zones of turbidity. Dead vegetation that has been removed or pushed aside is likely to decay, potentially reducing oxygen levels and creating pockets of anoxic conditions.

Depending on the extent of disturbance during construction, some loss of ecoservices (temporary or permanent) may occur. Likely scenarios relate primarily to hydrological or physical wetland functions, where flow is interrupted or blocked limiting the ability of the affected section to perform ecoservices such as nitrate removal or flood attenuation. The significance of the impacts are related to the extent and positioning of the infilling. In this respect, the preferred and alternative layout options differ significantly around Wokumagbe. The impacts associated with infilling for the access road and foundations for the alternative option will be more significant than those associated with the preferred layout option, due to the former traversing the entire wetland system, including the seasonal channel. This may significantly affect the hydrology of the system and affect the functionality of the downstream portion of the wetland system.

Given the above, this impact is anticipated to be of high significance without mitigation for the alternative layout and of medium significance for the preferred alternative.

The following essential management actions must be implemented during the construction phase:

- Effective site management and proper disposal of hydrocarbon fluids will alleviate concerns of contamination.
- Clearing of vegetation to be kept to a minimum, keeping the width and length of the earth works to a minimum
- The number of new roads will be kept to a minimum and as far as possible existing roads will be used only requiring a degree of upgrading
- All services must be coupled to the access roads thus minimising the development footprint
- Chemicals used must be stored safely on site and surrounded by bunds. Chemical storage containers must be regularly inspected so that any leaks are detected early.
- No stockpiling should take place within a wetland area.
- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds.
- Stockpiles must be located away from river channels.

The impact on freshwater wetland ecology associated with the construction of the preferred layout is assessed to be of **medium** significance with the implementation of the above mitigation measures.

Operation

No significant impacts on freshwater ecology are anticipated during the operation phase, at this stage. Hydrocarbon contamination and reduced wetland functionality could arise. The former, from lubricating fluid spillages and the later if land reclamation is undertaken.

Contamination by lubricants may result in the localised disturbance and possibly the killing of aquatic fauna and flora at the site of the spill. The stagnant nature of the freshwater wetland systems may result in the contamination remaining largely local and in close proximity to the source. Contamination may be temporary i.e. a small spillage occurs and is quickly cleaned up or more prolonged, in the event of a leak from the turbine itself. The latter may go long periods without identification or rectification. At worst the impact significance is likely to be medium (before mitigation).

The effects of land reclamation may manifest themselves during the operational phase as changes in surface flow and loss or alteration of aquatic and wetland habitat. Over time such changes may have localised effects on the water quality and aquatic/wetland fauna and flora ultimately affecting community structure and usage. Such changes may render a small portion of the wetland dysfunctional or with impaired functionality. This impact is essentially a residual impact as result of the construction phase disturbance. As such the significance of the land reclamation on wetland functionality during the operational phase is low (before mitigation).

To address the abovementioned operation impacts on freshwater wetlands, the following management actions are recommended:

- During operational maintenance, drip trays must be utilised to prevent lubricant spillages. All lubricants must be stored correctly if kept on site. Alternatively all lubricants and other hazardous substances must be stored off site between maintenance operations.
- Hydrocarbon spill kits must be kept on site
- Any spills must be cleaned up rapidly to avoid prolonged exposure and to contain the extent of the spill.
- Where land reclamation has taken place maintaining the hydrology through adequate drainage/system connectivity is considered important to maintaining some degree of wetland functionality. An example includes incorporating culverts beneath access roads to maintain connectivity and flow between a section of wetland that has been infilled.

The significance of the impact after mitigation is likely to be **low**.

Review of Alternatives

The alternative with the least wetland disturbance is recommended. In this instance, the preferred alternative will have the least significant impact on the Wokumagbe wetland system as the preferred layout option does not cross the wetland system (Figure 7-8). The footprint of disturbance is likely to be smaller for the preferred layout, offering less disturbance and less opportunity for hydrological and ecosystem changes.

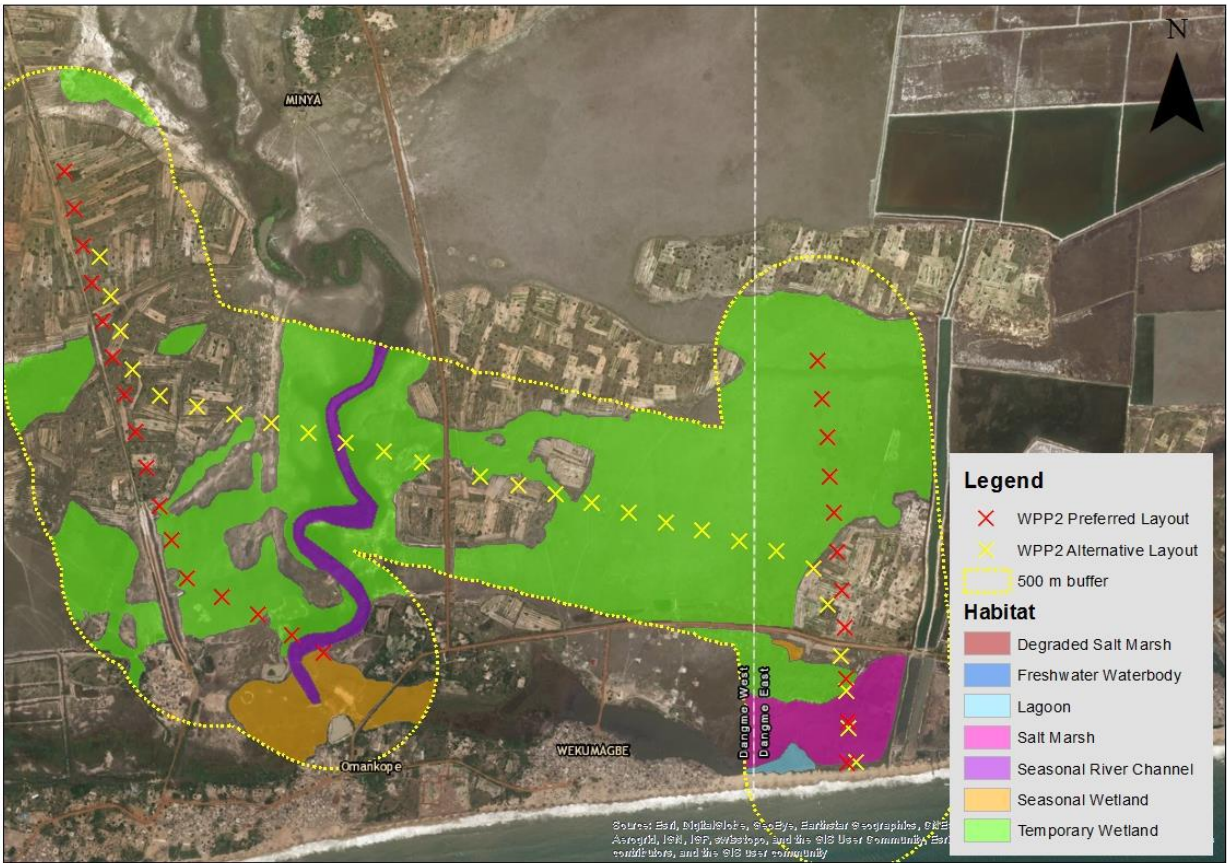

Figure 7-8: The positioning of the turbines within the wetland system near Wokumagbe.

7.6.2.6 Impacts associated with flooding

Seasonal flooding at Wokumagbe is possible and is dictated by local rainfall and flow within the seasonal watercourse. Due to the potential flood risk, it is recommended that a flood risk assessment be undertaken prior to the commencement of construction. It is believed that the alternative layout option has the higher flood risk due to its proximity to the seasonal channel. Based on this observation, the preferred layout option is considered less of a risk and more acceptable.

7.6.2.7 Decommissioning impacts

The primary impacts are associated with the construction phase and operational phase. Should the project be decommissioned and the turbines removed, the affected areas are likely to return to a state similar to the status quo, except where infilling and foundations have been established and cannot be removed.

Impacts as a result of decommissioning are likely to be temporary in nature and be related the following:

- Operation of plant used to dismantle the turbines
- Physical disturbances associated with the breaking up of platforms or removal of roads

Likely impacts may include:

- Localised turbidity which may temporarily displace fish and aquatic fauna.
- Vibration and noise which may temporarily displace fauna (fish, birds, terrestrial fauna).
- Waste material such as rubble, steel and potentially used hydrocarbon lubricants which may contaminate the surrounding soil and water.

<u>Essential management measures include the following:</u>

- Rehabilitation of the turbine sites. This must include removal of all material and hard structures. The vacant area must be ripped and seeded/planted if terrestrial.
- Waste disposal skips must be available during decommissioning.
- The working area must be screened using shade cloth fencing (terrestrial sites only)

For both layout options, decommissioning impacts are considered to be of low significance and **very low** after implementation of mitigation measures.

7.6.2.8 Cumulative Impacts

7.6.2.8.1 Other development and associated infrastructure

The WPP 2 footprint in the Wokumagbe and Goi areas is relatively small and compact, with the turbine clusters concentrated. A recent proposal has been put forward by Upwind Ayitepa Ltd to establish an extensive wind power generation operation incorporating areas around Akplabanya, Ayitepa and KoniKablo, adjacent to and within the proposed WPP 2 footprint. In terms of new infrastructure and associated impacts, the Upwind proposal, due to its extensive nature is likely to have a more profound and obvious impact on the landscape, wetland and aquatic habitats to the south of Sege and Dawa.

From the available information, the apparent number of new roads required for the proposed Upwind project would result in numerous new wetland and watercourse crossings, potentially altering the surface flow and runoff of the entire area. The significance of the cumulative impact on the local freshwater wetland ecology by the proposed WPP 2 project and the Upwind project is therefore anticipated to be at least medium, however the confidence level is low as it will be dependent on the final design and construction methods proposed for the larger Upwind project.

<u>To ensure that the impact of associated infrastructure and related upgrades remain low it is essential that the following be implemented:</u>

Ultimately co-ordination and integrated planning will be required to ensure that impacts related to all wind power projects are considered and effectively mitigated against. To ensure that the impacts remain acceptable, the following needs to be considered further by the relevant authorities and applicants:

1) Existing servitudes and routes should be used wherever possible.
2) Where new routes are required, the route of least impact is implemented.
3) The construction phase be managed and undertaken according to the relevant environmental management plans.
4) Surface flow and regional hydrology be considered when designing access roads, foundations and all other associated infrastructure.

Successful implementation of these mitigation measures may reduce the cumulative impact significance to low (best case) or at least reduce the risk of the impact significance increasing as described above. Broad scale planning and inter-ministry co-operation. No management actions are proposed.

7.6.3 Impact Assessment Summary

A summary of identified impacts, impact significance and mitigation and management measures is provided below in Table 7-12 to Table 7-15.

Table 7-12: ESIA level Impact assessment summary table for the Construction Phase

CONSTRUCTION PHASE

Direct Impacts

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Alternative Site	Status	Spatial Extent	Duration	Intensity	Probability	Reversibility of Impact	Irreplaceability	Can the Impact/Risk be Avoided?	Can the Impact/Risk be Mitigated/ Managed?	Significance of Impact and Risk		Confidence Level
												Without Mitigation/ Management	*With Mitigation/ Management (Residual Impact/ Risk)*	
Disturbance of Wetland Birds	Disturbance of birds associated with the loss of habitat	Preferred	Negative	Site specific	Permanent (habitat loss, other disturbances temporary)	Medium - Low	Probable	Moderate reversibility	Low irreplaceability	No	Yes	Low	Very Low	Medium
Disturbance of Wetland Birds	Disturbance of birds/bats associated with the loss of habitat	Alternative	Negative	Site specific	Permanent (habitat loss, other disturbances temporary)	Medium - Low	Probable	Moderate reversibility	Low irreplaceability	No	Yes	Low	Very Low	Medium
Disturbance of other fauna	Construction related activity such as excavation and noise	Preferred	Negative	Site specific	Temporary	Medium	Highly probably	High reversibility	Replaceable	No	Yes	Low	Very low	Medium
Disturbance of other fauna	Construction related activity such as excavation and noise	Alternative	Negative	Site specific	Temporary	Medium - Low	Probable	High reversibility	Replaceable	No	Yes	Low	Very low	Medium
Disturbance of salt marsh and coastal habitat	Loss of salt marsh habitat due to construction activities and Loss of habitat due to excavation and infilling	Both	Negative	Site specific	Permanent	Medium-Low	Definite	Non-reversible	High irreplaceability	No	Yes	Medium	Low	Medium
Coastal	Disturbance of coastal dynamics	Both	Negative	Site specific	Permanent	Medium	Improbable	Moderate reversibility	Replaceable	No	Yes	Very Low	Very Low	Medium
Freshwater wetlands	Loss of habitat due to excavation and infilling. Changes in water quality associated with habitat and hydrological changes	Preferred	Negative	Site specific	Permanent	Medium-Low	Definite	Non - reversible	High irreplaceability	No	Yes	Medium	Low	Medium
Freshwater wetlands	Loss of habitat due to excavation and infilling. Changes in water quality associated with habitat and hydrological changes	Alternative	Negative	Site specific	Permanent	Medium	Definite	Non - reversible	High irreplaceability	No	Yes	High	Medium	Medium

Table 7-13: ESIA level Impact assessment summary table for the Operational Phase

OPERATIONAL PHASE

Direct Impacts

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Disturbance of Wetland Birds	Bird strikes by operating turbines and general disturbance of resident birds. May influence migrating birds to the Songor Lagoon	Preferred	Negative	Local (but possibly international	Permanent	Medium – Low	Highly probable	Low reversibility	Replaceable	No	Yes	Long term monitoring by relevant specialists	Medium	Low	Low
Disturbance of Wetland Birds	Bird strikes by operating turbines and general disturbance of resident birds. May influence migrating birds to the Songor Lagoon	Alternative	Negative	Local (but possibly international	Permanent	Medium – Low	Highly probable	Low reversibility	Replaceable	No	Yes	Long term monitoring by relevant specialists	Medium	Low	Low
Disturbance of other fauna	Fauna may become trapped in infrastructure or area.	Preferred	Negative	Site specific	Permanent	Low	Probable	Low reversibility	Replaceable	No	Yes	Capture and relocate fauna. Regular inspections and checks	Low	Very low	Medium
Disturbance of other fauna	Fauna may become trapped in infrastructure or area.	Alternative	Negative	Site specific	Permanent	Low	Probable	Low reversibility	Replaceable	No	Yes	Capture and relocate fauna. Regular inspections and checks	Low	Very low	Medium
Disturbance of salt marsh and coastal habitat	Loss of habitat and a change in estuarine processes.	Both	Negative	Site specific	Permanent	Low	Probable	Non-reversible	High irreplaceability	No	Yes	Shift turbines outside of mangrove habitats.	Low	Very low	Medium
Coastal	Alteration of coastal processes and increased risk of coastal erosion	Both	Negative	Site specific	Permanent	Medium	Improbable	Moderate reversibility	Replaceable	No	Yes	None required	Very Low	Very Low	Medium
Freshwater wetlands	Contamination associated with maintenance activities.	Preferred	Negative	Site specific	Permanent	Medium - Low	Probable	Non-reversible	High irreplaceability	No	Yes	Store hazardous substances/materials correctly during maintenance.	Low	Low	Medium
Freshwater wetlands	Impacts of land reclamation on wetland functionality.	Alternative	Negative	Site specific	Permanent	Medium	Probable	Non-reversible	High irreplaceability	No	Yes	Adequate drainage/system connectivity	Medium	Low	Medium

Table 7-14: ESIA level Impact assessment summary table for the Decommissioning Phase

DECOMMISSIONING PHASE														
Direct Impacts														
Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Alternative Site	Status	Spatial Extent	Duration	Intensity	Probability	Reversibility of Impact	Irreplaceability	Can the Impact/Risk be Avoided?	Can the Impact/Risk be Mitigated/ Managed?	Significance of Impact and Risk		Confidence Level
												Without Mitigation/ Management	*With Mitigation/ Management (Residual Impact/ Risk)*	
Return to status quo	Removal of infrastructure and rehabilitation	Both	Neutral	Site specific	Temporary	Low	Definite	NA	NA	No	Yes	Low	Very Low	Medium

Table 7-15: ESIA level cumulative impact assessment summary table

Cumulative Impacts														
Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Alternative Site	Status	Spatial Extent	Duration	Intensity	Probability	Reversibility of Impact	Irreplaceability	Can the Impact/Risk be Avoided?	Can the Impact/Risk be Mitigated/ Managed?	Significance of Impact and Risk		Confidence Level
												Without Mitigation/ Management	*With Mitigation/ Management (Residual Impact/ Risk)*	
Other development and associated infrastructure	Establishment of additional infrastructure in association with the proposed Upwind Wind power project	Both	Negative	Regional	Long term	Medium	Highly Probable	Non-reversible	Moderate irreplaceability	Yes	Yes	Medium	Low	Low

7.7 NOISE AND FLICKER IMPACTS

An assessment of the noise and flicker impacts of the proposed project was conducted by Nicolette von Reiche from Airshed Planning Professionals (refer to Appendix 7). The findings of this study are discussed below.

7.7.1 Identification of Key Issues

The acoustic climate of the WPP2 area and noise levels within the communities of Omankope, Wokumagbe, Lekpoguno, Akplabnya, and Goi will be impacted during the construction, operational, and decommissioning phases.

The main impact of the operational phase is disturbance as a result of increased environmental noise levels caused by operating WTGs.

Whereas the significance of construction and decommissioning phase impacts are hereafter assessed based typical noise impacts during construction and decommissioning activities, noise impacts associated with the operational phase are assessed based on the results of environmental noise calculations and simulations.

When considering environmental noise, the impact is always direct in nature. Furthermore, since the impact of a project is dependent on prevailing background noise levels, noise assessments by default, consider cumulative impacts. The cumulative impacts associated with the proposed developments within 20 km are however also considered if applicable.
Shadow flicker impacts are only of concern during the operational phase of a WEF.

7.7.2 Assessment of Impacts

7.7.2.1 Construction and Decommissioning Phases

The main impact of construction and decommissioning phases are disturbance as a result of increased environmental noise levels caused by traffic, earthworks, infrastructure erection and demolition.
Noise from construction/decommissioning works can be difficult to control for several reasons, including:

- Activities are carried out in the open;
- Although transient in nature, it can cause notable disturbances when ongoing;
- Noise arises from many different activities and types of plants and the intensity and character can vary significantly at different phases of construction/decommissioning;
- Sites cannot be excluded by planning control from areas sensitive to noise.

The impact for both alternatives is local in extent, of temporary duration, highly reversible and as a result is of **low** significance. With the alternative layout for WPP2, residents of Omankope will however not be impacted by construction/demolition noise expect for the Omankope Presbyterian Primary School which will be situated in very close proximity to a WTG construction site.

Low impact significance implies that the impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation and management measures. Such measures proposed for adoption in WPP2 environmental management plan are discussed in detail below and entails general good practice for managing environmental noise impacts from these phases.

<u>Compulsory Mitigation Measures:</u>

To manage noise impacts and ensure low significance noise impacts, the following must be included in the project's environmental management plan:

- The Omankope Presbyterian Primary School must be relocated should the preferred layout for WPP2 be selected.
- Construction and decommissioning activities *must be limited to day-time working hours*;
- *Implement a complaint register* at site offices where members of the public can easily communicate issues to VRA and contractors. In response to any complaints received, short term monitoring must be conducted as per the methodology set out in Section 8.1.1.3 of the Nosie and Flicker Specialist Report in Appendix 8. Once the source or sources of noise resulting in complaints have been identified, appropriate good practice measures (Section 8.1.1.2 of the Nosie and Flicker Specialist Report in Appendix 8) must be implemented.

The measures discussed in this section are measures typically applicable to construction sites and considered good practice by the IFC (2007) and BSI (2008). They are also considered applicable to the decommissioning phase. Noise control measures can be applied at the source, at the receiver, or the path from source to receiver. The focus of the measures below is on noise control at the source and the path from source to receiver.

Good Practice Measures

General Good Practice Measures

General measures to reduce noise levels at the source include:

a) Avoiding unnecessary revving and idling times for all mobile construction equipment.
b) Minimising individual construction vehicle engine, transmission, and body noise/vibration. This is achieved through the implementation of an equipment maintenance program.
c) Keeping temporary construction roads well maintained and avoiding steep inclines.
d) Using rubber linings in for instance chutes and dump trucks to reduce impact noise.
e) Minimizing drop height of materials to reduce impact noise.
f) The sequential start-up of equipment and plants rather than simultaneously.
g) All movements and activities on site should take cognisance of the location of NSRs and normal operating hours of the site as far as is practicable.
h) Minimising the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing, but necessary, reverse warnings will occur. Alternatives to the traditional reverse ‘beeper’ alarm such as a ‘self-adjusting’ or ‘smart’ alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level near the moving equipment. The promotional material for some smart alarms does state that the ability to adjust the level of the alarm is of advantage to those sites ‘with low ambient noise level’ (Burgess & McCarty, 2009). Also, when reversing, vehicles should travel in a direction away from NSRs if possible.
i) Limit construction traffic and activities to day-time work hours (08:00 to 17:00).

Specifications and Equipment Design

If a construction site is within an especially sensitive area, equipment and methods to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels.

Enclosures

A far as is practically possible, source of significant noise should be enclosed. The extent of enclosure will depend on the nature of the machine and their ventilation requirements. Generators and air compressors are examples of such equipment. It should be noted that the effectiveness of partial enclosures and screens can be reduced if used incorrectly, e.g. noise should be directed into a partial enclosure and not out of, there should not be and reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.

Use and Siting of Equipment

Plant and equipment should be sited as far away from NSRs as possible. Also:

a) Machines (e.g. cranes) used intermittently should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy.
b) Plants or equipment from which noise generated is known to be particularly directional, should be orientated so that the noise is directed away from NSRs.
c) Acoustic covers of engines and compressors should be kept closed when in use or idling.
d) Construction materials such as beams and bricks should be lowered and not dropped.

Maintenance

Regular and effective maintenance of equipment and plants are essential to noise control. Increases in equipment noise are often indicative of eminent mechanical failure. Also, sound reducing equipment/materials can lose effectiveness before failure and can be identified by visual inspection.

Noise generated by vibrating machinery and equipment with vibrating parts can be reduced through the use of vibration isolation mountings or proper balancing. Cutting tools and saws must be kept sharp to reduce frictional noise. Noise generated by friction in conveyor rollers, trolley etc. can be reduced by sufficient lubrication.

Naturally, if noise activities can be minimised or avoided, the amount of noise reaching NSRs will be reduced. Alternatively, the distance between source and receiver must be increased, or noise reduction screens, barriers, or berms must be installed.

Distance

To increase the distance between source and receiver is often the most effective method of controlling noise since, for a typical point source at ground level, a 6 dB decrease can be achieved with every doubling in distance. It is however conceded that it might not always be possible. Ideally, stationary plants such as generators, compressors, cement and asphalt works (if applicable) should be located as far away from NSRs within the development footprint.

Screening

If noise control at the source and the use of distance between source and receiver is not possible, screening methods must be considered. The effectiveness of a noise barrier is dependent on its length, effective height, and position relative to the source and receiver as well as material of construction. To optimize the effect of screening, screens should be located close to either the source of the noise, or the receiver.

The careful placement of barriers such as screens or berms can significantly reduce noise impacts but may result in additional visual impacts. Although vegetation such as shrubs or trees may improve the visual impact of construction sites, it will not significantly reduce noise impacts and should not be considered as a control measure.

Site buildings such as construction offices and stores can be grouped together to form a substantial barrier between construction activities and nearby NRs. Similarly, one may use construction materials such as bricks, timber and aggregate if placed strategically.

Monitoring

Noise monitoring at sites where noise is an issue or may become an issue is essential. In the event that noise related complaints are received during either the construction or decommissioning phase, short term (24-hour) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The following procedures should be adopted for all noise surveys during the construction and decommissioning phase:

- All surveys should be designed and conducted by a trained specialist.
- Sampling should be carried out using a Type 1 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory.
- The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
- Samples of at least 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic environment should be taken.
- The following acoustic indices should be recoded and reported: L_{Aeq} (T), statistical noise level $L_{A90,}$ L_{AFmin} and $L_{AFmax,}$ octave band or 3rd octave band frequency spectra.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

The investigation of complaints should include an investigation into equipment or machinery that could likely result or resulted in noise levels annoying to the community. This could be achieved with source noise measurements.

7.7.2.2 Operational Phase

7.7.2.2.1 Increase environmental noise levels

The main impact of the operational phase is disturbance as a result of increased environmental noise levels caused by operating WTGs. The propagation of noise generated by WPP2 during its operational phase was calculated with WindPRO in accordance with ISO 9613. Site specific acoustic parameters, source data and results of the modelling are presented in the Noise Impact Assessment Specialist Study (Appendix 7).

Results are presented in the form of isophones (Figure 7-9 to Figure 7-12).

WPP2 Preferred Layout

Simulations indicate that the most notable noise impact as a result of the preferred layout proposed for WPP2 will occur at Omankope, specifically the **Omankope Presbyterian Primary School** (NSR6) which is situated approximately 70 m from WTG A-12. Noise levels in exceedance of the 55-dBA day-time IFC guideline and Ghana EPA limit are likely at the Omankope Presbyterian Primary School should the GE 1.7-103 WTGs without LNTE technology be used. By using LNTE technology and changing the operational mode of WTGs A-10, A-11, A-12, A-13, A-14, A-15, and A-16 to NRO100 during the day (school hours), the L_{A90} may be minimised to levels below 55 dBA. However, given the sampled day-time background noise level within Omankope of 37 dBA, the increase in noise level will remain in excess of 11 dBA during school hours[6]. The relocation of the school is therefore considered necessary.

Residents of **Omankope** (the closest of which is situated approximately 310 m from WTG A-12) may also be exposed to night-time noise levels in exceedance of the impact criterion of 45 dBA if impacts are unmitigated. LNTE technology and the operation of WTGs A-10, A-

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[6] The reader is reminded of uncertainties related to background noise measurements and conservative estimates of prevailing baseline noise conditions.

11, A-12, A-13, A-14, A-15, and A-16 at NRO103 or lower, will reduce night-time noise levels to below 45 dBA at Omankope as well as western most residences of Wokumagbe (NSR 8). Given low background noise levels at Omankope, increases noise levels of between 3 and 12 dBA may be expected during the day, with night-time noise level increases between 5 and 15 dBA, depending on WTG operational mode. By using LNTE technology and changing the operational mode of WTGs A-10, A-11, A-12, A-13, A-14, A-15, and A-16 to NRO100 during the night, the L_{A90} may be minimised to levels below 45 dBA with the expected increase in night-time noise levels between 6 and 9 dBA.

Noise generated by WTGs forming part of the easternmost array of the preferred layout (array “C”) may result in impacts in exceedance of 45 dBA at **Akplabnya** and the western extent of **Goi** if unmitigated.

To reduce noise impacts at **Akplabnya**, LNTE technology needs to be implemented. Additionally, WTGs C-32, C-33, C-34, and C35 need to be operated at the NRO103 mode or better.

To minimise impacts at **Goi**, WTGs C-43, C44, and C45 need to be operated at the NRO100 mode. With the 45-dBA impact area of a single operating GE 1.7-103 WTG with LNTE technology at a distance of approximately 200 m and the impact area of more than one WTG in close proximity to one-another at 530 m, residence of Goi within 2 to 5 rotor diameters of WTG C-45 may need to be relocated.

On average, NSRs within 5 rotor diameters from WTG arrays (assuming LNTE technology is employed) may be exposed to noise levels in exceedance of the IFC night-time guideline of 45 dBA.

WPP2 Alternative Layout

Noise impacts associated with the alternative layout vary notably from the preferred layout at Omankope, Wokumagbe, and Goi. These variations are discussed below.

The preferred layout proposed for WPP2 is not expected to result in exceedances of even the strictest assessment criterion (45 dBA) at residents of Omankope or the Omankope Presbyterian Primary School (NSR6). With the alternative layout, the closest WTG will be situated at a distance of approximately 850 m from the Omankope Presbyterian Primary School.

With the alternative layout, the Lekpoguno section WPP2 will pass within approximately 410 m of Wokumagbe. This results in noise levels in exceedance of 45 dBA the K3 International Primary School (NSR11), and the closest residence (NSR12) where noise levels of 46.8 dBA and 48.6 dBA are predicted respectively. With the installation of LNTE technology and applying NRO101 mode or better at WTGs A-17, A-18, A-19, and A-20 during night-time hours, impacts at Wokumagbe may be reduced to within 45 dBA.

Noise impacts at Goi will shift to the northern part of the village (NSR20), where residents within 300 m from the easternmost array (array “C”) consisting of WTGs C-43, C-44, and C-45, will be affected by noise levels in exceedance of 45 dBA. The impact at Goi can be minimised with the implementation of LNTE technology and applying the NRO100 mode during night-time hours. As for the preferred layout, residents within 2 to 5 rotor diameters from WTGs C-43, C-44, and C-45may need to be relocated. The closest residence of Goi is sited approximately 50 m from WTG C-45.

On average, NSRs within 5 rotor diameters from WTG arrays (assuming LNTE technology is employed) may be exposed to noise levels in exceedance of the IFC night-time guideline of 45 dBA.

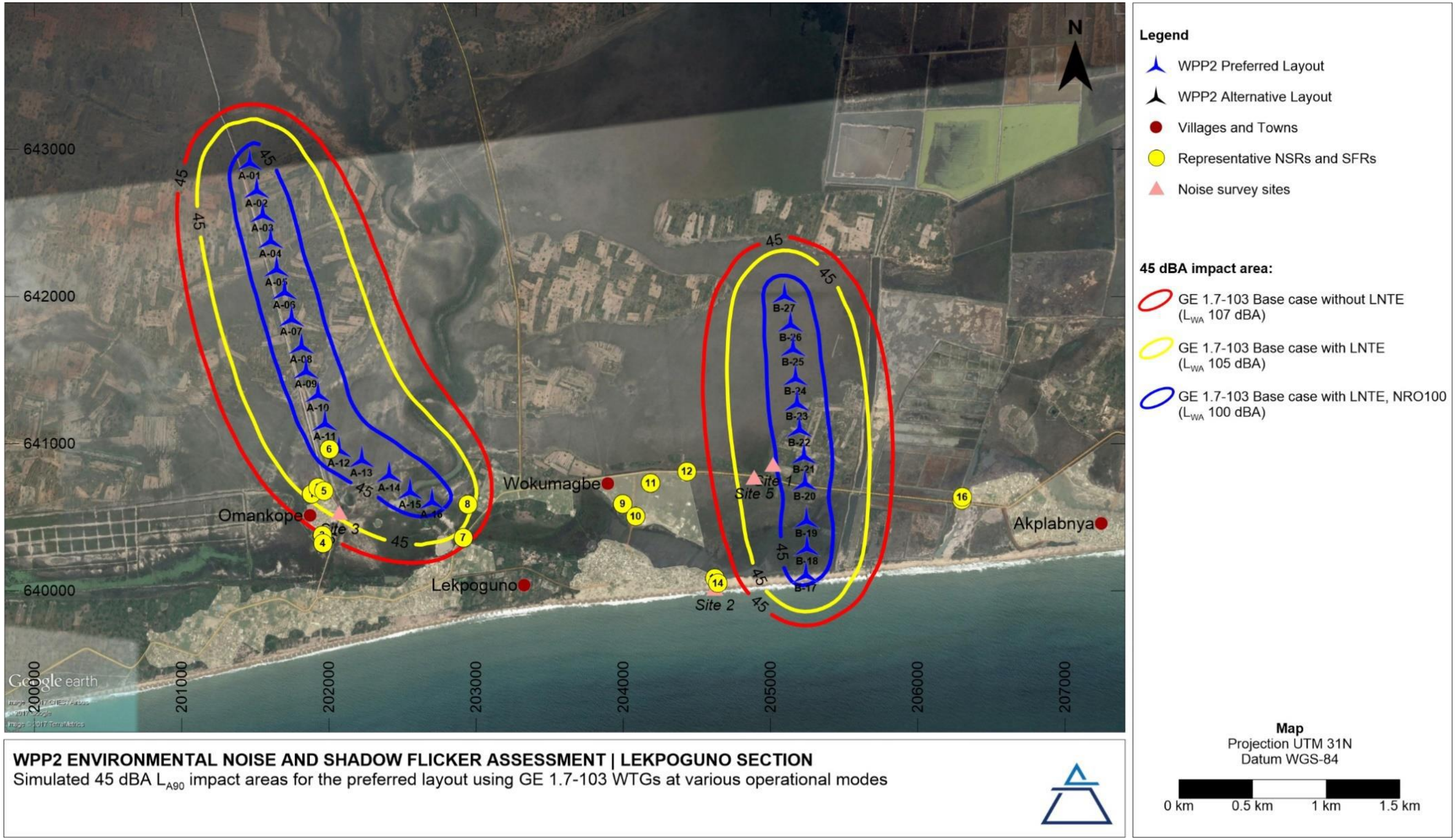


Figure 7-9: **Simulated 45 dBA L_{A90} impact areas for the WPP2 preferred layout, Lekpoguno Section | GE 1.7-103 WTGs**

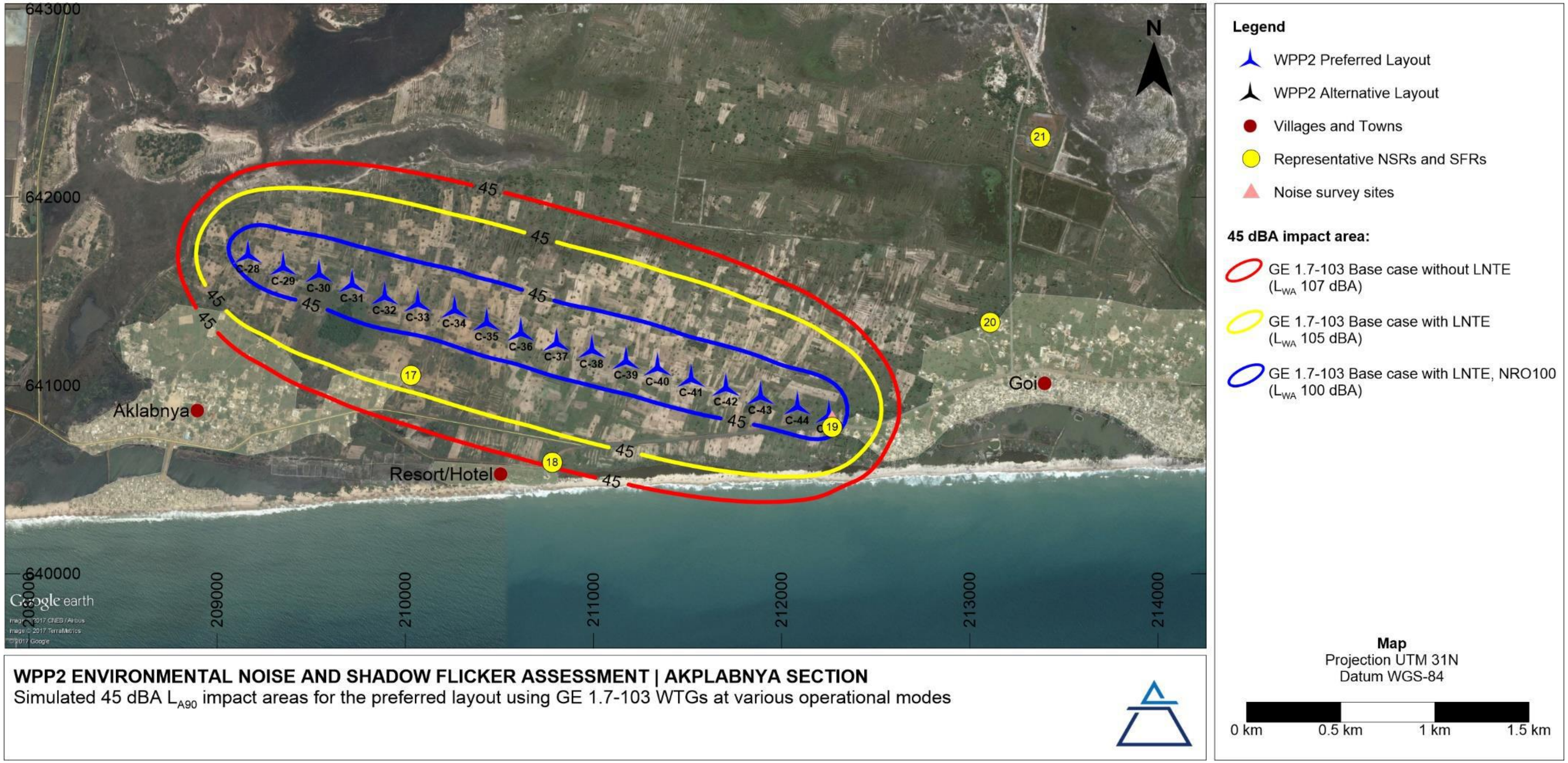


Figure 7-10: Simulated 45 dBA L_{A90} impact areas for the WPP2 preferred layout, Akplabnya Section | GE 1.7-103 WTGs

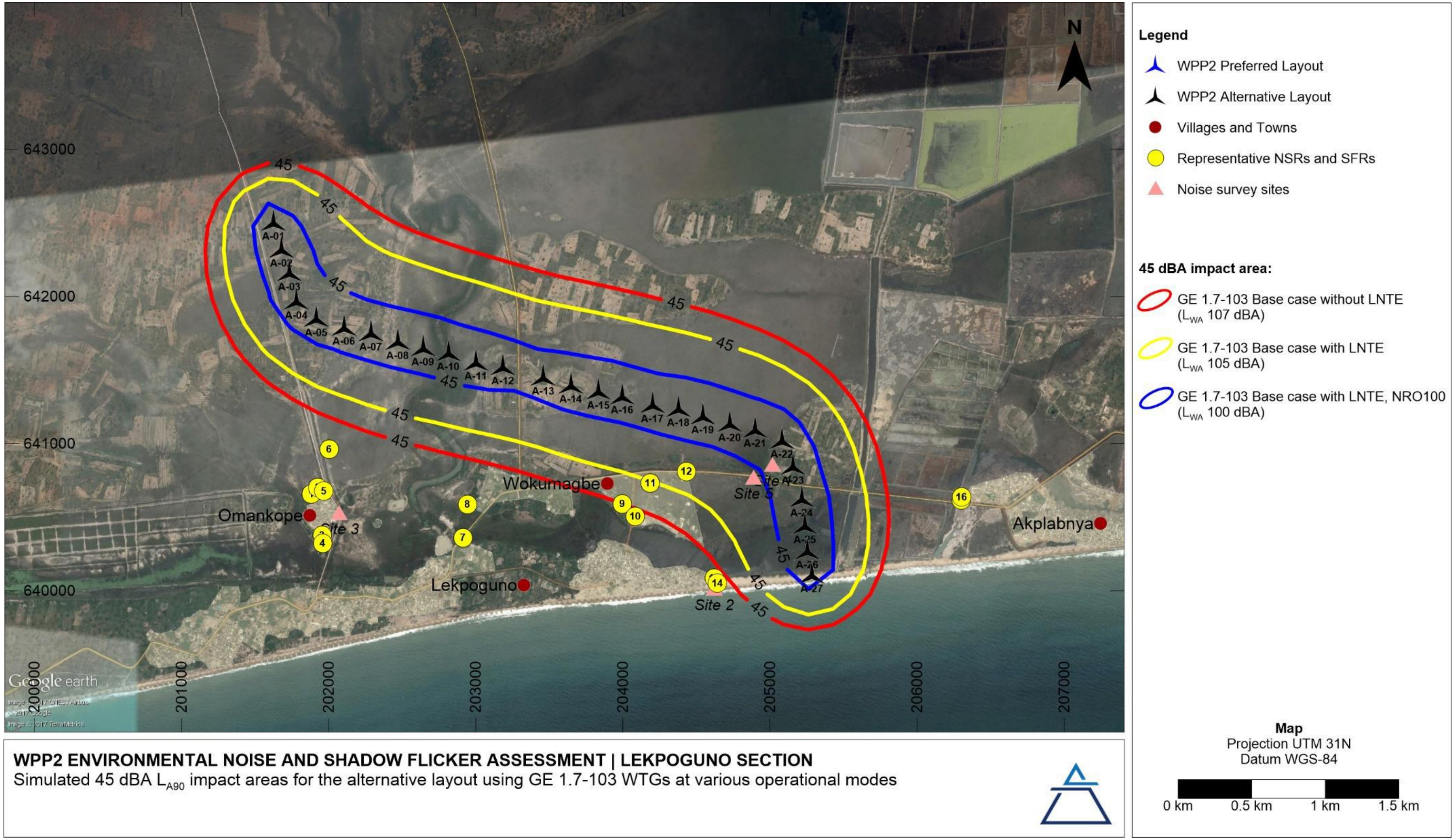


Figure 7-11: **Simulated 45 dBA L_{A90} impact areas for the WPP2 alternative layout, Lekpoguno Section | GE 1.7-103 WTGs**

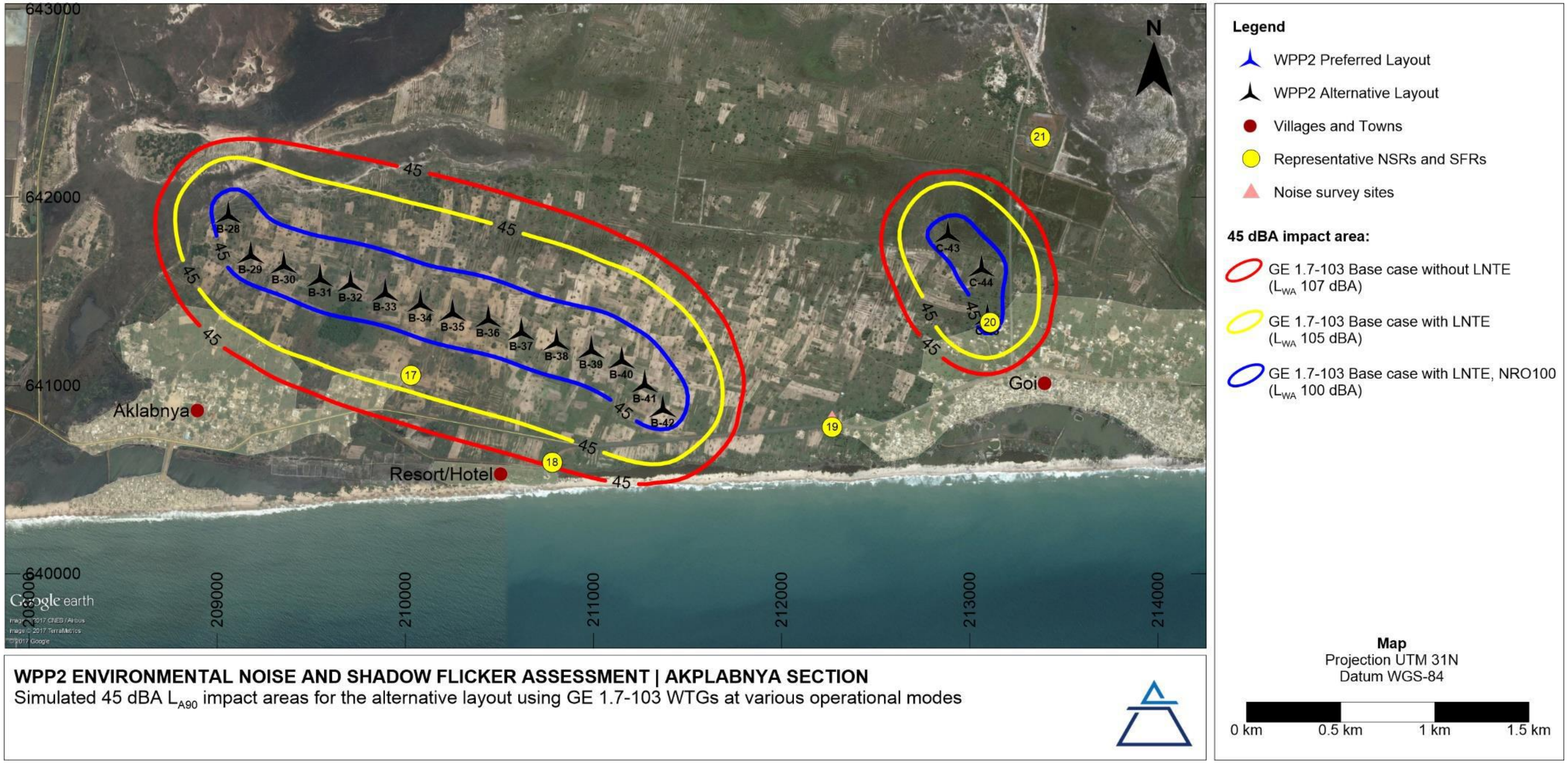


Figure 7-12: Simulated 45 dBA L_{A90} impact areas for the WPP2 alternative layout, Akplabnya Section | GE 1.7-103 WTGs

Measures to prevent and control noise are mainly related to engineering design standards and WTG siting. With modern turbines, mechanical noise is usually significantly lower than aerodynamic noise, and continuous improvement in aerofoil design is reducing the latter (IFC, 2015). Additional recommended noise management measures might include:

- Using LNTE technology on WTGs.
- Operating turbines in reduced noise modes where necessary.
- Building walls/appropriate noise barriers around potentially affected buildings (only an option in hilly terrain, due to the height of turbines).

<u>The measures recommended and discussed below are compulsory for WPP2.</u>

WTG Design

It is recommended that the GE 1.7-103 WTG *with the LNTE* be selected for WPP2.

To reduce and minimise noise impacts on NSRs, reduced operational modes are recommended for the following WTGs:

- WPP2 <u>preferred layout</u>, night-time:
    - NR100 (L_{WA} 100 dBA):
        - Lekpoguno section: A-10, A-11, A-12, A-13, A-14, A-15, and A-16
        - Akplabnya section: C-43, C-44, and C-45
    - NR103 (L_{WA} 103 dBA):
        - Akplabnya section: C-32, C-33, C-34, and C-35
    - Optimised mode (base) (L_{WA} 105 dBA):
        - All other WTGs
- WPP2 <u>alternative layout</u>, night-time:
    - NR100 (L_{WA} 100 dBA):
        - Akplabnya section: C-43, C-44, and C-45
    - NR101 (L_{WA} 101 dBA):
        - Lekpoguno section: A-17, A-18, A-19, and A-20
    - NR102 (L_{WA} 102 dBA):
        - Akplabnya section: B-33, B-34, and B-35
    - Optimised mode (base) (L_{WA} 105 dBA):
        - All other WTGs

Separation Distance

Increasing the distance between source and receiver is an essential mitigation measure since noise reduction options for WTGs are limited. For an elevated point source such as a WTG, a 6 dB decrease can be achieved with every doubling in distance.

It is recommended that no permanent residences be permitted within 45 dBA impact area of WPP2 WTG arrays. The impact area corresponds roughly to between 2 and 5 rotor diameters from WTGs of the preferred and alternative layout. The recommended buffer zones are shown in Figure 7-13 and Figure 7-14 for the Lekpoguno and Akplabnya section of WPP2 respectively and assumes that NRO modes recommended in Section 8.1.2.2 of the Noise and Flicker Impact Assessment Report in Appendix 7) are implemented. All residences and community locations such as schools and churches already within these zones must be relocated.

Specifically, in the event the preferred layout is selected, provision should be made to relocate the Omankope Presbyterian Primary School. Relocation of selected residences at Goi will be required for both the preferred and alternative layout.

Monitoring

ETSU (1996) and the IFC (2015) clearly specify noise monitoring practices for WEFs. Methods closely follow the IFC’s general monitoring requirements but requires the additional monitoring of wind speed. Environmental noise measurements at receptors near WEF’s need also be longer in duration to facility determining impacts under various wind conditions.

For the preferred layout, a permanent monitoring station should be installed at Omankope (in the vicinity of site 3 of the background noise survey) and Akplabnya (in the vicinity of NSR17). For the alternative layout, a station should be established at Wokumagbe (near NSR12) and at Goi (in the vicinity of NSR20). Both noise and wind speed/wind direction must be recorded. It is recommended that such stations be maintained for a period of 1 year from the day WPP2 is fully operation. The specification of such a remote semi-permanent station will depend on power supply options, security of equipment, and remote data access options.

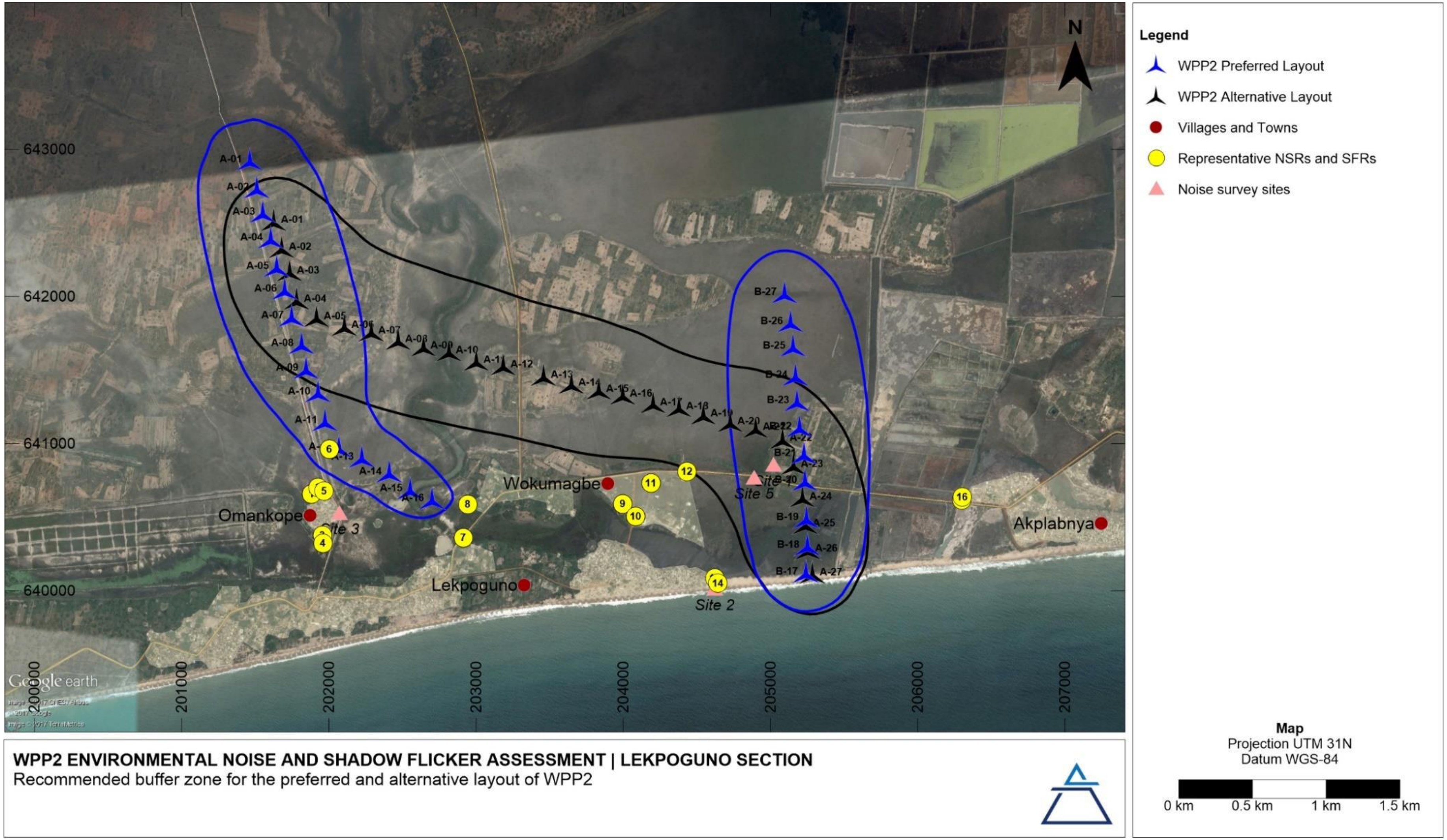


Figure 7-13: Recommended buffer zone for the Lekpoguno section of WPP2, for noise impact mitigation and management.

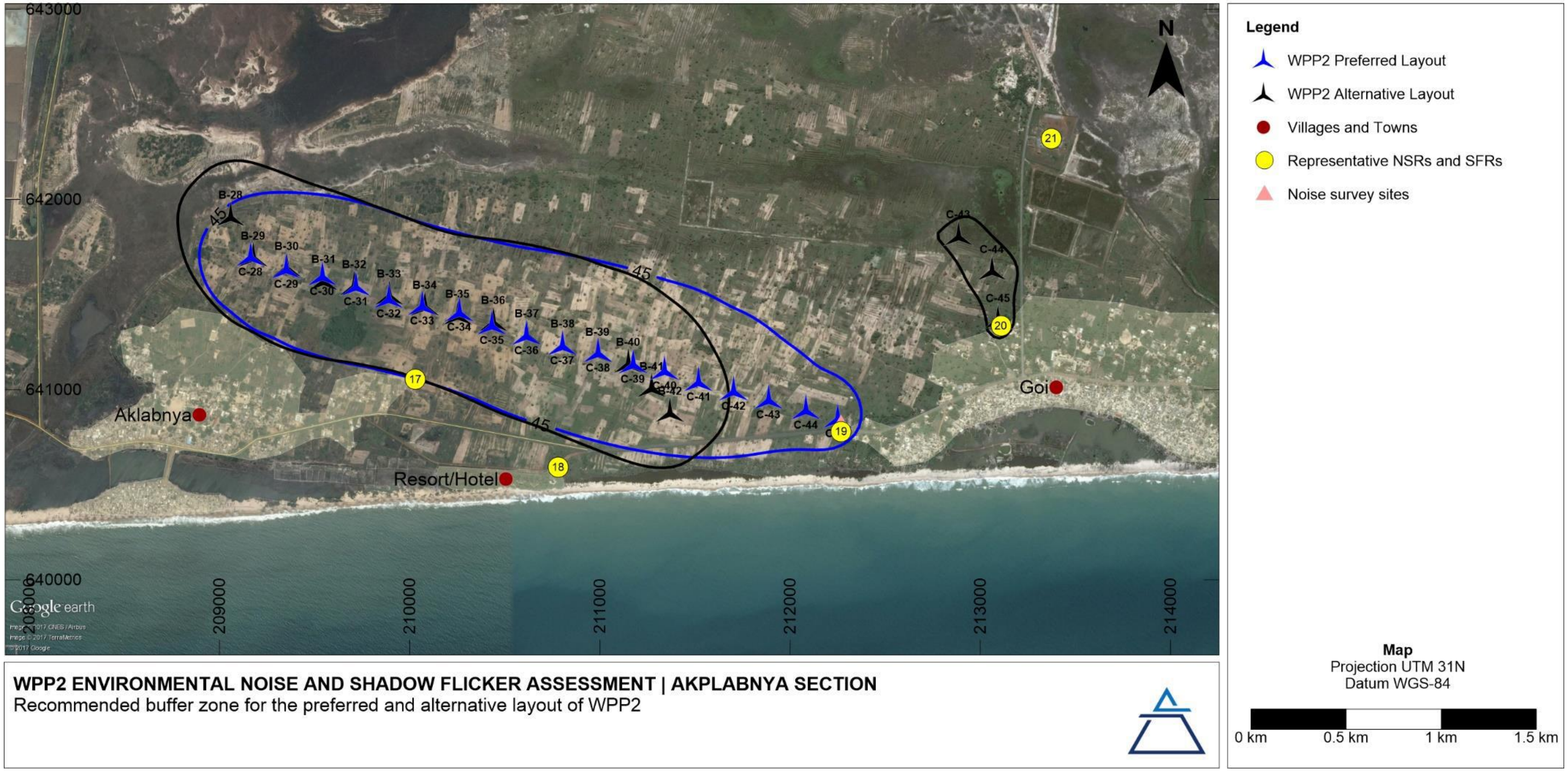


Figure 7-14: Recommended buffer zone for the Akplabnya section of WPP2, for noise impact mitigation and management.

7.7.2.2.2 Shadow Flicker

Shadow flicker impacts are only of concern during the operational phase of a WEF.

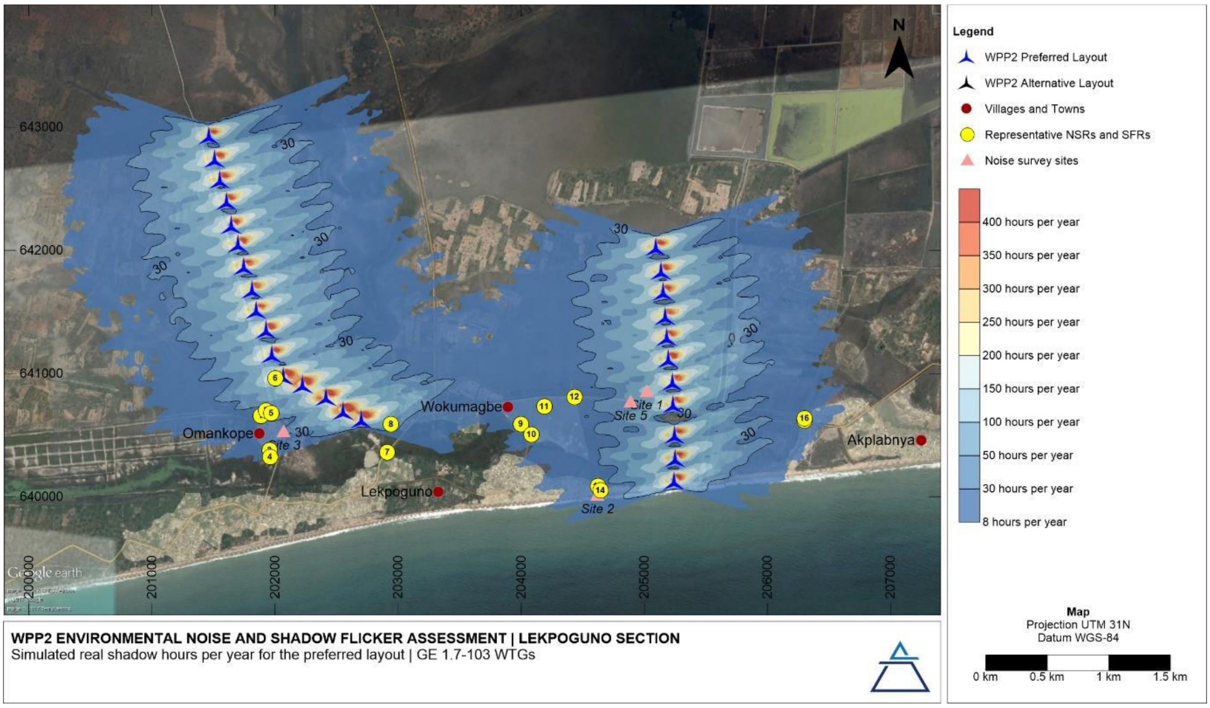
Operational phase shadow flicker impacts are anticipated to be of medium significance for both the preferred and the alternative layouts. This means the impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures. The impact will also only have an influence on the decision-making if not mitigated. Prevention and control measures to avoid significant shadow flicker impacts generally include the following:

- Site wind turbines appropriately to avoid shadow flicker being experienced; or
- Wind turbines can be programmed to shut down at times when shadow flicker limits are exceeded.

The IFC recommends that, if it is not possible to locate the wind energy facility/turbines such that neighbouring receptors experience no shadow flicker effects, 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 (IFC, 2007).

Whereas curtailment of WTG operational hours can be used to mitigate shadow flicker impacts at Omankope, Wokumagbe, and Goi, the Omankope Presbyterian Primary School (SFR6), as well eastern-most and northernmost residents of Goi in the vicinity of SFR19 and SFR20 must be relocated.

By adhering to the buffer zone and relocations recommended to mitigate noise impacts, shadow flicker impacts will also be avoided.



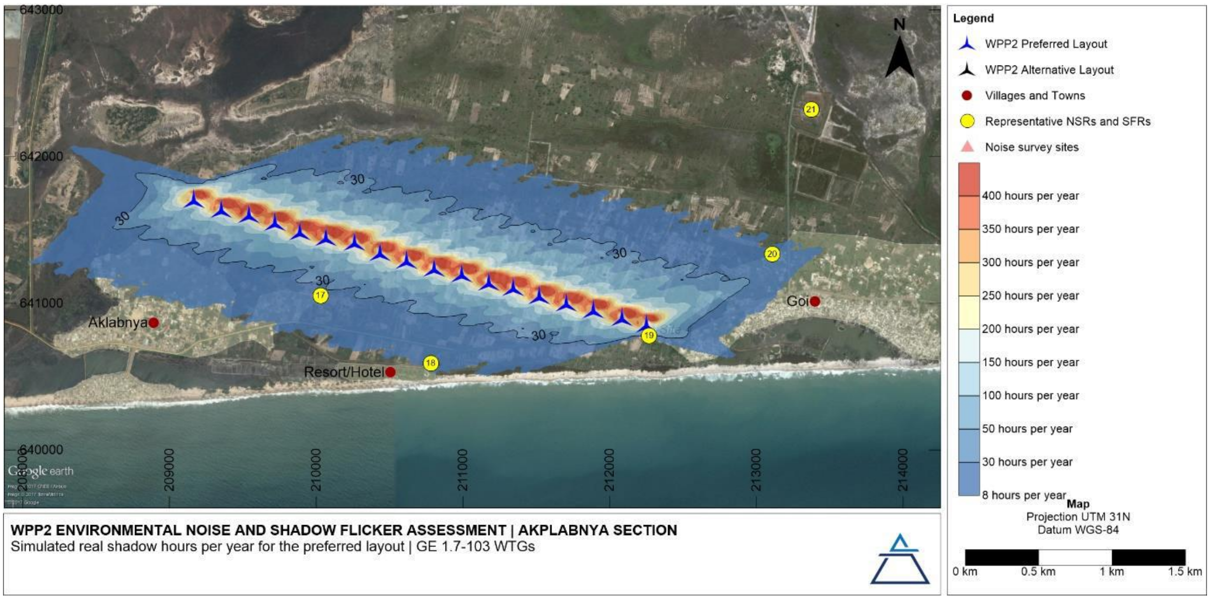
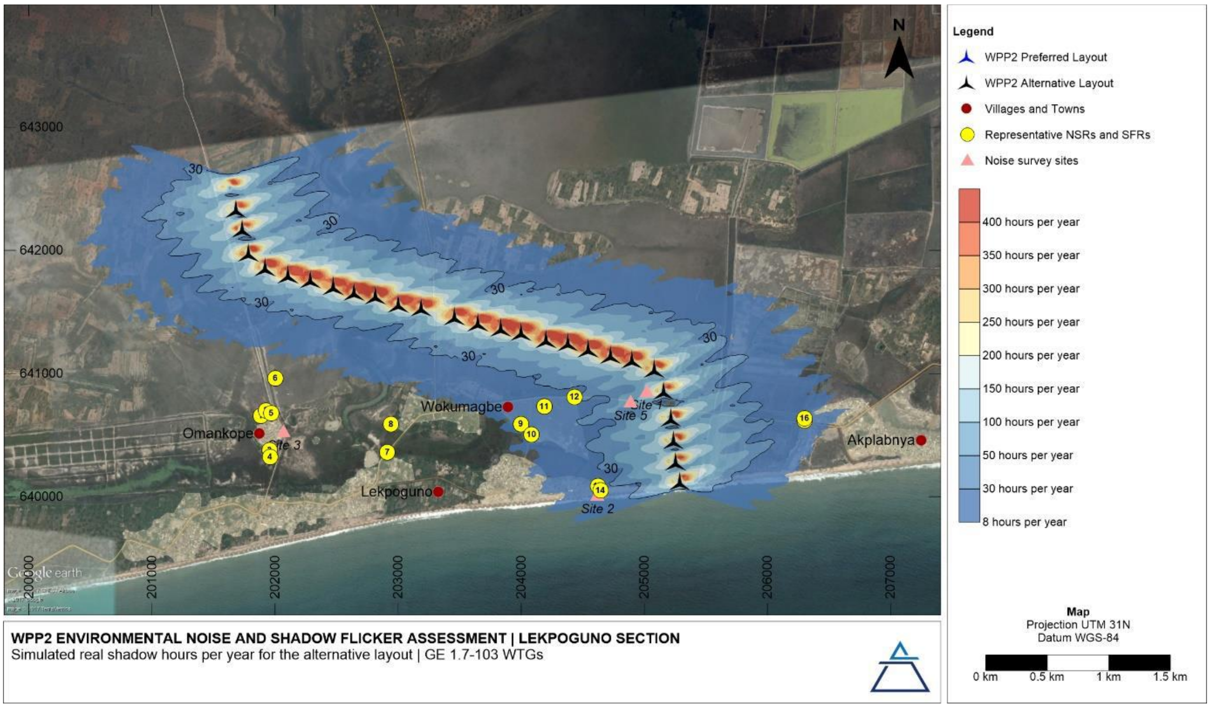
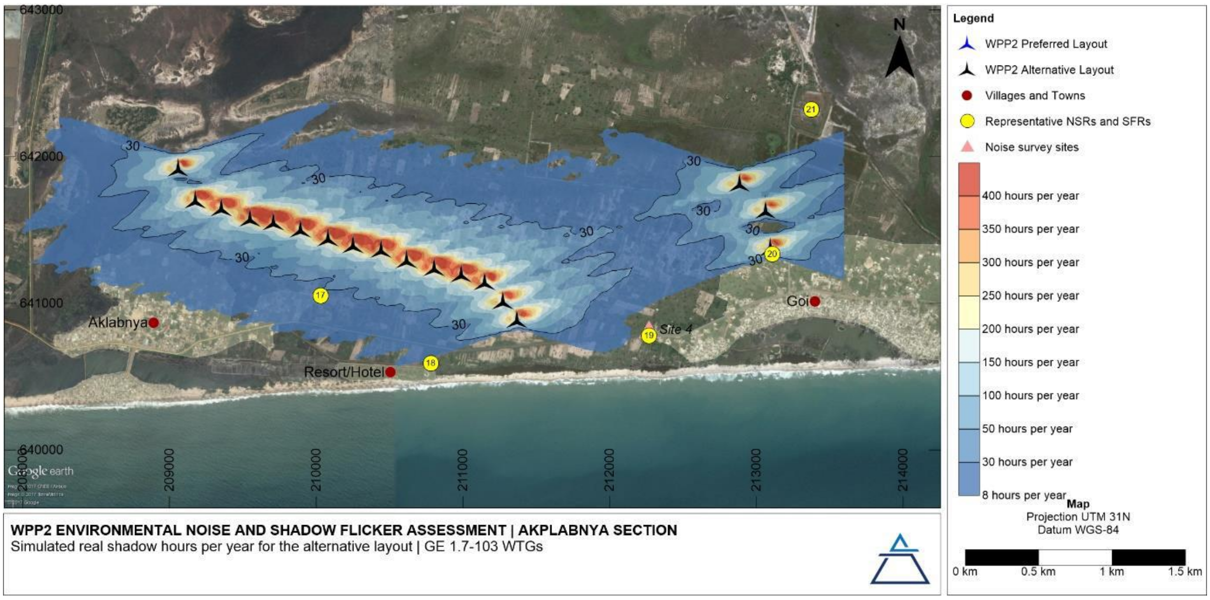


Figure 7-15: Simulated real shadow hours per year for the WPP2 preferred layout



WPP2 ENVIRONMENTAL NOISE AND SHADOW FLICKER ASSESSMENT | LEKPOGUNO SECTION
Simulated real shadow hours per year for the alternative layout | GE 1.7-103 WTGs



WPP2 ENVIRONMENTAL NOISE AND SHADOW FLICKER ASSESSMENT | AKPLABNYA SECTION
Simulated real shadow hours per year for the alternative layout | GE 1.7-103 WTGs

Figure 7-16: Simulated real shadow hours per year for the WPP2 alternative layout

7.7.2.3 Cumulative Impacts

UpWind Ayitepa Ltd. is proposing to construct a 300 MW WEF north of Lekpoguno, extending to the N1 (a distance of approximately 9.5 km), and to the north of Goi and Akplabnya, extending to the southern boundary of the Songor Lagoon. UpWind proposes to construct 90 to 100 turbines.

Cumulative impacts are highly likely at Akplabnya and Goi where the footprint areas of the UpWind project and WPP2 overlap towards the south. The significance of cumulative impacts, for both the preferred and alternative layouts of WPP2, is considered ***medium***. With the implementation of a buffer zone and the relocation of receptors within the zone, the significance may be reduced to ***low***. Note however that ***the extent of the buffer will need to increase*** thereby affecting more people within the nearby communities.

It is estimated that, given the WTGs proposed as part of the UpWind project (3 MW Nordex WTGs) and its reference noise level of 104.5 dBA, the buffer zone will need to extend by 4.5 to 6.5 rotor diameters from the entire WTG array.

7.7.3 Impact Assessment Summary

A summary of identified impacts, impact significance and mitigation and management measures is provided below in Table 7-16 to Table 7-18.

Table 7-16: Impact assessment summary table for the construction phase of the preferred and alternative layout

CONSTRUCTION PHASE, PREFERRED AND ALTERATIVE LAYOUT														
Direct, cumulative impacts														
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Site Alternative**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplace-ability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Significance of Impact**		**Confidence Level**
												Without Mitigation/Management	***With Mitigation/Management***	
Construction noise, traffic, bulk earthworks, infra-structure erection	Disturbance as a result of increased environmental noise levels caused by construction of WTGs	Preferred layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	Medium	Low	Medium
		Alternative layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	Medium	Low	Medium

Table 7-17: Impact assessment summary table for the operational phase of the preferred and alternative layout

OPERATIONAL PHASE, PREFERRED AND ALTERNATIVE LAYOUT														
Direct, cumulative impacts														
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Site Alternative**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Significance of Impact**		**Confidence Level**
												Without Mitigation/Management	***With Mitigation/Management***	
WTG noise	Disturbance as a result of increased environmental noise levels caused by operational WTGs	Preferred layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	Medium	Low	Medium
		Alternative layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	Medium	Low	Medium
Shadow Flicker	Disturbance as a result of shadows cast by operational WTGs	Preferred layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	Medium	Low	Medium
		Alternative layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	Medium	Low	Medium

Table 7-18: Impact assessment summary table for the decommissioning phase for the preferred and alternative layout

DECOMMISSIONING PHASE, PREFERRED AND ALTERNATIVE LAYOUT														
Direct, cumulative impacts														
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Site Alternative**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplace-ability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Significance of Impact**		**Confidence Level**
												Without Mitigation/Management	***With Mitigation/Management***	
Decommissioning noise, traffic, bulk earthworks, infra-structure demolishing	Disturbance as a result of increased environmental noise levels caused by decommissioning activities WTGs	Preferred layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	Low	Low	Medium
		Alternative layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	Low	Low	Medium

7.8 VISUAL IMPACTS

An assessment of the visual impacts associated with the proposed project was conducted by Scott Masson from SRK Consulting (South Africa) (Pty) Ltd (SRK) (refer to **Appendix 8)**. The findings of this study are discussed below.

7.8.1 Identification of Key Issues

Direct visual and aesthetic impacts in the construction / decommissioning and operations phases are likely to result from a number of project interventions and/or activities:

- Construction Phase:
    - Earthworks, vegetation clearance and resultant scarring;
    - Construction activities and presence of heavy construction vehicles and equipment;
    - Dust generation; and
    - Construction traffic.
- Operations Phase:
    - Change in character of the site and landscape caused by wind turbines;
    - Nightglow nuisance caused by security lighting and aviation warning lights; and
    - Change in character of the site and landscape caused by shadow flicker.
- Decommissioning Phase:
    - Decommissioning activities and presence of heavy construction vehicles and equipment;
    - Dust generation; and
    - Traffic.

The visual and aesthetic impacts generated by the project are likely to be associated with changes to sense of place and visual intrusion.

The following criteria are taken into consideration in the assessment of the visual impacts associated with the proposed project: visual exposure, visual absorption capacity, visibility, viewer sensitivity and landscape integrity. The detailed assessment of those criteria is included in the Visual Impact assessment specialist study (refer to Appendix 9). The magnitude or intensity of the overall visual impact that is expected to result from the project has been rated. Table 7-19 provides a summary of the criteria, a descriptor summarizing the status of the criteria and projected impact magnitude ratings.

The overall magnitude of the visual impact that is expected to result from the project is rated as *high*. The low level of compatibility of the project and the high visibility of the turbines increases the intensity of the project.

Table 7-19: Magnitude of Overall Visual Impact

Criteria	Rating	Comments
Visual Exposure	High	The project will be exposed across an extensive area.
Visual Absorption Capacity	Low	Relatively flat landscape (including vegetation) provides ineffective screening.
Viewer Sensitivity (Receptors)	Moderate	Sensitive receptors in close proximity to the WEF.
Viewing Distance and Visibility	High	High visibility of the turbines in a flat landscape and close proximity to receptors.
Landscape Integrity	Low	Scale of turbines incompatible with the existing nature of the area.

7.8.2 Assessment of Impacts

7.8.2.1 Construction Phase

7.8.2.1.1 Altered Sense of Place and Visual Intrusion from Construction Activities

Visual impacts will be generated by construction activities such as vegetation stripping and bulk earthworks, which can cause scarring, and from construction infrastructure, plant and materials on site (e.g. site camp, cranes and stockpiles). Dust generated at the site will be visually unappealing and may further detract from the visual quality of the area. Such impacts are typically limited to the immediate area surrounding the construction site and to the construction period.

Loss of sense of place is expected during construction since construction activities and the change in the state of the site (scarring, construction equipment and dust generation) are incongruent with the current character and nature of the surrounding area.

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low**.

Essential mitigation measures include the following:

- Limit and phase vegetation clearance and the footprint of construction activities to what is absolutely essential;
- Utilise existing access roads as far as possible;
- Avoid excavation, handling and transport of materials which may generate dust under very windy conditions;
- Enforce speed limit of 30km/hr on site;
- Consolidate the footprint of the construction camp to a functional minimum. Screen the yard with materials that blend into the surrounding area;
- Keep construction sites tidy and all activities, material and machinery contained within an area that is as small as possible;
- Rehabilitate disturbed areas incrementally and as soon as possible, not necessarily waiting until completion of the Construction Phase; and
- Set targets for the use of local labour to give locals a sense of ownership and pride in the project.

7.8.2.1.2 Altered Sense of Place from Increased Traffic

The increased number of construction vehicles on the road (and the related noise impacts) will reduce the sense of place to neighbouring receptors. The impaired sense of place will have a greater impact within the foreground as sensitive receptors in close proximity to the access roads will be particularly exposed to this impact.

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low**.

Essential mitigation measures include the following:

- Limit construction activities to Mondays to Saturdays between the hours of 07h00 and 18h00, or in accordance with relevant District bylaws, if applicable; and
- Maintain all generators, vehicles and other equipment in good working order.

7.8.2.2 Operations Phase

7.8.2.2.1 Altered Sense of Place and Visual Intrusion from the WEF

There is a degree of subjectivity in determining receptors' responses to WEFs - wind turbines may be perceived as negative or positive, majestic or dominant, depending on receptors' perception of the landscape and the value they ascribe to 'green energy'. Many societies acknowledge that renewable energy projects reduce dependency on fossils fuels (and associated carbon emissions / climate change) and are therefore more tolerant of visual and sense of place impacts that there would be for other similar scale projects.

The WEF will change the sites from unbuilt, predominantly natural to built sites.

The turbines at 80 m (from ground level to turbine nacelle) will be prominent vertical elements in the landscape. The turbines will be visually overpowering and dominating to receptors within 1 km of the turbines. There are many receptors (residents) within 1 km of the WEF at Lekpoguno, Akplabnya and Goi (note, the closest receptor is within 100 m of a turbine). Visual intrusion is likely to be significant to these receptors.

WPP2 will be moderately compatible with the existing land use of the area as this area has been altered by agricultural activities and the salt works, although the turbines will be of a scale very different to the current rural nature of the study area.

The impact for **both alternatives** is assessed to be of **high** significance with and without the implementation of mitigation.

It is difficult to mitigate tall vertical elements in the landscape, but essential mitigation measures include:

- Minimise associated infrastructure on site (access roads, transformers, store rooms) to reduce visual clutter;
- Plant large indigenous trees around receptors in the immediate vicinity of the WEF to provide visual screening to partially reduce the visual impact on these receptors; and

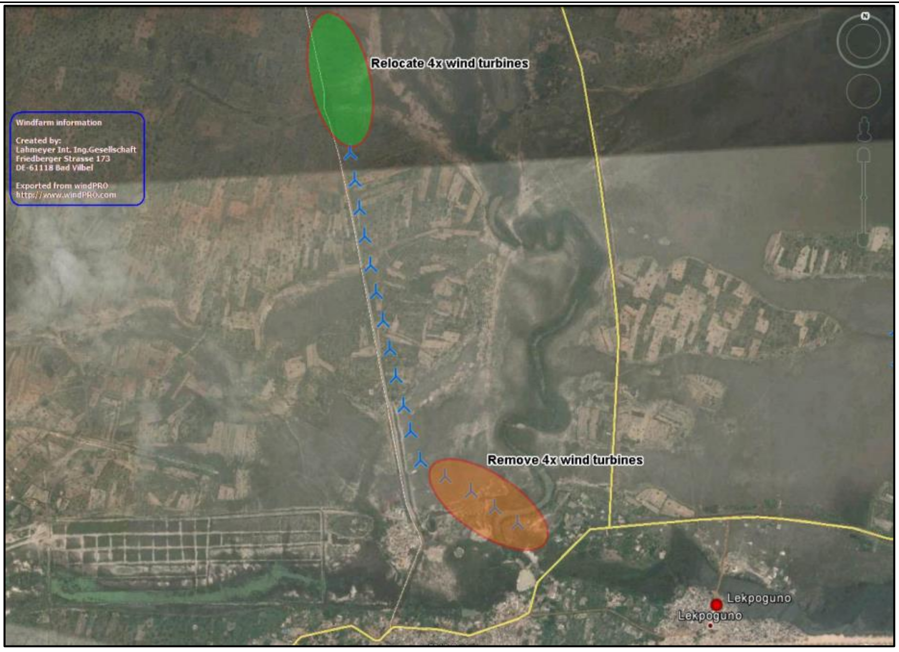
- Maintain a uniform size (height) and colour (white) of the turbine towers, nacelles and blades and avoid any markings on the turbine.

Figure 7-17: Markings on the tower (or nacelle / blades) increase the visual intrusion of the turbine

For the Preferred Layout, a non-essential however and as best practice layout change suggested suggested would be for Volta River Authority (VRA) to consider relocating a number of proposed turbines According to

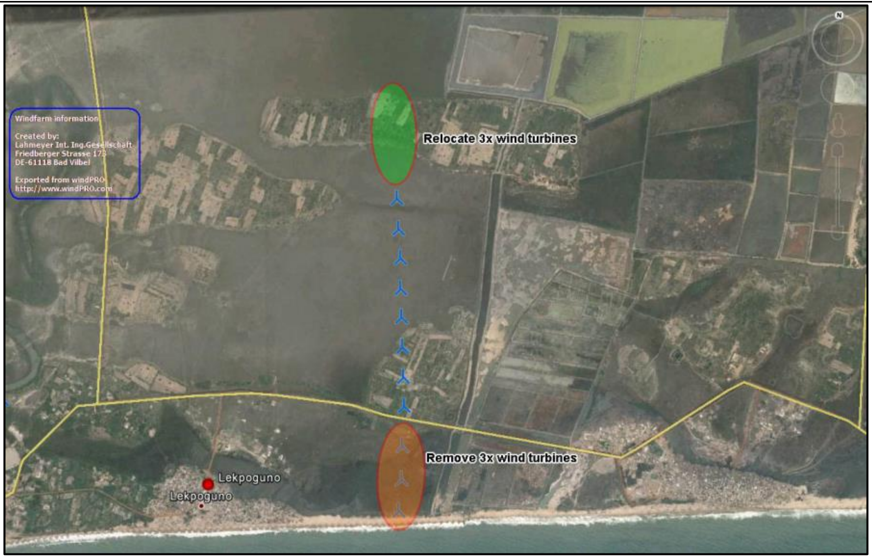
Figure 7-18 to

Figure 7-20.



srk consulting	**VIA SCOPING PHASE INPUT** Lekpoguno-Aklabnya WEF	Project No. 499656

Figure 7-18: Suggested layout amendments of Lekpoguno-Aklabnya WEF (1)



srk consulting	**VIA SCOPING PHASE INPUT** Lekpoguno-Aklabnya WEF	Project No. 499656

Figure 7-19: Suggested layout amendments of Lekpoguno-Aklabnya WEF (2)

VIA SCOPING PHASE INPUT

Lekpoguno-Aklabnya WEF

Project No. 499656

Figure 7-20: Suggested layout amendments of Lekpoguno-Aklabnya WEF (3)

7.8.2.2.2 Altered Sense of Place and Visual Character caused by Light Pollution at Night

According to the Draft Feasibility Study (Lahmeyer International, 2015), the Ghana Civil Aviation Authority may prescribe that one “Medium Intensity Light Type B/C” must be placed on top of the nacelle and one “Low Intensity Light Type A/B” must be placed 45 m up the wind turbine tower. In addition, security lighting may be installed at the WEF.

The lighting at the WEF may contribute to light pollution in the area, since existing ambient night time light in the area is low, in a relatively undeveloped area with minimal lighting. The additional lighting from the WEF will alter the visual character of the landscape at night.

Lighting is not easily screened by vegetation and topography, and receptors’ experience of the impact is more intense. Good external security lighting design and lighting fixtures can restrict the upward emission of light into the atmosphere reducing the visual impact (altered sense of place).

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low**.

Essential mitigation measures include the following:

- Clarify the requirements of the Ghana Civil Aviation Authority and clarify if pilot activated lighting is possible;
- Direct security lighting inwards and downwards to avoid light spillage and trespass. External lights should be fitted with reflectors (“full cut-off’ luminaires) to direct illumination downward and inward to the specific illuminated areas; and
- Avoid working at night unless absolutely necessary.

7.8.2.2.3 Altered Sense of Place from Shadow Flicker

Shadow flicker is the flicker of the sun through the turbine blades. Shadow flicker can be defined spatially but with some difficulty as sun angles, climate, and viewpoints determine the presence, duration and level of flicker (CNdV, 2006). Shadow flicker is considered significant within 1 km of a turbine (http://www.windvigilance.com).

Guidelines developed in Germany (WEA-Schattenwurf-Hinweise, date unknown) are the most widely adopted and state the following:

- Shadow flicker should not occur for more than 30 hours per annum; **and**
- Shadow flicker should not occur for more than 30 minutes per day.

Shadow flicker will be significant for those residents located within 1 km of the wind turbines (unless screened by vegetation or structures).

The impact for **both alternatives** is assessed to be of **high** significance and with the implementation of mitigation, is reduced to **low**.

Essential mitigation measures include the following:

- Calculate the effects of shadow flicker (taking account of local screening) on those residents located within 1 km of the wind turbines and relocate residents accordingly (in accordance with a Resettlement Action Plan).

7.8.2.3 Decommissioning Phase

7.8.2.3.1 Altered Sense of Place and Visual Intrusion from Decommissioning Activities

Visual impacts generated during the Decommissioning Phase will be similar to those generated during the Construction Phase: from infrastructure, plant and materials on site (e.g. site camp, cranes) and dust. Such impacts are typically limited to the immediate area surrounding the WEF and to the decommissioning period.

Loss of sense of place is expected during decommissioning since activities and the change in the state of the site (decommissioning equipment and dust generation) are incongruent with the current character and nature of the surrounding area.

The impact for **both alternatives** is assessed to be of **medium** significance and with the implementation of mitigation, is reduced to **low**.

Essential mitigation measures include the following:

- Utilise existing access roads as far as possible;
- Avoid handling and transport of materials which may generate dust under very windy conditions;
- Enforce speed limit of 30km/hr on site;
- Consolidate the footprint of the site camp to a functional minimum. Screen the yard with materials that blend into the surrounding area;
- Keep all activities, material and machinery contained within an area that is as small as possible; and
- Rehabilitate disturbed areas incrementally and as soon as possible, not necessarily waiting until completion of the Decommissioning Phase.

7.8.2.3.2 Altered Sense of Place from Increased Traffic

The increased number of heavy vehicles on the road (and the related noise impacts) will reduce the sense of place to neighbouring receptors. The impaired sense of place will have a greater impact within the foreground as sensitive receptors in close proximity to the access roads will be particularly exposed to this impact.

The impact for **both alternatives** is assessed to be of medium significance and with the implementation of mitigation, is reduced to **low**.

Essential mitigation measures include the following:

- Limit decommissioning activities to Mondays to Saturdays between the hours of 07h00 and 18h00, or in accordance with relevant District bylaws, if applicable; and
- Maintain all generators, vehicles and other equipment in good working order.

7.8.2.4 Cumulative Impacts

The visual quality of the study area is largely ascribable to the predominantly rural landscape. There are some elements that detract slightly from the visual quality of the project area, notably the degraded (and abandoned) farmlands, the salt works and eroded areas, but no existing industrial activities, renewable energy projects or prominent vertical elements were identified within the project's area of influence.

However, UpWind is proposing to construct a 300 MW WEF north of Lekpoguno, extending to the N1 (a distance of approximately 9.5 km), and to the north of Goi and Akplabnya, extending to the southern boundary of the Songor Lagoon (Figure 7-21). UpWind proposes to construct 90 to 100 turbines.

Due to the close proximity of the two WEFs to each other, WPP2 and the UpWind WEF are likely to be viewed as a single WEF. The high number of turbines proposed for the UpWind WEF across a broad area will significantly alter the sense of place and, in combination, will significantly increase the overall visual impact of WPP2.

The cumulative impact for **both WPP2 alternatives** is thus assessed to be of **high** significance.

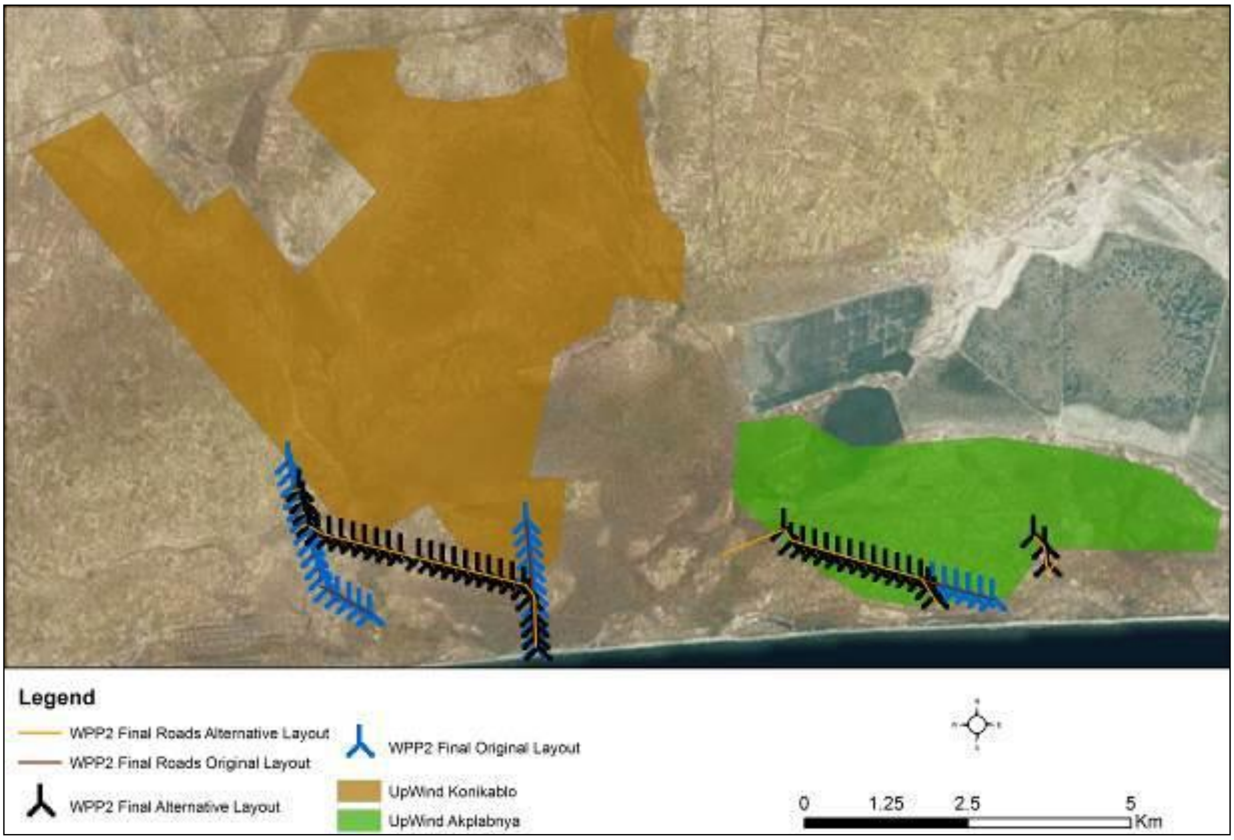


Figure 7-21: WPP2 in relation to the extent of the proposed Upwind WEF

7.8.3 Impact Assessment Summary

A summary of identified impacts, impact significance and mitigation and management measures is provided below in Table 7-20 to Table 7-22.

Table 7-20: Impact assessment summary table for the Construction Phase

CONSTRUCTION PHASE

Direct Impacts

Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Significance of Impact and Risk**		**Confidence Level**
												Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Earthworks and vegetation clearance	Altered sense of place and visual intrusion from construction activities	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	Medium	Low	High
Construction activities and presence of heavy construction vehicles and equipment														
Dust generation														
Construction traffic	Altered sense of place from increased traffic	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	Medium	Low	High

Table 7-21: Impact assessment summary table for the Operations Phase

OPERATIONS PHASE

Direct Impacts

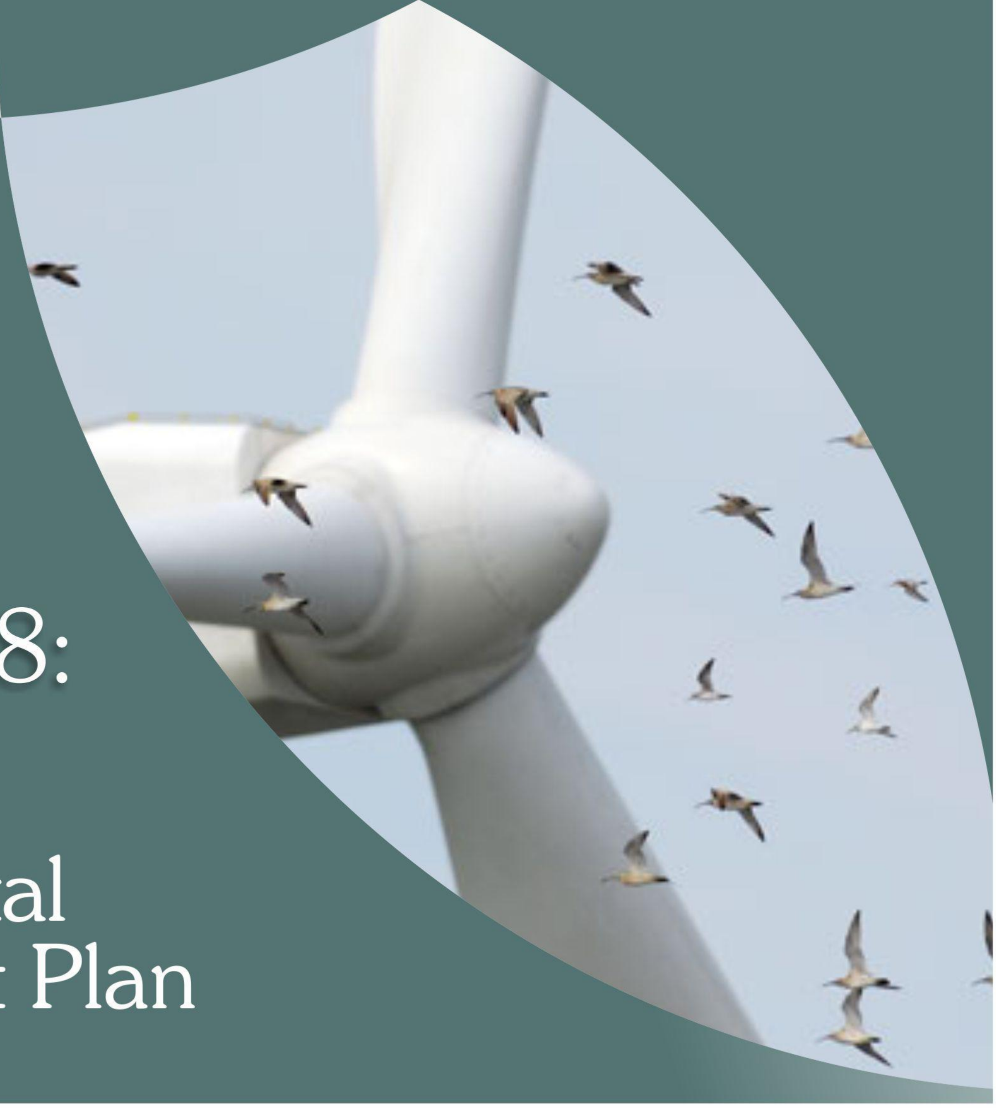
Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Alternative Site	Status	Spatial Extent	Duration	Intensity	Probability	Reversibility of Impact	Irreplaceability	Can the Impact/Risk be Avoided?	Can the Impact/Risk be Mitigated/ Managed?	Significance of Impact and Risk		Confidence Level
												Without Mitigation/ Management	*With Mitigation/ Management (Residual Impact/ Risk)*	
Change in character of site caused wind turbines	Altered sense of place and visual intrusion from the WEF	Preferred Layout and Alternative Layout	Negative	Regional	Long-term	High	Probable	High	Low	No	No	High	High	High
Security lighting and aviation warning lights	Altered Sense of Place and Visual Character caused by Light Pollution at Night	Preferred Layout and Alternative Layout	Negative	Regional	Long-term	Medium-Low	Definite	High	Low	No	Yes	Medium	Low	High
Shadow flicker	Altered Sense of Place from Shadow Flicker	Preferred Layout and Alternative Layout	Negative	Local	Long-term	High	Highly Probable	High	Moderate	Yes	Yes	High	Low	High

Table 7-22: Impact assessment summary table for the Decommissioning Phase

DECOMMISSIONING PHASE														
Direct Impacts														
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Alternative Site**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Can the Impact/Risk be Avoided?**	**Can the Impact/Risk be Mitigated/ Managed?**	**Significance of Impact and Risk**		**Confidence Level**
												Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Construction activities and presence of heavy construction vehicles and equipment	Altered sense of place and visual intrusion from decommissioning activities	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	Medium	Low	High
Dust generation														
Traffic	Altered sense of place from increased traffic	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	Medium	Low	High

Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)



CHAPTER 8:

Provisional Environmental Management Plan

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TABLES

FIGURES

8 PROVISIONAL ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan (EMP) shall be fully integrated with the overall management of the proposed wind power Project. Its effective planning and implementation will be the responsibility of the Project Developer. This is a requirement under the country's EA Regulations, LI 1652. Section 24 (1) of the EA Regulations, LI 1652 indicates that "*The person responsible for an undertaking in respect of which a preliminary environmental report or an environmental impact statement has been approved shall submit to the Agency an environmental management plan in respect of his operations within 18 months of commencement of operations and thereafter every 3 years*". The EMP is expected to set out steps that are intended to be taken to manage any significant environmental impact that may result from the operation of the undertaking.

This Provisional EMP (PEMP) has therefore been developed to comply with the requirements of national legislation and to adhere to EPA guidelines on the compilation of ESIA reports. It has been compiled as for the implementation of management actions aimed at reducing negative environmental impacts and enhancing positive impacts arising from the proposed development. Subsequently, this PEMP forms the initial working document that is being submitted to the EPA for decision making at this initial stage of the project. The EMP covers all phases of the project implementation from pre-construction (Feasibility/Design) right through to decommissioning.

A comprehensive listing of the mitigation measures (actions) that the Project will implement at all phases as well as monitoring activities is provided in a proposed action plan as outlined in Section 8.7. It must be noted that the action plan outlined in this PEMP is legally binding and will be updated following comments from various stakeholders as well as issues arising following commencement of constructional activities. A stand-alone EMP document will be prepared after 18 months of project operations as required and this will form the basis of the issuance of renewed Environmental Permits for the operational phase of the project.

8.1 OBJECTIVES OF THE EMP

The aim of the EMP is to develop an efficient implementation instrument and support tool for sustainable environment management of the project area and the immediate surroundings. The broad objectives of the EMP are:

- To set out the actions required in mitigation;
- To identify the responsible party for implementation of suggested mitigation measures;
- To ensure sustainable development and outline management activities to minimize negative impacts;
- To comply with the relevant laws and regulations in Ghana;
- To facilitate harmonious co-existence between the project and other land uses in the area; and
- To contribute to the environmental baseline and understanding of environmental impacts of wind farms and associated infrastructure in a Ghanaian context through providing monitoring records from the construction and operation phases.

8.2 ROLES AND RESPONSIBILITIES

In order to ensure the management measures are implemented, the PEMP identifies roles and responsibilities for various people involved in the proposed development. As a guide, the generic roles that need to be defined are those of the:

- Project Applicant, represented by the Project Environmental Officer.
- Project Engineering Consultant, represented by an Independent Environmental Control Officer.
- Project Contractor, represented by a construction Environmental Health and Safety Manager.

It is acknowledged that the specific titles for these functions will vary from project to project. The intent of this section is to give a generic outline of what the roles typically require. It is expected that this will be appropriately defined at a later stage and expressed in the stand alone EMP documents for the operational phase.

It must be noted that in addition to the above, other interested parties, as appropriate, will have an important part to play in the environmental management in the implementation of the EMP. These include the following:

- EPA as represented by the Accra East Regional Director in Tema
- Ghana Wildlife Division (Forestry Commission), represented by Manager of the Songor Lagoon Complex Ramsar site.
- The Ada West Municipal Assembly, represented by the District Chief Executive and other key agencies under it such as the Physical Planning Department, Environmental Health Department, etc.
- Ghana Civil Aviation represented by the Director-General
- Ghana Highway Authority represented by the Regional Director in Accra
- Tradional and and leaders in the Ada West Traditional Area
- Civil society organisations, both national and international.

8.2.1 Project Applicant and Project Environmental Officer

The Project applicant (i.e. VRA) is legally responsible for ensuring that the conditions of the Environmental Permit issued in terms of EIA Regulations (should the project receive such authorisation) are fully satisfied, as well as ensuring that any other necessary permits or licenses are obtained and complied with. It is expected that the Project Applicant will appoint the Project Environmental Officer (PEO) to oversee the various phases of the project. The PEO will be sourced from the existing Environment & Sustainable Development Department of the VRA.

The PEO shall monitor the compliance of the proposed project with the conditions of EP during the various phases. The PEO must also monitor compliance of the proposed project with environmental legislation and recommendations of the EMP. The PEO will be responsible for preparing the Final EMP based on this Draft EMP, as well as updating the EMP as and when necessary, and compiling a monitoring checklist based on the EMP. The roles and responsibilities of the PEO should include the following:

During *construction*, the PEO will be responsible for the following:

- Meeting on site with the Construction Manager prior to the commencement of construction activities to confirm the construction procedure and designated activity zones;
- Daily, weekly or bi-weekly (i.e. every two weeks) monitoring of site activities during construction to ensure adherence to the specifications contained in the EMP, using a monitoring checklist that is to be prepared by the PEO at the start of the construction phase;
- Preparation of the monitoring report based on the weekly or bi-weekly site visit; and
- Conducting an environmental inspection on completion of the construction period and 'signing off' the construction process with the Construction Manager.

During *operation*, the PEO will be responsible for:

- Overseeing the implementation of the EMP for the operation phase;
- Ensuring that the necessary environmental monitoring takes place as specified in the EMP; and
- Updating the EMP and ensuring that records are kept of all monitoring activities and results.

During *decommissioning*, the PEO will be responsible for:

- Overseeing the implementation of the EMP for the decommissioning phase; and
- Conducting an environmental inspection on completion of decommissioning and 'signing off' the site rehabilitation process.

At the time of preparing this PEMP, the PEO appointments are still to be made by the project applicant. The appointments of the PEO are dependent upon the projects proceeding to the construction phase.

8.2.2 Project Engineering Consultant

The project applicant will appoint an Engineering Consultant for the project. An Independent Environmental Control Officer (ECO) shall be appointed by Engineering Consultant to work with the Project Applicant's PEO to monitor the compliance of the proposed project through all the phases of the project including the feasibility stage. The ECO will be responsible for assisting the VRA in the preparation of the Final EMP.

VRA has currently appointed Lahmeyer International, as Engineering Consultant to the project for the design and constructional phase of the project.

8.2.3 Project Contractor (Lead Contractor)

The contractor is typically appointed by the project applicant to undertake construction and decommissioning of the proposed development. The lead contractor and any other subcontractors will need to comply with the requirements of the EMP.

The lead contractor will be responsible for the following:

- Overall construction programme, project delivery and quality control for the construction of the facility.
- Overseeing compliance with the Health, Safety and Environmental Responsibilities specific to the project construction.
- Promoting total job safety and environmental awareness by employees, contractors and sub-contractors and stress to all employees and contractors and sub-contractors the importance that the project proponent attaches to safety and the environment.
- Ensuring that each subcontractor employ an Environmental Officer (or have a designated Environmental Officer function) to monitor and report on the daily activities on-site during the construction period.
- Ensuring that safe, environmentally acceptable working methods and practices are implemented, and that sufficient plant and equipment is made available, is properly operated and maintained to facilitate proper access and enable any operation to be carried out safely.
- Meeting on site with the EHS Manager prior to the commencement of construction activities to confirm the construction procedure and designated activity zones.
- Ensuring that all appointed contractors and sub-contractors are aware of this EMP and their responsibilities in relation to the programme.

- Ensuring that all appointed contractors and sub-contractors repair, at their own cost, any environmental damage because of a contravention of the specifications contained in the EMP, to the satisfaction of the EHS Manager.

At the time of preparing this EMP, the appointment of a lead contractor has not been made and will depend on the project proceeding to the construction phase. In addition, and to achieve the above, the Lead contractor will appoint an EHS Manager. This is a qualified person who will oversee the implementation of the EMP during the construction and decommissioning phase and will work directly with the Project Applicant's PEO in the management and monitoring environmental impacts, record-keeping and updating of the EMP as and when necessary on behalf of the contractor. The appointment of the EHS Manager is dependent upon the project proceeding to the construction phase and contractor being engaged.

8.3 ENVIRONMENTAL AWARENESS

The ESIA report is a public document and any I&AP can have access to it. Comments can be made by I&APs relating to the impacts of the project within the project boundaries as well as impacts that may occur as a result of the project outside the site boundaries during construction and operation. Training is one of the important aspects of managing impacts. All staff on site must be trained on the obligations of the project applicant and all training must be formally recorded. Environmental awareness training for the project must:

- familiarise workers with the contents of the EMP;
- detail consequences of not adhering to the contents of the EMP;
- have a reporting mechanism for workers to report non compliance;
- include the appropriate handling, storage and disposal of waste and chemicals and
- raise awareness about potential incidents and emergencies and have a response plan.

8.4 EMERGENCY RESPONSE PLAN

The project Applicant must identify any potential emergencies and must develop any procedures to prevent and/or react to said emergencies. Emergency reaction procedures must be in place before construction and operation commence. Emergency procedures to be considered include:

- Fire
- Spills
- Contamination of ground water
- Employee incidents/accidents

Emergency telephone numbers should be kept visible on site at all times throughout construction and operation

8.5 MONITORING AND RECORD KEEPING

Environmental monitoring is envisioned as an important process in the proposed management plan. It will reveal changes and trends brought about by the presence and operations of the proposed Wind Power Project. Environmental monitoring will be the responsibility of the Project Applicant since it is an essential tool in relation to environmental management. Environmental monitoring provides the basis for rational management decisions regarding impact control and mitigation. Monitoring is envisioned as an important process in the protection of environment of the project area. It will reveal changes and trends brought about by the presence and operations of the installed wind park facility. By using the information collected through monitoring, impact mitigation and benefit enhancement measures can be improved, and projects works, or operations will be modified or halted when necessary.

The significance of monitoring stems from the fact that the inputs derived from the EIA into the project design and planning, including mitigation measures and environmental management plan are largely based on “predictions”. It is therefore essential that the basis for the choices, options and decisions made in formulating or designing the project and other environmental and social safeguard measures are verified for adequacy and appropriateness during the monitoring process. Monitoring verifies the effectiveness of impact management, including the extent to which mitigation measures are successfully implemented. The results of environmental monitoring will determine the success and efficacy of the proposed mitigation measures in protecting the environment. The project management will therefore undertake to conduct sustained environmental monitoring of the project area during the life of Wind Power Project.

- Monitoring required is to be undertaken for the following:
- Compliance to EMP/Permit Conditions
- Daily list of any concerns on site
- Records of waste volumes
- Monitoring of any leakages during construction and operation phase
- Record all non-compliance with the EMP and and any incidents.

The PEO and EHS Manager will be directly responsible for the monitoring and adhering to the laws and regulations which are applicable. The monitoring data must be used by the applicant and relevant interested parties to ensure management measures are working effectively. Any failure to comply with legislation during construction and operation must be reported by the PEO.

During the construction and decommissioning phases, daily inspections and monthly audits will be conducted by the PEO. In the operational phase, weekly inspections and quarterly audits will be conducted. The audit findings will be documented for both record keeping purposes and for informing continual improvement. Monitoring reports will be provided to the relevant authorities as per permits and authorisations issued by the relevant departments and ministries.

8.6 COST ESTIMATES OF ENVIRONMENTAL MANAGEMENT

The cost estimates for the proposed environmental management and monitoring has been captured in the costs for the various phases of the project. For the design phase, the costs involved budgetary expenditure for activities under the ongoing feasibility study, including the EIA and Roads Survey studies and this was for a period of three (3) years. Estimated costs for environmental management for constructional and decommission phases forms part of the contractor's cost and any specific contracts required for consultancy assignments. Associated costs for the operational phase and monitoring activities has been estimated on an annual basis and will be sourced from annual recurrent budgets of the Project Applicant.

The total cost for the protection of the environment and other related activities is provided in Table 8-1. The cost estimates as provided for the proposed environmental management and monitoring includes variables such as remuneration for contract works and services for project contractors and supervising engineers, specialist consultancy services for any requited studies, cost of equipment and consumables, payments for sample analysis, capacity building for project team, transport expenses, report writing and other documentation as well as miscellaneous expenses, which has been estimated as a percentage of the total cost. The total costs provided excludes that for compensation payments which will be provided in the Compensation Action Plan Report for the project.

Table 8-1: Cost Estimates Environmental Management & Monitoring

Project Phase	**Budget (US$)**	
	Impact Management	***Monitoring Activities***
Feasibility & Design Phase	142,100.00	17,800.00
Constructional Phase	1,093,905.75	53,900.00
Operational & Maintenance (Annual Recurrent Budget)	487,042.50	11,650.00
Decommissioning Phase	150,517.50	3,500.00
Cumulative Impacts	275,625.00	0.00

8.7 MANAGEMENT, MITIGATION AND MONITORING PLANS

8.7.1 Design Phase

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
8.7.1.1 Alien Invasive Management Plan									
Impacts due to establishment of alien invasive plants	Ensure the appropriate removal of alien invasive vegetation from the proposed project area and prevent the establishment and spread of alien invasive plants due to the project activities	• Appoint a suitable vegetation contractor to inspect the site and remove any exotic weeds prior to the commencement of construction	No establishment and spread of invasive alien plants.	During the planning and design phase	$7,000	Project Applicant	• Sign off appointment letter of specialist	• Once-off during the design phase	$300
		• Compile an Alien Invasive Vegetation Management Plan to ensure that these species are eradicated and controlled to prevent their spread beyond the project footprint. The plan must include timeframes for restoration which must indicate rehabilitation within the shortest possible time after completion of construction activities to reduce the amount of habitat converted at any one time and to speed up the recovery of natural habitats. • Appoint a relevant specialist to compile an Alien Invasive Vegetation Management Plan		During the planning and design phase		Project Applicant/ Project Engineering Consultant	• Prepare monitoring programme which will monitor the presence of alien invasive species on the site via visual inspection (in disturbed areas as well as on any materials brought onto the site such as sand for construction). • Sign off the alien invasive vegetation management plan	• Once-off during the design phase	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
8.7.1.2 Plant Rescue and Protection Plan									
Loss of pristine or sensitive habitats associated with clearing of vegetation	Locate turbines in such a way to minimise loss of sensitive habitat and IUCN protected species	• Undertake a site preconstruction walk and fauna and plant search and rescue, and possible removal/relocation of flora and fauna of value within the affected site (i.e. such specimens may be relocated/removed or avoided	Avoid loss of habitat within the designated sensitive areas.	Once-off prior to construction	$5,500	Project Applicant	• Appoint a suitable Search and Rescue Specialist/Contractor • Review signed minutes of meetings or signed reports for turbine and new access roads micro siting.	• Once-off, prior to the commencement of construction	$10,000
	Ensure compliance with relevant legislation in respect of habitat and vegetation forms.	• Refine the final layout of proposed infrastructure (turbines on each site (micro-siting) during the detailed design phase, to minimise the footprint on valuable or sensitive habitat • Turbine sites and the proposed road network should preferably take place on sites that have undergone prior disturbance, rather than on undisturbed sites		Once-off during the planning and design phase		Project Applicant/ Project Engineering Consultant	• Final layout for the proposed development to be signed off by a suitable aquatic ecologist	• Once-off during the planning and design phase.	
		• Ensure the necessary permits or licenses are identified and applied for as applicable for removal of protected, indigenous vegetation.		Once-off during the planning and design phase		Project Applicant	• Audit permitting requirements and check validity of permits	• Once-off, prior to the commencement of construction	
The ousting of fauna through anthropogenic activities, disturbance of refugia and general change in habitat, with impacts on	Avoidance of unnecessary disturbance to the site and surrounds, and to establish buffers where required.	• Avoid of major drainage lines during the design and layout of the proposed facility. An Ecologist should be appointed to review the layout plan in relation to existing drainage lines and comment accordingly. Ensure that sensitive habitat and features (as defined in Figure 18 of the Wetland Impact	Minimal disturbance to fauna in the area	Duration of the design phase		Project Applicant / Project Engineering Consultant	• Final layout for the proposed development to be signed off by a suitable ecologist	• Once-off, prior to the commencement of construction	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
terrestrial and aquatic ecology as a result of the final site layout and routes of the access roads.		Assessment are considered in the design							
		• Consider the most applicable access road to site		Once-off during the planning and design phase	$12,500	Project Applicant / Project Engineering Consultant	• Review signed minutes of meetings or signed reports.	• Once-off, prior to the commencement of construction	$1,500
		• Appoint a specialist team to flush animals from the construction area		Once-off during the planning and design phase		Project Applicant	• Appoint a specialist to undertake animal sweep.	• Appoint specialist once-off, prior to the commencement of construction	
		• Consideration of the siting and layout of the temporary construction site and worker camp		Once-off during the planning and design phase		Project Applicant / Project Engineering Consultant	• Final layout for the construction site to be signed off by a suitable ecologist	• Once-off during the planning and design phase	
8.7.1.3 Storm Water Management Plan									
Impact of uncontrolled stormwater on the surrounding environment	To limit the effect of uncontrolled stormwater run-off from developed areas onto natural areas.	• Prepare a detailed stormwater management plan outlining appropriate measures to - address runoff from disturbed portions of the site, such that they: (1) do not result in concentrated flows into natural water courses i.e. provision	Limit uncontrolled stormwater run-off onto natural features	Duration of design phase		Project Applicant/ Project Engineering Consultant	• Review and sign off of stormwater management plan	• Once-off during the planning and design phase	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		should be made for temporary or permanent measures that allow for attenuation, control of velocities and capturing of sediment upstream of natural water courses; (2) do not result in any necessity for concrete or other lining of natural water courses to protect them from concentrated flows off the development; (3) do not divert flows out of their natural flow pathways, thus depriving downstream water courses of water. - Ensure that clean and contaminated stormwater are kept separate			$10,000				$500
		• Where drainage lines on the development platform would need to be crossed by roads, maintain the hydrology through adequate drainage/system connectivity. The following measures should be incorporated into the design of these roads: - Equip the roads with adequate culverts, that do not result in concentration of flows as a result of stream narrowing under flood conditions; - If the roads are constructed as drifts, ensure that they are designed to accommodate the		Duration of design phase		Project Applicant/ Project Engineering Consultant	• Identify potential sources of pollution and design methods of keeping “clean” and “dirty” water separate	• Once-off during the planning and design phase	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		full width of the streams under flood conditions, and such that they do not result in increases in velocity in downstream areas, or changes in the gradient of the upstream bed, resulting in erosion; - Design drainage along the sides of the roads to avoid concentrated flows into water courses – check dams and sedimentation areas (small barriers constructed by rocks and gravel) should be provided along roadside drainage systems, and ensure adequate unhardened space is available on either side of the roads to allow runoff to be dissipated, rather than being passed into the streams themselves.							
8.7.1.4 Traffic Management Plan									
Disturbance of local traffic on public roads and damages of roads due to increase in traffic volumes during the construction phase (as a result of the	To minimise the impact of the construction activities on the local traffic and road structures.	• Compile and implement a road/traffic management plan, including external and internal roads to be used by all employees and contractors. Determine and restrict use of transportation routes during the construction phase. Deviation from these routes may only be allowed if exceptional circumstances e.g. if road is closed. Ensure that local authorities are	Limited impacts on local traffic and road structures.	Duration of design phase	$8,000	Project Applicant	• Sign off the road/traffic management plan	• Once off prior to construction	$1,000

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
transport of construction staff and materials)		involved in defining optimum project traffic routes and times for transit							
		- If abnormal loads need to be transported by road to the site, a permit needs to be obtained from the Ghana Highway Authority.		Duration of design phase		Project Applicant	- Ensure that the permits are applied for and obtained prior to commencement. - Verify that this has been undertaken by reviewing approved permits.	- Once-off during the design phase	
8.7.1.5 Specific Project Related Impacts									
Unnecessary clearing of vegetation associated with new infrastructure	Minimise the number of new tracks/roads necessary	- Construction of new tracks should be kept to the barest minimum and the use of existing roads should be encouraged. Track routes should be selected in such a way as to minimize any damage to farms and crops.	Maximise use of existing roads/tracks	Duration of design phase	$25,000	Project Applicant	- Changes in design of the project and records of choice of use of existing roads	- Once off during design phase	$3000
Crossing of watercourses results in the physical destruction and loss of aquatic habitat and ecosystem services and may impact on the hydrology of the area	Minimise the need for crossings to alleviate the impact on loss of aquatic habitat (as a result of physical destruction) and ecosystem services; and to reduce potential hydrological impacts	- Proponent and engineers should develop the layout so that a minimal number of crossings are required, with the smallest possible footprints, e.g. select crossings with the smallest possible floodline areas as crossing points	Reduce number of crossings required to an absolute minimum	Duration of design phase		Project Applicant	- Ensure that the proposed crossing are signed off by a suitable Aquatic ecologist	- Once off during design phase	
		- All hardstand areas must also be excluded from the riverine and buffer areas;		Duration of design phase		Project Applicant / Project Engineering Consultant	- Ensure that the proposed crossing are signed off by a suitable aquatic ecologist	- Once off during design phase	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
Impacts associated with flooding	Identify any flood and erosion risk areas prior to construction	• Undertake a flood and erosion risk assessment prior to the commencement of construction.	No flood and erosion risk impacts on the project	Duration of design phase	$2,000	Project Applicant / Project Engineering Consultant	• Sign off Flood and Erosion risk assessment • Adhere to recommendations of the above assessment regarding the layout of the wind power project	• Once off during design phase	$100
Change in habitat through clearance of vegetation, habitat modification and related factors Vegetation and habitat alteration, and change in ecological processes and habitat with reversion to secondary habitat structure at transformed sites	Re-vegetation and rehabilitation of the disturbed site is aimed at approximating as near as possible the natural vegetative conditions prevailing prior to construction Leave the project area in a condition that protects soil and surface materials, both on and off site, against erosion and instability.	• Appoint a suitably qualified ecologist to compile a Vegetation Rehabilitation Plan to improve habitat diversity and maintenance of improved habitat within areas subject to change because of the proposed development • Ensure that the Rehabilitation Plan identifies tasks and procedures to be instituted at specific sites where transformation of habitat has arisen	Effective rehabilitation following construction	Prior to construction	$8,000	Project Applicant / Project Engineering Consultant	• Sign off on Rehabilitation Plan	• Once off during design phase	$100
Impacts on Avifauna	Layout and design of turbines (where applicable) to minimise risk of collisions for birds and bats	• Additional pre construction monitoring is recommended, particularly during the migration months where higher bird activity would be recorded. 24 hour-a-day monitoring during the three months September, October and November should be undertaken. • The avifaunal specialist should	Design of turbines and final project layout to minimise impacts on birds and bats	During the design phase	$15,100	Project Applicant	• Recording of bird count and behaviour prepared by a qualified bird specialists for use in the monitoring plan	• During migration months of September, October and November.	$350

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		conduct a site walkthrough prior to construction, confirming the final road routes as well as the final turbine positions, to identify any nests/breeding activity of sensitive species, as well as any additional sensitive habitats within which construction activities may need to be excluded. • Providing wide corridors between clusters of closely spaced turbines							
Impacts on cultural heritage	Identify land owners to be compensated for the removal of any cultural heritage sites and shrines	• Avoid heritage sites where possible and practical through micro siting of infrastructure; • Where avoidance is not possible, compensate community members for the removal of shrines	Compensation of all community members for the removal of important heritage sites	Duration of design phase	$14,000	Project Applicant/ Project Engineering Consultant	• Evidence of compensation of affected community members • Adhere to the cultural heritage aspect contained in the Compensation Action plan	• Once off during design phase	$200
		• Assess all final lay down areas, turbine, road, cabling, sub-station, powerline positions to ensure all works occur inside the development footprint		Duration of design phase		Project Applicant / Project Engineering Consultant	• Finalise final layout to avoid heritage areas identified in the Heritage Impact Assessment Report (See Section 1.7 of Appendix 4 of the ESIA report)	• Once off during design phase	
Disturbance as a result of increased environmental noise levels caused by operating WTGs.	Minimise operational noise from turbines	• Operational modes and blade designs selected must adhere to those specified in section 8.1.2 of the Noise Impact Assessment Specialist study (Appendix 7 of the ESIA report). • Changes to the operational modes of the WTGs with Noise Sensitive Receptors (NSRs) within the recommended buffer distances (as identified from satellite imagery) are required to meet assessment	Operational modes and blade designs of turbines selected must be such that the reference LWA of the selected WTG is 105.5 or lower	Duration of design phase	$18,000	Project Applicant / Project Engineering Consultant	• Confirm that the noise emissions for the actual turbines selected for implementation are comparable to or better than the type of turbines used in the noise study for the ESIA • Final layout of the turbines needs to be signed off by a noise specialists • Ensure the recommendations in the Compensation Action Plan is taken into consideration	• Once off during design phase and before construction commences	$400

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		criteria: For the preferred layout: o To reduce noise impacts at Akplabnya, LNTE technology needs to be implemented. Additionally, WTGs C-32, C-33, C-34, and C35 need to be operated at the NRO103 mode or better. o To minimise impacts at Goi, WTGs C-43, C44, and C45 need to be operated at the NRO100 mode. With the 45-dBA impact area of a single operating GE 1.7-103 WTG with LNTE technology at a distance of approximately 200 m and the impact area of more than one WTG in close proximity to one-another at 530 m, residence of Goi within 2 to 5 rotor diameters of WTG C-45 will need to be relocated. For the alternative layout, o the impact at Goi can be minimised with the implementation of LNTE technology and applying the NRO100 mode during night-time hours. Residents within 2 to 5 rotor diameters from WTGs C-43, C-44, and C-45 will need to be relocated. • Increasing the distance between							

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		source and receiver is an essential mitigation measure since noise reduction options for WTGs are limited. For an elevated point source such as a WTG, a 6 dB decrease can be achieved with every doubling in distance. • Relocation of residences already within these zones will be required if operating at lower noise modes as recommended in Section 8.1.2.2 of the Noise Impact Assessment Specialist Report are not possible (Appendix 7 of the ESIA Report).							
		• Relocation of the Omankope Presbyterian Primary School		Prior to construction			• Ensure a resettlement plan is developed and implemented	• Once off during the design phase and before construction commences	
		• It is recommended that no permanent residences be permitted within 45 dBA impact area of WPP2 WTG arrays. The impact area corresponds roughly to between 2 and 5 rotor diameters from WTGs of the preferred and alternative layout. The recommended buffer zones are shown in Annexure 1, Figures 1 to 2 of the PEMP for the Lekpoguno and Akplabnya section of WPP2 respectively and assumes that NRO modes recommended in Section		Duration of design phase		Project Applicant	• Ensure this is communicated to the relevant Municipal district	• Once off during the design phase and before construction commences	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		8.1.2.2 of the Noise and Flicker Impact Assessment Report, Appendix 7, are implemented.							
Shadow flicker impacts	Minimise shadow flicker impacts on residents near the wind energy facility during operation phase	- Curtailment of WTG operational hours can be used to mitigate shadow flicker impacts at Omankope, Wokumagbe, and Goi, The Omankope Presbyterian Primary School (SFR6), as well eastern-most and northernmost residents of Goi in the vicinity of SFR19 and SFR20 may need to be relocated	Ensure no shadow flicker impacts on sensitive receptors	Duration of design phase	$15,000	Project Applicant	- Ensure the recommendations in the Compensation Action Plan is taken into consideration - Record of the number of residents in Goi which have been relocated and compensated	- Once off during the design phase and before construction commences	$250
Visual Impacts	Prevent unnecessary visual clutter and focusing attention of surrounding visual receptors on the proposed development	- Minimise anxilliary infrastructure on site (access roads, transformers, store rooms) to reduce visual clutter - Appropriate coloured materials should be used for structures to blend in with the backdrop of the project	Reduce visual intrusion of construction activities project wide.	Duration of design phase		Project Applicant	- Changes in design of the project and records of choice of minimal structures	- During design phase and before construction commences	
				Duration of design phase		Project Applicant	- Ensure that this is taken into consideration during the planning and design phase by reviewing signed minutes of meetings or signed reports	- During design phase and before construction commences	

8.7.2 Construction Phase

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
8.7.2.1 Alien Invasive Management Plan									
Increased spread of alien invasive plants due to construction activities	Reduce the establishment and spread of alien invasive plants during the proposed project and as a result of the proposed project activities, such as disturbance of the surface areas	• Keep disturbance of indigenous vegetation to a minimum and rehabilitate disturbed areas as quickly as possible	Avoid establishment and reduce the spread of alien invasive plants due to the project activities.	Duration of the construction phase	$9397	Project Applicant / Project Contractor	• Monitor and manage vegetation clearing by undertaking visual inspections to ensure minimal disturbance and to restrict activities to within demarcated areas • Rehabilitate disturbed areas and monitor the presence of alien invasive species on site	• Weekly inspections • Ongoing	$1000
		• Do not import soil stockpiles from areas with alien plants species		Duration of the construction phase		Project Engineering Consultant / Project Contractor	• Strict control of all contracted staff and monitoring of presence of stockpiles with alien invasive plants during the construction phase via visual inspections and take action to remove and control these species	• Weekly inspections	
		• Use only plants and seed collected on-site for revegetation		Duration of the construction phase		Project Engineering Consultant / Project Contractor	• Revegetation of the project areas should be conducted by trained specialists and conducted as recommended in the Alien Invasive management Plan.	• Weekly inspections	
		• Immediately control any alien plants that become established using registered control methods		Duration of the construction phase		Project Engineering Consultant / Project Contractor	• Rehabilitate disturbed areas and monitor the presence of alien invasive species on site	• Ongoing	
		• Inspection of all persons and machinery before entry to the site • Quarantine and elimination of all suspected carriers of invasive		Duration of the construction phase		Project Engineering Consultant / Project	• Daily inspections at the entry point of site of all machinery and staff. • Recording and removal of any alien plants found during checks	• Daily inspections	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
						Contractor		• As required	
		• Keep clearance and disturbance of indigenous vegetation to a minimum.		Duration of the construction phase		Project Contractor	• Strict control of all contracted staff to adhere to designated project footprint • Monitor and manage vegetation clearing by undertaking visual inspections to ensure minimal disturbance and to restrict activities to within demarcated areas.	• Ongoing	
		• The Government of Ghana (GoG) quarantine inspection and procedures should be followed to ensure that invasive or alien species do not enter the area.		Duration of construction phase		Project Applicant/ Project Contractor	• Strict control (visual inspections) over the behaviour of construction workers, restricting activities to within demarcated areas for construction • Strict adherence to the GoG quarantine requirements	• Daily	
8.7.2.2 Plant Rescue and Protection Plan, including rehabilitation plan									
Loss of protected species/Species of Conservation Concern in and outside the development footprint area	Ensure that where protected/listed plants species are to be removed, these are rescued and relocated	• Demarcate all no-go areas and sensitive areas should be avoided • No activities within no go areas	Turbine positions and road layout is strictly in accordance with the approved design.	Duration of Construction Phase	$6878	Project Engineering Consultant / Project Contractor	• Visual inspection to ensure no go areas have been suitably demarcated • Strict control over the behaviour of construction workers, restricting activities to within construction areas.	• Prior to Construction Phase • Daily	$400
		• Search and rescue of indigenous species must be undertaken and, where possible, these species must be relocated to a suitable nursery or relocated to an alternate location within the site or used for rehabilitation, in consultation with conservation authorities and relevant	Removal and relocation of all protected species/SSC (Species of Special Concern)	Duration of Construction Phase		Project Engineering Consultant / Project Contractor	• Visual inspection of the translocation process	• As needed	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		specialists.							
		• No listed/protected or rare plant may be dislocated or disturbed without the permission of the ECO		Duration of Construction Phase		Project Engineering Consultant / Project Contractor	• Strict control over the behaviour of construction workers, restricting activities to within construction areas.	• As needed	
		• Lost biodiversity on the disturbed area should be restored through planting of appropriate trees and shrubs and protection of fauna species and their habitat		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Photographic evidence of revegetation for the duration of construction phase	• Quarterly	
Vegetation and habitat alteration, and change in ecological processes and habitat with reversion to secondary habitat structure at transformed sites. **Recruitment and behavioural change in fauna (i.e. change in ecological processes and habitat).**	All damaged areas shall be rehabilitated upon completion of the contract. Re-vegetation of the disturbed site is aimed at approximating as near as possible the natural vegetative conditions prevailing prior to operation.	• Rehabilitation of temporary cleared construction areas such as laydown areas should commence as soon as possible after they are not required anymore. • All natural areas must be rehabilitated with species indigenous to the area. Re-seed with locally-sourced seed of indigenous grass species that were recorded on site pre-construction. • Rehabilitation must be executed in such a manner that surface run-off will not cause erosion of disturbed areas.		Duration of Construction Phase	$6893 $13,178	Project Engineering Consultant / Project Contractor	• Conduct site visits and inspections in order to verify and monitor the effectiveness of the rehabilitation plan via visual inspections. • Establish an effective record keeping system for each area denuded of vegetation for constructional purposes. These records should be included in environmental performance reports, and should include all the records below: ✓ Date of vegetation removal. ✓ Whether topsoil was stripped or only vegetation. ✓ Date of cessation of constructional activities at the particular site. ✓ Photograph the area on cessation of constructional activities. ✓ Date of re-spreading of topsoil.	• Weekly	$100 $100

8.7.2.3 Storm Water Management Plan

Pollution of the surrounding environment as a result of the contamination of stormwater.	To prevent contaminated stormwater from entering into and adversely impacting on freshwater ecosystems and reducing the water quality.	• Inspection of stormwater infrastructure to ensure it's free of waste, debris and weeds. to avoid contamination and to allow for free flow of water	No contamination of stormwater	Duration of construction phase	$21,630	Project Engineering Consultant / Project Contractor	• Visual inspections of stormwater structures.	• Daily	$1000
		• Ensure spills are attended immediately to avoid contamination of stormwater		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Monitor if spillages have taken place and if they are removed correctly. • Visual inspections of construction areas for spillages	• Daily • Ad hoc	
		• Ensure hazardous substances are adequately handled and stored to avoid any contamination of stormwater		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Visual inspections of hazardous substances storage areas. • Monitor the storage and handling of dangerous goods and hazardous materials on site via site audits. Monitor if spillages have taken place and if they are removed correctly.	• Daily	
Sedimentation of the surrounding drainage lines as a result of stormwater runoff and stockpiling of excavated material during the construction phase. This could also impact on avifauna.	Reduce sedimentation as a result of erosion caused by stockpiling and stormwater runoff.	• All material that is excavated during the construction phase must be stored appropriately on site in order to minimise impacts on the surrounding aquatic environment.	No contamination of stormwater	Duration of construction phase	$5303	Project Engineering Consultant / Project Contractor	• Monitor the excavations and stockpiling process via visual site inspections. • Check compliance with specified conditions of the Stormwater Management Plan	• Daily • Daily	$500
		• Stockpiles must be located at least 32 m away from the drainage lines, on flat areas where run-off will be minimised.		Duration of construction phase		Project Engineering Consultant / Project Contractor			
		• During periods of strong winds and heavy rain (in line with relevant rainfall patterns), the stockpiles should be covered with appropriate material (e.g. cloth, tarpaulin etc.).		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Visual inspection of covered stockpiles	• As needed	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		• Exposed soil surfaces should be graded to minimise runoff and increase infiltration.		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Monitor the excavations and stockpiling process via visual site inspections	• Weekly	
		• Undertake rehabilitation of disturbed areas as construction progresses.		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Visual inspection of rehabilitated areas to assess effectiveness	• Weekly	
		• Where possible, sandbags (or similar) should be placed at the bases of the stockpiled material in order to prevent erosion of the material.		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Monitor via visual inspections	• As needed	
		• Undertake periodic inspections and maintenance of soil erosion measures and stormwater control structures		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Monitor via visual inspections	• Weekly	
8.7.2.4 Erosion Management Plan									
Erosion of surface soils, rilling and gulleys	Reduce erosion risks and associated visual impacts during construction	• Ensure that erosion control structures such as gabions, berms and diversion structures are built in the appropriate place, in particular in steep areas such as access roads on slopes.	Minimal erosion inside the construction areas and surrounds.	Duration of construction phase	$6,353	Project Applicant/ Project Engineering Consultant	• Visual inspections to monitor the erosion on site during construction, as well as the implementation and effectiveness of erosion control on site (such as the use of geofabric, stone gabions and re-vegetation or similar measures)	• Weekly	$100
Increased wind erosion and resultant deposition of dust	Prevent wind erosion and resultant deposition of dust on surrounding	• During construction, efforts should be made to retain as much natural vegetation as possible on the site, to reduce disturbed areas and maintain plant cover. • Comply with the rehabilitation and re-	Minimise the loss of topsoil as a result of construction activities	Duration of construction phase	$7,403	Project Applicant/ Project Engineering Consultant	• Monitor rehabilitation activities via site inspections	• Weekly	$100

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
	indigenous vegetation.	vegetation plan.							
		• Strip and stockpile topsoil from all areas where soil will be disturbed • Topsoil is removed and stored correctly to be used in onsite rehabilitation measures		Duration of construction phase		Project Applicant/ Project Engineering Consultant	• Monitor the stockpiling process throughout the construction phase via visual site inspections.	• Daily	
		• Maintain topsoil stockpiles below 5 meters in height. • After cessation of disturbance, re-spread topsoil over the surface.		Duration of construction phase		Project Applicant/ Project Engineering Consultant	• Visual site inspections	• Daily • After construction phase	
		• Dispose of any sub-surface, clay spoils from excavations where they will not impact on land that supports vegetation, or where they can be effectively covered with topsoil.		Duration of construction phase		Project Applicant/ Project Engineering Consultant	• Undertake regular inspections of the via site audits to verify that clay is disposed of as instructed.	• Daily	
		• Where unavoidable beds or banks of channels are crossed, these will require erosion protection (e.g. gabions and Reno mattress) to prevent erosion		Duration of construction phase		Project Applicant/ Project Engineering Consultant	• Visual site inspections.	• Daily	
		• All soils compacted as a result of construction activities falling outside of the project footprint areas should be ripped and profiled.		Duration of construction phase		Project Applicant/ Project Engineering Consultant	• Visual site inspections.	• Daily	

8.7.2.5 Hazardous Substance Leakage or Spillage Management Plan

Contamination of surface water, soil and risk of damage to vegetation and/or fauna through spillage of hazardous substances, fuels and oils	Prevent the spillage of fuel, oil or grease on site and remedy this should it occur	• Ensure that adequate containment structures are provided for the temporary storage of liquid dangerous goods and hazardous materials on site (such as chemicals, oil, fuel, hydraulic fluids, lubricating oils etc.). Appropriate bund areas must be provided for the storage of these materials at the site camp. No storage of such chemicals should be permitted within the riparian buffer zones. Bund areas should contain an impervious surface in order to prevent spillages from entering the ground. Bund areas should have a capacity of 110 % of the volume of the largest tank in the bund (tanks include storage of fuel/diesel)	Zero spillage of hazardous substances, including fuel, oil or grease on site	Duration of construction phase	$15,330	Project Engineering Consultant / Project Contractor	• Monitor the storage and handling of dangerous goods and hazardous materials on site via visual inspection	• Weekly	$500
		• The Contractor must compile a Spill Contingency Plan		Duration of construction phase		Project Applicant/ Project Contractor	• Approve and sign off Spill Response Method Statement and refuelling/servicing procedure	• Prior to construction	
		• Construction equipment is checked daily to ensure that no fuel spillage takes place from construction vehicles or machinery		Duration of construction phase		Project Applicant/ Project Contractor	• Audit the vehicles and construction equipment maintenance records	• Daily	
		• Compile a maintenance plan and ensure construction equipment and vehicles are maintained according to the plan • Keep record of maintenance		Duration of construction phase		Project Applicant/ Project Contractor	• Sign off on maintenance plan • Audits equipment and vehicles maintenance records	• Once off • Monthly	$1000
		• Use drip trays under all equipment and plant parked.		Duration of construction phase		Project Applicant/ Project Contractor	• Provide sufficient drip trays for the duration of construction • Visual inspection of construction areas to ensure drip trays are in use and no spills are visible	• Daily	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		• Used oils and lubricants are to be contained and correctly disposed of off-site.		Duration of construction phase		Project Applicant/ Project Contractor	• Visual inspection of disposal of oils and lubricants in the correct manner. Audit disposal slips/way bills.	• Daily	
		• The Contractor should compile a Method statement for refuelling/servicing activities under normal and emergency situations • A designated (impervious) area for refuelling/maintenance purposes. No vehicle maintenance or refuelling on beach. • Drip trays or similar impervious materials must also be used during refuelling/servicing, especially during emergency procedures.		Duration of construction phase		Project Applicant/ Project Contractor	• Sign off of refueling/servicing method statement • Visual inspection to ensure drip trays are in use. • Monitor the placement and designation of the area for refuelling at the site camp via visual inspections • Monitor the refuelling/servicing process (visual inspection) and record the occurrence of any spillages.	• Once-off before construction • Daily	
		• Spilled fuel, oil or grease is retrieved where possible, and contaminated soil removed, cleaned and replaced. Contaminated soil to be collected by the EHS Manager (under observation of ECO) and disposed of at a waste site designated for this purpose.		Duration of construction phase		Project Applicant/ Project Contractor	• Carry out site audits to verify the proof of disposal of the contaminated material and waybills kept on file • Monitor the handling and storage of fuels and oils via site audits and monitor if spillages have taken place and if so, are removed correctly	• Daily	
		• Attend all spills immediately and keep records.		Duration of construction phase		Project Applicant/ Project Contractor	• Visual inspection of construction areas to ensure no spills are visible • Monitor the occurrence of spills and the management process. Audit spill records and ensure that corrective action was taken	• Daily	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
							immediately		
		• Portable bioremediation kit (to remedy chemical spills) is to be held on site and used as required.		Duration of construction phase		Project Applicant/ Project Contractor	• Visual inspection of portable bioremediation kit to ensure it is located at the correct place	• Daily	
Contamination of soil (change in pH) and risk of damage to vegetation and/or fauna through spillage of concrete	Prevent spillage of cement, sand and stone into soil and vegetation beyond defined areas for concrete mixing and batching	• Concrete mixing areas (if any) are defined on the site map (no concrete mixing allowed on the shore). If any concrete mixing takes place on site, this is to be done in a clearly marked, designated area at the site camp on an impermeable surface (for example on board or plastic sheeting and/or within a bunded area with an impermeable surface), which is to be removed from the site once concreting is completed; or in areas to be covered by further construction • Sand, stone and cement are stored in demarcated areas, and are covered or sealed to prevent wind erosion and resultant deposition of dust on the surrounding indigenous vegetation	Minimum spillage of cement into the environment; zero spillage beyond the site	Duration of construction phase	$22,680	Project Contractor	• Monitor the handling and storage of sand, stone and cement as instructed. • Visual inspection of storage areas to ensure these are bunded and covered	• Daily	$1000
		• A washout facility must be provided for washing of concrete associated equipment. Water used for washing must be restricted.		Duration of construction phase		Project Applicant/ Project Contractor	• Approval of a wash out facility • Visual inspection of construction areas to ensure that washing is undertaken in the dedicated washout facility	• Once off • Daily	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		• Any excess sand, stone and cement must be removed from site at the completion of the construction period.		Duration of construction phase		Project Applicant	• Audit disposal records and waybills	• Monthly	
		• Hardened concrete from the washout facility or concrete mixer can either be reused or disposed of at an appropriate licensed disposal facility. Proof of disposal should be retained on file for auditing purposes.		Duration of construction phase		Project Applicant	• Audit disposal records and waybills	• Monthly	
		• Attend any concrete spills immediately and remove contaminated soil and disposed of appropriately • Keep records of spills		Duration of construction phase		Project Applicant/ Project Contractor	• Visual inspection of the construction areas to ensure no spills are visible. • Monitor the occurrence of spills and the management process. Audit spill records and ensure that corrective action was taken immediately	• Daily • Monthly	
8.7.2.6 Traffic Management Plan									
Potential increased number of road accidents due to increased traffic during construction	Reduce number of road accidents due to increased traffic during construction	• Appoint trained drivers during the construction phase.	Limited impacts on local traffic. Zero accidents	Duration of construction phase	$32,025	Project Engineering Consultant / Project Contractor	• Audit drivers licenses and certificates to ensure they have been adequately trained,	• As required	$1000
		• Defensive driving training should be provided to drivers		Prior to construction commencing		Project Engineering Consultant / Project Contractor	• Identify a defensive driving course provider and implement training • Monitor all drivers and report	• Prior to construction phase • Daily	
		• Install clear and visible signage at vantage points along access routes and around the site indicating movement of construction vehicles to ensure safe entry		Prior to construction commencing		Project Engineering Consultant / Project	• Carry out random inspections to verify whether proper construction signage is being implemented.	• Weekly	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		and exit.				Contractor			
		• Install traffic calming measures (speed bumps and rumble strips) to slow traffic down where heavy vehicles cross or enter busy roads. • Speed limits will be enforced for heavy good vehicles and workforce transportation vehicles		Prior to construction commencing		Project Engineering Consultant / Project Contractor	• Ensure that speed limits are adhered to. • Carry out random visual inspections to verify speed limits and general awareness of vehicle drivers	• Ad hoc	
		• Where possible, limit construction vehicles travelling through densely populated residential areas		Duration of construction phase		Project Engineering Consultant / Project Contractor	• Monitor (audit) schedule of trips and itinerary.	• Daily	
		• During the construction phase, suitable parking areas should be designated for trucks and vehicles.		Duration of construction phase		Project Applicant	• Monitor the placement of the designated parking area for trucks and vehicles via visual inspections	• Once-off prior to construction and weekly during the construction phase.	
		• Develop and implement a “No Drinking” “No Alcohol” policy on site.		Duration of construction phase		Project Contractor	• Visual inspection of all vehicles to ensure they have a “No Alcohol” sticker. • Conduct periodic and routine alcohol checks for all site drivers and site workers	• At random during construction	
		• Ensure that construction vehicles are roadworthy, properly serviced and maintained, and respect the vehicle safety standards implemented by the Project Developer		Duration of construction phase		Project Applicant/ Project Contractor	• Audit maintenance and roadworthiness records	• Monthly	
		• Engage communities on road risk and educate them through constant		Duration of construction		Project Applicant/	• Audit minutes of meetings • Keep records and monitor number	• Monthly	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		communications, road signals as well as with communications with the local authorities and community leaders • Improve and enhance community sensitization on road traffic accidents within the project area		phase		Project Contractor	of accidents		
Increased dust generation as a result of construction vehicles and equipment	Limit the generation of dust to an adequate level and ensure that dust levels comply with health and safety requirements	• Implement management strategies for dust generation during the construction phase, such as applying dust suppressants on exposed areas and stockpiles. • Postpone or reduce dust-generating activities during periods with strong wind.	No complaints logged by the community. No visible excessive dust	Duration of construction phase	$40,950	Project Applicant/ Project Contractor	• Visual inspection on site to ensure that there is no excessive visible dust	• Ongoing	$5000
		• Ensure that construction vehicles travelling on unpaved roads do not exceed a speed limit of 40 km/hour.		Duration of construction phase		Project Applicant/ Project Contractor	• Audit complaint register	• Weekly	
		• Ensure the trucks are covered with appropriate material (such as tarpaulin) during periods with strong winds or when driving above 40km/h.		Duration of construction phase		Project Applicant/ Project Contractor	• Visual inspections to ensure that covers are used when necessary	• Weekly	
Accelerated degradation of road structure due to construction traffic	Limit the deterioration of the road condition due to construction traffic	• Construction activities will have a higher impact than the normal road activity and therefore the main access roads to site should be inspected on a weekly basis for structural damage.	No visible deterioration of roads during construction	Duration of construction phase	$32,655	Project Applicant/ Project Contractor	• Ensure that the main access road to site maintains current condition through photographic surveys and monitoring	• Monthly	$100
		• It is recommended that vehicles are not overloaded during the construction phase in order to reduce impacts on the road structures, particularly the access roads leading to the site.		Duration of construction phase		Project Applicant/ Project Contractor	• Perform visual inspection of vehicles during the construction phase to monitor for overloading.	• Random visual inspection of vehicles weekly	

8.7.2.7 General Construction Management Plan

Overall compliance with the conditions of the Environmental Permit	Handover the site to the project operator at the end of the construction phase, in a form that satisfies all requirements of the Environmental Authorisation for the construction phase.	• Audit the implementation of the EMP requirements for the construction phase	Full compliance with the EMP specifications & Environmental Permits requirements for construction phase	Duration of Construction Phase	$27,300	Project Applicant/ Project Contractor/EPA	• Audit report on compliance with actions & monitoring requirements in the Construction Phase EMP	• As required by EPA	$1500
Effective management of civil contractors and sub-contractors	Ensure disciplined operation of sub-contractors Ensure that construction activities are carried out in an environmentally friendly manner	• Ensure that construction staff has attended an environmental awareness training to ensure that basic environmental principles are adhered to	Full compliance with specified conditions in contracts of sub-contractors. No littering on construction sites. No findings during compliance audits	During of construction phase	$74,550	Project Applicant/ Project Contractor	• Conduct audits of the signed attendance registers.	• Weekly or bi-weekly	$5000
		• Contractors and sub-contractors will not be permitted to remain on the site overnight (bar security personnel)		During of construction phase		Project Applicant/ Project Contractor	• Visual inspections of site activities	• Daily	
		• Contractors and sub-contractors will use the chemical toilet situated in a designated area of the site; no personal hygiene (e.g. washing) will be permitted outside the designated area		During of construction phase		Project Applicant/ Project Contractor	• Check compliance with specified conditions, using a report card, and allocate fines when necessary. • Visual inspections of site activities	• Daily	
		• Cooking will take place in a designated area shown on the site map and no firewood or kindling may be gathered from the site or surrounds		During of construction phase		Project Applicant/ Project Contractor	• Check compliance with specified conditions, using a report card, and allocate fines when necessary. • Visual inspections of site activities	• Daily	
		• All litter will be deposited in a clearly marked, closed, animal-proof disposal bin in the construction area; particular attention needs to be paid to food waste		During of construction phase		Project Applicant/ Project Contractor	• Check compliance with specified conditions, using a report card, and allocate fines when necessary. • Visual inspections of site activities	• Daily	
		• No one other than the ECO or personnel authorised by the ECO, will disturb or pick plants outside the demarcated construction		During of construction phase		Project Applicant/ Project	• Check compliance with specified conditions, using a report card, and allocate fines when necessary.	• Daily	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		area; or disturb animals on the site (no trapping, shooting etc.).				Contractor	• Visual inspections of site activities		
		• Animals disturbed during construction activities should not be harmed but should be allowed to move off to an undisturbed area of the site		During of construction phase		Project Applicant/ Project Contractor	• Check compliance with specified conditions, using a report card, and allocate fines when necessary. • Visual inspections of site activities	• Daily	
		• Feral dogs and cats should not be fed or encouraged to visit the site		During of construction phase		Project Applicant/ Project Contractor	• Check compliance with specified conditions, using a report card, and allocate fines when necessary. • Visual inspections of site activities	• Daily	
		• Hunting activities should follow the Wildlife Act		During of construction phase		Project Applicant/ Project Contractor	• Check compliance with specified conditions, using a report card, and allocate fines when necessary. • Visual inspections of site activities	• Duration of construction	
		• No off-road driving allowed. All vehicle is required to remain on demarcated roads		During of construction phase		Project Applicant/ Project Contractor	• Visual inspection to see if there are off-road vehicle tracks in specific areas.	• Daily	
Impacts on the surrounding environment associated with construction activities	Minimise the surface area that will be affected by construction activities	• Clearing of vegetation to be kept to a minimum, keeping the width and length of the earth works to a minimum	Clearing of vegetation limited to agreed and demarcated areas. No disturbance of no go areas	During of construction phase	$27,825	Project Applicant/ Project Contractor	• Visual inspection of clearing and no go areas	• Duration of construction	$10000
		• Demarcating and labelling of no-go areas in proximity to the development footprint, such as sensitive areas		During of construction phase		Project Applicant/ Project Contractor	• Strict control over the behaviour of construction workers, restricting activities to within demarcated areas for construction.	• Prior to construction	
		• Keep all activities, material and machinery contained within an area that is as small as possible. • Camp sites and all building, laydown and stockpiling areas are located in the recommended development platform		During of construction phase		Project Applicant/ Project Contractor	• Include periodical site inspection in environmental performance reporting that specifically records occurrence of off-road vehicle tracks in specific areas.	• Weekly	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		areas and in low sensitivity areas.							
Erosion and spread of alien plant species associated with disturbed areas during construction activities	To ensure that all areas affected by the project are appropriately rehabilitated and re-vegetated in a manner congruent with the surrounding bio-physical environment.	• Stockpile the shallow topsoil layer separately from the subsoil layers. Reinstate the topsoil layers (containing seed and vegetative material) when construction is complete to allow the plants to rapidly re-colonise the bare soil areas.	No spread of alien invasive species	Prior commencement of construction	$12,075	Project Applicant/ Project Contractor	• Monitor disturbed areas to ensure that rehabilitation is undertaken as soon as construction activities are completed. • Monitor re-vegetated areas to assess effectiveness	• Weekly	$500
Impacts associated with the storage and handling of wastes on the environment	Ensure that wastes are managed in an environmentally friendly and responsible manner	• Compile a waste management plan • A refuse control system will be established for the construction period to efficiently separate all forms of solid waste from the site in recycling and non-recycling streams • Waste collection points must be sealed/enclosed to eliminate the risk of wind scatter and scavenging by wildlife	Recycling of wastes where possible. Zero impact of construction wastes on the environment.	Duration of construction phase	$18,375	Project Applicant/ Project Contractor	• Sign off waste management plan • Visual inspections of waste storage facilities •	• Once off prior to construction • Daily	$1000

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		• General waste (i.e. construction waste, building rubble, discarded concrete, bricks, tiles, wood, glass, window panes, air conditioners, plastic, metal, excavated material, packaging material, paper and domestic waste etc.) generated during the construction phase should be stockpiled temporarily (i.e. once-off) on site in a designated area within suitable waste collection bins and skips (or similar). • Hazardous waste (i.e. empty tins, oils, fuel spillages, spilled materials and chemicals etc.) generated during the construction phase should be stockpiled temporarily (i.e. once-off) on site in a designated area in suitable waste collection bins and leak-proof storage skips (or similar).				Project Applicant/ Project Contractor	• Monitor the strategic placement of the temporary, designated waste stockpiling area at the site camp via visual inspections, and record and report any non-compliance. • Monitor the temporary storage and handling of general waste on site via site audits and	• Once-off prior to the commencement of the construction phase and as required as the construction phase process evolves. • Daily	
		• Normal sewage management practises should be implemented. These include ensuring that portable sanitation facilities are regularly emptied and the resulting sewage is contained and transported safely (by an appointed (suitable) service provider) for correct disposal at an appropriate, licenced facility. Proof of disposal (in the form of waste disposal slips or waybills) should be retained on file for auditing purposes. No waste water must be discharged to the natural environment. • As part of the Environmental Awareness Training, all construction personnel should be made aware of the sewage				Project Applicant/ Project Contractor	• Monitor the placement of sanitation facilities during the construction phase via visual site inspections. Record non-compliance and incidents. • Ensure that a suitable Contractor is appointed to remove and dispose the sewage at an appropriate, licenced facility. • Monitor waste disposal slips and waybills via site audits and record non-compliance and incidents. • Carry out Environmental Awareness Training.	• Weekly • During construction • Weekly • Once-off training and ensure that all new staff are inducted.	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		management practises					• Conduct audits of the signed attendance registers.	• Monthly	
		• Under no circumstances is any solid waste to be burned or buried on or in the vicinity of the site		Duration of construction phase		Project Applicant/ Project Contractor	• Visual inspections	• Random inspections weekly	
		• Empty cement bags must be secured with adequate binding material if these will be temporarily stored on site. Empty cement bags must be collected from the construction area at the end of every day. Sand and aggregates containing cement must be kept damp to prevent the generation of dust		Duration of construction phase		Project Applicant/ Project Contractor	• Visual inspections of waste storage facilities	• Daily	
		• Ensure that all waste is removed from the site on a regular basis, and safely disposed at an appropriate, licenced waste disposal facility by an approved waste management Contractor • Keep records of wastes sent for recycling and disposal (e.g. wastes manifests from disposal/recycling facility)		Duration of construction phase		Project Applicant/ Project Contractor	• Ensure that a suitable Waste Management Contractor is appointed to remove and dispose the waste at an appropriate, licenced waste disposal facility. • Monitor waste disposal slips and waybills and record non-compliance and incidents	• Once off prior to construction commencing • Weekly	
Weed and pest control	Manage pests ad weeds with mechanical weed control methods	• Mechanical weed control should be used instead of chemical weed control • Avoid the use of chemicals in the control of pests, rodents, snakes etc. around the project site and settlement areas	Avoid use of chemical pest control	Duration of construction phase	$8,505	Project Applicant/ Project Contractor	• Monitor and record instances of use of chemical control	• Monthly	$500
		• In situations where chemical control is inevitable, adopt spot application strategy in chemical application instead of the broadcast method in other to minimize exposure to non-targeted plants and		Duration of construction phase		Project Applicant/ Project Contractor	• Monitor the use of chemical control	• As needed	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		animals							
8.7.2.8 Specific Project Related Environmental Impacts									
8.7.2.8.1 Socio Economic Impacts Management– Positive Impacts									
Increased Employment Opportunities	Enhance impacts associated with project investment / expenditure	• Prepare Labour Management Plan as part of HSE Plan for the construction phase. • Implement employment and workforce policies to mitigate environmental, health and social impacts that are associated with the influx of formal and informal workers by the Contractor	Socio-economic benefits to accrue to the local communities Meet set local labour target	Duration of construction phase	$9,450	Project Applicant	• Sign off the Labour Management Plan	• Once off prior to construction	$500
		• Local employment and sourcing policies are to be used to give priorities to people within the three project communities and the Ada West District and this must be done in line with VRA Local Content Policy. Set targets for how much local labour should be used based on the needs of the applicant and the availability of existing skills and people that are willing to undergo training.		Duration of construction phase		Project Applicant	• Monitor local labour against targets • Verify purchase of local goods and services through proof of purchase in accordance with socio economic investment plan for the area	• At least three times during the duration of construction	
		• Announcement of job opportunities must be made via both the electronic and print media. Announcements must be in English and the local dialects since a large proportion of the populace in the project area have no formal education.		Duration of construction phase		Project Applicant	• Evidence of job advertisements in local newspapers and project applicant website	• As needed	
		• Food vendors from the local communities must be encouraged via information		Duration of construction		Project Applicant	• Hold an information briefing session and record attendees using	• Prior to construction and	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		briefing session to sell their food to workers at designated place at within the project site.		phase			an attendance register	quarterly throughout construction	
		• Appoint a Community Liaison Officer as a designated point of contact for the community.		Duration of construction phase		Project Applicant	• Sign off on appointment of a community liaison officer • Presence of community liaison officer for duration of construction	• Prior to construction	
		• Supply the workers with STD prevention devices including the male and female condoms		Duration of construction phase		Project Applicant	• Verify the presence of contraceptive methods in site office weekly	• Weekly	
		• Put in place a worker grievance mechanism including monitoring and resolving of such concerns.		Duration of construction phase		Project Applicant	• Record keeping register of grievances and proposed solutions to grievances	• As needed	
8.7.2.8.2 Socio Economic Impacts Management– Negative Impacts									
Impacts regarding changes in Current Land Use	Minimise impacts on changes to land use	• Institute appropriate consultations with all stakeholders to raise awareness about the project. • Implement a grievance mechanism (i.e. complain register) and keep record of all complaints from the community	All land owners informed of wind power project Zero grievances complaints from land owners regarding changes in current land use	Start of construction period	$6,930	Project Applicant	• Project applicant to measure and record land used and compare with proposed layout in hectares during construction • Audit records of grievances to ensure these have been adequately and timeously addressed	• Quarterly during construction • Monthly	$500
Impacts on Land Acquisition	Reduce land acquisition requirements where possible Effectively and transparently manage land acquisition	• Utilise existing right of way to minimise land acquisition	Effectively and transparently manage land acquisition process. Zero grievances of non-payment from rightful land	During the design phase of the project	$14,175	Project Applicant	• Adhere to recommendations of the Compensation Action Plan	• As directed by the Compensation Action Plan	$1500
		• Undertake detailed survey of project-affected persons for the purposes of compensation payment		During the design phase of the project		Project Applicant	• Records of detailed land survey	• As needed	
		• Prepare a "Compensation Action Plan" to guide compensation payment		Prior to construction		Project Applicant	• Completed and signed off Compensation Action Plan	• Once off prior to construction	

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
	process.		owners	Phase					
		• Pay prompt, adequate and fair compensation to all project-affected persons before the start of constructional activities		Prior to construction Phase		Project Applicant	• Records of payments to rightful land owners	• Once off prior to construction	
		• Appoint a Community Liaison Officer as a designated point of contact for the community		Prior to construction Phase		Project Applicant	• Sign off on appointment of a community liaison officer • Presence of community liaison officer for duration of construction	• Prior to construction and as needed for the duration of construction	
		• Institute appropriate grievance mechanisms to address concerns of the public and keep records		Duration of construction phase		Project Applicant	• Audit records of grievances to ensure these have been adequately and timeously addressed • Project Applicant to hold public briefings as necessary with the Liaison officer for any community grievances	• Monthly • As required	
Impacts on Labour and Working Conditions	Ensure working conditions of employees are according to international standards	• Apply relevant national policies, labour laws and codes concerning employment conduct	Minimal grievances related to Labour conditions on the project site.	Duration of the construction phase	$8,505	Project Applicant	• Monitor adherence to Labour management Plan • Audit the employee grievance register	• Monthly	$3000
		• Appoint a Community Liaison Officer as a designated point of contact for the community		Prior to construction Phase		Project Applicant	• Sign off on appointment of a community liaison officer • Presence of community liaison officer for duration of construction	• Prior to construction • On going	
		• Institute appropriate grievance mechanisms to address concerns of both workers and the public and keep records		Duration of construction phase		Project Applicant	• Audit records of grievances and solutions provided to grievances	• Monthly	
		• Design and operate work camps in accordance with the requirements set by IFC PS2 and the relevant guidelines within the guidance document Workers' Accommodation: Processes and		Prior to construction		Project Applicant	• Audit of camps against the requirements of IFC PS2 standards	• Quarterly for the duration of construction	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		Standards: A Guidance Note by IFC and EBRD							
Impacts on Community, Health, Safety and Security	Reduce impacts associated with the influx of people during the construction phase	• Develop Health and safety measures related to the working conditions as part of the Health and Safety Plan	Influx of people and impacts during the construction phase to be appropriately managed	Duration of the construction phase	$40,425	Project Applicant/ Project Contractor	• Project applicant to draw up Labour Management Plan as part of the Health and Safety	• Once off prior to construction	$1000
		• Undertake health education with regard to communicable diseases as part of the induction training for workforce members • Organize and support education programmes to increase awareness and change public attitudes towards HIV/AIDS and other sexually transmitted diseases.	Influx of people and impacts during the construction phase to be appropriately managed	Duration of the construction phase		Project Applicant/ Project Contractor	• Adhere to the Labour Management Plan • Attendance registers of support education programmes to increase awareness and change public attitudes towards HIV/AIDS and other sexually transmitted diseases	• Ongoing • Three times during the estimated 14 month construction period (i.e. at 3 months, 6 months, and 9 months).	
		• Convene a complaint redress committee and put in place a grievance mechanism including monitoring and resolving concerns and keep records. • The committee should be headed by the Project Engineer with representation from professionals with background in Social Work, Economics, Land Administration and Law. • The committee should also involve an impartial representative from the communities, district or municipal officers, traditional, religious and community leaders.		Duration of the construction phase		Project Applicant/ Project Contractor	• Audit register of grievances and solutions provided to grievances to ensure that all complaints filed by workers regarding construction are resolved timeously	• Monthly	
		• Put in place mechanisms to deter the work force from engaging in cutting of trees for fuel wood, charcoal burning, and		Duration of the construction		Project Applicant/ Project	• Applicant and Construction Manager to ensure that all complaints filed by surrounding	• Ongoing	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		building material and for any other purposes, which has the potential of causing conflict with the communities		phase		Contractor	land owners regarding construction workers are resolved timeously		
8.7.2.8.3 Terrestrial Ecology Management									
Loss of vegetation due to the clearing of vegetation	Reduce loss of vegetation cover and impact on listed plant species	• Removal of stream bank vegetation (especially bamboo/mangrove) must be avoided as much as possible • Mangrove revegetation and tree planting should be undertaken to reverse the decline in the vegetation cover of the project footprint where possible	Full compliance with national legislation on alien and indigenous vegetation handling procedures	Duration of construction phase	$16,852	Project Applicant/ Project Contractor	• Strict control (visual inspections) over the behaviour of construction workers, restricting activities to within demarcated areas for construction • All mangrove removed to be replanted at an appropriate location determined by an Ecological Specialist	• Daily • As needed • As needed	$500
		• Cutting of trees must be done by a certified timber contractor. The landing area of falling trees should be carefully selected to minimize damage to farms. Adequate warning should be given to ensure that public safety is not compromised.		Duration of construction phase		Project Applicant/ Project Contractor	• Sign off on appointment of certified timber contractor • Monitor cutting of trees to ensure safety requirements are adhered to	• As needed	
Impact on plants due to the release of fine particulate matter or sediment into the environment	Minimise the impact on plants from fine particulate matter and/or sediment from construction	• Use artificial wash on plants	No plants affected by particulate matter	Duration of construction phase	$7,402	Project Applicant/ Project Contractor	• Random visual inspections to ensure fine particulate matters on plants are minimal •	• Weekly	$200
		• Excavation activities should not be carried out during high wind speed moment of the day. This will reduce the extent of spread of the particulate matter in the project footprint. Minor trenches and holes should be dug manually to reduce the release of particulate matter.		Duration of construction phase		Project Applicant/ Project Contractor	• Strict control (visual inspections) over the behaviour of construction workers, restricting activities to within demarcated areas for construction	• Daily	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
Excessive loss of fauna in and outside the development footprint area	Minimise impact of construction activities on fauna during construction	• Develop and implement a faunal rescue plan • Remove fauna to safety where necessary and keep records of fauna mortality	Successful rescue operations are performed.	Duration of construction phase	$6,352	Project Applicant/ Project Contractor	• Visual inspection of site for signs of fauna • Audit records of fauna mortality	• Daily • Monthly	$500
		• Ensure adherence to speed limits		Duration of construction phase		Project Applicant/ Project Contractor	• Carry out random visual inspections to verify speed limits and general awareness of vehicle drivers	• Weekly	
		• Ensure that trenches and holes are not left open for extended periods of time without escape opportunities for fauna		Duration of construction phase		Project Applicant/ Project Contractor	• Visual inspection of construction area to confirm no trenches and holes are left uncovered. Record of noncompliance must be kept	• Daily	
Restriction on fauna movement due to fencing of the construction site	Ensure that fauna movement is not	• Mesh fencing that has mesh at bottom (ground-level) can allow passage of small and medium-sized mammals and. prevent human access (including children) for security and health and safety reasons and where the fence crosses drainage lines, attention should be paid in places to using wide pipes or culverts beneath the fencing to create longitudinal links between the site and downstream areas.	No restriction of fauna movement	Duration of construction phase	$110,302	Project Applicant/ Project Contractor	• Conduct regular visual inspections of the fence line to address any animals that may be affected by the fence • Audit register and address any unusual increase in faunal disturbance	• Weekly	$500
Impacts on fauna and flora due to compaction of soils by traffic and through the use of compactors	Minimise compaction of soils and subsequent impacts on fauna	• The number of passes of heavy trucks to and from the project sites should be regulated and minimised.	Construction phase does not significantly impact on local fauna	Duration of construction phase	$32,602	Project Applicant/ Project Contractor	• Ensure that number of passes of heavy trucks are kept to a minimum via random visual inspections • Carry out Environmental Awareness Training • Conduct audits of the signed attendance registers	• Daily • Monthly • Monthly	$300

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
8.7.2.8.4 Wetland and Estuaries Management									
Removal of mangrove vegetation and brackish water swamp vegetation can cause intense evaporation of water body and destruction of habitats	Minimise the removal of mangrove vegetation	• Avoiding destruction of mangrove swamp where possible. • Limit the footprint area of the construction activities to what is only essential in order to minimise environmental damage.	Minimise the removal of mangrove vegetation	Duration of the construction phase	$194,775	Project Applicant/ Project Contractor	• ECO must monitor activities and record and report non-compliance • Strict control over the behaviour of construction workers, restricting activities to within demarcated areas for construction.	• Daily	$5000
Estuarine Impacts	Minimise impacts on estuaries environments in the project area	• Land reclamation must be limited to essential areas only	Minimise impacts on estuaries environments in the project area.	Duration of construction phase	$125,580	Project Applicant/ Project Contractor	• Undertake site and visual inspections on behaviour of construction workers and reporting any non-compliance	• As needed	$3000
		• Effective site management and proper disposal of hydrocarbon fluids will alleviate concerns of contamination		Duration of construction phase		Project Applicant/ Project Contractor	• Carry out visual inspections to monitor handling and storage of hydrocarbon fluids and record and rectify any non-compliance • Undertake site and visual inspections on behaviour of construction workers	• Daily	
		• No stockpiling should take place near an estuarine channel or within a mangrove or salt marsh area		Duration of construction phase		Project Applicant/ Project Contractor	• Undertake site and visual inspections	• Daily	
Alteration of surface drainage patterns on account of construction activities leading		• Ensure that there is no ad-hoc crossing of channels by vehicles during the construction phase. Access routes across the site should be strictly demarcated and selected with a view to minimise impacts on drainage lines		Duration of construction phase	$11,602	Project Applicant/ Project Contractor	• Carry out visual inspections to ensure strict control over the behaviour of staff in order to restrict activities to within demarcated areas	• Daily	$1000

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
to change in plant communities and general habitat structure		• Avoidance of major drainage features during construction. The proposed project footprint must be demarcated to reduce unnecessary disturbance beyond the proposed project area. Demarcate as no-go areas.		Duration of construction phase		Project Applicant/ Project Contractor	• Carry out visual inspections to ensure strict control over the behaviour of staff in order to restrict activities to within demarcated areas.	• Daily	
		• Undertaking and completion of earthworks and road construction outside of the high rainfall period (if possible)		Duration of construction phase		Project Applicant/ Project Contractor	• Monitor construction activities schedule	• Weekly	
8.7.2.8.5 Avifauna Management									
Destruction of Bird Habitat as well as the disturbance and displacement of birds and bats	Avoid destruction of bird habitat	• Avoid prolonged disturbance by phasing clearing and ground work activities.	Bird species are not displaced due to disturbance during construction phase.	Duration of construction phase	$9817.50	Project Engineer and Project Contractor	• Visual inspection to ensure no go areas have been suitably demarcated • Strict control over the behaviour of construction workers, restricting activities to within construction areas.	• Prior to Construction Phase • Daily	$2500
		• Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist, since certain raptor species breed in these areas and should not be impacted. • Any site rehabilitation should use only indigenous plant species. • Minimise the impact on natural vegetation by keeping staff numbers to a minimum, as well as the number of large vehicles and general vehicular traffic. • The avifaunal specialist should conduct a site walkthrough prior to construction, confirming the final road alignment, as					• Prepare monitoring programme which will monitor the presence of alien invasive species on the site via visual inspection (in disturbed areas as well as on any materials brought onto the site such as sand for construction). • Sign off the alien invasive vegetation management plan • Sign off on the final walk through of the avifaunal specialist	• Once off	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		well as the final turbine positions, to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats and no go areas. These results may inform the final construction schedule, including reducing the construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise.							
8.7.2.8.6 Heritage Management									
Impacts on cultural heritage	Avoid impacts on cultural heritage	- Examination, documentation and/or removal of shrines by archaeologist.	No damage to any significant cultural heritage features on site	Duration of construction	$40,530	Project Applicant/ Project Contractor	- Carry out visual inspections to ensure strict control over the behaviour of construction staff in order to restrict activities to within demarcated areas - Carry out Environmental Awareness Training to ensure that the Contractors are informed of the possible type of heritage features that may be encountered during the construction phase	- Weekly - Prior to construction	$500
		- Adhere to taboo rules of the area		Duration of construction			- Carry out visual inspections to ensure strict control over the behaviour of construction staff in order to restrict activities to within demarcated areas	- Daily	
Disturbance, damage to and destruction of heritage resources	Avoid disturbance, damage to and destruction of heritage resources Enhance Gains to	- Examination, documentation and/or removal of archaeological material by archaeologist - Proper documentation and reporting of chance finds	No damage to any significant cultural heritage features on site	Duration of construction	$17,430	Project Applicant/ Project Contractor	- Monitor excavations and construction activities for archaeological materials via visual inspections and report the finds accordingly. - Contact the heritage authorities and	- As needed	$1000

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
Gains to the science of archaeology by recording chance finds	the science of archaeology by recording chance finds	• If archaeological features are uncovered unexpectedly during construction, stop construction and consult an archaeologist			$13,230		the identified archaeologist if any heritage features are uncovered.		$500
8.7.2.8.7 Noise Management									
Disturbance as a result of increased environmental noise levels caused by traffic, earthworks, infrastructure erection and demolition	Reduce and monitor construction noise	• All noise monitoring surveys must be designed and conducted by a trained specialist. • A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site. General Good Practice Measures. General measures to reduce noise levels at the source include: • Avoiding unnecessary revving and idling times for all mobile construction equipment. • Minimising individual construction vehicle engine, transmission, and body noise/vibration. This is achieved through the implementation of an equipment maintenance program. • Keeping temporary construction roads well maintained and avoiding steep inclines. • Using rubber linings in for instance chutes and dump trucks to reduce impact noise. • Minimizing drop height of materials to	No complaints from surrounding communities	Duration of construction phase	$16,380	Project Applicant/ Project Contractor	• Noise sensitivity training to be provided. • Ambient noise monitoring to be conducted by a trained specialist four times during the construction period ✓ Sampling should be carried out using a Type 1 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory. ✓ The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session. ✓ Samples of at least 24 hours in duration and sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples representative of the day- and night-time acoustic environment should be taken. ✓ The following acoustic indices should be recorded and reported:	• Every three months for the duration of construction	$1000

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		reduce impact noise. • The sequential start-up of equipment and plants rather than simultaneously. • All movements and activities on site should take cognisance of the location of NSRs and normal operating hours of the site as far as is practicable. • Minimising the need for trucks/equipment to reverse. This will reduce the frequency at which disturbing, but necessary, reverse warnings will occur. Alternatives to the traditional reverse 'beeper' alarm such as a 'self-adjusting' or 'smart' alarm could be considered. These alarms include a mechanism to detect the local noise level and automatically adjust the output of the alarm is so that it is 5 to 10 dB above the noise level near the moving equipment. The promotional material for some smart alarms does state that the ability to adjust the level of the alarm is of advantage to those sites 'with low ambient noise level' (Burgess & McCarty, 2009). Also, when reversing, vehicles should travel in a direction away from NSRs if possible. Specifications and Equipment Design • If a construction site is within an especially sensitive area, equipment and methods to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in					LAeq (T), statistical noise level LA90, LAFmin and LAFmax, octave band or 3rd octave band frequency spectra. ✓ The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface. ✓ Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet. • Audit noise monitoring records to assess effectiveness of management actions implemented. Implement corrective action if noise levels are above recommended levels. • Audit vehicles and equipment maintenance records		

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels. Use and Siting of Equipment • Plant and equipment should be sited as far away from NSRs as possible. • Machines (e.g. cranes) used intermittently should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy. • Plants or equipment from which noise generated is known to be particularly directional, should be orientated so that the noise is directed away from NSRs. • Acoustic covers of engines and compressors should be kept closed when in use or idling. • Construction materials such as beams and bricks should be lowered and not dropped. Maintenance • Regular and effective maintenance of equipment and plants are essential to noise control. Increases in equipment noise are often indicative of eminent mechanical failure. Also, sound reducing equipment/materials can lose effectiveness before failure and can be identified by visual inspection. • Noise generated by vibrating machinery and equipment with vibrating parts can be							

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		reduced through the use of vibration isolation mountings or proper balancing. Cutting tools and saws must be kept sharp to reduce frictional noise. Noise generated by friction in conveyor rollers, trolley etc. can be reduced by sufficient lubrication. • Naturally, if noise activities can be minimised or avoided, the amount of noise reaching NSRs will be reduced. Alternatively, the distance between source and receiver must be increased, or noise reduction screens, barriers, or berms must be installed. Distance • Increasing the distance between source and receiver is often the most effective method of controlling noise since, for a typical point source at ground level, a 6 dB decrease can be achieved with every doubling in distance. However it might not always be possible. • Stationary plants such as generators, compressors, cement and asphalt works (if applicable) should be located as far away from NSRs within the development footprint. Screening • If noise control at the source and the use of distance between source and receiver is not possible, screening methods must be considered. To optimize the effect of screening, screens should be located close							

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		to either the source of the noise, or the receiver. • The careful placement of barriers such as screens or berms can significantly reduce noise impacts but may result in additional visual impacts. • Site buildings such as construction offices and stores can be grouped together to form a substantial barrier between construction activities and nearby NRs. Similarly, one may use construction materials such as bricks, timber and aggregate if placed strategically.							
		• Construction and decommissioning activities must be limited to day-time working hours (08:00-17:00);		Duration of construction		Project Applicant/ Project Contractor	• Implement a complaint register at site offices where members of the public can easily communicate issues to VRA and contractors. In response to any complaints received, short term monitoring must be conducted as per the methodology set out in Section 8.1.1.3 of the Noise Impact Assessment Specialist Report. Once the source or sources of noise resulting in complaints have been identified, appropriate good practice measures must be implemented. • Audit the complaint register to ensure that corrective action was taken timeously	• Ongoing as needed • Monthly	
8.7.2.8.8 Visual Impact Management									
Altered Sense of	Reduce visual	• Limit and phase vegetation clearance and	Minimal visual	Duration of	$16,380	Project	• Conduct site inspections to monitor	• Weekly	$1000

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
Place and Visual Intrusion from Construction Activities	intrusion of construction activities project wide.	the footprint of construction activities to what is absolutely essential	intrusion of construction activities project wide.	construction phase		Applicant and ECO	the phasing of construction to verify unnecessary soil disturbance and clearing		
		• Avoid excavation, handling and transport of materials which may generate dust under very windy conditions		Duration of construction phase		Project Contractor	• Monitor wind condition during construction activities	• Daily	
		• Enforce speed limit of 30km/hr on site;		Duration of construction phase		Project Contractor	• Visual inspections and monitoring of adherence to speed limit prescribed	• Daily	
		• Consolidate the footprint of the construction camp to a functional minimum. Screen the yard with materials that blend into the surrounding area		Duration of construction phase		Project Contractor	• Monitoring of contracted employees to ensure adherence to project footprint	• Ongoing	
		• Rehabilitate disturbed areas incrementally and as soon as possible, not necessarily waiting until completion of the Construction Phase		Duration of construction phase		Project Contractor	• Visit sites requiring rehabilitation. • Photograph evidence to show rehabilitation of sites	• Quarterly for the duration of construction	
Altered Sense of Place from Increased Traffic	Prevent unnecessary visual clutter and focusing attention of surrounding visual receptors on the proposed development.	• Limit construction activities to Mondays to Saturdays between the hours of 07h00 and 17h00, or in accordance with relevant District bylaws, if applicable; and	Minimise impact on sense of place from traffic during construction phase	Duration of construction phase	$5,880	Project Contractor	• Construction operation times to be monitored and managed (as well as included in the tender contract)	• Daily	$500
		• Parking areas should be demarcated and strictly controlled so that vehicles are limited to specific areas only.		Duration of construction phase		Project Contractor	• Carry out visual inspections to ensure the construction area and parking area is demarcated clearly • Carry out visual inspections to ensure strict control over the parking of construction vehicles and access routes in order to restrict activities to within demarcated areas.	• Weekly	

8.7.3 Operations Phase

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
8.7.3.1 Alien Invasive Management Plan									
Spread of Alien invasive vegetation during operation	Ensure that the site is kept clear of alien plants through regular monitoring and removal of alien plants	• Regular alien clearing activities using registered control methods	Site clear of any alien invasive vegetation.	Duration of the operation phase	$8,977	Project Applicant	• Visual inspection of project area and immediate surroundings for the presence of alien plants	• Monthly for the first 3 months of operation and thereafter bi-annually	$300
8.7.3.2 Plant Rescue and Protection Plan, including rehabilitation plan									
Loss of protected species/Species of Conservation Concern in and outside the development footprint area	Control loss of natural vegetation during the operational phase. Prevent impacts on natural vegetation in sensitive habitats and SSC.	• Unnecessary impacts on surrounding natural vegetation must be avoided. All operational and maintenance vehicles to remain on the roads and no driving off road allowed. No unauthorized persons should be allowed onto the site		Duration of the operation phase	$20,527	Project Applicant	• Strict control over the behaviour of operation workers, restricting activities to within demarcated areas for operation. Strict control and proper education of staff to prevent misconduct	• Monthly	$300
		• The collection, hunting or harvesting of any plants, any protected trees, fuel wood or animals at the site should be strictly forbidden and the staff educated to prevent this from happening		Duration of the operation phase		Project Applicant	• Strict control over the behaviour of construction workers, restricting activities to within demarcated areas for construction • Carry out Environmental Awareness Training • Conduct audits of the signed attendance registers	• Daily • Once-off training and ensure all new staff are inducted. • As required	
		• All hazardous materials should be stored in the appropriate manner to prevent impacts on vegetation. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner as related to the nature of the spill		Duration of the operation phase		Project Applicant	• Monitor the handling and storage of hazardous materials via visual inspections, and record and report any non-compliance	• Daily	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		• Re-vegetation as part of a rehabilitation plan is always advocated, and the success thereof should be monitored at least 12 months into the operational phase				Project Applicant	• Photograph the area to show vegetation establishment over time	• Weekly or Monthly for one year after operation commenced	
Alteration of micro-climate	Minimise impacts on plants and rare species associated with alteration of micro climate	• Implement the rehabilitation and monitoring plan for plants within the project footprint. • Relocation of any affected rare species which have been identified.	Minimise impacts on plants and rare species associated with alteration of micro climate	Duration of operation phase	$1,627	Project Applicant	• Monitor and record the presence of plants that may be impacted during the operational phase via visual inspections and site visits • Professional ecologist to remove any rare species that have been identified on site •	• Quarterly during operation	$50
8.7.3.3 Storm Water Management Plan									
The operational wind energy facility has the ability to negatively impact on ecosystems due to contaminated stormwater discharge and/or erosion and sedimentation	To prevent contaminated stormwater from entering into and adversely impacting on freshwater ecosystems. To reduce sedimentation of nearby water courses. To apply best practice principles in managing risks to stormwater pollution.	• A storm-water management plan must be implemented during the operational phase. Regular inspections of stormwater infrastructure should be undertaken to ensure that it is kept clear of all debris and weeds • The effectiveness of any storm water control measures must be monitored during the operational phase	The operational wind energy facility does not negatively impact on ecosystem services, habitat fragmentation and/or erosion and sedimentation	Duration of operation phase	$7,402	Project Applicant	• Verify that the stormwater management plan is being implemented and signed off prior the commencement of operations • Undertake regular inspections of the stormwater infrastructure (i.e. by implementing walk through inspections) • Inspect all crossings for any signs of degradation, blockages or areas of excessive scour below culverts	• Prior to commencement of operations. • Weekly/Monthly • As required during operations.	$100
		• All hardstand areas must also be excluded from the riverine and buffer areas;		Duration of operation phase		Project Applicant	• Visual inspections of the location of hard standing areas	• Weekly	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
Contaminants will negatively impact on water quality	Prevent the introduction of contaminants other than sediments which will negatively impact on water quality	• Chemicals used must be stored safely on site and surrounded by bunds. Chemical storage containers must be regularly inspected so that any leaks are detected early • Littering and contamination of water sources during operation must be prevented • Emergency plans must be in place in case of spillages onto road surfaces and water courses	Water quality remains as it currently is and is not worsened because of operational activities	Duration of operation phase	$5,565	Project Applicant	• Monitor the storage and handling of dangerous goods and hazardous materials on site via site audits • Monitor if spillages have taken place and if they are removed correctly	• Weekly	$150
8.7.3.4 Erosion Management Plan									
Erosion occurs onsite as a result of an increase in hardened surfaces	Prevent and remedy soil erosion problems at the site	• Implement an effective system of run-off control which collects and safely disseminates run-off water from hardened or increased run-off surfaces and prevents potential down slope erosion. Remedial actions, including rehabilitation and additional erosion control structures may be necessary • To prevent erosion, indigenous grasses that seed themselves should (where possible) be left to form a ground cover and kept short. • The use of silt fences, sand bags or other suitable methods must be implemented in areas that are susceptible to erosion. Other erosion control measures that can be implemented are as follows: 1) Brush packing with cleared vegetation, 2) Planting of vegetation, 3) Hydro seeding/hand sowing. All erosion control mechanisms need to be regularly	No erosion problems are occurring at the site as a result of the roads and other infrastructure.	Duration of operations phase	$3,202	Project Applicant	• Site inspection and maintain a log of erosion problems and the actions taken to solve the problems. • Periodic inspections and maintenance of soil erosion measures and stormwater control structures, the effectiveness and integrity of the run-off control system •	• Quarterly	$500

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		maintained.							
8.7.3.5 Hazardous Substance Leakage or Spillage Management Plan									
Potential impacts on the environment due spillage of hazardous substances, including fuels and oils	Ensure all wastes are disposed of in an environmental friendly and responsible manner	• During operational maintenance, drip trays must be utilised to prevent lubricant spillages. All lubricants must be stored correctly if kept on site. Alternatively all lubricants and other hazardous substances must be stored off site between maintenance operations • Hydrocarbon spill kits must be kept on site	Zero spillage of fuel, oil or grease on site	Duration of operation phase	$13,702	Project Applicant	• Visual inspection of site to ensure no visible spills • Monitor spills records and ensure that spill clean-up and corrective action was undertaken immediately	• Weekly • Weekly • Daily	$500
		• Any spills must be cleaned up rapidly to avoid prolonged exposure and to contain the extent of the spill • Spilled fuel, oil or grease is retrieved during operation where possible and contaminated soil removed, cleaned and replaced • Contaminated soil to be collected by the EHS Manager and disposed of at a waste site designated for this purpose.		Duration of operation phase		Project Applicant	• Monitor the handling and storage of fuels and oils via site audits and monitor if spillages have taken place and if so, are removed correctly • Monitor waste disposal slips and waybills via site audits and record non-compliance and incidents	• During spills	
		• Implement specifications for maintenance equipment use as specified by the maintenance Contractor.		Duration of operation phase		Project Applicant	• Maintenance equipment is checked by EHS Manager to ensure that no fuel spillage takes place from vehicles or machinery	• Monthly	
		• Portable bioremediation kit (to remedy chemical spills) is to be held on site and used as required		Duration of operation phase		Project Applicant	• Visual inspection of portable bioremediation kit to ensure it is located at the correct place	• Daily	

8.7.3.6 General Management Plan

Impacts associated with the storage and handling of wastes on the environment	Ensure that wastes are managed in an environmentally friendly and responsible manner	• A refuse control system will be established for the operational period to efficiently separate and remove all forms of solid waste from the site for recycling, or disposal at a licensed disposal site • Under no circumstances is any solid waste to be burned or buried on or near the site • Waste collection points must be sealed/enclosed to eliminate the risk of wind scatter and scavenging by wildlife	Recycling of wastes where possible. Zero impact of construction wastes on the environment.	Duration of operation phase	$13,282	Project Applicant	• Monitor the handling and storage of fuels and oils via site audits and monitor if spillages have taken place and if so, are removed correctly	• Daily	
		• All solid waste to be disposed of at a licensed landfill • All liquid waste (used oil, paints, lubricating compounds and grease, wastewater) to be packaged and disposed of by appropriate means • Adequate containers for the cleaning of equipment and materials (paint, solvent) must be provided as to avoid spillages		Duration of operation phase		Project Applicant	• Monitor the storage and handling of dangerous goods and hazardous materials on site via site audits and record non-compliance and incidents • Monitor waste disposal slips and waybills via site audits and record non-compliance and incidents	• Weekly • Monthly	
		• Keep records of wastes sent for recycling and disposal (e.g. wastes manifests from disposal/recycling facility)				Project Applicant	• Monitor waste disposal slips and waybills and record non-compliance and incidents	• Monthly	

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
8.7.3.7 Specific Project Related Environmental Impacts									
8.7.3.7.1 Socio Economic Impact Management – Positive Impacts									
Stabilization of Electricity **Inclusion in Ghana's National Determined Commitments**	Maintain and enhance contribution of the project to the national grid	• Development of policy options that supports competitive markets with equitable rate structures • Provide reliable electricity supply with a socially acceptable level of local or large-scale outages • Develop a system to allow a smooth transition in the architecture and operation of the present power system	No outages during the operation of the wind energy facility	Duration of operation phase	$89,880	Project Applicant	• Regular and routine maintenance of wind power facilities	• Quarterly for the duration of operation phase	$900
Promotion of Economic Growth	Socio-economic benefits to accrue to the local businesses and communities	• Payment of taxes to Government for national developments • Provide job opportunities for locals and nationals to enhance their economic development.	Optimum employment creation while taking cognizance of the local levels of experience and education.	Duration of operation		Project Applicant	• Verify that local labour is, as far as practically possible, being used, by cross-referencing the Compensation Action Plan with current recruitment practices	• Once a year during the operational phase.	
		• Landowner lease and project revenue payments as part of Corporate Social Responsibilities to enhance local economy		Duration of operation		Project Applicant	• Sign off on the Corporate Social Responsibility related to the wind power project	• Once a year during the operational phase.	
Increased Employment Opportunities	Maximise positive impacts associated with expenditure on the construction and operation of the project	• Capacity building of operational and maintenance staff for the purposes of developing their efficiency • Apply relevant national policies, labour laws and codes concerning employment conduct • Implement the Labour Management Plan prepared as part of HSE Plan for the construction phase	Socio-economic benefits to accrue to the local communities	Duration of operation phase	$6,930	Project Applicant	• Verify that Stakeholder Engagement Plan is being implemented with written proof of such engagement with the PAP • Verify that local labour is, as far as practically possible, being used, by cross-referencing the Plan with current recruitment practices	• Once a year during the operational phase.	$300

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
		• Set targets for how much local labour should be used based on the needs of the applicant and the availability of existing skills and people that are willing to undergo training. • Local employment and sourcing policies are to be used to give priorities to people within the three project communities and the Ada West District and this must be done in line with VRA Local Content Policy		Duration of operation phase		Project Applicant	• Verify that Stakeholder Engagement Plan is being implemented with written proof of such engagement with the PAP • Verify that local labour is, as far as practically possible, being used, by cross-referencing the VRA Local Content Policy with current recruitment practices	• Once a year during the operational phase.	
		• Announcement of job opportunities must be made via both the electronic and print media. Announcements must be in English and the local dialects since a large proportion of the populace in the project area have no formal education.		Duration of operation phase		Project Applicant	• Verify purchase of local goods and services through proof of purchase • Verify that local labour is, as far as practically possible, being used, by cross-referencing the VRA Local Content Policy with current recruitment practices	• Quarterly during the operational phase.	
		• Put in place a worker grievance mechanism including monitoring and resolving of such concerns		Duration of operation phase		Project Applicant	• Record and monitor a grievance register	• Monthly	
8.7.3.7.2 Socio Economic Resources – Negative Impacts									
Impact on Land Use	Minimise changes in land use for affected parties	• Formulate resettlement and livelihood restoration activities to improve the standards of living and long-term wellbeing of the affected persons	Minimise changes in land use for affected parties	Duration on operation phase	$8,137	Project Applicant	• Adherence to recommendations made in the Compensation Action Plan	• During operational Phase	$200
Impacts on Community, Health, Safety and Security	Reduce negative impacts on communities, workers health and safety	• Adopt the IFC Occupational Health and Safety (OHS) Guidelines for wind energy projects • Take precautions to beef up the security of the wind farm and the staff quarters. • Appropriate warning signs are to be provided at the site where there is a risk to	Minimise accidents and grievances from community during operational phase	Duration of operational phase	$83,055	Project Applicant	• Verify adherence to Labour management Plan guidelines and by cross checking with IFC Occupational Health and Safety (OHS) Guidelines for wind energy projects • Monitor the grievance register	• Ongoing during construction • Monthly	$1000

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
		health and safety • Support relevant local CBOs to conserve the plant resources including participation in planting of trees and mangrove rehabilitation in the project area. • A comprehensive fire detection and protection system will be installed to cover all equipment on site that could constitute a fire risk.					• Verify that local labour is, as far as practically possible, being used, by cross-referencing the VRA Local Content Policy with current recruitment practices	• Ongoing during construction	
8.7.3.7.3 Terrestrial Ecology Management									
Impact on fauna during the operation of the wind turbines **“Island effect” or fragmentation which negatively impacts on the movement of fauna across site**	Keep impacts on fauna during operation to a low level. Ensure that fauna have free passage through the facility	• Ensure that no parts of the site are obstructing fauna movement or causing mortality - Provision of critter paths within the fencing should be considered in the design. • Promote and support faunal presence and activities within the proposed facility by prohibiting hunting, trading and consumption of bush meat in the project sites • Access to the site should be strictly controlled. • All vehicles at the site should adhere to a low speed limit and any fauna on roads should receive right or way or can be moved off the road in the direction that the animal was moving in the case of slow-moving fauna such as tortoises. • Identify where fauna may be affecting operations of site (burrows etc.) and consider redress if necessary • Establish a register of all faunal siting; indicating date of siting, species affected, position of species (specific or indicative) and other observations.	Fauna are free to move around the site without risk of injury or mortality	Duration of operations phase	$18,600	Project Applicant	• Monitor and record the presence of fauna during the operational phase via visual inspections and site visits • Conduct regular visual inspections of the fence line to address any animals that may be affected by the fence • Audit register and address any unusual increase in faunal disturbance	• Quarterly during operation • Weekly • Weekly	$400

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
Impact and loss of fauna as a result of operational activities.	Impacts on fauna during the operational phase of development are reduced as far as possible through the implementation of appropriate management measures	• Ensure that environmental management of the facility is in accordance with the EMP • Establish reporting procedure	Keep impacts on fauna during operation to a low level.	Duration of operation	$4,305	Project Applicant	• Monitor the presence of fauna during the operational phase via visual inspections and site visits.	• Daily	$400
		• Carry out Environmental Awareness Training for all new staff		Duration of operation		Project Applicant	• Conduct audits of the signed attendance registers.	• Every 6 months	
Impact on flora during maintenance activities.	Control loss of natural vegetation during operation. Prevent impacts on natural vegetation in sensitive habitats and species of special concern	• Avoid broadcast spraying of chemical herbicides during vegetation clearance • Replant native rare plants in buffer zones to prevent extinction • Minor vegetation clearance should be done manually	Minimal loss of natural vegetation	Duration of operation phase	$9,082	Project Applicant	• Strict control over the behaviour of operation workers, restricting activities to within demarcated areas for operation • Replanting of vegetation should be done by a qualified Ecological Specialist	• Daily • As needed	$300
8.7.3.7.4 Avifaunal Impacts									
Collision with turbines **Disturbance and Displacement**	Restrict the number of birds and bats killed through collision with turbine blades to an acceptable level	• Develop and implement a carcass search programme for birds during the first 24 months of operation (at the start of operations at the wind farm). It is recommended to make use of webcams.	Minimise bird mortality through collisions with turbine structures Minimise disturbance to bird, particularly breeding bird species.	Duration of operation phase	$8,505	Project Applicant and Project Engineer	• Appointment of a qualified avifaunal specialist to develop post construction monitoring plan • Post construction monitoring according to framework designed by avifaunal specialist	• Weekly for 24 months post construction	$750

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
		• The on-site WEF manager (or a suitably appointed Environmental Manager) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possible breeding by these species.					• Appointment of an Avifaunal Specialist • Records of training undertaken by Lead Contractor	• Once off	
		• Develop and implement a 24 month post-construction bird activity monitoring programme, including thorough and ongoing nest searches and nest monitoring for breeding success, which mimics the pre-construction monitoring surveys/ walkthroughs. If a priority species or Red Data species is found to be breeding (e.g. a nest site is located) on the operational WEF, the nest/breeding site must not be disturbed and an avifaunal specialist must be contacted for further instruction.		Duration of operation phase			• Appointment of a qualified avifaunal specialist to develop post construction monitoring plan • Post construction monitoring according to framework designed by avifaunal specialist. Record of all nests and any Red Data listed species found on site	• Once off • Weekly for 24 months post construction	
		• Frequent and regular review of monitoring data (activity and carcass) and results by an avifaunal specialist during the operation phase. This will establish the requirement for continued monitoring studies (activity and carcass) throughout the operational and decommissioning phases of the development. • If unacceptable impacts are observed (in the opinion of the bird specialist and independent review), the specialist should conduct a literature review specific to the impact (e.g. collision) and provide updated and relevant mitigation options to be implemented. As a starting point for the review of possible mitigations, the		Duration of operation phase		Project Applicant and Project Engineer	• Comparison of kill rates of bats and birds with international standards to determine if the power facility exceeds this rate • Should the facility exceed these rates, shut down or curtailments records during migration seasons or specific turbines responsible for high fatalities	• Once off • Once off • As needed for the duration of the operation phase	

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
		following may need to be considered: o Assess the suitability of using deterrent devices to reduce collision risk (e.g. DTBird© and ultrasonic/radar/electromagnetic deterrents for bats) o Nests and roost sites should be removed from the turbine cluster area to reduce raptor flight activity and subsequent possible collisions. o As much as possible the ponds and pools in close proximity of turbines should be avoided as these serve as water sources for most bird species. o Turbines should be placed outside of high sensitivity areas, such as ridge edges and nest buffers. • If it becomes necessary, based on outcomes of the operation monitoring results, regulation of the operation of the turbines so as to reduce collision risks must be employed. If the real-time assessment proves that more collisions are occurring, turbines can be regulated during operations by reducing speed or stopping them of during certain months when we know (from the surveys) that significant numbers of birds move through the project area.							
		• If permissible by the Ghana Civil Aviation Authority (GCAA), the use of constant lighting on top of turbines should be avoided, as this may disorientate birds in flight. Intermittent lighting should rather be used.		Duration of operation phase		Project applicant	• Written communication for GCAA regarding the lighting which is acceptable	• Once off	

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
		• An operational phase bird monitoring programme must be implemented and must include monitoring of all nest sites for breeding success. Where necessary and under the supervision of an avifauna specialist, nests and roost sites should be removed from the turbine cluster area prior to construction.	Minimise disturbance to bird, particularly breeding bird species.	Duration of operation phase	$13,965	Project applicant and Project engineer	• Record of all nests and any Red Data listed species found on site	• Prior to construction and bi annually for duration of operation	$450
Disruption of Bird Movements/ Patterns		• A precautionary disturbance distance of 1km should be implemented around wader habitat. • As much as possible the ponds and pools in close proximity of turbines should be avoided as these serve as water source for most bird species.		Duration of operation phase	$42,630	Project applicant and Project engineer	• Maintain strict control of staff, vehicles and other machinery at all times on site during operational phase. Only official roads may be used at all times. • Unrestricted movement around the site should not be allowed.	• Duration of preconstruction monitoring • Duration of operation phase • Duration of operation phase	$450
8.7.3.7.5 Heritage Management									
Impacts on cultural heritage	Avoid impacts on cultural heritage	The project must consistently ensure strict observation of the cultural taboos listed in Cultural heritage specialist report	Observance of cultural taboos on the project site	Duration of operation phase	$4,147	Project Applicant	• Carry out visual inspections to ensure strict control over the behaviour of operational staff in order to restrict activities to within demarcated areas	• Weekly	$200
8.7.3.7.6 Wetland Management									
Impact on local artisanal fisheries	Minimise impact on local artisanal fisheries	• Access restriction measures must be limited to the individual turbines and essential infrastructure where possible	The turbines must not restrict access or use of the surrounding area.	Duration of operation phase	$2467	Project Applicant	• Fencing or demarcation restricted to individual turbines and essential infrastructure	• Once off prior to operation	$200
Impact on the site's hydrology associated with	Minimise impacts on site's hydrology	• Where land reclamation has taken place, ensure that hydrology is maintained through adequate drainage/system	To reduce the impact of the proposed project on the	Duration of operation phase	$66,255	Project Applicant	• Monitor via site audits	• During the operational phase	$500

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
new infrastructure		connectivity to maintaining some degree of tidal influence. • Incorporating culverts beneath access roads to maintain connectivity and flow between sections of mangrove that have been segmented by infill.	surrounding drainage lines and hydrology of the area						
8.7.3.7.7 Noise Management									
Disturbance because of increased environmental noise levels caused by operating WTGs.	Minimise operational noise from turbines	• It is recommended that no new permanent residences be permitted within between 2 and 5 rotor diameters from WTGs of the preferred and alternative layout • Monitoring • ETSU (1996) and the IFC (2015) clearly specify noise monitoring practices for WEFs. Methods closely follow the IFC's general monitoring requirements but requires the additional monitoring of wind speed. Environmental noise measurements at receptors near WEF's need also be longer in duration to facility determining impacts under various wind conditions. • At least one monitoring station should be installed in Omankope (in the vicinity of site 3 of the background noise survey) and Akplabnya (in the vicinity of NSR17). For the alternative layout, one station should be established at Wokumagbe (near NSR12), and Goi (in the vicinity of NSR20).	Noise levels to be below the recommend IFC guidelines of 45db at night and 55db during the day	Duration of operation phase	$22,680	Project Applicant	• Ambient noise monitoring to be conducted by a trained specialist • A complaint register at site offices where members of the public can easily communicate issues to VRA and contractors. In response to any complaints received, short term monitoring must be conducted as per the methodology set out in Section 8.1.1.3 of the Noise Impact Assessment Specialist Report.	• Four times a year • As needed	$1500
Shadow flicker impacts	Minimise shadow flicker impacts on residents near the wind energy facility during	• Curtailment of WTG operational hours can be used to mitigate shadow flicker impacts at Omankope, Wokumagbe, and Goi, the Omankope Presbyterian Primary School (SFR6), as well eastern-most and	Ensure no shadow flicker impacts on sensitive receptors	Beginning of operation phase	$6,877.50	Project Applicant	• Records of residents relocated within these recommended rotor diameters	As needed within the 8 to 30-hour real shadow impact zone for Goi	$500

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party	Methods	Frequency	Budget
	operation phase	northernmost residents of Goi in the vicinity of SFR19 and SFR20 must be relocated. • By adhering to the buffer zone and relocations recommended to mitigate noise impacts, shadow flicker impacts will also be avoided.							
8.7.3.7.8 Visual Impact Management									
Altered Sense of Place and Visual Intrusion from the WEF	Prevent unnecessary visual clutter and focusing attention of surrounding visual receptors on the proposed development.	• Plant large indigenous trees around receptors in the immediate vicinity of the WEF to provide visual screening to partially reduce the visual impact on these receptors; and	Prevent unnecessary visual clutter and focusing attention of surrounding visual receptors on the proposed development.	Beginning of Operation phase	$20,055	Project Applicant	• Carry out visual inspections during site audits to verify the effectiveness of the rehabilitation • Carry out an inspection of energy facility to ensure that it is being maintained in a good condition	• Monthly	$500
		• Maintain a uniform size (height) and colour (white) of the turbine towers, nacelles and blades and avoid any markings on the turbine		Duration of operation phase		Project Applicant	• Carry out an inspection of energy facility to ensure that it is being maintained in a good condition	• Bi-Annually	
Altered Sense of Place and Visual Character caused by Light Pollution at Night	Minimise altered sense of place cause by light pollution	Direct security lighting inwards and downwards to avoid light spillage and trespass. External lights should be fitted with reflectors ("full cut-off" luminaires) to direct illumination downward and inward to the specific illuminated areas; and	Minimise the altered sense of place caused by night light	Duration of operation phase	$1,627	Project Applicant	• Visit surrounding neighbouring farmsteads and ensure that residents in the surrounding landscape are not affected by glaring lights from the plant • Complaints about night lights should be investigated and documented in a register. • Investigate any complaints about night lights and document it in a register.	As complaints, arise	$300

Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
8.7.3.7.9 Aviation Impact Management									
Avoid Interference with Communication Navigation and Surveillance (CNS) signals	Avoid Interference with Communication Navigation and Surveillance (CNS) signals	• Contact Ghana Civil Aviation to register the project and get the necessary permits and guidance on suitable lighting	No impact on CNS Signals	Duration of operation phase	$1,942	Project Applicant	• Contact Ghana Civil Aviation to register the project and get the necessary permits • Ensure adherence to Ghana Civil Aviation permit requirements	• Once off • Duration of operation	$300
Adverse effects of tall structures such as wind turbines on aviation traffic	Avoid obstructions to aviation traffic	• Clarify the lighting and marking requirements with the Ghana Civil Aviation Authority	Obstruction lights in accordance with Ghana Civil Aviation Authority (GCAA) standards.	Beginning of Operation phase	$2,152	Project Applicant	• Signed agreement with the GCAA with regards to lighting and marking of turbines • Inspect lightings of turbines	• Once off at the end of the construction phase or the start of the operational Phase. • Monthly	$200

8.7.4 Decommissioning Phase

The proposed facility would be expected to run for a minimum period of 20 years, after which it would either be decommissioned, alternatively upgraded or an application submitted to obtain a new license. Should the plant be decommissioned, the area would be rehabilitated to its original (pre-development) state. If decommissioning occurs, and assuming implementation of mitigation measures recommended as part of this EMP, the hydrological regime should fully recover over time to present day conditions. It must be ensured that the construction mitigation and management measures stipulated in section 8.7.2 are adhered to during the decommissioning phase. The table below specifies additional mitigation and management measures to be implemented during the decommissioning phase.

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
8.7.4.1 Alien Invasive Management Plan									
Alien plant species may pose a threat to the re-establishment of indigenous species	Ensure that decommissioning does not result in extensive alien plant invasion	• All disturbed areas must be rehabilitated with species indigenous to the area, i.e. planting of appropriate trees and shrubs. Re-seed with locally-sourced seed of indigenous grass species that were recorded on site pre-construction • The Government of Ghana (GoG) quarantine inspection and procedures should be followed to ensure that invasive or alien species do not enter the area	Project site kept clear of all alien species and weeds	Duration of decommissioning and beyond	$24,727	Project Applicant	• Final external audit of area to confirm that area is rehabilitated to an acceptable level • Monitor newly disturbed areas where infrastructure has been removed to detect and quantify any aliens and weeds that may become established during and after decommissioning and rehabilitation • Final external audit of area to confirm that area is free of alien invasive plants after 5 years	• Once off after five years of decommissioning • Monthly for the first 3 months after decommissioning and thereafter bi-annually for 5 years • Once off after five years of decommissioning	$500
		• The landing area of falling turbines should be carefully selected to minimize damage to vulnerable plants and human lives. Adequate warning should be given to ensure that public safety is not compromised.		Duration of decommissioning and beyond		Project Applicant	• Monitoring via visual inspection to ensure landing of turbines occurs within demarcated areas	• As needed during decommissioning of turbines	
		• Compile a weed eradication programme for a period of 12 months after the decommissioning exercise. • Weed eradication exercise to be undertaken every 6 months		Duration of decommissioning and beyond		Project Applicant	• Appoint contractor to undertake the weed eradication programme. • Monitor newly disturbed areas where infrastructure has been removed to detect and quantify any weeds that may become established after decommissioning and rehabilitation.	• Once off • Every 6 months for a period of 12 months following decommissioning.	

Management Plan						**Monitoring**			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
8.7.4.2 Erosion Management Plan									
Decommissioning activities if not managed correctly have the potential to result in erosion and sedimentation of water sources.	Soil erosion and the sedimentation of downstream water courses is avoided completely through the implementation of appropriate management measures,	• Implement an effective system of run-off control which collects and safely disseminates run-off water from hardened or increased run-off surfaces and prevents potential down slope erosion.	Minimal erosion on and around the site. No sedimentation of nearby water sources	Duration of decommissioning phase	$32,130	Project Applicant / Project Contractor	• Inspect all cleared areas for an signs of degradation and erosion • Include periodical site inspection in environmental performance reporting that inspects the effectiveness of the run-off control system and specifically records occurrence or not of any erosion on site or downstream.	• Weekly	$500
		• Soil erosion and the sedimentation of downstream water courses is avoided completely through the implementation of appropriate management measures		Duration of decommissioning phase			• Include periodical site inspection in environmental performance reporting that inspects the effectiveness of the run-off control system and specifically records occurrence or not of any erosion on site or downstream.		
		• Re-vegetation as part of a rehabilitation plan is always advocated, and the success thereof should be monitored at least 12 months after decommissioning.		Duration of decommissioning phase and 12 months beyond		Project Applicant / Project Contractor	• Establish an effective record keeping system for each area denuded of vegetation for constructional purposes. These records should be included in environmental performance reports, and should include all the records below	• 12 months after decommissioning	
8.7.4.3 General Management Plan									
Degradation of project area	Return the project area to its original state	• Develop a closure and rehabilitation plan that satisfies best practice requirements for wind farms and for habitat management. This plan should include the removal of wind farm	Site returned in a condition that enables on-going agricultural activities currently undertaken	Duration of Decommissioning Phase	$37,905	Project Applicant / Project Contractor	• Audit the implementation of the closure and rehabilitation plan	• Start of Decommissioning phase	$500

Management Plan						Monitoring			
Impact	**Objective**	**Actual Action**	**Target**	**Time Frame**	**Budget**	**Responsible Party**	**Methods**	**Frequency**	**Budget**
		infrastructure, with the exception of the below ground foundations	on site and does not foreclose other potential options						
Extended storage of tanks and equipment can cause visual impact, soil pollution and waste resources.	Reduce soil pollution and visual impacts during the decommissioning phase.	• Redundant equipment shall not be stored outside, but shall be protected from the weather. • The equipment and machinery shall be sold or removed within a reasonable time period. Recycling or re-use of redundant equipment shall be investigated.		Duration of Decommissioning Phase	$8,505	Project Applicant / Project Contractor	• Inspection of state of equipment	• Monthly	$500
8.7.4.4 Specific Project Related Environmental Impacts									
8.7.4.4.1 Socio Economic Impacts– Negative Impacts									
Impact on job losses from closure of the wind power project	Minimize job losses	• The proponent should comply with relevant labour legislation when retrenching employees • VRA must implement appropriate succession training of locally employed staff earmarked for retrenchment during decommissioning • All project infrastructures should be decommissioned appropriately and thoroughly to avoid misuse.	Minimal job losses		$47,250	Project Applicant	• Verify that retrenchment practices are compliant with labour legislation • Verify that VRA implemented succession training of locally employed staff before the plant is decommissioned • Verify that decommissioned infrastructure does not pose any significant risk to the environment or the people living in the environment.	• Once-off during the decommissioning phase	$1500

8.7.5 Cumulative Impact Management Plans

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party
8.7.5.1.1 Terrestrial Ecology Management						
Reduced ability to meet conservation obligations & targets	Reduce vegetation an species of special concern loss at large scale	• Preconstruction walk-through of the facility, especially the roads and turbine locations to ensure that sensitive habitats are avoided. • Minimise the development footprint as far as possible.	Reduce vegetation an species of special concern loss at large scale	Duration of the project from construction phase	$38,535	Project Applicant/ Project Engineering Consultant
Impact on the disruption of broad-scale ecological processes	Reduce impact on the disruption of broad-scale ecological processes	• Preconstruction walk-through of the facility, especially the roads and turbine locations to ensure that sensitive habitats are avoided. • Minimise the development footprint as far as possible. • Key mitigation measures proposed by the specialist include: • Stringent construction-phase monitoring of activities at the site to ensure that mitigation measures are adhered to and that the overall ecological impact of the development is maintained at a low level. • The use of structures which may inhibit movement of fauna, such as mesh and electric fencing should be avoided as far as possible.	Reduce impact on the disruption of broad-scale ecological processes	Duration of the project from construction phase	$32,760	Project Applicant/ Project Engineering Consultant
8.7.5.1.2 Wetland Management						
The cumulative impact of construction of several new large infrastructure	Reduction of impacts on wetlands from large scale projects in the area	• Rehabilitation of the turbine sites. This must include removal of all material and hard structures. The vacant area must be ripped and seeded/planted if terrestrial. • Waste disposal skips must be available during decommissioning. • The working area must be screened using shade cloth fencing (terrestrial sites only)	Reduce impacts on wetlands from large scale projects in the area	Duration of the project from construction phase	$28,140	Project Applicant/ Project Engineering Consultant
8.7.5.1.3 Aviation						
Cumulative impact on Aviation in the area	Record and analyse impacts of large scale wind farms on the	• Liaise with the GCAA authority on impacts of wind turbines on the area on aviation activities.	Reduce impacts on aviation environment from large scale projects	Prior to Construction and duration of	$14490	Project Applicant/ Project Engineering Consultant

Impact	Objective	Actual Action	Target	Time Frame	Budget	Responsible Party
	aviation environment		in the area	operation phase		
8.7.5.1.4 Visual Impact Management						
Altered sense of place	Minimise impacts of a number of wind energy facilities on residents	• Ensure all measures detailed in construction and operation phase are adhered to	Minimise the altered sense of place as much as possible	Duration of the project from construction phase	$8,085	Project Applicant/ Project Engineering Consultant
8.7.5.1.5 Avifauna Impact Management						
Collision of avifauna with turbines	Minimise impacts on bird populations in the area	• Use results of pre and post construction monitoring to determine the impact of the project on birds • Adhere to all actions outlined for construction, operation and decommissioning for avifaunal impacts in this EMP	Minimise bird mortality through collisions with turbine structures Minimise disturbance to bird, particularly breeding bird species.	Duration of the project from construction phase	$85,575	Project Applicant/ Project Engineering Consultant
8.7.5.1.6 Noise Impact Management						
Impact of noise from operation of turbines on local receptors	Minimise the impact of noise from operation of turbines on local receptors	• Recommend buffer zone and the relocation of receptors within the zone to be adhered to • It is estimated that, given the WTGs proposed as part of the UpWind project (3 MW Nordex WTGs) and its reference noise level of 104.5 dBA, the buffer zone will need to extend by 4.5 to 6.5 rotor diameters from the entire WTG array.	Noise levels to be below the recommend IFC guidelines of 45db at night and 55db during the day	Duration of the project from design phase	$68,040	Project Applicant/ Project Engineering Consultant

8.8 ANNEXURE 1: RECOMMENDED BUFFERS FOR NOISE IMPACT MITIGATION MEASURES

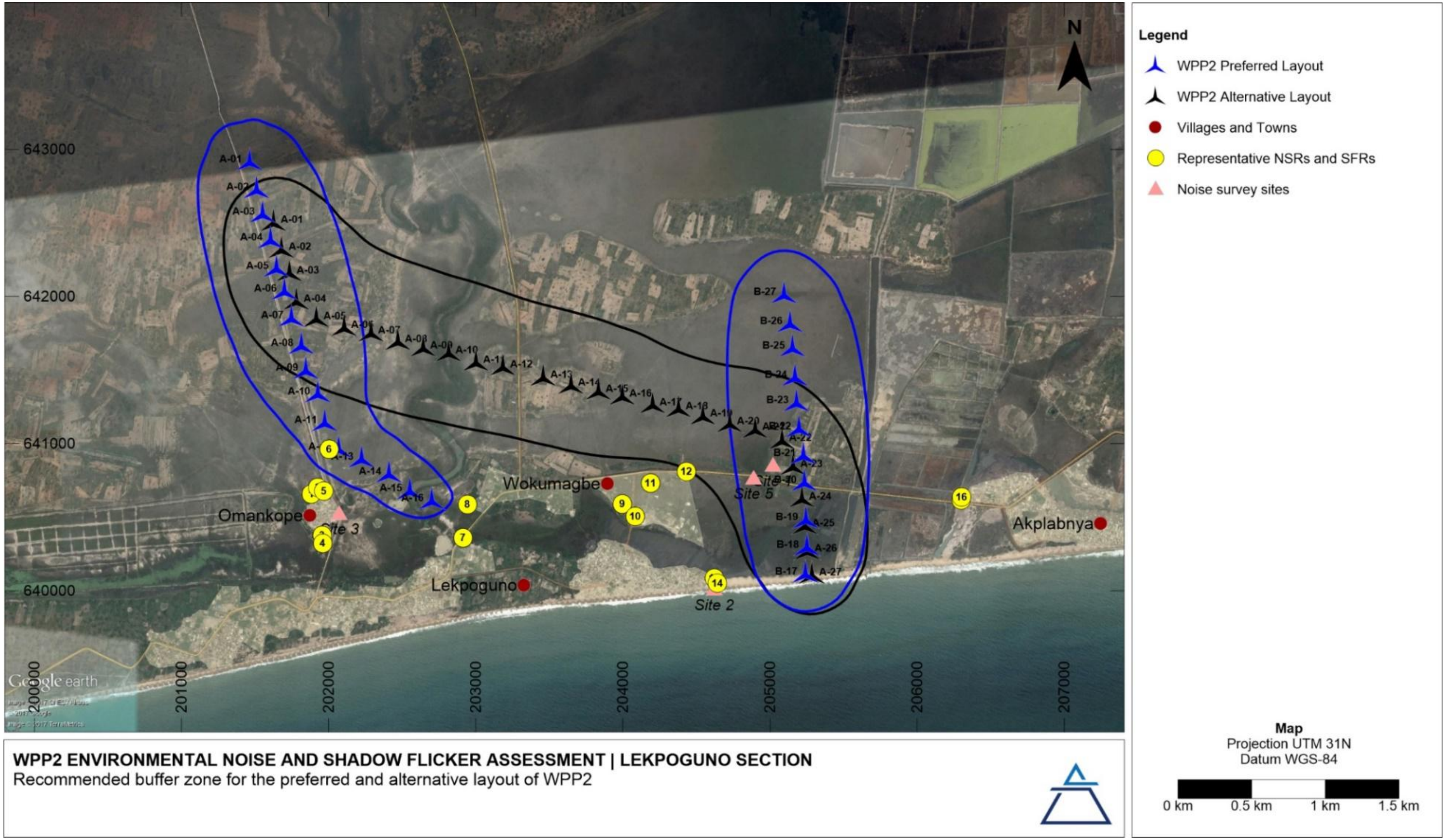

Figure 1: **Recommended buffer zone for the Lekpoguno section of WPP2, for noise impact mitigation and management**

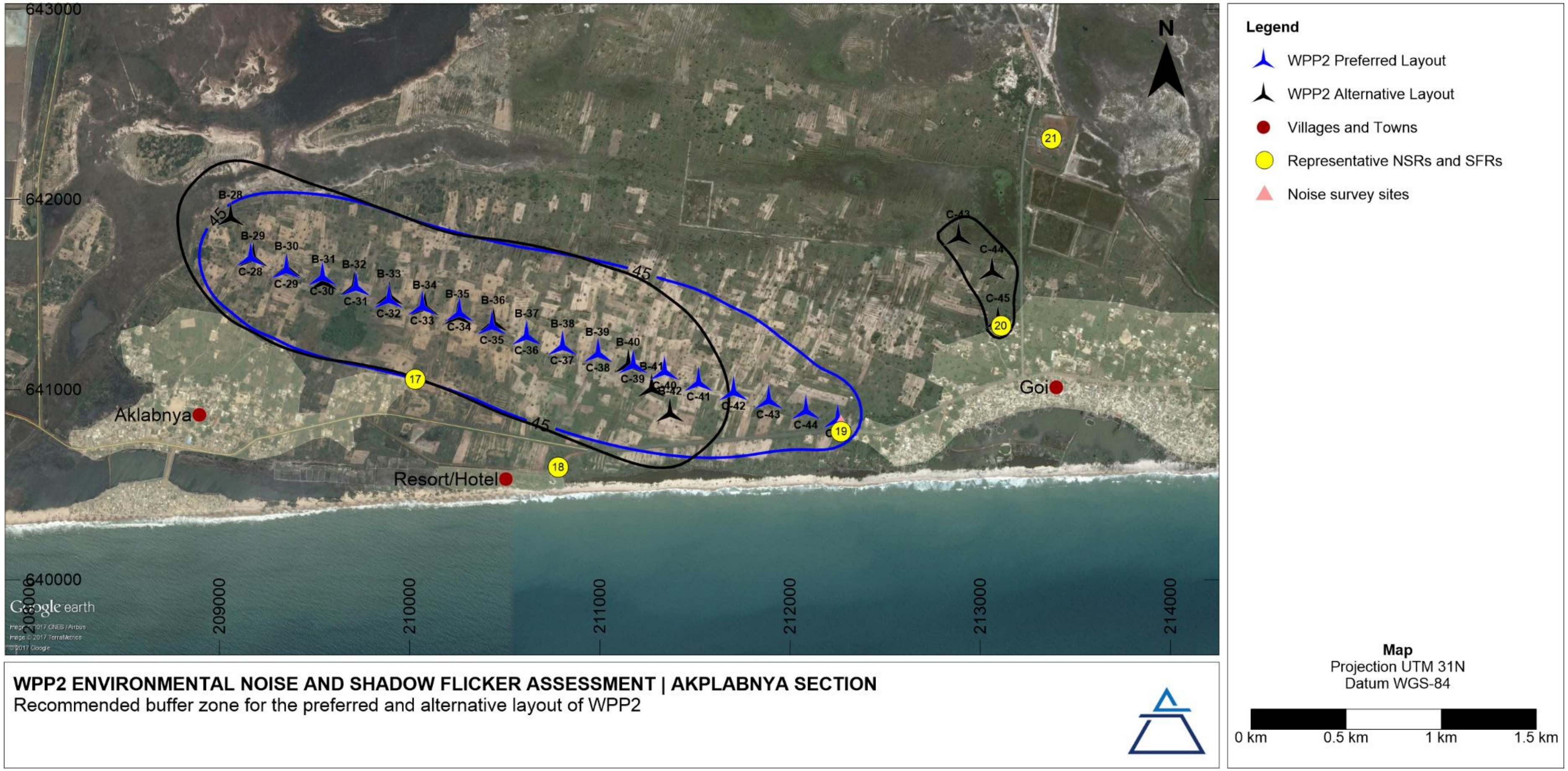

Figure 2: **Recommended buffer zone for the Akplabnya section of WPP2, for noise impact mitigation and management**

Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 9:

Conclusions and Recommendations

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9 CONCLUSIONS AND RECOMMENDATIONS

This chapter contains the main conclusions and recommendations from the ESIA process, provides the key findings of the specialist studies (i.e. outlines the most significant impacts identified, together with the key management actions required to avoid or mitigate the negative impacts or enhance positive benefits), an integrated summary of impacts that will influence decision-making by the Competent Authority (i.e. the EPA) and the associated management actions. In addition, the chapter also includes the EAP's opinion on the environmental suitability of the project and whether the project should receive EP.

9.1 SUMMARY OF IMPACT SIGNIFICANCE: MAIN IMPACTS AND KEY RECOMMENDATIONS

This section provides a summary of significant impacts identified and assessed by the specialists in Appendices 1-8 of this ESIA Report (as noted in Table 9-1 below). The significant impacts and corresponding impact significance ratings before and after mitigation and associated mitigation and management measures are summarised in this section.

Table 9-1: Specialist Studies

Specialist Team			
Name	***Organisation***	***Role/Specialist Study***	***Chapter in this ESIA Report***
Kofi Gatu	Seljen Consult Limited	Socio-economic Impact Assessment Study	Appendix 1
Dr. James Kojo Adomako	University of Ghana	Terrestrial Ecology Impact Assessment Study	Appendix 2
Dr. Erasmus Owusu Mr Patrick Morant Dr Andrews Agyekumhene	University of Ghana CSIR	Bird Impact Assessment Study Bird Impact Assessment Study Review Bird Impact Assessment Survey and study Review	Appendix 3 Appendix 3 Appendix 3
Dr. Wazi Apoh	University of Ghana	Heritage Impact Assessment Study	Appendix 4
Emmanuel Hayford	University of Ghana	Aviation & Communication Impact Assessment Study	Appendix 5
Alex Whitehead Charles Amankwah	Ghana Wildlife Division Sustainable Development Planning	Wetland Impact Assessment Study	Appendix 6
Nicolette von Reiche	Airshed Planning Professionals	Noise and Flicker Impact Assessment Study	Appendix 7
Scott Masson	SRK South Africa	Visual Impact Assessment Study	Appendix 8

It should be noted that all the mitigation and management measures proposed by the specialists, including those additional impacts and management measures identified by the EAP (such as impacts on traffic, stockpiling recommendations, waste management and the management of dangerous goods on site) have been included in the EMP (Chapter 8 of this ESIA).

9.1.1 Socioeconomic Assessment

A Socioeconomic Impact Assessment has been undertaken in order to provide supporting information (relating to socioeconomic aspects and associated impacts) in terms of the proposed development of the wind power facility. The assessment included desktop evaluations, as well as site evaluations.

Table 9-2 and Table 9-3 illustrate a summary of the total number of positive and negative impacts identified in the Socioeconomic Impact Assessment.

Table 9-2: Summary positive of Socioeconomic Impacts

		Significance Before Mitigation				**Significance After Mitigation**			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase	**1**	0	0	1	0	0	0	0	1
Operational Phase	**4**	0	0	2	2	0	0	2	2
Decommissioning Phase	**0**	0	0	0	0	0	0	0	0
TOTAL IMPACTS	**5**								

Table 9-3: Summary negative of Socioeconomic Impacts

		Significance Before Mitigation				**Significance After Mitigation**			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase	**7**	1	2	2	2	5	2	0	0
Operational Phase	**7**	3	1	3	0	7	0	0	0
Decommissioning Phase	**4**	1	1	2	0	4	0	0	0
TOTAL IMPACTS	**18**								

The assessment considered **both** the **preferred** and **alternative layout** and the significance for both impacts is the same. No negative impacts were assessed as being of high significance with implementation of mitigation.

Prior to mitigation, the overall significance rating of the negative socio-economic impacts associated with the proposed project is high to very low; whereas the overall significance rating of the positive socio-economic impacts associated with the proposed development is high to medium.

The following main mitigation measures were identified in the Social Impact Assessment:

- Design the wind power facility to good practice standards aiming at preventing releases (liquid waste, solid waste and dust) and minimising their potential consequences such that any effects would be insignificant.
- Keeping all communities abreast of all project development activities and they should sufficiently be consulted on all matters that concern them.
- Preparation of a “Compensation Action Plan” in order to minimize the adverse effects of the land acquisition on individuals, communities and/or families or clans to ensure that the PAPs are compensated properly.
- Development of a suitable programme of mitigation in the event of any significant chance finds in consultation with the Archaeology Department of the University of Ghana and the National Museums Board.
- Application of relevant national policies, labour laws and codes of concerning employment conduct and local employment and sourcing policies are to be used to give priorities to people within the project affected areas.
- Preparation of a Labour Management Plan as part of their Health, Safety & Environmental (HSE) Plan for the construction phase.
- Provision of alternative source of energy during the implementation of the project to ensure that uncontrolled utilization woody resources does not take place in the project area. In addition, there will be a need to explore more efficient ways of making charcoal through efficient kilns and saving energy with efficient stoves such as the Gyampa Stoves.

9.1.2 Terrestrial Impact Assessment

A Terrestrial Impact Assessment has been undertaken in order to provide supporting information (relating to ecological features and associated impacts) in terms of the proposed development of the wind power facility. The assessment included desktop evaluations, as well as site evaluations.

The study identified the mangrove and thicket vegetation as critical habitats that would be impacted by the project through clearance. The thicket has species such as *Ritchiea reflexa*, which is of conservation concern in Ghana. Furthermore, some fauna would be dislodged or destroyed with the implementation of the project. The soil would be compacted and as such could prevent natural regeneration after temporary facilities are removed.

Wind energy facilities are diffuse and distributed across a broad area and the footprint from an ecological perspective is considerably greater than the extent of transformation. Nevertheless, the areas of the site consist of plant communities with relatively low floral diversity.

The major impacts associated with the development are likely to occur during the construction phase. A large amount of physical disturbance and activity will occur during construction and effective management of associated impacts would be a key element in reducing the overall impact of the development.

Table 9-4 illustrates a summary of the total number of impacts identified in the Terrestrial Impact Assessment.

Table 9-4: Summary of Ecological Impacts

		Significance Before Mitigation				**Significance After Mitigation**			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase	**8**	0	3	5	0	3	5	0	0
Operational Phase	**4**	0	3	1	0	2	2	0	0
Decommissioning Phase	**3**	0	3	0	0	2	1	0	0
TOTAL IMPACTS	**15**								

All impacts in the Terrestrial Impact Assessment were rated with a negative status. Overall, as indicated in Table 9-4, the impacts identified in the Terrestrial Impact Assessment are predicted to be of a medium to low significance without the implementation of mitigation measures and of low/very low significance with mitigation measures. No impacts were assessed as being of high significance after the implementation of mitigation measures.

The Terrestrial Impact Assessment concludes that based on the consideration of the site and its present ecological state, as well as the nature of the proposed development, it is in the specialists opinion that the development cannot be precluded from the site on ecological grounds, provided that suitable measures, as noted in the study (Chapter 8 of this ESIA Report) are implemented. The study recommends that as far as possible, species of conservation concern are identified and adequate measures taken to protect them. Such species could be translocated to safe areas in the project area or their propagules collected and replanted outside the project impact areas.

The **preferred layout** is recommended since the alternative layout would not lead to any significant reduction of the anticipated impacts.

The following key management actions and mitigation measures include, but are not limited to:

- Careful pre-construction micro-siting of the infrastructure of the development.
- Preconstruction walk-through of the development footprint to locate species and habitats of conservation concern that should either be avoided or translocated prior to construction.
- Stringent construction-phase monitoring of activities at the site to ensure that mitigation measures are adhered to and that impacts such as erosion and alien plant invasion are managed before that become serious impacts that may be difficult to control.
- Minimising the footprint of the development as much as possible, with particular emphasis on rehabilitation of disturbed areas with local species.
- Ensure a rehabilitation and re-vegetation programme is effectively implemented.
- Adopt a faunal rescue plan and prohibit hunting/poaching activities.
- Ensure a good housekeeping during construction activities and all vehicles at the site should adhere to a low speed limit

9.1.3 Bird Impact Assessment

A Bird Impact Assessment has been undertaken in order to provide supporting information in terms of the proposed development of the wind power facility. The assessment included desktop evaluations, as well as one site evaluations in February 2016.

The study did not identify any bird species of special concern in the area. It must be noted however that more site surveys need to be conducted in the migration months of September, to November to confirm results of filed surveys that have already been done as well as to influence the post construction monitoring and mitigation measures that must be employed by VRA. As the study area is in close proximity to the Songor Ramsar Site which is an Important Bird Area, due diligence must ensure that significant impacts on bird populations do not occur.

The main impacts on avifauna identified as part of this study include disturbance associated with habitat destruction during the construction phase as well as disruption of local bird movement patterns and collision with turbines during the operational phase, which will remain of medium significance with mitigation measures. The other impacts on avifauna have been assessed to be of low significance following the effective implementation of recommended mitigation measures. Both layouts (preferred and alternative layout) are anticipated to lead to the same level of impacts.

Table 9-5 illustrates a summary of the total number of impacts identified in the Bird Impact Assessment.

Table 9-5: Summary of Bird Impacts

		Significance Before Mitigation				**Significance After Mitigation**			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase	**3**	0	1	2	0	0	2	1	0
Operational Phase	**3**	0	1	1	1	0	1	2	0
Decommissioning Phase	**2**	0	2	0	0	0	2	0	0
Cumulative Impacts	**1**	0	0	1	0	0	1	0	0
TOTAL IMPACTS	**9**								

All impacts in the Bird Impact Assessment were rated with a negative status. Overall, as indicated in **Table 9-5**, the impacts identified in the Bird Impact Assessment are predicted to be of a high to low significance without the implementation of mitigation measures and of medium to low significance with mitigation measures. No impacts were assessed as being of high significance after the implementation of mitigation measures.

The study recommends a pre-construction monitoring programme is recommended, particularly during the migration months where higher bird activity would be recorded. 24 hour-a-day monitoring during the three months September to November should be undertaken. Such real-time monitoring should be continued throughout the life of the facility to allow modification of the wind turbine operational regime in response to the presence of significant numbers of these birds.

The **preferred layout** is recommended since the alternative layout would not lead to any significant reduction of the anticipated impacts.

The following key management actions and mitigation measures include, but are not limited to:

- A pre-construction monitoring programme is recommended, particularly during the migration months where higher bird activity would be recorded. 24 hour-a-day monitoring during the three months September, October and November should be undertaken. Such real-time monitoring should be continued throughout the life of the facility to allow modification of the wind turbine operational regime in response to the presence of significant numbers of these birds.
- The review of monitoring data and results should strive to identify sensitive locations, including turbines that may require additional mitigation. If unacceptable impacts are observed (in the opinion of the bird specialist and independent review), the specialist should conduct a literature review specific to the impact (e.g. collision) and provide updated and relevant mitigation options to be implemented. As a starting point for the review of possible mitigations, the following may need to be considered:
    - Assess the suitability of using deterrent devices to reduce collision risk (e.g. DTBird© and ultrasonic/radar/electromagnetic deterrents for bats)

  - Identify modification options to turbine operation to reduce collision risk if absolutely necessary and if other methods are not achieving the desired results (e.g. temporary curtailment or shut-down on demand).
- For the Preferred Layout, a non-essential, however best practice layout change suggested would be for Volta River Authority (VRA) to consider relocating the last three proposed turbines located along the coast at the Wokumagbe 1 site.

9.1.4 Archaeological & Cultural Heritage Impact Assessment

An Archaeological & Cultural Heritage Impact Assessment was undertaken as part of the ESIA Process.

Table 9-6 and Table 9-7 illustrate a summary of the total number of negative and positive impacts identified in the Archaeological & Cultural Heritage Impact Assessment.

Table 9-6: Summary of Negative Heritage Impacts

		Significance Before Mitigation				Significance After Mitigation			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase: Direct Impacts	**2**	0	0	2	0	0	2	0	0
Operational Phase: Direct Impacts	**1**	0	0	1	0	1	0	0	0
Decommissioning Phase: Direct Impacts	**2**	1	1	0	0	1	1	0	0
Cumulative Impacts	**1**	0	0	1	0	0	0	1	0
TOTAL IMPACTS	**6**								

Table 9-7: Summary of Positve Heritage Impacts

		Significance Before Mitigation				Significance After Mitigation			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase	**1**	0	0	1	0	0	0	1	0
Operational Phase	**0**	0	0	0	0	0	0	0	0
Decommissioning Phase	**0**	0	0	0	0	0	0	0	0
TOTAL IMPACTS	**1**								

Five of the above impacts were rated with a negative status and one with a positive significance. Overall, the above impacts are predicted to be of a high to medium significance without the implementation of mitigation measures. No impacts were assessed as being of high significance with the implementation of mitigation.

The study concluded that the project site is not located in a designated archaeological priority area nor contains any scheduled ancient monuments, listed buildings or locally listed buildings. There are no listed heritage sites located within the area of the property proposed for the project site.

However other cultural heritage sites of importance that needs to be considered during project implementation include:

- An abandoned clay house measuring 12 x 20m that was in ruins. It has only remaining short walls and no roof.
- The Buokomaa Shrine is an active shrine of the people of Wokumagbe

Given that all the activities related to project during the construction, operational and decommissioning stages shall be confined to the designated site, and the nature and magnitude of the activities, when mitigated, the impact on cultural resources will be medium to very low. The identified shrines in the areas surveyed will not be directly affected by construction activities should they be moved. However, it is expected that requirements for various pacification should be outlined in the Compensation Action Plan for the project, including effective dialogue with community members in the event of the necessity to move shrines. The key recommended mitigation action includes the strict observations of the cultural taboos during the construction and operation phases of the project.

The impact significance rating for **both,** the **preferred** and **alternative layout,** is anticipated to be similar.

9.1.5 Aviation Impact Assessment

An Aviation Impact Assessment has been undertaken in order to provide supporting information in terms of the proposed development of the wind power facility. The assessment included desktop evaluations, as well as site evaluations.

Table 9-8 illustrates a summary of the total number of impacts identified in the Aviation Impact Assessment.

Table 9-8: Summary of Aviation Impacts

		Significance Before Mitigation				**Significance After Mitigation**			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase: Direct Impacts	**0**	0	0	0	0	0	0	0	0
Operational Phase: Direct Impacts	**1**	1	0	0	0	1	0	0	0
Decommissioning Phase: Direct Impacts	**0**	0	0	0	0	0	0	0	0
Cumulative Impacts	**0**	0	0	0	0	0	0	0	0
TOTAL IMPACTS	**1**								

The impact identified in the Aviation Impact Assessment is predicted to be of very low significance with and without the implementation of mitigation measures.

The Aviation Impact Assessment concluded that the facility could have some form of interference on CNS system of the proposed future airport; however, this perceived interference would be very low for both the **preferred** and the **alternative layouts**.

High intensity lighting would need to be mounted on the wind turbine nacelles, with potential additional intermediate lighting on the turbine towers based on guidance from the GCAA. Best practice measures include dialogue with the Ghana Civil Aviation Authority on permit and lighting requirements.

9.1.6 Wetland Impact Assessment

As noted above, a Wetland Impact Assessment has been undertaken in order to provide supporting information in terms of the proposed development relating to wetland features and associated impacts of the power facility. The assessment included desktop evaluations, as well as site evaluations.

A review of available information and a preliminary site investigation indicated that a portion of the project location (the Goi site) falls within the Songor Lagoon Ramsar Site and Biosphere Reserve. This Ramsar Site and Biosphere Reserve is characterized by an extensive lagoon, estuarine habitat (in the east) and freshwater wetlands. The lagoon and associated habitats support a range of fauna and flora, but are known specifically for their importance for migratory birds. Large areas of the Songor Lagoon have been modified for salt production, agriculture and human settlement. Because of the beneficial use by the local community the Ramsar Site is zoned into three areas:

- A central Core Area
- A buffer zone and
- An outer transitional zone

The project area is situated within the more disturbed western extremity of the Songor Ramsar Site and Biosphere Reserve. The following sensitive habitats were identified within the project area (as defined by a 500 m radius):

1) Salt marsh
2) Lagoons
3) Freshwater wetlands and depressions
4) Open water bodies (freshwater)

Table 9-9 illustrates a summary of the total number of impacts identified in the Wetland Impact Assessment.

Table 9-9: Summary of Wetland Impacts

		Significance Before Mitigation				**Significance After Mitigation**			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase: Direct Impacts	**5**	1	2	2	1	3	2	1	0
Operational Phase: Direct Impacts	**5**	1	3	2	0	3	2	0	0
Decommissioning Phase: Direct Impacts	**1**	0	1	0	0	1	0	0	0
Cumulative Impacts	**1**	0	0	1	0	0	1	0	0
TOTAL IMPACTS	**12**								

A number of the impacts were applicable to both proposed alternatives, however the Alternative layout is likely to have a more significant impact on freshwater wetland habitat, and other semi aquatic fauna than the **Preferred layout** option. This is associated with the Alternative layout proposing to place a continuous line of turbines across the main seasonal watercourse and associated seasonal wetland. The likelihood of hydrological and physical changes to occur is high as well as the potential to encounter and disturb semi aquatic fauna.

The following key management actions and mitigation measures are recommended to be implemented:

- **Design Phase**
    - Prior to the commencement of construction a flood risk assessment must be undertaken to determine the flood risk posed to the turbines.
- **Construction Phase**
    - The construction zone must be inspected for active bird nesting site by an ornithologist.
    - Any birds that become trapped in the construction area must be removed and safely relocated.
    - Relocation of sensitive terrestrial and semi aquatic fauna prior to construction
    - Safely remove trapped terrestrial fauna
    - Clearing of vegetation must be kept to a minimum
    - Limit construction footprint (this will limit habitat loss)
    - Hydrocarbon lubricants and fuels must be stored and disposed correctly and safely
    - The establishment of new access roads must be kept to a minimum. Where possible utilize or upgrade existing roads.
    - Services to follow road servitudes
    - All chemicals (in addition to hydrocarbons) must be stored correctly
    - No material is to be stockpiled in wetland areas, mangrove areas or adjacent to tidal channels
    - Stockpiles must be protected from erosion/slumping
    - Hardened surfaces must be kept to a minimum
    - Fuel and other hydrocarbons must be stored off site
- **Operational phase**
    - Monitoring of the turbine sites and recording of bird strikes (if any)
    - Drip trays must be utilised during maintenance operations when changing hydrocarbon lubricants
    - Hydrocarbon spill kits must be kept on site
    - Hydrocarbon spills must be cleaned up rapidly

  - Adequate drainage must be provided where infilling has occurred to maintain wetland and estuarine system connectivity

- **Decommissioning Phase**
  - Rehabilitation of the turbine sites
  - Removal of all waste (skips to be provided and serviced regularly)
  - The working area must be screened using shade cloth fencing (terrestrial sites only)

9.1.7 Noise and Flicker Impact Assessment

A Noise and Flicker Impact Assessment has been undertaken in order to provide supporting information in terms of the proposed development of the wind power facility. The assessment included desktop evaluations, as well as site evaluations.

Table 9-10 illustrates a summary of the total number of impacts identified in the Noise and Flicker Impact Assessment.

Table 9-10: Summary of Noise and Flicker Impacts

		Significance Before Mitigation				Significance After Mitigation			
	Total Impacts	Very Low	Low	Medium	High	Very Low	Low	Medium	High
Construction Phase: Direct Impacts	**1**	0	0	1	0	0	1	0	0
Operational Phase: Direct Impacts	**2**	0	0	2	0	0	2	0	0
Decommissioning Phase: Direct Impacts	**1**	0	1	0	0	0	1	0	0
Cumulative Impacts	**1**	0	0	1	0	0	1	0	0
TOTAL IMPACTS	**5**								

Overall, all the impacts identified in the Noise and Flicker Impact Assessment can be reduced to low significance following the effective implementation of the recommended mitigation measures.

9.1.7.1 Noise

The assessment concluded that during the construction and decommissioning phases of the project, low significance noise impacts may be achieved by implementing basic good practice measures such as the maintenance of diesel mobile equipment, traffic management, and limiting noise generating activities to day-time hours.

The main impact identified during the operational phase is the exceedance of the noise IFC guidelines at several residential structures in the vicinity of the proposed turbines. This is particularly applicable to the Omankope Presbyterian Primary School (NSR6) which is situated approximately 70 m from WTG A-12 and where noise levels in exceedance of the 55-dBA day-time IFC guideline and Ghana EPA limit are expected should the GE 1.7-103 WTGs without LNTE technology be used. By using LNTE technology and changing the operational mode of WTGs A-10, A-11, A-12, A-13, A-14, A-15, and A-16 to NRO100 during the day (school hours), the LA90 may be minimised to levels below 55 dBA. However, given the sampled day-time background noise level within Omankope of 37 dBA, the increase in noise level will remain in excess of 11 dBA during school hours. The relocation of the school is therefore considered necessary. On average, NSRs within 5 rotor diameters from WTG arrays (assuming LNTE technology is employed) may be exposed to noise levels in exceedance of the IFC night-time guideline of 45 dBA.

From an environmental noise perspective, the alternative layout is the preferred option since it will result in noise levels below 45 dBA at residents of the more densely populated Omankope. Although the alternative layout will impact the Wokumagbe community more notably, fewer residences and community locations will be affected.

On average, exceedance of impact guidelines may occur up to 5 rotor diameters from WTG arrays. Given available satellite imagery, several residential structures fall within this distance from WPP2. Special measures must be adopted to manage noise impacts at all NSR within 5 rotor diameters of WTGs. Such measures include:

- The implementation of LNTE technology on all WTGs;
- Using NRO modes during specific times of the day at selected WTGs to reduce/minimise impacts.
- Establishing buffer zones (Figure 9-1 to Figure 9-2), around WTG arrays within which permanent residences, educational, and institutional activities must be restricted.

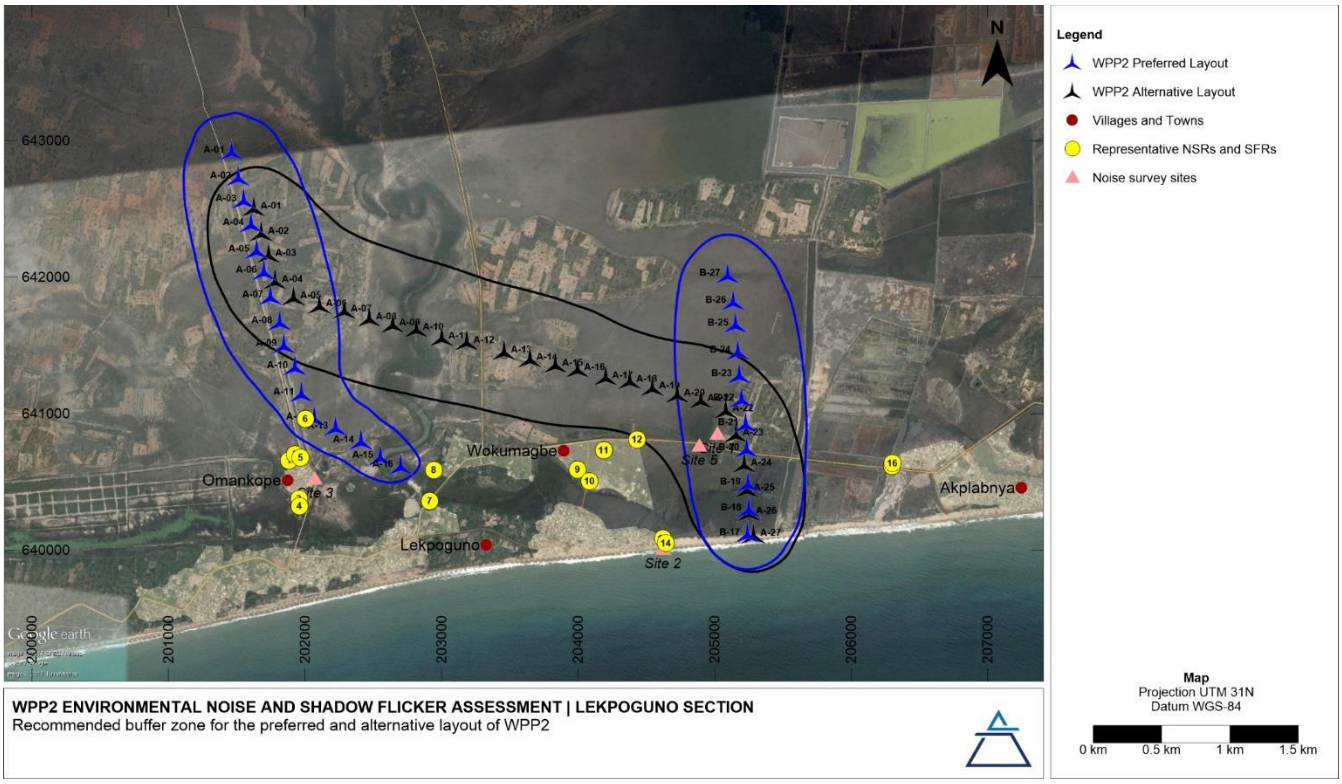


Figure 9-1: Recommended buffer zone for the Lekpoguno section of WPP2, for noise impact mitigation and management

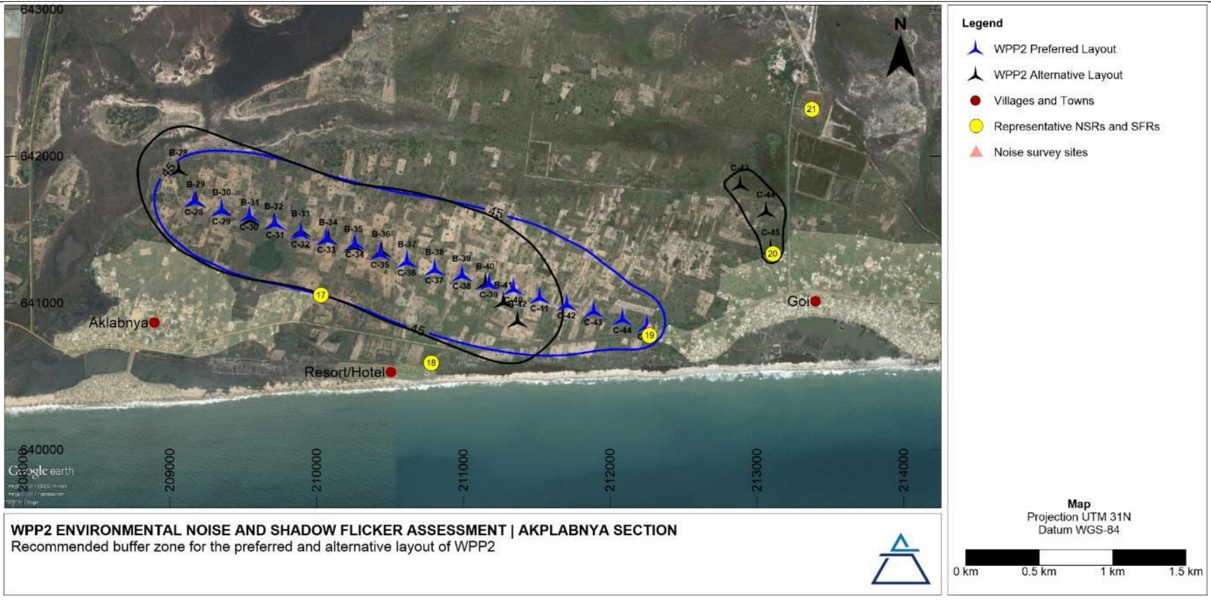


Figure 9-2: Recommended buffer zone for the Akplabnya section of WPP2, for noise impact mitigation and management

It is also concluded that, from an environmental noise perspective, the **alternative layout** is the preferred option since it will result in noise levels below 45 dBA at residents of the more densely populated Omankope. Although the alternative layout will impact the Wokumagbe community more notably, fewer residences and community locations will be affected.

9.1.7.2 Shadow Flicker

Shadow flicker impacts are only of concern during the operational phase and are anticipated to be of medium significance without mitigation (for the preferred and alternative layout).

From the simulation results for the preferred layout exceedance of the shadow flicker criterion is likely to occur at Omankope (in the vicinity of SFR6, SFR1, SFR2, and SFR5) as a result of WTG nos. 12 to 16, and Goi (in the vicinity of SFR19) as a result of WTG nos. 32 to 45.

The maximum shadow impact will occur at SFR6, the Omankope Primary School (333 hours per year). This school, which is situated ~70 m from the nearest WTG, will be affected by shadows from WTG no. 12 between 06:30 and 10:30 every day from March to November. Residents in the eastern part of Goi (in the vicinity of SFR19) will experience shadow in the afternoon hours between 16:30: to 18:00 from May to August every year.

From a shadow flicker impact perspective, the **alternative layout** is favoured since the number of affected SFRs are greatly reduced in comparison with the preferred layout.

The following main mitigation measures were identified in the Noise and Flicker Impact Assessment specialist study:

Construction and Decommissioning Phase

- Limit activities to day-time hours, complaints register and investigation through short term monitoring.

Operation Phase

- It is recommended that the GE 1.7-103 WTG with the LNTE be selected for WPP2.
- Reduced Noise Operating Modes
- In the event the preferred layout is selected, provision should be made to relocate the Omankope Presbyterian Primary School.

- Relocation of selected residences at Goi will be required for both the preferred and alternative layout
- Maintaining buffer and relocations as recommended for noise.
- Implement a noise monitoring programme

9.1.8 Visual Impact Assessment

A Visual Impact Assessment has been undertaken in order to provide supporting information in terms of the proposed construction of the facility. The assessment included desktop evaluations, as well as site evaluations.

Table 9-11 illustrates a summary of the total number of impacts identified in the Visual Impact Assessment

Table 9-11: Summary of Visual Impacts

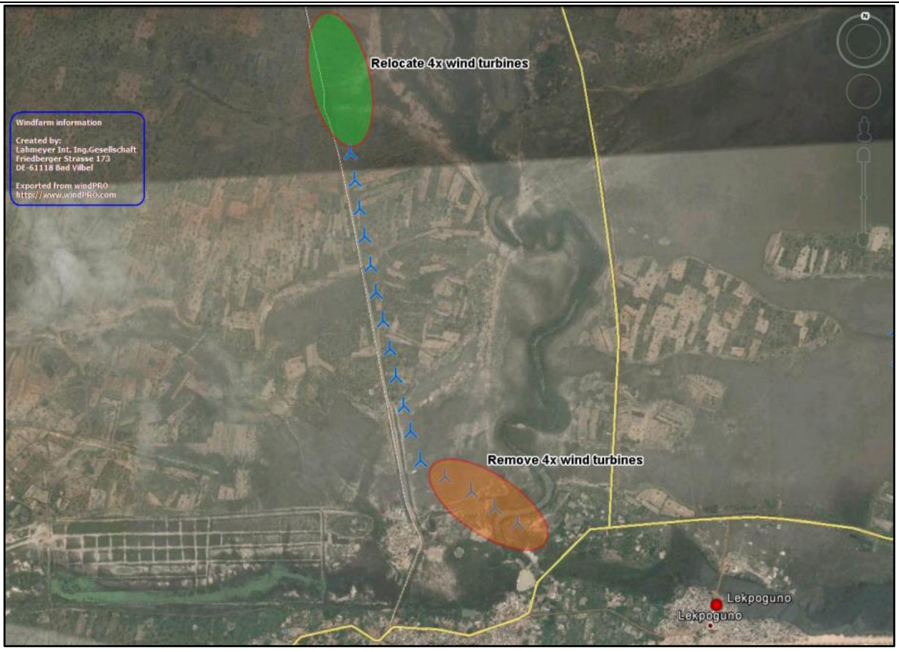
		Significance Before Mitigation				Significance After Mitigation			
	Total Impacts	**Very Low**	**Low**	**Medium**	**High**	**Very Low**	**Low**	**Medium**	**High**
Construction Phase: Direct Impacts	**2**	0	0	2	0	0	2	0	0
Operational Phase: Direct Impacts	**3**	0	0	1	2	0	2	0	1
Decommissioning Phase: Direct Impacts	**2**	0	0	2	0	0	2	0	0
Cumulative Impacts	**1**	0	0	0	1	0	0	0	0
TOTAL IMPACTS	**7**								

Overall, the impacts identified in the Visual Impact Assessment can all be reduced to a low significance with the effective implementation of mitigation measures, except for the altered Sense of Place and Visual Intrusion associated with the operation of the WEF which will remain of high significance.

It should be recognised, however, that there is a degree of subjectivity in determining receptors' responses to WEFs - wind turbines may be perceived as negative or positive, majestic or dominant, depending on receptors' perception of the landscape and the value they ascribe to 'green energy'. Many societies acknowledge that renewable energy projects reduce dependency on fossils fuels (and associated carbon emissions / climate change) and are therefore more tolerant of visual and sense of place impacts that there would be for other similar scale projects.

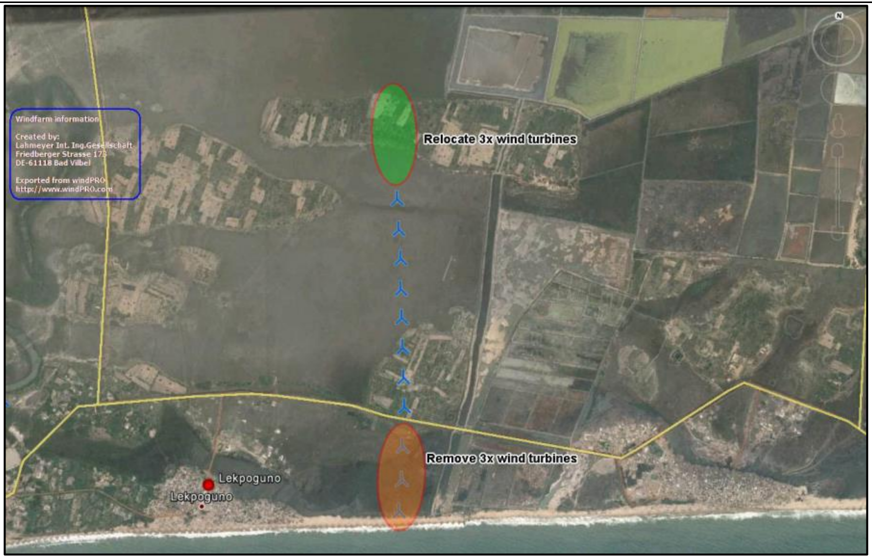
The Visual Impact Assessment concluded that:

- The WEF will change the sites from unbuilt, predominantly natural to built sites. The wind turbines will be prominent vertical elements in the landscape. The turbines will be visually overpowering and dominating to those receptors within 1 km of the turbines. There are many receptors (residents) within 1 km of the WEF at Lekpoguno, Akplabnya and Goi (note, the closest receptor is within 100 m of a turbine).
- For the Preferred Layout, a non-essential, however best practice, layout change suggested would be for Volta River Authority (VRA) to consider relocating a number of proposed turbines According to Figure 9-3 to
- Figure 9-5.



srk consulting	**VIA SCOPING PHASE INPUT** Lekpoguno-Aklabnya WEF	Project No. 499656

Figure 9-3: Suggested layout amendments of Lekpoguno-Aklabnya WEF (1)



srk consulting	**VIA SCOPING PHASE INPUT** Lekpoguno-Aklabnya WEF	Project No. 499656

Figure 9-4: Suggested layout amendments of Lekpoguno-Aklabnya WEF (2)

srk consulting	**VIA SCOPING PHASE INPUT** Lekpoguno-Aklabnya WEF	Project No. 499656

Figure 9-5: Suggested layout amendments of Lekpoguno-Aklabnya WEF (3)

The following main mitigation measures were identified in the Visual Impact Assessment specialist study:

Construction Phase:

- Limit and phase vegetation clearance;
- Avoid excavation, handling and transport of materials which may generate dust under very windy conditions;
- Rehabilitate disturbed areas incrementally and as soon as possible; and
- Set targets for the use of local labour to give locals a sense of ownership and pride in the project.

Operational Phase:

- Minimise associated infrastructure on site;
- Plant large indigenous trees around receptors in the immediate vicinity of the WEF to provide visual screening; and
- Maintain a uniform size (height) and colour (white) of the turbine towers, nacelles and blades and avoid any markings.
- Clarify the requirements of the Ghana Civil Aviation Authority and clarify if pilot activated lighting is possible.

Decommissioning Phase:

- Utilise existing access roads as far as possible;
- Avoid handling and transport of materials which may generate dust under very windy conditions;
- Keep all activities, material and machinery contained within an area that is as small as possible; and
- Rehabilitate disturbed areas incrementally.

9.2 SUMMARY: COMPARATIVE ASSESSMENT OF POSITIVE AND NEGATIVE DIRECT AND INDIRECT IMPACTS

This section provides a summary of the findings of the specialist studies (or inputs) that were sourced as part of this ESIA Process. Table 9-12 and Table 9-13 summarise the overall significance of these impacts following the implementation of the recommended mitigation and management measures. From this table it can be seen that there is one visual impact (altered Sense of Place and Visual Intrusion from the WEF) that will be of negative high significance as a result of the proposed project after all stipulated management actions are implemented effectively. The positive impacts generated by the project are associated with the economic benefits from employment opportunities, and potential positive archaeological gains.

Table 9-12: Comparative Assessment of Positive Direct and Indirect Impacts

Specialist Study	Overall Impact Significance Before Mitigation or Enhancement	Overall Impact Significance After Mitigation or Enhancement
Socio-economic Impact Assessment Study	High - Medium	High
Heritage Impact Assessment Study	Medium	Medium

Table 9-13: Comparative Assessment of Negative Direct and Indirect Impacts

Specialist Study	Overall Impact Significance Before Mitigation or Enhancement	Overall Impact Significance After Mitigation or Enhancement (Preferred and Alternative layout)
Socio-economic Impact Assessment Study	High -Medium	Low – Very Low
Terrestrial Ecology Impact Assessment Study	Low	Low- Very Low
Bird Impact Assessment Study	Low - High	Low - Medium
Heritage Impact Assessment Study	Medium - Low	Medium- Very Low
Aviation & Communication Impact Assessment Study	Very Low	Very Low
Wetland Impact Assessment Study	High - Low	Medium-Very Low
Noise and Flicker Impact Assessment Study	Medium-Low	Low
Visual Impact Assessment Study	High-Medium	High-Low

9.3 SUMMARY OF CUMULATIVE IMPACTS

Table 9-14 below provides a summary of the cumulative impacts that the proposed WPP2 project in conjunction with other proposed projects within a 20 km of the WPP2 will have on the receiving environment. The mitigation and management measures to be implemented for the cumulative impacts are detailed in the relevant specialist chapters.

Table 9-14: Comparative Assessment of Cumulative Impacts

Specialist Study	**Impact Description**	**Cumulative Impact Significance** **Before Mitigation**	**Cumulative Impact Significance** **After Mitigation**
Socioeconomic Impact Assessment	The project will make a significant contribution to national energy policy by moderating Ghana's dependence on fuel based energy. It will also provide stable and economic energy supplies, enhancing the sustainability of existing industry in the country.	Very Low	No mitigation applicable
Terrestrial Impact Assessment	The loss of unprotected vegetation types on a cumulative basis from the broad area may impact the countries' ability to meet its conservation targets, particularly the Gold Star index vegetation. The presence of the facility and associated infrastructure could potentially contribute to the disruption of broad-scale ecological processes such as dispersal, migration or the ability of fauna to respond to fluctuations in climate or other conditions. There are no other renewable energy facilities in the broad area the cumulative impact of these on habitat loss and the broad scale disruption of landscape connectivity is currently not a concern. As there are no other large development projects in the project's area of influence, the cumulative impact for both alternatives is thus assessed to be of low significance.	Low	Low

Specialist Study	**Impact Description**	**Cumulative Impact Significance** **Before Mitigation**	**Cumulative Impact Significance** **After Mitigation**
Bird Impact Assessment	According to Kingsley & Whittam (2005) and Percival (2005) there is little relationship between the scale of a wind farm and the amount of bird mortality that occurs. For examples a large, appropriately sited wind farm may kill fewer birds than a small, poorly sited one. However, in isolation, it is unlikely that small numbers of fatalities per year at a wind farm would be considered significant, unless some of those fatalities were of threatened species, in which case impacts might occur at the population level. It should also be noted that cumulative effects of small numbers of fatalities at two or more wind farms may be sufficient to result in population impacts. As a result when considering potential impact, it is important to consider the average effect of each turbine, the cumulative effect of the total number of turbines and associated structures such as overhead power lines, meteorological masts on a farm, and even the cumulative impact of other wind farms in the range of a bird population, particularly where rare or threatened species occur. (Australian Wind Energy Association 2002; Everaert & Stienen 2007). With regards to the proposed development at Wokumagbe and Goi, the birds observed in the area are species of no conservation concern as there is the wider landscape with several options available for species to adapt.	Medium	Medium
Aviation Impact Assessment	Existing information on the potential cumulative impacts of these wind farm projects is inadequate.	Very Low	No mitigation applicable
Wetland Impact Assessment	Changes associated with other associated activities such as the upgrade of roads may result in the loss of more estuarine and wetland habitat where the footprint of the main roads will be increased in addition to the obvious habitat loss associated with the turbines. From the available information, the apparent number of new roads required for the proposed Upwind project would result in numerous new wetland and watercourse crossings, potentially altering the surface flow and runoff of the entire area. The significance of the cumulative impact on the local freshwater wetland ecology by the proposed WPP 2 project and the Upwind project is therefore anticipated to be at least medium, however the confidence level is low as it will be dependent on the final design and construction methods proposed for the larger Upwind project.	Medium	Low
Archaeology and Cultural Heritage Impact Assessment	Because no sites of high archaeological significance were found within the present study area, the cumulative impact consequence is rated as slight with the probability of impacts being unlikely. These combine to provide a significance rating of medium for this project.	Medium	No mitigation applicable

Specialist Study	**Impact Description**	**Cumulative Impact Significance** **Before Mitigation**	**Cumulative Impact Significance** **After Mitigation**
Noise Impact Assessment	Cumulative impacts are highly likely at Akplabnya and Goi where the footprint areas of the UpWind project and WPP2 overlap towards the south.	Medium	Low
Visual Impact Assessment	Due to the close proximity of the two WEFs to each other, WPP2 and the UpWind WEF are likely to be viewed as a single WEF. The high number of turbines proposed for the UpWind WEF across a broad area will significantly alter the sense of place and, in combination, will significantly increase the overall visual impact of WPP2.	High	No mitigation applicable

9.4 CONSIDERATION OF ALTERNATIVES

The alternatives that were considered as part of the ESIA Phase for the WPP2 facility are included in Chapter 3 of this ESIA Report.

The alternatives considered are as follows:

- No Go Alternative
- Alternatives for the Generation of Electricity from a Non-Renewable Resource
- Technology Alternatives
- Layout Alternatives

9.4.1 No-Go Alternative

The no-go alternative assumes that the proposed project will not go ahead i.e. the proposed project is not constructed and developed into an operational energy facility. This alternative entails that the development of the proposed facility would not drive any environmental change and results in no environmental impacts on the site or surrounding local area. It provides the status quo or baseline against which other alternatives are compared and will be considered throughout the report.

The costs/implications and benefits of implementing the ‘no-go’ alternative is presented in

Table 9-15. Implementing the 'no-go' alternative entails that this WEF facility will not be contributing to environmental, social and economic change (positive/negative) in the area proposed at the project site.

Table 9-15: Costs and benefits of implementing the 'no-go' alternative

COSTS	BENEFITS
▪ **No additional power will be generated or supplied through means of wind energy generation by this project at this location.** ▪ **A WEF is not present to assist Government in achieving its energy generation targets.** ▪ **Electricity generation sources will remain unchanged.** ▪ **Electricity generation will remain constant (i.e. no additional energy generation will occur on the proposed site) entailing that the local economy will not be diversified.** ▪ **The local municipality's vulnerability to economic downturns will increase because of limited access to capital.** ▪ **No additional employment opportunities will be created. Both skilled and unskilled employment opportunities are anticipated to be created for the construction and operation of the WEF.** ▪ **No additional opportunities for skills transfer and education/training of local communities created.** ▪ **Potential positive socio-economic impacts likely to result from the project, such as increased local spending and the creation of local employment opportunities, will not be realised.**	No threatened vegetation will be disturbed or removed. The current landscape character will not be altered. No influx of people (mainly job-seekers), driven by the development of a facility will occur, which entails that there would not be additional pressures on the infrastructure and service delivery of local municipalities and towns in the area. No fragmentation of habitat or disturbance to faunal species.

In summary, whilst the "no-go" alternative will not necessarily directly drive any negative environmental and social impacts; it will also not result in any positive community development or socio-economic benefits. Furthermore, it will also not assist government in addressing electricity shortages and electricity demand within the country. Based on the above, the "no-go" alternative is not deemed to be the preferred alternative but will be taken forward and indirectly considered within the ESIA Phase as this alternative will serve as the baseline against which the potential impacts associated with the project are assessed.

9.4.2 Alternatives for the Generation of Electricity from a Non-Renewable Resource

VRA is undertaking more generation projects and is planning to add about 1,000 MW of generation capacity by 2020. This includes upgrading simple cycle plants to combine cycle to reduce cost of supply, pursuing Solar and Wind energy projects as well as pursuing the use of Liquefied Natural Gas (LNG) to generate electricity as a measure to secure future gas supply reliability. The proposed 76MW Power project could be obtained through the use of fossil fuels to generate electricity. However, by so doing, VRA will not be responding to the requirement of slowing down on fossil fuel consumption that is adding to global warming on the one hand and on the other hand depleting the resources.

The Government of Ghana has formulated a Renewable Energy (RE) policy that projects that 10% of Ghana's electricity needs should come from RE by 2020. The RE Law is to provide for the management, development and utilization of renewable energy (RE); to provide for the sustainable and adequate supply of renewable energy; and to provide for related matters. The object of this Act is to promote the sustainable development and utilization of RE resources for electricity and heat generation.

The uptake of renewable energy offers the opportunity to address energy needs in an environmentally responsible manner and thereby allows Ghana to contribute towards mitigating climate change through the reduction of greenhouse gas (GHG) emissions. According to the National GHG Inventory Report (2014), Ghana generated 3 955.9 GWh of thermal-based electricity to the economy in 2012. Out of this, 64.14%, 35.17% and 0.68% of thermal electricity were produced from LCO, natural gas and diesel fuels. This resulted in a total of 3.2MtCO2e greenhouse gas emissions, which was about 85% higher than the 2000 emission levels. This translated into CO2 intensity of 0.07 GgCO2e/GWh in 2000 to 0.26 GgCO2e/GWh in 2012.

The 10% Renewable Energy into the electricity mix targeted by 2020 means 500MW of RE and this project is helping achieve the national target. Thus the use of other forms of energy like fossil fuels (Light crude oil, diesel fuel oil, heavy fuel oil, natural gas) as an alternative power generation with high impact on climate change will not assist the Ghanaian government in addressing climate change, in reaching the set targets for renewable energy, nor will it assist in supplying the increasing electricity demand within the country.

9.4.3 Technology Alternatives

There is a limited range of alternative technologies (turbines) for commercial scale wind energy facilities. In addition, the technology is constantly evolving and there are currently no significant differences from an environmental perspective between technologies. As indicated earlier, VRA has engaged the services of two wind developers, Vestas Eolica and Elsewedy/EYRA (Energia y Recursos Ambientales S.A.). The WPP2 site is proposed to be equipped with WTGs manufactured by general Electric and would comprise 45 General Electric GE1.7-103, each of 1.7 MW nominal power on a hub height of 80 m above ground level.

9.4.4 Layout Alternatives

This section provides a description of the three site locations which form part of WPP2 for the preferred and alternative layout. The conceptual layout for each of the three sites is shown in Figure 9-6 to Figure 9-11 below.

9.4.4.1.1.1 Goi

The site encompasses 67.68 ha properties, where it is planned to install 16 turbines of 1.7 MW each for the preferred layout and no turbines for the alternative layout.

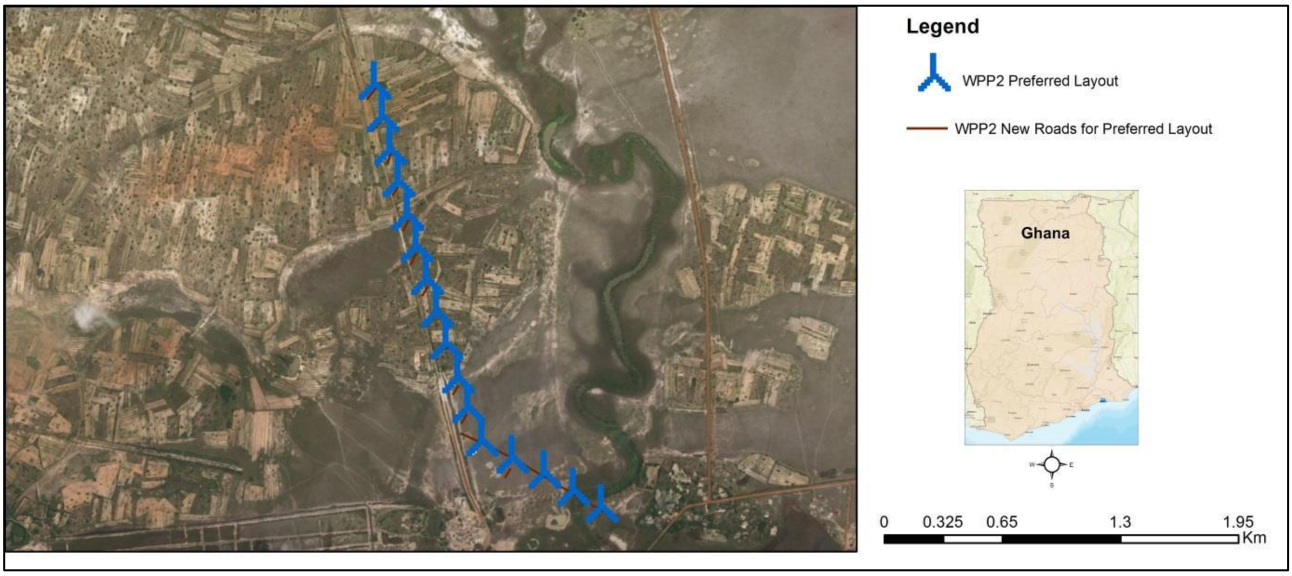


Figure 9-6: location of Goi preferred location

9.4.4.1.1.2 Wokumagbe 1

The site encompasses 60.64 ha properties, where it is planned to install 11 turbines of 1.7 MW each for the preferred layout and 27 turbines of 1.7 MW each for the alternative layout.

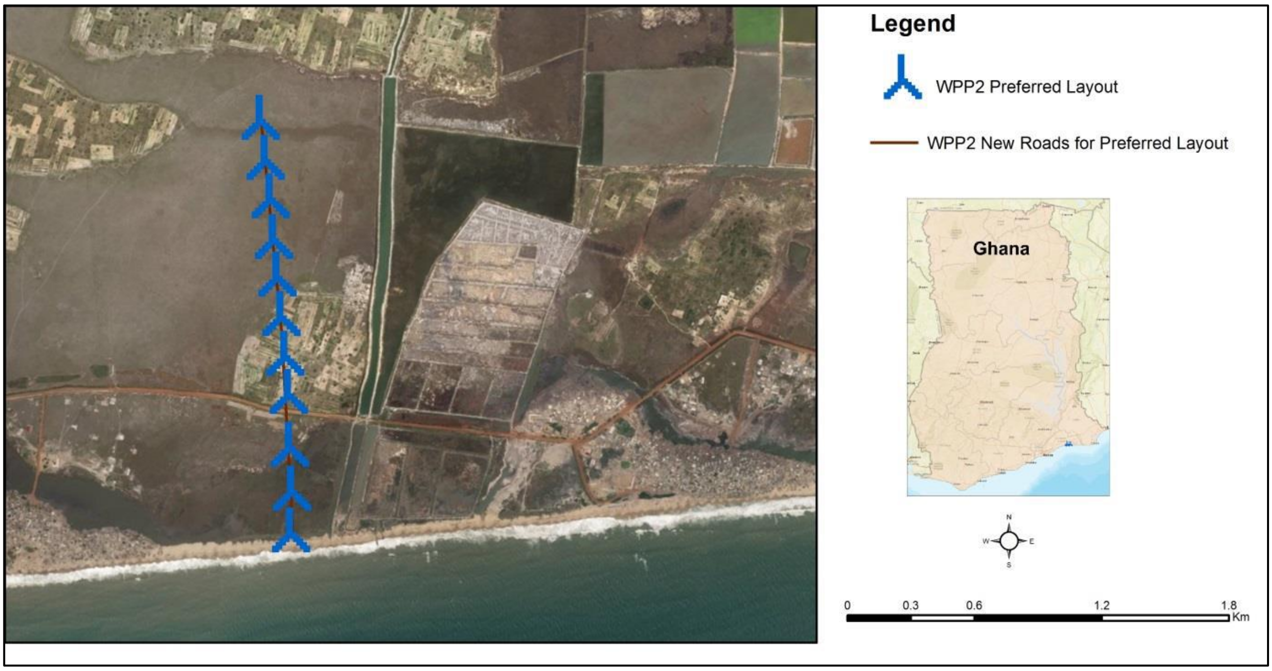


Figure 9-7: Location of Wokumagbe 1 preferred layout

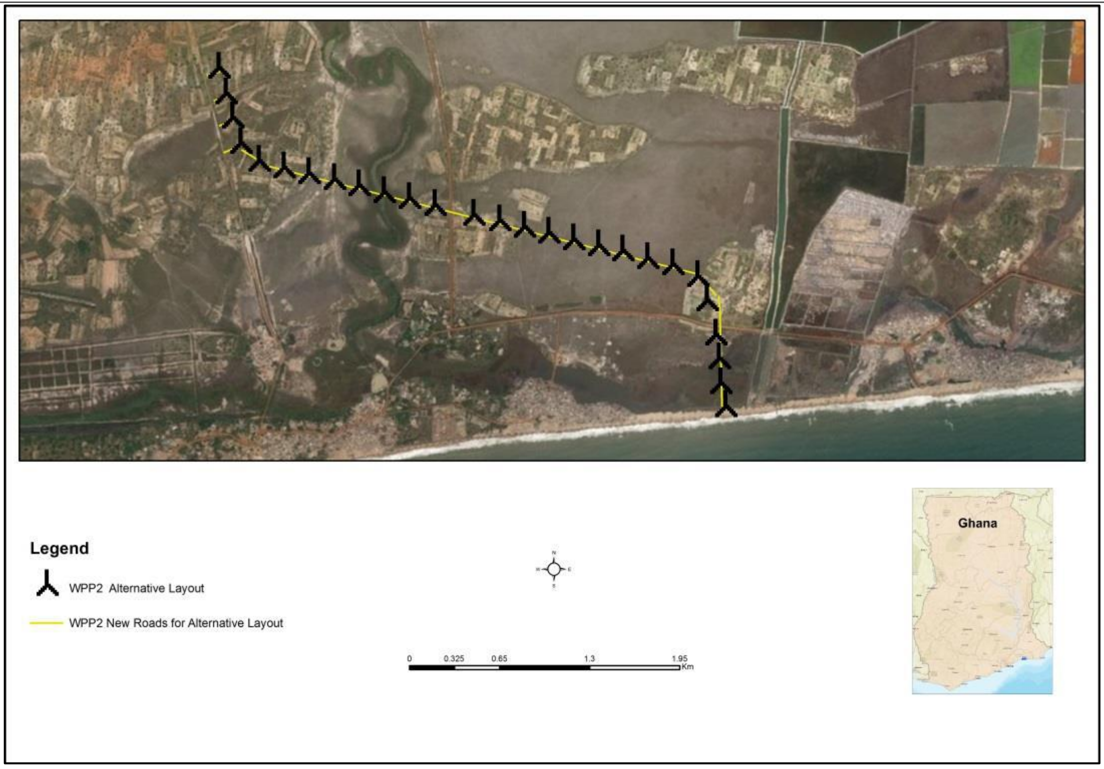


Figure 9-8: Wokumagbe 1 alternative layout

9.4.4.1.1.3 Wokumagbe 2

The site encompasses 94.38 ha properties, where it is planned to install 18 turbines of 1.7 MW each and 15 turbines of 1.7 MW each for the alternative layout.

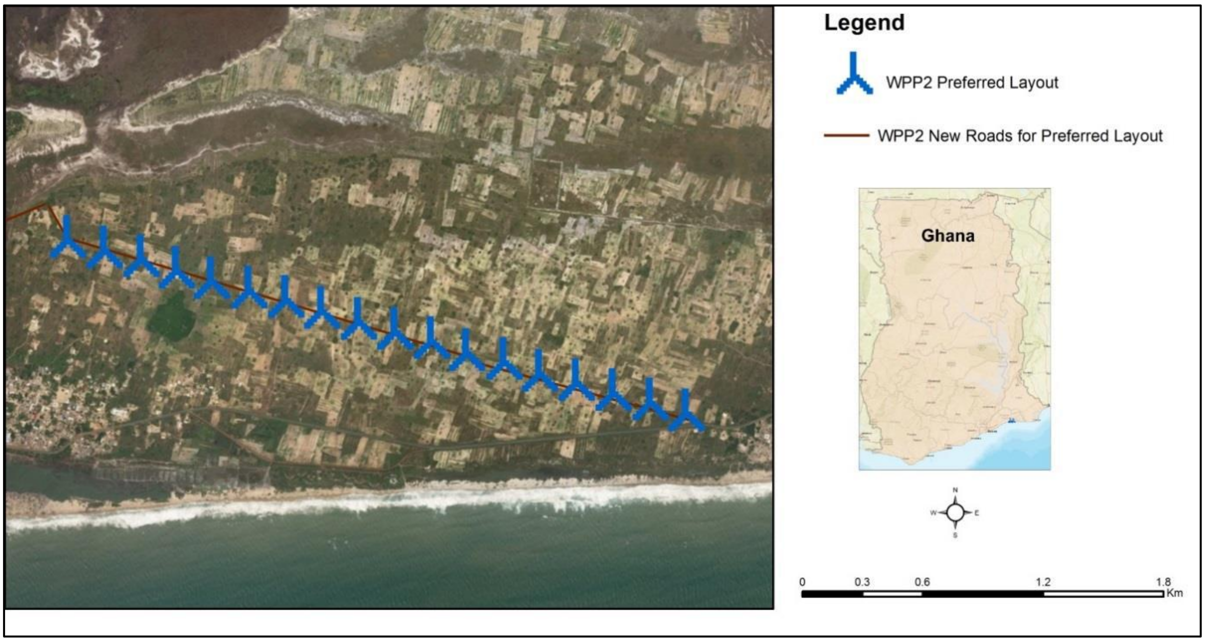


Figure 9-9: Location of Wokumagbe 2 preferred layout

Figure 9-10: Location of Wokumagbe 2 alternative layout

9.4.4.1.1.4 Wokumagbe 3

The site encompasses 56.16 ha properties, where it is planned to install 3 turbines of 1.7 MW each for the alternative layout and no turbines for the preferred layout.

Figure 9-11: Location of Wokumagbe 3 alternative layout

9.5 PERMITS AND LICENSES REQUIRED

The necessary statutory permits and licenses that have to be acquired for the construction and operational/maintenance phases of WPP2 are as follows:

- Environmental Permit from the EPA (also to be submitted to Energy Commission)
- Generation & Electricity Wholesale Supply Licence from the Energy Commission
- Development Permit from the Ada West District Assembly
- Air Space Safety Permit from the Ghana Civil Aviation Authority
- Water Use Permit from the Water Resources Commission

The legal basis for these statutory requirements is discussed in this Section and VRA will adhere to them during project implementation.

9.5.1 Environmental Permit from the Environmental Protection Agency

WPP2 is to be subjected to an environmental assessment and permitting prior to construction as required under the Environmental Protection Agency Act, 1994 (Act 490). Subsequently, before clearing of the proposed site is initiated, an Environmental Permit must be granted by the EPA in terms of the EIA Regulations. In view of this, VRA has formally registered the project with the EPA. As part of the process, the EPA accepted the Scoping Report and Plan of Study for the ESIA. This ESIA report has therefore been compiled to provide the EPA with the information required to decide on whether to grant or reject the issuance of an Environmental Permit.

9.5.2 Generation & Electricity Wholesale Supply License from the Energy Commission

The provisions of the Energy Commission Act (Act 541), 1997 require the Project proponent to be issued with a "Generation & Electricity Wholesale Supply Licence" prior to commencement of the operation of the wind power project. However, before the issuance of such a license for the operational phase, the following are also required to be issued:

- Provisional License
- Siting Permit
- Construction Permit

Details of these requirements have been outlined in the "***Licence Application Manual for Service Providers in the Electricity Supply Industry***" dated May 2012. So far, the Energy Commission has since issued a provisional license for the WPP 1. The next step is to obtain a Siting Permit now that the site has been defined and the Construction permit. It must be noted that the issuance of the Construction Permit by the Energy Commission is subject to the granting of an Environmental Permit by the EPA.

9.5.3 Development Permit from the Ada West District Municipal Assembly

The provisions of the Local Government Act 462 of 1993, requires the Land Use and Spatial Planning Authority (LUSPA) formerly referred to as the Town and Country Planning Department (TCPD) to issue Development Permits for persons or organizations that wants to put up a building, transform an existing building, demolish an existing structure. LUSPA operates under the auspices of the respective Metropolitan, Municipal & District Assembly. The project is therefore required to acquire a Development Permit and a Building Permit

Application Form is required to be duly completed and submitted to the Ada West District Assembly, with required attachments.

9.5.4 Air Space Safety Permit by Ghana Civil Aviation Authority

In Ghana, all structures higher than 10 metres above ground level must be assessed and registered as potential obstacles to aviation. Under the provisions of the Ghana Civil Aviation Act 678, Act 2004, the Ghana Civil Aviation Regulations (GCARs), the Ghana Civil Aviation Authority (GCAA) is the competent authority that approves or refuses the erection of structures on or near an aerodrome as well as proposed future aerodrome.

With wind turbines for WPP2 having hub heights of 80 m for the preferred layout and alternative layout, they present an impact to aviation. Completed forms with associated cadastral maps were sent to GCAA, and they have in turn undertake relevant site inspection has been completed. VRA has since made payment towards the issuance of an airspace safety permit.

9.5.5 Water Use Permit from the Water Resources Commission

The Water Resources Commission Act (1996), Act 552 controls activities in and around water resources, as well as the general management of water resources, including abstraction of groundwater and disposal of water. Any abstraction of ground water for use on the project will require application from the WRC for the issuance of a Water Use Permit.

9.6 OVERALL EVALUATION OF IMPACTS BY THE EAP

Based on the findings of the specialist studies, which all recommend that the proposed project can proceed and should be authorised by the EPA, the proposed project is considered to have an overall low to medium negative environmental impact and an overall medium positive socio-economic impact with the effective implementation of recommended mitigation and enhancement measures.

This ESIA considered the nature, scale and location of the development as well as the wise use of land (i.e. is this the right time and place for the development of this proposed project).

With regards to the layout alternatives, based on specialist recommendations; both layouts will have similar impacts however the Noise study recommended the Alternative Layout and the Wetland Study in particular recommended the Preferred layout as one with the least impacts.

Ghana is currently facing considerable constraints in the availability and stability of electricity supply. The development of wind energy is important for Ghana to reduce its overall environmental footprint from power generation (including externality costs), and thereby to steer the country on a pathway towards sustainability. On a municipal planning level, the proposed project does not go against any of the objectives set within the districts. The proposed project will be in line with and will be supportive of the objective of creating more job opportunities. The proposed wind energy facility will assist in local job creation during the construction and operation phases of the project (if approved by the EPA). It should however be noted that employment during the construction phase will be temporary. During the operational phase of the project (estimated to be more 20 years), long-term employment opportunities will be created.

The locality of the proposed project will fall within an area that is a transformed and has fragments of sensitive environment however provided that the recommended management actions are implemented effectively, no residual negative impacts have been identified within the ambient of this EIA that, in the opinion of the Environmental Assessment Practitioner, should be considered “fatal flaws” from an environmental perspective, and thereby necessitate substantial re-design or termination of the project.

The findings of this ESIA show that all natural resources will be used in a sustainable manner (i.e. this project is a renewable energy project and the majority of the negative site specific and cumulative environmental impacts are considered to be of medium - low significance with mitigation measures implemented), while the benefits from the project will promote justifiable economic and social development.

In order to ensure the effective implementation of the mitigation and management actions, an EMP has been compiled as part of this ESIA Report. The mitigation measures necessary to ensure that the project is planned, constructed, operated and decommissioned in an environmentally responsible manner are listed in this EMP. The EMP is a dynamic document that should be updated regularly and provide clear and implementable measures for the establishment and operation of the proposed Wind Power facility.

Taking into consideration the findings of the ESIA Process and given the national and provincial strategic requirements for infrastructure development, it is the opinion of the EAP that the project benefits outweigh the costs and that the project will make a positive contribution to steering Ghana on a pathway towards sustainable infrastructure development. Provided that the specified mitigation measures are applied effectively, it is recommended that the project receive EP.

Environmental & Social Impact Assessment

for the proposed development of Wind Energy Facility in Wokumagbe and Goi (WPP2)

CHAPTER 10:

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