Environmental & Social Impact Assessment

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

Volume 2

APPENDICES

Environmental & Social Impact Assessment

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

APPENDIX 1:

Socio-economic Impact Assessment Study

SOCIO-ECONOMIC IMPACT ASSESSMENT REPORT:

Environmental & Social Impact Assessment for 75MW Wind Power Project situated at Wokumagbe and Goi in the Greater Accra Region - Ghana

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EXECUTIVE SUMMARY

As part of the project's Environmental & Social Impact Assessment (ESIA) Study, Mr. Kofi Gatu of Seljen Consult Limited was engaged to assess the potential socio-economic impacts that might occur through the installation of a proposed 76.5 MW wind energy facility that the Volta River Authority (VRA) is developing in Ghana. The terms of reference were to evaluate the baseline socioeconomic environment and the impact of the project on such environment with a view to providing recommendations to mitigate these impacts.

The wind power facility known as Wind Power Project 2 is to be developed at identified sites at Wokumagbe and Goi communities in the Ada West District of the Greater Accra Region and has an estimated capacity of 75MW. However, the final capacity of the project would be determined by the micro siting of the project 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. Currently, to reach the demanded capacity, 45 General Electric GE1.7-103 wind turbines each with 1.7 MW nominal power and on a hub height of 80 m above ground level will be installed on the site bringing the capacity to 76.5 MW. The integration of the wind farm to the existing grid would be done by a new substation in the wind farm and a new 40 km HV transmission line to the existing grid in Tema.

The project is required to comply with the relevant Ghanaian laws and regulations, as well as relevant international standards for environmental and social sustainability**.** Key ones of relevance to the project are in the areas of Environmental Protection, Public Health & Safety, Labour & Other Social responsibilities as well as Land Use & Planning. Those reviewed and are of relevance to the wind power project are discussed.

To predict the probable impact of the development it is important to have a clear understanding of the baseline socio-economic conditions of the study area. The revised structure for Ghana ESIA Reports requires the discussion of the following issues as part of the socio-cultural baseline information:

- The land area taken up by the development, its location clearly shown on a map and geographical coordinates provided.
- Human beings: (population composition and distribution, socio-economic conditions, cultural and ethnic diversity, population growth rate);
- Land use: (agriculture, forests, industrial, commercial, residential), transportation routes such as roads, rail, water and air, utility corridors;
- Social services: (electricity, telecommunication, water supply, hospitals, etc.);
- Cultural heritage: (unique features of the area or its people; cemetery, fetish grove, festivals, etc.).

The above data is used as a baseline against which predicted changes can be assessed for their significance. For this reason, the discussion of baseline socio-economic conditions has largely covered these issues within the context of the two project communities, namely Wokumagbe and Goi communities, the immediate impact area as well as the Ada West District in the Greater Accra Region, which is the broader impact area. The secondary and primary data on socioeconomic baseline information was collated at three levels of assessment, namely through literature review, public disclosure and project briefing with stakeholders. Through this process, an understanding of the social spectrum of the local area, the dynamics, hierarchies and wants of the local community was obtained. The information obtained was then analysed and summarised to identify the baseline socio-economic conditions, to determine the potential project impacts, to develop the mitigation measures and to enable monitoring and evaluation of 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, various socio-economic impacts, both positive and negative, are anticipated. The project benefits are at both national and local levels. At the national level, the project benefits will include:

1. Stabilization of electricity access and reduction of power outage in Ghana

2. Promotion of renewable energy and reduction of carbon dioxide equivalent for use in mitigating the country's emission commitments.

3. Stimulating economic growth in Ghana.

At the local level, the positive benefits include:

1. Employment opportunities for the local community during the construction and operation phases of the project (e.g. masons, carpenters, cooks and indirect spins-off, such as livestock and fish trade, ecotourism, etc.);

2. The rehabilitation of existing road networks will facilitate the transportation of livestock and fish products to external markets;

3. The project will provide human and financial assistance in the development of health and education facilities through Corporate Social Responsibility by the Client in order to improve health conditions and literacy of local community, especially the marginalized groups, the women and the youth.

Against the above positive benefits brought about by the project, there will be some negative socio-economic impacts emanating from both the construction and operation activities of the wind power project, some of which are:

1. Economic displacement due to acquisition of land of an area of about 193.31 Ha of land.

2. Visual intrusion because of project facilities such as the wind turbines,

3. Contamination of local culture due to influx of construction employees,

4. Increased conflicts and insecurity within the community,

5. Exploitation of natural resources,

6. Increased incidences of diseases such as HIV/AIDS

7. Potential challenges and impacts of labour force management, and

8. Increased accidents and occupational hazards.

Proposed management measures have been designed to promote positive impacts and avoid, minimize, manage, mitigate, or compensate for negative impacts. Subsequently, various recommendations have been proposed for the client to implement to ensure that proposed associated socioeconomic benefits are realised and impacts mitigated. Key amongst them include:

a) 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.

b) Keeping all communities abreast of all project development activities and they should sufficiently be consulted on all matters that concern them.

c) 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.

d) 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.

e) 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.

f) Preparation of a Labour Management Plan as part of their Health, Safety & Environmental (HSE) Plan for the construction phase.

g) 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.

LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
AIDS	Acquired Immune Deficiency Syndrome
AoI	Area of Influence
ARI	Acute Respiratory Infection
BID	Background Information Document
CBR	Crude Birth Rate
CSIR-SA	Council for Scientific and Industrial Research, South Africa
CWSA	Community Water and Sanitation Agency
DCE	District Chief Executive
EA	Environmental Assessment
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency - Ghana
EPA	Environmental Protection Agency
ESIA	Environmental and Social Impact Assessment
GHA	Ghana Highways Authority
GHS	Ghana Health Service
GLSS6/LFS	Ghana Living Standard Survey 6 with Labour Force Module
GMMB	Ghana Museums and Monuments Board
GN1	Guidance Note 1
GNFS	Ghana National Fire Service
GSS	Ghana Statistical Service
HDI	Human Development Index
HIV	Human Immuno Virus
HSE	Health, Safety & Environment
HV	High Voltage
I&AP	Interested and Affected Persons
I&APs	Interested and Affected Party
ICT	Information and Communication Technology
ILO	International Labour Organization
ISSER	Institute of Statistical Social and Economic Research

ABBREVIATION	MEANING
KVIP	Kumasi Ventilated Improved Pit latrine
MCE	Municipal Chief Executive
MDAs	Ministries, Departments and Agencies
MDG	Millennium Development Goal
MMDAs	Metropolitan, Municipal and District Assemblies
NDPC	National Development Planning Commission
OP	Operational Policy
PAP	Project Affected Persons
PHC	Population and Housing Census
PHCR	Population and Housing Census Report
PPE	Personal Protective Equipment
PPP	Public Private Partnership
PS	Performance Standard
PWD	Persons With Disability
RCC	Regional Coordinating Council
REDP	Renewable Energy Development Program
ROW	Right of Way
RPF	Resettlement Policy Framework
SCL	Seljen Consult Limited
STD	Sexually Transmitted Disease
TMS	Traffic Method Statement
TOR	Terms of Reference
UNDP	United Nation Development Programme
VRA	Volta River Authority
WB	World Bank
WC	Water Closet
WHO	World Health Organization
WPP	Wind Power Project
WTG	Wind Turbine Generators

GLOSSARY

DEFINITIONS	
Client	The Client refers to the developer, in this case the Volta River Authority
Cultural Heritage Sites	Cultural heritage sites Tangible and intangible cultural heritage sites and items,
Currently employed	There are two situations in which a person can be classified as being currently employed. Either the person was engaged in any work (as defined above) during the reference week, or he/she had an attachment to a job or business but for some reasons did not work during the reference week.
Currently Unemployed	A person is considered as currently unemployed if he/she was not engaged in any work (as defined above), had no attachment to a job or business, reported that he/she was available for work and had taken some specific steps to look for work.
Economically Active	A person is considered as economically active if he/she was employed or unemployed, or was available for work and seeking for work during the reference period; otherwise the person is economically not active.
Economically Not Active	The economically not active persons are those who did not work and were not seeking for work, that is are not currently employed or unemployed. This group includes persons such as those who are studying or performing household duties (homemakers), retired persons, the disabled and persons who were unable to work because of their age (too young or old to work).
Ethnicity	Ethnicity refers to the ethnic group that a person belongs to.
Formal and Informal Settlements	Formal and informal settlements including temporary and permanent human residents with both formal and informal tenure of land/structures
Industry	Industry refers to the type of product produced, or service rendered at the respondent’s place of work (irrespective of the occupation the person has). In this report, information on only the main product produced or service rendered in the establishment during the reference period has been considered.
Labour Force	This is the proportion of a country’s working-age population that engages actively in the labor market, either by working or looking for work. It provides an indication of the relative size of the supply of labor available to engage in the production of goods and services.
Local	Applies to the site and the closest communities which are Wokumagbe and Goi
District	Applies to the Ada West District
Occupation	Occupation refers to the type of work the person is engaged in at the establishment where he/she worked.

DEFINITIONS	
Population Dynamics	Population dynamics including population size, structure, settlement patterns and migration;
Regional	Applies to wider area of Greater Accra Region
Social Infrastructure	Social infrastructure including both tangible (i.e. schools, community centers, electricity and potable water services) and intangible items (i.e. meeting places, fishing areas etc.
Stakeholder	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.
Work	Work refers to any economic activity performed by the respondent that contributes to economic production of goods and services.
WPP2	The means the 76.5MW Wind Power Project 2 to be in Wokumagbe and Goi communities and its environs within the Ada West District of the Greater Accra Region of Ghana.

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SOCIO-ECONOMIC IMPACT ASSESSMENT

1. INTRODUCTION

Mr. Kofi Gatu of Seljen Consult Limited conducted the assessment of the potential socio-economic impacts that might occur through the proposed construction, operation and decommissioning of a 76.5 MW Wind Energy Facility at Wokumagbe and Goi communities (Figure 1.1) in the Ada West District of the Greater Accra Region of Ghana which is being developed by the Volta River Authority (VRA). This project is known as the Wind Power Project 2 or WPP2.

This socio-economic baseline study seeks to:

a) Understand the existing environmental and socio-economic context, and provide a benchmark of pre-project conditions to help predict proposed project induced changes and inform impact predictions (positive and negative), and assessments of the ability of social receptors to benefit from, adapt to and/or accept change;

b) Understand the existing socio-economic development context in the Study Area and the extent to which the proposed Project supports and is aligned with local development objectives, if applicable;

c) Identify individual stakeholders and stakeholder organizations that may have roles and responsibilities about implementation of the proposed Project (e.g. local administrators, politicians and development NGOs) as well as stakeholders who are sensitive to the proposed Project or able to support in the implementation of information disclosure and mitigation measures; and

d) Inform the client on how best to distribute information and collect feedback from stakeholders.

This Report presents an overview of the social receiving environment within the Study Area. It focuses on the social and economic effects that have potential to occur because of the construction and operation of the proposed WPP2.

2. TERMS OF REFERENCE FOR SPECIALIST

The terms of reference were to evaluate the baseline socioeconomic environment and the impact of the project on such environment with a view to providing recommendations to mitigate these impacts. The evaluation was to include an analysis of the situation and possible legal and regulatory requirements. Information to be obtained was to cover the following:

- Population and Demographics
- Ethnic, Religious and Cultural Heritage
- Historical resources
- Aesthetics and Tourism
- Infrastructure
- Education
- Land tenure and Land Ownership
- Land Use
- Employment/Manufacturing
- Agriculture
- Public Health (including HIV/AIDS)

Specifically, the TOR include the following:

- Provide the degree of fit with local, regional and national economic development visions and plans including renewable energy plans.
- To collate the socio-economic baseline data
- Provide a context for understanding feedback from stakeholders, specifically verifying reports from stakeholders and beginning to understand the differences between stakeholders' perceptions of impacts and actual impacts.
- Feed into proposed Project design and customizing of mitigation measures;

- Identify the impacts on overall economic development potential in the area including impacts on commercial enterprises nearby the site (incl. tourism, agriculture, small businesses and others).
- Identify impacts associated with project on direct and indirect employment and household incomes.
- Potential negative impacts on neighbouring land owners that have economic implications.
- Provide a basis for monitoring from which to evaluate actual residual impacts, and the success of mitigation measures following implementation;

3. PROJECT DESCRIPTION

The wind power facility known as Wind Power Project 2 is to be developed at identified sites at Wokumagbe and Goi communities in the Ada West District of the Greater Accra Region and has estimated capacity of 75MW. Currently, to reach the demanded capacity, 45 General Electric GE1.7-103 wind turbines each with 1.7 MW nominal power and on a hub height of 80 m above ground level will be installed on the site (See **Figure 3-1**) bringing the capacity to 76.5 MW. However, the final capacity of the project would be determined by the micro siting of the project 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. The integration of the wind farm to the existing grid would be done by a new substation in the wind farm and a new 40 km HV transmission line to the existing grid in Tema.

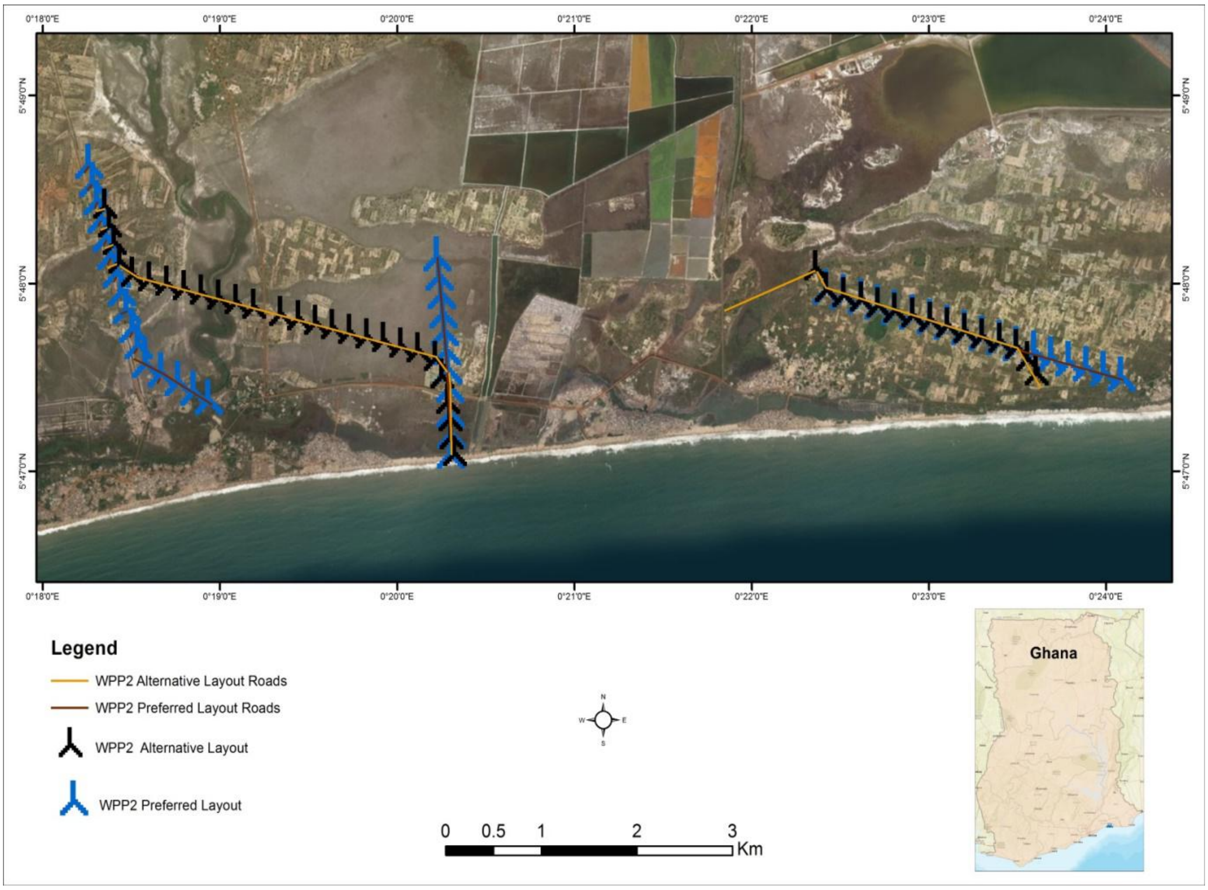

Figure 3-1: Locality Map for the Preferred and Alternative Layouts for WPP2

WPP2 will have the following main components, which will affect the social and economic characteristics of the affected communities due to the land take and project activities:

- **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).

Details on the project description is provided under Chapter 3 of the ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

4.1 OVERVIEW

The project is required to comply with the relevant Ghanaian laws and regulations, as well as the relevant international standards for environmental and social sustainability**.** Key ones of relevance to the project are in the areas of Environmental Protection, Public Health & Safety, Labour & Other Social responsibilities as well as Land Use & Planning. Those reviewed and are of relevance to the wind power project are listed below and discussed.

4.2 ENVIRONMENTAL PROTECTION

4.2.1 Applicable Laws

a) **The Constitution of the Republic of Ghana, 1992** came into force on January 7th, 1993. The Constitution is the fundamental law of Ghana and provides the framework on which all other laws stand. Within Article 36 of Chapter 0 - Directive principles of State policy, the Ghana Constitution states “The State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek co-operation with other states and bodies for purposes of protecting the wider international environment for mankind”. Within the Article 41(k) of the same Chapter 0, it is also stated, “it shall be the duty of every citizen […] to protect and safeguard the environment”. The right to information is guaranteed by the Constitution under Chapter 5 – Fundamental human rights and freedoms, Article 21(1) (f) stating that “All persons shall have the right to information subject to such qualifications and laws as are necessary in a democratic society”.

   This principle is shown also in the stakeholder consultation requirements within the EIA process. Based on the framework established by the Constitution of the 4th Republic of Ghana, the government initiates policy actions and legislation to promote sound environmental protection and management. It is also in response to the provisions of the

Constitution that the Parliament promulgated the Environmental Protection Agency Act 1994, which establishes the EPA who is responsible for enforcement of environmental laws.

b) The Ghana EPA Guidelines, Volume 2 Report – a follow up report linked to the Environmental Assessment Regulations, LI 1652 (1999) requires that a social impact assessment should address a range of issues. Those potential impacts and benefits considered applicable to the project are as follows:

- Social discontent, unhappiness, increased illness, and a loss of economic productivity, leading to loss of income;
- Impact on demographics and employment levels;
- Impact on the general lifestyle of local communities;
- Effects on the sacred and cultural sites of importance to the local community due to their cultural beliefs; and
- Contribution to local infrastructure and economic development and social facilities.

c) World Bank OP 4.01 – Environmental Assessment (Jan. 1999) evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimising, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. EA considers the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and trans-boundary and global environmental aspects.

d) IFC Performance Standard 1 (PS1) (2012): Assessment and Management of Environmental and Social Risks and Impacts - and supporting Guidance Note 1 (GN1) requires social risks and impacts of the project to be identified. The level of assessment should be proportionate to the location, scale and potential significance of the impacts. A social baseline should be presented on which to make the assessment. The assessment should consider all relevant risks and impacts, referring, where relevant, to Performance Standards 2-8 (IFC, 2012). If relevant, include mitigation and management measures relating to significant social impacts identified within an ESAP.

4.2.2 Applicability to Project

These legal requirements provide guidance on assessing the proposed Project's potential environmental and social risks and impacts and addressing these through planning and mitigation. The wind power project has been subjected to an environmental assessment and permitting prior to construction and issues on socio economic impacts are to be considered. This is ongoing, and it is important that mitigation measures provided to ensure improved likelihood and compensation are implemented as required.

4.3 PUBLIC HEALTH & SAFETY

4.3.1 Applicable Laws

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.

c) **Road Traffic Acts, 2004, Act 683** act 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

(Amendment) Regulations (1995), LI 952, LI953 and the Road Traffic (Amendment) Act 2008 (Act 761)

Any driver plying on the road cannot use a mobile phone, they cannot put a child on their lap whilst driving nor can a child below the age of fifteen sit on a passenger seat beside the driver. The act enforces the rule that all passengers should have their seat belts on. In addition, drivers would be required to carry on their vehicles all necessary accessories like fire extinguishers and genuine driving license. Again, no driver would be allowed to drive when he or she is improperly dressed.

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) **IFC Performance Standard 4: Community Health, Safety, and Security** recognises that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. PS4 requires that the risks of health and safety to the Affected Communities is assessed. The risk and impact should be minimised with mitigation and control measures. The risk factors to be included are infrastructure and equipment design, hazardous materials, ecosystem, exposure to disease, and risk of emergency. Security for the development should not use disproportionate force against local communities.

4.3.2 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. The laws seek 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 during 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.

4.4 LABOUR & OTHER SOCIAL RESPONSIBILITY LAWS

4.4.1 Applicable Laws

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. Section 9(c) 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 during 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.

b) **National Labour Commission Regulations 2006, LI 1822** is to aid the Labour Commission exercise the powers conferred on it under Section 152 of the Labour Act, 2003, Act 651. The Regulations provide for mainly negotiation, mediation and arbitration procedures and arrangements to ensure that labour related disputes and complaints are resolved amicably. It provides a sample form (Complaint Form A) for registering of complaints at the Labour Commission if mediation procedures are to be adopted. The LI provides for various options available to workers or employers through which disputes or complaints can be resolved. The key institution of concern here is the Labour Commission.

c) **Labour Regulations, 2007 (LI 1833)** contains regulations concerning employment agencies, conditions of employment, organised labour, employment of persons with disability, health and employment, restriction on recruitment including prohibition of human trafficking.

d) **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.

e) **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.

f) **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).

4.4.2 Applicability to Project

These legal requirements seek 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.

4.5 LAND USE & PLANNING LAWS

4.5.1 Applicable Laws

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 es**tablish a Local Government Service and this was to provide for the objects, functions, administration and management of the Service and for connected purposes. The object of the Service is to secure the effective administration and management of local government in the country.

c) **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 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.

d) **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.

e) The **State Lands Regulations (1962) LI 230** was passed for 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 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.

f) **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.

g) **Lands (Statutory Wayleaves) Act 1963 (Act 186)** provides for entry on any land for 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 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.

h) **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.

i) **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.

j) **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.

The RPF has been developed in line with the World Bank/IFC Performance Standards and as part of a World Bank funding application for support of the PPP programme. The RPF guidelines and requirements must be adhered to during the planning, construction and operation of any PPP project. This Project will be developed and operated by VRA representing the Government of Ghana in collaboration with various stakeholders. As such, the Project can be considered as PPP, and these guidelines will be taken into consideration in the planning and implementation of the resettlement aspects related to land acquisition.

k) **World Bank OP 4.11 – Physical Cultural Resources (July 2006), Revised April 2013** addresses physical cultural resources, which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be in urban or rural settings, and may be above or below ground, or under water. Their cultural interest may be at the local, provincial or national level, or within the international community. Any project involving significant excavations, demolition, movement of earth, flooding, or other environmental changes are to take cognisance of this policy in the ESIA.

l) **World Bank OP 4.12 - Involuntary Resettlement (December 2001), Revised April 2013** is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimise and mitigate its adverse social and economic impacts. It promotes participation of displaced people in resettlement planning and implementation, and its key economic objective is to assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement. The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects.

m) **IFC Performance Standard 5: Land Acquisition and Involuntary Resettlement** recognises that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) because of project-related land acquisition and/or restrictions on land use. The objectives are to avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.

PS5 also aims to avoid forced eviction and to anticipate and avoid, or where not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by:

i) Providing compensation for loss of assets at replacement costs and

ii) Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.

Further objectives include the need to improve, or restore, the livelihoods and standards of living of displaced persons and to improve the living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

4.5.2 Applicability to Project

These legal requirements seek 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.

5. METHODOLOGY

To predict the probable impact of the development it is important to have a clear understanding of the baseline socio-economic conditions of the study area. This is used as a baseline against which predicted changes can be assessed for their significance. Subsequently, the terms of reference (TOR) for the socioeconomic assessment study as provided under Section 2.0 of this report required the evaluation of the baseline socioeconomic environment and the impact of the project on the environment with a view to providing recommendations to mitigate these impacts.

The secondary and primary data on socioeconomic baseline information was collated at three levels of assessment, namely through literature review, public disclosure and project briefing with stakeholders. Through this process, we obtained an understanding of the social spectrum of the local area, the dynamics, hierarchies and wants of the local community. This involvement also gave us an opportunity to introduce ourselves and present the project to the local area. The information obtained was then analysed and summarised to identify the baseline socio-economic conditions, to determine the potential project impacts, to develop the mitigation measures and to enable monitoring and evaluation of the Project. Proposed management measures have been designed to promote positive impacts and avoid, minimize, manage, mitigate, or compensate for negative impacts.

5.1 LITERATURE REVIEW

The team reviewed the social economic factors, the existing information and available socio-economic studies of the study area. Key documentations reviewed concerning the baseline socioeconomic data for the project area included the following:

a) 2014-17 Medium Term Development Plan for the Ada West District Assembly prepared within the context of the Ghana Shared Growth & Development Agenda.

b) 2010 Population & Housing Census, District Analytical Report, Ada West District Assembly, Ghana Statistical Service, October 2014

c) 2010 Population & Housing Census, Regional Analytical Report, Greater Accra Region, Ghana Statistical Service, June 2013

d) 2010 Population & Housing Census, National Analytical Report, Ghana Statistical Service, May 2013

e) Ghana Living Standards Survey 6 with Labour Force Module (GlSS6/LFS), 2012/2013: Ghana Statistical Service, September 2013.

The team also assessed the legislative requirements for such an assessment in Ghana to international standards and the information obtained discussed under Section 4.0 of this report. In addition, a review of the Scoping Report for WPP2 (June 2016) that was submitted to the Ghana Environmental Protection Agency (EPA) and scoping opinion and all other available consultation feedback has been undertaken to inform this assessment. It must be noted that the source of data or information were not independently verified. Never-the-less, the existing data be indicative of the current situation. The specialist, therefore, does not assume responsibility for their accuracy or fullness in completion of fact or ideas

5.2 PUBLIC DISCLOSURE

As part of disclosing project information to the public, the study team developed a Background Information Document (BID)[1] for the project. The rationale for the BID is to allow Interested and Affected Party (I&APs) to register their interest in the project 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 literature and consultative information and assessment provided for input into this document

In addition, the Client also placed a Scoping Notice in the national newspapers of the proposed wind energy facilities to serve as public information for the Scoping Report for the EIA Study, as required under the procedures for the conduct of EIA in accordance with Regulation 15 (1) of LI. 1652. The Scoping Notice was disclosed in the August 9, 2016 edition of the Daily Graphic

[1] See Appendix 1 for the BID

as well as the August 24, 2016 edition of the Ghanaian Times. Any person(s) who have an interest, concern, or special knowledge relating to potential environmental effects of the proposed undertaking may contact or submit such concerns, etc.[2]. The Scoping Notice was also placed at the Ada West District Assembly as well as vantage areas within the communities for the information of the locals. It must be noted that the Scoping Report for the EIA Study is available at the Client's website at www.vra.com. Feedback on the Scoping Report has served as information source for a good appreciation of the socio-economic dynamics in the area.

5.3 PROJECT BRIEFING OF STAKEHOLDERS

Using a participatory approach, the study team used its existing knowledge of the region and knowledge of the social dynamics within the area to approach and engage government institutions and the communities surrounding the project site. Primary data collected for this analysis was both qualitative and quantitative, and was derived from key informants' interviews, village-level surveys, community meetings and focus group discussions. The Study Team conducted interviews with the various stakeholders including community leaders, local government officials, government departments, the affected farmers or individuals within the project area.

Verbal brief, in Akan/Ada (local languages) or in English language as may be appropriate, on project information provided the stakeholders 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 150MW of Wind Energy.

[2] See Appendix 2 for Scoping Notice

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 75MW.

e) Again, sites have been identified at Goi and Wokumagbe in the Ada West District as potential sites for a 75MW.

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 75 MW, 38 VESTAS V110 each with 2 MW nominal power and on a hub height of 95 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.
- ✓ The integration of the wind farm to the existing grid will be done by the construction of a new 161/33 kV substation (100 MVA) in the Wind Farm ("wind farm substation"); preliminarily it is assumed to be implemented in the northwest area of the wind farm and a new to be built 161 kV overhead transmission line (OHL) of approximately 40 km to the existing grid at the Tema substation.
- ✓ Within the wind farm, all 38 WTGs will be connected on MV level to the sub-station.
- ✓ Construction of underground electrical collection system leading to the project substation
- ✓ 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 engaged SCL and CSIR-SA to undertake the ESIA for the study.

j) The ESIA is on-going and relevant health, safety, environmental, social and economic issues are being identified for input into the ESIA study report. 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.

k) As part of the ESIA, 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.

l) It is expected that the ESIA Studies for the 2 projects are to be completed by June 2016 for which an Environmental permit is to be issued to allow for physical construction to commence.

m) Physical construction could commence by close of 2017.

A power point presentation on the key issues on the project was also prepared and made to stakeholders during the engagements where applicable. The various briefing with the I&APS undertaken are discussed below[3]. Table 5-1 provides the list of the issues and needs raised at the various briefing from the perspectives of the various stakeholders.

5.3.1 Meeting with Project Affected Communities

At the scoping sessions with communities around the proposed site, groups and individuals were first provided all relevant information about siting of, construction at and operation of the Wind Farm and the Consultants' experience on projects like 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.

5.3.2 Meeting with General Assembly of the Ada West District

The socioeconomic Team took opportunity of the General assembly of the Ada West District Assembly held on March 31, 2016 at the Ada West District Assembly hall and briefed 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

[3] See Appendix 3 for Pictures for the project briefings

- ✓ Department of Social Welfare
- ✓ Department of Community Development
- ✓ Environmental health & Sanitation Department
- ✓ National Disaster Management Organization
- ✓ Information Services Department
- ✓ Works Department

5.3.3 Consultations with State Agencies

Various engagements 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 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

5.3.4 Public Forum

In October 2016, the study team organised a major formal consultation 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 EIA report was presented to attendees.

Table 5-1: Stakeholders' Perceptions & Needs

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.
			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

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			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
			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,	Chief and Elders of	Pentecost Church,	1. They are aware of the choice of their	No Response needed.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
2016	Omankope	Omankope	community for the project	
			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 Assembly	District Finance Office, Sege Ada	1. They are aware of the project's location within the district	No Response needed.
			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 was explained to them. Background information to the project will be made available to them in due course. These documents contain all issues there is to the project.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			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 the Ada West District Assembly	Ada West District Assembly	1. The physical construction of the project is taking too long to commence.	Projects development in the power sector is quite laborious and requires very forms of studies to come to 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,

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
				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 landowners and ensure compensation is paid directly to such people.	Detailed property valuation will be done leading to the development of the Compensation Action Plan which is expected to adequately address this concern.
			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 bird's 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.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			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 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.
October 20, 2016	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.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			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 bird's 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 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.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			8. There is the need for VRA to acquire a construction permit for the project.	
			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.
			10. VRA should improve the road network within the communities as part of the project.	The road network will 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 Songhor 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.

6. DESCRIPTION OF THE AFFECTED ENVIRONMENT

6.1 OVERVIEW

This section presents a description of the social and economic characteristics of the project area. It is anticipated that the most significant socio-economic impacts will occur within Wokumagbe and Goi communities and its environs within the Ada West District of the Greater Accra Region. For this reason, the discussion of baseline socio-economic conditions as indicated earlier was looked at within the context of these two communities as the immediate impact area as well as the Ada West District in the Greater Accra Region, which is the broader impact area.

The revised structure for Ghana ESIA Reports requires the discussion of the following issues as part of the socio-cultural baseline information and these have been examined in this Report:

- The land area taken up by the development, its location clearly shown on a map and geographical coordinates provided.
- Human beings: (population composition and distribution, socio-economic conditions, cultural and ethnic diversity, population growth rate);
- Land use: (agriculture, forests, industrial, commercial, residential), transportation routes such as roads, rail, water and air, utility corridors
- Social services: (electricity, telecommunication, water supply, hospitals, etc);
- Cultural heritage: (unique features of the area or its people; cemetery, fetish grove, festivals etc).

6.2 LAND REQUIREMENTS

The proposed Wind Power Project 2 is located within the Wokumagbe and Goi communities in the Ada West District of the Greater Accra Region. The total land area of the District is approximately 323.72 Square km, which is about 10% of the total land size of the Greater Accra Region. The geographical coordinates for the proposed layout of the wind energy facilities at the three sites are provided in Table 6-1. WPP2 will cover an area of approximately 193.31 ha (refer to Table 6-2). 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 Facilities.

Table 6-1: Geographical Coordinates for WPP2

Site	Coordinates
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
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
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 6-2: Land Requirements for WPP2

Site	Land Required	
Wokumagbe 1	2.153km x 0.2km 0.879km x 0.2km	60.64 Ha
Wokumagbe 2	2.083km x 0.2km	41.66 Ha
Internal Grid	3.555km x 0.06km	21.33Ha
Substation	0.2km x 0.1km	2Ha
Goi	3.384km x 0.2km	67.68 Ha
Total		**193.31 Ha**

6.3 BACKGROUND OF PROJECT COMMUNITIES

The Ada West District is among the sixteen districts in the Greater Accra Region and it is situated in the south-eastern corner of Ghana. It was carved out of the former Dangme East in the year 2012 and established by the Legislative Instrument 2129 of 2012. The District lies between Latitudes 5°45'S and 6°00'N and Longitude 0°20'W and 0°35'E. 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 Kilometres (27.9 miles) from Wokumagbe through Goi to Kablevu.

The District is made up of approximately 52 communities with the coastal communities being relatively more compact as compared with the dispersed nature of communities in the inland. Some of the major settlements are Sege, Anyamam, Akplabanya, Koluedor, Koluedor, Lolonya, Wokumagbe, Bornikope and Goi with population above 2000. The wind farm site is located in two communities in the Ada West District, namely Wokumagbe and Goi. The project area is traditionally the home of the Ningo people in the west and the Ada people in the east. These groups belong to the larger group of the Dangbes who migrated from the east in the past. According to oral history, the Adas are believed to have migrated from Israel with a long stopover in Benin under King Agokoli then to Tagologo near Shai-Osodoku in the former Dangme West District. The people of Ada are called Dangmeli and they speak Dangme as their local dialect. It is estimated that, several hundred years ago, the Ada initially settled at a place called Okorwhem, a few meters away from the Anyamam in the south-western part of the District.

The indigenes of Ada West are part of the sub-group of people within the patrilineal society governed by hierarchical, centralized authority. The Ada state was originally made up of eight clans namely; Adibiawe, Lomobiawe, Tekperbiawe, Dangmebiawe, Kabiawe, Ohuewem, Korgbor and Kudjragbe. Later, the Kabiawe was divided into three separate clans, i.e. Kabiawe-tsu, Kabiawe-yumu and Kabiawe-Kponor. Each member belongs to a clan in which they are believed to have descended along the male line.

The vicinity of the wind farm site at Wokumagbe 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. The indigenes are engaged in fishing and farming activities.

The vicinity of the wind farm site at Goi is located along the road linking Akplabanya to the Goi Township. The name Goi came about because of the abundance of the Borassus sp (Emaa kube) on the land. This plant is called ‘Agor’ in Ga Adangbe. Since it was in abundance in the area it was called Goi.

6.4 GOVERNANCE (POLITICAL AND ADMINISTRATIVE STRUCTURE)

In Ghana, two parallel government systems operate at the local level: the district assembly administrative structure and the traditional administrative system. While the district administration consists of elected representatives and central government appointed personnel, the traditional administration derives from the chieftaincy institutions. At the community level, the elected assemblyperson serves as the main link between the district assembly and the community and these play important roles in community mobilization and development.

In the hierarchy of chieftaincy institution, the paramount chief assumes the highest rank and serves as the overlord with enormous powers. Underneath the paramount chief there are divisional and sub-chiefs who serve in different position and perform varied responsibilities. The chiefs have their own territory and assume the name of the stool they represent. The position of chief is protected by the Constitution of Ghana. Paramount Chiefs and elders constitute the traditional administrative institution and they play both judicial and executive functions within the communities, carrying great influence. They are the traditional custodians of the land and are recognized by the formal administrative structures. In the traditional setting, the traditional authorities also have their own court system, which adjudicates cases relating to land dispute, chieftaincy tittle disputes, violation of traditional customs, and disputes between localities, families and individuals. The chiefs in the district are members of the Regional house of chief and represent the interest of the people.

This section explains briefly the governance and administrative structures relevant to the proposed Project, including informal and formal leadership structures.

6.4.1 Formal Administrative Structures

The Ada West District Assembly is the highest administrative and planning authority in the project area. The District Assembly with the political and administrative authority is made up of elected and government appointed Assembly members. There are 22 Assembly members in the District out of which the 15 elected and 7 appointed. The members serve on the five statutory sub-committees of the Assembly. The established sub-committees function as the operating arm of the Executive Committee and assist in the implementation of specific activities of the Assembly. The sub- committees include: Justice and Security, Finance and Administration, Social Services, Works and Development Planning.

The General Assembly elects a Presiding Member from among themselves by two-third majority. He presides over the meetings of the assembly for a two-year term. The Assembly has an Executive Committee presided over by the District Chief Executive (DCE) who is usually appointed by the President with prior approval of not less than 2/3 majority of members of the Assembly present and voting at a meeting. The DCE who is the political head of the Assembly, heads the District Assembly. He also chairs the Executive committee, the decision-making organ of the District Assembly. The Central Administration assists in the general administration of the Assembly. The District Coordinating Director (DCD) with the support of Planning, Budget and Finance Officers and Heads of other sector departments such as Health, Agriculture, Education, and Physical Planning constitute the District Planning and Coordinating Unit.

6.4.2 Traditional Administration Structures

The Ada West District is part of the Ada Traditional Area. The Traditional political head of the Adas (Okorli) is the paramount chief (Matse). The next in command is the Clan Head (Wetsoyi) followed by the Chiefs (Asafoatseme). Every village is affiliated to a clan and in each of these clans is a sub-chief who is a subject to the Asafoatseme. There are also hamlets headed by headmen who preside over the people on behalf of the sub-chiefs.

Nene Osibli Sebi is the paramount chief of the land and he hails from the Tekpebiawe clan. The Tekpebiawe clan are the land owners in Goi. Lolonya, Amanyakorpe and Dawa share boundaries with Goi. The Goi indigenes are fisher, farmers and fishmongers. The land is owned by the Tekpebiawe Clan although 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.

The Traditional political head of the Adas (Okorli) is the paramount chief (Matse). The next in command is the Clan Head (Wetsoyi) followed by the Chiefs (Asafoatseme). Every village is affiliated to a clan and in each of these clans is a sub-chief who is a subject to the Asafoatseme. There are also hamlets headed by headmen who preside over the people on behalf of the sub-chiefs.

6.5 DEMOGRAPHICS

6.5.1 Population Size, Composition & Age Structure

The population of Ada West District according to the 2010 Population and Housing Census is 59,124 representing 1.5 percent of the region's total population. Males constitute 48.3 percent and females represent 51.7 percent (See Table 6-3). About 70 percent (70.3 %) of the population reside in rural localities. The district has a sex ratio (number males per 100 females) of 93.6. 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) 6.7 percent. 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 6-3: Population By Cohort By Sex in Ada West

Age Cohort	Both Sex		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%**

Source: Ghana Statistical Service, 2010 Population and Housing Census

The age structure of the district shows a broad base pattern that gradually tapers off with increasing age. The broad base of the population pyramid indicates that the population of the district is very young. This means that many resources will be needed for the provision of schools, health care facilities and employment opportunities for the youth. The Ada West District is relatively rural. The rural-urban classification of localities is population based on the Statistical Service classification with population of 5000 and above being urban, while community with population less than 5000 classified as rural. The district has more than two-third of the population (70.31%) living in rural areas while less than one third (29.70%) of the population living in urban settlements.

Table 6-4 shows the population by sex and age for the 2 project affected communities. Specifically, for the project communities, the population of Wokumgbe has 1,628 people made up of 765 males and 863 females, whilst that of Goi is 3,657, made up of 1,707 males and 1,950 females. For Goi, the working population is 46% whilst that of Wokumagbe is 40%.

Table 6-4: Population By Sex & Age in Wokumagbe and Goi

	Wokumagbe				Goi			
Age	**Male**	**Female**	**Total**	**Sex ratio**	**Male**	**Female**	**Total**	**Sex ratio**
0-4	147	141	288	104	237	232	469	102
5-9	110	123	233	89	214	233	447	92
10-14	77	95	172	81	198	201	399	99
15-19	90	81	171	111	195	186	381	105
20-24	66	80	146	83	163	183	346	89
25-29	59	62	121	95	128	157	285	82
30-34	42	52	94	81	107	121	228	88
35-39	33	57	90	58	100	115	215	87
40-44	30	34	64	88	73	83	156	88
45-49	15	22	37	68	45	79	124	57
50-54	22	28	50	79	60	97	157	62
55-59	15	13	28	115	37	44	81	84
60-64	10	20	30	50	42	52	94	81
65-69	17	11	28	155	38	29	67	131
70-74	9	14	23	64	34	59	93	58
75-79	7	12	19	58	18	26	44	69
80-84	11	10	21	110	11	29	40	38
85-89	-	7	7	-	6	13	19	46
90-94	4	1	5	400	1	7	8	14
95+	1	-	1	-	-	4	4	-
Total	**765**	**863**	**1,628**	**89**	**1,707**	**1,950**	**3,657**	**88**

Source: Ghana Statistical Service, 2010

6.5.2 Fertility, mortality and migration

The Total Fertility Rate (TFR) for the Ada West District is 4.0. The General Fertility Rate (GFR) is 115.3 births per 1000 women aged 15-49 years which is the highest for the region. The Crude Birth Rate (CBR) is 27.8 per 1000 population. The Crude Death Rate (CDR) for the district is 6.5 per 1000. Twenty-five (25) out of every hundred people in the district is a migrant. These migrants can be a potential asset for the district by tapping their skills and using them for the benefits of the district. It can however be a potential problem if they become a liability to the district by engaging in nefarious activities. Majority of migrants (54.0%) living in the District were born in another region in Ghana. For migrants born in another region, those born in Volta (15.6%) form the majority followed by Eastern (11.1%) and Ashanti (3.5%) regions.

6.5.3 Religion & Ethnic Composition

In the Ada West, Christianity is the predominant religion and is represented by 88.3% of the population, while Traditional Religion and Islam represent 1.5% and 4.8% respectively.

6.5.4 Marital Status

Within the Ada West District, about four in ten (44.2%) of the population aged 12 years and older are married, 41.4 percent have never married, 5.5 percent are widowed, 2.7 percent are separated, and 4.2 percent are in consensual unions. By age 25-29 years, more than half of females (66.6%) are married compared to a little over one-third of males (41.7%). At age 65 and above, widowed females account for as high as 58.0 percent while widowed males account for only 13.3 percent. Among the married, 45.0 percent have no education while half of those divorced (50.6%) and separated (50.0%) of the never married have never been to school. About 8 out of 10 of the married population (82.8%)) are employed, 2.8 percent are unemployed and 14.4 percent are economically not active. A greater proportion of those who have never married (62.5%) are economically not active with 3.5 percent unemployed.

6.6 ARCHAEOLOGICAL, HERITAGE & CULTURAL STRUCTURE

The people of Ada West have a very rich and old age culture. The celebration of Asafotufiami is one of the prominent festivals celebrated every year. Asafotufiami simple connotes “the firing of musketeers”. In real terms, it is celebrated once a year in the month of August 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 celebration of this festival is very symbolic featuring the carrying of Chiefs and Queen mothers in palanquins in remembrance of their predecessors and to make them realize that much is dependent upon them. Among the activities in the celebration is the trip to Okorwhem. The purpose of the visitation is to give an official announcement to the ancestors. It is usually led by four chief priests from the Adibiawe clan called the Laluwornyo. These priests are also expected to notify the ancestors following the death or entombment of a Chief.

Okor Forest or Okorhuem, the mystical ancestral home of the Adas can be found at Anyamam, about 10 kilometres south of Sege, the capital of Ada West District. Okorhuem represents the soul and embodiment of the Ada state. It is a unique forest with a rich cultural essence and history. Anyamam plays a very important role in the history of Adas because it is the home to the Okor Forest, which served as the last refuge for the Adas before they migrated to their various settlements. The importance of this historic heritage site to the future fortunes of Ada West District cannot be gainsaid since it has the capacity to open up most of the coastal communities to the outside world and also create the opportunities for the people. Besides the tourism potential of Okorhuem, it is a veritable resource centre for anthropological studies.

Part of the Songhor Lagoon (reported to be around the Lufenya section of 'the lagoon) is believed to be the abode of the lagoon god, Yomo. This area (c. 400 m^2) is considered sacred, and no activity; 'including fishing and salt collection is permitted in the area. The older generation believe that the salt in the lagoon is provided by the lagoon god. The fetish priest performs certain rites and offers sacrifices every year at the beginning of the dry season before the people are allowed to start salt collection.

Archaeological, heritage and cultural studies was undertaken by experts from the Department of Archaeology & Heritage studies from the University of Ghana. The reconnaissance survey conducted over the Wokumagbe project area did not reveal any archaeological site of significance. It is mainly flood zone and grazing fields. The land at Wokumagbe belongs to the Kuogbo clan. ‘Osuola’ is the deity of the land and the shrine of the ‘Buokumaa’ deity (See Plate 6-1) is situated on their land. The deity forbids chaos and murder hence its isolation from the community. The reconnaissance survey conducted over the Goi project area identified an abandoned local building and associated cultural remains on the site (See Plate 6-2). This archaeological site was tested for buried archaeological remains but could not yield any significant material culture.

Plate 6-1: The Shrine of Buokumaa deity at Wokumagbe

Source: Archaeological & Cultural Heritage Impact Assessment: ESIA for Wind Power Project (Wokumagbe & Goi Sites), April 017

Plate 6-2: Possible archaeological site in the Goi project area

Source: Archaeological & Cultural Heritage Impact Assessment: ESIA for Wind Power Project (Wokumagbe & Goi Sites), April 017

6.7 LAND TENURE SYSTEM

Land ownership in Ghana can broadly be divided into four main categories and these are customary ownership, state ownership, individual ownership and vested ownership involving shared ownership between the government (with legal interest held in trust) and the customary land owners (beneficiary interest). The current land tenure system constitutes a serious disincentive to investment in Ghana's economy. The variety of customary arrangements, combined with some inconsistencies in the procedures for deed and title registration, make it difficult, though not impossible, for potential investors to acquire large parcels of land for large-scale economic activities. This is particularly the case where the activity has a long economic gestation period.

In addition, the different traditional ownership structure, in some cases, requires negotiations with many allodial titleholders. Such negotiations can often be protracted, cumbersome, frustrating and expensive. It is unlikely that serious large overseas investors would be prepared to undertake protracted negotiations, on a one-to-one basis, with several allodial titleholders to put together suitable large parcels of land for large-scale commercial agricultural projects. Even where this is possible, investors potentially face the problem of on-going litigation over the legal right of the land they have acquired or leased. It is not uncommon for the rights to land, which has already been leased or rented and compensation duly paid by an investor to one allodial titleholder, to be challenged or disputed by another allodial titleholder. One commonly hears of stories from friends where disputes have arisen when individuals had successfully negotiated parcels of land for residential/commercial construction only to be challenged by other parties, who also claim ownership of, or interest in, the same parcel of land.

Land is the embodiment of the soul and spirit of the people in the Ada West District. In the District, customary ownership is the most predominant form of land ownership and it is families that own land. Land as an invaluable productive asset, and it is generally owned and managed by communities, families, and clan as well as private individuals through inheritance, lease and outright purchase. The methods of transferring land rights are within lineage through gift and inheritance. Land rights could also be transferred to non-members of the lineage through rent, sharecropping contracts (tenancies), customary mortgage and land pledging. These forms and mechanisms of land transfer have roots embedded in traditions and a reflection of the socio-economic arrangement. Land gift system was a common practice where the original owner of the title presents the land to another person without necessarily with exchange of money or property. This act is a permanent one, which cannot be reversed, if there are witnesses to the transfer. Land transferred through inheritance follow patrimonial rule imbedded in the customary law. The scarcity of land and appreciation in value of land has made land transfer through gift and land pledging, the thing of the past.

Head of the family manage the customary land. The family lands have fuzzy boundaries marked by landmarks and the family have collective right of ownership. People in the district who wish to own land for any development purpose may have to negotiate with the family heads. In such negotiation, land could be acquired through outright purchases, or the lease system. Land tenure is one of the teething challenges confronting investment because of the family ownership of land in practice. Land is owned by kinship groups or families and is administered by the elders of the group. Traditionally, land use rights of members of the group are permanent, where, for example, land once farmed by a member of the family cannot be taken away from him without his permission. In view of this, where land for development is needed in the interest of the public, the Assembly can invoke the compulsory land acquisition provisions. The District Assembly therefore have a compelling need to create land banks for future development.

The project will necessitate land acquisition and both physical and economic displacement. WPP2 will cover an area of approximately 193.31 ha. A Right of Way of 200m, 100 m each side of a wind turbine will be acquired. In addition, a right of way of 30m will be acquired with the associated 40Km 161 kV Transmission line. It is hoped that physical displacement for associated facilities can be avoided as much as possible. During the ESIA exercise, various bodies and processes were found to be involved in the land acquisition. The Wokumagbe site is located along the Wokumagbe - Akplabanya road. Ownership of this parcel is being contested by both the Kabiawe Clan of Omankope and Sowu & Tsawena clan from Wokumagbe. 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 Omankope, lands in the community belong to the clans (e.g.Kabiawe) in the community but not owned by individuals. He also pointed out that Wokumagbe is under Omankope so he is in charge of the land.

As indicated, the project site at Goi is located along the road linking Akplabanya to the Goi township. It is a farm land with crop and vegetable cultivations. Lolonya, Amanyakorpe and Dawa share boundaries with Goi. The Goi indigenes are fisherfolks, farmers and fishmongers. The land is owned by the Tekpebiawe Clan although 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.

6.8 ECONOMIC CHARACTERISTICS

6.8.1 Economic Activity Status

In the Ada West District, a little over Seventy percent (73.0%) of the population aged 15 years and older are economically active while 27.0 per cent are economically not active. Of the economically active population, 95.8 percent are employed while 4.2 0 percent are unemployed. For those who are economically not active, a larger percentage of them are students (58.8 %), (15.2 %) perform household duties and 12.5 percent are too old/young to work. Five out of ten (51.6%) have worked before, seeking work and available while 48.4 are unemployed and are seeking work for the first time.

Table 6-5 provides the activity status of persons above 15 years in the 2 project communities.

Table 6-5: Activity status of persons 15 years and older by sex in Wokumagbe and Goi

Activity Status	Wokumagbe			Goi		
	Male	Female	Total	Male	Female	Total
Economically active	321	408	729	731	904	1635
Employed	274	311	585	700	825	1525
Unemployed	47	97	144	31	79	110
Economically not active	110	96	206	327	380	707
Total	**431**	**504**	**935**	**1058**	**1284**	**2342**

Source: Ghana Statistical Service, 2010

As indicated, 95.8 percent of the economically active population in the Ada west District is employed. This proportion is quite high compared to other districts in the region. It is recommended that the status quo be examined and if possible improved upon. The females also lag behind the men in proportion concerning employment. Equal opportunities regarding gender should be closely looked at. It is also worth mentioning that the age group with the highest level of unemployment is the 20-24 age groups. This age group is also one of the most vulnerable age groups and they can succumb to all sorts of illegal temptations. Some employment drives should be specifically targeted at this age group.

There are no major manufacturing activities in the district. However, some of the citizens are engaged in other on small-scale industrial activities. These activities are categorized into food processing, alcoholic beverages, manufacturing and service industries. The major manufacturing industries are mainly in metal fabrication, block making, and food processing. There are small-scale workshops with basic equipment located in some of the urban centres to produce metal products such as hand tools for farming and cassava graters.

Agriculture constitutes the main economic activity and a major source of livelihood for most of the rural dwellers. According to the 2010 Population and Housing Census, the agriculture sector provides employment for about 42.5% of household head 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 and other sister districts.

There is only one bank in the district, the Ada Rural Bank, which is an agency whose headquarters is located at Kaseh in Ada East District. Considering the production factors of proximity and time, these banks are woefully inadequate. Besides the banks, the Micro-Finance and Small-Scale Loan Centre (MASLOC) has also assisted farmers and businesspersons with small-scale loans to enhance production and business.

The Gulf of Guinea and the vast wetlands is very large resource base for marine fishing and eco-tourism. The large savannah plains are suitable for irrigation, livestock rearing and large-scale farming among others. These resources are opportunities for investment in areas such as processing of water melon, tomatoes, and pepper, mango and dairy products (there is an existing Milk collection point at Sege). The presence of NGOs and financial institutions provides opportunities for collaboration. Some of the major constraints hindering a swift growth of the agriculture sector include low crop yield and output due to low soil fertility and over-dependency on rainfall; unsustainable agriculture practices; limited number of extension services; low agriculture mechanization; low exploitation of groundwater for irrigation purposes due to lack of irrigational inputs; incidence of limited value addition and high post-harvest losses as well as limited access to marketing centres due to poor road network.

6.8.2 Employment Status And Sector

Within the Ada West District, of the population 15 years and older, 60.5 percent are self-employed without employees, 14.2 percent are contributing family workers and employees respectively. 1.8 percent are apprentice and 4.4 percent are casual workers. Overall, men constitute the highest proportion in each employment category except for self- employed without employee(s) and contributing family worker as well as apprentices. The private informal sector is the largest employer in the district, employing 89.6 percent of the population followed by the private formal with 5.7 percent.

Of the employed population, about 42.1 percent are engaged as skilled agricultural, forestry and fishery workers, 18.6 percent in craft and related trade. 17.4 percent are engaged as service and sales workers whiles 8.3 percent are engaged as assemblers. One remarkable feature of the district economy is that it is dominated by the private informal sector. The private informal sector employed 89.6% of person aged 15 years and above, whiles the private formal sector accounts for only 5.7% and the public (government) sector 4.1%. Less than 1% of employees are in semi-public/parastatal (0.2%), Non-Governmental Organization (NGOs) (0.4%) or other international organization (0.1). The employment status and sector in the project communities of Wokumagbe and Goi is shown in Table 6-6 and Table 6-7.

Table 6-6: Employment status of persons 15 years and older by sex in Wokumagbe and Goi

Employment status	Wokumagbe			Goi		
	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**

Source: Ghana Statistical Service, 2010

Table 6-7: Employment sector of persons 15 years and older by sex in Wokumagbe and Goi

Sector of employment	Wokumagbe			Goi		
	Male	Female	Total	Male	Female	Total
Public (Government)	9	8	17	56	46	102
Private Formal	20	7	27	156	69	225
Private Informal	236	294	530	471	705	1,176
Semi-Public/Parastatal	9	2	11	3	-	3
NGOs (Local and International)				14	5	19
Total	**274**	**311**	**585**	**700**	**825**	**1,525**

Source: Ghana Statistical Service, 2010

6.8.3 Agriculture

In the Ada West 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. In the rural localities, it is 63.5 percent compared to 43.4 percent in urban localities. The dominant agricultural activities of households engage in agriculture is crop farming (48.1%). Over half (57.4%) of agricultural households engage in crop farming.

The District is noted for the cultivation of cassava, maize, legumes, fruits and varieties of vegetables. With the exception of maize and cassava, the District account 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 also noted for marine fishing activities. The major fishes harvested are King Fish, Anchovy, Mackerel, Tuna Spp, Shrimp, Herrings and Baracuda. Most of the fish cashes were smoked, dried and packaged to Kasseh, Denu, Agbogbloshie, Mamprobi, and Techiman markets for wholesale. The fishing gears commonly used are beach seine, set net, Nifa Nifa, Ali, Poli, and Watsa.

The Agro-forestry sub-sector of the Agriculture sector is quite negligible since majority of the farmers do not have the necessary dexterity to engage in the sector. The District is quite noted for the cultivation of food crops especially vegetables and to a large extent enjoys a comparative advantage in its production. Table 6-8 shows the agricultural and non-agricultural households in the project communities.

Table 6-8: Agriculture and non-agriculture households in Wokumagbe and Goi

Households in agriculture	Wokumagbe		Goi	
	Number	Percent	Number	Percent
Agriculture household	55	20.7	300	41.2
Non-agriculture household	211	79.3	428	58.8
Total	**266**	**100.0**	**728**	**100.0**

Source: Ghana Statistical Service, 2010

The proportion of the agricultural households engaged in crop farming is sufficiently high but relatively low in livestock rearing, and extremely low in tree growing and fish farming. The deforestation and its negative effect on climate change require that tree growing be encouraged. Livestock rearing, tree growing, and fish farming in the district require pragmatic approach and effective promotion or strategies beyond what currently pertains in order to encourage many agricultural households to go into those farming activities.

6.8.4 Salt Mining

In addition to agriculture, majority of the residents especially those located around the Akplabanya-Goi sites are engaged in the production of salt on small to medium scale. The Songor Salt Mining Company which is arguably one of the largest salt mining company in Ghana is located within some few kilometers from the project site. The Songhor Salt is the major mining company in the district and is located on the Songhor Lagoon, which covers a total land area of about 12,500 acres. The Project employed a total labour force of about 300 and produces approximately 90,000 metric tonnes of salt annually to meet the demands of both the local and international markets in Togo, Burkina Faso, Mali and Nigeria. Under full production capacity, the project is expected to generate more than 1,500 employments to the youth. Feasibility studies and empirical evidence have adjudged the industry to have tremendous capabilities to support the proposed petro-chemical industry.

6.8.5 Tourism

Tourism is one of the key contributors to National Income yet, in the district, it has remained underdeveloped. There are a number of potentials including, Okor Forest or Okorhuem which is the mystical ancestral home of Adas, Songor Ramsar site, lagoon for water sport and opportunities for hospitality industry. The Ada West district has a coastline that stretches from Goi to Akplabanya and this long stretch of sandy beach has the potential of being developed to attract tourists from all over the world like its sister district does. The District however is new and lacks the capacity to adequately harness policies, strategies as well as the necessary material and financial resources to promote the development of a vibrant domestic tourism.

The Hospitality Industry on the other hand is also underdeveloped since there are no standard hotels and restaurants except for a Guesthouse and a few local “Chop bars” currently available in the district. There are many opportunities in the hospitality industry most especially in view of the comparative advantage of the district being along an international high way.

6.9 EDUCATION & LITERACY

The Ada West District is divided into four circuits for proper management and supervision. Sege circuit has the highest number of teachers for the primary level as well as for the JHs while Afiadenyigba circuit has the least number of teachers for both primary and JHS level. Table 6-9 and Table 6-10 below shows the distribution of the public educational facilities among the various Urban/Town/Area Councils.

Table 6-9: School Facility and Teacher Population by level and category

Level	Category		Total Number of Schools
	Public school	Private School	
Kindergarten	33	25	58
Primary	33	24	57
Junior High School	23	9	32
Senior High School	1	0	1
Total	**90**	**58**	**148**

Source: GES, SEGE, 2013

Table 6-10: Name of Circuit and Number of schools in the District

S/N	Name of Circuit	2013/2014		Total
		Public	Private	
1	Afiadenyigba	33	25	58
2	Koluedor	33	24	57
3	Sege	23	9	32
4	Anyamam	1	0	1
Total		**90**	**58**	**148**

Source: GES, SEGE, 2013

The public and private sectors continue to collaborate to provide educational services in the District. The private sector contributes about 39.2% of the total school facilities while the public sector contributes 60.8%. At the Kindergarten, of all the total schools, the Private sector accounts for 43.1% while the public-sector accounts for 56.9%. Similar trend can be observed for the primary level where the private sector accounts 42.1% while the public sector provides 57.9%. It is only at the Junior High School where the contribution of the private sector is far lower (28.1%) than the public sector (71.9%)

The Ada West District has a total of 438 teachers supporting teaching and learning activities. Out of this number, 406 teachers representing 92.7 % constitutes the total number of trained teachers in the entire district (with 156 being females and 250 constituting males) while 32 are untrained representing 7.3 % who are currently assisting the trained teachers. There are also 11Community Education Trained Assistance (CETA) under the National Youth Employment who are supplementing the teaching staff. The number of teachers in the public schools at all levels had witnessed considerable increase from 2012/2013 to 2013/2014.

At the KG level, the total number of teachers increased from 18 to 41, while at the primary schools' level, the teachers' population rose from 183 to 222 and at the JHS it increased from 161 to 175. These increases are expected to be reflected in the improvement in the Pupil-Teacher Ratio hence the quality of teaching and learning. There is a general improvement in the number of trained teachers in the public schools from 344 in 2012/2013 to 406 in 2013/2014 which shows an 8.02% increase in trained teachers.

The Educational level persons 3 years and older by sex, for the 2 project communities is shown in Table 6-11. School attendance for the project communities of Goi and Wokumagbe are shown Table 6-12.

Table 6-11: Educational level persons 3 years and older by sex in Wokumagbe and Goi

Level of education	Wokumagbe			Goi		
	Male	Female	Total	Male	Female	Total
Nursery	22	23	45	48	68	116
Kindergarten	13	19	32	59	73	132
Primary	169	186	355	450	432	882
JSS/JHS	84	58	142	217	213	430
Middle	26	6	32	92	80	172
SSS/SHS	26	3	29	112	85	197
Secondary	-	3	3	38	29	67
Post middle/secondary certificate	1	-	1	10	32	42
Post-secondary diploma	6	2	8	68	38	106
Bachelor degree	1	-	1	79	63	142
Vocational/Technical/Commercial	0	0	0	35	31	66
Post graduate (Cert., Diploma, Masters, PHD, ect)	0	0	0	30	10	40
Total	**348**	**300**	**648**	**1,238**	**1,154**	**2,392**

Table 6-12: School attendance of persons of 3 years older by sex in Wokumagbe and Goi

School attendance	Wokumagbe			Goi		
	Male	Female	Total	Male	Female	Total
Never attended	346	475	821	320	654	974
Currently attending	179	179	358	633	569	1,202
Attended in the past	169	121	290	605	585	1,190
Total	**694**	**775**	**1,469**	**1,558**	**1,808**	**3,366**

Source: Ghana Statistical Service, 2010

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 percent are literate, and 31.5 percent are non-literate. 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 percent have never attended school, 40.3 percent are currently attending, and 29.7 percent have attended in the past.

6.10 HEALTH PROFILE

6.10.1 Leading Causes of Mortality & Morbidity

Malaria remains the dominant disease in the Ada West district due to the high level of poor environmental sanitation. The number of Malaria cases increased to 13,776 in 2011 from 9,955 in 2010. But from 2011 to 2013 there was a significant decline of 57.2% over that period. This may be explained by many factors including the establishment of an environmental health office at Sege. This means that there is the need for a more intensive education on the environment to reduce the high incidence of malaria and other environmentally related diseases.

6.10.2 Maternal Health

Maternal health in the Ada West district is experiencing improvement in supervised delivery where a gradual increase, insignificant though, could be observed from 25% to 26% to 27% in 2011, 2012, and 2013. In addition, similar improvement can be seen in the Post Natal Counselling (PNC) coverage increase from 42.1% in 2011 to 51% in 2013. However, on the ANC coverage it be observed unstable coverage over the three years. The increase in the TBA delivery from 17% in 2011 to 21% in 2013 can be explained by lack adequate health facilities and critical personnel to man the health facilities. This may imply that a lot more of the mothers deliver at unapproved place which either put the child and the mother at risk.

6.10.3 Maternal Mortality Ratio

Another measure of mortality is the Maternal Mortality Ratio (MMR). The MMR is defined as the number of women who die due to pregnancy and childbirth complications per 100,000 live births in a year. This ratio is calculated per 100,000 rather than per 1,000 because the ratio rarely exceeds two per cent of mothers dying, and it is to have more digits in the rate to compare figures across countries. The MMR for Ada West district is shown in Table 6-13.

Table 6-13: Maternal Mortality Ratio (MMR) in Ada West District

Year	Maternal Health Indicators										
	Expected Pregnancy	ANC Coverage		Average ANC Attendance	4th ANC Visit		TBA Delivery		Supervised Delivery		PNC Coverage
2013	1745	1519	87%	2.6	295	17%	383	21%	382	27%	51%
2012	1698	1686	99.2%	2.2	510	30.2%	190	11.2%	454	26.7%	38%
2011	1642	1484	90.4%	2.1	372	25.5%	281	17.1%	410	25%	42.1%

Source: Ghana Health Service, Sege, 2013

6.10.4 Infant Mortality

The Infant Mortality Rate (IMR) is considered one of the most sensitive measures of a nation's health. In less developed countries, the chances of dying are greatest at infancy and remain high during the first few years of childhood. When a country has a high rate of infant death, it usually signals high risks from infectious, parasitic, communicable, and other diseases associated with poor sanitary conditions and malnourishment. As Table 6-14 shows, for Ada West, infant mortality declines 2010 to 2012 and remained constant up to 2013. Even though infant mortality is very low in the District, poor sanitation issues are high and to this end, there would be the need to focus on environmental sanitation to either eliminate or maintain the current level of infant mortality.

Table 6-14: Infant Mortality

Year	Total Infants (0-11 months)	Institutional infant death	Infant Mortality Rate
2013	62,335	1	0.016
2012	60,641	1	0.016
2011	58,643	1	0.017
2010	56,879	2	0.035

Source: Ghana Health Service, 2013, Sege

6.10.5 HIV/AIDS

Table 6-15 below shows the details of the HIV and AIDS cases in the District from the year 2011 to 2013. The incidence of HIV and AIDS is of greater concern is in the Ada West district. It is difficult to assess the exact rate of the disease in the district since in-migrants and patients across other district access the health services in the district for treatment. However, the available figure indicated that the HIV and AIDS cases have seen relative reduction over the years.

Table 6-15: Trend in HIV/AIDS in the Ada West District

Year	Sources of cases			Prevalence Rate	AIDS Death
	Counselling and Testing	Prevention of Mother to Child Transmission (PMCT)	Total		
2013	36	18	54	?.0	N/A
2012	42	27	68	3.0	N/A
2011	29	35	64	3.3	N/A

Source: Ghana Health Service, 2013, Sege

6.11 PERSONS WITH DISABILITY

In the Ada West District, about 2.2 percent of the total population have one form of disability or the other. The proportion of the female population with disability is slightly higher (2.3%) than males (2.0%). The types of disability in the district include sight, hearing, speech, physical, intellect, and emotion. Persons with sight and physical disability recorded the highest of 31.4 percent each respectively, followed by emotional disability (19.4). About 4.6 percent of the population with disability are in the urban localities. There are more males with sight disability compare to their female counterparts in both urban and rural localities. Of the population disabled, 46.2 percent have never been to school. Distribution of disability types in the two project affected communities is shown in Table 6-16.

Table 6-16: Distribution of disability type in Wokumagbe and Goi

Type of disability	Wokumagbe			Goi		
	Male	Female	Total	Male	Female	Total
Sight	-	1	1	11	18	29
Hearing	-	2	2	8	7	15
Speech	2	-	2	6	8	14
Intellectual	1	1	2	12	24	36
Emotional				9	4	13
Other forms of disability				9	13	22
Total	**3**	**1**	**4**	**63**	**82**	**145**

Source: Ghana Statistical Service, 2010

6.12 SOCIAL SERVICES

6.12.1 Health Services

In the Ada West, health services are provided by one Health Centre in each of the three sub-districts. There are eleven demarcated CHPS Zones but only three have operational CHPS facilities. These are located at Madavunu, Matsekope, and Luhuor. There are no private health facilities but there are however eleven chemical sellers (Shops) and about 30 untrained Traditional Birth Attendants widely distributed over the district. Physical access to health care services is limited by inadequacy of health facilities. The District provides outreach health services by Community Health Nurses in 42 mostly remote areas in the district with support from the Health Centres. The District is newly created, and the health Directorate has no permanent office and operates from limited space within the premises of the existing Sege Health Centre. The distribution of the health facilities is outlined in Table 6-17.

Table 6-17: Distribution of Health facilities in the Ada West District

Level of Health Facility	Category			
	Public		Private	
	Number In The District	Location	Number In The District	Location
Hospital	0		0	
Clinics /Polyclinic	0		0	
Health Centres	3	Sege / Bonikope /Anyamam	0	
Maternity homes	0		0	
CHPS	3	Madavunu / Matsekope/Luhuor	0	
RCH Units	0		0	
Total	**6**			

Source: Ghana Health Service, Sege, 2013

Another indicator of access to health services is defined by the number of people in the district registered with the National Health Insurance Scheme. In Ada West, there is no permanent District NHIS office though the District continues to rely on the service provided by the mother District at Ada East District. This arrangement is a great disincentive and affects the level of accessing the service since both beneficiaries and prospective registrants must travel over long distances to access the facilities. From Table 6-18, it is shown that outpatient visit to health facilities increase to 45% in 2012 from a level of 37% in 2010, but fell back to 40% in 2013. In contrast, there is a consistent increase in the number of insurance clients from 58.2% to 70% in 2013.

Table 6-18: Facility Attendance and Mode of Payment in the Ada West District

YEAR	Total Outpatient visits	%	Mode of payment			
			Insurance clients	%	Non-insured clients	%
2013	22,440	40%	15,699	70%	6,749	30.0%
2012	27,273	45%	18,616	68.3%	8,657	31.7%
2011	25,640	44%	17,902	69.8%	7,738	30.2%
2010	20,873	37%	12,152	58.2%	8,721	41.6%

Source: Ghana Health Service, Sege, 2013

The Ada West District being newly created is confronted with many challenges. Prominent among them are:

a) Absence of fully functional health administration. Currently the Health Directorate does not have a well organised office for effective service delivery. The staffs do not have access to residential accommodation and must commute from Accra and other adjourning district ton deliver service.

b) Limited access to efficient health service. There is no District hospital in the district and referral cases are either sent to Accra, Sogakope or Battor and in case of emergency, the patience may risk his or her life. The available health facilities lack the needed logistic to work with thus the population is exposed to poor access to health care services

c) Limited key staff to provide efficient health service.

6.12.2 Road Network

The availability of good road infrastructure plays vital role in the economic development of every country. Ada West District is accessed mainly by a mix of road network of highways, feeder roads and water transport. Unfortunately, most of the feeder roads become impassable during the rainy season as a result of serious erosion problem due to lack of good drainage system and the bad condition of the roads. The state of the roads is the result of the type of maintenance which, to some extent, aggravates the situation. Specifically, the annual ritual of reshaping without proper drainage exposes the roads to erosion and deep gulley development. Road transport is by far the principal mode of transport used in the district.

It is estimated that the current feeder road network totals 171.12 kilometres, consisting of:

a) 14 km of good tarred trunk roads stretching from Ada Kasseh to Dawa linking Accra to Aflao.

b) 108.12 km of feeder roads which are either gravel or earth.

c) 24 Km of un-engineered feeder road

d) 25 km of urban roads, most of which are tarred but a long portion of it is in poor conditions due to threat of heavy weight trucks cutting boulders from quarry site along Sege -Battor Road and Sege Akplabanya.

In the District, two categories of feeder roads can be identified as engineered and un-engineered roads. The total length of engineered feeder roads is 108.12Km while the un-engineered road has total length of 24.47 Km. Out of the engineered feeder roads in the District only 1.7Km is covered with bitumen and classified as good; 30Km of gravelled roads are also good and all earth road are bad. Overall, only 30% of all feeder roads are good and motorable all year round. On the other hand, all the 24 Km un-engineered feeder roads are earth roads and are very bad though they play very important role in the general roads network in the District.

6.12.3 Security Service

The Ada West District lacks adequate security service since the closest Police Stations are located in the Dawa and Kasseh in the Ningo Prampram District and the Ada East District respectively. Most of the security issues are handled by the District Security Committee (DISEC). The major security issues prevalent in the district is the highway armed robbery.

6.12.4 Telecommunication Systems and Users

The Ada West district is covered with almost all the telecommunication networks operating in Ghana. There is one post office in Sege and one postal agency at Anyamam but with the increase in the use of mobile phone, the role of post office has outlived its purposes. In the district, 44.3%t of the population above 12 years and older own mobile phones. This is less than half of the population though. Males that own mobile phone form 52.6% and females are 37.1%. This shows that there are more males who own mobile phones than females. Ownership of mobile phones by sex in the 2 project communities is outlined in Table 6-19.

Table 6-19: Ownership of mobile phone by sex in Wokumagbe and Goi

	Wokumagbe			Goi		
Mobile phone	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Yes	192	132	324	701	675	1,376
No	285	432	717	464	735	1,199
Total	**477**	**564**	**1,041**	**1,165**	**1,410**	**2,575**

Source: Ghana Statistical Service, 2010

Concerning access to internet facility, only 4.5% of the population aged 12 years and above have access. The proportion of males constitutes 6.7% of internet facility users and females are 2.5 %. Only 498 households representing 4.3 percent of the total households in the district have desktop/laptop computers. The analysis shows that ICT usage is very low in the district especially in rural areas. There are likely to be a number of reasons for this, including access and availability of required infrastructure, e.g. mobile phone coverage and connectivity. It is therefore recommended that the District Assembly direct investment in ICT infrastructure and services. To increase the use of internet, the government, especially the District perhaps needs to establish internet facilities in public places such as schools, libraries, local government decentralized departments and agencies in collaboration with community organizations. This will make it possible for rural populations to be linked with the rest of the district, region, Ghana and beyond, and tap into the enormous developmental opportunities that internet usage brings.

6.12.5 Waste Disposal

In the Ada West District, the most widely method of solid waste disposal is by public dump (open space) accounting for 39.4 percent of the households within the district. About three in ten households (29.7) dump their solid waste by burning while 10.5% dumped their solid waste indiscriminately whereas house-to-house waste collection accounts for 9.6 percent. For liquid waste disposal, throwing waste onto the compound (50.1%) and onto the street (34.2%) are the two most common methods used by households in the district.

Sanitation disposal of both liquid and solid household waste, toilet and bathing facilities is poor in the district. It appears that expenditure on solid waste disposal and drainage is rarely seen as forming part of a portfolio of investments in public health. Rather, it is generally perceived by decision makers as comparable with other investments such as roads or public transportation, which are not considered public health interventions. Sewage disposal should be planned as a major health intervention. Its linkage to financial sustainability of the National Health Insurance Scheme (NHIS) needs to be explored given that several diseases are linked to poor sanitation.

The proportion using public toilets is also quite high. The district initiatives to construct them as revenue-generating units and this might explain the pervasive use of public toilets in spite of the unhygienic conditions of most the facilities. Infact the district has a big role to play in the provision of adequate public toilet facilities and maintaining their hygiene. Almost one in ten dwelling units does not have access to any toilet facilities and household members use the bush/beach and open fields. Laws requiring landlords to provide toilet facilities in houses should be enforced by the district and should also apply to owner-occupier households. Project proponents could consider providing such facilities to impacted communities as part of corporate social responsibilities.

6.12.6 Water Coverage

According to the 2010 Population and Housing Census there are six (6) main sources of drinking water for dwelling units in the Ada West District. These are Public tap/Standpipe (63.1%), Pipe borne outside the dwelling unit (19.9%), Sachet water constitutes (7.2%), Pipe-born inside the dwelling unit (4.7%), Dugout/Pond/Lake/Dam/Canal also form (2.2%) of the main water source use, and Borehole/Pump tube well (1.5%). In the urban locality more dwelling units use public tap/standpipe (69.6%) compared to 60.3% used in the rural areas. 21.0% of rural dwelling units use pipe-borne outside dwelling than in the urban locality (17.5%). Besides, more dwelling units in the urban locality use sachet water 10.5% compared to rural dwelling units sachet water use of 5.7%. The use of Dugout / Pond / Lake / Dam /Canal is 3.1% in rural dwelling units with 0.0% use in urban communities in the district. Table 6-20 shows the sources of drinking water in the two (2) project communities.

Table 6-20: Source of drinking water for households in Wokumagbe and Goi

Drinking water	Wokumagbe		Goi	
	Number	Percent	Number	Percent
Pipe-borne inside dwelling	3	1.1	199	27.3
Pipe-borne outside dwelling	140	52.6	36	4.9
Public tap/Standpipe	118	44.4	484	66.5
Satchet water	5	1.9	7	1.0
Bottled water			1	0.1
Tanker supply/Vendor provided			1	0.1
Total	**266**	**100.0**	**728**	**100.0**

Source: Ghana Statistical Service, 2010

6.12.7 Households

The Ada West District has a household population of 57,746 with a total number of 11,642 households. The average population per house is 8.7 and the average household size is 5.1. Children constitute the largest proportion of households and accounts for 40.7 followed by Grandchildren 14.4 percent respectively. Spouses form about 7.8% of households. Nuclear households (head, spouse(s) and children) constitute 21.5 percent of the total number of households in the district. The population per house in urban areas (10.2) is higher than in rural areas (8.1). Although there is a higher proportion of male heads of household than females, the difference is not very wide. It is recommended that economic and educational opportunities continue to be expanded for females in order for them to enhance their already important role in the households.

Over half (62.4 %) of all dwelling units in the district are compound houses; 26.4 percent are separate houses and 4.3 percent are semi-detached houses. A little above sixty percent (63.6 %) of the dwelling units in the district are owned by members of the household; 21.0 percent are owned by relative who is not a member of the household, 12.4 are owned by other private individuals; and only 0.8 percent are owned by public or government. Less than one percent (0.3 %) of the dwelling units is owned through mortgage schemes. One room constitutes the highest percentage (85.9%) of sleeping rooms occupied by households in housing units in the district. About 4.4 percent of households with 10 or more members occupy single rooms. The types of household dwellings in the two project communities is shown in Table 6-21.

Table 6-21: Types of household dwellings in Goi and Wokumagbe

Type of dwelling	Wokumagbe		Goi	
	Number	Percent	Number	Percent
Separate house	49	17.9	137	18.1
Semi-detached house	26	9.5	80	10.6
Flat/Apartment	5	1.8	78	10.3
Compound house (rooms)	193	70.4	419	55.4
Huts/Buildings (different compound)	1	0.4	8	1.1
Huts/Buildings (same compound)			20	2.6
Tent			2	0.3
Living quarters attached to office/shop			9	1.2
Uncompleted building			2	0.3
Other			2	0.3
Total	**274**	**100.0**	**757**	**100.0**

6.12.8 Utilities and household facilities

For the Ada West, the three main sources of lighting in dwelling units are electricity (66.0%), kerosene lamp (27.2%) and flashlight/torch (5.0%).). The main source of fuel for cooking for most households in the district is charcoal (55.2%). The proportion for urban (69.0%) is higher than that of rural (49.2%). The four main sources of water in the district are public tap/standpipe (63.1%), Pipe - borne outside dwelling (19.9%), and sachet water (7.2). Majority of the households in the district representing 58.4 percent do not have toilet facilities followed by public toilet (W.C, KVIP, pit, pan, etc.) (18.5%). Eleven percent of the households in the district also use KVIP. About four out of ten households (37.2%) use shared open cubicle bathrooms whiles 25.8 percent of households in the district share separate bathrooms in the same house and 17.8 percent use own bathroom for exclusive use.

7. IDENTIFICATION OF KEY ISSUES

7.1 OVERVIEW

As indicated, 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, we organised a stakeholder forum in October 2016 where we invited the public and state agencies for a briefing on the project. At these consultations, the project team explained the findings of the outcomes from the various independent studies and Table 5-1 outlines the stakeholders' perceptions and needs arising out of these engagements.

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
- Eco Tourism Potential
- Improvement in Infrastructure
- Impact on Salt Mining in the Songhor Lagoon
- Impacts on proposed nearby wind power projects
- Environmental Challenges
- Change Management

A synopsis of these issues is provided below:

7.2 EMPLOYMENT OPPORTUNITY

Employment for locals has been one of the key issues of concern to all parties during the stakeholder engagements. The Chiefs expressed the need for their community members to benefit from the expected employment opportunities under the project. The issue of local content be considered critically, and local labour should be considered during recruitment. Specifically, the community members should be the first to benefit from menial works such as security, masons, labourers, etc.

The Client explained that its Local Content Policy will be applicable to the project and the contractor will be required to consider locals for recruitment. 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). 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. 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.

Some of the workforce could be sourced from the communities where the project is located. Low to medium skilled workers such as construction workers (Masons, carpenters and steel benders), drivers and cooks abound in some of these communities. Again, there is the likelihood of an indirect employment through suppliers and other complementary industry such as transport, hotelier among others. In addition, the possibility of a skill transfer or skill training for the local recruits will positively influence the local economy

The Client will subsequently explain to the contractor 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.

7.3 CHANGES IN LAND USE

The implementation of the project will lead to a permanent loss of land by the locals who mostly depend on such resources for a living. The project will necessitate land acquisition and both physical and economic displacement. This will result in loss of livelihood for landowners and farmers who utilise the land for agricultural and other socio-economic activities. The residents indicated that they had been informed by the Chiefs and land owners that the project would be developed near their village soon, and therefore they should not carry out anymore constructions of any permanent structures.

7.4 COMPENSATION FOR LOSS PROPERTY

The proposed project would affect Land and property owners, especially farms, and this should be compensated according to the existing Government of Ghana compensation regulations and procedures. Some other business activities may be suspended during the construction stage but will be restored with the completion of project construction. Such activities may also be entitled to be paid compensation because on their business activities. Currently, there is anxiety about compensation by landowners and this must be critically looked at and properly addressed.

The Client recognises that compensation issues are key to the success of the project and is developing a Compensation Action Plan to adequately address this concern. The Client will have to demarcate lands and explain the modalities and time for compensation payment as soon as possible in order not to create any antagonism with the landowners. This will be done after the project site has been properly demarcated and the total area clearly determined. Property valuation will be done, and payment effected in line with requirements of the Lands Commission. To facilitate compensation payments, Landowners are urged to have a proper land title document to their property. The Client will also conduct further checks to determine the true owners of the land before compensations are paid.

7.5 RISK TO PUBLIC SAFETY AND HEALTH

Various stakeholders raised concerns that the possible influx of migrant workers may result in increased sexual activities, which may result in escalation of sexually transmitted diseases and unwanted pregnancies as well as increased pressure on infrastructure, services (such as healthcare) and roads, particularly with the establishment of informal settlements. The resultant effect of increased unwanted pregnancies may include increase in abortion, school dropout rate, broken homes among others. Additional traffic and transport from huge haulages may result in accidents and injury to the community members.

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. Labour laws should be enforced to ensure appropriate behaviours of all employees.

7.6 ECOTOURISM POTENTIAL

The siting of the project will attract more tourists to the proposed project location and the potential spill over effect of tourist to explore the rich culture, traditions, festivals, beaches and other existing tourist site and the potential to invest in tourist related infrastructure. The Local Government Authority is therefore urged to consider boosting the ecotourism potential to be realised from the development of the project.

Another key issue was for workers to respect their traditions and observe festivals. It was therefore important that this be made known to the contractor for adherence. The workers and the entire team should be adequately briefed on these traditional rights and festivals. Issues related to the allowable activities on the land about of do’s and don’ts as required by their taboos needs to be respected by project contractors.

7.7 IMPROVEMENT IN INFRASTRUCTURE

Many of the stakeholders requested for the enhancement of existing infrastructure as part of the project development. Indeed, they made various request for the project to contribute to improving roads and providing health and educational facilities. The construction of the wind farm is likely to lead to improvement in infrastructural facilities such as access roads, water and electricity supplies for the affected communities. At the national level, it is apparent that the implementation of the Wind Power Project will have positive impact on the Country's long-term development agenda as laid out by the Client with the goal of improving the power situation in the country.

At completion, the wind power project is projected to add an extra 100MW – 150MW into the country's national grid. This will go a long way in enabling the country to realize the planned incremental power supply in the country. In principle, this will augment the country's plan to accelerate rural electrification programme in the different parts of the Country. The result is an attendant multiplier effect on socio-economic benefit likely to arise from power supply. Execution of the project presents the country with a prospect to depend less on the costly fuel powered options and steering in a period of green energy with less environmental problems.

Stakeholders also raised the issue that the development on the Akosombo Dam has negatively affected the socio-economic life of affected persons and hoped it will not be the same with the wind power project. The Client made it known that the level of impact associated with hydropower is very different from that of the wind power. By being within VRA's operational areas, the Ada west district, just like the Keta Municipality, will benefit from VRA's Corporate Social Responsibility Program.

7.8 IMPACT ON SALT MINING IN THE SONGHOR LAGOON

The Songhor Lagoon has about 34,775 acres of lagoon basin on the Atlantic Coast, with the greatest potential for large-scale salt production in West Africa for export and industrial use. Currently, salt winning is a major commercial activity in villages around the Songhor 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. Members of the Ada Songhor Salt Women's Association in October 2016 held a demonstration and a media conference at Sege and in Accra concurrently to press home their demand for the collective ownership of the Ada Songhor Lagoon. The salt winners insisted that the lagoon must be maintained as a communal resource open to all salt winners from communities along the lagoon and to every other Ghanaian.

The Ministry for Lands & Natural Resources raised the issue of the need for VRA to consult them regarding lands acquisition due to the probable impact on Songhor lagoon and salt production in the area and the associated land conflict. VRA and the Ministry will therefore have to work together to address this issue.

7.9 IMPACTS ON PROPOSED NEARBY WIND POWER PROJECTS

Upwind Konikablo Limited and Upwind Akplanya Limited have 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. Ongoing cumulative impact studies has identified the overlap of WPP2 with the Upwind Project and this is shown in Figure 7-1. VRA and Upwind will therefore have to work together to address this issue.

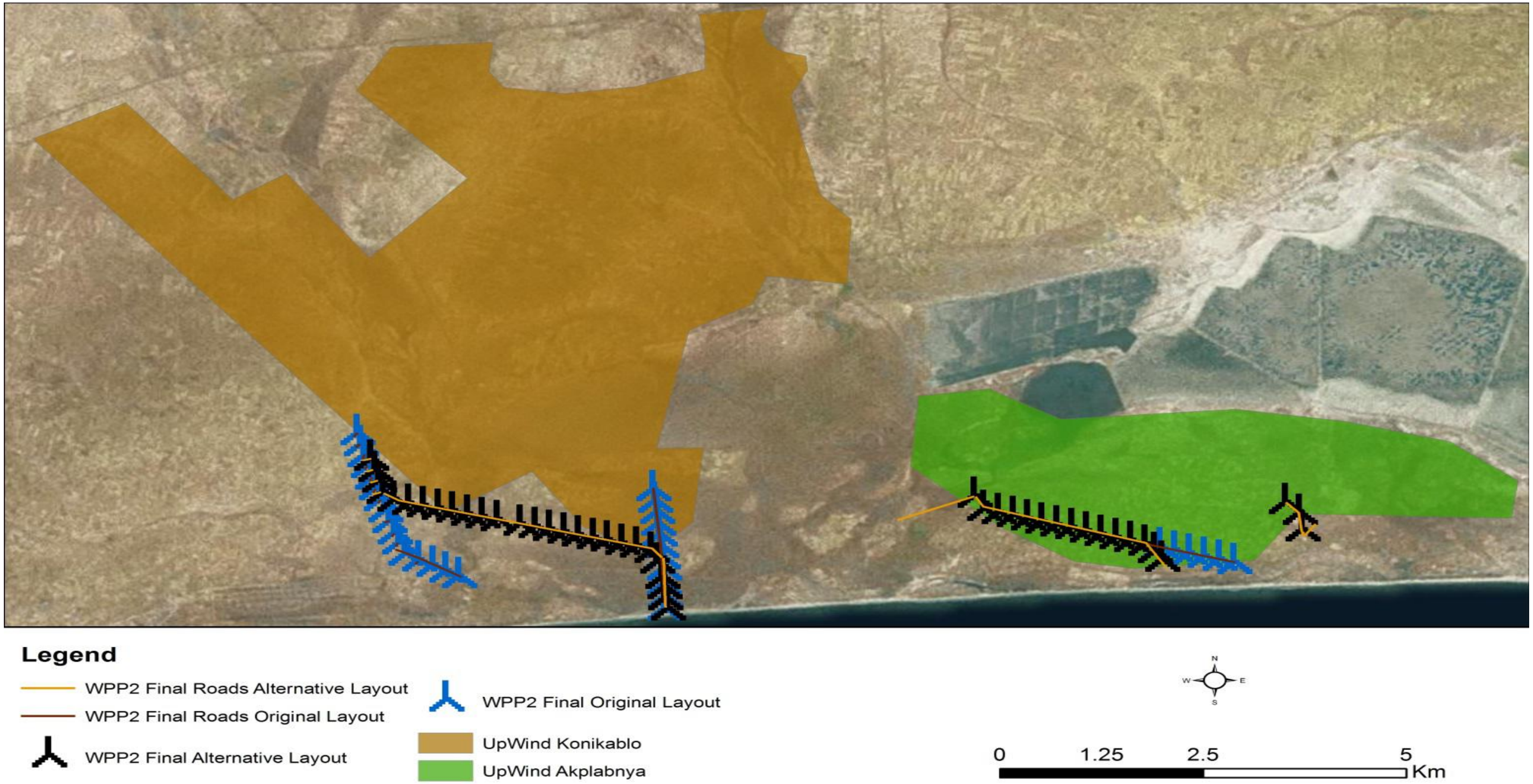

Figure 7-1: Overlap of WPP 2 Sites With The Upwind Project Areas:

7.10 ENVIRONMENTAL PROBLEMS

It was noted that during the constructional phase, the wastes that would be generated if not collected and safely disposed of, are likely to pose environmental problems to the surrounding communities. Other environmental effects of concern were the effect of noise, dust, and traffic movements on economic and leisure amenities during the construction stage. The Client noted that a detailed EIA study was underway, and this would look at these impacts and propose mitigation measures to address them. Associated impacts like noise and shadow flicker would be investigated and the siting of the turbines will be done to mitigate these.

7.11 CHANGE MANAGEMENT

A major concern raised by the stakeholders was that the project implementation seems to delay, and this is causing anxiety amongst the affected landowners. This is because landowners are now unavailable to take major decisions on how to utilise their lands, as they are now aware that the Client intends to acquire them for the project. Various investors have also expressed interest, however as this is a state project and the impact is national on nature, it is considered as priority. It is therefore important the Change management's issues especially with respect to project timelines and duration should be communicated expeditiously to stakeholders.

The Client explained that projects development in the power sector is quite laborious and requires very forms of studies to come to 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. The Client will however endeavour to keep the stakeholders and landowners informed on project status for planning purposes.

8. HIGH LEVEL ASSESSMENT OF IMPACT/RISKS AND IDENTIFICATION OF MANAGEMENT ACTIONS

Key socioeconomic issues of concern raised by the public as well as through field investigations have been highlighted under Chapter 4 of this report. The potential social, economic, health and public safety related impacts likely to be associated with the Project from site preparation to its operational phase are listed and detailed out in the following sections.

8.1 POSITIVE IMPACTS OF PROPOSED PROJECT

The VRA has currently developed a 5-10 year Renewable Energy generation target of 164 MW comprising 150MW of wind power and 14MW of solar power. This is in line with the National Renewable Energy Law and takes cognisance of the local and export demands as well as system constraints. 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 sub-sector are to increase the proportion of renewable energy in the total national energy mix and ensure its efficient production and use.

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 considered. 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, contribution to the Government revenue, increased employment and improvement of roads in the project area among other positive benefits. The ratings of the significance of these positive impacts are outlined in Table 8-2 and the rationale for arriving at these ratings provided in the corresponding texts.

8.1.1 Stabilization of Electricity

8.1.1.1 Operational Phase

Developing the wind power facility to feed the national grid with about 75MW 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. Again, 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 soon, 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 (+16) as it will lead to improvement of environment and individual livelihoods for the entire country during the 25 years of its operations.

8.1.1.2 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.

8.1.2 Potential for Carbon Market

8.1.2.1 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 do 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 such as this is the avoidance of generation of Greenhouse Gases (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 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 (+16) 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.

8.1.2.2 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.

8.1.3 Promotion of Economic Growth

8.1.3.1 Operational Phase

This project will play a significance 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, especially 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[4]. 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[5] 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[6], in its 2014 study[7] also indicates that on the average, the country

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

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

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

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. This is because the power generated from the project will cost far less than from any other existing sources on the long-term as its production cost will not increase thereafter. In effect, this implies that the project has the potential to usher the country into a low-power tariff regime in the end. This has not only a positive effect on the cost of the energy production but will also lead to economic gains through improved competitiveness.

Again, the proposed Project may also offer potential economic benefits at the local level through ecotourism as well as the procurement of goods and services. Road enhancement will occur due to the wind power installations and associated facilities to support these developments. The proposed Project may also offer potential economic benefits through the procurement of goods and services. 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. 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 social 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.

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

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 (+9) as it is national and of long term in nature and definite.

8.1.3.2 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.

8.1.4 Increased Employment Opportunities

8.1.4.1 Constructional Phase

Initial consultation with the residents revealed that they are aware of the imminent commencement of the project, which is very close to their location. The residents expressed positive feedback about the commencement of this development and the Project as being beneficial for their local economy. When asked about how they believe these developments will benefit them economically, they indicated that the commencement of the construction of such projects would bring opportunities for employment, which could continue during their operation. Some of the women expressed their positive attitude towards the developments as they see them as opportunities for them to engage in petty trading and food vending with the construction workers on site. This, they hope, will improve their livelihoods financially and enable them to pay for their children’s education.

The 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.

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 (+10) impact.

8.1.4.2 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 Keta Municipality 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.

8.1.4.3 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 many 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 benefits are 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 (+9) in nature.

8.1.4.4 Enhancement Measures

The enhancement measures outlined under the constructional phase is also very pertinent to the operational phase. In addition, ensuring 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.

Table 8-1: 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

8.2 NEGATIVE IMPACTS ON 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 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 many 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 8-3 and the rationale for arriving at these ratings provided in the subsequent texts.

8.2.1 Impacts on Land Use

8.2.1.1 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 NEGATIVE** (-13). 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.

8.2.1.2 Mitigation Measures

Land ownership structures and land-use characteristics will have to change within the affected area. This potential adverse effect on land ownership and land-use requires mitigation measures to minimize the impact on individuals and the community. This will need to be properly managed through sensitization and information sharing. 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.

The New Lands Commission Act (2008) Act 76 provides for the management of public lands and other lands and for related matters and the Commission will to assist in the execution of, a comprehensive programme for the registration of title to lands to facilitate compensation payment to land owners. Under the Local Government Act, 1993 act 462, the Town and Country Planning Department will be responsible for the overall planning and development control within its jurisdiction and will be responsible for the integration of social, economic and physical development of the project area. The Town & Country Planning will also have to demarcate the area and map out accordingly.

To maintain harmony among various communities in the project area, there will be a dire need to raise awareness about the project. Of special importance is awareness about project benefits that different communities stand to gain. The project management should, however, guard against raising expectations that cannot be met. All communities need to be kept abreast of all project development activities and should sufficiently be consulted on all matters that concern them. The project should engage a neutral person who is accepted by all the communities in the project area to interact with communities, raise awareness on the project activities and to resolve any conflicts that may arise between the project and the communities involved.

8.2.1.3 Operational Phase

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. Due to land acquisition, farming activities may now be restricted during the operational phase, as the acquired land will 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 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 park construction activities including the quarries, borrow pits, 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 park facility in otherwise an unspoilt natural environment is likely to be visually intrusive to some people. It has the potential to detract observers from the normal scenery. It is therefore necessary to paint the turbine, mast, blades and other components with colours that blend with the environment especially shades of pale green, brown and grey to further reduce visual intrusion in the project area. It may, however, be noted that the wind park 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** (-9). 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.

8.2.1.4 Mitigation Measures

Resettlement and livelihood restoration activities will be formulated as sustainable development activities that at least restore but aim to improve the standards of living and long-term wellbeing of the affected persons. This will include a consideration of existing land uses and recreational activities within the vicinity of the site, local tourism activities, employment generation and any indirect economic effects arising from the proposed Wind Power Project.

8.2.2 Impacts on Land Quality

8.2.2.1 Constructional Phase

Contamination of ground and groundwater at the development site may be present because of past releases. However, as the site is a greenfield development, 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 (-0.75). 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.

8.2.2.2 Mitigation Measures

The design of the facility to good practice standards will aim to prevent such releases and minimise the potential consequences such that any effects should be insignificant. Clearing and grading of access and corridor tracks of the wind turbines and the excavation of foundation and tower base areas will be limited to the minimum area requirements. Other measures for minimizing erosion and managing excavated materials, wastewater from excavations and accidental spillage of oil, fuel and paints are valid for the prevention of ground and ground water quality.

8.2.2.3 Operational Phase

When the Project is completed, the areas surrounding new installations will be reinstated to their former state. The construction compound will be removed after construction and the area reinstated. 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. 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. It is expected that operational activities of the wind power facilities will not have any direct impact on the quality of the land.

The significance rating of the impact of the project on land quality during the operational phase can be described as VERY LOW (-0.75). 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.

8.2.2.4 Mitigation Measures

As in the constructional phase, the design of the facility to good practice standards during the operational phase will also aim to prevent such releases and minimise the potential consequences such that any effects should be insignificant. Other measures for minimizing spillage of oil, fuel and paints are valid for the prevention of ground and ground water quality.

8.2.3 Impacts on Loss of Property

8.2.3.1 Constructional Phase

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 (-13). 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.

8.2.3.2 Mitigation Measures

The project requires the acquisition of land for the development of the wind power projects in the various areas. Baseline socio-economic surveys has been undertaken to confirm potential for residence and farming or other economic activity sites on the project area and provide a cut-off date against opportunistic settlers moving into the area. During the study, it was determined that due to economic displacements and lands to be acquired; there will be need for compensation as part of the proposed project. To minimize the adverse effects of the land acquisition on individuals, communities and/or families or clans a detailed survey of project-affected persons is being carried out as part of the ESIA for the purposes of compensation payment. Prompt, adequate and fair compensation will be paid to all project-affected persons before the start of constructional activities.

As part of the process, VRA shall engage the Land Valuation Division of the Ghana Lands Commission (Accra Office) to determine the compensation to be paid for the crops and any other identified infrastructure within the site. Cognisance has been taken of IFC PS5 and consultations are ongoing with the Property Affected Persons (PAPs). Currently, project-affected persons (PAPs) are being engaged in a meaningful manner, and to provide opportunity for their participation in the planning and execution of resettlement programs. In view of this, the client is considering involuntary compensation as an integral part of project design, and subsequently deal with resettlement issues from the earliest stages of project preparation. A "***Compensation Action Plan***" report is under preparation by the same Land Valuation Division and the Client, to ensure that the PAPs were compensated properly.

Alongside the valuation and compensation process, there is the legal administration of land acquisition that must be undertaken. Those to be considered are the Local Government Service Act, 2003 Act 656, State Lands (Amendment) Act (2005) Act 586, Lands Commission Act (2008) Act 76 and the State Lands Regulations (1962) LI 230. The Lands Commission Act (2008) Act 76 provides for the management of public lands and other lands and for related matters and the Commission will to assist in the execution of, a comprehensive programme for the registration of title to lands to facilitate compensation payment to land owners.

Thus, the land acquisition procedures are to be carried out in accordance with national regulations. This entails the Client communicating with the Ministry of Lands and Natural Resources to apply for land for the specific project. Then the Public and Vested Lands Management Divisions (PVLMD) in the region initiates proceedings by establishing a committee which reviews the site and advises if land chosen conflicts with any existing developments or land transaction underway. With approval of the land and an interim valuation certificate to estimate compensation, the Ministry will formally notify authorisation to acquire the designated lands in the public interest.

In a project of this magnitude where the developer must contend with the acquisition of a large area of land, involuntary resettlement of displaced local communities becomes a thorny issue. In such cases, the donors would prefer that the developer follow the guidelines contained in the World Bank (WB) Operational Policy on Involuntary Settlement (OP 4.12) in the resettlement of the project-affected persons (PAPs) as well as the IFC Performance Standard 5: Land Acquisition and Involuntary Resettlement.

The WB guidelines recognize that involuntary resettlement brought about by development projects, if unmitigated, is likely to cause severe economic, social and environmental risks. The policy addresses direct economic and social impacts that are caused by the involuntary taking of land, resulting in:

a) Relocation or loss of shelter;

b) Loss of assets or access to assets; and

c) Loss of income sources or means of livelihood, whether the affected persons must move to another location.

The Bank's policy advocates that where feasible, involuntary resettlement should be avoided or minimized. In addition, the resettlement must be conceived and executed as a sustainable development program, providing sufficient investment resources to enable persons displaced by the project share in project benefit. In this case persons displaced must be:

a) Meaningfully consulted and should have opportunity to participate in the planning and execution of the resettlement;

b) Compensated for their losses at full replacement cost prior to civil works;

c) Assisted with the move and supported during the transitional period in the resettlement site; and

d) Assisted in their effort to improve their former living standards, income earning capacity and production levels or at least to restore them.

To adhere to both national and internationals requirements, the "***Compensation Action Plan***" would seeks to achieve the following:

- To determine the compensation and resettlement strategy in accordance with the local Laws and Regulations of both Ghana and World Bank guidelines on involuntary resettlement;
- To compensate Project-Affected Persons (PAPs) fully and fairly for all assets lost permanently or temporarily, this means timely payment of full replacement value prior to construction;
- To ensure that only PAPs who meet agreed eligibility criteria will be entitled to compensation and relocation measures;
- To ensure that lack of legal rights to land and assets occupied or used will not preclude a PAP from entitlement to resettlement and compensation measures;
- To assist PAPs in proportion to impact, recognizing the special needs of vulnerable populations; i.e. widows, orphans, HIV/AIDS victims, elderly people and handicapped people;

- To ensure that PAPs who lose income-generating resources are assisted in their efforts to improve their livelihoods and standards of living or at least restore them, in real terms, to pre-project levels;
- To disclose the proposed mitigation measures to the local community prior to resettlement and conduct ongoing consultation with affected communities during the resettlement process and afterwards;
- To provide a grievance procedure whereby local people can lodge concerns and complaints regarding the resettlement;
- 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;
- To facilitate a smooth integration with the host communities;
- To ensure that pre-construction and actual construction work on each affected site will not commence until PAPs have been satisfactorily compensated and/or relocated.

Owners of the shrines encountered within the project area have agreed to carry out of certain traditional/customary rites if the project will affect them. Out of respect for the sensibilities of the owners and the communities, the items for the rites shall not be discussed here. The proponent shall do all within its means to ensure that these rites are successfully carried out and prompt and adequate compensation paid when it becomes necessary to impact on these community properties. The proponent shall however endeavour to align the project activities to avoid these community properties prior to the commencement of construction activities

8.2.3.3 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 (-7.0). Land acquisition and economic displacement will require compensation. PAPs to be impacted are to be paid prior to project development. The intensity of this impact can be said to be medium low, negative, direct and irreversible. The spatial extent of the impact will be specific to the people within the project site.

8.2.3.4 Mitigation Measures

A "***Compensation Action Plant***" report is under preparation by to ensure that the PAPs were compensated properly. It is expected that its implementation would continue during the operational phase. Further, VRA should put in place appropriate grievance mechanisms to address concerns of both workers and the public as part of a wider Stakeholder Engagement Plan enabling community concerns to be documented and resolved in a timely fashion. VRA should effect prompt payment of outstanding compensation and continue to institute appropriate grievance mechanisms to address concerns of both workers and the public should continue to be put in place.

8.2.4 Impacts on Labour and Working Conditions

8.2.4.1 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, out of the estimated 18 months for the construction phase. Temporary camps will not be required to house the workforce. VRA is advised to hold discussions with the house owners 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.

One key example is owners will very often demand the same completion date, despite the added work scope. 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 (-3). 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.

8.2.4.2 Mitigation Measures

The Client should apply relevant national policies, labour laws and codes concerning employment conduct as discussed under Section 4.4 to regulate behaviour of workers in the local communities. Measures should 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. Local employment and sourcing policies are to be used to give priorities to people within the project affected areas.

The Client should put in place appropriate grievance mechanisms to address concerns of both workers and the public as part of a wider Stakeholder Engagement Plan enabling community concerns to be documented and resolved in a timely fashion. The Client should appoint a Community Liaison Officer as a designated point of contact for the community. Ensure that the community understands that this person is a point of contact for the project and that they can have access to him/her always, that they act as means of communication with the project management and are a potential source of conflict resolution with the project as well. This Community Liaison Officer should be integrated into the management of the grievance mechanism process.

The Client should prepare a Labour Management Plan as part of their Health, Safety & Environmental (HSE) Plan for the construction phase. This should cover maximising employment opportunities for the project within the local communities, managing expectations, and reducing the potential for influx into the area during the construction. The Plan will also aim to consider vulnerable groups such as women. The Plan will include for job training and capacity building during the construction activities.

This influx of workers will be limited for the Project, with clear recruitment and employment policies put into place. The Project will aim to reduce the influx of workers by:

a) Making clear that there will be no recruitment of workforce "at the gate", clearly advertising the formal recruitment process, hence discouraging an influx of opportunistic in-migrants; and

b) Work in conjunction with local authorities, municipalities, village Chiefs and their staff to discourage settlement of opportunistic in-migrants.

It is understood that no temporary accommodation will be provided or constructed for the workforce. If, however camps are developed, they will need to be designed and operated by the contractor 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 the European Bank for Reconstruction and Development (EBRD).

To maintain a healthy environment for the labour force, the project management should put in place suitable measures to clean the environment associated with labour camps. This will include proper disposal of human waste. 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.

8.2.4.3 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. 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 most 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 causes 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.

Any labour unrest or community vandalism or attack during the operational phase will result in project shut down and loss of 76.5MW of power to the national grid, and its subsequent impact on the economy.

The significance of the impact on labour and working conditions during operational phase is Medium Negative (-6.5). 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.

8.2.4.4 Mitigation Measures

Mitigation measures proposed for the constructional phase will be same as the operational phase.

8.2.5 Impact on Historical & Cultural Heritage Resources

8.2.5.1 Constructional Phase

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. The sensitivity of a cultural feature to direct impacts reflects the level of importance assigned to it. This is the product of many factors, including for features of present day cultural value: its current role; its cultural or sacred associations, its aesthetic value;

association with significant historical events or traditions and its role as a sacred site or local landmark; and in addition, for those of heritage value, its potential as a resource of archaeological data.

The significance of an impact, either direct or upon setting (indirect), on a site is assessed by combining the magnitude of the impact and the sensitivity of the site. The impacts will either be:

- ✓ **Direct impact** involving physical damage to cultural features or disruption to customary law, practice and tradition. Any direct impacts on tangible features will be permanent and irreversible

- ✓ **Indirect impact** including visual impact on cultural features, influences the appreciation of the inter-relationship between these sites, impacts on the relationship of a site to the wider landscape and impacts on significant views from and to sites.

Construction activities and land take has the potential to impact on areas of cultural heritage. Potential impacts that may disturb or damage on cultural heritage or historical resources may arise from site digging for construction. Potential impacts on archaeology may relate to the possibility for disturbance, removal or destruction of archaeological deposits during construction activities. Specific activities with the potential to affect archaeology may include the excavations of foundations and piling. Archaeological relics could be delivered to the site at any time during the life of the site, but the occurrence will be seldom and random. This is high priority only initially. Proposed development works, or longer-term effects of an operational development may affect archaeological heritage that was not identified prior to the commencement of development works.

The main impacts relate to areas of ground excavation required for construction purposes e.g. lay down areas of work camps, new access roads, etc. As with any project site, there is a potential for previously unrecorded cultural sites to lie within. As all unknown cultural heritage will be sub-surface it is only direct impacts arising from disturbance that could occur. Disturbance within the project area following operation could potentially occur during the excavation works of building facilities, infrastructure, pipelines 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 paleontology by allowing fossils that would not otherwise have been found to be recovered, identified, studied, and preserved.

The project site is however 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. The land at Wokumangbe belongs to the Kuogbo clan. 'Osuola' is the deity of the land and the shrine of the 'Buokumaa' deity is also situated on their land. The deity forbids chaos and murder hence its isolation from the community. A reconnaissance survey conducted 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.

The impact of the proposed project on the cultural landscape is expected to occur during the construction phase. The significance of the impact on historical and cultural heritage during the constructional phase is Low Negative (-2.5). There will be no direct impact on historical and cultural heritage resources even though various sites have been identified. Looking at the type of resources identified, the intensity of this impact can be said to be medium low. The spatial extent of the impact will be local. The duration of the impact will be temporal and will last during the construction period with a probability of occurring.

8.2.5.2 Mitigation Measures

Under the study, various pacification rites have been discussed with the various caretakers and these shall be subjected to negotiations during implementation to pave way for constructional activities to commence. In addition, the Client should put in place a procedure for chance finds. As with any project site, there is a potential for previously unrecorded cultural sites to lie within. Disturbance within the project area could potentially occur during the excavation works of building facilities, infrastructure, pipelines and the installation of fencing for other works. An appropriate watching brief will be implemented to ensure that in the case of unearthing important archaeological finds during excavation, the following procedure, which is derived from the National Museum Decree 1969, (NLCD 387), for dealing with all such finds, shall be triggered.

In the event of any significant finds, a suitable programme of mitigation agreed upon with the Archaeology Department of the University of Ghana and the National Museums Board should be implemented. Again, all site workers will be briefed on sensitive cultural issues onsite as part of the workforce "Code of Conduct" training.

8.2.5.3 Operational Phase

There are no documented sites of archeological, historical, or cultural significance at the proposed plant site and in its vicinity as stated earlier. Only very limited ground or excavation works are expected during the operational phase of the project. It is therefore not anticipated that there will be any impact on such resources during this phase. However, as indicated, there may also be impacts upon unknown sites; however, the potential for the presence of unknown sites is low. A suitable chance finds procedure will be carried out during any excavation works.

The significance of the impact on historical and cultural heritage during the operational phase is Very Low Negative (-0.75). Looking at the type of resources identified and the rural landscape to one characterized by electrical infrastructure, the intensity of this impact can be said to be low. The spatial extent of the impact will be site specific. The duration of the impact will be temporal and with low probability of occurring.

8.2.5.4 Mitigation Measures

Under the study, various pacification rites have been discussed with the various caretakers and these shall be subjected to negotiations during implementation to pave way for constructional activities to commence. In addition, the Client should put in place a procedure for chance finds. As with any project site, there is a potential for previously unrecorded cultural sites to lie within. Disturbance within the project area could potentially occur during the excavation works of building facilities, infrastructure, pipelines and the installation of fencing for other works. An appropriate watching brief will be implemented to ensure that in the case of unearthing important archaeological finds during excavation, the following procedure, which is derived from the National Museum Decree 1969, (NLCD 387), for dealing with all such finds, shall be triggered.

In the event of any significant finds, a suitable programme of mitigation agreed upon with the Archaeology Department of the University of Ghana and the National Museums Board should be implemented. Again, all site workers will be briefed on sensitive cultural issues onsite as part of the workforce "Code of Conduct" training.

8.2.6 Impacts on Community, Health, Safety and Security

8.2.6.1 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, considering 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 many 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 increase volume of human and motor traffic. increase 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 park facility. This is likely to result in a higher risk of accidents occurring in operation during the road rehabilitation, wind park construction and wind park operation phases.

During the implementation of the road rehabilitation and wind park construction phases, several activities including vehicular transport, operation of heavy machineries and blasting of hard rock in quarries have potential for accidents risks both among 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, borrow pits 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. 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 are largely comprised of:

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 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 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.

This in-migration can lead to negative impacts on the surrounding villages/communities. This is because the project may also experience the influx of night-time (sex) workers to the area, which may result in the increase in sexually transmitted infections and HIV cases. Regarding the influx of commercial sex workers into project area following the project activities, the project should be prepared for an increase in the prevalence of HIV/AIDS. To prevent the spread of HIV/AIDS in the project area, the developer and other stakeholders including the administration, community leaders, opinion leaders, and other stakeholders must organize and support education programmes to increase awareness and change public attitudes towards HIV/AIDS and other sexually transmitted diseases (STDs). To protect the project workers, there will be a need for the project developer to supply the workers with STD prevention devices including the male and female condoms.

The significance rating of the impact of the project on community health, safety and security can be described as Medium Negative (-9.0). 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.

8.2.6.2 Mitigation Measures

The Client should develop Health and safety measures related to the working conditions as part of the Health and Safety Plan prior to the commencement of construction works. This plan should include recommendations and measures to protect the surrounding villages / communities during this phase of the Project. Aspects to be covered in this Plan include:

a) Barricading the working areas;

b) Health and safety training for all employees;

c) Health and safety training on the use of chemical and hazardous materials

d) Provision of the appropriate Personal Protective Equipment (PPE);

e) Traffic management plan and driver training;

f) Accident prevention monitoring;

g) Training in the use of all equipment;

h) Safeguards of environmental pollution of water resources;

i) Safeguards in hazardous materials handling and transportation;

j) First Aid access and communications; and

k) Emergency Preparedness Plan and Emergency Response Procedures.

In addition, health education about communicable diseases will be undertaken as part of the induction training for workforce members. This will include health education on STIs as well as diseases such as malaria. There will be an influx of people during construction, although this will be minimised via the Labour Management Plan. However, an increase in the wealth in the area may also lead to an increase in STIs through prostitution. As such, provision will be made for education awareness of communicable diseases within the wider community. Induction training will be undertaken for construction and operation personnel covering aspects such as health, safety and environmental and cultural awareness.

Worker grievance mechanism will be put in place for both construction and operation so that workers can raise reasonable workplace concerns and for the monitoring and resolving of such concerns. All personnel will be informed of this mechanism at the time of being hired. In addition, a 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. This is so because despite best efforts, there is a possibility that the individuals / communities affected by the project will be dissatisfied with the measures adopted to address the adverse impacts of the project and addressing the grievances at the root level will ensure the timely and successful implementation of the project.

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.

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 project management should also 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. This will deter the labour force from unnecessary cutting and trampling of vegetation and enhance the protection of the scanty natural vegetation of the project area. To maintain a healthy environment for the labour force, the project management should put in place suitable measures to clean the environment associated with labour camps. This will include proper disposal of human waste. The Client 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.

8.2.6.3 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 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 park operation and maintenance activities will be minimal. Nevertheless, there are potential occupational hazards regarding work force engagement in both day-time 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 (-2.25). Considering the number of workers involved at this stage, the intensity of this impact can be said to be Medium, the spatial extent of the impact will be local, the duration of the impact will be long term and reversible there is a low probability of the impact occurring.

8.2.6.4 Mitigation Measures

Operation of the plant could have an impact on the public and workers through general operation activities and because of accidental spills and fires. During the construction, operation and decommissioning phases of the proposed project, the Client will mainly adopt the IFC Occupational Health and Safety (OHS) Guidelines for wind energy projects in the prevention of accidents, containment of health hazards and management of security and fire outbreaks among other contingencies in the project area. Appropriate warning signs will also be provided at the site where there is a risk to health and safety. The design of the substation includes mechanisms for ensuring the highest standard of safety and protection. A comprehensive fire detection and protection system will be installed to cover all equipment on site that could constitute a fire risk.

Despite the fact that the communities within the project area is a relatively peaceful area, land rights and acquisition issues usually become fraught with insecurity problems. This was experienced during the ESIA process where the consultant’s specialists were attacked by a mob for being suspected trespassers on the land. The Client should therefore take precautions to beef up the security of the wind park and the staff quarters. There will be a need to hire services of the local guards. However, the local guards will need to be reinforced by a more professional security force from the leading security firms in Ghana. In addition, an alarm system should be installed as a backup for the above outlined security measures. Even more important, the project management should cultivate harmonious co-existence between itself and the local communities in the project area.

As stated in Section 6.12.7 of this report, the main source of fuel for cooking for most households in the municipality is wood and charcoal, also made from wood. Any increased population in the project area will make high demand of fuel wood resources. There is therefore a need for the 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. The project should encourage the local population through support of the relevant local CBOs to conserve the plant resources including participation in planting of trees and mangrove rehabilitation in the project area.

8.2.7 Traffic and Transport Impacts

8.2.7.1 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 **Plate 8-1**[8]. 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.

[8] *Source*: Draft Feasibility Study for Lekpoguno/Aklabanya Wind Farm, August 2015

Plate 8-1: 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 (-9.0). 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.

8.2.7.2 Mitigation Measures

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.

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 to ensure technical failures do not occur;
- Through planning and channelling of traffic, the densest areas of traffic if possible will be avoided.
- Install traffic safety signage at vantage points along project site access routes. 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 is to be accompanied by a sketch of the location plan. Thus, in all cases, where the project will influence public roads due notification to the public and appropriate authorities (GHA, Urban Roads and/or Keta Municipality will be given as required.

8.2.7.3 Operational Phase

Currently, the road conditions of project area are in a very poor state. 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 (-1.5). 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.

8.2.7.4 Mitigation Measures

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.

8.3 POTENTIAL CUMULATIVE IMPACTS

Cumulative impacts are impacts on the environment that result when the effects of implementing the project's activities are added to the effects of other past, present and reasonably foreseeable future actions. Cumulative impacts are important because impacts of individual projects may be minor when considered in isolation but quite significant when the projects are viewed collectively Cumulative impacts with existing and planned facilities may occur during construction and operation.

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 75MW 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 as discussed under Section 4.9.

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, 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.

8.4 IMPACTS OF PROJECT DE-COMMISSIONING

Generally, the disposal of the turbine components during project de-commissioning has the potential to affect the environment. However, this may not be the case for the project area. It is likely that the turbine will be dismantled and re-exported, since 88% (by weight) of the turbine can be re-used. This means that the environment is spared extra extraction of non-renewable resources. However, there will be wasted energy used to break down the turbine from the project site. In addition, de-commissioning activities will cause some minor negative impacts on the flora and physical environment of the project area. Following the de-commissioning of the turbines, buildings belonging to the project will either be acquired by the Government or other selected stakeholders in the project area. It is important to note that the proposed wind farm will be in the project area for a long time. It is expected that after 20-25 years, new windmills will replace the old ones. The project buildings will last about 50 years before they are replaced.

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 Table 8-3. Mitigative measures proposed for the constructional phase for these impacts also pertains to the decommissioning phase.

Table 8-2: 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	Negati	Site	Long Term	Medium	Definite	Low	High	Medium	Very 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*	
	personal and commercial use	ve	Specific								
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 Resources	Destruction / loss of Historical & Cultural Heritage Resources	Negative	Site Specific	Temporal	Low	Low	Low	Moderate	Very Low	Very Low	High
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

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence/ Intensity	Probability	Reversibility	Irreplaceability	Significance		Confidence Level
									Without Mitigation	*With Mitigation*	
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

9. CONCLUSION & RECOMMENDATIONS

9.1 CONCLUSION

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. As at close of 2016, nearly 43% of the power capacity in Ghana is based on hydropower. Over the last thirty years or so, the country has paid a heavy price for over reliance on hydropower due to poor rainfalls into the Volta Lake leaving power rationing in its wake. 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.

Comprehensive execution of the proposed wind power project will have far-reaching effects nationally and in the project area. This project will play a significance role in stimulating economic growth in Ghana. The power input will contribute significantly to the Ghana's Rural Electrification Programme, which has potential to promote spin-off effects on rural economy in Ghana. The project also has power export potential to the neighbouring countries including Togo and Benin as well as La Cote D'Ivoire. The extents of the predicted environmental and socio-economic impacts have been carefully examined at various stages of the project planning.

Based on the issues raised at the project briefings, status quo conditions of the study area and the nature of the proposed wind power project, the following socio-economic impacts are anticipated:

- Land Use
- Land Quality
- Traffic & Transport
- Compensation for Loss Property
- Labour & Working Conditions
- Historical & Cultural Heritage Resources

- Community, Health, Safety & Security

These identified impacts could be positive and negative. The project benefits are at both national and local levels. At the national level, the project benefits will include:

4. Diversification of power sources - Implementation of the project presents Ghana with an opportunity to rely less on the expensive fossil fuel fired powered alternatives;

5. Promotion of renewable energy and reduction of carbon dioxide equivalent for use in mitigating the country's emission commitments. The proposed project will achieve CO_2 emission reduction by replacing electricity generated by fossil fuel fired power plant connected to the national grid.

6. Stabilization of electricity access and reduction of power outage in Ghana - At its completion, the project is expected to add an extra 75 MW of power into the country's national grid. This will bolster the country's plan to expedite rural electrification programs in different parts of the country. The result is an attendant multiplier effect on the socio-economic parameters of the whole country and stable power supply network;

7. Reduction of the cost of the power - The power generated from the project will cost far less than from any other existing sources on the long-term as its production cost will not increase thereafter. In effect, this implies that the project has the potential to usher the country into a low-power tariff regime in the end. This has not only a positive effect on the cost of the energy production but will also lead to economic gains through improved competitiveness;

At the local level, the positive benefits include:

a) Employment opportunities for the local community during the construction and operation phases of the project (e.g. masons, carpenters, cooks and indirect spins-off, such as livestock and fish trade, ecotourism, etc.);

b) The rehabilitation of existing road networks will facilitate the transportation of livestock and fish products to external markets;

c) The project will provide human and financial assistance in the development of health and education facilities through Corporate Social Responsibility by the Client to improve health conditions and literacy of local community, especially the marginalized groups, the women and the youth.

Against the above positive benefits brought about by the project, there will be some negative socio-economic impacts emanating from both the construction and operation activities of the wife power project, some of which are:

a) Economic displacement due to acquisition of land of an area of about 193.31 Ha of land.

b) Visual intrusion because of project facilities such as the wind turbines,

c) Contamination of local culture due to influx of construction employees,

d) Increased conflicts and insecurity within the community,

e) Exploitation of natural resources,

f) Increased incidences of diseases such as HIV/AIDS

g) Potential challenges and impacts of labour force management, and

h) Increased accidents and occupational hazards.

9.2 RECOMMENDATIONS

Various recommendations have been proposed for the client to implement to ensure that proposed associated socioeconomic benefits are realised and impacts mitigated. Key amongst them include:

a) Design the wind power facility to good practice standards aiming at preventing releases and minimising its potential consequences such that any effects would be insignificant.

b) Keeping all communities abreast of all project development activities and they should sufficiently be consulted on all matters that concern them.

c) 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.

d) 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.

e) 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.

f) Preparation of a Labour Management Plan as part of their Health, Safety & Environmental (HSE) Plan for the construction phase.

g) 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.

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11. APPENDICES

Appendix 1: Background Information Document for the Wind Power Project

Appendix 2: Scoping Notice

Appendix 3: Pictures from Project Briefings

APPENDIX 1:

BACKGROUND INFORMATION DOCUMENT FOR THE WIND POWER PROJECT

APPENDIX 1 - SOCIO-ECONOMIC IMPACT ASSESSMENT STUDY

INTRODUCTION

The Volta River Authority in Ghana (hereinafter referred to as VRA) was established in 1961 with the main focus of the company being the generation and supply of electricity for domestic use in Ghana. VRA works with landowners, project developers, technology providers, regulators and investors to source and develop energy projects. Currently, the Government of Ghana has formulated a Renewable Energy (RE) Policy which aims to have 10% of Ghana's electricity needs come from RE by 2020. Subsequently, the Government passed a RE law in November 2011 to provide the necessary legal and regulatory framework to promote the sustainable development and utilization of RE resources for electricity and heat generation.

In line with this legislation, VRA has set a 5-10 year Renewable Energy (RE) generation capacity target taking into consideration the local and export demand as well as the current system's energy constraints. VRA's RE Development Programme Phase 1 (REDP1) aims at developing about 164 MW of installed renewable energy capacity before 2020. The program consists of three components, namely (a) a 150 MW Wind Power Project (Phase 1) (b) a 14 MW Solar Power Project (Phase 1), and (c) Renewable Energy Planning & Development Integration into the current energy plan.

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

- 75MW Wind Power Project 1 (Anloga Extension) located at Anloga, Anyanui & Srogbe communities in the Keta Municipal in the Volta Region (Site A)
- 75MW 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)

In accordance with the requirements of the Environmental Assessment Regulations, 1999 (LI 1652) and as outlined in the Environmental Impact Assessment (EIA) Guidelines for the Energy Sector, Volume 1, dated August 2010, the construction of wind energy facilities exceeding 20 hectares or exceeding an installed capacity of 15MW falls into the category for which an EIA Study is required. 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.

An integrated Public Participation Process (PPP) will be undertaken for the proposed projects. Two separate Scoping Reports and two separate Environmental and Social Impact Assessment (ESIA) reports will be submitted to the Environmental Protection Agency (EPA) for decision-making.

WIND ENERGY FACILITIES

The proposed ***75 MW Wind Power Project 1*** will cover an area of approximately 177.46 ha (Site A). Site A is located east of the flat Volta River delta near the communities of Anloga, Srogbe and Anyanui on the coast in the Keta Municipality in the Volta Region. The electricity generated at the proposed ***Wind Power Project 1*** will be evacuated via a newly constructed 69/33 kV substation onsite and will be connected to the grid via a 69 kV overhead transmission line of approximately 37 km from the onsite substation to the Sogakofe Substation.

The proposed ***75 MW Wind Power Project 2*** will cover an area of approximately 193.31 ha (Site B). Site B is located within the Wokumagbe and Goi communities in the Ada West District of the Greater Accra Region. The electricity generated at the proposed ***Wind Power Project 2*** will be evacuated via a newly constructed substation onsite and will be connected to the grid via a new dedicated High Voltage transmission line to the existing grid.

STUDY AREA

The study area for the Scoping and Environmental & Social Impact Assessment consists of sites at Anloga, Srogbe and Anyanui communities for the 75MW *Wind Power Project 1* and Wokumagbe and Goi communities for the *Wind Power Project 2* which are 424 and 470 ha, respectively (Figure 1 and 2 below).

Figure 1 – Locality Map for the Proposed Development of 75 MW Wind Power Project 1 at Anloga, Srogbe and Anyanui (Anloga Extension) in the Keta Municipal, Ghana.

Figure 2 – Locality Map for the Proposed Development of 75MW Wind Power Project 2 at Goi and Wokumagbe in the Ada West District, Ghana.

WHAT DOES THE BACKGROUND INFORMATION DOCUMENT TELL YOU?

This Background Information Document (BID) provides you, as an Interested and Affected Party (I&AP), with the background information on the proposed projects as follows;

- A description of the ESIA and Public Participation Processes that will be undertaken for the proposed projects; and
- Details on how to register as an Interested and Affected Party (I&AP) to indicate your interest in the projects and receive further information.

If you register as an I&AP, there will be opportunities for you to be involved in the Scoping and ESIA Processes through receiving information, registering your interest on the project database, raising issues of concern and commenting on reports. Inputs from I&APs, together with the information and assessment provided by the Environmental Assessment Practitioner and relevant specialists, will assist the Environmental Protection Agency Board with their decision-making in terms of whether to grant or refuse an environmental permit for the proposed projects.

What do the projects entail?

The 75MW Wind Power Project 1 (Anloga Extension) and 75MW Wind Power Project 2 (Wokumagbe and Goi) will each consist of the main components listed below. The components and their dimensions will be discussed in the Scoping and the ESIA Reports that will be produced for each facility:

- Wind Energy Facilities
    - Wind turbines
    - Building infrastructure
    - Offices;
    - Operational control centre;
    - Warehouse/workshop;
    - Ablution facilities; and
    - Converter station.
- Associated Infrastructure
    - Electrical infrastructure (including transmission lines and substations);
    - Access roads;
    - Internal gravel roads;
    - Fencing;
    - Operation and Maintenance Area;
    - Laydown Area;
    - Stormwater channels; and
    - Water pipelines.

ENVIRONMENTAL AUTHORISATION

The applicable regulations that would be triggered in the context of the proposed projects are:

- The Constitution of the Republic of Ghana, 1992
- Environmental Protection Agency Act, 1994 (Act 490)
- Environmental Assessment Regulations 1999, LI 1652
- Renewable Energy (RE) Act, Act 832 of 2011
- Factories, Offices and Shops Act (1970) Act 328
- The Ghana Civil Aviation Act 678, 2004
- Road Traffic Acts, 2004, Act 683
- National Road Safety Commission Act 567 of 1999
- Road Traffic Offences Regulations, 1974 (Li 952).
- Ghana Civil Aviation Regulations (GCAR) part 1, LI 1818
- Labour Act No (2003) Act 651
- Labour Regulations, 2007 (LI 1833)
- New Lands Commission Act (2008) Act 767
- State Lands Regulations (1962) LI 230
- National Museums Decree (1969) NLCD 387
- National Land Policy, 1999
- National Biodiversity Strategy for Ghana, 2002
- Wetland Management (Ramsar Sites) Regulations LI 1999
- National Wetlands Conservation Strategy, 1999

The list of relevant regulations will be refined during the course of the Scoping and ESIA Processes, and other regulations triggered may be removed or added as applicable. The applicable project activities require environmental permit from the Environmental Protection Agency. The Scoping and ESIA Process needs to show the potential impacts of the proposed developments on the biophysical, social and economic environment. The steps in the Scoping and ESIA Process are outlined below.

Scoping and ESIA Process

The Scoping and ESIA Process being implemented can be summarised as follows:

Stage 1: Environmental Scoping:

This Scoping Process is being planned and conducted in a manner that is intended to provide sufficient information to enable the authorities to reach a decision regarding the scope of issues to be addressed in the ESIA, and in particular to convey the range of specialist studies that will be included as part of the Environmental Impact Reporting Phase of the ESIA, as well as the approach to these specialist studies.

Stage 2: ESIA:

One of the purposes of this stage of the ESIA Process is to undertake specialist investigations to address the issues of concern that have been raised and identified through the Scoping Process. The following specialist studies have been identified, at this stage, to form part of the ESIA Phase of the proposed projects:

- Ecological Survey & Habitat Assessment Study;
- Historical Resources & Cultural Heritage Assessment;
- Landscape & Visual Intrusion Assessment;
- Aviation & Communication Impact;
- Compensation Action Plan;
- Noise and Flicker Impact Assessment

Public participation process

Step 1: Notify Authorities and I&APs of the Scoping and EIA Processes (30 days)

Step 2: Preparation of Applications for Environmental Permit, and Scoping Report

Step 3: Submission of Applications for environmental permit

Step 4: Authority and I&AP Review of the Scoping Report (21 days)

Step 5: Submission of Scoping Report to the Environmental Protection Agency for Decision-Making

Step 6: Undertake Specialist Studies and Preparation of ESIA Reports (including the Environmental Management Programme (EMPr))

Step 7: EPA and I&AP Review of the ESIA Reports and EMPr (21 days)

Step 8: Submission of the ESIA Reports to the Environmental Protection Agency for Decision-Making

Step 9: Notification of Environmental Decision and Appeal Period

How can you get involved?

1. By responding to our invitation to register as an interested and affected party for this project.
2. By mailing or faxing a Comment and Registration Form to the Seljen Consult Limited (contact details provided below).
3. By telephonically contacting the Seljen Consult Limited if you have a query, comment, or require further project information.
4. By reviewing the various reports within the stipulated comment periods provided.
5. By attending any feedback meetings, which may be held during the review period.

Contact us:

To register as an I&AP, please complete the Comment and Registration Form included with this BID and kindly return to:

Name	Email	Mobile
Kofi Gatu	seljencon@gmail.com	+233-20-843-4557 / +233-24-206-3391
Dr. James Kojo Adomako	jadomak@yahooc.com	+233-20-818-0362 / +233-54-434-0346
Frank Cudjoe	cudjoefrank@yahoo.com	+233-50-973-8415 / +233-24-280-7339

Postal Address:
Seljen Consult Limited, P. O. Box AT 140, Achimota-Accra. Ghana-West Africa

REGISTRATION AND COMMENT SHEET:

Should you have any queries, comments or suggestions regarding the proposed 75MW Wind Power Project 1 (Anloga Extension) and 75MW Wind Power Project 2 (Wokumagbe and Goi) being developed by the Volta River Authority respectively in the Keta Municipality and Ada West Districts in Ghana, please note them below and return this sheet to:

Name	Email	Mobile
Kofi Gatu	seljencon@gmail.com	+233-20-843-4557 / +233-24-206-3391
Dr. James Kojo Adomako	jadomak@yahooc.com	+233-20-818-0362 / +233-54-434-0346
Frank Cudjoe	cudjoefrank@yahoo.com	+233-50-973-8415 / +233-24-280-7339

Please formally register me as stakeholder and provide further information and notifications during ESIA process		Yes	No
I would like to receive my notifications by:	Fax	Post	Email

Comments:

Please fill-in your contact details below for the project database:

Title & Name			
Organisation			
Telephone		**Fax**	
Mobile Phone		**Email**	
Postal Address			

Name	Signature	Date

SELJEN CONSULT	**Thank you for the Participation**	CSIR our future through science

MARCH 2016

APPENDIX 2: SCOPING NOTICE

36 Visit www.graphic.com.gh **Daily Graphic**, Tuesday, August 9, 2016.

SCOPING NOTICE

The Volta River Authority (VRA) intends to construct and operate two wind energy facilities as follows:

A. 75MW Wind Power Project 1 (Anloga Extension) located at Anloga, Anyanui & Srogbe communities in the Keta Municipal in the Volta Region

B. 75MW Wind Power Project 2 (Wokumagbe and Goi) located in Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region

Notice of the proposed wind energy facilities is hereby served for public information, as required under the procedures for the conduct of EIA in accordance with Regulation 15 (1) of LI. 1652.

Any person(s) who have an interest, concern, or special knowledge relating to potential environmental effects of the proposed undertaking may contact or submit such concerns, etc., to:

The Chief Executive	**AND**	The Executive Director
Volta River Authority		Environmental Protection Agency
P. O. Box MB 77, Accra		P. O. Box M 326, Accra
Tel No: +233-302-664941-9		Tel No: +233-302-664697/8
Fax: +233-30-2662610		Fax No: +233-302-562690
Email: corpcomm@vra.com		Email: info@epa.gov.gh

Not later than 15th September, 2016

PUBLIC NOTICE

WARNING AGAINST SALE/PURCHASE & ENCROACHMENT OF LANDS WITHIN THE VOLTA GORGE PROTECTION ZONE

The Volta River Authority wishes to inform the General Public that by the Volta River Development Act (1961) Act 46, it is mandated to plan, execute, manage and ensure the protection of the lake side area of the Akosombo Dam.

In furtherance to this, the entire Volta Gorge measuring approximately 5,149.29 hectares has been designated as a protection zone hence no development can be carried out in this area without express permission from the Authority.

The said land is bounded on the West Bank of the dam by the Adjena, Anyaase, Dasaase, Pese, Gyakiti, Sawa townships, on the East Bank by Mpakadan, Anum and Dodi in the Akwamu, Anum and Boso Traditional Areas in the Asuogyaman District in the Eastern Region of the Republic of Ghana, on the North East by the Dodi Stool Land on the North West by the Pese Stool land on the South East by the Akosombo Dam and the South West by the Adjena Stool and.

The Authority hereby warns all prospective land purchasers to desist from purchasing lands within the Gorge Area as no development would be permitted. Any person who commences development activity will be prosecuted and the project demolished.

Persons who do not adhere to this directive do so at their own risk.

For further enquiries, please contact:

The Director, Real Estate & Security Department, VRA on 0302675168/0302660078 or the 8th Floor of the Heritage Tower Building, Ambassadorial Area, Accra from 8:00a.m. to 4:00p.m. during working hours.

VOLTA RIVER AUTHORITY

APPENDIX 3: PICTURES FROM PROJECT BRIEFINGS

CONSULTATIONS WITH HEADS OF ADA WEST DISTRICT ASSEMBLY

CONSULTATIONS WITH COMMUNITY ELDERS

Consultations with Chiefs & Elders of Wokumagbe

Consultations with Chiefs & Elders of Goi

Consultations with Chiefs & Elders of Omankope, near Wokumagbe

STAKEHOLDERS' FORUM

SPECIALIST CURRICULUM VITAE

1.0 PERSONAL DATA

Contact Address:	P. O. Box AT 427, Achimota, Accra
Mobile Number:	0208434557
Email:	kofigatu@gmail.com
Profession:	Environmental & Social Impact Practioneer

2.0 SUMMARY PROFILE

Kofi Gatu has an educational background in Environmental Psychology, Human Resource Management and Local Government Administration, and now with over 10 years' experience in Environmental Assessments, primarily in the Leadership and integration functions. In this role, Kofi has conducted several research/data collation for input into several ESIAs for companies in order to strengthen their green credentials in the marketplace and protect the environment. His various roles have included stakeholder mapping/engagement, community mobilisations, identification and quantification of socio-economic issues, including legal implications for both project/property affected persons.

Kofi joined Moses Consulting Limited, an Environmental Consultancy firm, in 2007 as an Associate Consultant providing specific input into the coordination of Environmental Scoping, Environmental Impact Assessment (EIA) studies, Environmental Auditing as well as the production of Environmental Management Plans (EMP) and Environmental Progress Reports, as part of compliance of relevant regulatory bodies and organizations.

In 2009, Kofi joined Seljen Consult Limited as Technical Director of the company. His various roles and responsibilities has now gained him immense expertise in project design and management, proposal development, social survey, establishments of grievance mechanism/ resolutions, scientific/environmental research involving data collection and analysis, stakeholder analysis and their appraisal for input into ESIA reports, including facilitating the processes of acquiring Environmental Protection Agency permits and certificates.

Kofi is now proficient in application of sustainable development concepts and the use of both local (AKOBEN Rating) and International Standards Organisation (ISO) Principles (ISO 9,000, 14,000 & OHSAS 18,000) for effective management of the environment and the qualitative production of goods and services for clients, especially in the extraction, utilities, processing, recycling, mining, manufacturing and production in line with both Ghanaian and international safeguard requirements, such as the IFC, World Bank, Equator Principles, etc.

3.0 EDUCATION

2012- 2014: MA in Local Gov't Administration and Organization: Institute of Local Government
2010 -2012: MSc. Environmental Psychology: University of the Rockies, Denver Colorado-USA
2006-2008 Bachelor in Business Studies Management (Human Resources Managements): Wisconsin International University College
2002 -2005: BA Psychology with Philosophy: University of Ghana

4.0 EMPLOYMENT RECORD

Employer:	Seljen Consult Limited
Period:	January 2009 – Till Date
Position:	Technical Director
Job Functions:	Project Design & Management, Proposal Development, Coordinating activities for acquisition of Environmental permits for clients.

Employer:	Moses Consulting Limited
Period:	July 2007 - January 2009
Position:	Associate Consultant
Job Functions:	Conducting Environmental Scoping, Environmental Impact Assessment (EIA) studies, Environmental Auditing/Due diligence as well as the production of Environmental Management Plans (EMP) and Environmental Progress Reports, for clients as part of compliance of relevant regulatory bodies and organizations.

RECENT CONSULTANCY ASSIGNMENTS:

1. Preliminary Environmental Assessment for Achimota-Mallam Transmission Line Upgrade Project, Ghana Grid Company Limited, March 2012
2. Environmental & Social Impact Assessment for the Construction of Community Senior High School Project , Ministry of Education –World Bank Funded Project in the Greater Accra, Eastern and Volta Regions, September to December 2014.
3. Health Impact Assessment for Romex Mining Resources, Amoamang, Upper Denkyera West District. November 2013
4. Preliminary Environmental Assessment for Prestea-Bogoso Transmission Line Upgrade Project, Ghana Grid Company Limited, March 2012 (in progress)
5. Proposed 401 Eastern Corridor Transmission Line, GridCo
6. Environmental & Social Impact Assessment (ESIA), P.W. Ghana Limited Quarry Project, Shai Hill, Feb 2014

7. Environmental & Social Impact Assessment (ESIA), P.W. Ghana Limited Estate Airport Project
8. Preliminary Environmental Assessment, Volta River Authority Water Restructuring Project, selected Resettlement Communities
9. Environmental & Social Impact Assessment, Community Water & Sanitation Water Restructuring Project, Asutsuare.

SPECIALIST DECLARATION

I, Kofi Gatu, as the appointed independent specialist, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence

Signature of the Specialist:

Name of Specialist: Kofi Gatu

Date: May 30, 2017

Environmental & Social Impact Assessment

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

APPENDIX 2:

Terrestrial Ecology Impact Assessment Study

TERRESTRIAL ECOLOGY IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76.5MW Wind Power Project situated at Wokumagbe/Goi in the Greater Accra District of Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	Dr. James Kojo Adomako Department of Botany University of Ghana P. O. Box LG 55 Legon Tel: 054-434-0346 Email: jadomako@ug.edu.gh

DECEMBER 2017

EXECUTIVE SUMMARY

Dr James Kojo Adomako was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts on Terrestrial Ecological resources that might occur through the proposed construction, operation and decommissioning of a 76.5 Megawatt (MW) Wind Energy Facility in Workumagbe and Goi (WPP2) areas in the Greater Accra region, Ghana. Two layout alternatives were considered in this study.

The aim of the study was to identify the presence of terrestrial flora and fauna species and sensitive areas in the study area and to inform the Environmental Management Plan (EMP) developed as part of this ESIA to assist VRA in managing the discovered ecological resources in a responsible manner, to protect and preserve them.

The following three main vegetation types were encountered in the study areas:

- Coastal grassland and thicket
- Estuarine mangrove
- Lagoon margin

Fifty-nine (59) species belonging to 35 families and 57 genera were identified in the study area. The family represented by the greatest number of species was Gramineae with 9 species. This was followed by Cyperaceae and Papilionaceae with 4 species each. All other families recorded were represented by less than 4 species. In all, leguminous families (Caesalpiniaceae, Mimosaceae and Papilionaceae) had a combined total of 8 species.

The mangrove and lagoon margin vegetation is patchy and degraded. It is composed of stunted *Avicennia germinans, Sesuvium portulacastrum, Cyperus maritimus, Opuntia vulgaris* and *Cocos nucifera*. The Thicket vegetation harbours species such *as Ritchiea reflexa* (Gold star species), *Sansevieria liberica* and *Uvaria chamae* which are restricted to the coastal scrub and thicket vegetation zones of Ghana. These habitats are therefore critical.

Some of the fauna that are known to occur in the area enjoy some level of protection under Ghana's wildlife laws. Also of significance are the Nile monitor (*Varanus niloticus*), and several snake species.

The key impacts (medium significance without mitigation) identified during this assessment are as follows:

<u>Construction phase</u>

- Potential loss of protected and listed species associated with the clearing of vegetation.
- Removal of mangrove vegetation and brackish water swamp vegetation lagoon margin can cause intense evaporation of water body and destruction of habitats.
- Compacting of soils leading to death and displacement of some faunal and microbial species as well as to the competition of some plant species over others.
- Harsh chemical control measures may be used which might have negative impacts on non-target plant species and the environment.
- Disturbance of fauna during construction activities and opportunistic animal species may benefit from the construction activities.

<u>Operation phase</u>

- Noise, Accidents and Disturbance of fauna during the operation of the proposed wind turbines.

The above impacts are anticipated to be of low significance following the effective implementation of key recommended mitigation measures. All other impacts on flora and fauna associated with the construction, operation and decommissioning of the proposed project have been assessed to be of low/very low significance without and with mitigation measures. Both layouts (preferred and alternative layout) are anticipated to lead to the same level of impacts.

The following key management actions are recommended to be implemented:

- Where possible, species of conservation concern are to be identified prior to construction 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.
- Ensure that camp sites, lay down areas and other temporary areas are located in areas of low sensitivity and that they are clearly demarcated
- Demarcate construction and no go areas and keep clearing to a minimum.
- Ensure a rehabilitation and re-vegetation programme is effectively implemented.
- Compile and implement an invasive or alien species management programme.
- Construction of new tracks should be kept to the barest minimum and the use of existing roads should be encouraged.
- Mechanical control should be used for all vegetation clearing.
- Minimised compaction by minimising the number of passes of heavy trucks to and from the project sites.
- 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.

The preferred layout is recommended since the alternative layout would not lead to any significant reduction of the anticipated impacts.

LIST OF ABBREVIATIONS

CITES	Convention on international trade in endangered species of wild flora and fauna (Appendices, 1975)
EI	Economic Index
GHI	Genetic Heat Index
IUCN	International Union for Conservation of Nature
kV	Kilo Volts
MW	Mega Watts
NWC	National wildlife conservation regulations (Schedules, 1995)
PI	Pioneer Index
VRA	Volta River Authority

GLOSSARY

DEFINITIONS	
Alien Invasive species	These are species whose introduction and/or spread outside their natural past or present distribution threaten biological diversity
CITES Appendix 1	Threatened species which cannot be traded in
CITES Appendix 2	Species for which levels of trade are limited
NWC Regulations Schedule 1	The hunting, capturing or destroying of these species is prohibited at all times
NWC Regulations Schedule 2	The hunting capturing or destroying of these species is absolutely prohibited between 1st August and 1st December of any season. The hunting, capturing or destroying of any young animal, or adult accompanied by its young, of these species is absolutely prohibited at all times
Duration	The timeframe during which the risk/impact will be experienced
Economic Index	EI reflects the degree to which economic species occur in a sample
Endangered	In danger of extinction, and survival unlikely if the causal factors continue operating

Flora	Flora is the plant life occurring in a particular region or time, generally, the natural occurring or indigenous (native plant life)
Genetic Heat Index	GHI is a score reflecting how much of a biodiversity hotspot a sample of vegetation is. GHI is calculated in terms of the concentration of globally significant species in the sample, weighted by the degree of rarity
Indeterminate	Known to be "Endangered" or "Vulnerable", but there is not enough information to say which category is appropriate
Least Concern	Does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened
Magnitude	The anticipated severity of the impact
Pioneer Index	PI reflects the degree to which pioneer species occur in a sample
Pioneer species	Hardy species which are the first to colonize previously disrupted or damaged ecosystems, beginning a chain of ecological succession that ultimately leads to a more bio diverse steady-state ecosystem.
Probability	The chance of the impact/risk occurring
Rare	Small localised world populations, and therefore at risk, but are currently not "Endangered" or "Vulnerable"
Significance	Will the impact cause a notable alteration of the environment?
Spatial extent	The size of the area that will be affected by the risk/impact
Species	A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.
Vulnerable	Believed likely to move to "Endangered" category, if the causal factors continue operating

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TABLES

FIGURES

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TERRESTRIAL ECOLOGY IMPACT ASSESSMENT

1. INTRODUCTION & METHODOLOGY

Dr James Kojo Adomako was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts to Terrestrial Ecological resources that might occur through the proposed construction, operation and decommissioning of a 76.5 Megawatt (MW) Wind Energy Facility Wokumagbe and Goi (WPP2) (Figure 1) areas in the Greater Accra region, Ghana.

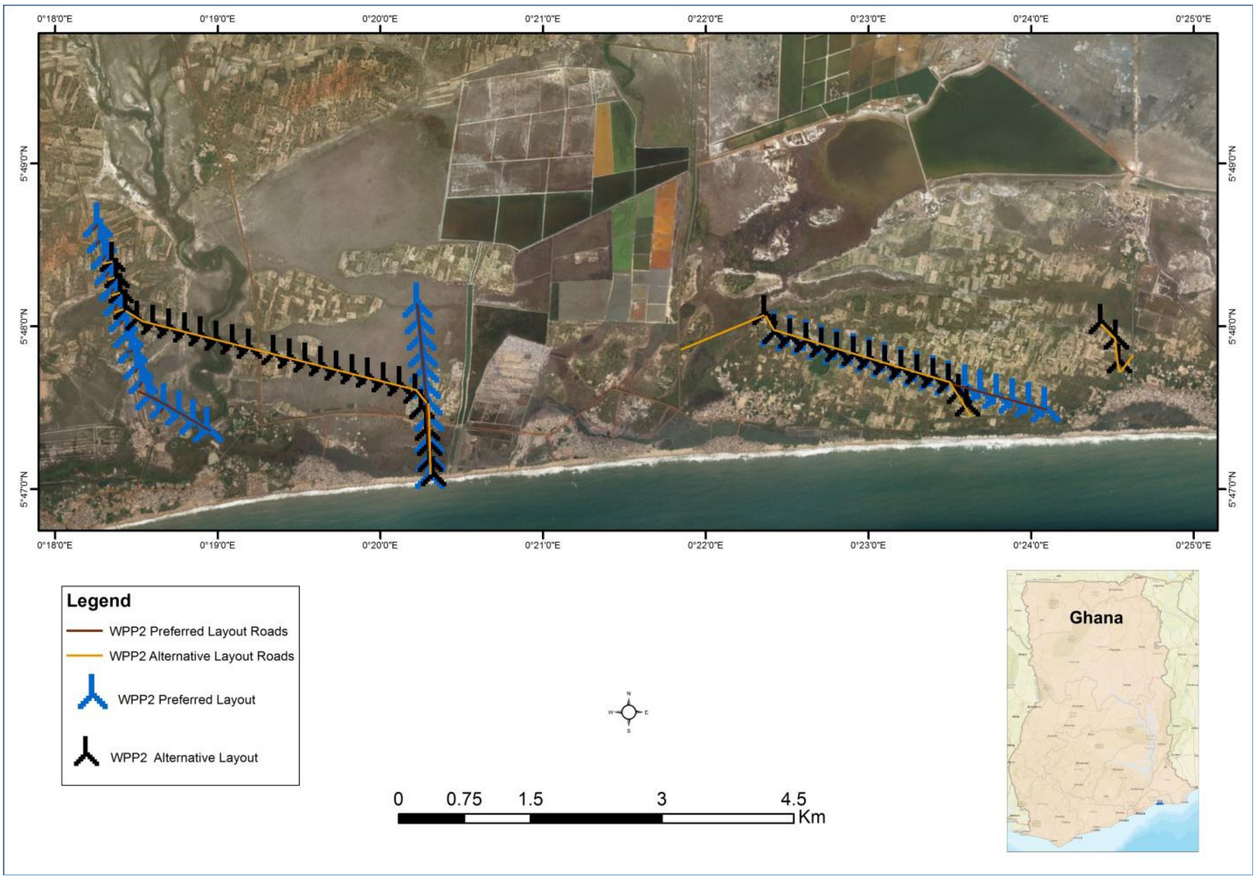

Figure 1: Location of the site for WPP2 with preferred and alternative layouts

The aim of the study was to identify potential terrestrial flora and fauna species and sensitive areas that may occur in the study area. This study aims to inform the ESIA in the development of a comprehensive Environmental Management Plan (EMP) to assist VRA in managing the discovered ecological resources in a responsible manner, to protect and preserve them.

2. TERMS OF REFERENCE

The assessment of the current ecological status of the proposed project site as well as impacts associated with the proposed project was undertaken in line with IFC PS 6 and World Bank OP 4.04. The scope of work was based on the following broad Terms of Reference which have been specified for this specialist study:

- List the prominent plant species (trees, shrubs, grasses and other herbaceous species of special interest) present for vegetation unit and ecosystem delimitation and determine the spatial distribution of native vegetation patches across the site.

- Identify plant and animal/fauna species (including bats) of conservation importance; which could possibly occur at the site.

- Assess impacts of the proposed wind development on terrestrial ecology, including loss of habitat and habitat fragmentation, potential risks for erosion, impacts on potential ecological corridors, loss of ecosystems services, etc.

- Make recommendation on the suitability of the proposed site for the project regarding the extent of impacts on ecology.

3. PROJECT DESCRIPTION

Any aspect of a development that disturbs the ground (e.g. foundations, roads, trenches and superstructures (e.g. wind turbines, buildings, fences)) would introduce impacts on terrestrial ecology. This project referred to as WPP2 will have the following main components which will impact on terrestrial ecology:

- **Wind turbine area**
    - Wind turbines;
    - Hard standing areas
- **Building Infrastructure:**
    - Offices;
    - Operational and maintenance control center;
    - Warehouse/workshop;
    - Ablution facilities;
    - Converter/Inverter stations;
    - On-site substation building; and
    - Guard Houses.
- **Associated Infrastructure**
    - Access roads;
    - Internal gravel roads;
    - Fencing;
    - Storm water channels; and
    - Temporary work area during the construction phase (i.e. laydown area).

Detailed project descriptions can be found in Chapter 3 of this ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

Table 1 briefly describes the legislation and permit requirements pertaining to fauna, flora and its related resources in Ghana, and how it applies to the proposed project.

Table 1: Policy and Legal Frameworks applicable to this project

Policy and Legal Framework	Summary of Core Requirements	Relation to Project
Biodiversity Strategies and Action Plan, 1998	An action plan to ensure sustainable use of the country's biological resources as enshrined in the Convention on Biological Diversity.	This project may cause the loss of some biological resources at the construction phase and should thus be guided by this Action plan.
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.	Destruction of economic plants listed in this framework during the construction phase of this project will be an offence.
Environmental Assessment Regulation, 1999, LI 1652	An Act which ensures that all projects conform to Environmental safety regulations of Ghana	This project may have a short to long term impact on the local and regional environment; hence should be regulated by the provisions of this Act.
Pesticide Control and Management Act, 1996	An Act to provide for the control, management and regulation of pesticides in Ghana and to provide for related matters.	This project should be guided against the use of pesticides.
Rivers Act, 1903	An Act to regulate the use of certain rivers and to provide for related matters.	Gallery vegetation of river bodies in and around the project site should be protected in compliance to the rivers Act.
Timber Resource Management Regulations, 1998	An Act which regulates how timber resources are accessed and used.	Destruction of timber resources in any forest reserve in relation to this project without permit will be an offence to the Republic of Ghana.
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.	Required in this project to protect habitats of wild animals.
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.	The project should be guided against the illegal hunting for wild animals and destruction of habitats of wild animals listed in the wholly or partly protected category of this legal framework.

5. METHODOLOGY

The methodology used in this study to determine the potential impacts of the proposed wind facility and associated infrastructures on terrestrial ecology included:

- a desktop study; and
- a field survey.

5.1 LITERATURE REVIEW AND INFORMATION SOURCES

A literature review was conducted to access existing information on the flora and fauna of the project area and to ascertain the broad vegetation types of the study area. The literature consulted included Taylor (1960), Hutchinson and Dalziel (1954-72) and Hall and Swaine (1981).

5.2 FIELD SURVEY

The following objectives were set for the field survey:

- To determine the spatial distribution of native vegetation patches across the site.
- To determine the presence of faunal species
- To record GPS locations of Sample point positions.
- To determine critical terrestrial ecological features that would be affected negatively by the proposed project.

5.2.1 Flora inventory

A reconnaissance walk along access routes crisscrossing the study area and along the external boundaries was undertaken to obtain an overview of the extent, topography and complexity of the vegetation. A rapid assessment of vascular plant species was conducted in the proposed site for WPP2 near the communities of Wokumagbe and Goi in the Ada West District of the Greater Accra Region. A total of twelve 20 m radius sweep sample plots (7 plots in Wokumagbe and 5 plots in Goi) were studied at the proposed project site (Table 2). The locations of the sample plots are shown in Figure 2 below.

Table 2: Coordinates and elevations of sampling locations

Sample number	Coordinates
GOI	
A1	N 05.78932 E 000.39372
A2	N 05.78999 E 000.39391
A3	N 05.79062 E 000. 39372
A4	N 05.79168 E 000.39391
A5	N 05.79485 E 000.39367
WORKUMAGBE	
G1	N 05.78469 E 000.33374
G2	N 05.78577 E 000.33374
G3	N 05.78782 E 000. 33378
G4	N 05.78957 E 000.33458
G5	N 05.79088 E 000.33466
G6	N 05.79133 E 000.33621
G7	N 05.79267 E 000.33543

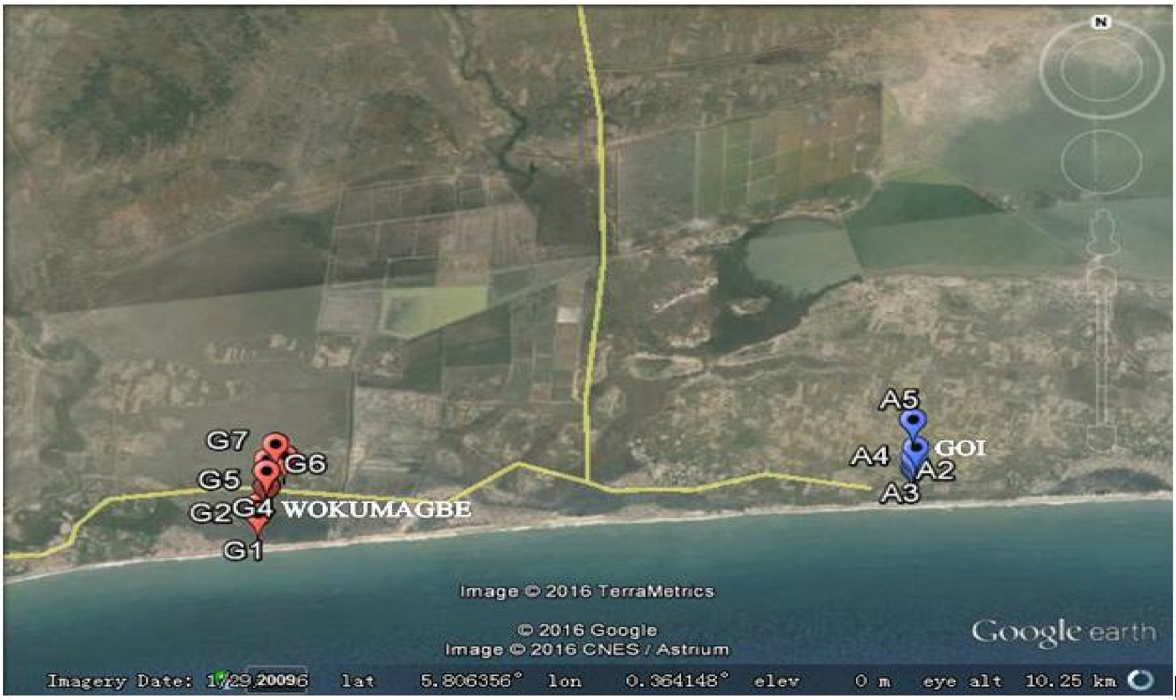

Figure 2: Sample plot locations

Specimens of species that could not readily be identified in the field were identified in the Ghana Herbarium, in Accra. Nomenclature follows the Flora of West Tropical Africa (Hutchinson and Dalziel, 1972). The conservation status of the species encountered were defined using the IUCN category and the star rating system adopted in the Forest Reserves of Ghana Geographic Information Exhibitor manual (Hawthorne, 1995) (Table 3).

Table 3: IUCN Star Rating categories

Rating	Description
Black Star species	Species rare internationally and at least uncommon in Ghana; urgent attention to conservation of populations needed
Gold Star species	Fairly rare internationally and/or locally
Blue star species	Widespread internationally but rare in Ghana or vice-versa
Scarlet star species	Common, but under serious pressure from heavy exploitation
Red Star species	Common, but under pressure from exploitation
Pink Star species	Common and moderately exploited. Also non-abundant species of high potential value
Green Star species	No particular conservation concern, common in Ghana

The proportions of species in the various categories were estimated and used in commenting on the conservational significance of the area.

The Bioquality of the study area was assessed using the Genetic Heat Index (GHI), the Economic Index (EI) and the Pioneer Index (PI), allowing prioritising the sites for various land uses (Box 1) (Hawthorne & Abu-Juam, 1995).

- A high Genetic Heat Index signifies that the area is of greater conservation priority and relatively rich in rare species such that loss or degradation of the area would represent a highly significant decline of genetic resources from the world and in Ghana in particular.

- A high Economic Index signifies that the area of the sample has a high priority for greater protection from, or at least more fine-grained control of, exploitation.

- A high Pioneer Index signifies that the area is well populated with pioneer species. Samples plots dominated by pioneer species are usually disturbed areas at the onset of ecological succession.

Box 1. Calculation of GHI, PI & EI

$$\mathbf{GHI} = \frac{[(BkS \times BkW) + (GS \times GW) + (BuS \times BuW)]}{N} \times 100$$

where:

BkS = Number of Black star species

BkW = Weight applicable to Black star species

GS = Number of Gold star species

GW = Weight applicable to Gold star species

BuS = Number of Blue star species

BuW = Weight applicable to Blue star species

N = Total number of species in a sample

NB. Black, Gold & Blue star weights are: 27, 9, 3 respectively

$$\mathbf{PI} = \frac{[(Pioneers \times Pw) + (NPLDs \times NPLDw)]}{N} \times 100$$

where:

Pw = Pioneer weight

NPLDw = NPLD weight

N = Total number of species in a sample

NB. Pioneer and NPLD weights are 2 & 1 respectively

$$\mathbf{EI} = \frac{[(SC \times SCw) + (RD \times RDw) + (PK \times PKw)]}{N} \times 100$$

where:

SC = Number of Scarlet star species

RD = Number of Red star species

PK = Number of Pink star species

SCw = Scarlet star weight

RDw = Red star weight

Pkw = Pink star weight

N = Total number of species in a sample

NB. Scarlet, Red and Pink star weights are: 3, 2 & 1 respectively

5.2.2 Faunal Inventory

The uses of four main methods were used in the faunal survey:

- direct/opportunistic observation,
- identification of animal spoors,
- interviews, and
- desk surveys of available literature (Hughes & Barry, 1969; Serle et al., 1992; Delany & Happold, 1979; Kingdon, 1987; Hughes, 1988; Haltenorth & Diller, 1988; Larsen, 1994).

Direct/opportunistic observation involved recording any animal sightings or animal trails while driving or walking within the project area. Transect walks to spot animal spoors (any sign left by a living animal, such as feeding sites, regular pathways, tracks, footprints, faecal pellets, nests, etc.) were also undertaken. Some individuals in villages within the project area were also interviewed to gather information about the fauna of the area. The interviews focused mainly on the various animals that commonly occurred in the area and their relative abundance.

5.3 ASSUMPTIONS AND LIMITATIONS

The assessment was undertaken using a random sampling sweep method. As such minor outliers within the site may not have been evaluated. The random sampling method, if correlated to topography and other aspects, is however a robust method of evaluating habitat across a large area. Upon the finalisation of the detailed design of the proposed project, an evaluation of the final footprint should be undertaken (subsequent to the issuing of an Environmental Permit (should one be granted for the proposed project) and upon completion of the detailed engineering prior to the commencement of construction).

6. DESCRIPTION OF THE AFFECTED ENVIRONMENT

6.1 GENERAL VEGETATION OF THE STUDY AREA

The project area lies in the coastal guinea savanna zone, which stretches from the east of Accra to the Western tip of Nigeria. This coastal guinea savanna zone interrupts the Upper Guinea forest ecosystem which occupies the coastal region of West Africa. The extent and quality of the Upper Guinea forest have declined considerably in response to human influences, notably growth of cities and agriculture.

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 vegetation of the project site at Workumagbe (Omankope) is seasonally flooded grassland vegetation which is heavily grazed (Plate 1), farm re-growth and isolated thicket clumps (Plate 2). 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*.

Plate 1: Seasonally flooded grassland at Workumagbe site

Plate 2: Fallow farmland with isolated thicket clumps at Workumagbe

The project site at Goi straddles lagoon margin and mangrove vegetation (Plate 3) and Thicket and grassland vegetation. The mangrove and lagoon margin vegetation is patchy and degraded. It 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*) (Plate 4). It occurs in a mosaic with farms and farm re-growths (Plate 5). Some of the common species of the thicket are *Azadirachta indica*, *Chassalia kholly*, *Millettia thonningii*, *Paullinia pinnata*, *Schrankia leptocarpa*, and *indigofera hirsuta*.

Plate 3: Lagoon with marginal mangrove vegetation (Avicennia germinans) at Goi

Plate 4: Cassava farm at Goi site

Plate 5: Fallow land with thicket clumps

6.2 FLORISTIC COMPOSITION OF THE STUDY SITES

59 species belonging to 35 families and 57 genera were identified in the study area. The family represented by the greatest number of species was Gramineae with 9 species. This was followed by *Cyperaceae* and *Papilionaceae* with 4 species each. All other families recorded were represented by less than 4 species. In all, leguminous families (*Caesalpiniaceae*, *Mimosaceae* and *Papilionaceae*) had a combined total of 8 species.

A list of all the plant species along with their families, life form, Star rating and IUCN status encountered in the study areas are presented in Table 4.

Table 4: Plant species encountered in the Study Sites

NAME	FAMILY	LIFE FORM	STAR RATING	IUCN STATUS
Agave sisalana	Agavaceae	Herb	NE	NA
Andropogon gayanus	Gramineae	Herb	NE	NA
Avicennia germinans	Avicenniaceae	Tree	NE	LC
Axonopus compressus	Gramineae	Herb	NE	NA
Azadirachta indica	Meliaceae	Tree	NE	NA
Borassus aethiopicum	Palmae	Tree	NE	NA
Byrsocarpus coccineus	Connaraceae	Shrub	NE	NA
Capparis erythrocarpos	Capparaceae	Climber	Green	NA
Cassia rotundifolia	Caesalpiniaceae	Shrub	NE	NA
Cassytha filiformis	Lauraceae	Climber	NE	NA
Cenchrus biflorus	Gramineae	Herb	NE	NA
Chassalia kholly	Rubiaceae	Shrub	Green	NA
Chloris pilosa	Gramineae	Herb	NE	NA
Cocos nucifera	Palmae	Tree	NE	NA
Commelina benghalensis	Commelinaceae	Herb	Green	LC
Crotalaria retusa	Papilionaceae	Shrub	NE	NA
Croton lobatus	Euphorbiaceae	Shrub	NE	NA
Cynodon dactylon	Gramineae	Herb	NE	NA
Cyperus articulates	Cyperaceae	Herb	NE	LC
Cyperus maritimus	Cyperaceae	Herb	NE	NA
Cyperus rotundus	Cyperaceae	Herb	NE	LC
Dactyloctenium aegyptium	Gramineae	Herb	NE	NA
Dialium guineense	Caesalpiniaceae	Tree	Green	NA
Dichrostachys cinerea	Mimosaceae	Tree	NE	LC
Elaeis guineensis	Palmae	Tree	Pink	NA
Eleusine indica	Gramineae	Herb	NE	LC
Euphorbia hirta	Euphorbiaceae	Shrub	NE	NA
Ficus elasticoides	Moraceae	Tree	NE	NA
Fimbristylis dichotoma	Cyperaceae	Herb	NE	LC

NAME	FAMILY	LIFE FORM	STAR RATING	IUCN STATUS
Flacourtia flavescens	Flacourtiaceae	Tree	Green	NA
Grewia carpinifolia	Tiliaceae	Climber	Blue	NA
Heteropogon contortus	Gramineae	Herb	NE	NA
Hewittia sublobata	Convolvulaceae	Climber	NE	NA
Hygrophila auriculata	Acanthaceae	Shrub	NE	LC
Indigofera hirsute	Papilionaceae	Shrub	NE	NA
Indigofera spicata	Papillionaceae	Shrub	NE	NA
Ipomoea pes-caprae	Convolvulaceae	Climber	NE	NA
Leonotis nepetifolia	Labiatae	Shrub	NE	NA
Mangifera indica	Anacardiaceae	Tree	NE	DD
Millettia thonningii	Papilionaceae	Tree	Blue	NA
Momordica charantia	Cucurbitaceae	Climber	NE	NA
Newbouldia laevis	Bignoniaceae	Tree	Green	NA
Opuntia vulgaris	Cactaceae	Tree	NE	NA
Passiflora foetida	Passifloraceae	Climber	NE	NA
Paullinia pinnata	Sapindaceae	Climber	Green	NA
Pergularia daemia	Asclepiadaceae	Climber	NE	NA
Philoxerus vermicularis	Amaranthaceae	Herb	NE	NA
Pupalia lappacea	Amaranthaceae	Shrub	NE	NA
Ritchiea reflexa	Capparaceae	Climber	Gold	NA
Schrankia leptocarpa	Mimosaceae	Shrub	NE	NA
Securinega virosa	Euphorbiaceae	Shrub	NE	NA
Sesuvium portulacastrum	Aizoaceae	Herb	NE	NA
Sporobolus pyramidalis	Gramineae	Herb	NE	NA
Stachytarpheta indica	Verbenaceae	Shrub	NE	NA
Triumfetta rhomboidea	Tiliaceae	Shrub	NE	NA
Typha domingensis	Typhaceae	Herb	NE	LC
Vernonia cinerea	Compositae	Shrub	NE	NA
Waltheria indica	Sterculiaceae	Shrub	NE	NA
Zanthoxylum xanthoxyloides	Rutaceae	Tree	NE	NA

LC – least concern; NA – Not yet assessed; NE – Not evaluated

Andropogon gayanus and *Elaeis guineensis* were the most frequent species occurring in nearly 42 – 67% of the samples studied.

6.2.1 IUCN category of plant species

Some of the species are of least concern (15%) and Data deficient (2%). However, 83% of the species have not been yet assessed by the IUCN. Although the conservation status of *Avicennia germinans* (Black mangrove) is of least concern (Table 4), its population trend is however decreasing.

Table 5: Distribution of IUCN status in the flora

IUCN Status	Frequency	%
Least concern (LC)	9	15
Data deficient (DD)	1	2
Not yet accessed (NA)	49	83
Total	59	100

6.2.2 Star Rating

The majority of the species (81%) have not been evaluated (NE). Green, Blue, Pink and Gold star species followed with 12%, 3% and 2% and 2% respectively (Table 6).

The Gold star species (Fairly rare internationally and/or locally) encountered in this study was *Ritchea reflexa*. The Blue star species (Widespread internationally but rare in Ghana or vice-versa) encountered in this study includes *Grewia carpinifolia* and *Millettia thonningii*.

Table 6: Distribution of star rating in the flora

Star Rating	Frequency	%
Green	7	12
Pink	1	2
Blue	2	3
Gold	1	2
Not evaluated	48	81
Total	59	100

6.2.3 Invasive Alien species

The invasive alien species encountered in this study was *Cyperus rotundus.*

6.2.4 Bioquality analysis

The following indices have been evaluated for the proposed project sites for WPP2:

- The Genetic Heat Index (GHI) value calculated for the project site at Goi was 23.1 (Table 7). This implies that the site is a hot spot for globally rare plant species, i.e. the area is relatively rich in species threatened in Ghana by overexploitation. Destruction of the vegetation for construction purposes can therefore result in the loss of such species in the area. In particular, *Ritchea reflexa*, a Gold star species (Fairly rare internationally and/or locally) was encountered at Goi. On the other hand, Workumagbe recorded zero GHI values thus raising no conservation concerns.

- Economic Index (EI) values for both sites were generally low (Table 7). This implies that all the two areas are generally low in the occurrence of Economic plants.

- The Pioneer Index (PI) values of WPP2 sites Goi and Workumagbe were 126.0 and 133.8 respectively (Table 7). Such high PI values indicate that the sites are very 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.

WPP2 sites were found to be poor in species richness as shown in Table 7. The study area however has some sensitive areas such as the mangrove and lagoon margin which may be affected during the construction phase.

Table 7: Bioquality analysis of the project sites

Community	Species Richness	PI	EI	GHI
Workumagbe	46	133.8	5.8	23.1
Goi	24	126.0	0.9	0.0

6.2.5 Classification of habitat types

The habitat types identified in the project area are presented in Table 8. Workumagbe has a seasonally flooded grassland, most probably an old lagoon, behind the sand bar. The sand bar has marginal strand vegetation. Goi has a small lagoon with patchy mangrove vegetation. The mangrove habitat, although patchy, provides ecosystem services such as breeding grounds for fish.

Table 8: Classification of Habitat Types

Classification	Community	
	Workumagbe	**Goi**
Habitat type	Critical habitat (Patchy strand/ seasonally flooded grassland)	Natural habitat (Lagoon margin / Mangrove)
Current State:	Degraded (heavily grazed)	Partly degraded
Importance:	Site for draining seasonal floods	Gallery to lagoon
Status	Low sensitivity	Moderate sensitivity

6.3 FAUNA

The viable wildlife populations of Ghana support a growing eco-tourism industry to complement the nation's strong cultural and historical attractions. Most of the wildlife is however found in the protected areas which are probably the only safe refuge for them against illegal hunting and habitat degradation from industrial and agricultural activities.

The terrestrial fauna of Ghana includes relatively small animals living in primary or secondary vegetation. These include frogs, toads, snakes and mice as well as smaller antelope species such as bushbuck. Notable among the mammals in Ghana are forest elephant, Red River Hog, and Leopards. The Primates species include Senegalese bush baby, Bosman's potto, Mona monkey, Spot-nosed monkey, and Black-and-white colobus. There are over 230 species of birds and 600 butterfly species. Reptiles are also fairly represented.

With the decrease in fish catches in recent years, the hunting of wild animals for sale and consumption of bushmeat has increased sharply. As a result the biomass of terrestrial wildlife species has dramatically declined in most coastal areas of Ghana (World Bank 2006; Brashares *et al.* 2004). Recent increase in coastal development has also resulted in declines in wildlife species and their habitats.

The WPP2 area lacks significant wildlife resources because of extensive farming activities in the area.

Based on the information gathered from the various methods and desktop analysis, Table 9 presents the faunal list of the study area. A number of the species known to occur in the area are of both national and global (IUCN, CITES) conservation significance (Anon, 1986).

Table 9: Fauna List

	Phylum	Class	Order	Family	CITES (1975) / NWC Regulations (1995)	IUCN status
INVERTIBRATES/ INSECTS						
Achatina sp. (Snail)	Mollusca	Gastropoda (Snails)			No data available	No data available
Archachatina sp.	Mollusca	Gastropoda (Snails)			No data available	No data available
Julus sp. (Millipede)	Arthropoda	Myriapoda			No data available	No data available
Graphium policenes	Arthropoda	Insecta (Insects)	Lepidoptera (Butterflies)	Papilionidae	No data available	No data available
Papilio cypraeophila	Arthropoda	Insecta	Lepidoptera	Papilionidae	No data available	No data available
Papilio demodocus	Arthropoda	Insecta	Lepidoptera	Papilionidae	No data available	No data available
Acraea sp.	Arthropoda	Insecta	Lepidoptera	Nymphalidae	No data available	No data available
Bematistis sp.	Arthropoda	Insecta	Lepidoptera	Nymphalidae	No data available	No data available
Bicyclus sp.	Arthropoda	Insecta	Lepidoptera	Nymphalidae	No data available	No data available
Catacroptera cloanthe	Arthropoda	Insecta	Lepidoptera	Nymphalidae	No data available	No data available
Charaxes sp.	Arthropoda	Insecta	Lepidoptera	Nymphalidae	No data available	No data available
Cymothoe sp.	Arthropoda	Insecta	Lepidoptera	Nymphalidae	No data available	No data available
Danaus chrysippus	Arthropoda	Insecta	Lepidoptera	Nymphalidae	No data available	No data available
Euphedra sp.	Arthropoda	Insecta	Lepidoptera	Nymphalidae	No data available	No data available

	Phylum	Class	Order	Family	CITES (1975) / NWC Regulations (1995)	IUCN status
Zonoceros variegatus	Arthropoda	Insecta	Orthoptera (Grasshoppers)		No data available	No data available
Palthothyreus sp.	Arthropoda	Insecta	Hymenoptera (Ants, Bees)		No data available	No data available
AMPHIBIANS						
Xenopus tropicalis (Clawed Toad)	Cordata	Amphibia	Anura (Salientia)	Pipidae (Clawed Toads)	No data available	No data available
Afrixalus dorsalis (Leaf folders)	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Afrixalus laevis	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Afrixalus nigeriensis	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Hyperolius baumanni (Reed frogs)	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Hyperolius bobirensis	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Hyperolius concolor	Cordata	Amphibia	Anura (Salientia)	Hyperoliidae	No data available	No data available
Hemisus guineensis (Shovel-nosed Frog)	Cordata	Amphibia	Anura (Salientia)	Hemisisdae (Shovel-nosed Frogs)	No data available	No data available
Dicroglossus occipitalis (Common Frog)	Cordata	Amphibia	Anura (Salientia)	Ranidae (Frogs)	No data available	No data available
Hylarana albolabris (Common	Cordata	Amphibia	Anura (Salientia)	Ranidae (Frogs)	No data available	No data available

	Phylum	Class	Order	Family	CITES (1975) / NWC Regulations (1995)	IUCN status
Frog)						
Hylarana occidentalis	Cordata	Amphibia	Anura (Salientia)	Ranidae (Frogs)	No data available	No data available
Phrynobatrachus accraensis (Puddle Frogs)	Cordata	Amphibia	Anura (Salientia)	Ranidae (Frogs)	No data available	No data available
Bufo maculatus	Cordata	Amphibia	Anura (Salientia)	Bufonide (True Toads)	No data available	No data available
Bufo regularis (Common Toad)	Cordata	Amphibia	Anura (Salientia)	Bufonide (True Toads)	No data available	No data available
Geotrypetes seraphini (Caecilian)	Cordata	Amphibia	Apoda (Gymnopiona)	Caecilidae (Leg-less Amphibians)	No data available	No data available
REPTILES						
Pelomedusa subrufa (Marsh Terrapin)	Cordata	Reptilia	Chelonia (Testudinata)	Pelomedusidae	S.2	No data available
Pelusios gabonensis (Gaboon Terrapin)	Cordata	Reptilia	Chelonia (Testudinata)	Pelomedusidae (Side-necked Terrapins)	S.2	No data available
Pelusios niger	Cordata	Reptilia	Chelonia (Testudinata)	Pelomedusidae (Side-necked Terrapins)	S.2	No data available
Kinixys erosa (Sweigger's Hingeback)	Cordata	Reptilia	Chelonia (Testudinata)	Testudinidae (Hinge-back Land Tortoises)	C.2 S.2	No data available

	Phylum	Class	Order	Family	CITES (1975) / NWC Regulations (1995)	IUCN status
Kinixys homeana (Hinged Tortoise)	Cordata	Reptilia	Chelonia (Testudinata)	Testudinidae (Hinge-back Land Tortoises)	C.2 S.2	No data available
Trionyx triunguis (River Turtle)	Cordata	Reptilia	Chelonia (Testudinata)	Trionychidae (Soft-shelled Turtles)	S.2	No data available
Agama agama (Agama/Rainbow Lizard)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Agamidae	No data available	No data available
Agama paragama [sylvanus]	Cordata	Reptilia	Squamata (Lizards and Snakes)	Agamidae	No data available	No data available
Mabuya perrotetii (Pink Bellied Skink)	Cordatas	Reptilia	Squamata (Lizards and Snakes)	Scincidae (Skinks)	No data available	No data available
Chamaeleo gracilis (Chameleon)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Chamaeleonidae (Chameleons)	C.2	No data available
Ancylodactylus spinicollis	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae (Geckos)	No data available	No data available
Hemidactylus brookei (Common House/Brooke's Gecko)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae (Geckos)	No data available	No data available
Hemidactylus fasciatus (Banded Gecko)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae (Geckos)	No data available	No data available
Lygodactylus conraui	Cordata	Reptilia	Squamata (Lizards and Snakes)	Gekkonidae (Geckos)	No data available	No data available
Lygodactylus picturatus	Cordata	Reptilia	Squamata (Lizards	Gekkonidae	No data available	No data available

	Phylum	**Class**	**Order**	**Family**	**CITES (1975) / NWC Regulations (1995)**	**IUCN status**
			and Snakes)	(Geckos)		
Varanus niloticus (Nile Monitor)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Varanidae (Monitors)	C.2 S.2	No data available
Amphisbaena muelleri (Worm Lizard)	Cordata	Reptilia	Squamata (Lizards and Snakes)	Amphisbaenidae (Leg-less/Worm Lizards)	No data available	No data available
Typhlops caecatus (Blind Snake)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Typhlopidae (Blind/Glass Snakes)	No data available	No data available
Typhlops punctatus (Spotted Blind/Glass Snake)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Boidae (Boas / Pythons)	No data available	No data available
Python sebae (African/Rock Python)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	C.2	No data available
Apparallactus modestus	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	No data available	No data available
Atractaspis aterrima	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	No data available	No data available
Philothamnus carinatus (Green Tree Snake)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	No data available	No data available
Psammophis phillipsi (Olive Grass Snake)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Colubridae (Typical snakes)	No data available	No data available
Thelothornis kirtlandii	Cordata	Reptilia	Serpentes (Ophidia)	Colubridae (Typical	No data available	No data available

	Phylum	Class	Order	Family	CITES (1975) / NWC Regulations (1995)	IUCN status
(Twig/Vine/Bird Snake)			(Snakes)	snakes)		
Dendroaspis. viridis (Green/Tree Mamba)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Elapidae (Cobras and mambas)	No data available	No data available
Naja melanoleuca (Black-and-white Cobra)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Atheris chlorechis (Green Tree Viper)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Atheris squamigera	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Bitis gabonica (Gaboon Adder/Viper)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Bitis nasicornis (Rhinoceros Viper)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
Causus maculatus (Night Adder)	Cordata	Reptilia	Serpentes (Ophidia) (Snakes)	Viperidae (Vipers and Adders)	No data available	No data available
MAMMALS						
Crocidura spp. (White-toothed Shrews)	Cordata	Mammalia	Insectivora	Soricidae (Shrews)	No data available	No data available
Eidolon helvum (African Fruit Bat)	Cordata	Mammalia	Chiroptera	Pteropodidae	S.2	No data available
Hypsignathus monstrosus (Hammer headed Bat)	Cordata	Mammalia	Chiroptera	Pteropodidae	S.2	No data available

	Phylum	**Class**	**Order**	**Family**	**CITES (1975) / NWC Regulations (1995)**	**IUCN status**
Perodicticus potto (Common/Bosman's Potto)	Cordata	Mammalia	Primates	Loridae	C.2 S.1	No data available
Galago senegalensis (Senegal Galago/Bush Baby)	Cordata	Mammalia	Primates	Galagonidae	C.2 S.1	No data available
Galagoides demidoff (Lesser/Dwarf Galago)	Cordata	Mammalia	Primates	Galagonidae	S.1	No data available
Epixerus ebi (Red-headed forest Squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	No data available	No data available
Funisciurus anerythrus (Redless Tree Squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	S.2	No data available
Funisciurus leucogenys (Orange-headed Tree-Squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	S.2	No data available
Funisciurus pyrrhopus (Cuvier's Fire-footed Tree-squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	S.2	No data available
Paraxerus poensis (Small Green/Bush Squirrel)	Cordata	Mammalia	Rodentia	Sciuridae	No data available	No data available
Cricetomys gambianus (Gambian/Pouched Giant Rat)	Cordata	Mammalia	Rodentia	Muridae	S.2	No data available
Mus spp. (Common Mice)	Cordata	Mammalia	Rodentia	Muridae	No data available	No data available
Thryonomys swinderianus (Cutting Grass/Cane Rat)	Cordata	Mammalia	Rodentia	Thryonomidae (Grasscutters)	No data available	No data available

	Phylum	**Class**	**Order**	**Family**	**CITES (1975) / NWC Regulations (1995)**	**IUCN status**
Atilax paludinosus (Marsh Mongoose)	Cordata	Mammalia	Carnivora	Herpestidae	S.2	No data available
Tragelaphus scriptus (Bushbuck)	Cordata	Mammalia	Artiodactyla	Bovidae	S.2	No data available

***Note*:**

IUCN Status: E – Endangered, LC – Least Concerned, Vu – Vulnerable, R - Rare

[C.1] … CITES Appendix 1; [C.2]… CITES Appendix 2

[S.1] NWC Regulations Schedule 1; [S.2] NWC Regulations Schedule 2

7. IDENTIFICATION OF KEY ISSUES

7.1 KEY ISSUES IDENTIFIED

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 in-to 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.

8. ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

8.1 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.

8.1.1 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.

8.1.2 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.

8.1.3 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.

8.1.4 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.

8.1.5 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.

8.1.6 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.

8.1.7 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.

8.1.8 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.

8.2 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.

8.2.1 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.

8.2.2 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.

8.2.3 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.

8.2.4 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

8.3 DECOMMISSIONING PHASE

8.3.1 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. In addition, the stabilisation of disturbed lands immediately after the

clearance of the land of the PV arrays and related infrastructure would serve to moderate the potential for invasion.

8.3.2 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.

8.3.3 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.

8.4 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 3). UpWind proposes to construct 90 to 100 turbines.

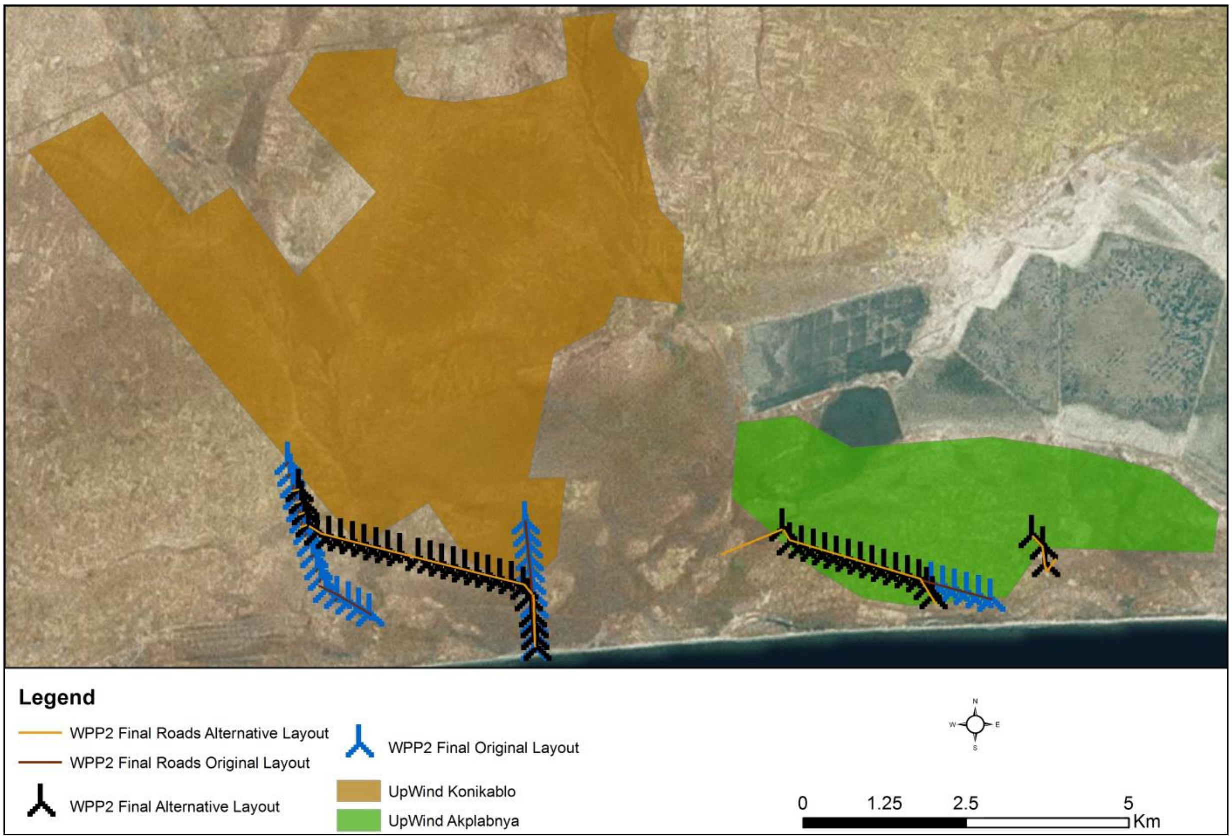

Figure 3: WPP2 in relation to the extent of the proposed Upwind WEF

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.

8.4.1 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.

8.4.2 Cumulative Impact 2: Impact on 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.

9. IMPACT ASSESSMENT SUMMARY

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Tables 10 to 12 below.

Table 10: Direct impacts assessment summary table for the Construction Phase for the preferred and alternative layout

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
Vegetation clearance	Loss of habitat and listed/rare species	Negative	Site and Local	Long-Term	High	Probable	Low	Low	• Any unwarranted destruction of vegetation and habitats beyond the designed wind park should be discouraged. • Lost biodiversity on the disturbed area should be restored through planting of appropriate trees and shrubs and protection of fauna species and their habitat. • Undertake a pre-construction walk through the site to identify species of concern that can be trans located if necessary • Mechanical control should be used for all vegetation clearing. • No listed/protected or rare plant may be dislocated or disturbed without the permission of the environmental manager • Cutting of trees must be done by a certified timber	Medium	Low	High

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
									contractor, and in line with the prescribed safety guidelines.			
	Increase in potential erosion during the clearing of vegetation	Negative	Local	Short term	Medium	Probable	Moderate	Moderate	• A rehabilitation and revegetation plan should be developed as part of the EMP • 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. • Erosion management plan	Low	Very low	High
	Removal of mangrove vegetation and brackish water swamp vegetation lagoon margin can cause intense	Negative	Local	Long-Term	Medium	Highly Probable	Moderate	Low	• Mangrove revegetation • Avoiding destruction of mangrove swamp where possible	Medium	Low	High

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
	evaporation of water body and destruction of habitats.											
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	• The number of passes of heavy trucks to and from the project sites should be regulated.	Medium	Low	Medium
	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	• Artificial wash off using a sprinkler. • Excavation activities should not be carried out during high wind speed period of the day. This will reduce the extent of spread of the particulate matter in the project footprint. • Minor trenches and holes should be constructed manually in order to reduce	Low	Very low	High

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
									the release of particulate matter.			
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	• Mechanical control should be used for all vegetation clearing. • 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-target plants and animals.	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	• 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	Low	Low	High

CONSTRUCTION PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
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	• 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	Medium	Low	High

Table 11: Impact assessment summary table for the Operational Phase for preferred and alternative layout

OPERATIONAL PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
Alteration of micro-climate	Changes in temperature, wind direction and speed	Neutral	Local	Long-Term	Medium	Probable	High	Low	• Monitoring of plant populations and replanting of native rare plants in buffer zones	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	• 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	Medium	Low	High
Impact on flora during maintenance activities.	Loss of biodiversity and habitats	Negative	Site-specific	Long-Term	Medium	Probable	Low	Moderate	• Avoid broadcast spraying of chemical herbicides during vegetation clearance • Uproot and burn invasive alien species ones spotted • eplant native rare plants in buffer zones	Low	Very low	High

OPERATIONAL PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence/ Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
									to prevent extinction. • Minor vegetation clearance should be done manually.			
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	• Minimising the development footprint wherever possible. • Revegetation of all cleared and bare areas created by the facility with local species.	Low	Low	

Table 12: Decommissioning Phase Impact assessment summary table for preferred and alternative layout

<table>
<tr><th colspan="13">DECOMMISSIONING PHASE</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">Consequence / Intensity</th><th rowspan="2">Probability</th><th rowspan="2">Reversibility</th><th rowspan="2">Irreplace-ability</th><th rowspan="2">Potential Mitigation Measures</th><th colspan="2">Significance</th><th rowspan="2">Confidence Level</th></tr>
<tr><th>Without Mitigation</th><th>With Mitigation</th></tr>
<tr><td>Exotic weed invasion as a consequence of abandonment of site and cessation of weed control measures</td><td>Habitat and species change</td><td>Negative</td><td>Local</td><td>Medium-Term</td><td>High</td><td>Probable</td><td>Low</td><td>Low</td><td>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.
Mitigation would include monitoring of the land and redress of exotic weeds found present on site</td><td>Low</td><td>Low</td><td>High</td></tr>
<tr><td>Exposed soil increase in erosion</td><td>Habitat and species population change</td><td>Negative</td><td>Local</td><td>Short-term</td><td>Medium</td><td>Probable</td><td>Medium</td><td>Low</td><td>Establishment of lawn in exposed areas * Establishment of lawn in exposed areas
Construction of proper permanent drainage system</td><td>Low</td><td>Very low</td><td>Medium</td></tr>
</table>

DECOMMISSIONING PHASE												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence / Intensity**	**Probability**	**Reversibility**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
	Impacts on fauna during construction decommissioning activities	Negative	Local	Short term	Medium	Probable	Low	Low		Low	Very Low	Medium

10. CONCLUSIONS AND RECOMMENDATIONS

The study identified the mangrove and thicket vegetation as critical habitats that would be impacted by the project through clearance. These are critical habitats as a result of all the ecosystems services they provide. The thicket has species such *as Ritchiea reflexa*, which is of conservation concern in Ghana. Black mangrove is listed as a Least Concern species however it has decreasing population and should be monitored. 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. The key mitigation measures identified in this report include the following basic activities, which are detailed in the report:

- 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

During the course of the EIA process, the turbine layout has been adapted to accommodate the various sensitivities identified in the various specialist studies. This has been a critical element in reducing the overall impact of the development. A similar approach should be adopted with regards to the associated infrastructure such as roads and underground cabling.

It is recommended 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.

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CURRICULUM VITAE OF JAMES K. ADOMAKO (DR.)

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Key Qualifications:

Dr. James Kojo Adomako is a botanist by profession and currently has a Ph.D. in ecology. He has undertaken various floral and faunal surveys, including that of fresh and marine water and which he has presented at various workshops and conferences. His research work in the field of ecology is extensive and has over 50 research papers to his name. He has worked as an individual consultant to many environmental consultancy firms during which he conducted ecological studies and provided recommendations on impacts and mitigation measures as a result of project development.

As terrestrial ecologist, Dr. Adomako has been responsible for the specific inputs into many environmental and scientific assignments some of which are indicated below:

- Consultant for WWF-International on the Biodiversity Convention, 1992-1994
- National Expert on Mangroves for the GEF Gulf of Guinea Large Marine Ecosystem Project 1997-1999
- Mapping of sudd vegetation on the Kpong head pond, Volta River Authority 1998-99
- Consultant Ecologist on the under listed Environmental Impact Studies
- Environmental Audit of small scale mining operations in Ghana, GTZ/Minerals Commission, 1993
- Dunkwa Environmental Audit, L&W of South Africa/SGMC
- Environmental impact studies for Aplaku and Nungua septage treatment projects, AY&A Consult, 1998
- Environmental impact studies for the Kwabenya Landfill Project, AY&A Consult, 1998

- Studies on the Underlying Causes of Deforestation and Forest Degradation in Ghana, ICA-Ghana, 1998
- Ecological Baseline Studies for Korle Lagoon, Scott Wilson Kirkpatirck & Co.Ltd, 1998-1999
- Kotoka International Airport runway expansion project, AY&A consult,1999
- Prestea-Obuasi transmission Line Right-of-Way, Refast, VRA, 2000
- Winneba water supply expansion project, AY&A,2000
- Aboadze-Tema transmission line Right-of-Way extension project, Refast Lines/VRA, 2002
- West Africa Gas Pipe Line Project, ESL/ICF Consulting, 2002-2003
- Floral Survey of the Biodiversity Component of the NRMP, Forestry Commission/ERML, 2001-2002
- Ex-Post Project Studies of 4 GEF-SGP funded Projects in Ghana, Global Environment Fund, 2004 - 2005.
- Tamale water supply Expansion project, AY&A Consult, 2006
- Ethnobotanical Survey in Inland Valley Sites, Inland Valleys Rice Development Project, GOG/AfDB/MoFA, 2006-2008 (Team Leader)
- EIA and EMP for Oil Palm Project, Dekel Oil, Abidjan Cote D'Ivoire, 2008
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a. PhD Botany (Ecology), University of Ghana, 2004,
b. Certificate (Diatom Taxonomy), University College London, 1998
c. MPhil Botany (Ecology), University of Ghana, 1991
d. BSc. (Hons) Botany with Zoology, University of Ghana, 1986

Employment Record:

Year:	**February 2001 to date**
Employer:	University of Ghana
Position:	Senior Lecturer
Responsibilities:	Teaches courses in Plant Ecology, Anatomy of Seed Plants, Conservation and Environmental Studies
Year:	**September 1992 - February 2001**
Employer:	University of Ghana
Position:	Lecturer
Responsibilities:	Teaches courses in Plant Ecology, Anatomy of Seed Plants and Conservation
Year:	**1986 – 1988**
Employer:	University of Ghana
Position:	Teaching Assistant
Responsibilities:	Assisting lecturers in practical assignment and course work in botany studies

Languages:

Languages:	***Speaking***	***Reading***	***Writing***
English	Excellent	Excellent	Excellent
Akan	Excellent	Excellent	Excellent
Ga	Excellent	Excellent	Excellent

SPECIALIST DECLARATION

I, **DR. JAMES KOJO ADOMAKO**, as the appointed independent specialist, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- Regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing – any decision to be taken with respect to the application by the competent authority; and – objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect to the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- All the particulars furnished by me in this specialist input/study are true and correct; and
- I realize that a false declaration is an offence

Signature of the specialist:

Name of the specialist: Dr. James Kojo Adomako

Date: February 19, 2017

Environmental & Social Impact Assessment

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

APPENDIX 3:

Bird Impact Assessment Study

ORNITHOLOGICAL BASELINE ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76.5MW Wind Power Project situated at Wokumagbe/Goi in the Greater Accra District of Ghana

Report prepared for:	*Report prepared by:*
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DECEMBER 2017

EXECUTIVE SUMMARY

The study aims at assessing the potential impacts on avifauna, associated with the proposed construction, operation and decommissioning of a 76.5 Megawatt (MW) Wind Energy Facility in Wokumagbe/ Goi (WPP2) areas in the Greater Accra District of Ghana (Figure 1). It will also inform the Environmental & Social Impact Assessment (ESIA) in the development of a comprehensive Environmental Management Programme (EMPr) to assist The Volta River Authority (VRA) in managing the impacts on avifauna in a responsible manner.

The proposed sites for the project have been highly modified by subsistence agriculture and perennial inundation of most of the marshy areas. Although some bird species of national conservation concern, mainly raptors belonging to the family *Accipitridae* as well as species belonging to the family *Ardeidea* (herons) were recorded at the sites, these were not present in significant numbers and other species recorded are common and widespread in Ghana as well within their geographic range. In general the study did not record any species or an ecological entity whose presence at both preferred and alternative layouts should preclude the development of the proposed project as both have similar potential impacts with regards to avifauna.

The key impacts associated with WEFs and birds are:

Construction phase:

- Habitat Destruction,
- Disturbance and Displacement

Operation Phase

- Collision with turbines
- Disturbance and displacement
- Disruption of bird movements

Decommissioning Phase:

- Disturbance and Displacement

Birds have proven to be resilient to most habitat changes, but impacts from developments such as wind turbines could have significant consequences on bird populations, particularly, vulnerable species. In general the study did not record any species or an ecological entity whose presence at both the preferred and the alternative layouts should preclude the development of the proposed project as both have similar potential impacts with regards to avifauna.

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.

The following key recommendations for Monitoring are made:

- 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).

LIST OF ABBREVIATIONS

CEMP	Construction Environmental Management Plan
CSIR	Council for Scientific & Industrial Research
dB	decibels
ECO	Environmental Control Officers
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
ESIA	Environmental & Social Impact Assessment
HV	High Voltage
IBA	Important Bird Area
IUCN	International Union for the Conservation of Nature and National Resource
km	kilometre
kV	kilovolts
m	metre
MV	medium voltage
MW	Megawatt
PA	Protected Area
SCL	Seljen Consult Limited
S/S	substation
sp.	species
VRA	Volta River Authority
WEF	Wind Energy Facility
WPP 2	Wind Power Project 2

GLOSSARY

DEFINITIONS	
Barrier effect	Phenomenon where bird movement is stampeded by barrier between feeding areas and breeding areas, thus affected productivity and populations.
Vulnerable species	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for vulnerability (see Red List Categories and Criteria Booklet for details), and it is therefore considered to be facing a high risk of extinction in the wild.
Refugia habitat	Remnants of habitat within a matrix of land use options that serve as refuge for species once their usual colonising site is altered.
Biome and Range Restricted species	Birds whose global distributions are restricted to the Guinea-Congo Forest block and the Upper Guinea Forest.

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ORNITHOLOGICAL BASELINE ASSESSMENT

1. INTRODUCTION

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 76.5 Megawatt (MW) Wind Energy Facility (WEF) in Wokumagbe/ Goi (WPP2) (Figure 1) areas in the Greater Accra District of Ghana.

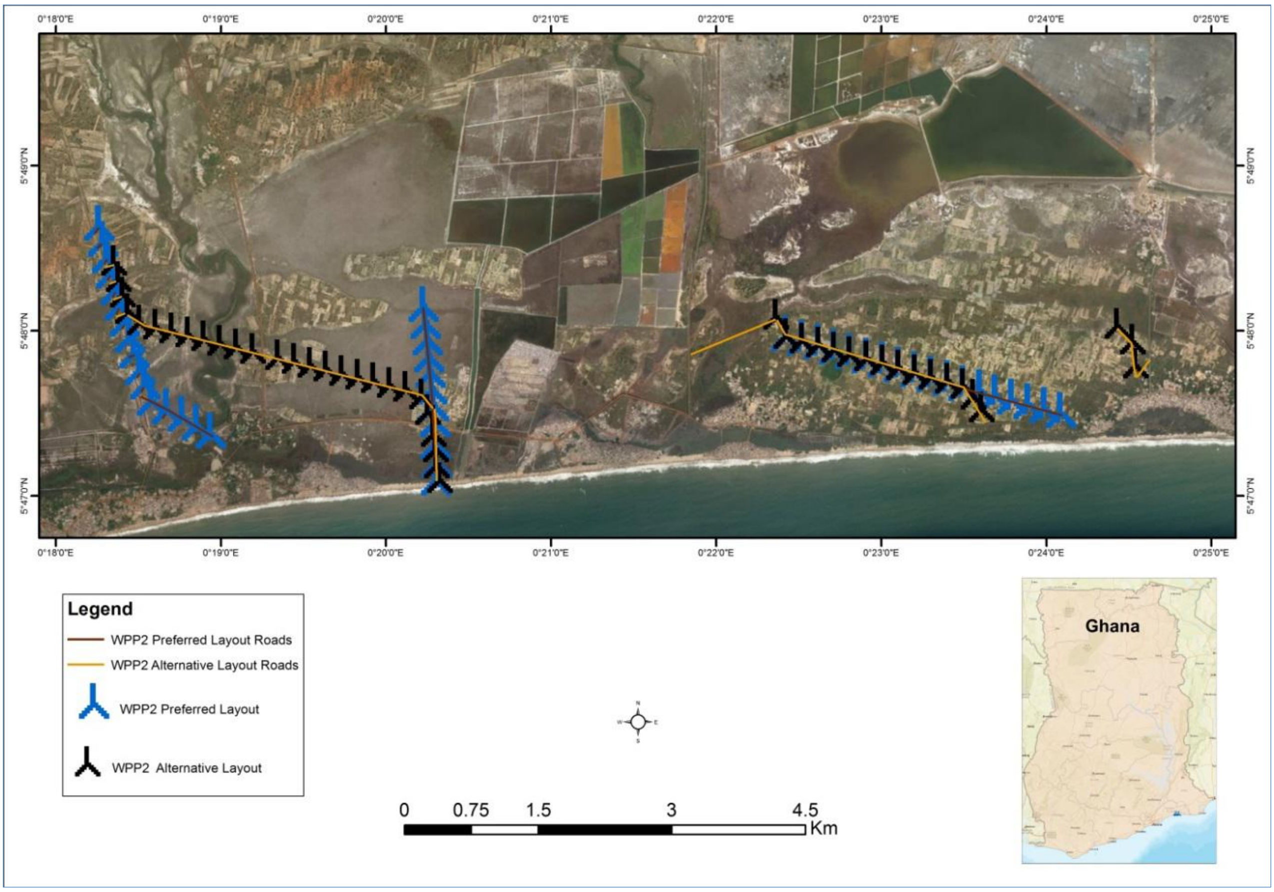

Figure 1: Location of the site for WPP2 with preferred and alternative layouts

This study aims to inform the Environmental & Social Impact Assessment (ESIA) in the development of a comprehensive Environmental Management Plan (EMP) to assist Volta River Authority (VRA) in managing the impacts on avifauna in a responsible manner.

2. TERMS OF REFERENCE FOR SPECIALIST STUDY

Birds are present in almost every faunal habitat type. In Ghana, the avifauna constitutes a significant and important component of the fauna resources of all ecological zones. In many cases, birds have been used in identifying priority areas for biodiversity conservation action (Conservation International, 1999, BirdLife International, 1998) and have proved to be reliable indicators of terrestrial biological richness and environmental conditions (Stattersfield, *et al*., 1998). Although they may not provide an ideal early warning signal of environmental deterioration; a change in bird population, species diversity and composition in a given habitat over a period of time is often indicative of ecological changes.

In terms of development impacts, birds have proven to be resilient to most habitat changes, but impacts from developments such as wind turbines could have significant consequences on bird populations, particularly vulnerable species. Such impacts could result from direct strikes; barrier effects; habitat loss and noise.

The Scope of Work is based on the following broad Terms of Reference, which have been specified for this specialist study:

- Undertake an ornithological survey to assess the biodiversity value of avifauna within the project area;
- Identify the potential threats to the identified bird species within the various phases of the project and prescribe interventions to mitigate identified issues;
- Provide inputs into the “Ecological Survey & Habitat Assessment Study” Report by preparing an “Ornithological Impact Assessment Report”.

This Bird Impact Assessment report has been compiled based on the information and data collected during the Scoping phase and contains the following:

- A description of the existing environment with regards to bird species and their habitats. Those bird species which are most likely to occur on site or be impacted upon as a result of the proposed development must be identified and described.
- A description of the potential impacts of the proposed facility on bird species.
- Recommendations for the management and mitigation of impacts.

The results of this analysis should be used to:

Inform the final turbine layout (or where the layout cannot be finalized within the ESIA, the assessment should be used to define no go areas and areas that should be sufficiently buffered).

Assess the significance of the potential impact of the proposed project alternatives and related activities - with and without mitigation - on avifaunal species and communities (with regards to potential disturbance, displacement, habitat loss and mortality through collision), including consideration of the spatial and temporal extent of these impacts.

Inform actions that should be taken to prevent or, if prevention is not feasible, to mitigate negative impacts during the planning, construction and operational phases of the development.

Inform the nature and extent of monitoring required during and post-construction

Highlight whether the proposed development is fatally flawed and should not be recommended for approval.

2.1 ASSUMPTIONS

Some assumptions included:

- Most species in the areas would be detected; and
- Larger species would easily be detected and identified; and
- This study assumes that the information sources used are accurate and reliable

2.2 LIMITATIONS

The major limitations encountered included:

- Monitoring programmes need to sample a wide set of environmental variables on site and this was not possible for the study. The length of time allocated for the study of bird species abundance and richness in an area is largely influenced by the time (season) of study (in this case dry season, where most of the vegetation had been burnt).
- Estimation of the flight height with no reference points against which to judge this is difficult and subjective.
- The presence of the observers on site is certain to have an effect on the birds itself. For example during walked transects, certain bird species will flush more easily than others, certain species may sit undetected, certain species may flee, and yet others may be inquisitive and approach the observers. Likewise with the vantage point counts, it is extremely unlikely that two observers sitting in position for three hours will have no effect on bird flight. Some species may avoid the vantage point position, because there are people there, and others may approach out of curiosity. In almost all data collection methods large bird species will be more easily detected, and their position in the landscape more easily estimated.

3. PROJECT DESCRIPTION

Birds have proven to be resilient to most habitat changes, but impacts from developments such as wind turbines could have significant consequences on bird populations, particularly vulnerable species. Such impacts could result from habitat loss associated with the construction of all components of the proposed facility and direct strikes by the turbines; barrier effects; and noise generated during the operation phase. The following main components of the proposed development may have impacts on avifauna:

- ***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;
  - Storm water channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

The proposed project will include 45 individual wind turbines with an approximate generation capacity of 1.7 MW each. The turbines will have a hub height of up to 80 m and a rotor diameter of 103 m. The integration of the wind farm to the existing grid will be done through a newly built 69/33 kV substation (S/S) on the wind farm (still to be constructed), as well as a newly built dedicated High Voltage (HV) transmission line, approximately 37 km in length (still to be constructed), to the nearest existing substation at Sogakofe. The transmission line does not form part of the scope of work of this ESIA. Within the wind farm, all 45 wind turbines will be connected on MV level to the substation. A detailed project description can be found in Chapter 3 of this ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The main domestic legislation governing wildlife in Ghana include:

1. Wild Animals Preservation Act, 1961 (Act 43) as variously amended;
2. Wildlife Conservation Regulation, 1971 (LI 685) as variously amended;
3. Wildlife Reserve Regulation, 1971 (LI 710) as variously amended;
4. Wetland Management (Ramsar Sites) Regulation 1999.

These all fall under the Act 43 of the Wild Animals Protection Act, 1961.

The Wild Animals Preservation Act, 1961 (Act 43) was subsequently amended by the Wild Animals Preservation (Amendment) Law, 1983 (PNDCL 55), and Forestry Commission Act, 1999 (Act 571). The main provisions of this Act include:

- It gives the Government the right to establish Protected Areas (PAs);
- It regulates hunting and trade in wild animals; including birds and trophies;
- It restricts the import and export of trophies without certificate;
- It prohibits certain methods of hunting;
- It contains five Schedules (of animals and birds) which provides various degrees of protection;
- It gives game officers the police powers of arrest;
- It provides indemnity to game officers for acts performed in good faith;

- It provides the institutional framework for management and conservation of wildlife, vested in Wildlife Division of Forestry Commission;
- It empowers the Sector Minister to make regulations for the administration of the Act; and
- It provides for sanctions in the event of non-compliance;

This law amends the five (5) Schedules provided under Act 43 and replaces them with three (3) new Schedules.

The Wildlife Conservation Regulations, 1971 (LI 685), as variously amended

- This law amends the five (5) Schedules provided under Act 43 and replaces them with three (3) new Schedules.
- Schedule I deals with animals that are under complete protection at all times (i.e. throughout the year). It is forbidden to hunt, capture or destroy any of the species contained in this Schedule. Examples include chimpanzees, lions, and elephants.
- Schedule II provides for animals that are under complete protection between 1st August and 1st December and those protected at all times when accompanied by their juvenile members. Examples include the Mona monkey, spotted hyenas, crested porcupines and tree bears.
- Schedule III deals with animals under complete protection between 1st August and 1st December. This Schedule further includes:
    - The prohibition of certain methods of hunting, such us using fires;
    - It provides for the acquisition of game licences for hunting of wild animals;
    - Enforcement of the law(s) entrusted to staff of the Wildlife Division;
    - The seizure of any equipment or apparatus in possession of any person who has contravened the law;
    - Permits required for the export of any animal and trophy;
    - Killing in defence of person(s); and
    - The provision of sanctions for breach of any of the provisions under the law.

The Wildlife Reserves Regulations, 1971 (LI 710), as variously amended, includes the following main provisions:

- To provide for the creation of national parks, game production reserves, strict nature reserves and wildlife sanctuaries;
- To provide for rules and regulations on entry;
- To prohibit certain activities within wildlife protected areas
- To provide for the protection of plant and animal life therein; and
- It provides sanctions in events of non-compliance.

Table 1 briefly describes the legislation and permit requirements pertaining to avifauna and its related resources in Ghana, and how it applies to the proposed project.

Table 1: Core requirements of applicable legislation and their relation to the project

Policy and Legal Framework	Summary of Core Requirements	Relation to Project
The Wildlife Conservation Regulations, 1971 (LI 685), as variously amended.	All species in Schedule I of the Regulation are wholly protected throughout the year.	The cattle egret and the yellow-billed kite and all raptors belonging to the family *Accipitridae* that were recorded in the project area, are fully protected. Hence any activity that would be undertaken would need to ensure that such species are not negatively impacted.
Wetland Management (Ramsar Sites) Regulations, 1999	Under this Regulation, no person shall through his/ her activities; i) pollute any water; ii) use poison, chemicals, explosives or any prohibited method for fishing; iii) the use of seine nets or other nets with mesh size below 25 mm; iv) do any other act that has or likely to have an adverse effect on the environment.	The site is part of the area that was designated as a Ramsar Site, under the Ghana Coastal Wetlands Management Project in 1992. The upland areas surrounding the lagoon are heavily degraded, freshwater flow into the lagoon is limited and large portions dry up during the long dry season. The main threat is the conversion into salt pans for salt production. This is likely to turn the entire lagoon into a salt reservoir. The location of the footprint within the larger landscape makes it important to pay attention to waterbirds that occur at Manya Lagoon, as their flight path could be impacted on by any future developments.

Policy and Legal Framework	Summary of Core Requirements	Relation to Project
The Wild Animals Preservation Act, 1961 (Act 43)	i. gives the Government the right to establish protected areas ii. regulation of hunting and trade in wild animals; including birds and trophies iii. To provide for sanctions in the event of non-compliance.	The Songor Lagoon as Ramsar site is also a protected area under the management of the Forestry Commission through the Wildlife Division of Ghana

5. METHODOLGY FOR ASSESSMENT OF IMPACTS

In order to assess the potential impacts, a standard field survey was conducted to determine, inter alia, the avian species composition of the selected sites. These included direct and indirect field observations and a combination of appropriate study methods.

5.1 AVIFAUNA

The initial field observations included two standard methods, transect and point counts. The two methods were selected based on the following;

a) The habitat of the proposed site is generally uniformly coastal savanna, with clear views for observing birds. Along the coast, lagoons that are documented habitat for migratory waterbirds exist.
b) Point counts using distance bands enable the estimation of species abundance and density.

The species list would be augmented by opportunistic observations. The method for bird identification and nomenclature followed that of Borrow and Demey (2001). Bird surveys were carried out in all the major representative habitat conditions. Major habitat types and site condition were predetermined using the current vegetation maps of the sites.

It is important to note that either method provides a quick and effective means of assessing the avifauna composition in different micro-habitat types. For the transects, counts were carried out every 200 m along footpaths and other access ways at the sites. Counts were carried out between 6:30 am and 10:00 am, and between 4:00 pm and 6:00 pm for four days per site, to ensure the complete species list is exhaustive. For each point of count, focus notes were taken in an attempt on movement patterns of the flocks with respect to the proposed wind farm location and which species were involved.

The point counts which were undertaken in patches, fell outside of the main transect, ensured that the species list would be exhaustive. Hence the vegetation data were used to enrich the species list. Since the primary purpose of the study was to identify and document the presence of bird species at the site, no distance limits were set for observations and, hence, any bird seen or heard anywhere in and around the site will be identified and recorded with the aid of telescopes and binoculars.

Mortality counts involved observations around each of the meteorological masts that have been installed on the sites to ascertain whether there were any signs of collision.

5.2 DATA ANALYSIS

Bird species recorded at the sites were grouped according to their family using the appropriate authorities and checklists, in this case, Borrow and Demey (2010). Global conservation and national protection status of each species were assessed using the International Union for the Conservation of Nature (IUCN) Red List of Threatened species (IUCN, 2012). The assessment of national protection status was based on the Ghana Wildlife Conservation Regulation 1971 (LI 685), where all species listed in Schedule I of the Wildlife Conservation Regulation are accorded full protection or wholly protected. Other measures of conservation significance such as Biome and Range Restriction (Bibby, *et al*., 1992; Stattersfield, *et al*., 1998) were used to consolidate the knowledge of conservation status of various species. Biome and Range Restricted species are birds whose global distributions are restricted to the Guinea-Congo Forest block and the Upper Guinea Forest. This attribute is important in any baseline study, in view of the rapid rate of disappearance of the Guinea - Congo Forest of West and Central Africa.

6. DESCRIPTION OF THE AFFECTED ORNITHOLOGICAL ENVIRONMENT

6.1 VEGETATION AND BIRD MICRO-HABITATS

The Wokumagbe and Goi project site constituting Wind Power Project 2 (WPP 2) falls within the Songor Ramsar Site, which is made up of large portions of the lagoon, which dries up in the dry season, resulting in hyper-saline conditions (Ntiamoa-Baidu, *et al.*, 2001) (Figure 2). The flood-plain is periodically inundated and the flooded areas are largely devoid of vegetation. There are also areas of freshwater marsh and coastal savanna grassland, the latter composed mainly of *Sesuvium portulacastrum*, with various grass species. The main wetland vegetation-type is saline marsh, with degraded mangroves (mainly *Avicennia* sp.) and waterlogged grassland along the margins of the lagoon; with riverine woodland, scattered thickets of shrubs, climbers and small trees on higher ground.

Terrestrial vegetation away from the lagoon is largely degraded coastal savanna, characterized by farmland, secondary vegetation on abandoned farms, wastelands and eroded lands invaded by neem trees *Azadirachta indica*, and isolated trees such as fan palm *Borassus aethiopum*, mango *Mangifera indica*, silk cotton tree *Ceiba pentandra* and baobab *Adansonia digitat*a. Human activities in and around the lagoon comprise mainly farming, fishing and intensive salt extraction. The site is well known ornithologically; it is the second most important site, after Keta Lagoon, for waterbirds on the Ghanaian coast, supporting estimated maximum numbers of over 100 000 birds (Ntiamoa-Baidu, *et al.*,2001).

The site is particularly important as a roosting site for terns; over 50 000 birds may be seen regularly during the peak months of September and October. The site has the highest count of Roseate Terns *Sterna dougallii* recorded at any site on the Ghanaian coast. The most important parts of the wetland for waterbirds are the Pute, Totope and Kablevu areas of the lagoon where spectacular flocks of terns, herons and egrets, *Recurvirostra avosetta*, stilts and several small wader species forage and roost together. Based on the above information, the site has been designated as an Important Bird Area (IBA)-GH36 (Ntiamoa-Baidu, *et al*., 2001).

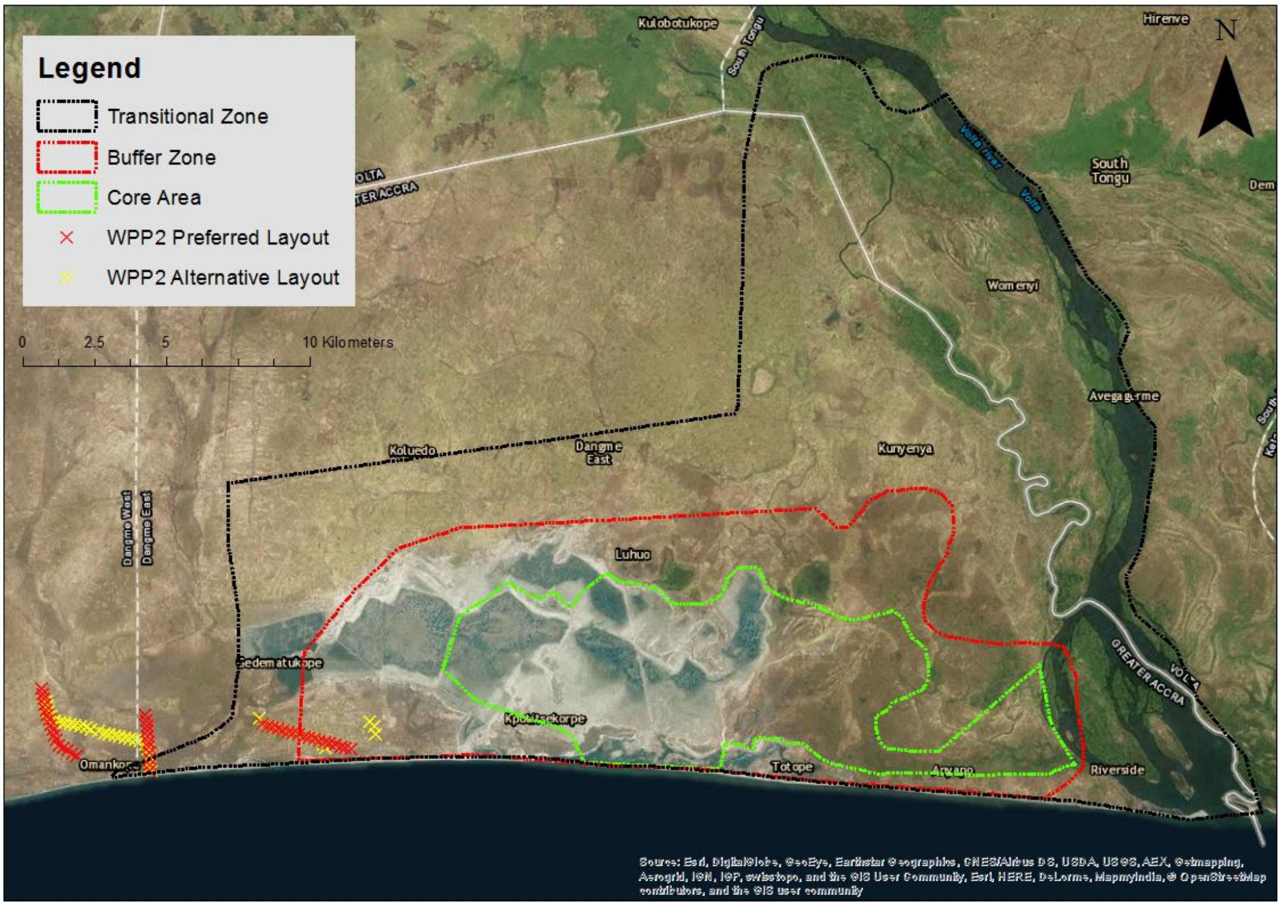

Figure 2: Relative position of the proposed WPP 2 turbines from the Songor Ramsar Site (*Green*: Core, *Red*: buffer and *Black*: Transition) (Amankwah C and Whitehead A, 2017)

Terns in particular, based on the experience of Grimes (1977) may fly inland to roost at saltpans after dark thereby exacerbating the risk of collision.

6.2 AVIFAUNAL COMMUNITY

A number of species of concern (Table 2) has been generated based on the abundance of the species, the flight patterns, and habitat preferences. All the species are listed as "Least Concern" on the IUCN Red List, hence their populations can be considered to be at low risk. This assessment also takes into account the presence of refugia habitat at all the sites for all the species in any event of habitat displacement that that may arise from the operational footprint within the study area. The listing here is therefore based on commonness and the risk of high probability of encountering wind turbines and obstructions from access roads etc.

Table 2: Species of Concern based on flight patterns and habitat preference

Species	Rational	Conservation Status National
CONSTRUCTION PHASE		
Common Bulbul	Clearance of habitat leading to displacement. Mid canopy bird.	Common, no special protection
Vinaceous Dove	Clearance of habitat leading to displacement	Common, no special protection
Village Weaver	Clearance of habitat leading to displacement	Common, no special protection
Yellow-crowned Gonolek	Clearance of habitat leading to displacement	Common, no special protection
Zitting Cisticola	Clearance of habitat leading to displacement	Common, no special protection
Black-crowned Tchagra	Clearance of habitat leading to displacement	Common, no special protection
Brown Babbler	Clearance of habitat leading to displacement. Gregarious and could be easily trapped	Common, no special protection
Bronze Mannikin	Clearance of habitat leading to displacement. Usually in large flocks in mid canopy	Common, no special protection
Northern Red Bishop	Clearance of habitat leading to displacement	Common, no special protection
Black-rumped Waxbill	Clearance of habitat leading to displacement	Common, no special protection
Black-billed Wood Dove	Clearance of habitat leading to displacement	Common, no special protection
African Wattled Lapwing	Clearance of habitat leading to displacement	Common, no special protection
Northern Grey-headed Sparrow	Clearance of habitat leading to displacement	Common, no special protection
Red-eyed Dove	Clearance of habitat leading to displacement	Common, no special protection
Yellow-billed Shrike	Clearance of habitat leading to displacement	Common, no special

Species	Rational	Conservation Status National
CONSTRUCTION PHASE		
		protection
Tawny-flanked Prinia	Clearance of habitat leading to displacement	Common, no special protection
OPERATION PHASE		
Yellow-billed Kite	Flight pattern increases its collision potential	Wholly protected
Purple Glossy Starling	Flight pattern increases its collision potential	Common, no special protection
Pied Crow	Flight pattern increases its collision potential	Common, no special protection
Western Grey Plantain-eater	Flight pattern increases its collision potential	Common, no special protection
Barn Swallow	Flight pattern increases its collision potential	Common, no special protection
White-throated Bee-eater	Flight pattern increases its collision potential	Common, no special protection
African Grey Hornbill	Flight pattern increases its collision potential. Medium sized bird with mid canopy movement	Common, no special protection

Besides the terrestrial bird species listed in Table 2 above, five species of terns (Grimes, 1977) and at least three species of waders (Delany *et al.*, 2009) could be affected by the proposed project. These two groups can be expected to forage and roost along the coastline. The terns hunt for fish in the inshore waters whereas the waders feed on invertebrates in the swash zone.

Grimes (1977) used radar to track the terns moving from their fishing grounds to inland roost sites on saltpans near Accra. The tern species are the Black *Chlidonias nigra*, Royal *Sterna maxima*, Sandwich *S. sandvicensis*, Common *S. hirundo* and Roseate *S. dougalli.* These terns are present during the boreal (Northern Hemisphere) autumn (September - December) during their southwards migration down the west coast of Africa. Upwelling, which occurs in autumn, results in shoals of fish, mainly sardine *Sardinella aurita* moving inshore where they are preyed upon by the terns. In spring no upwelling occurs and the terns travel northwards to their breeding grounds via a different route thus are not likely to be present in the Wokumagbe 2 area in significant numbers.

Delany *et al.* (2009) list three species of waders, Common Ringed Plover *Charadrius hiaticula*, White-fronted Plover *C. marginatus*, and Sanderling *Calidris alba*, that could be present in the Anloga area throughout the boreal winter from autumn to spring. These birds forage along the shore when sea conditions permit but will move inland to feed in shallow wetlands when the sea conditions are too rough.

Both these tern and wader species can be expected to roost at Saltpans or on island in the wetlands and thus are at risk from collision with the wind turbine blades. Terns in particular, based on the experience of Grimes (1977) may fly inland to roost after dark thereby exacerbating the risk of collision.

The surveys undertaken as part of this ESIA were too few in number and limited in scope and thus may not have provided representative data on these birds. Ideally 24 hour-a-day monitoring during the three months September, October and November should be undertaken to clarify the situation. 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.

An extensive list of common waterbird species and their abundance on coastal Ramsar Sites, including Songor Ramsar Site, as obtained in a single count in January 2017 can be found in Appendix 4 of the Wetland Impact Assessment Report. (Appendix 6 of this ESIA Report).

7. IDENTIFICATION OF KEY ISSUES

7.1 KEY ISSUES IDENTIFIED DURING SCOPING

Any aspect of a development that disturbs the ground (e.g. foundations, roads, trenches and superstructures (e.g. wind turbines, buildings, fences)) would introduce impacts on avifauna. However, the final capacity of the project would be determined by the micro siting of the project to minimise potential environmental 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.

The following key issues related to avifauna have been identified during the scoping 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 flushing 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

- *Collision of birds with turbine blades:*

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.

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.

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 precise location of a wind farm site can be critical. Soaring species may use particular topographic features for lift (Barrios & Rodriguez 2004; De Lucas et. al. 2008) or such features can result in large numbers of birds being funnelled through an area of turbines (Drewitt & Langston 2006). Birds also lower their flight height in some locations, for example when following the coastline or crossing a ridge, which might place them at greater risk of collision with rotors.

The size and alignment of turbines and rotor speed are likely to influence collision risk; however, physical structure is probably only significant in combination with other factors, especially wind speed, with gentle winds resulting in the highest risk (Barrios & Rodriguez 2004; Stewart et. al. 2007). De Lucas *et al*. (2008) found that turbine height and higher elevations may raise the risk (taller/higher = higher risk), but that abundance was not directly related to collision risk, at least for Eurasian Griffon Vulture *Gyps fulvus*.

- *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.

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.

7.2 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 Songor Ramsar site known to harbour significant number of birds and important migratory birds.

8. HIGH LEVEL ASSESSMENT OF IMPACTS/RISKS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The methodology used to assess the potential impacts on avifauna is detailed in Chapter 2 of the ESIA report. The identified impacts/ risks posed to avifauna during the construction, operation and decommissioning phases are detailed below.

8.1 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

8.1.1 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.

8.1.1.1 Mitigation

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.

8.1.2 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 Medium for the preferred and alternative layout prior to the application of mitigation measures, and is Low following mitigation.

8.1.2.1 Mitigation

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.

8.2 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

8.2.1 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.

8.2.1.1 Mitigation

- 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 Section 8.1.1.1 and 8.1.2.1.
- 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 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).

- 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.

8.2.2 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 Section 8.1.2, 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 medium 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.

8.2.2.1 Mitigation

- 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.

8.2.3 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) and is the impact is unlikely to occur. The consequence of this impact is considered medium. The significance of the impact is rated as Low prior to the application of mitigation measures, and as Low following mitigation.

8.2.3.1 Mitigation

- 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.

8.3 DECOMMISSIONING PHASE

8.3.1 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.

8.3.1.1 Mitigation

- 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.

8.4 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.

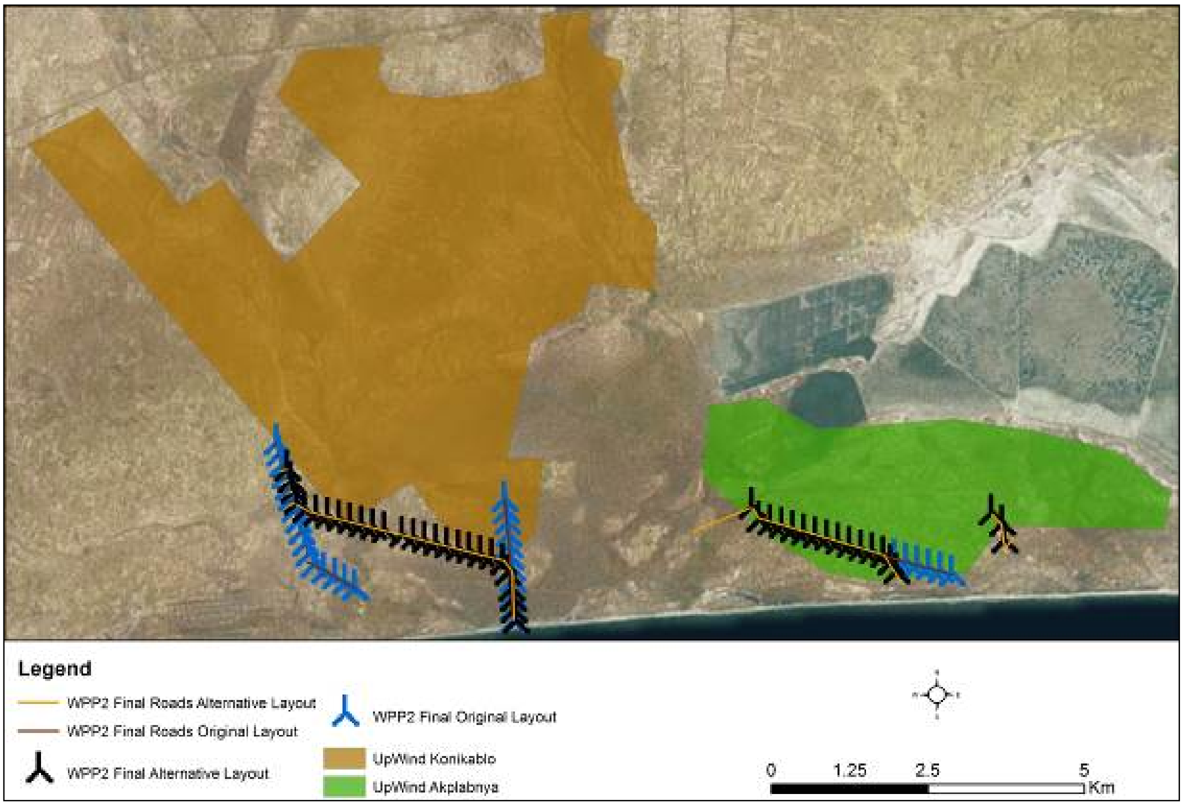

Figure 3: WPP2 in relation to the extent of the proposed Upwind WEF

9. IMPACT ASSESSMENT SUMMARY

The assessment of potential key issues, as discussed above, is collated in Table 3 below.

Table 3: 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

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*	
Turbine avoidance	Disruption and alteration of local bird movement patterns	Negative	Regional	Long-term	Medium	Probable	High	Moderate	Medium	Medium	Low
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

10. CONCLUSION AND RECOMMENDATIONS

The proposed sites for the project have been highly modified by subsistence agriculture and perennial inundation of most of the marshy areas. Although some bird species of national conservation concern, mainly raptors belonging to the family *Accipitridae* as well as species belonging to the family *Ardeidea* (herons) were recorded at the sites, these were not present in significant number and other species recorded are common and widespread in Ghana as well within their geographic range. In general the study did not record any species or an ecological entity whose presence at both preferred and alternative layouts should preclude the development of the proposed project as both have similar potential impacts with regards to avifauna.

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.

The following key recommendations for Monitoring are made:

- 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 aim is to establish appropriate monitoring criteria, to verify the predicted impact of the project, and to ensure that any unforeseen impacts are detected and the mitigation adjusted where needed at an early stage. Also the monitoring plan will ensure that mitigating measures and impacts of the project during construction and operational phases are implemented.

  - Also the monitoring results will provide information on the actual nature and extent of key impacts and the effectiveness of mitigation and benefit enhancement measures put in place and through a feedback mechanism, can be used enhance environmental compliance.
- The recommended monitoring programme will:
  - confirm the location of the proposed turbines in relation to migration routes,
  - estimate the number of birds regularly present or resident within the project area,
  - confirm patterns of bird movement in the vicinity of the proposed project and
  - therefore assess collision risks for key species
- Develop and implement a programme for birds during the first 24 months of operation (at the start of operations at the wind farm).

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).

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12. APPENDICES

List of common waterbird species and their abundance on coastal Ramsar Sites, including the Songor Ramsar Site, as obtained in a single count in January 2017 (*Source*: Wildlife Division, 2017).

Species		Densu Delta	Muni - Pomadze	Sakumo	Songor	Keta	Grand Total
Common Name	**Scientific Name**						
Common Sandpiper	*Actitis hypoleucos*	51	48	15	36	32	182
African Jacana	*Actophilornis africanus*			54			54
Great White Egret	*Ardea alba*	194		59		261	514
Yellow-billed Egret	*Ardea brachyrhyncha*					1	1
Grey heron	*Ardea cinerea*	649	2	9	4	144	808
Purple Heron	*Ardea purpurea*	1		3		8	12
Squacco Heron	*Ardeola ralloides*	15		16			31
Turnstone	*Arenaria interpres*	2			1	8	11
Cattle Egret	*Bubulcus ibis*			71			71
Senegal Thick-knee	*Burhinus senegalensis*			2			2
Dwarf Bittern	*Butorides striata*				1		1
Sanderling	*Calidris alba*	140	83		123	201	547
Knot	*Calidris canutus*		38	1	2	1	42
Cerlew sand piper	*Calidris ferruginea*	1613	113	13	1512	14395	17646
Little stint	*Calidris minuta*	430			933	902	2265
Ruff	*Calidris pugnax*			5			5
Ringed plover	*Charadrius hiaticula*	3775	236	2	569	2610	7192
White-fronted Plover	*Charadrius marginatus*		3			5	8
Kittlitz's plover	*Charadrius pecuarius*				73	345	418
Black Tern	*Chlidonias niger*	85	99	27		102	313
Fulvous Whistling Duck	*Dendrocygna bicolor*			5		00	5
White-faced Whistling Duck	*Dendrocygna viduata*	24		3		174	201
Black Heron	*Egretta ardesiaca*	99			1	7	107

Species		Densu Delta	Muni - Pomadze	Sakumo	Songor	Keta	Grand Total
Common Name	**Scientific Name**						
Little egret	*Egretta garzetta*	446	17	71	96	407	1037
Western reef heron	*Egretta gularis*	394	12	2	35	124	567
Common Moorhen	*Gallinula chloropus*	24			1		25
Collared Practincole	*Glareola pratincola*	1		101			102
Black-wing stilt	*Himantopus himantopus*	601	54		60	903	1618
Caspian Tern	*Hydroprogne caspia*					1	1
Lesser black backed gull	*Larus fuscus*		1			19	20
Black-headed gull	*Larus ridibundus*					18	18
Bar-tailed godwit	*Limosa lapponica*	8	13		3	11	35
Black-tailed godwit	*Limosa limosa*					13	13
Long-tailed Cormorant	*Microcarbo africanus*	3270	37	20		5465	8792
Curlew	*Numenius arquata*	39				7	46
Whimbrel	*Numenius phaeopus*	159	35		1	42	237
Grey plover	*Pluvialis squatarola*	23	75		62	29	189
Avocet	*Recurvirostra avosetta*				1		1
Painted snipe	*Rostratula benghalensis*	1	0	1			2
Roseatte tern	*Sterna dougallii*		1				1
Common tern	*Sterna hirundo*	110	411		254	929	1704
Little tern	*Sternula albifrons*				137	232	369
Royal Tern	*Thalasseus maximus*	388	212		50	127	777
Sandwich Tern	*Thalasseus sandvicensis*	238	352		51	371	1012
Wood sand piper	*Tringa glareola*	160		15	2	2	179
Greenshank	*Tringa nebularia*	277	124	31	75	1817	2324
Marsh sand piper	*Tringa stagnatilis*	12	19	16	6	46	99
Redshank	*Tringa totanus*	4	7		8	1	20
Wattle Plover	*Vanellus senegallus*			19			19
Spur-winged plover	*Vanellus spinosus*		5	53	1	2	61
Terek Sandpiper	*Xenus cinereus*		1				1
	Grand Total	13,233	1,998	614	4,098	29,762	49,705

CURRICULUM VITAE OF ERASMUS HENAKU OWUSU

PERSONAL

Name:	Dr Erasmus Henaku Owusu
Date of Birth:	30th October 1967
Marital Status:	Married
Nationality:	Ghanaian
Languages:	English (Fluent), French (Read), Akan (Twi-Fluent)
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PROFILE

Dr Erasmus H. Owusu is a Conservation Scientist and a Senior Lecturer at the University of Ghana Legon. He holds a PhD in Biodiversity Management from the University of Kent, Canterbury, UK. Dr Owusu has extensive knowledge of natural resource and environmental conservation in Ghana and Africa with **22 years** functional experience. His areas of expertise include community-based natural resource management; protected areas management & planning; environmental impact assessment as well as monitoring and evaluation of environmental projects. Since the year 2003, he has lectured in Conservation Sciences, Animal Ecology, Wildlife Management, and Wetland Ecology, among others, at undergraduate level. Within the same period he lectured in Advanced Animal Ecology, Human Dimensions of Conservation Science and Ecological Restoration at the graduate level at the University of Ghana. Dr Owusu has published **38 articles comprising 30** in refereed journals, **five (5)** as book chapters and **three (3)** Books. He co-authored the Birds of Ghana and was the project manager of the Important Bird Areas of Africa Project which was funded by the GEF/UNDP. The project surveyed and compiled forest of important biodiversity under his supervision and he co-authored the Ghana chapter of the Important Bird Areas of Africa and Associated Islands which was an outcome of the project. He was part of the core team that established the Kakum National Park in Ghana.

At the international level, Dr Owusu is currently the representative of Western Africa on the Technical Committee of the African Euro-Asian Waterbird Agreement (AEWA-Bonn Germany), and Representative of West Africa on the East Atlantic Flyway Initiative Task Force (UK). He is currently the only African serving as International Jury Member of the Quarry Life Award Programme for Restoration of Degraded Mining Sites of Heidelberg Cement Group, Germany. He was a Member of the Global Council of BirdLife International (UK) from 2008-2009 and served as the Chair of the Council of African Partners of BirdLife International between 2005 and 2006.

SPECIALIST DECLARATION

I, **Dr Erasmus Owusu**........, as the appointed independent specialist, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- Regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence

Signature of the Specialist: _______ ________________________

Name of Specialist: **___Dr Erasmus Owusu__________________**

Date: **__________________18th January 2017_________________**

Environmental & Social Impact Assessment

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

APPENDIX 4:

Heritage Impact Assessment Study

ARCHAEOLOGICAL & CULTURAL HERITAGE IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76.5MW Wind Power Project situated at Wokumagbe/Goi in the Greater Accra District of Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	*Wazi Apoh (Dr.)* Department of Archaeology and Heritage Studies P. O. BOX, LG 3 University of Ghana Legon -Accra

DECEMBER 2017

EXECUTIVE SUMMARY

Dr Apoh Wazi was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts to archaeological and cultural heritage resources, that might occur through the proposed construction, operation and decommissioning of the 76.5 Megawatt (MW) Wind Energy Facility (WEF) in Wokumagbe and Goi (WPP2).

The primary aims of this assessment are to describe the archaeological and cultural heritage resources baseline, assess the potential impacts on archaeological and cultural heritage resources associated with the proposed WEF and identify effective and practicable mitigation measures to assist VRA in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Museums Decree (1969) NLCD 387. Heritage resources are unique and non-renewable; as such any impact on such resources must be seen as an impact that should be mitigated where possible. 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 following wide range of places and objects were investigated during the survey:

a) Places, buildings, structures and equipment
b) Places to which oral traditions are attached or which are associated with living heritage;
c) Historical settlements and townscapes;
d) Landscapes and natural features;
e) Geological sites of scientific or cultural importance;
f) Archaeological and palaeontological sites;
g) Graves and burial grounds,
h) Movable objects

Key findings from this study include:

a. 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 most common type of heritage resources encountered in the study area was the Buokomaa Shrine of Wokumagbe. This will not be directly impacted. However there is the need to build a buffer of a 100m around the shrine to preserve its sanctity. The other feature that will be directly impacted is an abandoned house ruin at the Goi Project site. It is recommended that the owner should be compensated and the site cleared.

b. The proposed project has the potential to impact on the cultural landscape. Some notable cultural taboos were documented in the project that needs to be observed to minimize its impact. It was indicated that that the Buokomaa deity abhors chaos and murder in the community of Wokumagbe.

Various recommendations have been proposed for the client to implement to ensure that proposed associated benefits are realised and impacts mitigated. Key actions include:

c. Preparation of a “Compensation Action Plan” in order to minimize the adverse effects of the shrine and land acquisition on individuals, communities and/or families or clans to ensure that the PAPs are compensated properly.

d. 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.

e. 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.

LIST OF ABBREVIATIONS

EP	Environmental Permit
EIA	Environmental Impact Assessment
ESIA	Environmental & Social Impact Assessment
UNESCO	United Nations Education, Scientific and Cultural Organization
GMMB	Ghana Museums and Monuments Board

GLOSSARY

DEFINITIONS	
Heritage	UNESCO's 1972 convention defines heritage as our legacy from the past, what we live with today and what we pass on to the future generations. My perspective is that: It is a complex of inherited tangible and intangible legacies that are usually bequeathed by individuals, families, groups, communities, societies, nations, continents and the globe.
Cultural Resources	The UNESCO 1972 convention views cultural resources as "monuments, groups of buildings and sites with historical, aesthetic, archaeological, scientific, or anthropological value…it can also be cultural practices or sites with extrinsic cultural and socio-economic value.
Chance Finds	Any artefact or cultural material of significant archaeological value that is accidentally encountered in the course of the project.

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ARCHAEOLOGICAL & CULTURAL HERITAGE IMPACT ASSESSMENT

1. INTRODUCTION

Dr Apoh Wazi was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts to archaeological and cultural heritage resources that might occur through the proposed construction, operation and decommissioning of the 76.5 Megawatt (MW) Wind Energy Facility in Wokumagbe and Goi (WPP2) (Figure 1) areas in the Greater Accra region, Ghana.

Figure 1: Location of the site for WPP2 with preferred and alternative layouts

The aim of the study is to identify possible archaeological and cultural heritage sites, finds and sensitive areas that may occur within the study area. The Archaeological and Cultural Heritage Impact Assessment aims to inform the ESIA in the development of a comprehensive Environmental Management Plan (EMP) to assist VRA in managing any discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them.

2. TERMS OF REFERENCE

The purpose of the Archaeological and Cultural Heritage study is to recommend mitigation measures for any heritage resources that would be adversely affected by the proposed development and assist VRA in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Museums Decree (1969) NLCD 387. Heritage resources are unique and non-renewable and as such any impact on such resources must be seen as an impact that should be mitigated where possible.

The following wide range of places and objects were investigated during the survey:

i) Places, buildings, structures and equipment
j) Places to which oral traditions are attached or which are associated with living heritage;
k) Historical settlements and townscapes;
l) Landscapes and natural features;
m) Geological sites of scientific or cultural importance;
n) Archaeological and palaeontological sites;
o) Graves and burial grounds,
p) Movable objects

The key impacts and recommendations of this study have been captured in Chapters 6, 7 and 8 of the ESIA report.

3. PROJECT DESCRIPTION

This project referred to as WPP2 will have the following main components which may impact on the Archaeology and cultural heritage resources:

- **Wind turbine area:**
  - Wind turbines; and
  - 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).

Any aspects that disturb the ground (e.g. foundations, roads, trenches) may affect archaeological, palaeontological, cultural heritage resources and graves, while all superstructures (e.g. wind turbines, buildings, fences) would introduce impacts to the cultural landscape.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The National Museums Decree (1969) NLCD 387, the Executive instrument (EI 118) of 1969 and the National Museums Regulation (EI 29) of 1973 provide the guidelines for this study. These legal documents, besides expounding on the duties and regulations of the Ghana Museums and Monuments Board (GMMB), also provide a definition of antiquities, monuments and cultural artefacts and protect a variety of archaeological and cultural heritage resources.
The definitions applicable to the protected heritage resources are as follows:

The National Museums Decree (1969) NLCD 387 indicates under Article 31 that

> 'Antiquity means an object of archaeological interest or land in which any such object is believed to exist or was discovered, including any land adjacent to such object or land which in the opinion of the Board is reasonably required to maintain the object or the land or its amenities or to provide access thereto, or for the exercise of proper control or management over such object or land; or
>
> Any work of art or craftwork, including any statue, modelled clay figure, cast or wrought iron metal carving, house post, door, ancestral figure, religious mask, staff, drum, bowl, ornament, utensil, weapon, armour, regalia, manuscript or document, if such work of art or craftwork is of indigenous origin and
>
> i) was made or fashioned before the year 1900 or-
>
> ii) is of historical, artistic, or scientific interest and is or has been used at any time in the performance, and for the purpose of, any traditional ceremony.

'Objects of archaeological interest' means-

a) any fossil remains of man or of animals found in association with man; or
b) any site, trace or ruin of an ancient habitation, working place, midden or sacred place; or
c) any cave or other natural shelter, or engraving, drawing, inscription, painting or inscription on rock or elsewhere; or
d) any stone object or implement believed to have been used or produced by early man; or

e) any ancient structure, erection, memorial, causeway, bridge, cairn, tumulus, grave, shrine, excavation, well, water tank, artificial pool, monolith, group of stones, earthworks, wall gateway or fortification; or

f) any antique tool or object of metal, wood, stone clay, leather, textile, basket ware or other material which is of archaeological interest

In addition, the above laws provide the foundational rules on the conduct of research on antiquities, protection and conservation as well as the sale and export of antiquities. Section 8(1) The National Museums Decree (1969) NLCD 387 requires that a permit be obtained from the GMMB before the search for any antiquities can begin.

5. METHODOLOGY

The methodology used in this study to determine potential impacts on archaeological, historical and cultural heritage resources associated with the construction and operation of the proposed wind facility consisted of the following approach:

- a desktop study;
- interviews and focus group meetings; and
- a field survey of the existing cultural heritage resources.

The assessment details are summarised as follows:

Type of specialist investigation	The specialist investigation was for an Archaeological and Cultural Heritage assessment
Date of specialist investigation	Field work was completed between 5-9 February and 21 and 25 July 2016
Season, relevance of season	Seasonality has no relevance on the fieldwork completed in relation to heritage resources

The following methods were used to identify historical and cultural heritage resources: archaeological reconnaissance survey, ethnographic study, and visual anthropological field methods and techniques.

5.1 LITERATURE SURVEY AND INFORMATION SOURCES

A survey of available literature was carried out to assess the general heritage context into which the development would be set. This literature included published material, unpublished commercial reports and online material.

5.2 FIELD SURVEY

The WPP2 sites and their alternative site locations were archaeologically assessed in the field from 5-9 February 2016 as well as 21-25 July 2016. The assessment included conducting a reconnaissance surveys in transect at the proposed preferred layout sites to record key ethnographic objects and surface archaeological materials in the project areas. The location of possible archaeological sites and heritage resources were recorded with the use of a GPS. A number of shovel test pits were dug to test some of the sites for buried cultural remains. None of these test pits revealed any buried remains of significant cultural value. The use of video and photographic documentation of sites, objects, landscapes, the built environment, craft production processes, sacred ceremonies, and other tangible lifeways in the project area were also deployed.

5.3 INTERVIEWS AND FOCUS GROUP MEETINGS

Focus group discussions and documentation of oral accounts, including migration and settlement histories of descendant communities in the project areas were held in the area. These discussions were held between 5-9 February 2016, to document the heritage resources, cultural practices and oral accounts.

Table 1: Dates and location of interviewees for documentation of heritage resources in the study area

Date	Location	Interviewees
17-02-2016	Pentecost Church, Omankope	Chief, Elders, Community Members
17-02-2016	Wokumagbe Community	Stool Father, Okyeame,Asafoatse and Elders of Wokumagbe
18-02-2016	Paramount Chief House	Elders of Omankofe - J.N Oman -Kabutey Tawiah -Alfred Tetteh -Stephen Tetteh
17^{th} & 19^{th} February 2016	In the house of an elder and Under coconut trees on the beach at Goi	Chief and Elders of Goi

5.4 LIMITATIONS

Size of the study area and time constraints

Due to the substantial size of the study area, only samples of the area were archaeologically tested to discover buried remains.

6. DESCRIPTION OF THE AFFECTED CULTURAL AND HISTORICAL ENVIRONMENT

WPP2 is proposed to be located in the Wokumagbe and Goi areas in the Ada West District in the Greater Accra Region. The proposed project is located close to the Akplabanya-Lekpoguno-Goi-Wokumagbe communities which are all situated west of the Volta River within the Ada West District of the Greater Accra Region.

The project area is traditionally the home of the Ningo people in the west and the Ada people in the east. These groups belong to the larger group of the Dangbes who migrated from the east in the past. According to oral history, the Adas are believed to have migrated from Israel with a long stopover in Benin under King Agorkoli then to Tagologo near Shai-Osodoku in the former Dangme West District. The people of Ada are called Dangmeli and they speak Dangme as their local dialect. It is estimated that, several hundred years ago, the Ada initially settled at a place called Okorwhuem, near Anyamam in the south-western part of the District.

The indigenes of Ada West are part of the sub-group of people within the patrilineal society governed by a hierarchical and centralized authority. The Ada state was originally made up of eight clans namely; Adibiawe, Lomobiawe, Tekperbiawe, Dangmebiawe, Kabiawe, Ohuewem, Korgbor and Kudjragbe. Later, the Kabiawe divided into three separate clans, i.e. Kabiawe-tsu, Kabiawe-yumu and Kabiawe-Kponor. Each member of the society belongs to a clan in which they are believed to have descended along the male line.

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. The indigenes are into fishing and farming.

Land ownership of the project area is being contested by both the Kabiawe Clan of Omankope and the 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 clan 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 Omankofe, lands in the community belong to the clans (e.g. Kabiawe) in the community but not owned by individuals. He also pointed out that Wokumagbe is under Omankofe who is in charge of the land.

The project site at Goi is located along the road linking Akplabanya to the Goi Township. It is a farm land with crop and vegetable cultivations. The name Goi came about as a result of the abundance of the Borassus *sp.* (Emaa kube) on the land. This plant is called 'Agor' in Ga Adangbe. Since it was in abundance in the area it was called Goi. Nene Osibli Sebi is the paramount chief of the land and he hails from the Tekpebiawe clan. The Tekpebiawe clan are the land owners in Goi. Lolonya, Amanyakorpe and Dawa share boundaries with Goi. The Goi indigenes are fisher, farmers and fishmongers. The land is owned by the Tekpebiawe Clan although 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.

The Traditional political head of the Adas (Okorli) is the paramount chief (Matse). The next in command is the Clan Head (Wetsoyi) followed by the Chiefs (Asafoatseme). Every village is affiliated to a clan and in each of these clans is a sub-chief who is a subject to the Asafoatseme. There are also hamlets headed by headmen who preside over the people on behalf of the sub-chiefs.

The Ada West District is part of the Ada Traditional Area. In the hierarchy of chieftaincy institution, the paramount chief assumes the highest rank and serves as the overlord with enormous powers. Underneath the paramount chief there are divisional and sub-chiefs who serve in different position and perform varied responsibilities. The chiefs have their own territory and assume the name of the stool they represent. The position of chief is protected by the Constitution of Ghana. The chiefs are regarded as the custodians of tradition, beliefs, religion and customs of the people. In the traditional setting, the traditional authorities also have their own court system which adjudicates cases relating to land dispute, chieftaincy title disputes, violation of traditional customs, and disputes between localities, families and individuals. The chiefs in the district are members of the Regional house of chiefs and represent the interests of the people.

Okor Forest or Okorhuem, the mystical ancestral home of the Adas can be found at Anyamam, about 10 kilometres south of Sege, the capital of Ada West District and about 3km to the north east of the proposed project area. Okorhuem represents the soul and embodiment of the Ada state. It is a unique forest with a rich cultural essence and history because it served as the last refuge for the Adas before they migrated to their various settlements. The importance of this historic heritage site to the future fortunes of Ada West District cannot be belittled since it has the capacity to open up most of the coastal communities to the outside world. Besides the tourism potential of Okorhuem, it is a veritable resource centre for anthropological studies.

The people of Ada West have a very rich and old age culture. The celebration of Asafotufiami is one of the prominent festivals celebrated every year. Asafotufiami simple connotes "the firing of musketeers". In real terms, it is celebrated once a year in the month of August 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 celebration of this festival is very symbolic featuring the carrying of Chiefs and Queen mothers in palanquins in remembrance of their predecessors and to make them realize that much is dependent upon them. Among the activities in the celebration is the trip to Okorhuem. The purpose of the visitation is to give an official announcement to the ancestors. It is usually led by four chief priests from the Adibiawe clan called the Laluwornyo. These priests are also expected to notify the ancestors following the death or entombment of a Chief.

The land at Wokumagbe belongs to the Kuogbo clan. 'Osuola' is the deity of the land and the shrine of the 'Buokumaa' deity (See Plate 1.1). It is also situated on their land. The deity forbids chaos and murder hence its isolation from the community.

Plate 1: The Buokomaa Shrine of Wokumagbe

The reconnaissance survey conducted over the Wokumagbe project area did not reveal any archaeological site of significance. It is mainly flood zone and grazing fields. The reconnaissance survey conducted over the Goi project area only revealed an abandoned local building and associated cultural remains (see Plate 1.2). This archaeological site was tested for buried archaeological remains by experts from the Department of Archaeology & Heritage studies from the University of Ghana but could not yield any significant material culture.

Plate 2: An abandoned local building at Goi Project Site

7. 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.

7.1 SENSITIVITY OF THE SITE IN RELATION TO THE PROPOSED ACTIVITY

The sensitivity of a cultural feature to direct impacts depends on the level of importance assigned to it. This is the product of a number of factors, including features of present day cultural value; its current role; its cultural or sacred associations, its aesthetic value; association with significant historical events or traditions and its role as a sacred site or local landmark. For cultural features of heritage value, its potential as a resource of archaeological data will also affect its sensitivity. The significance of an impact, either direct or indirect, on a site is assessed by combining the magnitude of the impact and the sensitivity of the site. The impacts will either be:

- Direct impact: involving physical damage to cultural features or disruption to customary law, practice and tradition. Any direct impacts on tangible features will be permanent and irreversible. Other possible direct impacts include preventing public access, interference with customary ritual practices (e.g., at shrine sites), or those caused by disturbance from noise, vibration, drainage or other changes in hydrology.

- Indirect impact: including visual impact on cultural features, impacts on the appreciation of the inter-relationship between these sites, impacts on the relationship of a site to the wider landscape and impacts on significant views from and to sites. Also, the lack of observance of intangible cultural taboos associated with the site. Some of these aforementioned issues can be considered direct impacts when the project affects them directly.

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. Specific activities with the potential to impact archaeology include ground excavations (foundations and piling) required for construction purposes e.g. lay down areas of work camps, new access roads, etc.

As with any project site, there is a potential for previously unrecorded cultural sites to lie within. As all unknown cultural heritage will be sub-surface it is only direct impacts arising from disturbance that could occur. Archaeological relics could be found to the site at any time during the life of the site, but the occurrence of archaeological heritage that was not identified prior to the commencement of development works will be seldom and random. 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 20 m 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 2 lists the archaeological and heritage resources that have been recorded in the study area during the course of the project.

Table 2: List of 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 20 m 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 100 m must be demarcated around it. The custodian must be consulted to observe the appropriate ritual.

8. ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The methodology applied to predict and assess impacts/risks is detailed in Chapter 6 of the ESIA report.

Direct archaeological and cultural heritage impacts during the construction / decommissioning and operation phases are likely to result from a number of project interventions and/or activities:

- Construction Phase:
  - Damage to and destruction of heritage resources.
  - Impacts on cultural landscape
  - Gain to the science of archaeology
- Operations Phase:
  - Impacts on cultural landscape
- Decommissioning Phase:
  - Damage to and destruction of heritage resources.
  - Impacts on cultural landscape

The following section describes the potential impacts during the construction, operations and decommissioning phases and assesses them utilising the impact rating methodology provided by the CSIR. Refer to the impact summary tables for the high level assessment of potential impacts (Tables 3, 4 and 5). 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 rating for both alternatives is the same according to the impact rating methodology, the significance of the cultural heritage impacts for the Alternative Layout will be marginally lower.

8.1 CONSTRUCTION PHASE

8.1.1 Disturbance, damage to and destruction of heritage resources

Construction activities have the potential to impact on heritage resources. Potential impacts that may disturb or damage on heritage/cultural resources may arise from ground excavation required for construction purposes e.g. lay down areas of work camps, new access roads, etc. It is anticipated that any known archaeological and heritage sites located within the final development footprint would be relocated to minimise impacts and any unknown could possibly be physically damaged or, more likely, destroyed when the surface is levelled in preparation for construction. The potential impact of damage to and destruction of archaeological resources is 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 and with mitigation, 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.

8.1.2 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 impact the heritage resources identified in section 1.6 of this report for both the preferred and alternative layouts. The proposed project will result in the identified shrine being moved and thus affecting the communities ability to observe cultural rites in the project area. Figure 1.5 is an illustration of the 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.

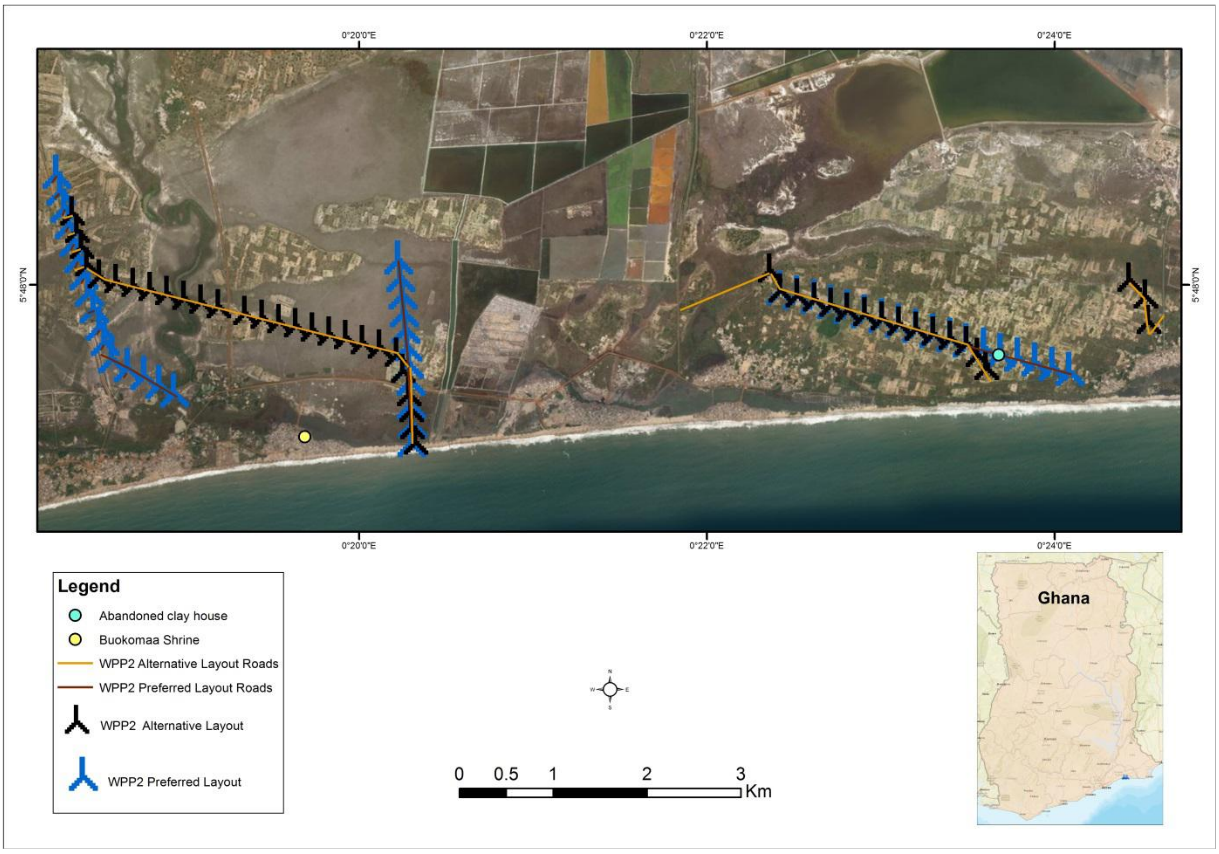

Figure 2: Heritage sites in relation to the proposed project area

8.2 OPERATIONAL PHASE

8.2.1 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.

8.3 DECOMMISSIONING PHASE

8.3.1 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.

8.3.2 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.

8.4 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 1.6), 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.

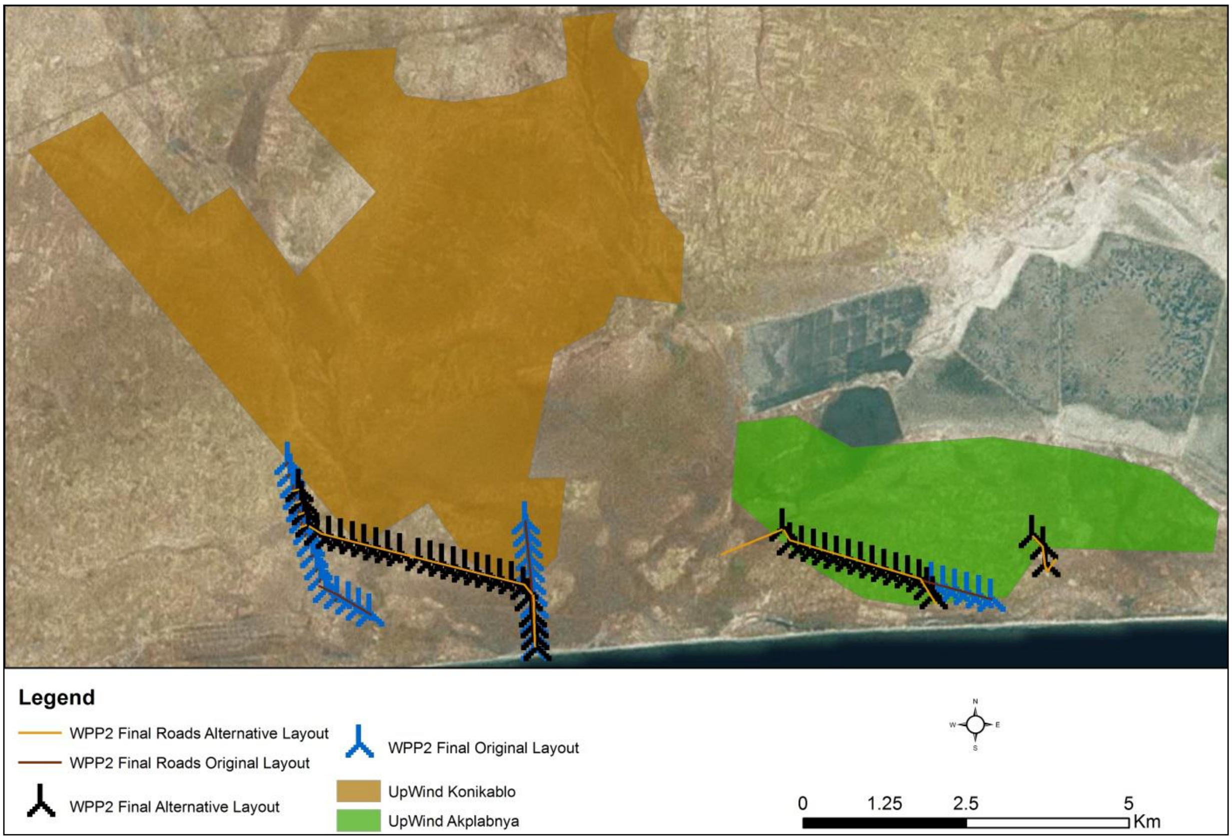

Figure 3: WPP2 in relation to the extent of the proposed Upwind WEF

9. IMPACT ASSESSMENT SUMMARY

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Tables 3 to 5 below.

Table 3: 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**	**Irreplace-ability**	**Potential Mitigation Measures**	**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	Ensure all works occur inside the approved development footprint. The owner of house ruin on site must be compensated before ruin is pulled down	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	Appropriate ritual items must be procured to appease the Buokomaa Deity of Wokumagbe	Medium	Low	High
Clearing of site and excavation works	Gain to the science of palaeontology	Positive	Site	Permanent	Medium	Definite	-	-	All accidental or chance finds must be reported to the Arcaheologist	Medium	Medium	High

Table 4: Impact assessment summary table for the Operational Phase for preferred and alternative layout

OPERATIONAL PHASE												
Direct Impacts												
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Intensity**	**Probability**	**Reversibility of Impact**	**Irreplace-ability**	**Potential Mitigation Measures**	**Significance of Impact and Risk**		**Specialist Confidence Level in Assessment**
										Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
The presence of the proposed facility	Impacts to the cultural landscape	Negative	Local	Long term	Medium	unlikely	High	Moderate	There must be cultural sensitivity and observance of customary rights. Arcaheoloical chance finds must be reported to the Arhaeologist	Medium	Very Low	High

Table 5: 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**	**Irreplace-ability**	**Potential Mitigation Measures**	**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	Ensure strict observation of cultural taboos Ensure all works occur inside the development footprint.	Low	Low	High
Removal of infrastructure	Damage or destruction of archaeological resources	Negative	Local	Long-term	Medium	Unlikely	Non-reversible	High	Ensure all works occur inside the development footprint.	Very low	Very low	High

10. CONCLUSION AND RECOMMENDATIONS

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, archaeological, heritage and cultural studies were conducted at some of the noted sites by experts from the Department of Archaeology & Heritage studies of the University of Ghana and this has shown no archaeological remains of significant value.

The only notable archaeological feature is the house ruin on the Goi project site. Apart from the clay wall remains, no artefacts were found in association with the building. The recommendation is for the owner to be compensated and the ruin pulled down to pave way for the project.

The Buokomaa Shrine is an active shrine near to the Wokumagbe project site. The recommendation is to leave a buffer zone of about 100 metres around the shrine to maintain its sanctity. In addition, appropriate rituals and protocol must be observed in consultation with its custodians.

Given that all the activities related to project during the construction or operational stages shall be confined to the designated site, and the nature and magnitude of the activities are too small, no impact on any of the archaeological or heritage properties are anticipated. Thus, the project is likely to have an impact on cultural heritage. However, it is expected that requirements for various pacification should be outlined in the Compensation Action Plan for the project. Similarly, all chance finds or artefacts of cultural value accidentally encountered in all phase of work must be reported to the Ghana Museums and Monuments Board.

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SPECIALIST EXPERTISE

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Doctor of Philosophy Degree in Archaeological Anthropology; conferral date	12-21-2008
Master of Philosophy Degree in Archaeology, University of Ghana, Legon	1999-2001

Publications

J. Anquandah, B. Kankpeyeng & Wazi Apoh (Eds)
2014 *Current Perspectives on the Archaeology of Ghana.* A Department of Archaeology and Heritage Studies Reader. Sub-Saharan Publishers. Accra. ISBN 9789988647988.

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November 2012 *Final Report.* King City Cultural Heritage Impact Assessment (CHIA) (Salvage Archaeology). Project Commissioned by King's City Development Company Ltd (November 2012)

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International Collaborative Research Projects
January 2015-Present: Co-Director of the Gonja Archaeological Project. A collaborative archaeological project between the Department of Archaeology and Heritage studies, University of Ghana, Legon and the Archaeology and Population in Africa laboratory, the University of Geneva, Switzerland.

August-December 2014: Comparative anthropological research on impact of mining on customary law and heritage resources at the Newmont-Akyem and Anglogold Ashanti Obuasi mine impacted communities in Ghana and the Northern Star mine impacted community of Wiluna in Western Australia

Research and Cultural Impact Assessment Projects

May 2014. Consultant Archaeologist for Golder Associates Ghana, Ltd. Engaged in Cultural Impact Assessment at Anglogold Ashanti Tailings Mine Site

December 2012. Engaged in Salvage archaeology at Appolonia-Accra under the Appolonia-City of Light Cultural Heritage Impact Assessment (CHIA) project. Project Commissioned By Appolonia Development Company Ltd (December 2012)

November 2012 Engaged in Salvage archaeology at Takoradi under the King City Cultural Heritage Impact Assessment (CHIA) project. Project Commissioned by King's City Development Company Ltd (November 2012)

02/2011: Consultant Archaeologist for Golder Associates Ghana, Ltd. Engaged in Cultural Impact Assessment at the Scantogo site near Tabligbo in Togo

01/2011-Present: Coordinator of Bui Dam Visual Anthropological Data Collection Phase (Bui Dam Resettlement Project)

11/15/2009-12/17/2010 & 02/24/2010-03/05/2010: Coordinated Bui Dam Salvage Archaeology Project as part of the Environmental, Social and Cultural Impact Assessment Project.

5/26/2003-7/31/2008: Worked as a Senior Research Aide in the Public Archaeology Facility (PAF) of the Dept. of Anthropology, Binghamton University under Dr. Nina Versaggi (Director). Cultural Resource Management duties include: site surveys, excavations and laboratory processing and analysis of archaeological data from New York State.

SPECIALIST DECLARATION

I, DR WAZI APOH, as the appointed independent specialist, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence

Signature of the Specialist: ________________________________

Name of Specialist: DR WAZI APOH

Date: January 20, 2017

Environmental & Social Impact Assessment

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

APPENDIX 5:

Aviation & Communication Impact Assessment Study

AVIATION AND COMMUNICATION IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76MW Wind Power Project situated at Anloga, Srogbe & Anyanui (Anloga Extension) in the Volta Region of Ghana

Report prepared for:	***Report prepared by:***
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	*Emmanuel Hayford* *P.O. Box KU 68* *Winneba* *Contact: +233 24 4687326* *Email:emmanuelhayford@gmail.com*

DECEMBER 2017

EXECUTIVE SUMMARY

Emmanuel Hayford was appointed by Seljen Consult Limited to conduct a specialist study on the potential impacts on aviation associated with the proposed construction, operation and decommissioning of the 76 Megawatt (MW) Wind Energy Facility in Lekpoguno-Akplabanya (WPP2) in the Greater Accra Region, Ghana. Two layout alternatives were considered in the Aviation Impact Assessment.

The Ghana Civil Aviation Authority (GCAA), the Government Agency responsible for aviation regulation and air navigation services, requires all prospective wind turbine developers to submit an aviation safety impact assessment. This document describes the available baseline aviation data, the potential impact of the proposed wind turbine development on aviation safety (air traffic management, airport airspace safeguarding and the general safety of air navigation installations). The assessment took into consideration issues related to the protection of the Airport Airspace Obstruction and Safeguarding, Communication, Navigation and Surveillance and Air Traffic Management of both the Kotoka International Airport (KIA) and the future Prampram International Airport.

The aviation safety impact assessment revealed the following:

- The proposed WEF in Lekpoguno-Akplabanya is not anticipated to affect the navigable airspace, in accordance with the Ghana Civil Aviation Authority (GCAA) standards,

- The proposed wind farm will not impact upon aircraft operations to and from Accra (Kotoka International Airport) as well as from the future Prampram Airport

- Flights operating under the Visual Flight Rules (VFR) should not be affected by the proposed wind farm as these flights are required to be conducted at a minimum height of 500 ft above ground level outside populous areas and will be above the level of the turbines.

- The structures will be sufficiently conspicuous by day, and at night, local en-route lowest safe altitudes (LSALTs) will provide clearance required for flights under the Instrument Flight Rules (IFR) and night operations under the Visual Flight Rules (Night VFR).

It is not anticipated to have any impacts on aviation safety during the construction and decommissioning phase. The only identified impact during operation phase is that of the interference with communication, Navigation and Surveillance. This impact is anticipated to be of very low significance for both the preferred and the alternative layouts.

LIST OF ABBREVIATIONS

ABBREVIATION	MEANING
ATC	Air Traffic Control
APPROX	Approximately
CAA	Civil Aviation Authority
CNS	Communication, Navigation and Surveillance
DOC	Document
EPA	Environmental Protection Agency
Ft	Feet
GA	General Aviation
GCAA	Ghana Civil Aviation Authority
GCARs	Ghana Civil Aviation Regulations
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
IFR	Instrument Flight Rules
KIA	Kotoka International Airport
KM	Kilometer
LOS	Line of Sight
M	Meter
MW	Mega Watts
NCA	National Communication Authority
NM	Nautical Mile
OLS	Obstacle Limitation Surface
PANS- OPS	Procedures for Air Navigation Services–Operations
PSR	Primary Surveillance Radar
SSR	Secondary Surveillance Radar
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VRA	Volta River Authority
WGS	World Geodetic System

GLOSSARY

DEFINITIONS	
Aerodrome	A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft. An aerodrome includes but is not limited to the following: airport, airstrip, heliport, helistop, vertiport, gliderport, seaplane base, ultralight flightpark, manned balloon launching facility, or other aircraft landing or take off area.
Navigable airspace	The airspace above the minimum altitudes of flight prescribed by the Regulations and includes airspace needed to ensure safety in the take-off and landing of aircraft.
Wind farm	A group of wind turbines in the same location used to produce electricity. A large wind farm may consist of several hundred individual wind turbines and cover an extended area of hundreds of acres of land.

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AVIATION AND COMMUNICATION IMPACT ASSESSMENT

1. INTRODUCTION

Emmanuel Hayford was appointed by Seljen Consult Limited to conduct an assessment of the potential impacts on aviation safety, associated with the proposed construction, operation and decommissioning of the 76 Megawatt (MW) Wind Energy Facility in Lekpoguno-Akplabanya (WPP2) in the Damgme West District in the Greater Accra Degion, Ghana (Figure 1).

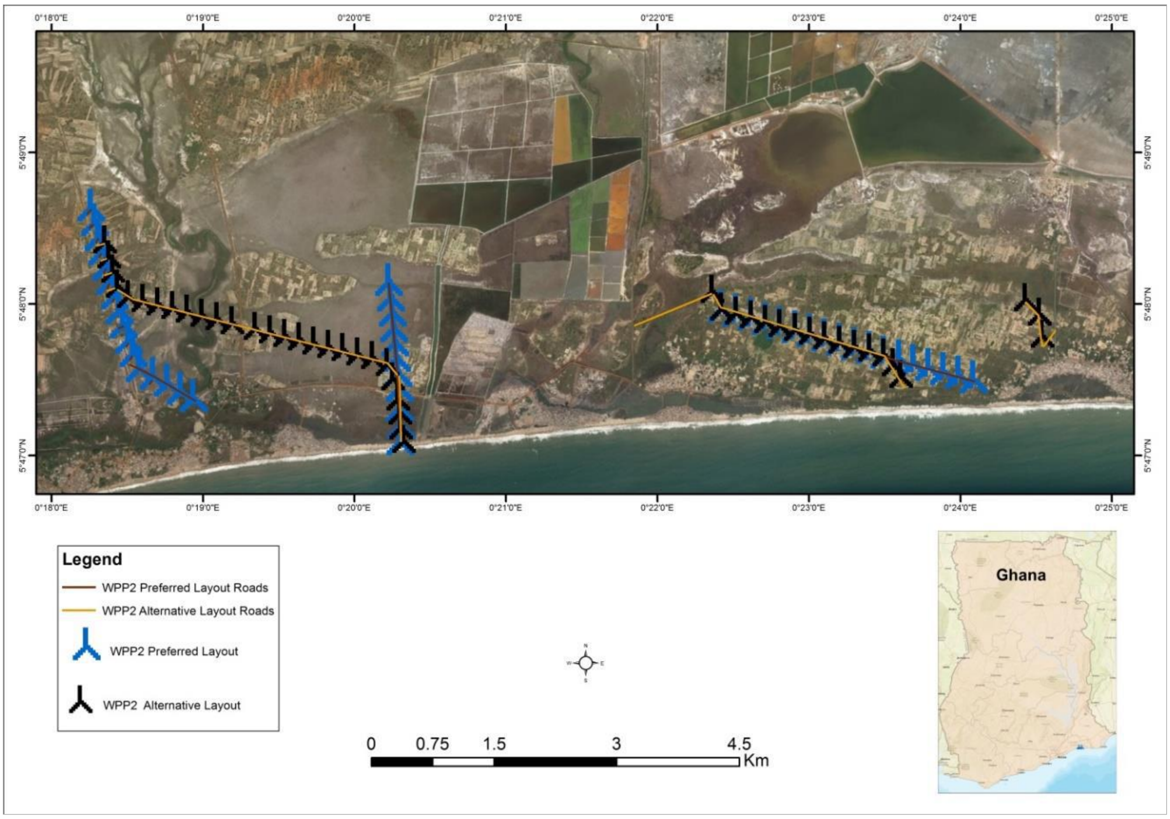

Figure 1: Location of the site for WPP2 with preferred and alternative layouts

This study aims at informing the Environmental and Social Impact Assessment (ESIA) in the development of a comprehensive Environmental Management Plan (EMP) to assist VRA in managing any aviation impacts.

2. TERMS OF REFERENCE

The purpose of the specialist study was to undertake an aviation safety impact assessment and 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, for the benefit of the country.

The Scope of Work is based on the following broad Terms of Reference, which have been specified for this specialist study:

- Review of Civil Aviation Legislative Framework regarding installation of highrise structures
- Conduct a literature review
- Consultation with relevant aviation stakeholders
- Field survey and compilation of data
- Detailed analysis of new and existing data
- Conduct an Obstruction evaluation for Obstacle Limitation Surfaces
- Conduct an Obstruction evaluation for PANS-OPS Surfaces
- Determine the potential interference with CNS Signals
- Develop Alternative Intervention Schemes
- Determine management actions for possible Risk of Intrusions into the Protected Airspace of Airports
- Determine management actions for possible Risks of Interference to CNS Signals
- Develop information materials for client's use at public hearing and public workshops about the project regarding the impacts on aviation.

The key impacts and recommendations of this study have been captured in Chapters 6, 7 and 8 of the ESIA report.

3. PROJECT DESCRIPTION

In Ghana, all structures higher than 10 metres above ground level must be assessed and registered as potential obstacles to aviation. Given that the proposed wind turbines for WPP1 have hub heights that range between 80 m (plus 103 m rotor radius) for the preferred and alternative layout, these present a potential impact to aviation.

The locations and route layout can be seen in Figure 1 above. Details on the project description can be found in Chapter 3 of the ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

Standards and guidelines established by the Ghana Civil Aviation Authority (GCAA) and the International Civil Aviation Organization (ICAO) stipulate suitable distances/dimensions for any proposed development in the vicinity of aerodromes. These guidelines are used to ensure wind farms that may pose a threat to aviation are not erected in the vicinity of airports and proposed airports. ICAO Annex 14 specifically addresses the issue of wind turbines. These standards have been implemented in Ghana by the Ghana Civil Aviation Act 678 of 2004 (GCAAct) and Part 27 (the Airports (Protection of Airspace)) of the Ghana Civil Aviation (Aerodrome) Regulations (GCAR), 2011, L.I. 2004.

Under the provisions of the GCAAct 678 of 2004 and the Part 27 of the GCARs of 2011 (L.I. 2004), the GCAA is the competent authority that approves or refuses the erection of structures on or near an aerodrome as well as proposed future aerodrome. If deemed necessary, the GCAA, in coordination with the Metropolitans, Municipals and District Assemblies (MMDAs), can order the removal of high rise structures which are classified as an obstruction or a hazard to aircraft operations by the Authority.

The GCAR Part 27 promulgates the requirements to be met in relation to obstacles and hazards and establishes standards for determining obstructions to air navigation. It requires the proponent of a proposed structure to notify the GCAA of their intention to erect any structure anywhere in the country and to provide the proposed height and location coordinates of the structure.

In accordance with the GCAR Part 27, the Authority's Safety Inspectors shall determine after conducting an aeronautical assessment that a high-rise structure is, or will not be hazardous to aircraft operation. The GCAA shall subsequently direct the proponent to light or mark the hazard in accordance with the Manual of Standards (MOS) – Aerodromes Advisory Circular Obstacle Marking and Lighting.

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 the GCAR Part 27 and that of the Manual of Standards (MOS), – Aerodromes.

The 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 the GAF.

According to international (ICAO) standards, aviation operations may be conducted at a height of 150 m (500 feet) above ground level, and lower if these can be carried out without being a hazard or nuisance to persons or property on the ground. Any obstacle protruding above this height is thus considered a danger to aviation.

4.1 GHANA CIVIL AVIATION AUTHORITY (GCAA) POLICY

The GCAAct emphasizes the need for conserving the navigable airspace for aircraft; preserving the integrity of the national airspace system; and protecting air navigation facilities from either electromagnetic or physical encroachments that would preclude normal operation A structure is therefore considered to have an adverse aeronautical effect if it exceeds the obstruction standards of the GCAR, and/or is found to have physical or electromagnetic radiation effect on the operation of air navigation facilities, unless the obstruction evaluation study determines otherwise.

If a structure is found to have a significant adverse impact, a "hazard" determination will be issued and will establish whether the proposed development would be a hazard to air navigation or not. The outcome of an evaluation of a proposed construction or alteration may be one of the following:

- object will exceed a standard but will not be a hazard to air navigation; or
- object will exceed a standard and will be a hazard to air navigation

However, in most cases, the GCAA works with the proponent until the conditions are met for a "no hazard" determination.

4.2 OBSTRUCTION STANDARDS

There are established standards for determining obstructions to air navigation as well as Industry best practices; including the Ghana Civil Aviation Regulation (GCAR) Part 27, Aerodrome Manual of Standards (MOS) and Ghana Civil Aviation guidelines. These apply to existing and proposed manmade objects, objects of natural growth and terrain. The standards apply to the use of navigable airspace by aircrafts and to existing air navigation facilities, such as an air navigation aid, airport, airway, instrument approach or departure procedure, or approved off airway route. Additionally, those standards apply to a planned facility or use, or a change in an existing facility or use.

The GCAA conducts aeronautical studies to determine the impact of a proposed structure, an existing structure that has not yet been studied by the GCAA, or an alteration of an existing structure on aeronautical operations, procedures, and the safety of flight. These studies include evaluating:

(1) The impact on present and future arrival, departure, and en-route procedures for aircraft operating under visual flight rules and any possible changes in those operations and procedures that would eliminate or alleviate the conflicting demands;

(2) The impact on present and future arrival, departure, and en-route procedures for aircraft operating under instrument flight rules and any possible changes in those operations and procedures that would eliminate or alleviate the conflicting demands;

(3) The impact on existing and planned public use aerodromes;

(4) Airport traffic capacity of existing public use aerodrome and public use aerodrome development plans received before the issuance of the final determination;

(5) Minimum obstacle clearance altitudes, minimum instrument flight rules altitudes, approved or planned instrument approach procedures, and departure procedures;

(6) The potential effect on operations of ATC radar, direction finders, ATC tower line-of-sight visibility, and physical or electromagnetic effects on air navigation, communication facilities, and other surveillance systems;

(7) The aeronautical effects resulting from the cumulative impact of a proposed construction or alteration of a structure when combined with the effects of other existing or proposed structures and any possible changes in the proposal that would eliminate or alleviate the conflicting demands.

An obstruction evaluation study shall identify:

a) the effect the proposed development would have:

i. on existing and proposed public-use and military airports and/or aeronautical facilities.

ii. on existing and proposed visual flight rule (VFR)/instrument flight rule (IFR) aeronautical departure, arrival and en-route operations, procedures, and minimum flight altitudes.

iii. regarding physical, electromagnetic, or line-of-sight interference on existing or proposed air navigation, communications, radar, and control systems facilities.

iv. on airport capacity, as well as the cumulative impact resulting from the structure when combined with the impact of other existing or proposed structures

b) the nature of marking and/or lighting on the development

The GCAR Part 27 states that all forms of development, which are beyond 10 nm and is 45 m (150 ft) or higher requires regulatory clearance. The proposed WEF exceeds this recommended height as the proposed hub heights range from 95 m to 126 m for the preferred and alternative layout will be above the recommended threshold of the GCAA (height of 46 m).

4.3 NOTICE REQUIREMENTS FOR CONSTRUCTION OR ALTERATION

Each applicant proposing any kind of construction, including wind turbines, shall apply to the GCAA for an obstruction evaluation and the granting of airspace safety permits for wind turbine developments (wind farm)/wind monitoring tower installations.

5. METHODOLOGY

The methodology used for this study consisted of the following approach to determine potential impacts on aviation (aircraft navigable airspace as well as aerodrome operations and expansion) from the proposed construction and operation of wind turbines:

- A Literature review
- Consultation with key stakeholders
- A field survey and
- A detailed analysis.

Further details on the above methodology can be found below.

5.1 LITERATURE REVIEW

In order to address the objectives of the study, a comprehensive literature review was conducted. The purpose of the literature review was to understand the unique features of wind turbine impact, background information on the project and the site, current and proposed aerodromes and CNS installations across the country and other factors that are likely to influence decision making.

5.2 CONSULTATION WITH STAKEHOLDERS

Project stakeholders are individuals and organizations that have interest and can influence the project from different perspectives. Since the objective of the assignment identified various cross sectional issues that are likely to impinge on aviation safety, the aviation consultant identified relevant stakeholders in the aviation community and determined the requirements and expectations. Table 1 below lists the stakeholders consulted and the nature of consultation.

Table 1: Stakeholder consultation

Name	Organisation	Date	Nature of consultation
Peter Akewetey	GCAA	3/03/2016	Face-to-face
Isaac Otu	GACL	23/03/2016	Face-to-face
James Narh Lawerteh	Assemblyman	4/04/2016	Face-to-face
Gilbert Akaba	Ag. District Coordinating Director	4/04/2016	Face-to face
Emmanual Andoh	NCA	21/04/2016	Telephone call

5.3 FIELD SURVEY AND COMPILATION OF DATA

The aviation consultant carried out a number of surveys and gathered field data to identify elements that will aid the aviation risk assessment process. Field surveys were carried on both proposed project locations from 2nd to 4th February, 2016. This visit was done to ascertain the situation on ground and some of the key elements that were looked at include grade aerodrome sites, geographic coordinates of wind turbines (WGS 84), accurate elevation data, air traffic route characteristics, radar coverages and line-of-sight. Brief reconnaissance visits were undertaken to affiliate with the conditions at the project site. Introductory meetings were held with the client’s representatives to rationalise emerging issues from the reconnaissance for smooth execution of the project during the field survey, confirmation of site coordinates and physical characteristics/data of the proposed wind turbine project area using hand held global positioning system (GPS) and the coordinates were plotted on google earth and geographic information system (GIS).

5.4 DETAILED ANALYSIS

A full scale obstruction evaluation and airport airspace analysis (OE/AAA) was performed to ensure that the effect of each turbine is taken into consideration. Details of the OE/AAA are as follows:

- Obstruction evaluation (Airport Obstacle Limitation Surfaces)
- Obstruction evaluation (PANS-OPS Obstacle Identification Surfaces)

Also, potential Interference with CNS Signals was assessed in detail to create a balance for safe coexistence of the wind farm and airport.

During the analysis, magnetic bearings, locations and heights of structures or any other objects within the proposed wind turbine site were derived by using clinometers, handheld GPS, Prismatic compasses and distance measuring devices (See Appendix 1). All other areas of the inspection were conducted visually and photographed for reference purposes.

Site data was compared with information from the Ghana Civil Aviation Authority (GCAA) standards and international best practices, including lighting guidance on wind turbines. An evaluation and analysis of all aviation activities related with the proposed site was considered and topographical maps, approach charts (including consideration of airspaces/navigation warnings-prohibited, restricted and danger areas) were reviewed.

6. DESCRIPTION OF THE AFFECTED AVIATION ENVIRONMENT

The proposed wind farm project site is on a south-eastern portion of Kokota International Airport (KIA) and the proposed Prampram Airport as can be seen in Figure 2 below. The preferred and alternative layout turbine have hub heights which range from 95 m to 126 m respectively, however the largest turbine being considered in this study has a maximum height of 150 m above ground level. As these proposed wind turbines could cause hazard to aircraft navigable airspace, GCAA must be notified for assessment of the risk this proposed structure may pose to civil aircraft operation.

The current aviation infrastructures available at KIA include, but are not limited to, very wide omnidirectional range (VOR) radar, outer marker beacon, middle maker beacon, inner marker beacon, localizer and glideslope. These facilities are located 56.8 km from Lekpoguno site and 63.7 km from Akplabanya site. The proposed future Prampram Airport however is closes, approximately 17.8 km from Lekpoguno site and 25.2 km from the Akplabanya site.

The airport master plan showing a comprehensive study of the Prampram airport and describing the short, medium, and long-term development plans was not available at the time of this study. As such, technical decisions concerning siting of airport infrastructure like radars is not certain. Figure 2 below illustrates the location of the KIA and the location of the proposed Prampram airports in relation to the study sites.

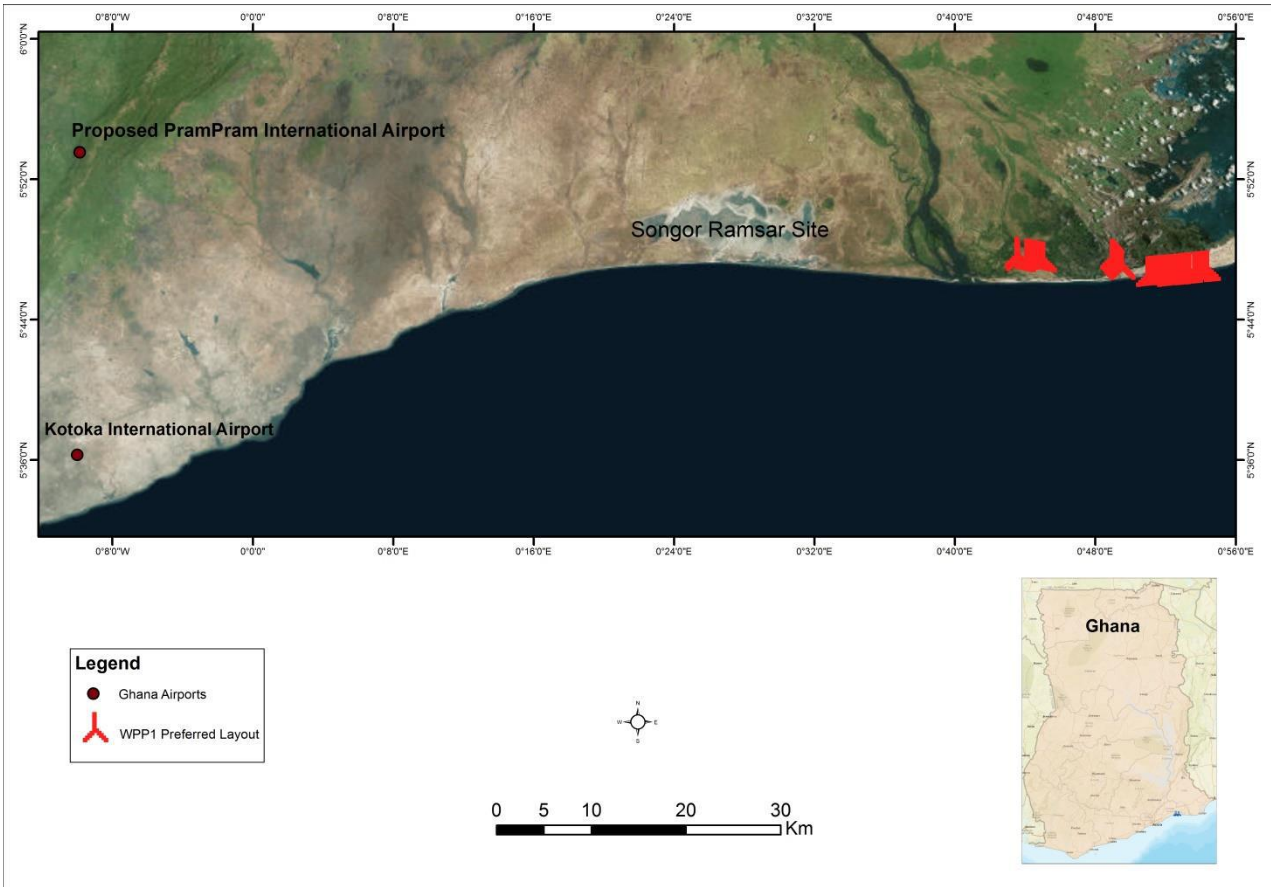

Figure 2: Location of the KIA and the proposed Prampram airports in relation to the study sites.

7. 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:

7.1 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.

7.2 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 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 airports. There is however a possibility that CNS may be affected thus the impact has been rated as very low in the impact assessment section.

7.3 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 effect 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.

7.4 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.

7.5 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.

7.6 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 9.6 NM and 13.6 NM from the proposed Lekpoguno and Akplabanya wind turbine project sites (WPP2) respectively.

7.7 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 Figures 3 and 4 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.

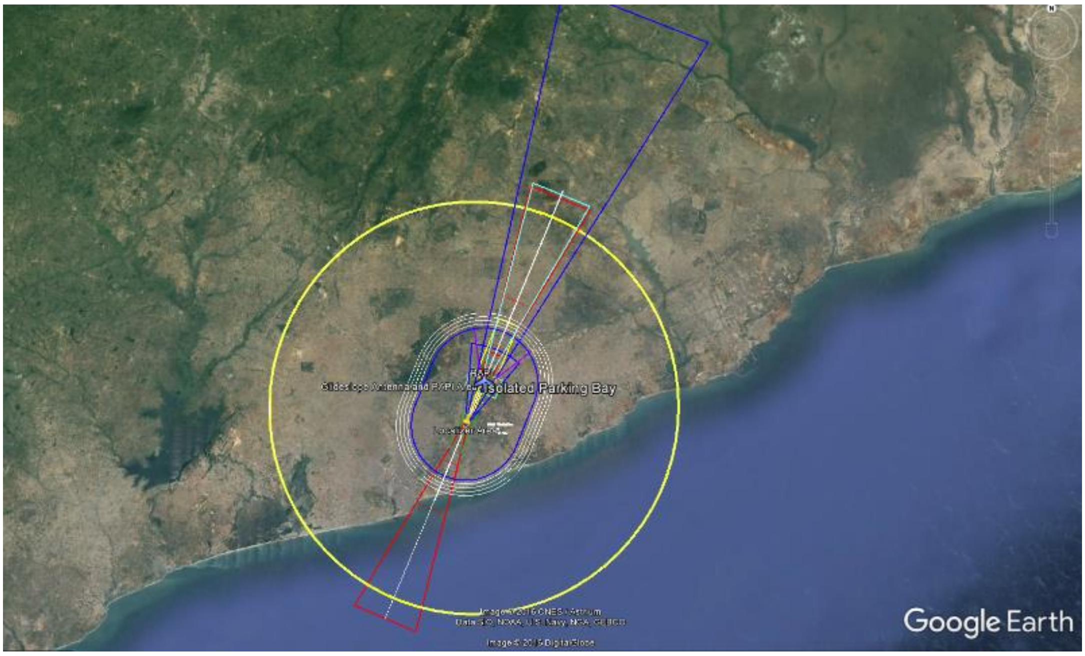

Figure 3: Protection Zones of Kotoka international Airport (KIA)

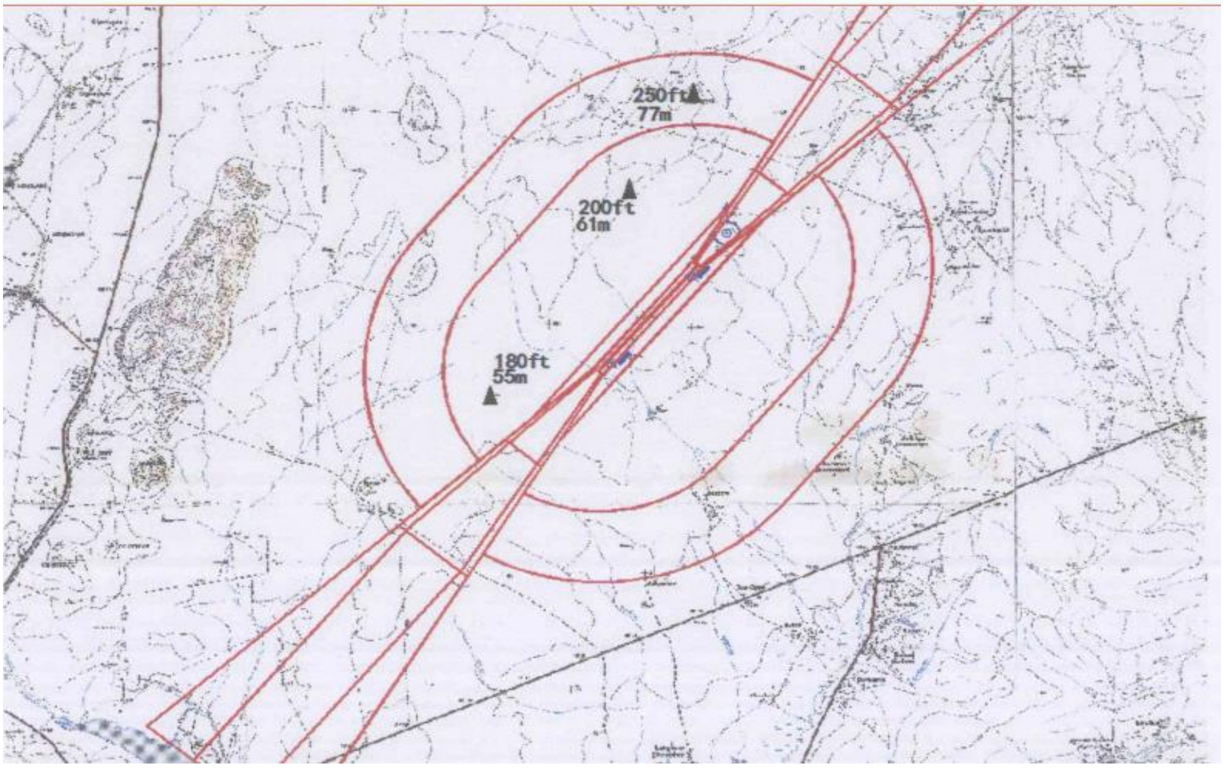

Figure 4: Proposed Protection Zones of future Prampram international Airport on 1:50,000 topographic map

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.

7.8 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.

8. HIGH LEVEL ASSESSMENT OF IMPACTS/RISKS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The methodology applied to predict and assess impacts/risks is detailed in Chapter 6 of the ESIA report. The Aviation Impacts during Construction, Operation and Decommissioning Phases of the proposed WPP1 are discussed below.

8.1 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.

8.2 OPERATIONAL PHASE

The potential impacts of a WEF on aviation during the operational phase include Interference with Communication, Navigation and Surveillance (CNS) signals.

8.2.1 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.

8.3 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.

8.4 CUMMULATIVE 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.

9. IMPACT ASSESSMENT SUMMARY

The assessment of potential impacts and recommendation of mitigation measures as discussed above are collated in Table 2 below.

Table 2: 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**	**Mitigation Measures**	**Significance of Impact**		**Confidence Level**
										Without Mitigation	***With Mitigation***	
Impact of Radar	Interference with Communication Navigation and Surveillance (CNS) signals	Negative	Local	Long term	Low	Improbable	High	Low	N/A	Very Low	Very Low	High

10. CONCLUSION AND RECOMMENDATIONS

It can be concluded that the wind farm 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.

The following best practice measure is recommended and would involve a collaborative and coordinated approach between the proponent, the GCAA and the industry. This approach would help to ensure continued investment in mitigation actions in the interest of aviation and wind energy, given their importance.

In practice, the wind farm is not expected to have any effect on instrument flight procedures due to the wind farm's distance from the airport and its direct approach routes in line with the provision of the GCARs.

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.

11. REFERENCES

ICAO Annex 14 Volume 1 (Aerodrome Design and Operations), 7th edition

Ghana Civil Aviation Authority (GCAA) Act, 2004, Act 678)

Ghana Civil Aviation (Aerodrome) Regulations Part 27

ICAO Document on Procedure for Air Navigation Services-Operations (PANS-OPS)

Ghana Civil Aviation Guidelines, 2016 Managing the Risk of Wind Turbine Developments (Wind Farm)/Wind Monitoring Tower Installations to Aviation Safety

Managing the Impact of Wind Turbines on Aviation Prepared by the Airspace & Safety Initiative Wind farm Working Group in consultation with DCLG, RTPI, and Planning Officers

www.pagerpower.com

Eurocontrol Guidelines on How to assess the potential of Wind Turbines on Surveillance Sensors

"Managing the impact of Wind Turbines on Aviation" by Air Space and Safety Initiative Wind farm Working Group (ASIWWG)

CAA Policy Statements on lighting for tall structures, http://www.caa.co.uk/docs/33/20121122PolicyStatementWTG.pdf

http://www.caa.co.uk/docs/33/DAP_LightingEnRouteObstaclesAndWindTurbines

http://www.ead.eurocontrol.int/eadbasic/pamslight12F7B41C44093026F4726315FAC19FD6/7FE5QZZF3FXUS/EN/AIC/P/0212011/EG_Circ_2011_P_021_en_2011-04-21.pdf

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COMPETENCE

Airport Engineer, Certified ICAO ACIP Integrated Safety Management Instructor, Airport Certification Specialist,
Obstruction Evaluation/Airport and Airspace Analysis (OEAAA) Specialist, with over 13 years of experience as Aerodrome Safety Inspector.

EDUCATION

- Graduate Diploma in Occupational Health, Safety and Environment, GIMPA, Ghana - 2010
- Graduate Diploma in Airport Engineering, Nanyang Technological University/Singapore Aviation Academy, Singapore - 2005
- B.Sc. Civil Engineering, University of Science and Technology, Kumasi, Ghana - 1999

COURSES ATTENDED

- IATA Dangerous Goods Regulations (DGR) Initial Category 6 Course, Accra - 2014
- Aircraft Accident Investigation Course - 2014
- ICAO Aeronautical Meteorology Inspectors Basic Training Course, Accra - 2013
- Resolution of Safety Concerns (International FAA Academy Course, 15209001) , Accra - 2013
- ICAO Aerodrome Inspectors Course (i.e. GSI Aerodromes), Accra, Ghana - 2012
- International Airport Certified Employee Program (IACE) by AAAE/FAA, Accra -

2010

- Inspector Training Systems and OJT Instructor Course by FAA, Accra, Ghana - 2010
- Work Tracking System (Course 21000054) by FAA, Accra, Ghana - 2010
- On-the-job training (OJT) course for ICAO ACIP ISM SMS Instructors, Accra, Ghana - 2010
- ICAO State Safety Programme (SSP) & SMS Train-the-Trainer Course, S. Africa - 2009
- Airspace and Procedures, Mike Monroney Aeronautical Center (MMAC), Oklahoma City- 2009
- ICAO Safety Management System (SMS) Training Course, Addis Ababa, Ethiopia - 2008
- Internal Auditor Training by AIR-TEC Africa, Accra-Ghana - 2007
- Airport Ramp Operations & Management, Singapore Aviation Academy - 2007
- Aerodrome Certification, Operations and Auditing, Gatwick, UKCAA - 2005
- Basic Obstruction Evaluation and Airport/Airspace Analysis (OE/AAA) Course, MMAC,
  Oklahoma City, OK, U.S.A. - 2002

WORKSHOP & SEMINARS

- Runway Safety and Pavement Maintenance Seminar for Africa by FAA, Lagos, Nigeria- 2012
- Ninth Meeting of the Aerodrome Operations Planning Sub-Group (AOP/SG/9),Senegal - 2011
- Course in Improving Workplace Attitude by Ghana Employers Association - 2010
- Personnel Licensing and Aircraft Operations Seminar (PEL/OPS) by ICAO ACIP, Accra - 2009
- Seminar on Air Safety Administration for African Countries, Beijing, China - 2009
- Aerodrome Emergency Planning Workshop, by ICAO, Abuja, Nigeria - 2006
- 1st ICAO Western & Central African Region (WACAF) Workshop on Certification of Aerodromes, Dakar, Senegal - 2003
- Total Quality Management (TQM) – AMISU Management Consultant - 2000
- Materials Engineers Seminar on Bituminous Surfacing – specifications and workmanship

EXPERIENCE

Ghana Civil Aviation Authority - 2001 to date

Senior Aviation Safety Inspector (Aerodrome Safety & Standards)

- Obstacle Evaluation and Airport Airspace Analysis (OE/AAA) specialist, responsible for airspace reviews and supervision of obstruction evaluation exercise;
- On-the-job training (OJT) instructor for OE/AAA Specialist
- Key member, WGS-84 Obstacle Surveys & Maintenance Team
- Supervision of development and management of obstacle data
- Certified ICAO State Safety Programme (SSP)/Safety Management Systems (SMS) Instructor
- Part-time lecturer at the Ghana Civil Aviation Training Academy
- Aerodrome Expert, Aviation Safety Technical Committee for the Banjul Accord Group Aviation Safety Oversight Organisation (BAGASOO)
- Leader, ICAO SSP Planning Committee (Ghana)
- Leading member - Drafting of all five (5) parts of Ghana Civil Aviation Regulations relating to aerodrome construction, certification and operations, and safeguarding, including offshore helicopter landing sites.
- Coordinator - Certification of aerodromes
- Leader - Development of Manual of Standards for Aerodromes and all guidance materials, forms and checklists relating to aerodromes
- Aerodrome Inspections/Audits
- Wealth of experience in aerodrome site selection & conduct of aeronautical reviews of airport proposals;
- Provision of guidance on broad range of aviation issues to aerodrome operators and airport consultants;
- Maintaining effective relationships with clients and performing surveillance activities
- Conduct initial and OJT to Aviation Safety Inspectors
- Leading member, Implementation Committee - Performance Based Navigation in the Accra FIR

SKILLS

- Excellent knowledge of Ghana Civil Aviation Regulations (GCARs)
- Sound knowledge of ICAO Annex 14 and other related documents; ICAO Doc 9774 on certification of aerodromes; ICAO Doc 9859 (Safety Management Manual);
- Knowledge of safe work practices related to aerodrome operations;
- Ability evaluate aerodrome designs and interpret aerodrome plans and specifications;
- Ability to effectively communicate orally and in writing;

- Ability to work in a team and instructional abilities to train others;
- Capacity to take initiative, exercise tact and sound judgment, and able to maintain good inter-personal relations with subordinates, superiors, other employees and the public
- Computer literate (excellent with Microsoft office applications & fair knowledge of AutoCAD)
- QGIS
- Use of surveying instruments.

LANGUAGE SKILLS

Competence Scale of 1 to 5 (1-excellent; 5-basic)

Language	Reading	Speaking	Writing
English	1	1	1
French	4	5	4
Fante	1	1	1
Twi	2	1	2
Effutu/Awutu	-	1	-
Ga	4	4	3

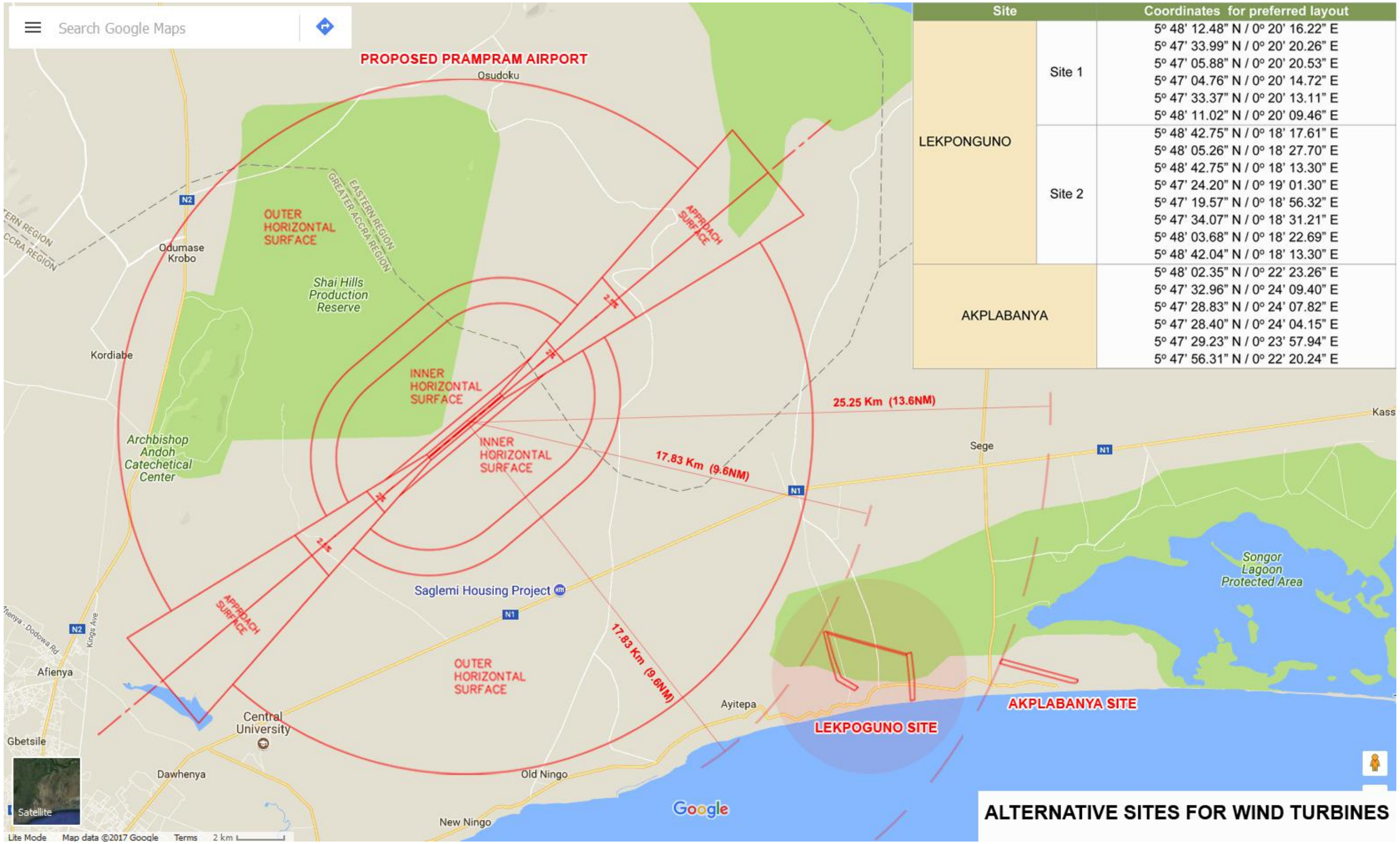
12. APPENDICES

APPENDIX 1: Table of coordinates of telecommunication towers

TELECOMMUNICATION TOWERS				
TOWER	**COMPANY**	**COORDINATES**	**HEIGHT**	**ELEVATION**
Kasseh Ada	Helios Tower Ghana Limited	05° 53' 44.52"N 000° 30' 55.91"E	60m	55ft
Krasseh Ada	Globacom Ghana Limited	05° 54' 12.00"N 000° 31' 08.85"E	36m	68ft
Krasseh Ada	Americal Tower Company Limited	05° 53' 48.52"N 000° 31' 26.72"E	36m	55ft
Dogo Ada	Globacom Ghana Limited	05° 53' 12.875"N 000° 33' 43.52"E	36m	18ft
Samavey Kope	Americal Tower Company Limited	05° 52' 02.57"N 000° 33' 54.91"E	36m	13ft
Samavey Kope	Globacom Ghana Limited	05° 50' 58.32"N 000° 26' 08.73"E	36m	18ft
Big Ada	Americal Tower Company Limited	05° 49' 35.50"N 000° 36' 54.88"E	40m	13ft
Big Ada	Vodafone Ghana Limited	05° 49' 29.64"N 000° 35' 53.64"E	60m	18ft
Ada	Helios Tower Ghana Limited	05° 47' 45.60"N 000° 37' 21.26"E	60m	7ft)
Ada	Americal Tower Company Limited	05° 47' 37.35"N 000° 37' 20.49"E	40	13ft
Ada	Vodafone Ghana Limited	05° 47' 04.18"N 000° 37' 39.52"E	60m	22ft
Ada Foah	Globacom Ghana Limited	05° 46' 53.40"N 000° 37' 53.69"E	40m	25ft
Ada Foah	Americal Tower Company Limited	05° 47' 02.95"N 000° 38' 09.63"E	60m	18ft

APPENDIX 2: Location of Telecommunication Towers

APPENDIX 3: Study area in relation to PramPram airport



Site		Coordinates for preferred layout
LEKPONGUNO	Site 1	5º 48' 12.48" N / 0º 20' 16.22" E 5º 47' 33.99" N / 0º 20' 20.26" E 5º 47' 05.88" N / 0º 20' 20.53" E 5º 47' 04.76" N / 0º 20' 14.72" E 5º 47' 33.37" N / 0º 20' 13.11" E 5º 48' 11.02" N / 0º 20' 09.46" E
	Site 2	5º 48' 42.75" N / 0º 18' 17.61" E 5º 48' 05.26" N / 0º 18' 27.70" E 5º 48' 42.75" N / 0º 18' 13.30" E 5º 47' 24.20" N / 0º 19' 01.30" E 5º 47' 19.57" N / 0º 18' 56.32" E 5º 47' 34.07" N / 0º 18' 31.21" E 5º 48' 03.68" N / 0º 18' 22.69" E 5º 48' 42.04" N / 0º 18' 13.30" E
AKPLABANYA		5º 48' 02.35" N / 0º 22' 23.26" E 5º 47' 32.96" N / 0º 24' 09.40" E 5º 47' 28.83" N / 0º 24' 07.82" E 5º 47' 28.40" N / 0º 24' 04.15" E 5º 47' 29.23" N / 0º 23' 57.94" E 5º 47' 56.31" N / 0º 22' 20.24" E

Environmental & Social Impact Assessment

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

APPENDIX 6:

Wetland Impact Assessment Study

WETLANDS IMPACT ASSESSMENT REPORT:

Ecological Survey and Wetland Habitat Assessment Report as part of the Environmental and Social Impact Assessment for a 75MW Wind Power Project situated at Wokumagbe and Goi in the Ada West District Assembly in the Greater Accra Region - Ghana

Report prepared for:	*Report prepared by:*
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DECEMBER 2017

EXECUTIVE SUMMARY

This report provides an overview of the wetland and aquatic ecology of the Wokumagbe and Goi sites for a proposed 75 MW wind power facility (WPP 2). The two sites make up the project area, which is situated within the Songor Lagoon Ramsar Site and Biosphere Reserve. The project area was characterised by salt marsh, brackish lagoons, freshwater wetlands (floodplain wetlands and depressions) and occasional small open water bodies (freshwater). Existing disturbances included human settlement and associated activities and infrastructure (roads in particular). Salt mining is a significant industry in the Songor area and a great source of disturbance and habitat alteration.

A review of the status quo indicated that the wetland habitats varied in nature, while the salt marsh and lagoon habitats were generally degraded. The Wokumagbe wetland systems scored higher than the Goi systems which were relatively more disturbed. Key issues identified and discussed included the following:

- Wetland birds, both resident and migratory species.
- Disturbance of freshwater and coastal habitats and ecology, including aquatic and semi aquatic fauna.
- The potential for flooding

A number of impacts were identified and have been summarised in Table (i) below. Impacts were are generally higher during the construction phase due primarily to the presence of recognised and clear disturbances associated with construction activities such as habitat loss and the disturbance of fauna.

Two alternative layouts options were assessed, the preferred layout and the alternative layout. The two layout options were very similar with the primary difference being the layout of the Wokumagbe turbine cluster. The preferred layout presented two separate turbine clusters, one east of Wokumagbe and one west of Wokumagbe. The alternative layout option presents a continuous diagonal line of turbines stretching from east to west. The alternative option was

found to present a number of additional wetland impacts and potential disturbances to semi aquatic fauna.

Overall, after the consideration of mitigation measures and management actions, impact significance for identified construction phase, operational phase and cumulative impacts varied between very low and medium, with the majority described as being of low significance.

Table (i): Summary of Impacts

Impact	Significance rating		Key mitigation/optimisation measures (summarised)
	Without	*With*	
CONSTRUCTION PHASE IMPACTS			
Disturbance of wetland birds due to habitat loss (Preferred)	LOW	VERY LOW	• Check construction area for nests prior to construction. • Safely remove and relocate and birds that become trapped
Disturbance of wetland birds due to habitat loss (Alternative)	LOW	VERY LOW	• Check construction area for nests prior to construction. • Safely remove and relocate and birds that become trapped
Disturbance of other fauna due to construction related activities – excavation/noise (Preferred)	LOW	VERY LOW	• Capture and relocate fauna
Disturbance of other fauna due to construction related activities – excavation/noise (Alternative)	LOW	VERY LOW	• Capture and relocate fauna
Disturbance of salt marsh and coastal habitat (Both)	MEDIUM	LOW	• Minimal clearance of vegetation • Limit land reclamation • Construction phase site management
Coastal (Both)	VERY LOW	VERY LOW	• None required
Loss of freshwater wetland habitat (Preferred)	MEDIUM	LOW	• Construction phase management only
Loss of freshwater wetland habitat (Alternative)	HIGH	MEDIUM	• Utilise preferred layout option • Construction phase management
OPERATIONS PHASE IMPACTS			
Bird strikes and disturbance of resident birds (Preferred)	MEDIUM	LOW	• Long term monitoring by avian specialist
Bird strikes and disturbance of	MEDIUM	LOW	• Long term monitoring by avian specialist

Impact	Significance rating		Key mitigation/optimisation measures (summarised)
	Without	***With***	
resident birds (Alternative)			
Fauna may become trapped in infrastructure area (Preferred)	LOW	VERY LOW	• Regular inspections and checks • Capture and relocate
Fauna may become trapped in infrastructure area (Alternative)	LOW	VERY LOW	• Regular inspections and checks • Capture and relocate
Disturbance of salt marsh and coastal habitat (Both options)	LOW	VERY LOW	• Shift turbines outside of salt marsh habitats
Coastal (Both options)	VERY LOW	VERY LOW	• None required
Freshwater wetlands – contamination associated with maintenance activities (Preferred)	LOW	LOW	• Store hazardous substances correctly during maintenance
Change in functionality due to infilling/land reclamation (Alternative)	MEDIUM	LOW	• Ensure adequate drainage and connectivity
DECOMMISSIONING PHASE IMPACTS			
Removal of infrastructure and rehabilitation	LOW	VERY LOW	• Rehabilitate areas disturbed during decommissioning • Management of decommissioning phase
CUMULATIVE IMPACTS			
Other development and associated infrastructure (Upwind)	MEDIUM	LOW	• Co-ordination and integrated planning required..

LIST OF ABBREVIATIONS

AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
amsl	Above mean sea level
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Environmental Management Committees
FAO	Food and Agriculture Organisation
IUCN	International Union of Conservation of Nature
LI	Legislative Instrument
MAR	Mean Annual Rainfall
MMDAs	Metropolitan, Municipal and District Assemblies
NCRC	Nature Conservation Research Centre
PES	Present Ecological State
UNEP	United Nations Environment Programme
WRRI	Water Resources Research Institute

GLOSSARY

DEFINITIONS	
Change in ecological character	Within the context of the Ramsar Convention, change in ecological character is the impairment or imbalance in any biological, physical, or chemical components of the wetland ecosystem, or in their interactions, which maintain the wetland and its products, functions and attributes.
Modified habitats	Areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.
Natural habitats	Areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.
Critical habitats	Areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.
Convention on Wetlands	Also known as the Ramsar Convention, is an intergovernmental environmental treaty established in 1971 by UNESCO, and coming into force in 1975.
Ramsar Site	A Ramsar Site is a wetland site designated of international importance under the Ramsar Convention.
Wetland	Means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

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WETLANDS IMPACT ASSESSMENT

1. INTRODUCTION

Charles Amankwah of the Wildlife Division (Ghana Forestry Commission) and Alex Whitehead of SDP Ecological and Environmental Services were appointed to conduct an aquatic ecology (including wetlands) specialist study as part of the ESIA for the proposed construction, operation and decommissioning of a 75 Megawatt (MW) Wind Energy Facility (WEF) (“WPP2”) in Wokumagbe and Goi in the Greater Accra Region, Ghana.

The report provides a reference in terms of wetlands and associated habitats, their extent and their relation to the proposed development, in line with the requirements of the Environmental Assessment Regulations, 1999 (LI 1652) and as outlined in the Environmental Impact Assessment (EIA) Guidelines for the Energy Sector, Volume 1, 2010.

The potential aquatic and wetland impacts of the proposed wind energy project were reviewed within the context of the ecological sensitivity of the Ada West district of the Greater Accra region and potential mitigation measures were recommended to minimise key impacts. Impacts on associated fauna such as birds and marine turtles have also been included in this study. Where possible, influences on the local communities have been highlighted, given their dependence on the local freshwater and marine resources.

Two alternative layouts for the proposed wind power project have been assessed in this report. Further recommendations regarding the layout of the turbines and the associated infrastructure have been provided in addition to other relevant mitigation and management measures.

2. TERMS OF REFERENCE

The following broad terms of reference were specified for the aquatic ecology specialist study:

- A desktop aquatic biodiversity assessment of the study area. This will cover the study area and a 500m development buffer in relation to available information on the aquatic vegetation (including streams and rivers).
- Maps depicting demarcated aquatic and wetland vegetation delineated to a scale of 1:10 000, following the recognized methods and international standards.
- The determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of water bodies within the study area, estimating their biodiversity, conservation and ecosystem function importance with regard ecosystem services.
- Recommend buffer zones and no-go areas around delineated aquatic areas within the study area, based on the relevant legislation or best practice.
- Identification and assessment of wetland and aquatic impacts.
- Provide mitigations regarding project related impacts, including engineering services that could negatively affect demarcated aquatic vegetation units and potentially aquatic fauna.
- Recommend specific actions that could enhance the aquatic functioning in the areas, allowing the potential for a positive contribution by the project.

3. PROJECT DESCRIPTION

This project referred to as WPP2, will have the following main components which may impact on the aquatic ecology aspects:

- **Wind turbine area:**
  - Wind turbines; and
  - 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).

A detailed description of the project components is included in Chapter 3 of the ESIA report.

Two layouts have been assessed as part of this specialist study (Figure 1):

- *Preferred layout*: It is proposed to place turbines in two groupings, one to the east near Goi, and a western grouping situated immediately east and west of Wokumagbe.

- *Alternative layout*: For this alternative layout, turbines would only be placed at similar locations to the preferred layout, but with varied orientation. The Goi grouping is proposed to be similar, but with outliers to the east and west, while the Wokumagbe grouping forms a continuous line stretching from the east of Wokumagbe to the immediate north west.

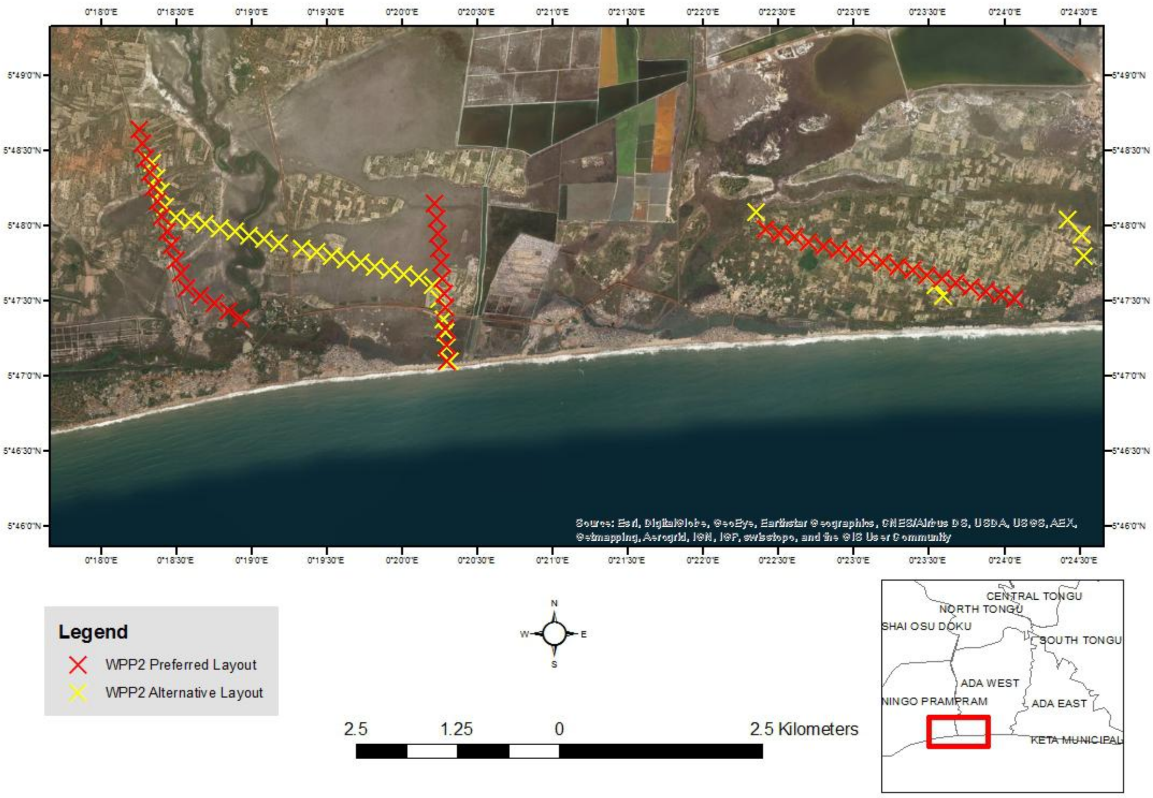

Figure 1: Location of the site for WPP2 with preferred and alternative layouts

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The Project is required to comply with the relevant Ghanaian laws and regulations, and International Conventions to which Ghana is a signatory (as well as the relevant international standards including Performance Standards) for Environmental and Social Sustainability**.** The relevant laws and regulations applicable to the assessment of impacts of wind energy production on aquatic ecology (including wetland) are discussed below:

4.1 NATIONAL

Environmental regulation within Ghana falls under the requirement of the EPA Act 1994, Act 490. The Act 490 mandates the EPA with the responsibility for environmental and compliance for development activities. Supporting legislation includes the Ghana EIA Procedures 1995 and the Environmental Assessment Regulations 1999 (L.I 1652), which are consistent with Section 28 of the EPA Act 490 and ensures impact assessment for all projects/developments likely to affect the environment.

Other applicable legislations to the current project include:

- Wild Animal Preservation Act, 1961 (Act 43), passed to protect wildlife by conserving representative samples of Ghana's ecosystems.
- Wildlife Conservation Regulation, 1971 (LI 685) that 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;
- Wildlife Reserves Regulations 1971 (LI 710) empowers the government to establish wildlife Protected Areas, including Ramsar Sites (and Marine Protected Areas) and also defines permissible and non-permissible activities within the Protected Area.

Fisheries, Wetlands, Coastal and Marine laws and regulations

- 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;
- 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;
- Rivers Ordinance, 1903 (Cap 226);
- The Act establishing the Water Resources Commission, among others, deals with pollution of water;
- There are numerous laws and regulations covering protection of coastal and marine resources: Maritime Zones Law, 1986; Town and Country Planning Ordinance; the Towns Ordinance; National Building Regulations, 1996; Local Government Act, 1999; and Oil in Navigable Water Act, 1964.

Land

- Land Planning and Soil Conservation Act, 1957;
- Town and Country Planning Ordinance 1945 (Cap 84);
- National Land Policy, 1999 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;
- Beaches Obstruction Ordinance, 1897 (Cap 240);
- Land Planning and Soil Conservation (Amendment) Act, 1957 (No. 35 of 1957)
- Volta River Development Act, 1961

Local Government Law

- Local Government Act, Act 462 gives local authorities (Metropolitan, Municipal and District Assemblies (MMDAs)) the responsibility for overall development of their areas of jurisdiction, including improvement and management of human settlements, management of solid waste, and other environmental issues.

- *The Metropolitan, Municipal and District Assemblies (MMDAs):* The development planning and administration of the MMDAs is fashioned by the Decentralization Policy and Local Government Act 462 (1993), introduced in 1988. The Policy mandates the Assemblies to enact byelaws that ensure good sanitation and to abate all nuisances within their jurisdiction. It also seeks to involve local communities in the political, social and economic administration of their districts within the broad framework of the national economic, social and political objectives. The assemblies work through committees and subcommittees, and in all cases has Environmental Management Committees (EMC) which handles issues related to the environment, including wetlands.
- Traditional management practices: a strong traditional base for protection of natural resources through indigenous management systems exists in Ghana. Most wetlands and their resources, for example, are protected and regulated through varied traditional practices, which involve customary laws or taboos. Though these rules and regulations are steeped in traditional beliefs, their main effect is to control resource use, which is generally observed by local populations. The administration of these traditional practices is not legally integrated with the district administrative structure though they provide viable and dependable structure through which development programmes are initiated and implemented. Chiefs and their elders perform executive, legislative and judicial functions at the village or community level.
- The existing coastal Ramsar Sites are generally not government acquired. Access to land within the Ramsar Sites partly remains under the control of the traditional authorities in most local communities and generally has to be consulted (Danso, 1998).

A number of Environmental related Policies exist in Ghana. These include:

- The National Environment Policy, 2012
- National Wetlands Conservation Strategy, 1999 and its 2007 revised version, National Wetlands Conservation and Action Plan (2007-2016) comprise 12

programme areas, covering conservation and sustainable use of wetland resources;

- National Land Policy, 1999, recognises wetlands as environmental conservation areas and precludes practices such as: physical draining of wetland water; draining of streams and water courses 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, provided that such uses serve to conserve the ecosystem, biodiversity and sustainable productivity of wetlands.

Other relevant policies are:

- Forest and Wildlife Policy, 2012
- Tourism Development Policy, 2006
- National Health Policy, 2007
- Energy Policy, 2010

The policies on marine and coastal protection, management and development are pivoted on the following three major areas:

- Integrated coastal zone management and sustainable development ;
- Marine environmental protection, both from land-based activities and from sea-based activities; and
- Sustainable use and conservation of marine living resources (both of the high seas and under national jurisdiction).

Important steps have been pursued towards the realization of prudent management of the marine and coastal environment. These include:

- Coastal Zone Management Indicative Plan, 1990
- National Environmental Action Plan, 1994
- Draft Integrated Coastal Zone Plan, 1998
- Coastal Zone Profile of Ghana, 1998

- National Oil Spill Contingency Plan with specific reference to the marine environment, 2002
- Environmental sensitivity map of the coastal areas of Ghana, 1999 and 2004

4.2 INTERNATIONAL TREATIES AND CONVENTIONS

Ghana has ratified or acceded to a large number of environmental and social international treaties and conventions. Those which may be relevant to the project are listed in Table 1 below:

Table 1: Relevant treaties and conventions

Treaties and Conventions	Year Ratified
African Convention on the Conservation of Nature and Natural Resources	1968
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 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
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	1988
Convention on Biological Diversity	1992
United Nations Framework Convention on Climate Change	1996
United Nations Convention to Combat Desertification	1997
International Covenant on Economic, Social and Cultural Rights	2000
Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)	2004

5. METHODS OF ASSESSMENT

5.1 MAPPING OF SENSITIVE AREAS

The identification of sensitive wetland and aquatic habitats was done using aerial photography and where possible on site verification during the site visit. ESRI online resources and Google Earth were used as aerial photography sources.

The identified habitats were classified as:

- Freshwater – wetlands (Floodplain and depression wetlands), water body (open water)
- Estuarine –salt marsh/salt flat, lagoon

The extent of these habitats was determined within a 500 m radius of the proposed wind turbines and associated infrastructure and road network (including larger arterial roads that may require upgrading).

5.2 PRESENT ECOLOGICAL STATE AND ECOLOGICAL IMPORTANCE AND SENSITIVITY

5.2.1 Estuarine ecosystems

No true estuarine ecosystems are present within the WPP 2 project area. The method described below has been used to estimate the state and importance of the lagoons and salt marsh areas present. Some of the criteria assumed for true estuaries were not applicable and adjusted accordingly.

The method used to determine the present ecological state (PES) of the estuarine systems is described by Taljaard et al (1999). This assessment method requires at least desktop data consisting of the following:

- Hydrology and estuarine physical dynamics
- Estuarine water quality

- Flora
- Fauna

Typically, the functional zone is defined as the area of tidal influence, generally up to 5m amsl. A description of the reference state of the system is required and is based on available information.

For the PES assessment the following criteria were scored from 0 to 5 in terms of change (0 critically modified, 5 natural) and the scores then assigned a confidence value based on the nature of the available information:

- Percentage of MAR currently abstracted
- Changes in seasonal river inflow patterns
- Changes in mouth condition
- Changes in water quality
- Changes in natural instream habitat
- Changes in riparian habitat
- Plants, including microalgae and macrophytes
- Benthic invertebrates
- Fish
- Birds

The Ecological Importance and Sensitivity (EIS) was then estimated using four criteria, which were scored from 1 to 5. The four criteria include:

- Rare/endangered/limited populations
- Habitat diversity (richness)
- Rarity of an estuary or unique estuarine features
- Input to the sea

Using the present ecological state score, an ecological management class (EMC) was assigned to the estuarine system within the study area (refer to Table 2)

Table 2: Ecological Management Classes based on the PES score

MEAN PRESENT ECOLOGICAL STATE SCORE	RECOMMENDED EMC CLASS	DESCRIPTION
> 4	A	Unmodified, natural – the natural abiotic template should not be modified. The characteristics of the resource should be completely determined by unmodified natural disturbance regimes. There should be no human induced risks to the abiotic and biotic maintenance of the resource.
> 3 and <= 4	B	Largely natural with few modifications – only a small risk of modifying the natural abiotic template and exceeding the resource base should be allowed. The risk to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may be slightly higher than expected under natural conditions.
> 2 and <= 3	C	Moderately modified – a moderate risk of modifying the natural abiotic template may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may generally be increased with some reduction of resilience and adaptability at a small number of localities.
> 1 and <= 2	D	Largely modified – a large risk of modifying the abiotic template and exceeding the resource base may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may generally be allowed to increase substantially with resulting low abundance and frequency of occurrence.
<= 1	Not acceptable, should be upgraded to at least a Class D	

5.2.2 Wetland ecosystems

The method for determining the Present Ecological State (PES) of the wetlands is described by Duthie (1999a). This method was applicable to the current study as the method utilised available information and aerial photography with site verification rather than the collection of primary data as more detailed methods require. The method consists of 4 steps:

1) Literature review
2) Aerial photographic assessment
3) Site visit and use of local knowledge
4) Assessment of criteria and generation of preliminary PES scores.

The criteria used for the PES assessment include the following:

1) Hydrology
2) Water Quality
3) Geomorphology and
4) Biota

The criteria and attributes were scored between 0 and 5 and the confidence levels are scored between 1 and 4. A PES category is assigned based on the average score (Table 3).

Table 3: Interpretation of scores for determining present ecological status

Interpretation of Mean of Scores for all Attributes: Rating of Present Ecological Status Category (PES Category)
WITHIN GENERALLY ACCEPTABLE RANGE
CATEGORY A >4; Unmodified, or approximates natural condition.
CATEGORY B >3 and<=4; Largely natural with few modifications, but with some loss of natural habitats.
CATEGORY C >2 and <=3; moderately modified, but with some loss of natural habitats.
CATEGORY D =2; Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E >0 and <2; Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F 0; Critically modified. Modifications have reached a critical level and the system has been modified completely with and almost complete loss of natural habitat.

The "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. The "*Ecological sensitivity*" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Duthie 1999b). In order to obtain an indication of the EIS of a wetland system, a number of determinants are rated on a scale of 0 to 4 (Duthie 1999b). The determinants are split into two categories – *primary determinants* and *modifying determinants*. The determinant scores are summed and the median calculated. The median is indicative of a predetermined EIS category (Table 4). Based on the median, an ecological management class (EMC) was then assigned for the wetland system.

Table 4: Ecological importance and sensitivity categories. Interpretation of median scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

5.3 WETLAND FUNCTIONALITY

Utilization was made of the Wet-EcoServices tool (Kotze et. al. 2007) to determine the functionality of the delineated wetlands. This involved the identification of hydrogeomorphic (HGM) units, followed by an assessment of each unit according to the scoring criteria provided.

A Level 2 assessment of their respective "Ecoservices" was undertaken. In total 15 eco-services (e.g. nutrient removal, phosphate removal etc.) which they provide were evaluated and an eco-services score was calculated for each service. This score indicates the level of benefit (service) offered by the HGM units and is ultimately an indication of the HGM units functional status. During the scoring process, criteria associated with each ecoservice were scored from 0 – 4 (0 = low, 4 = high)

Criteria are split into two sections; "*effectiveness*" and "*opportunity*". The average value of criterion for each section provides a score of *effectiveness* and *opportunity*. The average of the *effectiveness* and *opportunity* scores provide an *overall score* for the specific ecoservice rendered. The overall score was then assigned to a class. Table 5 below provides the classes for determining the extent to which a "functional benefit" is provided based on the overall scores

Table 5: Classes for determining the possible extent to which a benefit is being supplied. The score represents the overall score for each benefit, e.g. flood attenuation (Kotze *et. al*. 2007).

Score:	<0.5	0.5-1.2	1.3-2.0	2.1-2.8	>2.8
Rating of the likely extent to which a benefit is being supplied	Low	Moderately Low	Intermediate	Moderately High	High

This method aligns with the wetland functions provided by the National Wetlands Conservation Strategy (1999) for wetlands in Ghana.

5.4 ASSUMPTIONS AND GAPS

Given the scope of the project the opportunity for primary data collection was limited.

The data, literature and assumptions used to prepare this report were primarily sourced or derived from documents or information provided by others and are duly acknowledged or referenced. The source of data or information was not independently verified. The specialist, therefore, does not assume responsibility for their accuracy or fullness in completion of fact or ideas.

It has been assumed that the final layout of the WEF will take cognizance of this and the other specialist studies, with particular reference to the internal services such as road, underground cabling and storm water management. It is therefore assumed that the developer will apply best practice principles during the final design phase, recognizing the recommendations in this report.

In order to obtain a comprehensive understanding of the dynamics of the aquatic environment within a study site, as well as the status of endemic, rare or threatened species in any area, assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints these long-term studies are not feasible and are mostly based on instantaneous sampling.

It should be further emphasised that information, as presented in this document, only has reference to the study area as indicated in the accompanying maps. Therefore, this information cannot be applied to any other area without detailed investigation.

6. DESCRIPTION OF THE AFFECTED ENVIRONMENT

The project is located approximately 150 km east of Accra (see Figure 1). Specifically, the location of the project facilities is close to the settlements of Akplabanya-Lekpoguno-Goi-Wokumagbe, all situated west of the Volta River within the Ada West District of the Greater Accra Region. The proposed project lies within the Songor Ramsar Site and Biosphere Reserve, along a coastal stretch of ***very high environmental sensitivity*** on the south-eastern coast of Ghana (EPA, 2004, Figure 3). The sensitivity ranking is attributed to, among others, the presence of certain natural features including open lagoons/estuarine, or as fertile breeding/nesting grounds for fisheries or marine turtles or the presence of mangroves.

The Songor Ramsar Site and Biosphere Reserve doubles as a UNESCO biosphere reserve and, together with the Keta site, is the most important wetland on the Ghanaian coast for waterbirds and constitutes the fourth most important waterbird sites on the Gulf of Guinea coast (Ntiamoa-Baidu et. al. 1998). Like all other coastal Ramsar Sites in Ghana, the Songor site was identified and listed as Wetlands of International Importance based on their regular support of 1% of the individuals in a population of one species or subspecies of waterbird - Criterion 6 of Criteria for Identifying Wetlands of International Importance (Appendix: 1).

Preliminary consultation with the manager of the Songor Ramsar Site and Biosphere Reserve and review of the management plan of the Songor Ramsar Site and Biosphere Reserve, (2014) indicated that the site is zoned into core, buffer and transitional zones based on perceived environmental sensitivity measure for management purposes. The extent of these zones and the relative position of the WPP 2 turbine cluster are provided in Figures 2 and 3. The restrictions relevant to each of the three zones is provided in Table 6 below.

Table 6: Songor Ramsar Site and Biosphere Reserve zones as per Figure 3 and the restrictions assigned by the management plan (Ntiamoa-Baibu and Gordon 1991).

Zone	**Management Plan Equivalent Zonation**	**Restrictions**
Core	*Core*	No development permitted
Buffer	*Controlled Area*	Environmental impact assessment required for ANY development/activity
Transitional	*Landuse Management Areas*	Environmental impact assessment required for industrial development/activities

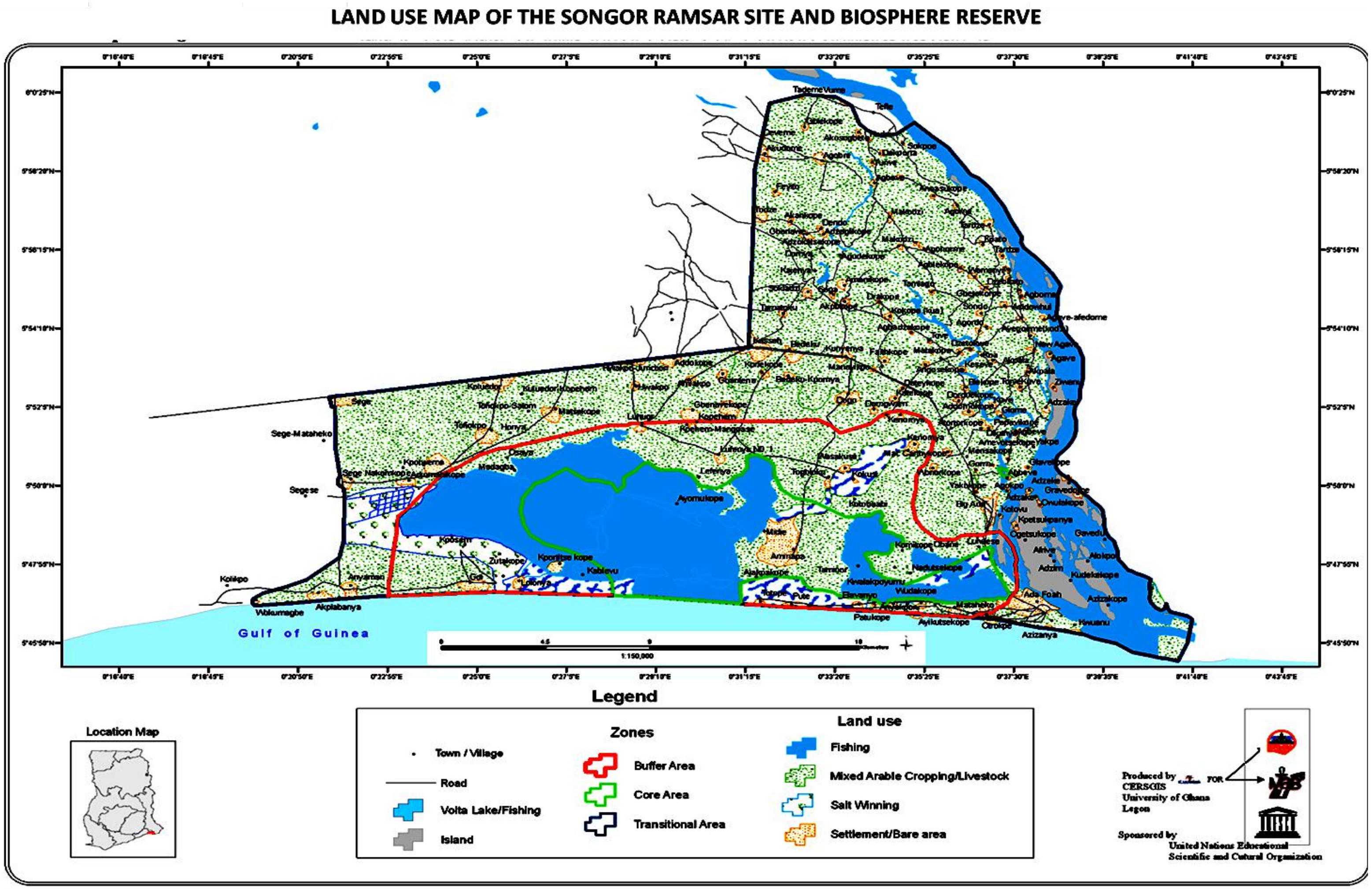

Figure 2: The Songor Ramsar Site and Biosphere Reserve

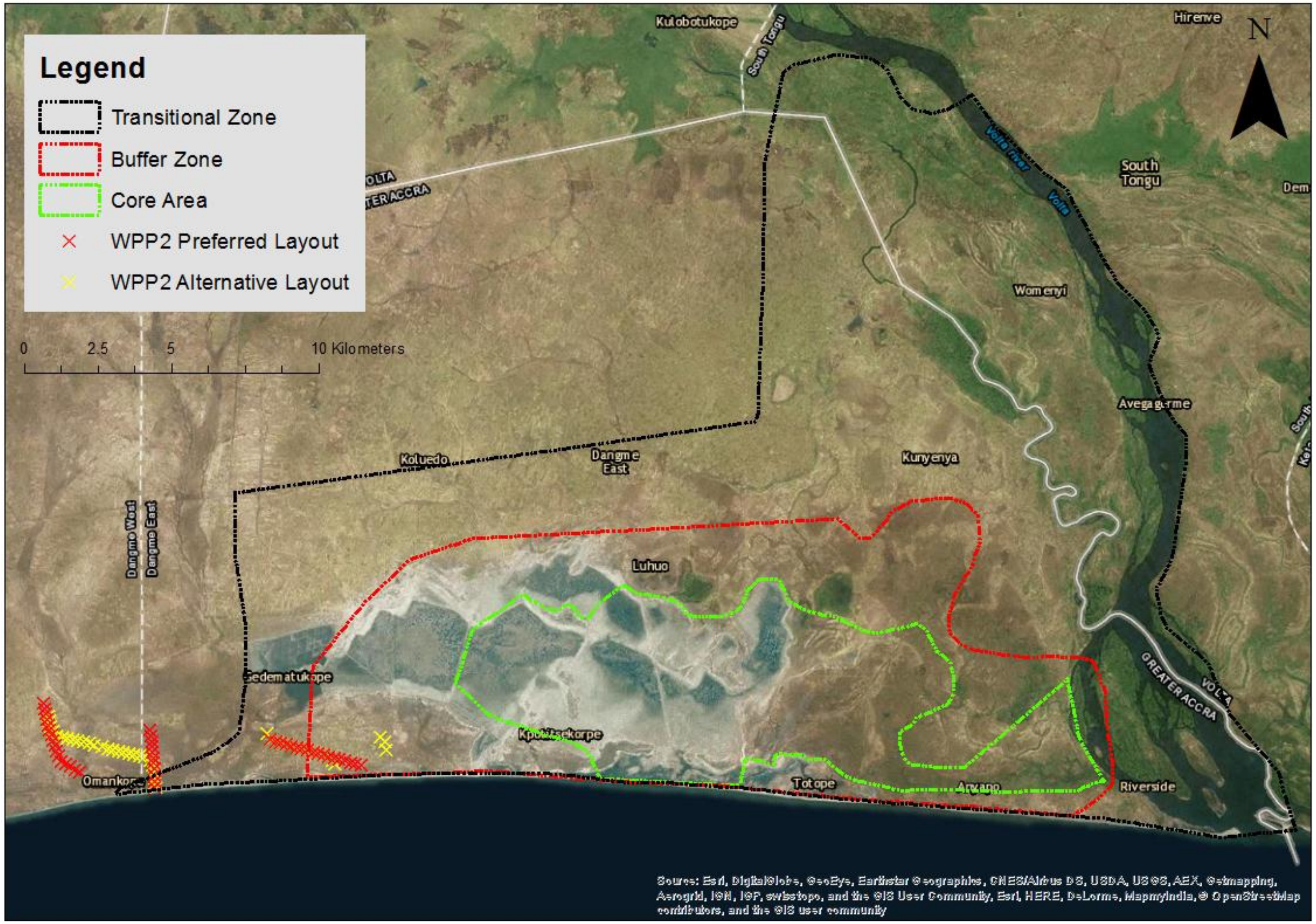

Figure 3: The extent of the Songor Ramsar Site and Biosphere Reserve and position of the proposed WPP 2 turbines.

6.1 PHYSICAL FEATURES

6.1.1 Climate

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). 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).

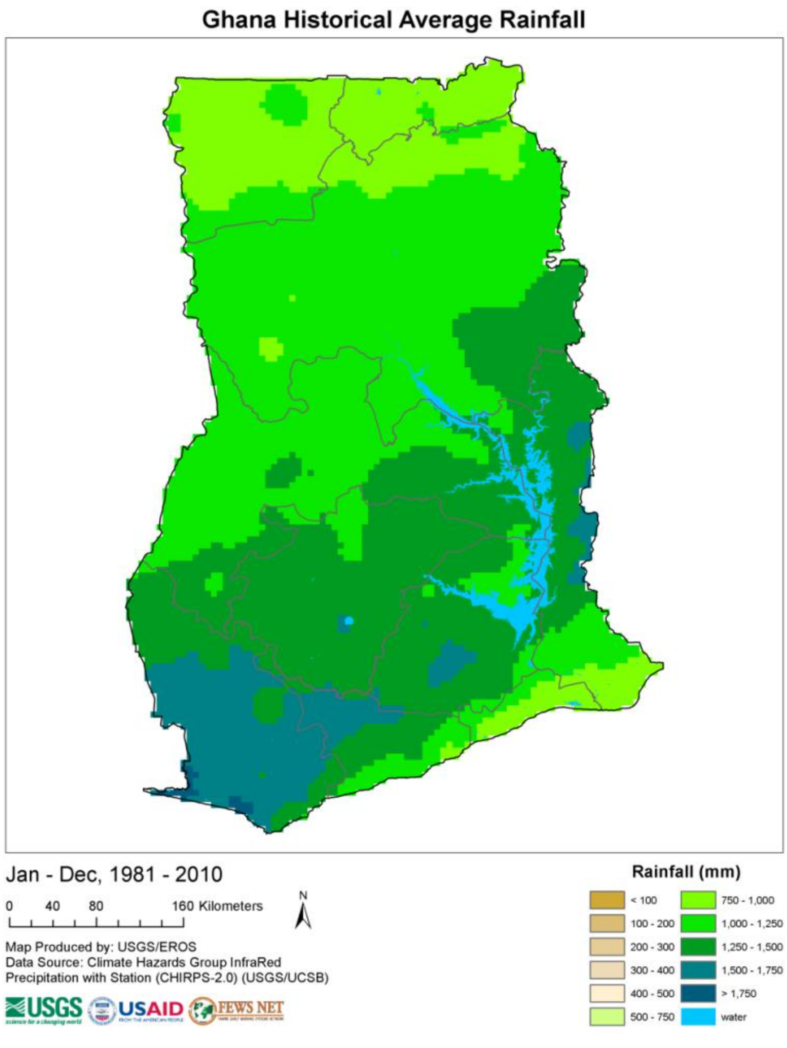

Figure 4: Mean Annual Rainfall Levels of Ghana (Source: Climate Hazards Group InfraRed, 2017)

The mean annual temperature in Ghana ranges from 25.9 °C to 29.7 °C due to the low latitude of Ghana (Figure 5). The average daily temperature of Tema, which is approximately 83 km from Ada Foah, is 27.7°C. The coolest time of the year is between June and September when the main rainfall occurs. Variations in temperature both annually and daily are quite small. In most areas the highest temperatures occur in March, the lowest in August.

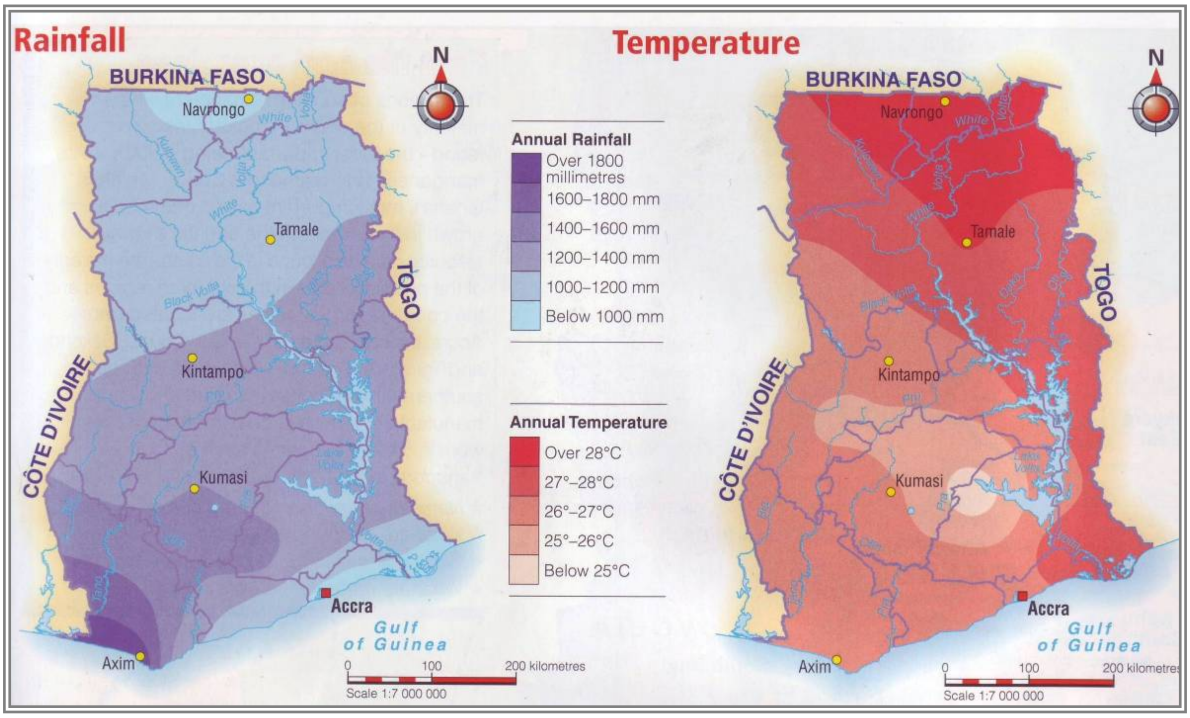

Figure 5: Average annual rainfall and temperatures in Ghana (MacMillan, 2007)

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 (0.6 miles). 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.

The proposed project sites lie within the dry equatorial climatic region of Ghana, which covers the entire south eastern coastal belt of the country. Temperatures are high throughout the year and range between 23°C and 33°C. August is normally the coldest month in the area. Rainfall is heavy during the major rainy season between March and September. The average rainfall is 750 mm per annum. Relative humidity ranges from 60% in the dry season to 80% in the rainy season. Evaporation ranges from 5.4 mm to 6.8 mm and is very high during the dry season (November -March). This is attributed to the proximity to the sea, the Volta River and other water bodies.

The prevailing wind direction is from the southwest all year round (the south-west monsoons). This is a characteristic feature for the entire coastal belt of the country (Tumbulto, 1997).

6.1.2 Hydrology, surface waters and flooding

Ghana lies along the Gulf of Guinea (3^0 5´ W and $1^0$10´ E and 4^0 35´N and 11^0 N) and has an area of about 239,000 km^2 and a 550 km coastline with about 90 lagoons and associated wetlands. Some of the lagoons are closed and others open to the sea (Mensah, 1979). The coastal zone covers about 6.5% of the total area (Figure 6) and houses about 25% of the national population as well as 60% of the nation's industries.

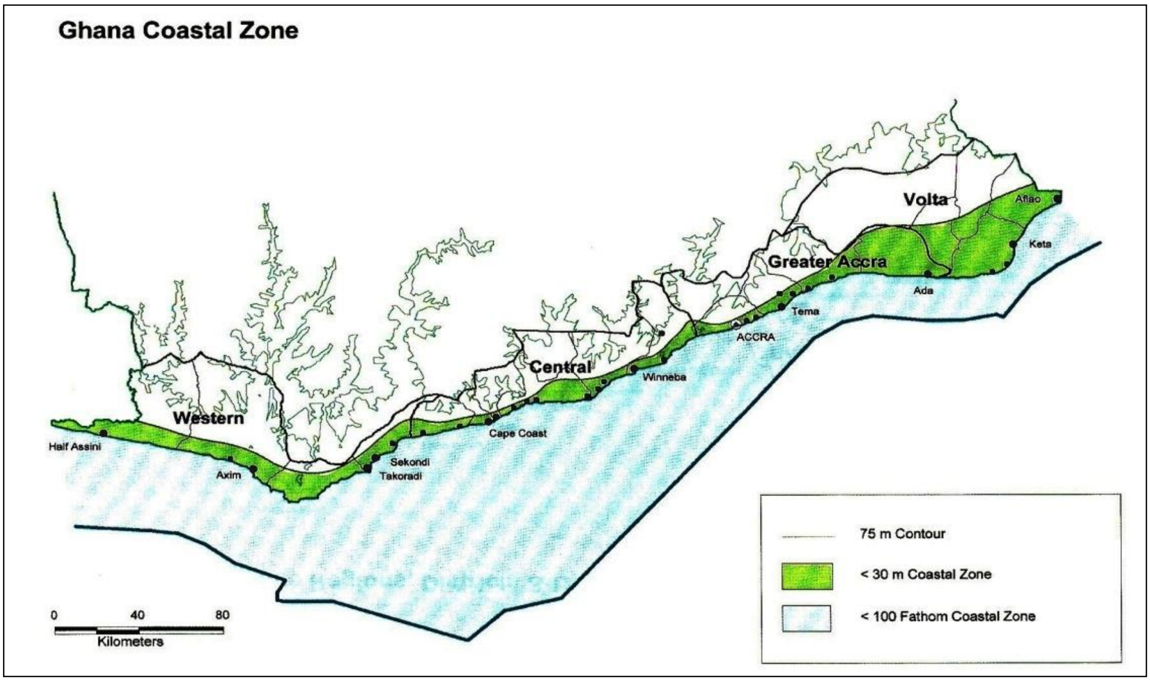

Figure 6: Map of Southern Ghana showing the coastal zones

The coastline has three geomorphic units. The West Coast (≈95 km), extends from the Ghana's-Côte d'Ivoire border to the Ankobra River estuary where there are gently sloping sandy beaches; the Central Coast (≈321 km) from the Ankobra estuary to Tema with rocky headlands and sandbars or spits enclosing coastal lagoons and the East Coast (≈149 km), stretching from Tema to the Ghana-Togo border where the shoreline is sandy and characterized by considerable coastal erosion (Ly, 1980).

The main watercourse along the East Coast is the Volta River, which discharges into the sea through an estuary at Ada-Foah, with extensive surrounding wetland floodplains and mangrove swamps on either side of its lower reaches (Figure 7). The Songor and the Keta Ramsar sites form part of the Volta River estuary within the project area of influence along the eastern coastline. The effective catchment area of the lower Volta estuary is estimated to be over 1,520 km^2 (estimated from total area of Songor and Keta Ramsar Sites). On the west of the Volta river estuary is the Songor lagoon, which receives fresh water inflow from the Sege and Zano streams. The lagoon has no direct access into the sea. Sea water replenishment results from seepage through sand dunes (Piersma & Ntiamoa-Baidu, 1995), where the proposed Akplabanya-Lekpoguno-Goi-Wokumagbe wind energy development facilities will be located.

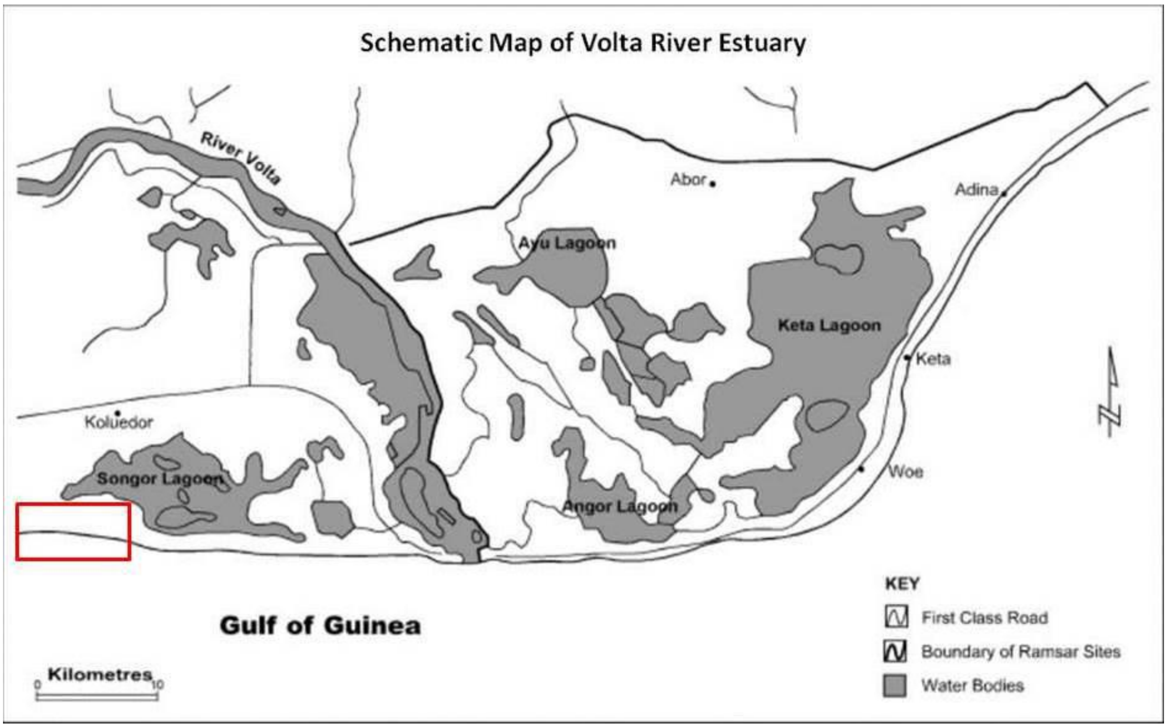

Figure 7: Schematic Map of the Volta River Estuary showing the Songor and Keta lagoons. The approximate position and extent of WPP 2 is indicated by the red frame adjacent to the Songor Lagoon.

The regulated flow in the Volta delta began when Akosombo and Kpong hydro-power plants were commissioned in 1965 and 1984, respectively. This has created a new flow regime between Kpong and Ada, resulting in a progressive growth of a sandbar at Ada, which restricts flood discharge (into the sea) and tidal movement into the river (Gordon and Amatekpor, 1999). The reservoir has reduced downstream flow patterns and effectively eliminated the dynamic interactions between the river and its floodplains, wetlands, deltas, estuaries, mangrove and beach environments. The resulting change in fauna and flora encouraged the growth of disease vectors such as schistosomiasis carrying snails, and created changes in the flow regime between the interconnecting creeks and streams between the Lower Volta River and the Songor lagoons.

Parts of the project core sites are considered to be vulnerable to flooding and as such, if the proposed facilities are built at current levels it is likely that they will be susceptible to inundation. If ground levels at the sites are raised to protect them from flooding this could however exacerbate flood risk in other low lying areas, potentially resulting in farmland or properties locally being flooded more frequently and or more severely than currently occurs.

In addition climate change related changes in sea level and or rainfall could further alter the flood regime locally. Essentially the Songor region is dynamic and susceptible to hydrological changes, whether natural or induced.

6.1.3 Geology and soils

The geological formations of the Ghana coastal areas are said to be influenced by the processes of continental drift during the Cretaceous period of about 135 million years ago. The underlying basement formations consist of hard granites, granodiorites and metamorphosed lava and pyroclastics. Some coastal areas are covered by Ordovician and Devonian sandstone and shale.

Specifically, the greater part of Ada East and West Districts, where the project sites are located is underlain by tertiary and recent deposits, a small section in the northern and eastern parts fall under the Dahomeyan complex rocks of Precambrian age. The unconsolidated sand, gravel and clay recently occur in the deltaic areas of the Volta River. While the rock of the basement is unknown, it is expected to be Dahomeyan, similar to the one cropping out to the north of the basin, and they consist of gneisses, schists, migmatities (Hilton, 1967) and weather into dark grey calcareous clay and silt that are slightly permeable.

Different soil types with peculiar characteristics and distributions may be found in one project site or the other and support agricultural activities as follows:

- Ada Association with mottled extremely acidic heavy clay is found at the estuary and the islands; it can support coconut trees, sugarcane plants, grasses for mat weaving, and mangroves.
- Red Earth with Reddish-brown Loamy texture, well drained, porous, and permit vast development, suitable mainly for the cultivation of maize, cashew, cassava and vegetables.
- Agawtow series with Grey brown soils, loamy on top with impervious clay below; cracks when dry. They are low in nutrients and difficult to work on but good for grazing or woodlots.
- Goi Association (Sundry clays) have sandy loam overlay heavy clays, easily eroded and often water-logged surface layers become droughty and would need draining. It is associated with salt leach and good for grazing, vegetables and cassava.
- Songor Association with red and grey mottled and extremely acidic compact clay is found in Songor lagoon area and other coastal lagoons; they are suitable for grazing and are uncultivated.
- Tropical grey earth (Avejeme Association) also grey brown firm sand or silt loam overlaying compact clay with thin layer of gravel beneath is found in the District and supports cassava cultivation (Dangme East District, 2006).

The Volta River has a dominant influence on the geomorphology of this coast. 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 2 m above Mean Sea Level (MSL).

6.1.4 Coastal erosion

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 (Armah, 1991). Several consequences could be expected from sea level rise in Ghana. In particular, low-lying sandy coastal areas at the eastern coast such as the Volta Delta and Songor lagoon could be profoundly affected. The expected impacts of sea-level rise are: direct inundation (or submergence) of low-lying wetland and dry land areas; erosion of soft shores by increasing offshore loss of sediment; increasing salinity of estuaries and aquifers; raised water tables; and exacerbated coastal flooding and storm damage (IPCC, 2007). These impacts have in turn influence on coastal habitats, bio-diversity and socio-economic activities.

6.1.5 Ada Foah Coastal Stretch

The area consists of approximately 15 km of coastline located between Long. 0°30’E and Long, 0°40’E west of the Volta Estuary. The stretch is fast eroding posing a great threat to property, infrastructure (Figure 8), tourism and sea turtle nesting sites. This has led to modification and subsequent incipient loss of ecotones and ecosystems (Armah, 1991) and coastal infrastructure.

Figure 8: Coastal road infrastructure damage by sea erosion at Ada

(Photo credit: Carl Fiati 2010)

A recent 45km stretch of beach profile study shows that the beaches of Ada experience uneven erosive dynamics (Agyeman, 2015). For example, accretion in sections of beaches at Ada between January and March 2015 was 3.53 m with a cliff height of 0.69m. An average erosion of 5.89m was recorded between the month April - June of the same year with a corresponding cliff height of 0.89m. Communities such as Totope, Anyamam and Wokumagbe near one of the proposed project site at Akplabanya were severely affected. Sections of the beaches that have been nourished and restored by *Dredging International* enjoy a stable condition with low cliff formation. Stable beaches promote fishing activity as a livelihood in beach communities. Turtles use stable natural beaches for nesting activities. .

6.2 BIOLOGICAL FEATURES

6.2.1 Overview

The coastal savanna zone covers approximately 12,000 km², some 5% of the land area. This zone runs westward from the Togo border, includes the delta of the Volta river, and narrows in width until it is replaced by forest zones in the Sekondi–Takoradi area, just east of Ghana's southernmost extremity, Cape Three Points (Figure 9). The vegetation consists of grasses and shrubs. Some mangrove stands occur in the south-east, around the Volta lagoons, and also in the west around the Amanzuri wetlands. Most of the mangrove forests in the east are degraded as a result of heavy exploitation.

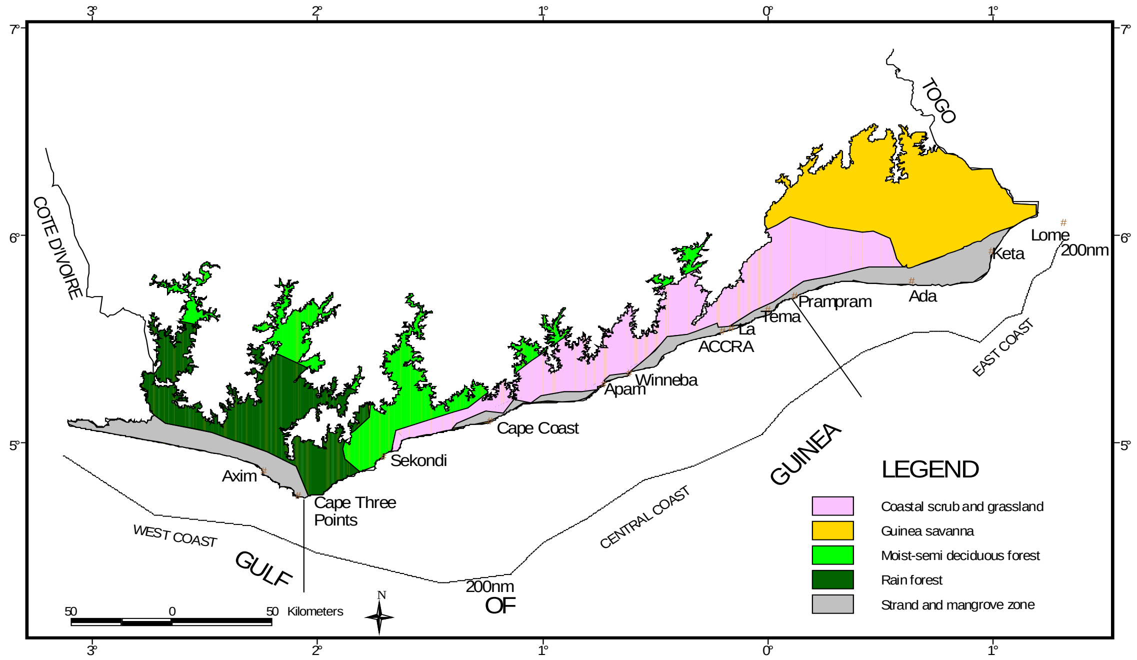

Figure 9: Vegetation of the Coastal Zone of Ghana

Ten wetland types based on the classification of the Ramsar Convention on Wetlands (Ramsar, Iran, 1971) occur in the coastal zone of Ghana (Gordon *et. al.*, 1998). The south eastern coastal area which comprises the study area, has wetland habitats including swamps, sandy beaches, lagoons, estuaries and mangroves. The wetland areas have a relatively low diversity of plant and animal species. The area has been modified by different anthropogenic activities such as settlement and farming, but small areas of primary vegetation may be intact.

6.2.2 Floral Diversity

The coastline vegetation is characterized by salt tolerant grasses like *Paspalum vaginatum, Sporobolus robustus,* the rhizomatous sedge *Cyperus articulatus* and the succulent forb *Sesuvium portulacastrum.* Madreporarian corals are found nearer to the shore of lagoons. Further landwards on floodable higher ground are grasses such as *Brachiaria distachyoides, Imperata cylindrica*, *Panicum repens*, tall grasses such as *Andropogon gayanus*, and *Vetiveria fulvibarbis.* Other vegetation includes the herbs *Cassia mimosoides and Croton lobatus*, and sedge *Fimbristylis pilosa.*

The terrestrial vegetation of the area is largely degraded and the terrain is characterised by farms, secondary growth on abandoned farms, and eroded lands invaded by Neem *Azadirachta indica*, and isolated trees like Fan Palm *Borassus aethiopum*, Mango *Magnifera indica,* Silk cotton Tree *Ceiba pentandra* and Baobab *Adansonia digitata*.

A hydro-biological survey of the Keta and Songor lagoons by Finlayson *et. al.* (2000), inform a preliminary definition of the floral baseline of the site. A list of aquatic and wetland plants from Songor lagoons and the swamps that occur between the lagoon and the Volta River is provided in Appendix 2. The list is certainly not comprehensive as it is confined to the plants found at particular survey sites in a particular season, but given the high number of species recorded (57) it is highly probable that this represents a major component of the macrophytic flora of the area.

The most dominant species were the large emergent species *Typha domingensis, Scirpus littoralis* and the rampant grass *Paspalum vaginatum.* These species were most common in the freshwater zones around both lagoons and towards the Volta River. At some sites they occurred together or in close proximity, whereas at others there was a definite monodominance. The relationship between these species and their preferred growth conditions is not known, but it is assumed that water depth and the extent of inundation would be influential. The drier and saline areas around the lagoons are characterised by a *Sesuvium portulacastrum* and *Sporobolus pyriamidalis* association. Whilst these species preferentially grow in the drier and more saline areas they also seem to be influenced by the extent of freshwater flooding, but again there is no evidence on which to base more specific comments.

The dry salt flats and shallow saline water bodies are dominated by *Sesuvium portulacastrum* and/or *Cyperus articularis* with some *Sporobolus pyramidalis* and *Paspalum vaginatum*. The deeper swamps adjacent to the wetlands contained extensive stands of *Paspalum vaginatum*, both in wet and dry conditions, and the tall *Typha domingensis* are generally found in wet areas or areas that prone to flooding.

The vegetation on the sand dunes or beach heads is subject to temperature extremes, high evaporation rates, sea sprays, windiness and unstable and unconsolidated substrates. Coconut (*Cocos nucifera*) plantations dominate the dunes whilst the ground cover is dominated by rhizomatous and straggling species including the sedges *Cyperus maritime* and *Remirea maritime*, the herbs, *Alternanthera maritima, Canavalia rosea,* and *Ipomoea pes-caprae*, and the grasses *Paspalum vaginatum, Sporobolus robustus* and *S. virginicus.* The creeping succulent forb *Sesuvium portulacastrum, Philoxerus vermicularis,* and xerophytes *Euphorbia glancophyll* and *Opuntia vulgaris* exist in the zone. Occasionally *Thespesia populnea* and the Indian almond *Terminalia catapa* may also occur (Boghey, 1957). The algae in the brackish habitats are rather poor and represented by ten species.

The existing natural vegetation of the project area (Figure 10) is a mosaic of coastal thicket and grassland as well as lagoon margin and estuarine mangrove. The extent and quality of the vegetation of the project area have declined considerably in response to human influences, notably growth of human settlements and agriculture. 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. 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*.

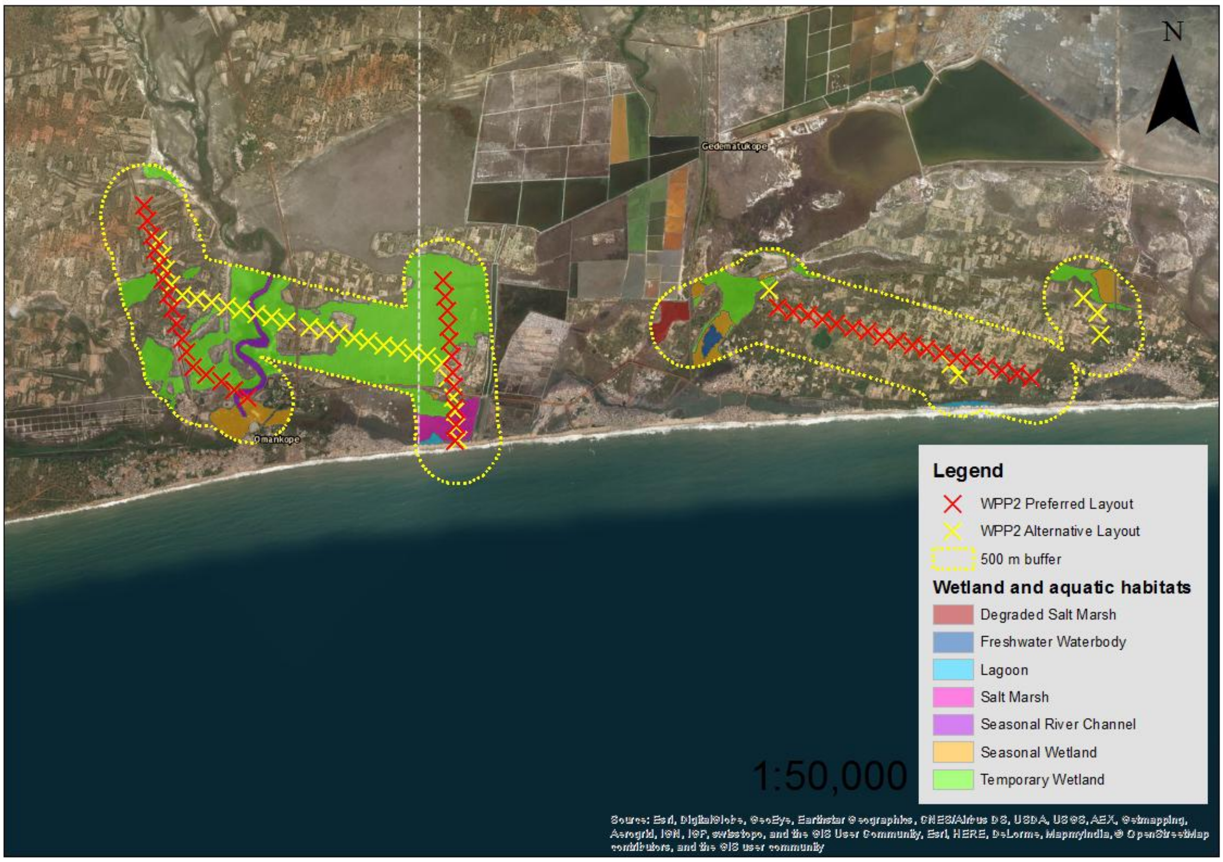

Figure 10: The proposed positioning of the turbine clusters for Preferred Layout and Alternative layout.

6.2.3 Mangroves

Mangroves along the coastline of Ghana are associated with coastal lagoons and estuaries. Their distribution is sparse and nature degraded through over-cutting and conversion to salt pans.

Good stands of mangroves are restricted to three main areas: the Amanzule wetlands in the Western Region, the Kakum River estuary west of Cape Coast (Central Region), and the Volta Delta. White mangrove *(Avicennia africana),* red mangroves *(Rhizophora racemosa)* and black mangroves *(Laguncularia racmosa)* are the dominant species. Typically *Rhizophora* and *Laguncularia* species are found on the seaward side of lagoons whilst *Avecinnia* is found on the landward side of the swamps (FAO/UNEP, 1981).

The *Avecinnia africana* and *Rhizophora racemosa* are common within the Songor Lagoon area, particularly in the east where the tidal influence of the Volta River is stronger. *Rhizophora racemosa* is not considered threatened by the IUCN Red List of Threatened Species and *Avicennia africana* has not been evaluated. The continual development of these species in the project areas is supported by the inundation of the mudflats of brackish water from the Volta River and the creeks.

Associated with the mangroves are swamp grasses and buttonwood *(Cornocarpus erectus).* Faunal composition includes the lagoon crab *(Cardiosoma amartum),* mudskipper *(Periophthalmus papilio), Tilapia* species, weaver birds, pied king fisher and western reef egret. Mangroves also play an important role as nursery areas for many species of fish and crustaceans.

6.2.4 Faunal Diversity

The large numbers of coastal lagoons and marine ecosystem provide rich and diverse habitats for significant populations of water birds, turtles and mammals of conservation importance.

6.2.4.1 Birds

Ghana is on the boundary of two international migratory water bird flyways – the *East Atlantic Flyway* and the *Mediterranean Flyway* and receives diverse migratory bird species along the coast (Figure 11). Therefore, about 90% of the bird populations in the coastal regions of Ghana are migrant species, which makes the coast very important in terms of the global conservation effort.

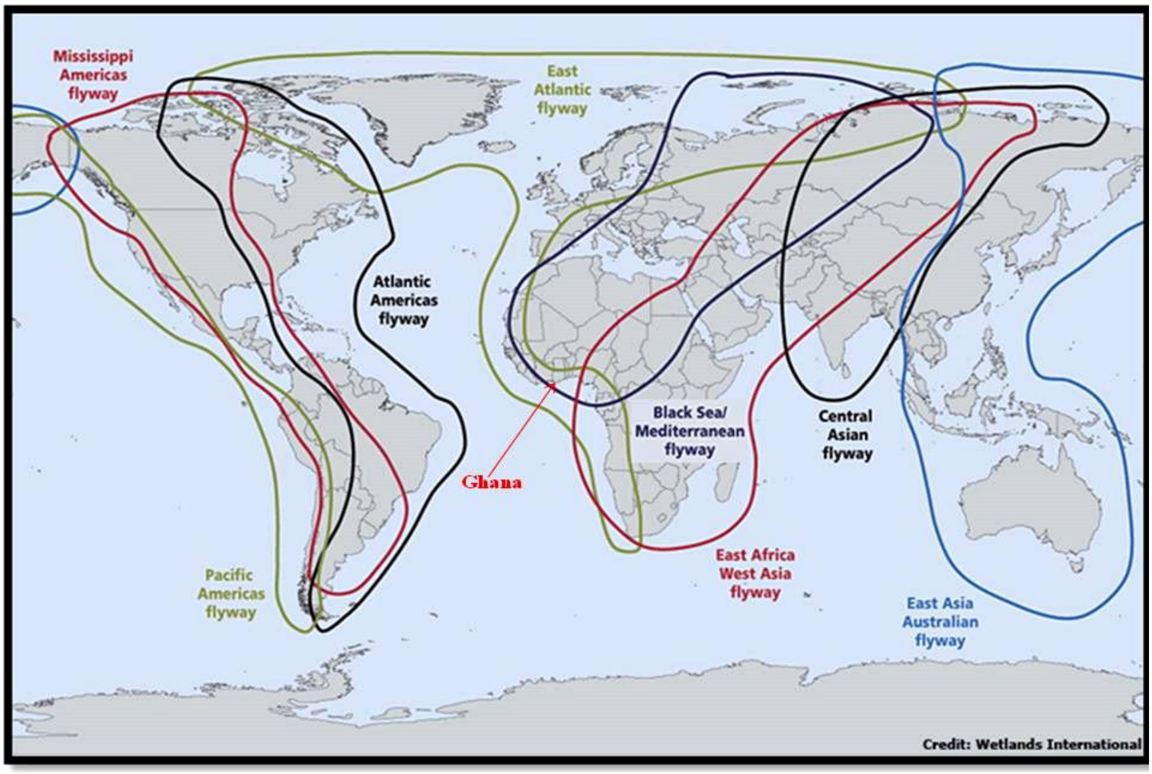

Figure 11: Map of the world showing the position of Ghana on the boundary of two international bird migratory routes (Birdlife International 2010)

Several coastal habitats are important for their biodiversity as well as for rare and endangered species. Sandy beaches, lagoons and floodplains on the coast provide feeding, roosting and nesting sites for a great number of birds, including mainly waterbirds such as waders, terns, herons/egrets etc.

Only five coastal protected areas currently exist within the country. These areas are all located onshore and are protected under the Ramsar convention (Ramsar, Iran, 1971) - the Muni-Pomadze, Densu Delta, Sakumo Lagoon, Songor Lagoon and the Keta Lagoon Complex Ramsar sites. The lagoon areas offer the highest avifaunal diversity. Species counts exceeding 40 have been recorded. They are the most important wetlands on the Ghanaian coast for waterbirds and are ranked fourth most important water bird sites on the Gulf of Guinea coast (Ntiamoa-Baidu *et.*

al. 1998). The Songor Ramsar site is also recognised as a UNESCO biosphere reserve. Like all other coastal Ramsar Sites in Ghana, the Keta and Songor sites were identified and listed as *Wetlands of International Importance* based on their regular support of 1% of the individuals in a population of one species or subspecies of waterbird - Criterion 6 of *Criteria for Identifying Wetlands of International Importance* (Appendix: 1).

The Ghana coast continues to be important for some species of waterbirds of the East Atlantic population using the different coastal wetlands, including the five coastal Ramsar Sites as staging or wintering sites (Appendix 4). Table 7 below shows number of species and individual waterbirds observed on coastal Ramsar Sites in Ghana in January 2017.

Table 7: Number of species and individual waterbirds observed on coastal Ramsar Sites in Ghana, January 2017 count. (*Source*: Wildlife Division, 2017).

Ramsar Site	No. of waterbird species	No. of waterbird individuals
Densu Delta	31	13,233
Muni-Pomadze	25	1,998
Sakumo	25	614
Songor	28	4,098
Keta	37	29,762
Total	**51**	**54,885**

Peak counts of waterbirds in Ghana are observed between September and November. Therefore, the noticeably low numbers of waterbirds observed at these Ramsar sites during the January 2017 waterbirds count does not devalue the importance of these sites (Wildlife Division, 2017).

The avifauna of the estuaries consist of herbivorous feeding ducks that feed in the freshwater marshes, as well as visual and tactile surface foraging waders feeding on both dry and wet mudflats. Stalking herons can also be found in this habitat and these feed in the dry and wet mudflats and within the shallow waters. A list of common waterbird species and their abundance on coastal Ramsar Sites, including the Songor Ramsar Site, as obtained in a single count in January 2017 can be found in Appendix 4.

6.2.4.2 Estuarine and freshwater fish and aquatic fauna

The fish fauna of a number of lagoons and estuaries have been documented. The dominant species in most lagoons belong to the Cichlidae, notably the black-chinned tilapia *Sarotherodon melanotheron* which makes up 80% to 99% of the fish biomass (Pauly, 1975, 1976; Koranteng *et al*., 1998, 2000).The remaining fish fauna are freshwater and marine species. Juveniles of marine fish are notably common in open (tidal) lagoons (Mensah, 1979, Pauly, 1975, 1976; Blay, 1998). Such systems serve as a vital nursery, providing food and sanctuary for juvenile fish. A number of marine fish species rely on functioning estuaries and lagoons for successful recruitment.

The wetlands of Volta Delta area, by aggregate, constitute about 70% of the coverage area of all the coastal wetlands of Ghana with over 50 species of fish, crustaceans and mollusc.

6.2.4.3 Marine Reptiles and Mammals

6.2.4.3.1 Marine Turtles

In general, five species of sea turtles have been identified as commonly nesting in the Gulf of Guinea (Marquez, 1990). About 70% of the 550 km shoreline of Ghana presents suitable sites for nesting turtles. These are the Leatherback Turtle *(Oermochelys coriacea),* Green Turtle *(Chelonia mydas),* Hawksbill Turtle *(Eretmochelys imbricata),* Loggerhead Turtle *(Caretta caretta)* and Olive Ridley Turtle *(Lepidochelys olivacea).* Leatherback and Hawksbill turtles are classified globally as Critically Endangered, green turtles as Endangered and Olive Ridley turtles as Vulnerable in the IUCN Red List of Threatened Species.

All five of the above named species of sea turtle are thought to nest on beaches in Ghana. Sea turtles are afforded protection in Ghana under the Wildlife Conservation Regulations, 1971 (LI 685), which prohibits hunting, capture and destruction of animals.

Beach cliffs impede emerging turtles from accessing suitable nesting sites along the beaches. Cliffs of 1.68 m high resulting from erosion by sea waves along the beach have been recorded at the beaches of the project sites (Agyeman, 2008).

Olive Ridley turtles can normally climb cliffs between 40-50 cm and will move as far as 80-120 m above the higher tidal mark to nest. Leatherback and Green turtles can only climb very gentle slopes and do not move far from high water mark to nest. The Leatherback, Olive Ridely and the Green Turtle are most common on the beaches close the project site (Wokumagbe and Goi), which they use for nesting generally between October and January.

6.2.4.3.2 Manatee

The West African manatee (*Trichechus senegalensis*) occurs in coastal marshlands as well as inland marshlands of Ghana. The mammal attracts much socio-cultural interest in Ghana. Communities living along the Avu lagoon do not use the manatee meat as food, but consider it as high priced meat which is processed for the markets in Accra. Some communities in the North Tongu District regard the West African manatee as deity and therefore perform rituals to pacify the gods when they are un-intentionally caught in fishermen's net.

The West African manatee is globally classified as vulnerable by the International Union for Conservation of Nature and Natural resources (IUCN). In Ghana however, no assessment of the manatee population has been carried out. A large number of manatees have been reportedly killed by local hunters in the Tano, Afram and Avu lagoon. In one dry season, over 40 individual manatees were reported killed along the Avu lagoon. Ofori-Danson and Agbogah (1998) reported one hunter killing over 17 individuals in the Afram River.

Fishermen in the Lower Volta associated wetlands and elsewhere reported fewer manatee sightings in recent times compared to the pre-impoundment period of the Volta River (Ofori-Danson and Agbogah 1998). These reports suggest that the manatee population is under threat of possible extinction from increasing over exploitation.

6.2.4.4 Terrestrial and other fauna

The rare ungulate, the Sitatunga (*Tragelaphus spekei gratus*) was common along the Volta River but their population was reduced close to extinction with the construction of the Akosombo dam in the early 60s, which led to loss of its original habitat. The Sitatunga was thought to have gone extinct in West Africa in the 70s and 80s, but a small population was discovered in an inland fresh water lagoon (Avu lagoon) of the Lower Volta River system (NCRC, 2005).

Habitat destruction, burning and draining of wetlands are the major threats to the long-term survival of the species. Sitatunga is classified as an endangered animal species and wholly protected under Wildlife laws of Ghana.

The Nile crocodile (*Crocodilus niloticus*) and the Long-snouted crocodile (*Crocodilus cataphractus*) as well as the Dwarf crocodile are found in and along the Volta River and the creek channels, quite a distant from the project area in the eastern portion of the Songor Ramsar Site and Biosphere Reserve.

The African Python (*Python sebae*) is found in most communities in Ada area, within marshy areas and sacred grooves along the banks of the Volta Rivers, many islands and creeks.

7. IDENTIFICATION OF KEY ISSUES

7.1 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 scope of assessment was initially based upon baseline knowledge of the project area and subsequently updated to accommodate relevant findings after public and statutory consultation during the scoping phase.

7.2 KEY ISSUES

The potential issues of concern identified during the scoping phase include:

- Impact on birds 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 Ada West area 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). 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.

Similarly 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.

8. ECOSYSTEM HEALTH AND SENSITIVITY

8.1 WETLAND AND COASTAL ECOSYSTEMS

A spatial representation of the freshwater and estuarine habitats is provided in Appendix 3. The specific habitats are discussed below.

8.1.1 Freshwater

8.1.1.1 Floodplain Wetlands and depressions

A number of interconnected and isolated freshwater wetland areas lie within the WPP2 project area. These consist of interconnected floodplain wetlands and isolated depressions. The majority of the wetland footprint was found to consist of temporary wetland, characterised by the dominance of hygrophilous grasses (Figure 12). The soils of the temporary wetland zones were dryer, sandy and light in colour. Seasonal wetland areas were situated adjacent to seasonal channels and in areas were surface water appeared to accumulate. These seasonal wetland areas were dominated by sedges, emergent macrophytes and when surface water is present, floating macrophytes (Figure 13). Soils of the seasonal wetland areas were moist to wet in places and generally darker in colour, varying from grey to black.

Although some of the identified wetland systems were isolated in terms of surface flow, all the wetlands are likely to be linked from a geohydrological perspective. Some of the larger floodplain wetland areas have become fragmented by road infrastructure in particular. Variances in surface water flow as a result of the roadways have resulted in localised changes in wetness and vegetation cover.

From a faunal perspective, these wetland habitats provide numerous aquatic and semi aquatic habitats suitable for amphibians, invertebrates, small mammals and juvenile fish.

Figure 12: An extensive temporary wetland area dominated by hygrophilous grasses.

Figure 13: A seasonal wetland situated in a depression within a more extensive temporary wetland.

Figure 14: The extensive temporary wetland associated with the floodplain of the seasonal watercourse near Wokumagbe.

8.1.1.2 Water bodies (open water)

Open freshwater dominated water bodies were limited in extent within only 1 substantial system identified within 500 m of the project area.

Vegetation is similar to that associated with the seasonal wetland areas, however emergent and aquatic macrophytes are dominant (Figure 15).

These open bodies of freshwater are likely to provide refuge for freshwater fish species that are less tolerant of saline conditions, amphibians and water birds.

Figure 15: A small open water habitat within the project area. Note the presence of floating and emergent macrophytes.

8.1.2 Coastal/Estuarine

No true estuarine habitats exist within the WPP 2 project area. Similar habitats such as salt marsh have developed adjacent to brackish lagoons and where artificial channels convey sea water to man-made salt pans. Natural saline conditions have been brought about by wave overtopping and intrusion through the beach sediments.

8.1.2.1 Salt marsh/salt flat

Salt marsh/salt flats are extensive flat areas characterised by xerophytic conditions and saline soils. These areas are usually found landward of the mangrove areas and indicate the outer limit of the estuarine habitat and saline influence. Within the project area, mangrove habitat was absent and salt marsh appeared where saline intrusion was evident in the slack environment between the coastline and freshwater wetland systems, often associated with small brackish lagoons. Salt marsh areas are inhabited by specialised plant species that are able to handle the xerophytic conditions. Grasses and succulents such as *Sesuvium portulacastrum, Paspalum vaginatum* and *Sporobolus virginicus* are dominant (Figure 16).

Although of low diversity, the salt marsh vegetation is unique and highly adapted to the conditions.

Extensive salt mining has caused degradation of salt marsh habitat (Figure 17) within the project area.

Figure 16: *Sesuvium portulacastrum* within a salt marsh habitat.

Figure 17: An example of a degraded salt marsh habitat, affected by salt mining, within the project area.

8.1.2.2 Lagoon

The main extent of the Songor Lagoon falls week to the north east of the proposed WPP 2 project area. A number of smaller brackish and saline lagoons were situated within the project area. These were situated close to the coastal zone, receiving saline water from wave overtopping and intrusion through the beach sediment. The most prominent lagoon was situated at Wokumagbe.

The lagoons were found to be shallow with their extent fluctuating slightly due to seasonality (freshwater input) and regularity of saline intrusion or overtopping. Vegetation around these lagoons was limited to salt tolerant species and salt marsh species. These saline waterbodies support the naturally occurring salt marsh habitats and provide foraging habitats for wading birds. Neighbouring settlement at Wokumagbe has resulted in degradation through the accumulation of waste within the lagoon and habitat loss (infilling) (Figures 18 and 19).

Figure 18: The lagoon at Wokumagbe situated behind the beach area. Note the accumulation of waste.

Figure 19: A small lagoon that is sustained by wave overtopping near Goi.

8.2 PRESENT ECOLOGICAL STATE

8.2.1 Wetland ecosystems

The wetland systems in Wokumagbe and Goi were assessed separately due to variances in the wetland characteristics and surrounding disturbance.

8.2.1.1 Wokumagbe

The wetland system within the Wokumagbe area (affected by the proposed WPP 2) consisted of an extensive floodplain wetland and isolated depressions, surrounded by slightly elevated more mesic areas. These dryer areas were almost entirely transformed into either areas of settlement or agriculture. The wetland system was crossed by three gravel roads, which have resulted in infilling and segmentation of the wetland system. These roads have caused minor flow modification and topographical changes. Associated with the roads were numerous small channels for the control of stormwater. These channels and the additional runoff they carry has resulted in the formation of zones of increased and varied wetness. No erosion or unnatural deposition was evident and the geomorphology of the system was intact. Limited invasion by exotic or terrestrial plant species was noted and natural hygrophilous vegetation dominated the wetland system.

Despite some disturbance and hydrological changes brought about by the establishment of existing roads, the extensive wetland system near Wokumagbe can be described as having a PES of B or largely natural (Table 8).

Table 8: Scores assigned to the attributes associated with the determination of the PES of the wetland systems within the Wokumagbe area.

Criteria and attributes	Relevance	Score	Confidence
Hydrological			
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	3	3
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	4	3
Water Quality			
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland	3	3
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	4	2
Hydraulic/Geomorphic			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	3	3
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns.	3	3
Biota			
Terrestrial encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	3	2
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	3	3
Invasive Plant Encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	3	2
Alien Fauna	Presence of alien fauna affecting faunal community structure.	4	2
Overutilisation of Biota	Overgrazing, Over-fishing, etc	3	3
Total		36	29
Mean		3.3	2.6
Category		**B**	

8.2.1.2 Goi

By comparison, the Goi portion of the project site is visibly more disturbed with settlement, agriculture and salt mining activities widespread and intense in areas. This has influenced the state of the surrounding wetlands, which consisted of a remaining segment of floodplain linked to the far west portion of the Songor Lagoon and isolated depressions. The disturbances mentioned above have brought about hydrological and geomorphic changes including canalisation, infilling, excavation, draining and back flooding. The main road from Sege forms a significant hydrological barrier, with westwards draining runoff seen attenuated to the east by the road. The introduction of sea water and salt mining activities to the west has resulted in a loss in connectivity between the floodplain wetland, the Songor lagoon and a southwards draining watercourse. The changes in flow dynamics and physical disturbances are likely to have altered the water quality, particularly aspects such as salinity and conductivity. The disturbed nature of the system has facilitated invasion by exotic plant species and resulted in changes to the natural wetland vegetation community.

Overall, the PES can be described as C or moderately modified (Table 9).

Table 9: Scores assigned to the attributes associated with the determination of the PES of the wetland systems within the Goi area.

Criteria and attributes	Relevance	Score	Confidence
Hydrological			
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	2	3
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	4	3
Water Quality			
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland	3	3
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	3	2
Hydraulic/Geomorphic			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	3	3
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduces or changes wetland habitat directly or through changes in inundation patterns.	2	3
Biota			
Terrestrial encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	2	2
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	3	3
Invasive Plant Encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	3	2
Alien Fauna	Presence of alien fauna affecting faunal community structure.	4	2
Overutilisation of Biota	Overgrazing, Over-fishing, etc	3	3
Total		32	29
Mean		2.9	2.6
Category		**C**	

8.2.2 Coastal/Estuarine ecosystems

8.2.2.1 Wokumagbe

Intact salt marsh and lagoon habitat is present between the Wokumagbe – Goi Road and the beach. A sea water intake channel situated to the east of the Wokumagbe site and salt mining activities have isolated this salt marsh system from other similar (but now degraded) salt flats, salt marsh and lagoon habitats further east near Goi. The lagoon receives some freshwater from the seasonal river and natural salinity variations occur within the lagoon. This corresponds with variations in the water level resulting in a dynamic environment, similar to an estuary, however the lagoon does not open to the sea and is therefore not an estuary also displaying estuarine characteristics.

The expansion of the Wokumagbe settlement has resulted in physical disturbance of the lagoon and associate salt marsh as well as a deterioration in water quality as result of dumping and domestic waste. The biota associated with the lagoon and salt marsh area appeared very depauperate.

The changes brought about to the lagoon and salt marsh system has affected its abiotic and biotic integrity. As such, the system can be described as having a PES of C or moderately modified (Table 10).

Table 10: Scores assigned to the attributes associated with the determination of the PES of the estuarine/coastal systems within the Wokumagbe area.

Component	Brief Description of Change (if any)	Score	Confidence
Habitat-related or abiotic components:			
% of natural MAR currently abstracted	Limited abstraction noted from freshwater sources.	4	Low
Changes in seasonal river inflow patterns	No change. River flow is natural	5	High
Changes in mouth condition (i.e. frequency and duration of mouth closure)	Not applicable		
Changes in water quality (referring to system variables, nutrients and toxic substances)	Pollution expected from adjacent settlements. Lagoon appeared to receive dumped waste	3	Low
Changes in natural in-stream habitat (i.e. estuary bed modification, channel modification, infilling, migration barriers, bridges, weirs, bulkheads, training walls, canalisation, jetties, marinas)**	Road crossings were present with some infilling.	3	Medium
Changes in riparian habitat (i.e. flood plain development, bank vegetation, agriculture, grazing, industry, housing, infrastructure, recreational development)	Dense settlement adjacent to the Wokumagbe Lagoon	2	High
Biotic components:			
Plants, including microalgae and macrophytes (i.e. change in botanical importance score)	terrestrial disturbance has caused some change in vegetation. Enrichment is likley to have altered microalgal community	3	Low
Benthic invertebrates	Dumping and enrichment of lagoon and adjacent area is likeyt to have had a significant affect on benthic invertebrates	2	Low
Fish (i.e. change in estuarine health index score for fish)	Naturally depauperate	2	Medium
Birds	Settlement is likely to be significant deterent to bird usage.	2	Medium
MEAN ECOLOGICAL INTEGRITY SCORE (averaging the 9 scores above. If no information is available for one of the 9 components, then it is not a divisor		2.6	
Category		C	

8.2.2.2 Goi

Only highly degraded salt marsh was identified within the Goi site area. The area has been seriously modified by salt mining activities, resulting in the formation of a near barren salt flat. Few indicators of natural ecosystem functioning remain. As a result, the best possible description is largely modified or a PES of D (Table 11).

Table 11. Scores assigned to the attributes associated with the determination of the PES of the estuarine/coastal systems within the Goi area.

Component	Brief Description of Change (if any)	Score	Confidence
Habitat-related or abiotic components:			
% of natural MAR currently abstracted	Not applicable - no watercourse present		Low
Changes in seasonal river inflow patterns	Not applicable - no watercourse present		High
Changes in mouth condition (i.e. frequency and duration of mouth closure)	Not applicable		
Changes in water quality (referring to system variables, nutrients and toxic substances)	Minor pollution expected from adjacent settlements	3	Low
Changes in natural in-stream habitat (i.e. estuary bed modification, channel modification, infilling, migration barriers, bridges, weirs, bulkheads, training walls, canalisation, jetties, marinas)**	Highly altered salt marsh habitat due to salt mining and ponds	1	Medium
Changes in riparian habitat (i.e. flood plain development, bank vegetation, agriculture, grazing, industry, housing, infrastructure, recreational development)	Highly altered salt marsh habitat due to salt mining and ponds	1	High
Biotic components:			
Plants, including microalgae and macrophytes (i.e. change in botanical importance score)	Poor due to the disturbance associated with salt mining	2	Low
Benthic invertebrates	Poor due to the disturbance associated with salt mining	1	Low
Fish (i.e. change in estuarine health index score for fish)	Not applicable - salt marsh only		Medium
Birds	Poor due to the disturbance associated with salt mining	2	Medium
MEAN ECOLOGICAL INTEGRITY SCORE (averaging the 9 scores above. If no information is available for one of the 9 components, then it is not a divisor		1.4	
Category		D	

8.3 WETLAND FUNCTIONALITY

A total of 5 HGM units were identified for further consideration. These are shown in Figure 20 and were determined based on their nature (floodplain or depression) and connectivity (connected to a watercourse or isolated).

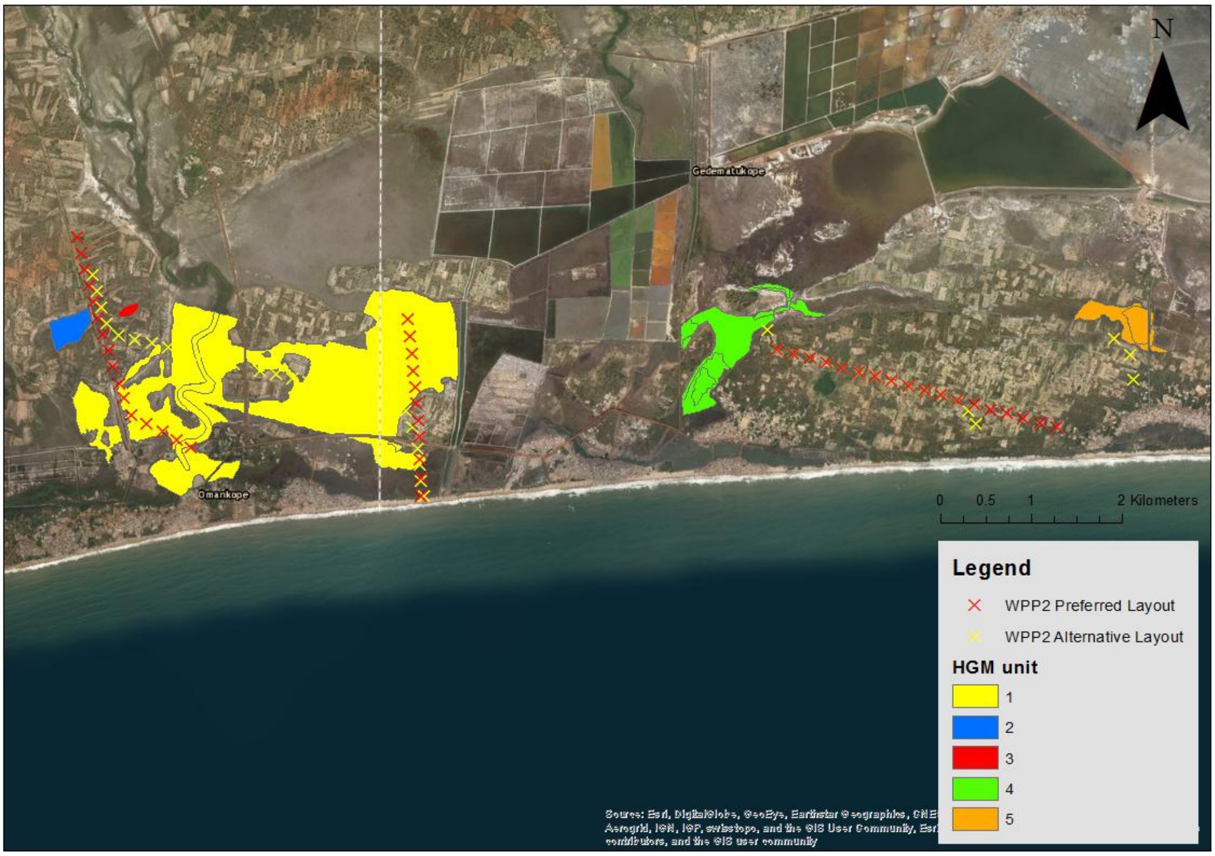

Figure 20: The wetlands within the WPP 2 project area displayed as HGM units.

Table 12 provides a summary of the ecoservice scores for the 5 HGM units. HGM unit 1, which is the largest of the HGM units, appears to be an important system from both a biophysical and social perspective. The large size and good vegetation cover makes it an ideal dry season grazing area and the fertile soils along its periphery are ideal for agriculture. The link with the seasonal watercourse and connectivity provide effective flood water dissipation and provides for the effective filtration (nitrate removal, phosphate removal, toxicant removal) of floodwaters. HGM unit 4 provided similar ecoservices, albeit at a slightly lower level due to its smaller size and lack of connectivity. HGM units 2 and 3 provide similar ecoservices scores. These two HGM units are situated close together and similar in nature, with the exception of size. HGM unit 5 only provided one ecoservice at a "high level" and potentially the least functional of the HGM units. The existence of a major access road and the loss of the eastern portion to salt mining have altered the hydrodynamics of the system affecting associated ecoservices.

Table 12: Ecoservices scores for the 15 ecoservices associated with the identified HGM units.

HGM unit	1	2	3	4	5
Type	FP	D	D	FP	D
Size (Ha)	403	12	2	58	22
Flood Attenuation	2.9	2.9	2.9	2.7	2.7
Stream Flow Regulation	1.6	1.0	0.0	1.6	0.8
Sediment Trapping	2.8	2.8	2.8	2.3	2.4
Phosphate Removal	2.8	2.9	2.9	2.3	2.5
Nitrate Removal	2.7	2.4	2.4	2.2	2.1
Toxicant Removal	2.3	2.3	2.3	1.8	1.9
Erosion Control	2.6	2.5	2.5	2.3	2.3
Carbon Storage	2.0	1.0	0.7	2.0	1.7
Maintenance of Biodiversity	2.4	2.3	2.0	2.1	2.3
Supply for Human Consumption	2.0	1.0	1.0	2.0	1.3
Provision of Harvestable Natural Resources	3.6	2.6	2.6	3.6	2.6
Provision of Cultivated Foods	3.8	3.2	3.2	3.8	3.2
Cultural Significance	2.0	1.3	1.3	2.0	1.3
Characteristics Contributing to Tourism Value	1.4	0.8	0.8	1.3	0.8
Education and Research	1.8	0.8	0.5	1.5	0.8

8.4 ECOLOGICAL IMPORTANCE AND SENSITIVITY

8.4.1 Wetland ecosystems

8.4.1.1 Wokumagbe

The ecological importance and sensitivity rating for the Wokumagbe wetland system was given as high (Table 13). Although not endowed with a diverse range of biota or habitats, large areas of intact habitat remain and as does a near natural hydrological state. This makes the system sensitive to hydrological change, as this is most likely to change the nature of the system, habitats and biota. The system is considered to have a level of protection as the lower portion of the system falls within the transitional zone of the Ramsar site.

Table 13: Scores and criteria for determining the EIS of the wetland system in the Wokumagbe area.

Determinant	Score	Confidence
PRIMARY DETERMINANTS		
Rare & Endangered Species	2	3
Populations of Unique Species	2	4
Species/taxon Richness	2	4
Diversity of Habitat Types or Features	2	4
Migration route/breeding and feeding site for wetland species	3	2
Sensitivity to Changes in the Natural Hydrological Regime	4	2
Sensitivity to Water Quality Changes	2	3
Flood Storage, Energy Dissipation & Particulate/Element Removal	3	3
MODIFYING DETERMINANTS		
Protected Status	3	4
Ecological Integrity	3	3
TOTAL	26	32
MEDIAN	2.6	3.2
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**High ("B")**	

8.4.1.2 Goi

The wetland system in the vicinity of Goi exhibits high levels of disturbance and limited habitat diversity and biodiversity. All wetland units have been altered from a hydrological perspective reducing their sensitivity to hydrological change. The units do fall within the transitional and buffer zones of the Ramsar site afforded a high level of protection to the wetland units. The poor ecological integrity of the system is however a significant factor. The ecological importance and sensitivity of the Goi wetland system is considered to be moderate (Table 14).

Table 14: Scores and criteria for determining the EIS of the wetland system in the Goi area.

Determinant	Score	Confidence
PRIMARY DETERMINANTS		
Rare & Endangered Species	1	3
Populations of Unique Species	1	4
Species/taxon Richness	2	4
Diversity of Habitat Types or Features	2	4
Migration route/breeding and feeding site for wetland species	2	2
Sensitivity to Changes in the Natural Hydrological Regime	1	2
Sensitivity to Water Quality Changes	1	3
Flood Storage, Energy Dissipation & Particulate/Element Removal	2	3
MODIFYING DETERMINANTS		
Protected Status	4	4
Ecological Integrity	1	3
TOTAL	17	32
MEDIAN	1.7	3.2
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**Moderate ("C")**	

8.4.2 Coastal/Estuarine ecosystems

8.4.2.1 Wokumagbe and Goi

The lagoon and salt marsh habitats present landward of the sandy beach environment, although estuarine like, are not true estuarine systems and are inherently of less importance as they lack certain fundamental functions (nursery and recruitment) and lack the habitat diversity characteristic of other true estuarine habitats in the Songor Ramsar site and Bioshpere Reserve (Table 15 and 16). Disturbance due to human settlement, agriculture and salt mining is high as it the level to which large areas have become degraded. The ecological importance and sensitivity of these areas at both Wokumagbe and Goi is considered to be low ("D").

Table 15: The EIS of the estuarine/coastal systems within the Wokumagbe area.

Component	Brief Motivation	Score	Confidence
Rare/endangered/limited populations	Use of the system by rare fauna e.g. Manatee	0	High
Habitat diversity (richness)	The number of habitat types in an estuary should be tallied using the following list: 1. open surface water area 2. sand flats 3. mudflats 4. submerged macrophyte beds 5. intertidal salt marsh 6. supratidal salt marsh 7. reeds and sedges 8. mangroves 9. lagoon swamp forest 10. rocks 11. deep channels	2	High
Rarity of an estuary or unique estuarine features	Presence of unique features and rarity of the system type on a national scale	1	High
Input to sea	Estuaries are rated according to size and their potential input of sediments and nutrients to the coastal zone.	0	Medium
MEAN ECOLOGICAL IMPORTANCE SCORE (averaging the 4 scores above)		0.75	
Category		D	

Table 16: The EIS of the estuarine/coastal systems within the Goi area

Component	Brief Motivation	Score	Confidence
Rare/endangered/limited populations	Use of the system by rare fauna e.g. Manatee	0	High
Habitat diversity (richness)	The number of habitat types in an estuary should be tallied using the following list: 1. open surface water area 2. sand flats 3. mudflats 4. submerged macrophyte beds 5. intertidal salt marsh 6. supratidal salt marsh 7. reeds and sedges 8. mangroves 9. lagoon swamp forest 10. rocks 11. deep channels	1	High
Rarity of an estuary or unique estuarine features	Presence of unique features and rarity of the system type on a national scale	1	High
Input to sea	Estuaries are rated according to size and their potential input of sediments and nutrients to the coastal zone.	0	Medium
MEAN ECOLOGICAL IMPORTANCE SCORE (averaging the 4 scores above)		0.5	
Category		D	

8.5 SUMMARY OF PES, EIS AND WETLAND ASSESSMENT

Wetland habitats, specifically floodplain and depression type wetlands consisting of seasonal and temporary wetland zones were identified within both the Wokumagbe and Goi project sites. The wetland system present at Wokumagbe was 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.

9. ASSESSMENT OF IMPACTS/RISKS AND IDENTIFICATION OF MANAGEMENT ACTIONS

9.1 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.

Due to the location of the construction activities away from the main lagoon and perceived prime habitats for water and migrating birds, the construction activities are unlikely to directly influence bird migration or water birds, the two most significant bird groups that utilise the Songor Ramsar Site and Biosphere Reserve. The construction phase is therefore not anticipated to present any physical barriers to the birds preventing their movement.

Based on the above, the impact of the construction phase of the proposed wind facility on wetland bird migration is anticipated to be of low significance without mitigation for layouts.

Management actions

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.

With the effective implementation of the above recommended management actions, the significance of the impacts of the proposed wind facility on birds/bats migration is anticipated to be very low for the preferred and the alternative layout during the construction phase.

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. 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. The significance of the potential impact that the project may have on the bird population (for both alternatives) is thus considered to be medium although the level of confidence of this prediction is low. Further and more detailed consideration has been provided in the specialist avian assessment.

Management actions

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.

9.2 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.

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.

Management actions

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 above 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.

Management actions

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, 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.

9.3 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.

Management actions

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.

Management actions

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 21, 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.

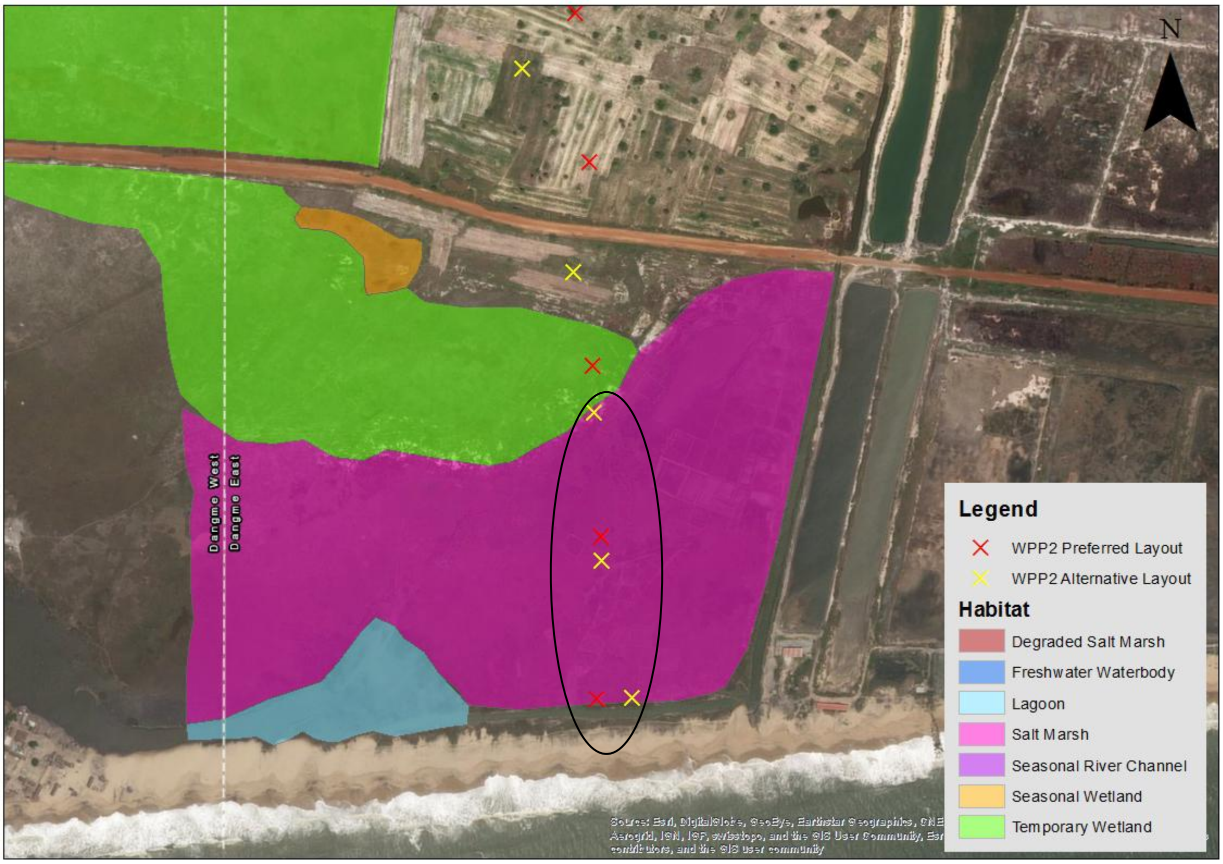

Figure 21: Location of the turbines within the salt marsh habitat near Wokumagbe

9.4 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.

Management actions

None required.

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.

Management actions

None required.

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.

9.5 FRESHWATER WETLAND IMPACTS

Construction

Freshwater wetland 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 and other semi aquatic fauna 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 during periods of inundation.

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 (Figure 22). 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.

Management actions

The impacts associated with the alternative layout option can be avoided by implementing the preferred layout option. If the alternative layout is favored, 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 alternative layout is assessed to be of medium significance with the implementation of the above and low for the preferred layout.

Operation

No significant impacts on freshwater wetland 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).

Management actions

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.

If implemented correctly, such measures are highly likely to reduce the residual impact significance. This may occur through the reduction of the probability of the impact occurring and the reduction of the resultant impact's magnitude. 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 22). The footprint of disturbance is likely to be smaller for the preferred layout, offering less disturbance and less opportunity for hydrological and ecosystem changes.

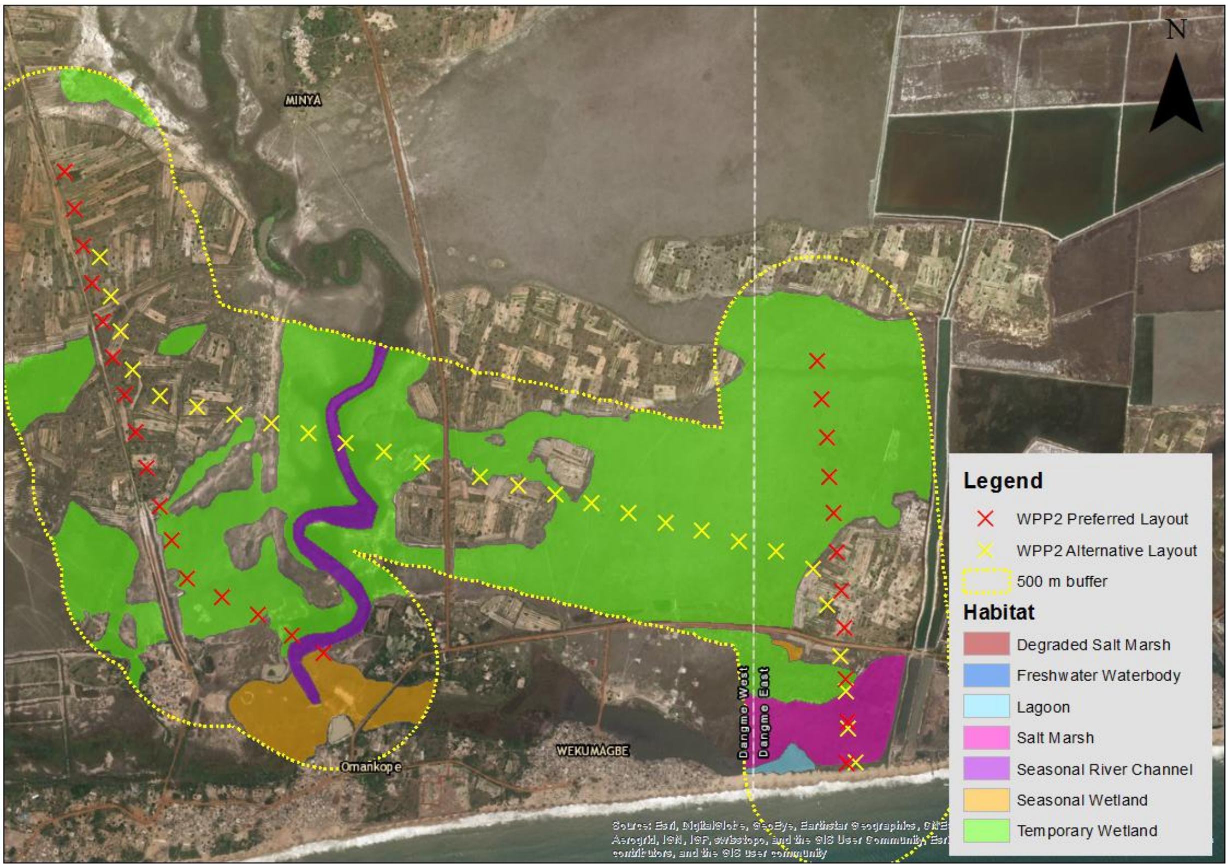

Figure 22: The positioning of the turbines within the wetland system near Wokumagbe.

9.6 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.

9.7 DECOMMISSIONING IMPACTS AND MANAGEMENT/MITIGATION ACTIONS

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.

Essential management measures include the following:

- 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 before mitigation and very low after implementation of mitigation measures.

9.8 CUMULATIVE IMPACTS

9.8.1 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.

Management actions

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.

9.9 IMPACT SUMMARY

A summary of identified impacts, impact significance and mitigation and management measures is provided below in Tables 17 to 20.

Table 17: 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?**	**Mitigation Measures**	**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	Check for nests and important habitat prior to commencement of construction	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	Check for nests and important habitat prior to commencement of construction	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	Capture and relocate fauna	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	Capture and relocate fauna	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	Minimal clearance of vegetation. Limited land reclamation. Site management. Services to be coupled with access road. Chemicals must be stored correctly. No stockpiling within salt marsh. Stockpiles must be protected from erosion.	Medium	Low	Medium
Coastal	Disturbance of coastal dynamics	Both	Negative	Site specific	Permanent	Medium	Improbable	Moderate reversibility	Replaceable	No	Yes	None required	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	Construction phase management only – • Disposal of hydrocarbon lubricants • Minimal clearance of vegetation • Minimal road infrastructure • Services linked with roads • Safe chemical storage • No stockpiling in wetlands • Stockpiles away from rivers/channels	Medium	Low	Medium

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?**	**Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
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	The preferred layout option is recommended for impact avoidance. If the alternative layout plan is implemented construction phase management is required – • Disposal of hydrocarbon lubricants • Minimal clearance of vegetation • Minimal road infrastructure • Services linked with roads • Safe chemical storage • No stockpiling in wetlands • Stockpiles away from rivers/channels	High	Medium	Medium

Table 18: 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 salt marsh 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 19: 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?**	**Mitigation Measures**	**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	Rehabilitate areas disturbed during decommissioning	Low	Very Low	Medium

Table 20: 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?**	**Mitigation Measures**	**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	Co-ordination and integrated planning required.	Medium	Low	Low

10. CONCLUSION AND RECOMMENDATIONS

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 eastern 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)

The Volta River, the most significant watercourse in the region, has been subjected to extreme changes in hydrology as a result of two hydro-power dams established during the 1960’s and 1980’s. The hydrological changes have affected the Songor Lagoon and associated ecosystems with significant coastal erosion having been recorded since the completion of the second dam. The PES, EIS and wetland functionality results are summarised in Table 21.

Table 21: Summary of the PES. EIS and functionality assessment.

Ecosystem	PES	EIS	Functionality (ecoservices)
Freshwater wetlands (Wokumagbe)	B (Largely Natural)	High	Moderately High
Freshwater wetlands (Goi)	C (Moderately Modified)	Moderate	Intermediate
Lagoons and salt marsh (Wokumagbe)	C (Moderately Modified)	Low	NA
Lagoons and salt marsh (Goi)	D (Largely Modified)	Low	NA

Based on the available data, a number of potential wetland and aquatic impacts were identified, mainly associated with the potential for habitat loss due to the land reclamation for the establishment of the turbine clusters and the operation of the turbines. Impacts included:

1) Interference with bird migration and behaviour through bird strikes and residual disturbances such as flight path diversion.

2) Displacement of other fauna during construction. Fauna may become trapped or their activity affected by the infrastructure.

3) Physical impacts such as habitat loss within the coastal environments and the potential to change dynamics at a site specific level

4) Physical disturbance and loss of wetland habitat through infilling and site specific hydrological alterations.

Although not an impact of the proposed turbines, the risk of flooding and the influence that this may have on the construction and operation of turbines was highlighted as a potential issue based on the nature of the surrounding area.

Long term cumulative impacts identified included the influence of other development and associated infrastructure that may arise as a result of the extensive Upwind Wind Power Project and WPP2.

During the exercise, the potential impact of the proposed WPP 2 turbines on resident and migrating birds will require further evaluation and operational phase monitoring. The position of the turbine clusters within seasonal and temporary wetland areas suggests that seasonal flooding may be an issues and further evaluation is required in the form of a flood risk assessment.

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 and must 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)

The following additional actions recommended by not essential, but if implemented will further reduce impact significance:

- *Construction Phase*
  - Management of construction noise
- *Operational Phase*
  - Habitat enhancement or creation as an offset for habitat loss
  - If the turbine sites are fenced, “critter paths” should be provided to allow smaller terrestrial fauna to move freely.

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CURRICULUM VITAE OF CHARLES CHRISTIAN AMANKWAH

1. PERSONAL RECORD

Full Name: CHARLES CHRISTIAN **AMANKWAH**
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2. EDUCATION

- University of Leicester, UK (1991–1993) M.Sc. Natural Resources Management
- KNUST, Kumasi Ghana (1984–1988) B.Sc. (Hons.) Biological Sciences
- Konongo-Odumase Secondary School, Ghana (1973-1981), GCE 'O' & 'A' levels

3. EMPLOYMENT RECORD

- Wildlife Division (Forestry Commission), (1995 – to date):
- GES: Science Teacher: Accra Girls' Sec. School (1990/1991),
- GES: Science Teacher Konongo-Odumase Sec. Sch. (1994/1995)
- National Service Secretariat, Ghana: Service Person: Team Leader – Community Improvement Unit (Fisheries) (1988-1990)

4. TRAINING & EXPERIENCE

- Pursued degree in Biological Sciences and Masters in Natural Resource Management.
- Built requisite knowledge through regular short courses in Ghana and abroad.
- Exposed to biodiversity related (Protected Area and Wetlands) management systems through job training, national and international training and workshops.
- Strong background training in natural resources management with extensive field work in ecological and social data collection, collation, inventory, analyses and information cataloging.
- Extensive skills in reporting and presentations at local and international meetings;

5. CURRENT POSITIONS

- **General Services Manager/Wetlands Coordinator:** Wildlife Division
- **National Focal Point**: Ramsar Convention on Wetlands
- **Focal Point**: Biodiversity Component of the GEF/Word Bank funded *Sustainable Land and Water Management Project* (SLWMP) hosted by Ministry of Environment, Science, Technology and Innovation (MESTI) (2011-2016);

- **Reviewer**: Natural Resources Sector Technical Review Committee, EPA Environmental Impact Assessments of development projects for recommendation on compatible land-use practices within wetland conservation areas and other Protected Areas;

6. COMPLIMENTARY JOB TRAINING

- Study Tour to Brazil and Mexico on ***Payment for Environmental Services***, August 18 - September 1, 2012.
- Global Environment Facility (GEF)/World Bank, Environment Alert: ***Training Workshop in Writing Skills***, Nov 1997, Accra, Ghana.
- Royal Society for the Protection of Birds (rspb): ***Practical Attachment Training to some Nature Reserves of the (RSPB), UK***, July 1996, UK.
- Ramsar Bureau/IUCN, ***Wetlands Inventory Training Course***, Dec. 2000, Kampala, Uganda
- Forestry Commission (FC), ***Training Programme in Team Building and Motivation***, April 2004, Ghana Institute of Management & Public Administration (GIMPA), Accra,
- Japan International Co-operation Agency (JICA), ***Short Course in Wetland Conservation***: Sept. – Nov. 1998, Japan.
- Protected Area Management & Wildlife Conservation Project (PAMWCP), Wildlife Division, ***Study Tour on Community Conservation Initiatives in Nature Conservation,*** April – May 1997, Kenya & Tanzania.
- Department for International Development (DfID), ***Short Course in Aquatic Resources, Environment and Project Management,*** May – June 1997, University of Hull, UK
- Remote Sensing Applications Unit, Dept. of Geography and Resource Development, ***Course in Spatial Information Management Technologies, Remote Sensing and GIS in Natural Resources Planning & Management***, December, 1999, Univ. of Ghana, Legon,
- ***Cross-Learning Dialogue on Climate Change Adaptation***, Centre for African Wetlands, University of Ghana, September 2010.

7. LIST OF WORK

- K.A.A. deGraft-Johnson, J. Blay, F.K.E. Nunoo, **C.C. Amankwah,** 2010. "Biodiversity Threats Assessment of the Western Region of Ghana". The *Integrated Coastal and Fisheries Governance (ICFG)* Initiative, Ghana.
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CURRICULUM VITAE OF ALEXANDER MICHAEL WHITEHEAD

Name:	Alexander Michael Whitehead
Profession:	Environmental Consultant/Ecologist
Date of Birth:	30/08/1983
Current Employment:	Sustainable Development Projects cc (SDP Ecological and Environmental Services)
Position:	Ecologist/Environmental Consultant
Years with Firm:	11
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Tertiary Qualifications:

Institution [Date from - Date to]	Degree(s) or Diploma(s) obtained:
Rhodes University [2002-2004]	BSc Ichthyology and Entomology (with distinction in Ichthyology)
Rhodes University [2005]	BSc (Hons.) Ichthyology and Fisheries Science (with distinction)

Professional Affiliations:
South African Council for Natural Scientific Professions – Reg. No. 400176/10 (Ecological Science)

Fields of interest:
- Ichthyology
- Entomology
- Aquaculture
- Aquatic Ecology

Key Skills and experience:
- Computer skills – (MS Word, STATISTICA, Excel, MS Access, PRIMER 5 (multivariate statistical program), CAP 4 (multivariate statistical program));
- Staff supervision
- Project management – management of Environmental Authorization processes and internal project management
- Bioassessment - Experience in sampling aquatic invertebrates (SASS 5) and ichthyofauna (Electrofishing and estuarine sampling techniques);

- Water quality - Experience in carrying out water samples and interpreting results in both freshwater and estuarine environments;
- Wetland and riparian habitat delineation – Delineation of wetland and riparian areas using accepted methods (DWAF 2005);
- Wetland functionality assessments – Assessment of wetland functionality using ecological indicators and standard methods such as Wet-Ecoservices and Wet-Health.
- Aquatic assessments – Assessment of freshwater ecosystems using bioassessment/sampling protocols, water quality data and ecological indicators.
- Terrestrial ecological assessments – General biodiversity assessments and identification of sensitive habitats.
- Environmental Impact Assessment (EIA) and Basic Assessment (BA) Processes – Undertaking and management of all aspects of the environmental approval processes. Project experience includes housing developments, aquaculture projects, industrial developments, coastal development, infrastructure, agri-industry and renewable energy (solar)
- Environmental management – Compilation of practical EMPr documents and environmental management processes.
- Rehabilitation – Compilation of wetland and terrestrial rehabilitation plans as well as practical experience in planning and conducting weed eradication and re-vegetation programs.
- Environmental monitoring and auditing – Environmental Control Officer (ECO) duties in both the construction and operational project phases. Experience includes ECO duties for the construction of housing developments, coastal infrastructure including piers and sand pumping schemes, industrial development and industrial operations and renewable energy projects.
- Open space and conservation planning – Identification of areas of open space or conservation importance.
- GIS competence (QGIS) and database usage (SANBI BGIS)
- ARC MAP 10.1 competent.
- Botanical/protected species permits and Risk Assessments – Permit applications under the National Forest Act (84 of 1998), Natal Nature Conservation Ordinance (15 of 1973) and National Environmental Management: Biodiversity Act (10 of 2004).
- Environmental Legislation – A good understanding of various statutes associated with environmental processes.
- Water Use License Applications – Managing the WULA process for Section 21 activities under the National Water Act (36 of 1998).
- ISO 14001 Environmental Management Systems
- National (Kwazulu-Natal, Western Cape, Eastern Cape, Northern Cape, Limpopo Province, Free State, Gauteng) and international (Ghana) experience.

Employment History:

- ***December 2003- January 2004***

Sustainable Development Projects cc.
Student work. Assisting with field research and preliminary report compilation. General administrative duties.

- ***January 2006 – Current***

Sustainable Development Projects cc.
Environmental consultant and specialist ecologist. Core duties included the following:

- ➢ EIA/BA reports/BID document compilation, client liaison, basic management of the environmental authorisation process.
- ➢ Environmental control officer duties, compliance monitoring.
- ➢ Water Use License Applications.
- ➢ Compilation of specialist ecological reports including bio-assessment, wetland functionality assessments, wetland delineations, general terrestrial and aquatic ecological assessments.
- ➢ GIS

Additional tasks include provide enviro-legal opinions on proposed developments and offer general advise for environmental matters (e.g. stocking of fish into dams, suitable plant species). General business administration and management.

Key Clients:

- ESKOM
- Umgeni Water
- Kwadukuza Municipality
- eThekwini Municipality
- Motheo Construction Group
- Scatec Solar
- CSIR

Other Experience and training:

1. Co-author on a paper presented at ASA conference in Grahamstown during 2005 “Testing clove oil as an anaesthetic for long distance transport of live fish: the case of the lake Victorian cichlid *Haplochromis obliquidens*”. Journal of Applied Ichthyology 22 (2006) 510-514
2. Main author “Reproductive and feeding biology of the endangered fiery redfin, *Pseudobarbus phlegethon* (Barnard 1938) (Teleostei: Cyprinidae), in the Noordhoeks River, South Africa.” Published in the African Journal of Aquatic Science Volume 32 No. 3 (2007) 99-111
3. Completed a LLM Natural Resources Law Course (Mr. E. Couzens University of Kwazulu-Natal) during 2007. NDP.
4. Attended the following workshops/short courses:
    - “Development of the new South African sludge guidelines series: Training Sessions on Volume 1, 2 and 3” hosted by the Department of Water Affairs and

Forestry and the Water Research Commission and presented by Dr. Heidi Snyman and Elize Herselman (18 July 2007).

- "Grass identification: Introduction to Grasses, How to Identify Grasses and Practical Grass Identification" presented by Fritz van Oudtshoorn (3 March 2009)
- "Habitat creation as offset for coastal development" presented by Prof. Mike Elliot and Mr. Nick Cutts (16 and 17 July 2009).

5. Co-author "Agricultural impact on the pelagic ecosystem of the Small temporarily open/closed
   Seteni Estuary, South Africa". Marine and Estuarine Research 2013, 64, 1-13.
6. QGIS training course - Dominic Wieners EKZN Wildlife. Basic GIS training including practical utilization of GIS software and familiarity with EKZN Wildlife GIS data.
7. Sembcorp Siza Water ISO 14001, 18001 and 9001 service provider training (September 2014).
8. ESRI ArcGIS Basic Training Course, 27 – 31 October 2014 – SAQA NQF level 6 competency received for "Demonstrate an understanding of the context of GI Science"
9. National Training and Development Buffer Zone Workshop, 29 & 30 October 2015, La Mercy Beach Hotel, Tongaat. Hosted by the Institute of Natural Resources NPC and Eco-Pulse Consulting.

Referees

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3) Francis Smith
Company: Geosure (Pty) Ltd
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SPECIALIST DECLARATIONS

I, **CHARLES CHRISTIAN AMANKWAH**, as the appointed independent specialist, hereby declare that:

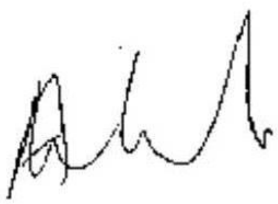
- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence

Charles Christian Amankwah

15 May 2017

I, **ALEXANDER MICHAEL WHITEHEAD**, as the appointed independent specialist, hereby declare that:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence



Alexander Michael Whitehead

15 May 2017

12. APPENDICES

Appendix 1:

Criteria for Identifying Wetlands of International Importance

Adopted by the 7th (1999) and 9th (2005) Meetings of the Conference of the Contracting Parties, superseding earlier Criteria adopted by the 4th and 6th Meetings of the COP (1990 and 1996), to guide implementation of Article 2.1 on designation of Ramsar Sites.

Group A of the Criteria **Sites containing representative, rare or unique wetland types**		**Criterion 1**: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Group B of the Criteria **Sites of international importance for conserving biodiversity**	Criteria based on species and ecological communities	**Criterion 2**: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
		Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
		Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
	Specific criteria based on waterbirds	**Criterion 5**: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
		Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
	Specific criteria based on fish	**Criterion 7**: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.
		Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
	Specific criteria based on other taxa	**Criterion 9**: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Appendix 2:

List of macrophyte species from Songor lagoon and associated wetlands.

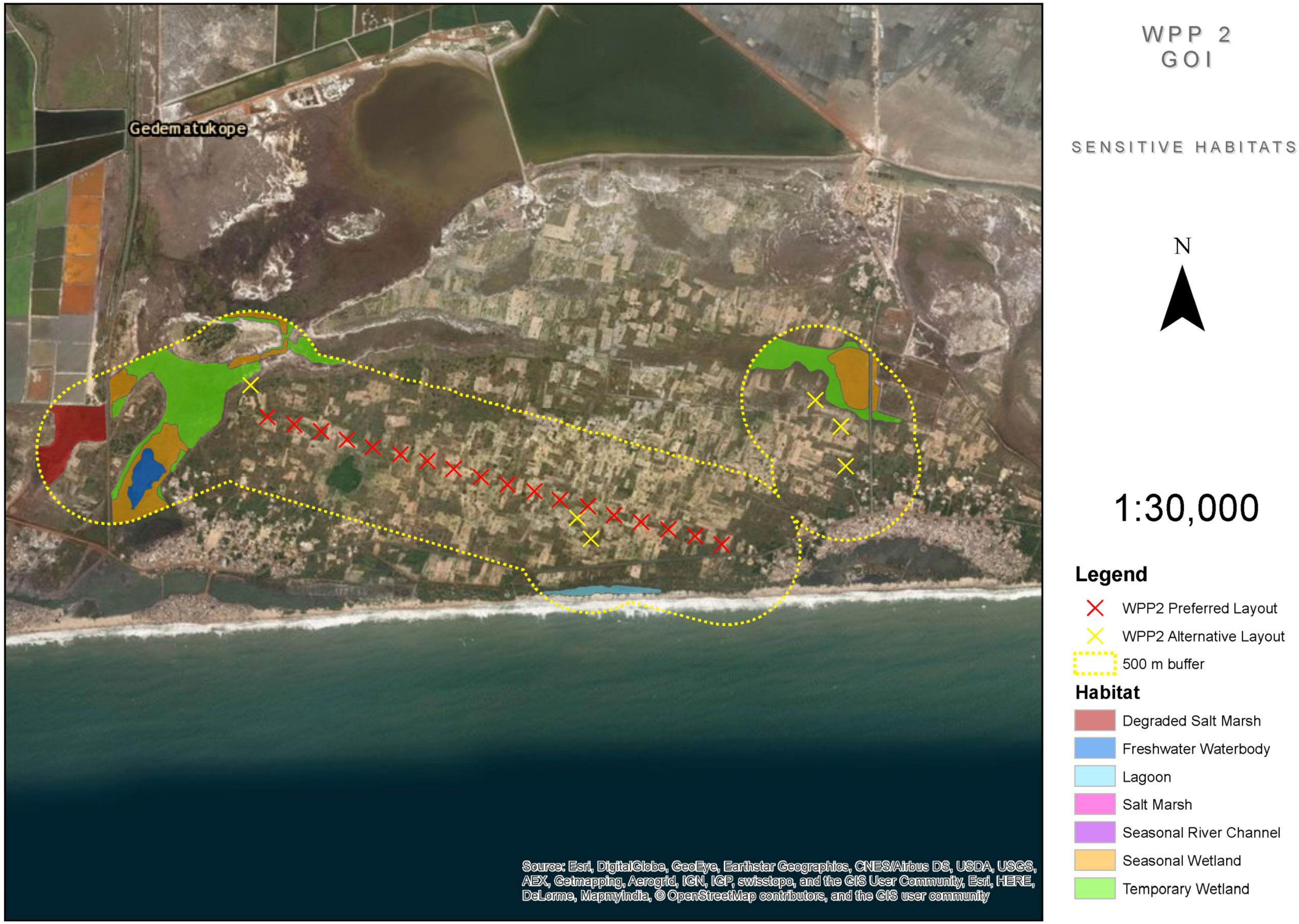
(*Adopted from*: Finlayson, *et. al.*, 2000).

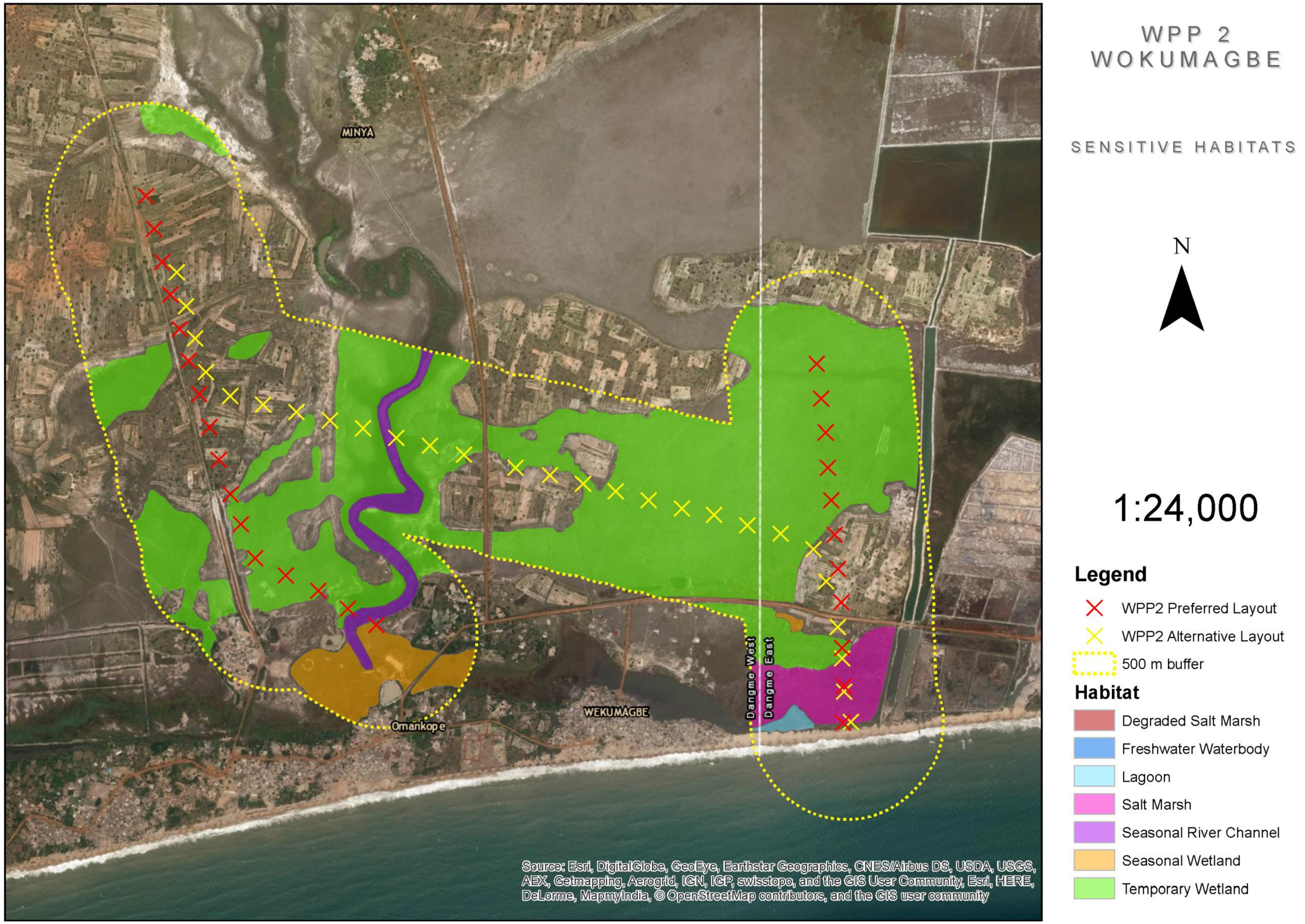
Species	Songor lagoon
Andropogon contortus	X
Andropogon gayanus	X
Avicennia nitida	X
Azolla africana	X
Bacopa crenata	X
Brachiaria mutica	X
Canavalia rosea	X
Chara sp.	X
Chloris gayana	X
Cocos nucifera	X
Conocarpus erectus	X
Crotalaria retusa	X
Cyperus articulatus	X
Cyperus denudatus	X
Cyperus distans	X
Echinochloa pyramidalis	X
Eclipta prostrata	X
Elaeis guineensis	X
Eleocharis mutata	X
Fimbristylis dichotoma	X
Fimbristylis obtusifolia	X
Fuirena umbellata	X
Hibiscus micrantha	X
Hygrophilla auriculata	X
Imperata cylindrica	X
Lactuca taraxacifolia	X
Lemna paucicostata	X
Ludwidgia stolonifera	X

Species	Songor lagoon
Ludwigia erecta	X
Mimosa pigra	X
Neptunia oleracea	X
Nymphaea lotus	X
Nymphaea micrantha	X
Opuntia sp.	X
Parkinsonia aculeata	X
Paspalum orbiculare	X
Paspalum vaginatum	X
Pentadon pentandrus	X
Philoxerus vermicularis	X
Pistia stratiotes	X
Remirea maritima	X
Ruppia maritima	X
Scaveola plumieri	X
Schizachyrium sanguinium	X
Scirpus cubensis	X
Scirpus littoralis	X
Sesbania sesbans	X
Sesuvium portulacastrum	X
Sphenoclea zeylanica	X
Sporobolus maritima	X
Sporobolus pyramidalis	X
Sporobolus virginicus	X
Typha domingensis	X
Utricularia inflexa	X
Vernonia cinerea	X
Vetiveria fulvibarbis	X
Wolfia arrhiza	X

Appendix 3:

Wetland and aquatic habitat mapping


Gedematukope
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
WPP 2
GOI
SENSITIVE HABITATS
N
1:30,000
Legend
WPP2 Preferred Layout
WPP2 Alternative Layout
500 m buffer
Habitat
Degraded Salt Marsh
Freshwater Waterbody
Lagoon
Salt Marsh
Seasonal River Channel
Seasonal Wetland
Temporary Wetland


WPP 2
WOKUMAGBE
SENSITIVE HABITATS
N
1:24,000
Legend
WPP2 Preferred Layout
WPP2 Alternative Layout
500 m buffer
Habitat
Degraded Salt Marsh
Freshwater Waterbody
Lagoon
Salt Marsh
Seasonal River Channel
Seasonal Wetland
Temporary Wetland
MINYA
Omankope
WEKUMAGBE
Dangme West
Dangme East
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Appendix 4:

List of common waterbird species and their abundance on coastal Ramsar Sites, including the Songor Ramsar Site, as obtained in a single count in January 2017.

(*Source*: Wildlife Division, 2017)

Species		Densu Delta	Muni - Pomadze	Sakumo	Songor	Keta	Grand Total
Common Name	**Scientific Name**						
Common Sandpiper	*Actitis hypoleucos*	51	48	15	36	32	182
African Jacana	*Actophilornis africanus*			54			54
Great White Egret	*Ardea alba*	194		59		261	514
Yellow-billed Egret	*Ardea brachyrhyncha*					1	1
Grey heron	*Ardea cinerea*	649	2	9	4	144	808
Purple Heron	*Ardea purpurea*	1		3		8	12
Squacco Heron	*Ardeola ralloides*	15		16			31
Turnstone	*Arenaria interpres*	2			1	8	11
Cattle Egret	*Bubulcus ibis*			71			71
Senegal Thick-knee	*Burhinus senegalensis*			2			2
Dwarf Bittern	*Butorides striata*				1		1
Sanderling	*Calidris alba*	140	83		123	201	547
Knot	*Calidris canutus*		38	1	2	1	42
Cerlew sand piper	*Calidris ferruginea*	1613	113	13	1512	14395	17646
Little stint	*Calidris minuta*	430			933	902	2265
Ruff	*Calidris pugnax*			5			5
Ringed plover	*Charadrius hiaticula*	3775	236	2	569	2610	7192
White-fronted Plover	*Charadrius marginatus*		3			5	8
Kittlitz's plover	*Charadrius pecuarius*				73	345	418
Black Tern	*Chlidonias niger*	85	99	27		102	313
Fulvous Whistling Duck	*Dendrocygna bicolor*			5		00	5
White-faced Whistling Duck	*Dendrocygna viduata*	24		3		174	201
Black Heron	*Egretta ardesiaca*	99			1	7	107
Little egret	*Egretta garzetta*	446	17	71	96	407	1037
Western reef heron	*Egretta gularis*	394	12	2	35	124	567
Common Moorhen	*Gallinula chloropus*	24			1		25
Collared Practincole	*Glareola pratincola*	1		101			102
Black-wing stilt	*Himantopus himantopus*	601	54		60	903	1618
Caspian Tern	*Hydroprogne caspia*					1	1
Lesser black backed gull	*Larus fuscus*		1			19	20
Black-headed gull	*Larus ridibundus*					18	18

Species		Densu Delta	Muni - Pomadze	Sakumo	Songor	Keta	Grand Total
Common Name	**Scientific Name**						
Bar-tailed godwit	*Limosa lapponica*	8	13		3	11	35
Black-tailed godwit	*Limosa limosa*					13	13
Long-tailed Cormorant	*Microcarbo africanus*	3270	37	20		5465	8792
Curlew	*Numenius arquata*	39				7	46
Whimbrel	*Numenius phaeopus*	159	35		1	42	237
Grey plover	*Pluvialis squatarola*	23	75		62	29	189
Avocet	*Recurvirostra avosetta*				1		1
Painted snipe	*Rostratula benghalensis*	1	0	1			2
Roseatte tern	*Sterna dougallii*		1				1
Common tern	*Sterna hirundo*	110	411		254	929	1704
Little tern	*Sternula albifrons*				137	232	369
Royal Tern	*Thalasseus maximus*	388	212		50	127	777
Sandwich Tern	*Thalasseus sandvicensis*	238	352		51	371	1012
Wood sand piper	*Tringa glareola*	160		15	2	2	179
Greenshank	*Tringa nebularia*	277	124	31	75	1817	2324
Marsh sand piper	*Tringa stagnatilis*	12	19	16	6	46	99
Redshank	*Tringa totanus*	4	7		8	1	20
Wattle Plover	*Vanellus senegallus*			19			19
Spur-winged plover	*Vanellus spinosus*		5	53	1	2	61
Terek Sandpiper	*Xenus cinereus*		1				1
	Grand Total	**13,233**	**1,998**	**614**	**4,098**	**29,762**	**49,705**

Species distribution of waterbirds on coastal Ramsar Sites in Ghana, January 2017 count.

(*Source*: Wildlife Division, 2017)

Family	Densu Delta	Muni - Pomadze	Sakumo	Songor	Keta	Grand Total
Anatidae	24		8		174	206
Ardeidae	1798	31	231	137	952	3149
Burhinidae			2			2
Charadridae	3798	319	74	705	2991	7887
Glareolidae	1		101			102
Jacanidae		48	54			102
Laridae		1			37	38
Phalacrocoracidae	3270	37	20		5465	8792
Rallidae	24			1		25
Recurvirostridae	601	54		61	903	1619
Rostratulidae	1		1			2
Scolopacidae	2895	433	96	2702	17478	23604
Sternidae	821	1075	27	492	1762	4177
Grand Total	**13,233**	**1,998**	**614**	**4,098**	**29,762**	**49,705**

Environmental & Social Impact Assessment

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

APPENDIX 7:

Noise and Flicker Impact Assessment Study

NOISE AND SHADOW IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76.5MW Wind Power Project situated at Wokumagbe/Goi in the Greater Accra District of Ghana

Report prepared for:	***Report prepared by:***
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	Airshed Planning Professionals (Pty) Ltd P. O. Box 5260 Halfway Gardens, 1685 South Africa

DECEMBER 2017

EXECUTIVE SUMMARY

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a specialist study on potential noise and shadow flicker impacts of the project through the construction, operation and decommissioning of a 76.5-megawatt (MW) Wind Energy Facility (WEF) at Wokumagbe and Goi in the Greater Accra Region of Ghana. The project is referred to as Wind Power Project 2 (WPP2). Two layout alternatives are under consideration.

The main objectives of the study were therefore to determine the significance of noise and shadow flicker impacts, and to identify and recommend suitable management and mitigation measures to ensure the impact of WPP2 on the receiving environment is minimised. To achieve the study objectives the following tasks were included in the Terms of Reference (ToR).

- A desktop review of existing data and literature on noise and flicker effects, both published and unpublished in order to determine the environmental baseline.
- A study of Ghanaian and international requirements pertaining to:
    - Environmental noise measurement and impact criteria; and
    - Shadow flicker impacts.
- A short-term baseline noise survey, incl.:
    - Attended short term measurements during day- and night-time;
    - Surveys of ground characteristics and other site-specific features that influence the propagation of noise such as meteorology, topography etc.
    - The identification of all existing sources of environmental noise such as communities, industries and public roads.
- A study of the receiving environment by referring to:
    - Survey results;
    - Noise and shadow flicker receptors (NSRs and SFRs); and
    - Details on the physical environment i.e. meteorology, land use and topography.
- Desktop environmental noise impact study:

- The compilation of a noise source inventory incl. identification and quantification sound power levels (L_W's) associated with proposed operational phase activities and description of noise sources typically present during the construction and decommissioning phases.
- Noise propagation simulations of wind turbine generator (WTG) noise during the operational phase using the WindPRO software.
- Compliance and impact assessment by comparing simulated noise levels to the relevant noise criteria as identified.
- The identification of noise management and mitigation measures based on the findings of the compliance and impact assessment.

- Desktop shadow flicker impact study:
  - Determining the impact of shadow flicker and identifying the need for it to be addressed and modelled if required due to the presence of receptors. If required, assessing the potential for shadow flicker impacts on property occupiers in the vicinity of WPP2, using internationally recognised guidelines or standards.
- The recommendation of monitoring and management measures to be included in the WPP2 Environmental Management Plan (EMP).

The conclusions of the environmental noise and shadow flicker impact studies are summarised below.

Environmental Noise

Given the findings of the environmental noise study it was concluded that the significance of environmental noise impacts during all project phases are considered *medium* but should be reduced to *low* with the implementation of management and mitigation measures recommended in this report as a condition of project approval.

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. It will however be necessary to relocate the Omankope Presbyterian Primary School should the preferred layout be selected.

The *medium significance* rating for the **operational phase** is based on the finding that exceedance of noise impact guidelines may occur between 2 to 5 rotor diameters from the WTG arrays. Given available satellite imagery, several residential structures fall within this distance from WPP2. To manage and mitigate noise impacts it is recommended that the LNTE GE 1.7-103 WTG be selected and specific WTGs be operated at NRO modes. It is further necessary to establish and maintain the buffer zone of between 2 and 5 rotor diameters around WTG arrays, within which permanent residences should be relocated and not be permitted in future (refer to Figure 26 and Figure 27 for the buffer zone delineation).

It is also concluded that, from an environmental noise perspective, the alternative layout is the preferred option since it will affect a smaller number of NSRs.

Shadow Flicker

It was concluded that shadow flicker impacts, only of concern during the operational phase are *of medium* significance (for the preferred and alternative layout) and must be reduced by implementing the appropriate mitigation measures as a condition for project approval.

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.

Whereas curtailment of WTG operational hours can be used to mitigate shadow flicker impacts at Omankope, Wokumagbe, and Goi, the Omankope Presbyterian Primary School, as well eastern-most and northernmost residents of Goi will need to be relocated. By adhering to the buffer zone and relocations recommended to mitigate noise impacts, shadow flicker impacts will also be avoided.

LIST OF ABBREVIATIONS AND TERMINOLOGY

DEFINITIONS	
Airshed	Airshed Planning Professionals (Pty) Ltd
CSIR	Council for Scientific and Industrial Research
dB	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure.
dBA	Descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure that has been A-weighted to simulate human hearing.
DTI	Department of Trade and Industry
EHS	Environmental, Health, and Safety (IFC)
EMP	Environmental Management Program
EPHC	Environment Protection Heritage Council (Australia)
ETSU	Energy Technology Support Unit (UK)
GE	General Electric
GEPA	Ghana Environmental Protection Agency
Hz	Frequency in Hertz
IEC	International Electro Technical Commission
IFC	International Finance Corporation
ISO	International Standards Organisation
Kn	Noise propagation correction factor
K1	Noise propagation correction for geometrical divergence
K2	Noise propagation correction for atmospheric absorption
K3	Noise propagation correction for the effect of ground surface;
K4	Noise propagation correction for reflection from surfaces
K5	Noise propagation correction for screening by obstacles
MW	Power in mega watt
L_{Aeq} (T)	The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured) (in dBA)
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels (L_{A90}) (in dBA)
L_{AFmax}	The A-weighted maximum sound pressure level recorded during the measurement period

L_{AFmin}	The A-weighted minimum sound pressure level recorded during the measurement period
LNTE	Low noise trailing edge
L_P	Sound pressure level (in dB)
L_{PA}	A-weighted sound pressure level (in dBA)
L_{PZ}	Un-weighted sound pressure level (in dB)
Ltd	Limited
L_W	Sound Power Level (in dB)
m^2	Area in square meters
m/s	Speed in meters per second
NRO	Noise reduced operation
NSR	Noise sensitive receptor
p	Pressure in Pa
Pa	Pressure in Pascal
µPa	Pressure in micro-pascal
p_{ref}	Reference pressure, 20 µPa
Pty	Proprietary
SLM	Sound Level Meter
SFR	Shadow flicker receptor
ToR	Terms of Reference
UK	United Kingdom
VRA	Volta River Authority
WEF	Wind energy facility
WHO	World Health Organisation
WPP2	Wind Power Project No. 2
WTG	Wind turbine generator
%	Percentage

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NOISE AND SHADOW IMPACT ASSESSMENT: ESIA PHASE

1. INTRODUCTION

Airshed Planning Professionals (Pty) Ltd (Airshed) was appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a specialist study on potential noise and shadow flicker impacts associated with the proposed construction, operation and decommissioning of a 76.5-megawatt (MW) Wind Energy Facility (WEF) situated at Wokumagbe and Goi in the Greater Accra Region of Ghana (Figure 1). The project is referred to as Wind Power Project 2 (WPP2). Two layout alternatives are under consideration.

Noise will be generated during the construction, operational as well as decommissioning phases of WPP2. Shadow flicker impacts will be limited to the operational phase of the project. The main objectives of the study were therefore to:

- For environmental noise
    - Determine the extent to which the existing acoustic climate of the area will be affected by noise as a result of WPP2; and
    - Identify and recommend suitable management and mitigation measures to ensure the impact of WPP2 on the receiving acoustic environment is minimised.
- For shadow flicker
    - Determine the impact of shadow flicker on nearby receptors; and
    - Identify and recommend suitable management and mitigation measures to ensure that the impacts associated with shadow flicker of WPP2 on nearby sensitive receptors is minimised.

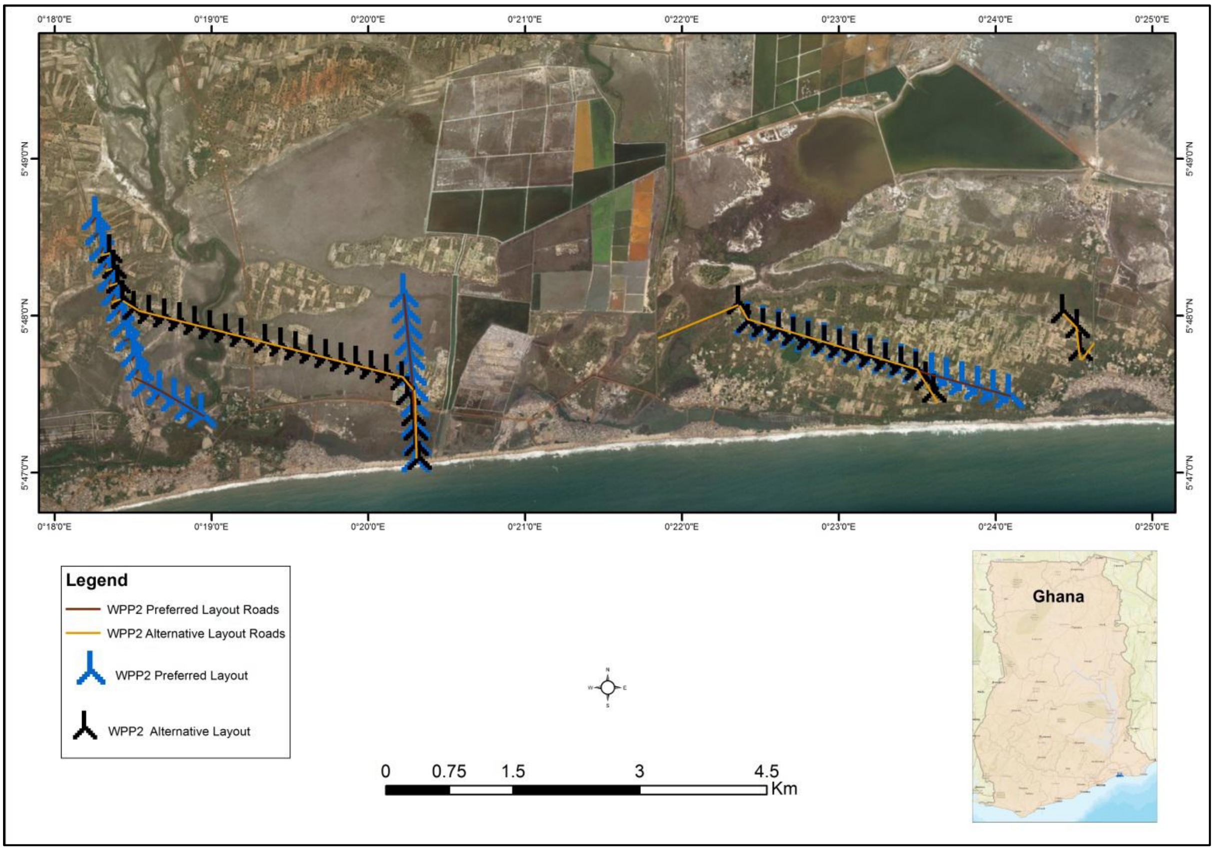


Figure 1: Location of the site for WPP2 with preferred and alternative layouts

2. TERMS OF REFERENCE

To achieve the study objectives, the following tasks were included in the Terms of Reference (ToR):

- A desktop review of existing data and literature on noise and flicker effects, both published and unpublished in order to determine the environmental baseline.
- A study of Ghanaian and international requirements pertaining to:
    - Environmental noise measurement and impact criteria for day- and night-time; and
    - Shadow flicker impacts.
- A short-term baseline noise survey, including:
    - Attended short term measurements during day- and night-time;
    - Surveys of ground characteristics and other site-specific features that influence the propagation of noise such as meteorology, topography etc.
    - The identification of all existing sources of environmental noise such as communities, industries and public roads.
- A study of the receiving environment by referring to:
    - Survey results;
    - Noise and shadow flicker sensitive receptors; and
    - Details on the physical environment i.e. meteorology, land use and topography.
- A desktop environmental noise impact study which involved:
    - A compilation of a noise source inventory including identification and quantification of sound power levels (L_W's) associated with proposed operational phase activities and description of noise sources typically present during the construction and decommissioning phases.
    - Noise propagation simulations of wind turbine generator (WTG) noise during the operational phase.
    - Compliance and impact assessment by comparing simulated noise levels to relevant noise criteria as identified.

    - Identification of noise management and mitigation measures based on the findings of the compliance and impact assessment.
- A desktop shadow flicker impact study to:
    - Determining the impact of shadow flicker and identifying the need to address and mode if required due to the presence of receptors. If required, assessing the potential for shadow flicker impacts on property occupiers in the vicinity of WPP2, using internationally recognised guidelines or standards.
- The recommendation of monitoring and management measures to be included in the WPP2 Environmental Management Plan (EMP).

Additionally, the ToR included training on WEF noise impact assessments to Volta River Authority (VRA) staff. Training included:

- An introduction to the physics of sound;
- Measurement of sound (practical showing the settings required on a noise meter) as well as the technical requirements from a measuring standard;
- An introduction to WindPro (BASIS and DECIBEL modules);
- Inputting digital elevation data, noise sensitive receptors and turbines;
- Modelling of a windfarm layout with the correct standards;
- Generating reports in WindPRO; and
- Integration of WindPRO with Google Earth.

The required Environmental and Social Impact Assessment (ESIA) end-product from the noise assessment, was to provide a comprehensive and detailed Noise and Shadow Flicker Impact Assessment (N&SFIA) that presents and evaluates the noise and shadow flicker impact of the wind turbines under different operating conditions.

3. PROJECT DESCRIPTION

3.1 ENVIRONMENTAL NOISE

3.1.1 Background to Environmental Noise and the Assessment Thereof

Before more details regarding WPP2, the approach and methodology adopted in the study is given, the reader is provided with some background, definitions and conventions used in the measurement, calculation and assessment of environmental noise.

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable as it is subjective rather than objective.

Noise is reported in decibels (dB). “dB” is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities that have the same units, in this case sound pressure. The relationship between sound pressure and sound pressure level is illustrated in the equation given below wherein Lp is the sound pressure level in dB, p is the actual sound pressure in Pa, and p_{ref} is the reference sound pressure (p_{ref} in air is 20 µPa).

$$L_p = 20 \cdot \log_{10}\left(\frac{p}{p_{ref}}\right)$$

where L_p is the sound pressure level in dB, p is the actual sound pressure in Pa; and p_{ref} is the reference sound pressure (p_{ref} in air is 20 µPa).

3.1.1.1 Perception of Sound

Sound has already been defined as any pressure variation that can be detected by the human ear. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). The hearing frequency of a young, healthy person ranges between 20 Hz and 20 000 Hz.

In terms of L_P, audible sound ranges from the threshold of hearing at 0 dB to the pain threshold of 130 dB and above. By doubling sound pressure (in Pa), the sound pressure level increases by 6 dBA. The smallest perceptible change is about 1 dB. Noise levels should increase by 8 to 10 dBA to appear significantly louder (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

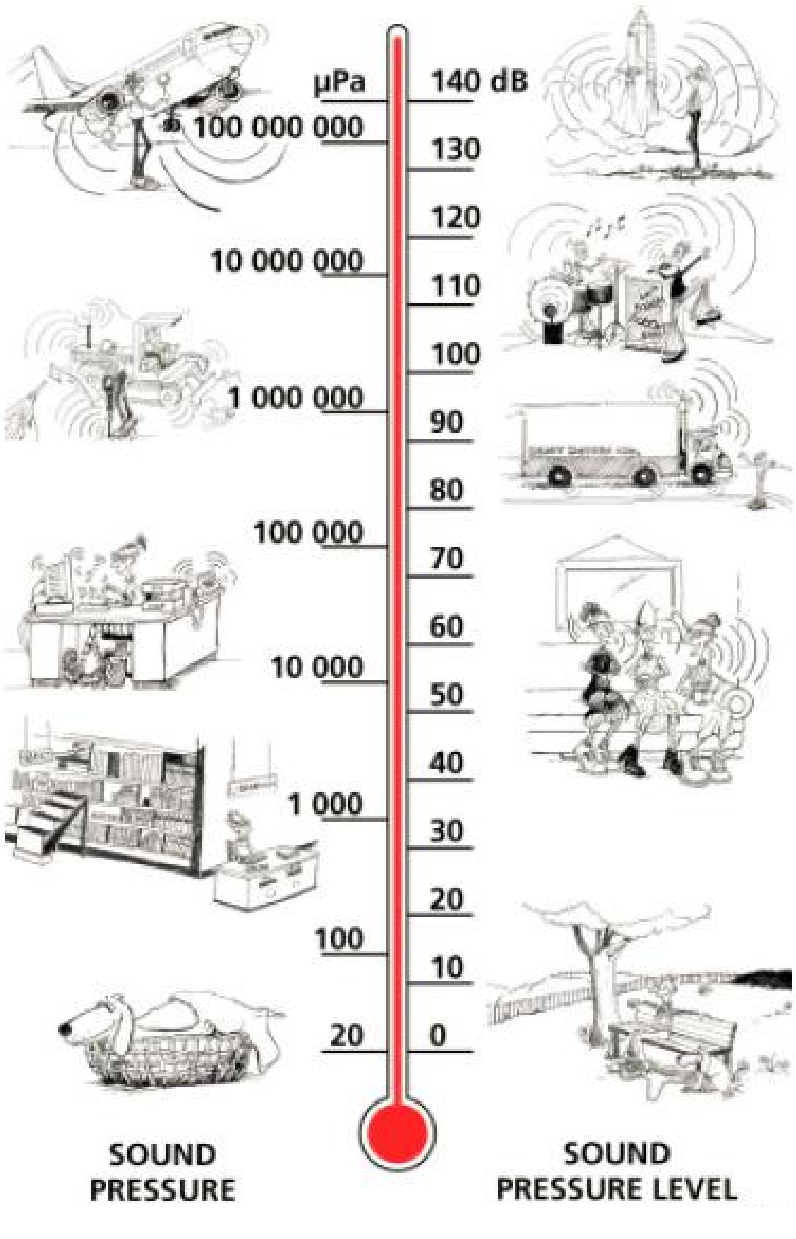


Figure 2: The decibel scale and typical noise levels (Brüel & Kjær Sound & Vibration Measurement A/S, 2000)

3.1.1.2 Frequency Weighting

Since human hearing is not equally sensitive to all frequencies, a ‘filter’ has been developed to simulate human hearing. The ‘A-weighting’ filter simulates the human hearing characteristic, which is less sensitive to sounds at low frequencies than at high frequencies (Figure 3). “dBA” is the descriptor that is used to indicate 10 times a logarithmic ratio of quantities, that have the same units (in this case sound pressure) that has been A-weighted.

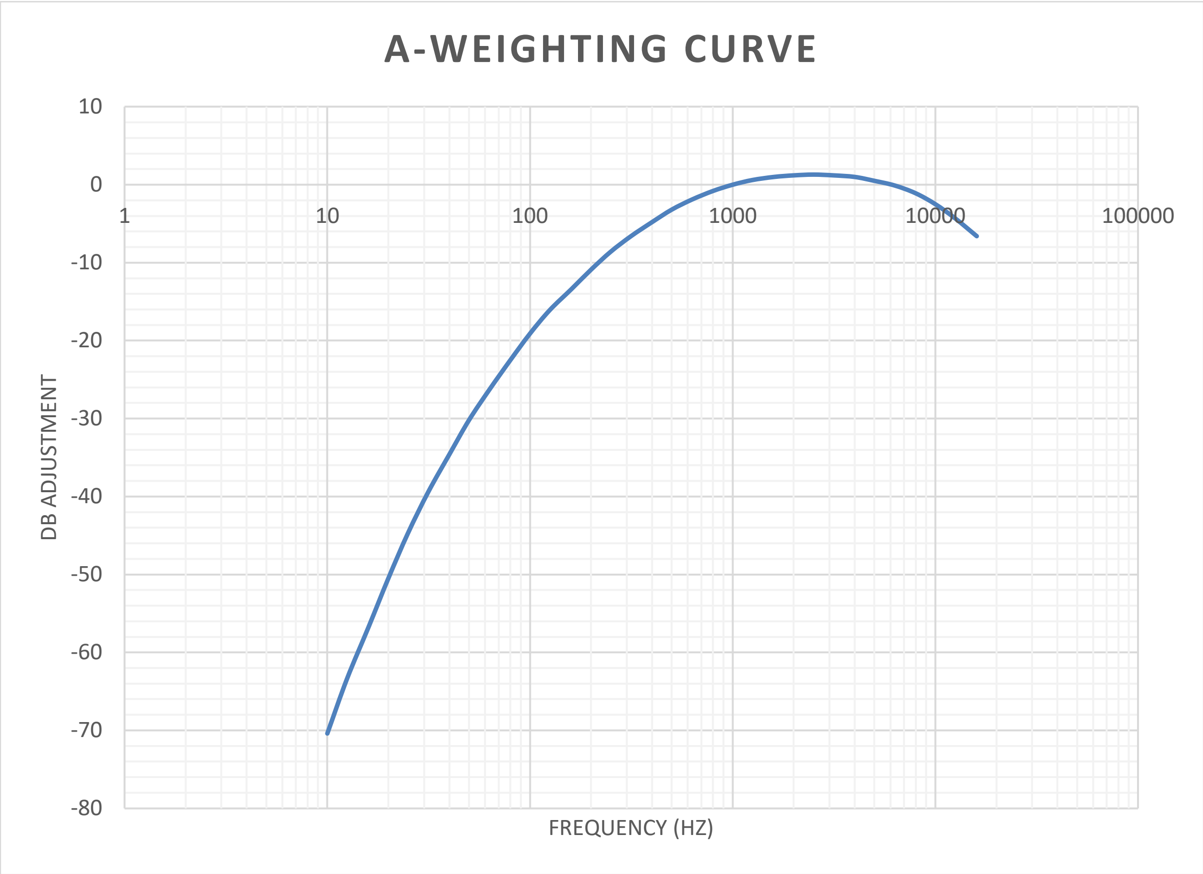


Figure 3: A-weighting curve

3.1.1.3 Adding Noise Levels

Since sound pressure levels are logarithmic values, the sound pressure levels as a result of two or more sources cannot just simply be added together. To obtain the combined sound pressure level of a combination of sources such as those at an industrial plant, individual sound pressure levels must be converted to their linear values and added using:

$$L_{p\_combined} = 10 \cdot \log\left(10^{\frac{L_{p1}}{10}} + 10^{\frac{L_{p2}}{10}} + 10^{\frac{L_{p3}}{10}} + \cdots 10^{\frac{L_{pi}}{10}}\right)$$

This implies that if the difference between the sound pressure levels of two sources is nil the combined sound pressure level is 3 dB more than the sound pressure level of one source alone. Similarly, if the difference between the sound pressure levels of two sources is more than 10 dB, the contribution of the quietest source can be disregarded (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

3.1.1.4 Environmental Noise Propagation

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power, L_W;
- The distance between the source and the receiver;
- Atmospheric conditions (wind speed and direction, temperature and temperature gradient, humidity etc.);
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption; and
- Reflections

To arrive at a representative result from either measurement or calculation, all these factors must be taken into account (Brüel & Kjær Sound & Vibration Measurement A/S, 2000).

3.1.1.5 Environmental Noise Indices

In assessing environmental noise either by measurement or calculation, reference is generally made to the following indices:

- **L_{Aeq} (T) –** The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged (calculated or measured).

- **L_{A90} –** The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor which provides an indication of what the L_{Aeq} could have been in the absence of noisy single events and is considered representative of background noise levels.

- **L_{AFmax} –** The maximum A-weighted noise level measured with the fast time weighting. It's the highest level of noise that occurred during a sampling period.

- **L_{AFmin} –** The minimum A-weighted noise level measured with the fast time weighting. It's the lowest level of noise that occurred during a sampling period.

3.1.2 Construction Phase Noise

Several activities associated with the construction/erection of wind turbines and hard standing areas, buildings and ancillary infrastructure will generate noise. Noise is emitted by construction equipment used for the fabrication, and erection of infrastructure including all related activities such as land clearing, site preparation, excavation, clean-up, and landscaping.

Construction equipment can be described or divided into distinct categories. These are earthmoving equipment, materials handling equipment, stationary equipment, impact equipment, and other types of equipment. The first three categories include machines that are powered by internal combustion engines. Machines in the latter two categories are powered pneumatically, hydraulically, or electrically. Additionally, exhaust noise tends to account for most of the noise emitted by machines in the first three categories (those that use internal combustion engines) whereas engine-related noise is usually secondary to the noise produced by the impact between impact equipment and the material on which it acts (Bugliarello, Alexandre, Barnes, & Wakstein, 1976).

Construction equipment generally produces noise in the lower end of the frequency spectrum. Reverse, or moving beeper, alarms emit at higher frequency ranges and are often heard over long distances.

Noise generated during construction is highly variably since it is characterised by variations in the power expended by construction equipment. Besides having daily variations in activities, major construction projects are accomplished in several different phases where each phase has a specific equipment mix depending on the work to accomplish during that phase.

3.1.3 Operational Phase Noise

3.1.3.1 Noise Mechanisms of Wind Turbines

Wind turbine operation generates four types of noise namely tonal, broadband, low-frequency, and impulsive (**Figure** 4) (Manwell, McGowan, & Rogers, 2009).

- *Tonal noise*, is noise at discrete frequencies that is caused by wind turbine components such as meshing gears, nonlinear boundary layer instabilities interacting with a rotor blade surface, by vortex shedding from a blunt trailing edge, or unstable flows over holes or slits.

- *Broadband noise*, is characterized by a continuous distribution of sound pressure with frequencies greater than 100 Hz. It is often caused by the interaction of wind turbine blades with atmospheric turbulence, and is also described as a characteristic 'swishing' or 'whooshing' sound.

- *Low frequency noise*, in the range of 20 Hz to 100 Hz, is mostly associated with downwind turbines i.e. machines have the rotor placed on the lee side of the tower. It is caused when the turbine blade encounters localized flow deficiencies due to the flow around a tower, wakes shed from other blades, etc. The wind turbine generator units proposed for WPP2 are upwind machines with rotors facing the wind.

- *Impulsive noise*, involves short acoustic impulses or thumping sounds that vary in amplitude with time characterize this noise. They may be caused by the interaction of wind turbine blades with disturbed air flow around the tower of a downwind machine, and/or the sudden deployment of tip breaks or actuators.

There are various causes of the noise emitted from operating wind turbines. These can be divided into two categories, namely (1) aerodynamic noise, and (2) mechanical noise.

Aerodynamic noise is generated by several complex flow phenomena of air around the rotor blades (Manwell, McGowan, & Rogers, 2009). It tends to increase with blade tip speed or tip speed ratio and is broadband in nature. It is typically also the largest source of wind turbine noise. During turbulent wind conditions, blades may emit low-frequency noise as they are buffeted by changing winds. Aerodynamic noise mechanisms, divided into three distinct groups, and its importance in wind turbine noise impacts, are summarised in Table 1.

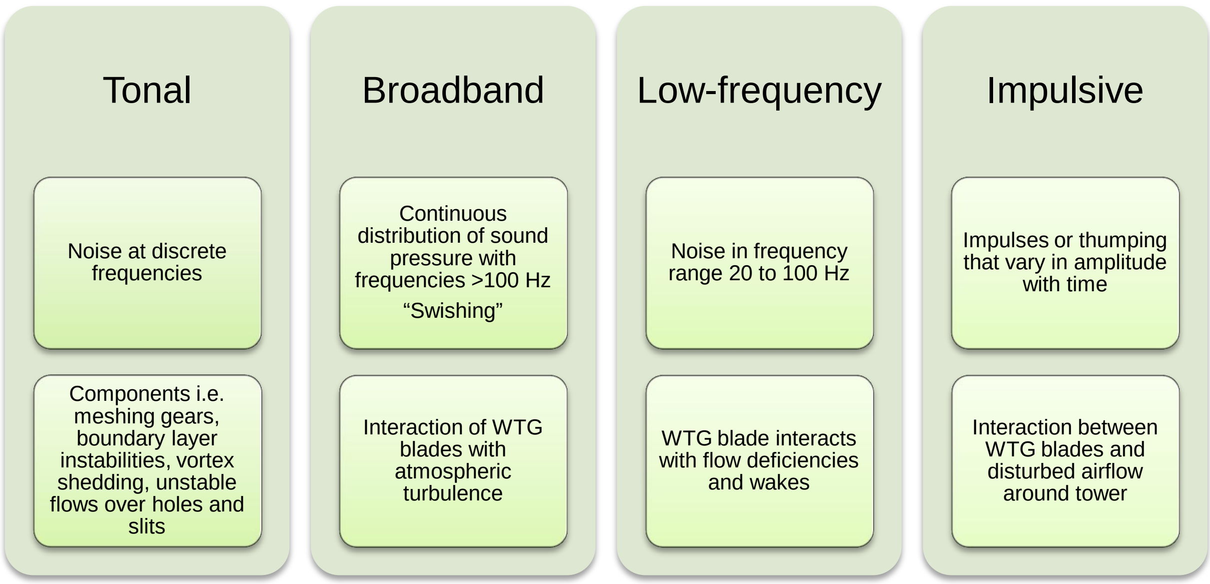
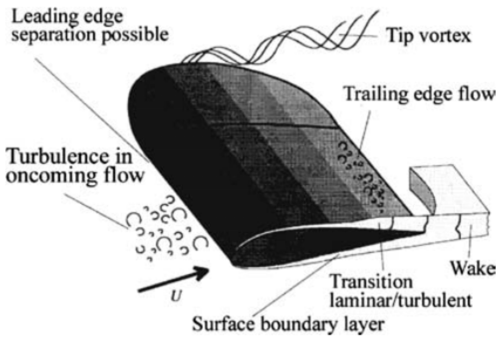


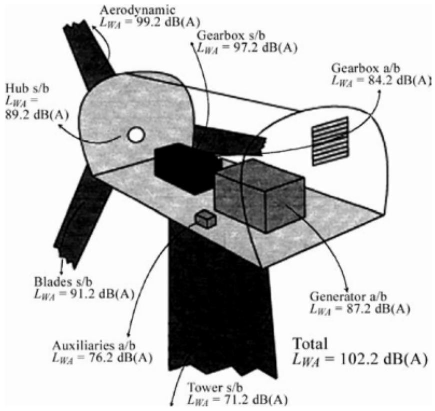
Figure 4: Types of noise generated by wind turbine operation

Table 1: Aerodynamic noise mechanisms (Manwell, McGowan, & Rogers, 2009)

Type of noise	Indication	Mechanism	Main characteristics and importance
Low frequency noise	Steady thickness noise; steady loading noise	Rotation of blades or rotation of lifting surfaces	Frequency is related to blade passing frequency, not important at current rotational speeds
	Unsteady loading noise	Passage of blades through tower velocity deficit or wakes	Frequency is related to blade passing frequency, small in cases of upwind turbines, possibly contributing in case of wind farms
Inflow turbulence noise		Interaction of blades with atmospheric turbulence	Contributing to broadband noise; not yet fully quantified
Airfoil (blade) self-noise	Trailing-edge noise	Interaction of boundary layer turbulence with blade trailing edge	Broadband, main source of high frequency noise (770 Hz to 2 kHz)
	Tip noise	Interaction of tip turbulence with blade tip surface	Broadband; not fully understood
	Stall, separation noise	Interaction of turbulence with blade surface	Broadband
	Laminar boundary layer noise	Nonlinear boundary layer instabilities interacting with the blade surface	Tonal, can be avoided
	Blunt trailing edge noise	Vortex shedding at blunt trailing edge	Tonal, can be avoided
	Noise from flow over holes, slits and intrusions	Unstable shear flows over holes and slits, vortex shedding from intrusions	Tonal, can be avoided

The relative motion of mechanical components and the dynamic response that results, results in *mechanical noise*. Main mechanical noise sources include the gearbox, generator, yaw drives, cooling fans, and auxiliary equipment such as hydraulics (Manwell, McGowan, & Rogers, 2009). Noise emitted by these components tend to be tonal in character but may have broadband components. Mechanically generated noise can also be transmitted, amplified and radiated by the hub, rotor and tower. The transmission of the noise can be air-borne (directly from the component into air) or structure-borne (noise transmitted along other structural components before being radiated to air). The diagrams in Figure 5, retrieved from *'Wind Energy Explained'* by Manwell, McGowan, & Rogers (2009), provides a visual representation noise from operating wind turbines.





(a) Aerodynamic noise, schematic of flow around a rotor blade

(b) Components and total sound power level for wind turbine (2 MW, 115 m downwind)

Figure 5: Schematic of airflow around a rotor blade and components as well as total L_W's for a 2 MW wind turbine at a downwind distance of 115 m (Manwell, McGowan, & Rogers, 2009)

3.1.3.2 Wind Turbine Selections for WPP2

WPP2 will consist of a total of 45 General Electric (GE) WTGs with 1.7 MW rated power, hub height at 80 m, and rotor diameter of 103 m (reference GE 1.7-103). The GE 1.7-103 is available with Low Noise Trailing Edge (LNTE) technology. The LNTE are fix mounted flow regulating elements fixed to the turbine blades. Additionally, the GE 1.7-103 can operate in several noise-reduced operating modes (NRO, "Noise-Reduced Operation") without any manual intervention. The NRO is a specific setting of control parameters related to the rotor speed and blade pitch angle (Lahmeyer International, 2016).

Noise curves as published by GE and/or supplied by Lahmeyer International GmbH (Lahmeyer International, 2016) and were included in the WindPRO database. L_{WA} data for the GE 1.7-103 without and with the LNTE at various NRO modes, are presented in Table 2. NRO results in reduced power output as is illustrated in Figure 6.

GE Power & Water states that at 10 m, wind speeds lower than 5 m/s the sound power levels decrease, and may get so low that wind turbine acoustics become indistinguishable from background noise. For a conservative calculation data at 5 m/s may be used. For 10 m wind speeds above 10 m/s, the wind turbine has reached rated power and blade pitch regulation acts in a way that tends to decrease noise levels. For a conservative calculation data at 10 m/s may be used. The highest normal operation calculated apparent sound power level for the 1.7-103 is L_{WA}, is 107.0 dB and 105.0 with the LNTE (GE Power & Water, 2014; GE Power & Water, 2015; Lahmeyer International, 2016).

Apparent sound power levels in Table 2 are calculated mean levels with an uncertainty level of less than 2 dB for the 95 % confidence level. The GE 1.7-103 has a value for tonality of less than 4 dB (GE Power & Water, 2014; GE Power & Water, 2015).

Table 2: Noise data for the GE 1.7-103

Wind speed, at 80 m hub height (m/s)	**GE 1.7-103 (L_{WA}, dBA)**	**GE 1.7-103 With LNTE (L_{WA}, dBA)**					
	Normal operation[a]	**Normal operation[a][b]**	**NRO104©**	**NRO103[c]**	**NRO102[c]**	**NRO101©**	**NRO100©**
4	n/d[e]	n/d	94.7	94.7	94.7	94.7	94.7
5	n/d	94.7	94.7	94.7	94.7	94.7	94.7
6	n/d	95.9	95.5	95.5	95.5	95.5	95.5
7	100.4	98.7	98.6	98.6	98.6	98.6	98.6
8	103.7	101.5	101.4	101.4	101.4	100.5	99.6
9	106.8	103.6	103.6	102.7	101.6	100.7	100.0
10	107.0	104.9	104.0	103.0	102.0	101.0	100.0
11	107.0	105.0	n/d	n/d	n/d	n/d	n/d
12	107.0	105.0	n/d	n/d	n/d	n/d	n/d
13	107.0	105.0	n/d	n/d	n/d	n/d	n/d
Rotor speed (pm)	n/d	15.8	14.7	14.0	13.4	12.7	12.2
Rated power (kW)	1 700	1 700	1 605	1 529	1 463	1 387	1 332

Notes:

(a) *Technical Documentation | Wind Turbine Generator Systems | 1.7-103 50 Hz and 60z* (GE Power & Water, 2014)

(b) *Technical Documentation | Wind Turbine Generator Systems | 1.7-103 with LNTE | 50 Hz and 60 Hz* (GE Power & Water, 2015)

(c) *Technical Report | Renewable Energy Development Programme, Ghana | Draft Feasibility Study for 75 MW Wind Power Project 2 (WPP2) in the Ada District of the Greater Accra Region* (Lahmeyer International, 2016)

(d) n/d – no data

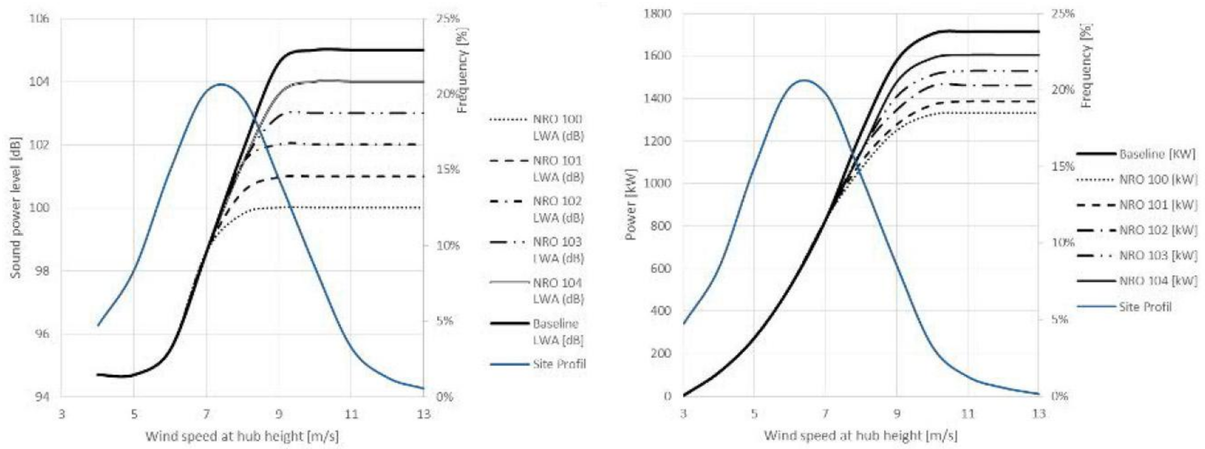


Figure 6: Sound power curves, power curves and site wind profiles vs. wind speed for the GE 1.7-103 WTG (Lahmeyer International, 2016)

3.1.4 Decommissioning Phase Noise

At the end of its operational lifetime, the WEF will be decommissioned and infrastructure removed. Information regarding the decommissioning phase was limited at the time but it can be reasonably assumed that noise sources and impacts would be similar to those of the construction phase.

It is expected to include the demolition and (or) removal of wind turbines and hard standing areas, buildings and ancillary infrastructure. Noise will also be emitted by mobile equipment and all related activities such as land clearing, site preparation, excavation, clean-up, and landscaping.

3.2 SHADOW FLICKER

When the moving blades of a wind turbine rotor cast moving shadows, shadow flicker occurs. This flickering effect may annoy people living close to the turbine. Sunlight may also be reflected from gloss-surfaced turbine blades and cause a “flashing” effect. Shadow flicker and blade glint is more of a problem in higher and lower latitudes, and the low angle of the sun in the sky (Manwell, McGowan, & Rogers, 2009).

In the worst-case conditions in Norther Europe, flickering only occurs for approximately 30 minutes a day for 10 to 14 weeks during winter. To mitigate shadow flicker and blade glint impacts European countries typically avoid wind turbines operation during short impact periods, site turbines taking account of the shadow path on nearby residences, and using non-reflective, no-gloss blades. In Denmark, a minimum separation distance of 6 to 8 rotor diameters between the turbine and closest neighbour is recommended (Manwell, McGowan, & Rogers, 2009).

To calculate shadow flicker impacts, the following information is typically needed:

- The position of wind turbine generator units and operational times;
- Hub heights and rotor diameters;
- The position of the shadow receptor object and its orientation;
- The geographic position of the project with time zone and daylight savings time information, if applicable; and
- Information about the earth’s orbit and rotation relative to the sun.

4. APPLICABLE LEGISLATION

Noise level guidelines and limits for calculating shadow flicker impacts are discussed in Sections 4.1 and 4.2 respectively.

4.1 ENVIRONMENTAL NOISE LEVEL GUIDELINES

This study refers to environmental noise standards published by the Ghana Environmental Protection Agency (GEPA), and guidelines published by the International Finance Corporation (IFC) in their General Environmental, Health, and Safety (EHS) Guidelines.

In the absence of specific of noise guidance in Ghana for WEFs, reference is also made to the report compiled as an Energy Technology Support Unit (ETSU) project by a working group on wind turbine noise and facilitated by the United Kingdom (UK) Department of Trade and Industry (DTI).

4.1.1 Environmental Noise Standards in Ghana

The GEPA specifies environmental noise standards for various zones during both day- and night-time (Table 3). Given the predominantly rural and residential nature of the study area and receptors, environmental noise standards for Zone A is considered most applicable. In residential areas with negligible or infrequent traffic (Zone A), outdoor noise levels at noise sensitive receptors should not exceed 55 dBA during the day, and 48 dBA during the night.

It should be noted that standards for Zone A are comparable to the IFC guidelines for residential, educational and institutional receptors (see Section 4.1.2).

Table 3: GEPA environmental noise standards

Zone	Description	Permissible noise level in dBA	
		Day (06:00 to 22:00)	**Night (22:00 to 06:00)**
A	Residential areas with negligible or infrequent transportation	55	48
B1	Educational and health facilities	55	50
B2	Areas with commercial or light industrial activities	60	55
C1	Areas with light industry, entertainment, public assembly or places of worship	65	60
C2	Commercial areas	75	65
D	Light industrial areas	70	60
E	Heavy industrial areas	70	70

4.1.2 IFC Environmental Noise Level Guidelines

The IFC General EHS Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines.

The IFC states that noise impacts **should not exceed the levels presented in Table** 4, OR result in a maximum **increase above background levels of 3 dBA** at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is, therefore, a useful significance indicator for a noise impact.

Table 4: IFC Noise Level Guidelines

Receptor Type	One-hour L_{Aeq} (dBA) 07:00 to 22:00	One-hour L_{Aeq} (dBA) 22:00 to 07:00
Industrial	70	70
Residential, Institutional and Educational	55	45

4.1.3 The Assessment and Rating of Noise from Wind Farms According to ETSU-R-97 (1996)

The main aim of the report by the Working Group on Noise from Wind Turbines (ETSU-R-97, 1996), was to provide information and advice to developers and planners on the environmental assessment of noise from wind turbines. It contains the consensus view of the members of the Noise Working Group who have extensive experience in assessing and controlling environmental impact of noise from wind farms.

Noise limits derived by the Noise Working Group took into account:

- Existing standards and guidance relating to noise;
- The need of society for renewable energy sources to reduce the emission of atmospheric pollutants in pursuance of energy policies;
- The ability of manufacturers to meet noise limits;
- Research of Noise Working Groups in the UK, Denmark, the Netherlands, and Germany; and
- The professional experience of members of the Noise Working Group.

An important finding by the Noise Working Group was that absolute noise limits, applied at all wind speeds, are not suited to wind farms and that limits set relative to the background noise are more appropriate. To accurately determine the impact of wind turbine noise (which varies with wind speed), background noise over a range of wind speeds must be measured. They do however make allowances for circumstances where a more simplified approach, based on a fixed limit, may be appropriate.

They further recommend that noise limits should only be set for wind speeds up to 12 m/s as recorded at a height of 10 m above ground level, siting the following reasons:

- In the UK wind speeds are not often measured at speeds greater than 12 m/s;
- Reliable measurement of background noise levels and turbine noise is difficult in high wind conditions;
- Turbine manufacturers are unlikely to be able to provide information on L_W's at high wind speeds for similar reasons; and
- If a wind farm meets noise limits at wind speeds lower than 12 m/s it is most unlikely to cause loss of amenity at higher wind speeds.

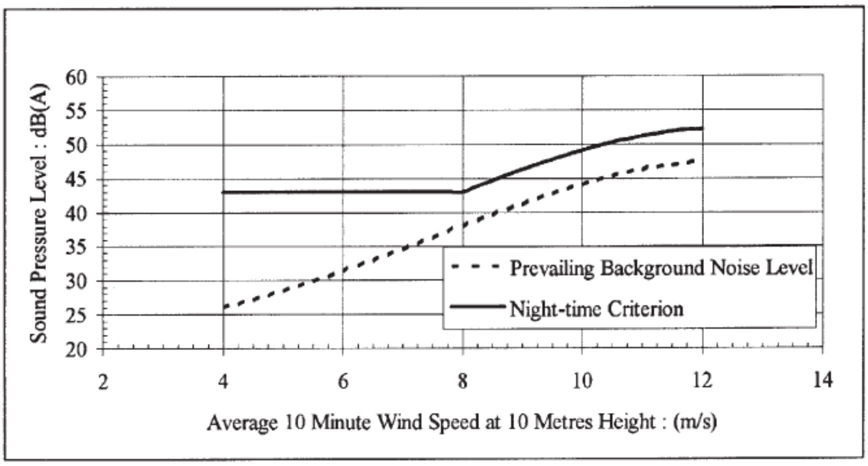
Separate noise limits should also be applied for day- and night-time, since during the night, protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. Whereas day-time limits should be derived from background noise data taken during quiet periods of the day, night-time noise levels must be derived from background noise data collected at night. Periods of the day are defined as follows:

- Quiet day-time periods:
  - All evenings from 18:00 to 23:00;
  - Saturdays from 13:00 to 18:00;
  - All day Sunday
- Night-time from 23:00 to 07:00

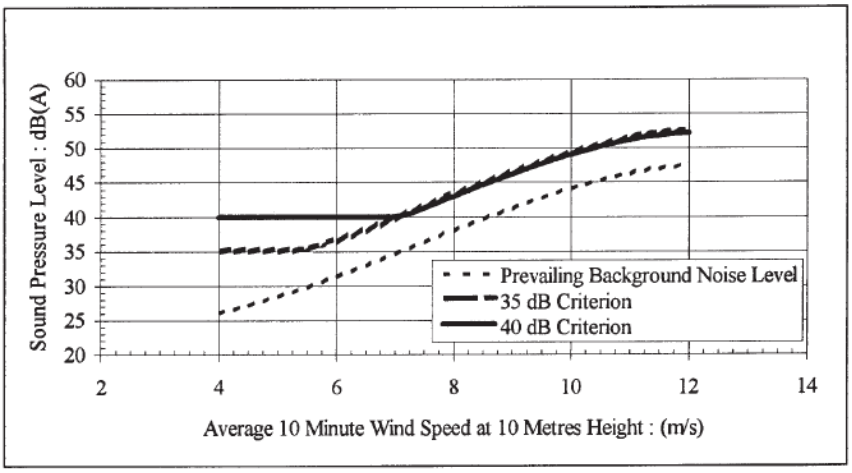
Furthermore:

- The $L_{A90,10min}$ descriptor should be used for both background and windfarm noise. It allows the reliable measurement of noise without interference from relatively loud, transitory noise events from other sources.
- When setting limits, it should be borne in mind that the $L_{A90,10min}$ of the wind farm is likely to be about 1.5 to 2.5 dBA less than the L_{Aeq} over the same period.
- Limits are applicable to free-field (except for ground reflection) measurements in the vicinity of NSRs.
- The cumulative effect of all wind turbines within an area must be considered. Existing wind farms must not be considered as part of the prevailing background noise.
- Background noise levels upon which limits are based and the noise limits themselves must be based on typical rather than extreme values at any given wind speed. The approach entails the derivation of limits from average levels but also appreciating that both background and turbine noise levels can vary over several dB for the same nominal conditions.
- Variation in background noise level with wind speed must be determined by correlating $L_{A90,10min}$ noise measurements taken over a period of time, with average wind speeds measured over the same 10 min periods and then fitting a curve to the data.

- Noise from a WEF should be limited to 5 dBA above background for both day- and night-time.
- In low noise environments the day-time level of the $L_{A90,10min}$ of the WEF should be limited to an absolute level within the range of 35 to 40 dBA. The actual choice of value will depend on:
    - The number of dwellings in the neighbourhood of the wind farm;
    - The effect of noise limits on the power generation capacity (i.e. operational mode vs power output sacrifice); and
    - Duration and level of exposure.
- The fixed night-time limit is 43 dBA. The value was derived from the 35 dBA sleep disturbance criteria with a 10-dBA allowance for noise attenuation through an open window and 2 dBA subtracted to account for the use of $L_{A90,10min}$ rather than $L_{Aeq,10min}$.
- The day- and night-time lower fixed limits can be increased to 45 dBA and the permissible margin above background increased where the occupier of the property has some financial involvement in the wind farm.
- If noise from a WEF is limited to an $L_{A90,10min}$ of 35 dBA up to wind speeds of 10 m/s measured 10 m above ground level, then this condition alone would offer sufficient protection of amenity and background noise surveys would be unnecessary.
- Recommended wind dependent limits based on typical background noise curves are presented in Figure 7.
- Penalties should be applied if wind turbines present tonal character.



(a) Example of night-time noise criterion at typical background noise levels



(b) Example of day-time noise criterion at typical background noise levels

Figure 7: Example wind-dependant noise limits for typical background noise conditions (ETSU-R-97, 1996)

4.2 GUIDELINES FOR SHADOW FLICKER

International regulations for shadow flicker vary widely. The most comprehensive regulations are those implemented in Germany. The limits are:

- A maximum of 30 hours per year and 30 minutes per day of astronomical maximum shadow (worst-case);
- A maximum of 8 hours per year for real shadow impact.

The limit is based on the following:

- The angle of the sun over the horizon must be at least 3 degrees; and
- The blade of the wind turbine must cover at least 20% of the sun.

Other European countries refer to German regulations with some minor modifications. For example, although no official guidelines have been set, Sweden and Demark use the 10-hour criterion for real shadow impact rather than 8. In the UK, no official limits are in force, however an assessment is required at all dwellings within 10 rotor diameters of turbine locations. In both the Republic of Ireland and Northern Ireland a worst-case limit of 30 hours per year, 30 minutes per day has been set.

In Australia, the Victorian guidelines specify a limit of 30 hours per year whereas the South Australian development plan suggests that shadows need only be considered out to a distance 500 m from the turbine.

One commonality in most regulations is the 30 hours per year limit which, according to the Australian Environment Protection and Heritage Council (EPHC, 2010), appears to be based on a German court ruling which set this as the acceptability limit for a particular wind farm. Subsequent studies have supported its use as a reasonable determinant for acceptable levels of annoyance. The EPHC notes however, that one study concluded that setting a limit based on hours per year is overly simplistic, as survey results show that the time of day and year at which shadow flicker occurs is important in determining its annoyance value. In the above court ruling and in the subsequent studies, the 30 hours per year limit is taken as the modelled (worst-case) limit, not the actual amount of shadow flicker, which may be considerably less because of cloud cover. This interpretation is not, however, universal and some regulations (notably in Australia) use 30 hours per year as the actual limit (EPHC, 2010).

For the purpose of this assessment, 30 hours per year of actual shadow impact was adopted as the assessment criterion.

5. METHODOLOGY AND STUDY APPROACH

5.1 ENVIRONMENTAL NOISE IMPACT STUDY

The approach to the environmental noise impact study and its components are discussed in more detail in this section.

5.1.1 Study of the Receiving Acoustic Environment

A study of the receiving acoustic environment was made by referring to:

- The results of a short-term baseline noise survey conducted by Airshed.
- The identification of potential noise sensitive receptors; and
- Details on the physical environment i.e. meteorology, land-use and topography and how these factors affect local atmospheric noise propagation.

The extent of noise impacts as a result of an intruding noise depends largely on existing noise levels in an area. Higher ambient noise levels will result in less noticeable noise impacts and a smaller impact area-the opposite also holds true. Increases in noise will be more noticeable in areas with low ambient noise levels. For WEFs both ambient and wind turbine noise increase with wind speed.

The survey methodology, which closely followed guidance provided by the IFC (2007), is summarised below:

- The survey was designed and conducted by a trained specialist on 17, 18 and 19 October 2016 at five sites (Figure 10 and Figure 11).
- Sampling was carried out using a Type 1 sound level meter (SLM) that meet all appropriate IEC standards and is subject to calibration by an accredited laboratory (Annex A). Equipment details are included in Table 5.
- The acoustic sensitivity of the SLM was tested with a portable acoustic calibrator before and after each sampling session and found to be within acceptable limits.

- Samples, 10 to 15 minutes in duration, representative and sufficient for statistical analysis were taken with the use of the portable SLM capable of logging data continuously over the sampling time period. Samples representative of the day- and night-time acoustic environment were taken.
- L_{Aeq} (T); L_{AFmax}; L_{AFmin}; L_{A90} and 3rd octave frequency spectra were recorded.
- The SLM was located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Measurements are not affected by residual noise and extraneous influences, e.g. electrical interference and any other non-acoustic interference, and the instrument was operated under the conditions specified by the manufacturer.
- A detailed electronic log and record was kept. Records included site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

Table 5: Sound level meter details

Equipment	Serial Number	Purpose	Last Calibration Date
Brüel & Kjær Type 2250 Lite SLM	S/N 2731851	Attended 15 to 30-minute sampling.	26 January 2016
Brüel & Kjær Type 4950 ½" Pre-polarized microphone	S/N 2709293	Attended 15 to 30-minute sampling.	26 January 2016
SVANTEK SV33 Class 1 Acoustic Calibrator	S/N 57649	Testing of the acoustic sensitivity before and after each daily sampling session.	14 June 2016

NSRs generally include private residences, community buildings such as schools, hospitals and any publicly accessible areas outside a facility/development property boundary. VRA supplied a list of specific NSRs to be included in the assessment. Other homesteads and residential areas which were included in the assessment as NSRs were identified from available satellite imagery and during visits to site.

5.1.2 Source Inventory

Wind turbine noise, its characteristics and origins, have been discussed in detail in Section 3.1.3. A-weighted noise emissions, L_{WA}'s as it is referred to, as per the specifications for the GE 1.7-103 units were applied in the study. For both the preferred and alternative layouts the normal operational mode with and without the LNTE and NRO were considered (Table 2, page 23). The reference L_{WA} without the LNTE is 107 dBA. With the LNTE, the L_{WA} is 105 dBA which can be reduced down to 100 dBA with NRO.

5.1.3 Noise Propagation Simulations

As per the requirements and ToR of the project, use was made of WindPRO and its BASIS and DECIBEL modules. To calculate the noise impact of one or more wind turbines, WindPRO requires the following information:

- Wind turbine positions and elevation;
- Wind turbine hub height and noise emissions $L_{WA,\ ref}$ at one or more wind speeds and if possible, at different frequencies;
- Pure tone contents in wind turbine noise;
- The location of NSRs;
- Impact criteria; and
- The required calculation model.

For the study of noise impacts from WPP2, use was made of the International Organisation for Standardization's (ISO) 9613-2 model 'Acoustics, Attenuation of sound during propagation outdoors, Part 2: General method of calculation'. With the ISO 9613-2 model, the user has access to all the parameters available in WindPRO.

5.1.3.1 ISO 9613

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favourable to propagation from sources of known sound emission. These conditions are for downwind propagation or, equivalently, propagation under a well-developed moderate ground based temperature inversion, such as commonly occurs at night.

The method also predicts an average A-weighted sound pressure level. The average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions. The method specified in ISO 9613 consists specifically of octave-band algorithms (with nominal midband frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following physical effects; geometrical divergence, atmospheric absorption, ground surface effects, reflection and obstacles. A basic representation of the model is given in the equation below:

$$L_P = L_W - \sum [K_1, K_2, K_3, K_4, K_5]$$

where;

- $\boldsymbol{L_P}$ *is the sound pressure level at the receiver;*
- $\boldsymbol{L_W}$ *is the sound power level of the source;*
- $\boldsymbol{K_1}$ *is the correction for geometrical divergence;*
- $\boldsymbol{K_2}$ *is the correction for atmospheric absorption;*
- $\boldsymbol{K_3}$ *is the correction for the effect of ground surface;*
- $\boldsymbol{K_4}$ *is the correction for reflection from surfaces; and*
- $\boldsymbol{K_5}$ *is the correction for screening by obstacles.*

This method is applicable in practice to a great variety of noise sources and environments.

5.1.3.2 WindPRO Noise Calculation Model Parameters

The WindPRO DECIBEL model setup makes it possible to choose settings from a range of parameters. Settings for the WPP2 are:

- Wind speed: Loudest.

- Octave data: In the absence of octave band source noise data, calculations were limited to the total noise value.
- Ground attenuation: General, terrain specific ground attenuation was selected. WindPRO calculates ground attenuation for each wind turbine-NSR pair as a weighting of hard and soft terrain along line-of sight.
- Meteorological coefficient: Defined to reflect damping due to special meteorological conditions i.e. propagation in the upwind direction. EMD, the developers of WindPro recommend using 0 since for wind turbines, noise is considered for downwind impact
- Type of demand in calculations: Use was made of the fixed 43 dBA guideline (ETSU-R-97, 1996) recommended for night-time for initial noise impact screening.
- Noise values in calculation: as per the ETSU recommendation, L_{A90} noise levels were calculated.
- Pure tones: Since, for modern turbines pure tones are a rare phenomenon, penalties are only applied if the specifications of wind turbines indicate its presence.
- Height of emission point above ground level: NSRs were simulated at 1.5 m above ground level.
- Deviation from official noise demands: None.
- Air absorption: Standard ISO 9613 air absorption coefficients.

Noise levels were simulated over an area of 80 km^2 at 25 m intervals and at NSRs. All simulation parameters are indicated in summary reports generated by WindPRO. These are included in Annex B.

5.1.4 Assumptions and Limitations

The noise impact study is based on a number of assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report.

- Since the loudest L_W were applied in simulations, results presented in this report may be considered conservative since it assumes continuous maximum noise emission levels.
- Wind dependent background noise levels were not available for the study area. The monitoring of baseline noise levels as per the recommendations of the IFC for WEFs (2015) were provided for in the original scope of work for the noise impact assessment.

VRA later changed requirement to short-term spot measurements as a result of time and budget constraints. In determining background noise levels, use was therefore made of average recorded background L_{A90} levels as recommended by ETSU (1996).

- Cumulative impacts are assessed by adding expected impacts from this proposed development to existing and proposed developments with similar impacts in a 20-km radius.

5.2 SHADOW FLICKER STUDY

Shadow flicker impacts were determined using the WindPRO SHADOW module. SHADOW calculates how often and the time of day a specific shadow flicker receptor (SFRs) will be affected by shadows generated by one or more WTGs. These calculations are 'worst-case' or 'astronomical maximum shadow' based solely on the position of the sun relative to WTGs and SFRs. If the weather is overcast or calm, or the rotor plane is parallel with the line between the sun and SFR, the WTG will not produce a shadow impact, but the impact will still appear in calculations.

SHADOW calculates the position of the sun relative to each WTG rotor at 1-minute intervals for a period of one year. If the shadow of the rotor, assumed to be solid, falls on a SFR for a calculation step, it is registered as a minute of shadow impact. SHADOW assumed the following standard parameters:

- The diameter of the sun 1 390 000 km
- The distance to the sun 150 000 000 km
- Angle of attack 0.531 degrees

Theoretically, this will result in shadow impacts up to 48 km behind a 45-m rotor. However, shadows would not reach the theoretical maximum due to the optical characteristics of the atmosphere. When the sun is very low on the horizon the shadow dissipates before it reaches the receptor. Exactly how far a shadow will be visible is not known but German guidelines have set a limit of 2.5 km or coverage of 20% of the sun disk, whichever is the shortest.

SFRs are objects for which the potential risk for shadow impact is calculated. Since very little is known about the orientation and construction of SFRs in the study area, use is made of the "greenhouse" mode which conservatively assumes the receptor faces all directions.

Furthermore, wind WTGs that are not within line of sight were excluded from calculations. The calculation is done using terrain data.

Shadow impacts were calculated for 'worst-case' and 'real' conditions. Worst-case, as discussed earlier, assumes no clouds, the wind direction aligned with WTG and SFR, and continuous operation. Circumstances more representative of 'real' conditions were taken into account by specifying (a) monthly sunshine possibilities, and (b) wind direction statistics.

Data on the former was obtained from Weatherbase at www.weatherbase.com[1], the closest reporting site to WPP2. Wind statistics were obtained from the report by Lahmeyer International (2015) for WPP2. It was still conservatively assumed that wind turbines will be operational all hours of the year. Monthly sunshine possibilities and wind direction statistics as applied in calculations are graphically presented in Figure 8 and Figure 9 respectively. All SHADOW model inputs and results reports are included in Annex C.

[1] http://www.weatherbase.com/weather/weatherall.php3?s=601993&cityname=Anloga%2C+Volta%2C+Ghana&units=

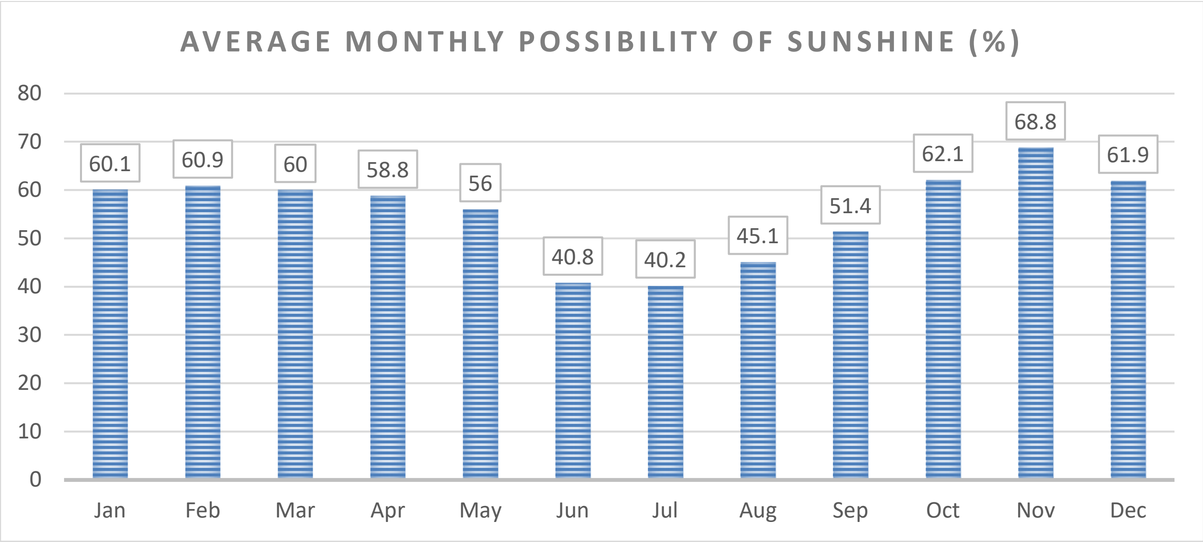


Figure 8: Average monthly possibility of sunshine, www.weartherbase.com

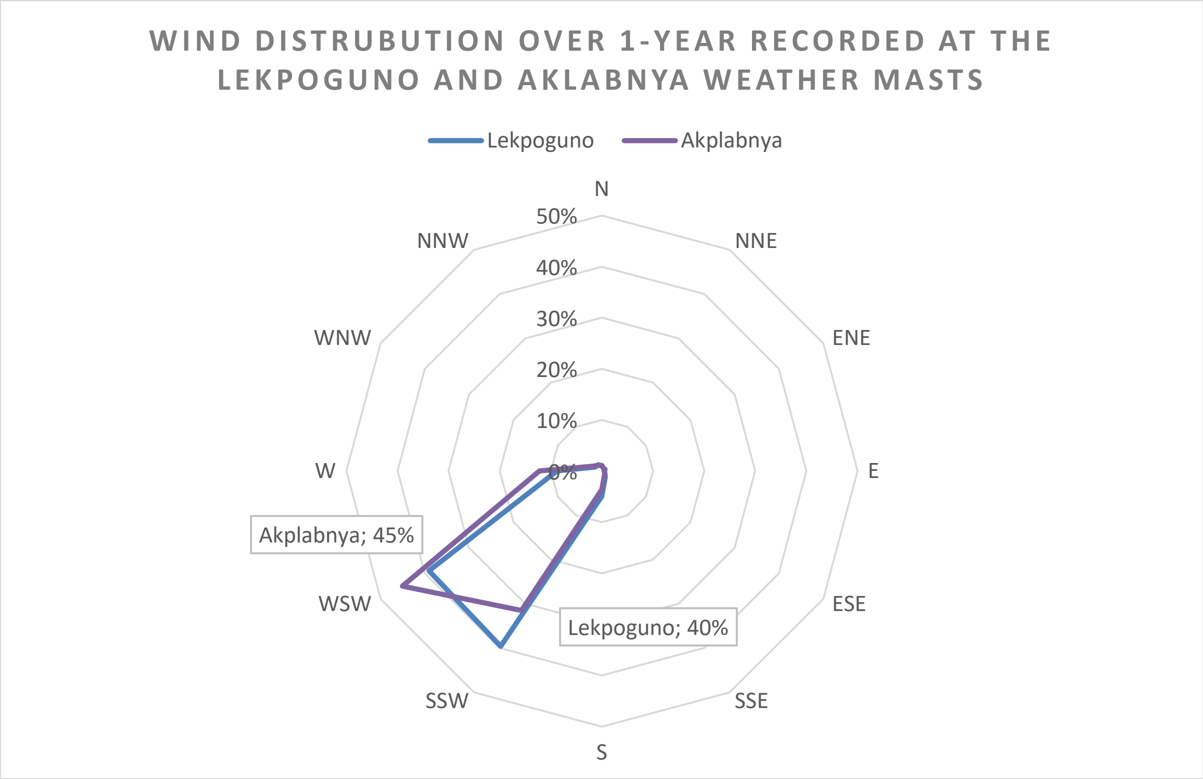


Figure 9: Wind distribution over 1-year at Lekpoguno and Akplabnya

6. DESCRIPTION OF THE BASELINE ENVIRONMENT

6.1 NOISE AND SHADOW SENSITIVE RECEPTORS

Villages likely to be affected by noise and shadow flicker include Omankope (Figure 10), Wokumagbe (Figure 10), Lekpoguno (Figure 10), Akplabnya (Figure 10 and Figure 11), and Goi (Figure 11). These were included as NSR areas. WindPRO, the simulation software, reports the maximum impact within each NSR area and the coordinate where the maximum occurs. The location of maximum impacts within each NSR area are indicated as discrete NSRs and SFRs in Figure 10 and Figure 11. At the request of Interested and Affected Parties (I&AP), several schools and churches were included as discrete NSRs and SFRs as well. A list of all discrete NSRs and SFRs, are listed in Table 6.

Table 6: NSR and SFR coordinates

Ref. no	Description	Easting	Northing	WPP2 Section
1	Omankope, Christ the Supreme Ministry Church	201883	640658	Lekpoguno
2	Omankope	201927	640701	Lekpoguno
3	Omankope, Panya Guest House	201956	640377	Lekpoguno
4	Omankope, Mozoma Disco Christo Church	201959	640324	Lekpoguno
5	Omankope	201968	640678	Lekpoguno
6	Omankope, Presbyterian Primary School	202003	640962	Lekpoguno
7	Lekpoguno	202913	640361	Lekpoguno
8	Wokumagbe	202943	640588	Lekpoguno
9	Wokumagbe, Baptist Church	203996	640591	Lekpoguno
10	Wokumagbe, D/A Basic School	204084	640506	Lekpoguno
11	Wokumagbe, K3 International Primary School	204187	640732	Lekpoguno
12	Wokumagbe	204432	640811	Lekpoguno
13	Lekpoguno	204622	640086	Lekpoguno
14	Lekpoguno	204643	640051	Lekpoguno
15	Akplabnya	206300	640617	Lekpoguno
16	Akplabnya	206302	640637	Lekpoguno
17	Akplabnya	210030	641054	Akplabnya
18	Resort/hotel	210781	640592	Akplabnya
19	Goi	212269	640780	Akplabnya
20	Goi	213109	641335	Akplabnya
21	Residence	213374	642321	Akplabnya

6.2 BACKGROUND NOISE LEVELS

Airshed conducted a background noise survey on 17, 18 and 19 October 2016 at the sites indicated in Figure 10 and Figure 11. The results of the survey are summarised in this section with detailed results included in Annex D.

During the survey, a slight breeze from the south-southwest with average wind speeds between 1.7 and 2.2 m/s was recorded; ambient air temperature was between 22.9 ºC and 30.8 ºC, humidity was between 69% and 80.4%, with some cloud cover.

Measurements and observations indicate noise levels influenced by noise from the ocean (waves breaking on the beach) and community activities, specifically road traffic and farming. Natural sources of noise include wind rustling trees and other vegetation, birds, frogs, and insects. Background noise levels reduce as one moves further away from the ocean and community activities.

Despite reduced community activity at night, night time noise levels were frequently found to be higher than during the day. This is mostly attributed to increased frog and insect noise but may also be a result of noise from the ocean surf which will propagate further during night-time conditions.

As per the recommendation of ETSU, background noise levels at NSRs were determined based on average L_{A90} values rather than extremes. Since background noise levels are highly variable throughout the study area, different background noise levels were assigned to NSRs depending on their location in relation to community activities, roads, the ocean, and measurement locations. These assignments are summarised in Table 8. Note that background noise levels could not be determined at different wind speeds. Levels used in this assessment are for low wind speed conditions which prevailed during measurements.

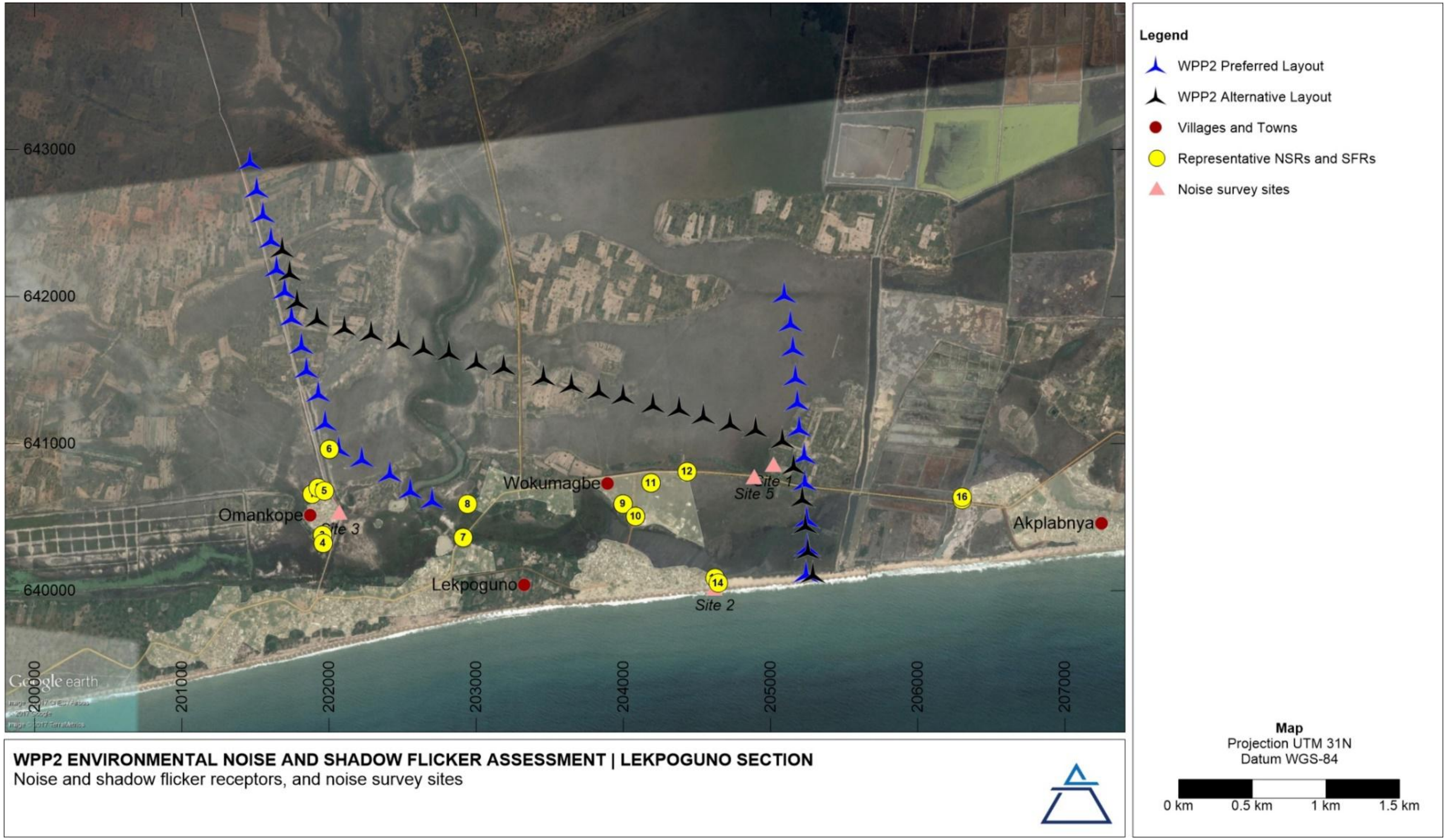


Figure 10: Noise sensitive and shadow receptors around the Lekpoguno section of WPP2

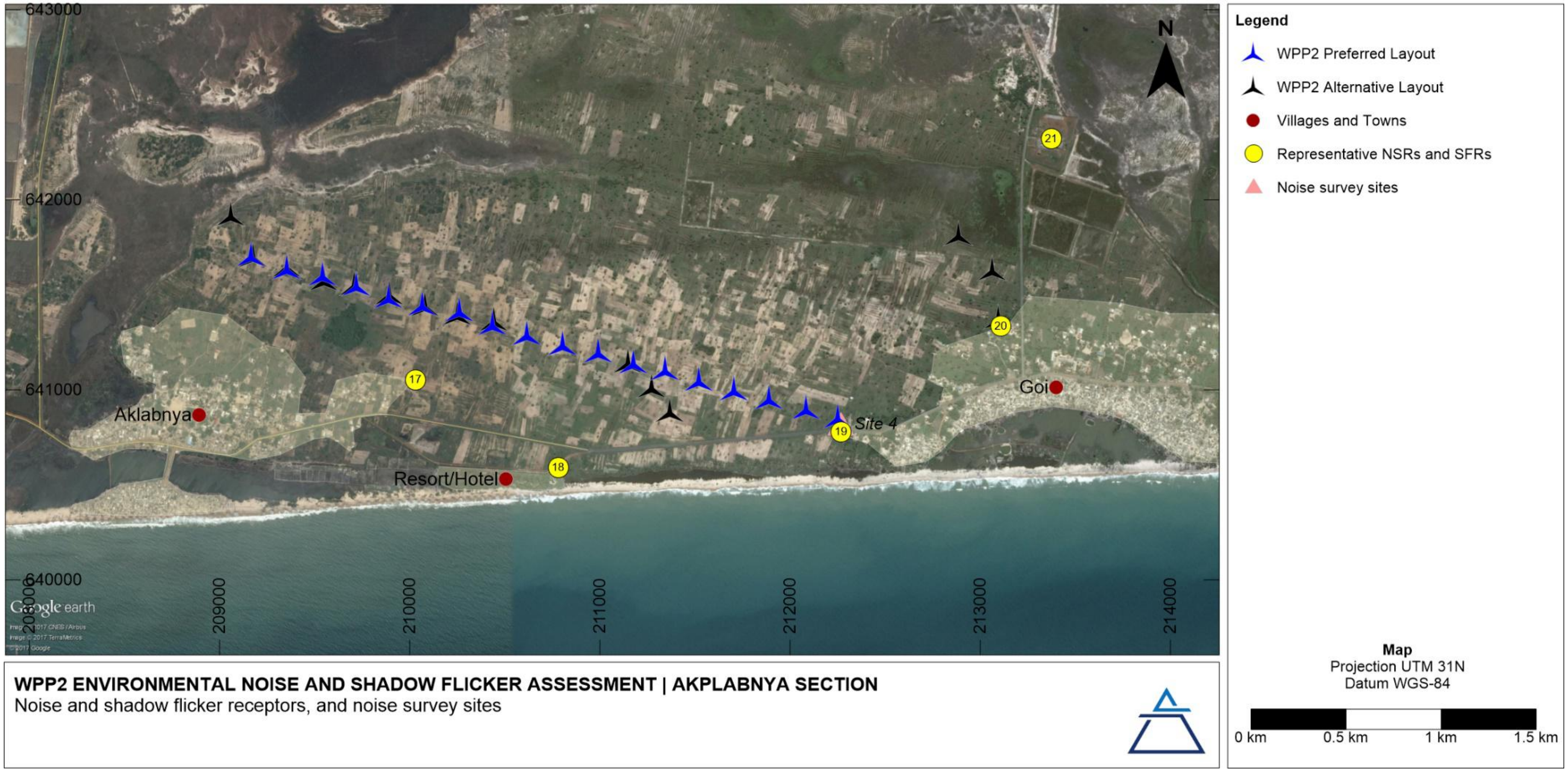


Figure 11: Noise sensitive and shadow receptors around the Akplabnya section of WPP2

Table 7: Summary of background noise data, L_{A90}, as measured and reported by Airshed and VRA

Site	Description	Coordinates	Measurement date and time	Notes and observations	L_{A90} in dBA (duration)	
					Day-time	*Night-time*[(a)]
Site 1	Lekpoguno, in a field approximately 120 m north of the road.	0.336517° E 5.791610° N	Day-time 17/10/2016 13:39	Background noise levels affected by road traffic, insects, birds and frogs. Wind generated noise in mangroves, trees and other vegetation.	33.4 (15 min)	-
Site 2	Lekpoguno, on the beach	0.332970° E 5.783984° N	Day-time 17/10/2016 14:23	Ocean surf, wind.	54.8 (15 min)	-
Site 3	Omankope	0.309941° E 5.788538° N	Day-time 17/10/2016 16:07 Night-time 17/10/2017 23:54	Community noise, domestic animals, livestock, birds, insects, frogs, and the wind.	37.0 (15 min)	33.6 (10 min)
Site 4	Goi, next to the road	0.401935° E 5.791570° N	Day-time 17/10/2016 16:07	Traffic, community noise, domestic animals, livestock, birds, insects, frogs, and the wind.	42.6 (15 min)	-
Site 5	Between Site 1 and Site 2, along the road between Lekpoguno and Akplabnya	0.335338° E 5.790818° N	Night-time 17/10/2016 22:50	Generally quiet, mostly frogs and insects.	-	47.8 (15 min)

***Notes*:**

(a) For security reasons, night time measurements were discontinued at 23:54 on 17 October 2017.

Table 8: Background L_{A90} at NSRs

Ref. no	Description	Coordinates		Background Noise Level (dBA)	
		Easting	*Northing*	*Day-time*	*Night-time*
1	Omankope, Christ the Supreme Ministry Church	201883	640658	37.0[(a)]	33.6[(a)]
2	Omankope	201927	640701	37.0[(a)]	33.6[(a)]
3	Omankope, Panya Guest House	201956	640377	37.0[(a)]	33.6[(a)]
4	Omankope, Mozoma Disco Christo Church	201959	640324	37.0[(a)]	33.6[(a)]
5	Omankope	201968	640678	37.0[(a)]	33.6[(a)]
6	Omankope, Presbyterian Primary School	202003	640962	37.0[(a)]	33.6[(a)]
7	Lekpoguno	202913	640361	43.5[(b)]	45.0[(d)]
8	Wokumagbe	202943	640588	43.5[(b)]	45.0[(d)]
9	Wokumagbe, Baptist Church	203996	640591	43.5[(b)]	45.0[(d)]
10	Wokumagbe, D/A Basic School	204084	640506	43.5[(b)]	45.0[(d)]
11	Wokumagbe, K3 International Primary School	204187	640732	43.5[(b)]	45.0[(d)]
12	Wokumagbe	204432	640811	43.5[(b)]	45.0[(d)]
13	Lekpoguno	204622	640086	54.8[(c)]	54.8[(c)]
14	Lekpoguno	204643	640051	54.8[(c)]	54.8[(c)]
15	Akplabnya	206300	640617	43.5[(b)]	45.0[(d)]
16	Akplabnya	206302	640637	43.5[(b)]	45.0[(d)]
17	Akplabnya	210030	641054	43.5[(b)]	45.0[(d)]
18	Resort/hotel	210781	640592	54.8[(c)]	54.8[(c)]
19	Goi	212269	640780	42.6[(e)]	45.0[(d)]
20	Goi	213109	641335	42.6[(e)]	45.0[(d)]
21	Residence	213374	642321	43.5[(b)]	45.0[(d)]

***Notes*:**

(a) Reference, site 3

(b) Reference, average of site 1, 3, and 5

(c) Reference, site 2. Because of the ocean, day- and night-time noise levels at residents close to the beach are expected to be similar.

(d) Reference, average of site 2 and 5.

(e) Reference, site 4.

7. NOISE AND SHADOW FLICKER IMPACTS

In this section, the results of noise and shadow flicker simulations are discussed in more detail.

7.1 ENVIRONMENTAL NOISE

7.1.1 Construction and Decommissioning Phases

Table 9 lists diesel mobile equipment that might be used in the construction of roads, platforms and erection of WTGs, and typical L_{WA}'s for such equipment. L_{WA}'s were sourced from the British Standard BS 5228-1:2009 code of practice for noise and vibration on construction and open sites (BSI, 2008). Resulting L_{Aeq} at 10 m, 100 m and 500 m from each activity or piece of equipment is also included in Table 9 and compared to the day-time Ghana EPA noise standard of 55 dBA. L_{Aeq}'s were calculated assuming hemispherical propagation and by conservatively not taking into account atmospheric and ground attenuation.

The impact of most activities reduces to below the Ghana EPA noise standard and IFC guideline for residential areas within 30 m to 350 m from the activity or piece of operational equipment. During the demolition of WTG platforms, the breaking of concrete may result in impacts up to 700 m from the platform.

The European Commission (EC) Working Group for the Assessment of Environmental Noise (WG-AEN) developed default area based L_{WA}'s for heavy industrial, light industrial, commercial, and port activities that are recommended for use when a detailed source inventory is not available. By assuming that construction and demolition activities within a certain area of activity will generate 65 dBA/m^2, the default for heavy industrial activities (EC WG-AEN, 2006), L_{Aeq} as a function of downwind distance can be calculated assuming hemispherical noise propagation. Figure 12 shows the likely impact area for different sized construction/demolition areas.

Table 9: Noise data for construction and demolition equipment

Activity	Equipment	LWA (dBA)	LAeq (dBA) at distance "d"		
			10 m	100 m	500 m
Sound level data on site preparation					
Clearing site	Dozer (142 kW)	103	75[a]	55	41
	Tracked excavator (102 kW)	106	78	58	44
	Wheeled backhoe loader (62 kW)	96	68	48	34
Distributing of material	Articulated dump truck (tipping fill) (187 kW)	102	74	54	40
	Articulated dump truck (187 kW)	109	81	61	47
Earthworks	Dozer (142 kW)	109	81	61	47
	Tracked excavator (226 kW)	107	79	59	45
Loading lorries	Tracked excavator (75 kW)	107	79	59	45
	Wheeled loader (193 kW)	108	80	60	46
Rolling and compacting	Dozer (towing roller) (142 kW)	109	81	61	47
	Hydraulic vibratory compactor (tracked excavator)	106	78	58	44
	Vibratory roller (29 kW)	102	74	54	40
Sound level data on piling and ancillary operations					
Rotary bored piling – cast in situ	Compressor for mini piling (45 kW)	103	75	55	41
	Large rotary bored piling rig	111	83	63	49
	Mini piling rig (29 kW)	104	76	56	42
	Mini tracked excavator (17 kW)	96	68	48	34
	Tracked drilling rig (104 kW)	110	82	62	48
Welding / cutting steel piles	Gas cutter (cutting top of pile)	96	68	48	34
	Generator for welding	101	73	53	39
	Hand-held gas cutter	93	65	45	31
	Hand-held welder (welding piles)	101	73	53	39
Sound level data on general site activities					
Distribution of materials	Articulated dump truck (194 kW)	109	81	61	47
	Fuel tanker lorry	104	76	56	42
	Fuel tanker pumping	100	72	52	38
	Tracked excavator (41 kW)	99	71	51	37
	Wheeled backhoe loader (62 kW)	95	67	47	33
	Wheeled excavator (90 kW)	94	66	46	32
Lifting	Caged material hoist (electric)	96	68	48	34
	Lifting platform (35 kW)	95	67	47	33
	Mobile telescopic crane (260 kW)	110	82	62	48
	Tower crane (51 kW)	105	77	57	43
	Tracked mobile crane (240 kW)	103	75	55	41
	Wheeled mobile crane (275 kW)	98	70	50	36
Miscellaneous	Angle grinder (grinding steel) (2.3 kW)	108	80	60	46
Mixing concrete	Cement mixer truck (discharging)	103	75	55	41
	Concrete mixer truck (216 kW)	108	80	60	46
Power for lighting	Diesel generator (15 kW)	93	65	45	31
	Pumping water (7.5 kW)	93	65	45	31
Power for site cabins	Diesel generator	94	66	46	32

Activity	Equipment	LWA (dBA)	LAeq (dBA) at distance "d"		
			10 m	100 m	500 m
Pumping concrete	Concrete mixer truck (discharging) & concrete pump (pumping)	103	75	55	41
Pumping water	Water pump (diesel) (10 kW)	96	68	48	34
	Water tanker extracting water	107	79	59	45
Dust suppression	Dust suppression unit trailer	106	78	58	44
Sound level data on road construction works					
Earthworks	Articulated dump truck (194 kW)	109	81	61	47
	Bulldozer (250 kW)	114	86	66	52
	Tracked excavator (172 kW)	108	80	60	46
Paving	Asphalt paver (and tipper truck) (94 kW)	112	84	64	50
Road planing	Road planer (185 kW)	110	82	62	48
Rolling and compaction	Road roller (95 kW)	108	80	60	46
Trenching	Tracked excavator (27 kW)	102	74	54	40
	Wheeled excavator (51 kW)	98	70	50	36
Sound level data on demolition					
Breaking up concrete	Breaker mounted on backhoe (59 kW)	120	92	72	58
	Hand-held pneumatic breaker	111	83	63	49
	Pulverizer mounted on excavator (147 kW)	104	76	56	42
Breaking up/cutting steel	Gas cutter	107	79	59	45
	Tracked excavator (74 kW)	111	83	63	49
Crushing concrete	Tracked crusher (172 kW)	110	82	62	48
Dumping rubble	Articulated dump truck (dumping) (250 kW)	108	80	60	46
	Tracked excavator (loading truck) (228 kW)	113	85	65	51

***Notes*:**

(a) Shaded cells indicate exceedance of Ghana EPA day-time noise guideline of 55 dBA

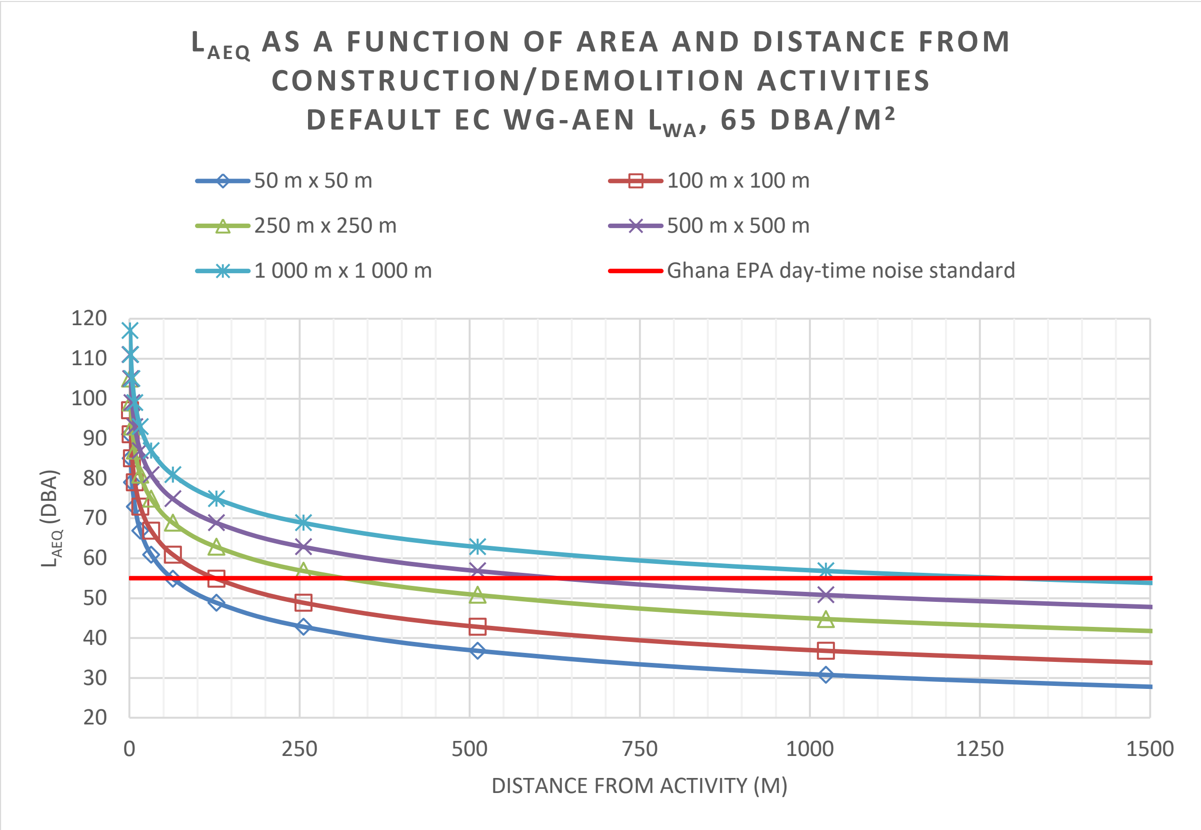


Figure 12: L_{Aeq} as a function of area and distance from construction/demolition activities using the default LWA of 65 dBA/m^2 for heavy industrial activities

7.1.2 Operational Phase

The propagation of noise generated by WPP2 during its operational phase was calculated with WindPRO in accordance with ISO 9613. Site specific acoustic parameters and source data discussed in Section 3.1.3.2, were applied in the model for the following scenarios:

1. Preferred layout, 45 *GE 1.7-103* WTGs:
    a. No LNTE, normal operating mode, reference L_{WA} 107 dBA
    b. LNTE, normal operating mode, reference L_{WA} 105 dBA
    c. LNTE NRO104, normal operating mode, reference L_{WA} 104 dBA
    d. LNTE NRO103, normal operating mode, reference L_{WA} 103 dBA
    e. LNTE NRO102, normal operating mode, reference L_{WA} 102 dBA
    f. LNTE NRO101, normal operating mode, reference L_{WA} 101 dBA

   g. LNTE NRO100, normal operating mode, reference L_{WA} 100 dBA

2. Alternative layout , 45 *GE 1.7-103* WTGs:
   a. No LNTE, normal operating mode, reference L_{WA} 107 dBA
   b. LNTE, normal operating mode, reference L_{WA} 105 dBA
   c. LNTE NRO104, normal operating mode, reference L_{WA} 104 dBA
   d. LNTE NRO103, normal operating mode, reference L_{WA} 103 dBA
   e. LNTE NRO102, normal operating mode, reference L_{WA} 102 dBA
   f. LNTE NRO101, normal operating mode, reference L_{WA} 101 dBA
   g. LNTE NRO100, normal operating mode, reference L_{WA} 100 dBA

Results are presented in tabular form in Table 10 for the preferred layout, and Table 11 for the alternative layout. Simulation results comparing the range of impact areas from WTG arrays, presented as isophones, are included Figure 13 to Figure 16.

An isophone is a line on a map connecting points at which a given variable (in this case L_{A90}) has a specified constant value. This is analogous to contour lines on a map showing terrain elevation. In the assessment of environmental noise, isopleths present lines of constant noise level as a function of distance. Detailed WindPRO reports are included in Annex B.

7.1.2.1 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[2]. 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-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.

The central array of the WPP2 preferred layout (array "B") is not expected to result in noise levels in exceedance of assessment criteria at surrounding NSRs.

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.

[2] The reader is reminded of uncertainties related to background noise measurements and conservative estimates of prevailing baseline noise conditions. Refer to Section 5.1.4 (page 5-4) and Section 6.2 (page 6-2) for more information.

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.

7.1.2.2 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.

Table 10: Simulation results (L_{A90}, dBA) at NSRs for the preferred layout of WPP2

#	Description	Distance to closest WTG (m)	Base	Base with LNTE	LNTE NRO104	LNTE NRO103	LNTE NRO102	LNTE NRO101	LNTE NRO100
1	Omankope, Christ the Supreme Ministry Church	372	47.6[(a)]	45.6[(a)]	44.5	43.5	42.5	41.5	40.6
2	Omankope	313	48.7[(a)(b)]	46.7[(a)]	45.6[(a)]	44.6	43.6	42.6	41.7
3	Omankope, Panya Guest House	599	44.9	42.9	41.8	40.8	39.8	38.8	37.9
4	Omankope, Mozoma Disco Christo Church	646	44.4	42.4	41.3	40.3	39.3	38.3	37.4
5	Omankope	319	48.8[(a)(b)]	46.8[(a)]	45.7[(a)]	44.7	43.7	42.7	41.8
6	Omankope, Presbyterian Primary School	68	55.5[(a)(b)(c)]	53.5[(a)(b)]	52.4[(a)(b)]	51.5[(a)(b)]	50.4[(a)(b)]	49.5[(a)(b)]	48.5[(a)(b)]
7	Lekpoguno	345	45.8[(a)]	43.8	42.7	41.7	40.7	39.7	38.8
8	Wokumagbe	247	47.9[(a)]	45.9[(a)]	44.8	43.9	42.8	41.9	40.9
9	Wokumagbe, Baptist Church	1 248	40.7	38.7	37.6	36.6	35.6	34.6	33.7
10	Wokumagbe, D/A Basic School	1 160	40.8	38.8	37.7	36.8	35.7	34.8	33.8
11	Wokumagbe, K3 International Primary School	1 047	41.7	39.7	38.6	37.6	36.6	35.6	34.7
12	Wokumagbe	803	43.5	41.5	40.4	39.4	38.4	37.4	36.5
13	Lekpoguno	618	43.2	41.2	40.1	39.1	38.1	37.1	36.2
14	Lekpoguno	601	43.2	41.2	40.1	39.1	38.1	37.1	36.2
15	Akplabnya	1 062	40.4	38.4	37.3	36.3	35.3	34.3	33.4
16	Akplabnya	1 066	40.4	38.4	37.3	36.3	35.3	34.3	33.4
17	Akplabnya	405	48.1[(a)(b)]	46.1[(a)]	45	44	43	42	41.1
18	Resort/hotel	653	45.2[(a)]	43.2	42.1	41.1	40.1	39.1	38.2
19	Goi	88	53.8[(a)(b)]	51.8[(a)(b)]	50.7[(a)(b)]	49.7[(a)(b)]	48.7[(a)(b)]	47.7[(a)]	46.8[(a)]
20	Goi	979	38.2	36.2	35.1	34.1	33.1	32.1	31.2
21	Residence	1 839	33.5	31.5	30.4	29.4	28.4	27.4	26.5

Notes:

(a) Exceeds 45 dBA IFC night-time noise guideline.

(b) Exceeds 48 dBA Ghana EPA night-time noise limit.

(c) Exceeds 55 dBA IFC and Ghana EPA day-time noise guideline/limit.

Table 11: Simulation results (L_{A90}, dBA) at NSRs for the alternative layout of WPP2

#	Description	Distance to closest WTG (m)	Base	Base with LNTE	LNTE NRO104	LNTE NRO103	LNTE NRO102	LNTE NRO101	LNTE NRO100
1	Omankope, Christ the Supreme Ministry Church	1172	40.4	38.4	37.3	36.3	35.3	34.3	33.4
2	Omankope	1122	40.8	38.8	37.7	36.8	35.7	34.8	33.8
3	Omankope, Panya Guest House	1431	38.9	36.9	35.8	34.8	33.8	32.8	31.9
4	Omankope, Mozoma Disco Christo Church	1479	38.6	36.6	35.5	34.5	33.5	32.5	31.6
5	Omankope	1139	40.8	38.8	37.7	36.7	35.7	34.7	33.8
6	Omankope, Presbyterian Primary School	853	43	41	39.9	38.9	37.9	36.9	36
7	Lekpoguno	1210	40.9	38.9	37.8	36.8	35.8	34.8	33.9
8	Wokumagbe	982	42.5	40.5	39.4	38.4	37.4	36.4	35.5
9	Wokumagbe, Baptist Church	721	45	43	41.9	40.9	39.9	38.9	38
10	Wokumagbe, D/A Basic School	785	44.6	42.6	41.5	40.5	39.5	38.5	37.6
11	Wokumagbe, K3 International Primary School	551	46.8[(a)]	44.8	43.7	42.7	41.7	40.7	39.8
12	Wokumagbe	412	48.6[(a)(b)]	46.6[(a)]	45.5[(a)]	44.5	43.5	42.5	41.6
13	Lekpoguno	664	44.3	42.3	41.2	40.2	39.2	38.2	37.3
14	Lekpoguno	648	44.2	42.2	41.1	40.2	39.1	38.2	37.2
15	Akplabnya	1 074	40.1	38.1	37	36	35	34	33.1
16	Akplabnya	1 079	40.1	38.1	37	36	35	34	33.1
17	Akplabnya	403	48.1[(a) (b)]	46.1[(a)]	45	44.1	43	42.1	41.1
18	Resort/hotel	649	45.2[(a)]	43.2	42.1	41.1	40.1	39.1	38.2
19	Goi	907	40.5	38.5	37.4	36.4	35.4	34.4	33.5
20	Goi	52	54.7[(a) (b)]	52.7[(a) (b)]	51.6[(a) (b)]	50.6[(a) (b)]	49.6[(a) (b)]	48.6[(a) (b)]	47.7[(a)]
21	Residence	697	39.9	37.9	36.8	35.8	34.8	33.8	32.9

***Notes*:**

(a) Exceeds 45 dBA IFC night-time noise guideline.

(b) Exceeds 48 dBA Ghana EPA night-time noise limit.

(c) Exceeds 55 dBA IFC and Ghana EPA day-time noise guideline/limit

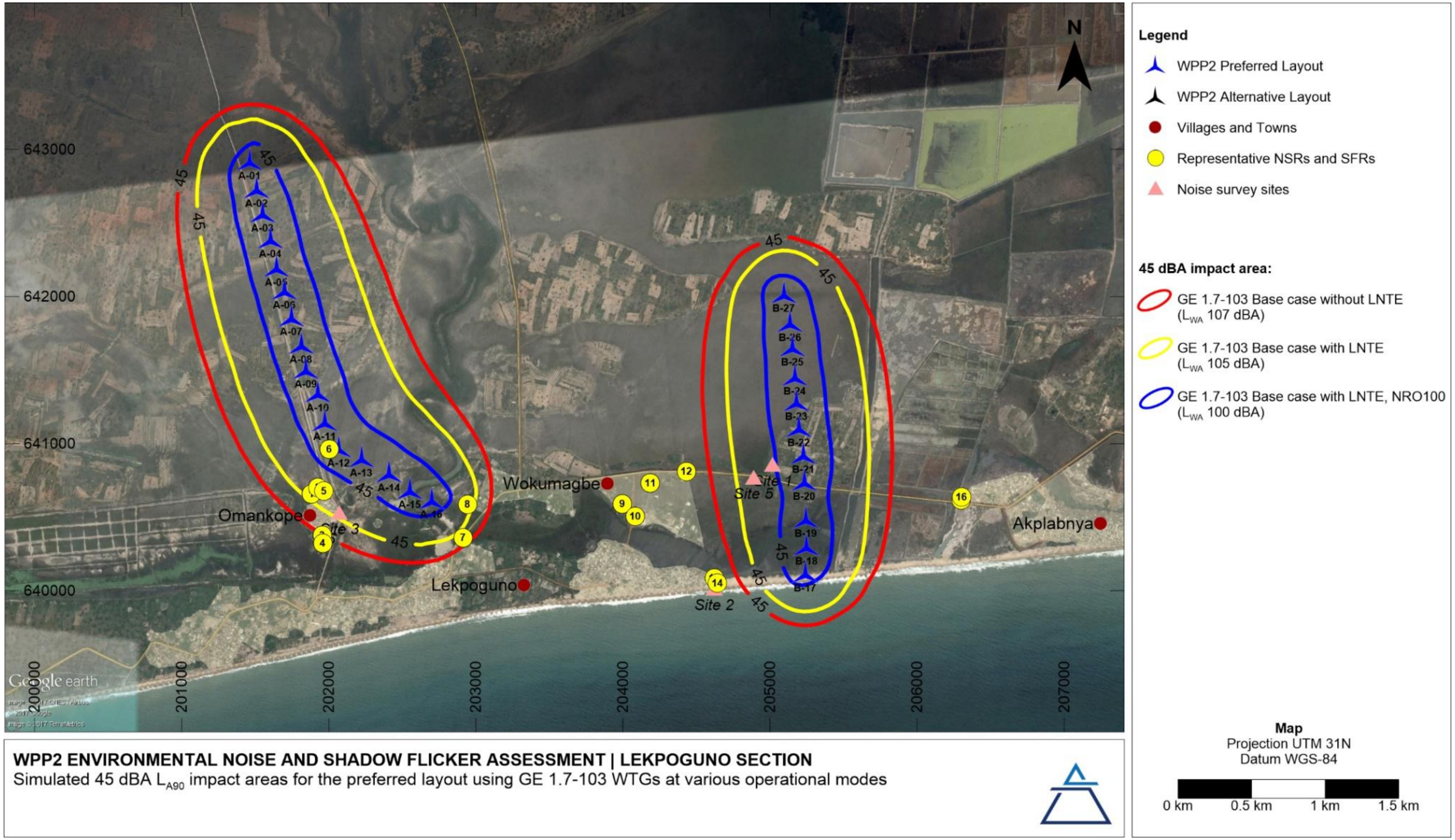


Figure 13: Simulated 45 dBA L_{A90} impact areas for the WPP2 preferred layout, Lekpoguno Section | GE 1.7-103 WTGs

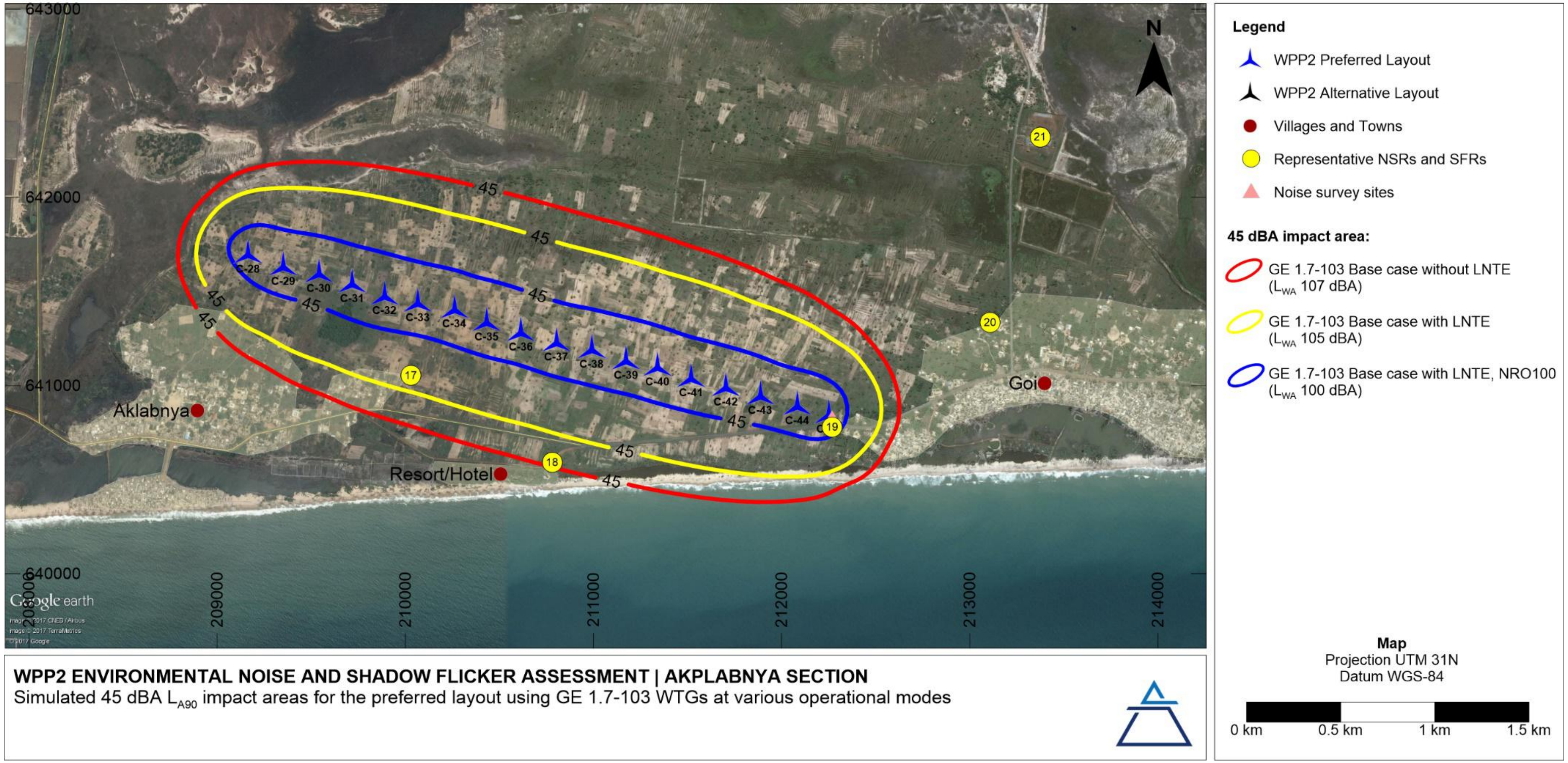


Figure 14: Simulated 45 dBA L_{A90} impact areas for the WPP2 preferred layout, Akplabnya Section | GE 1.7-103 WTGs

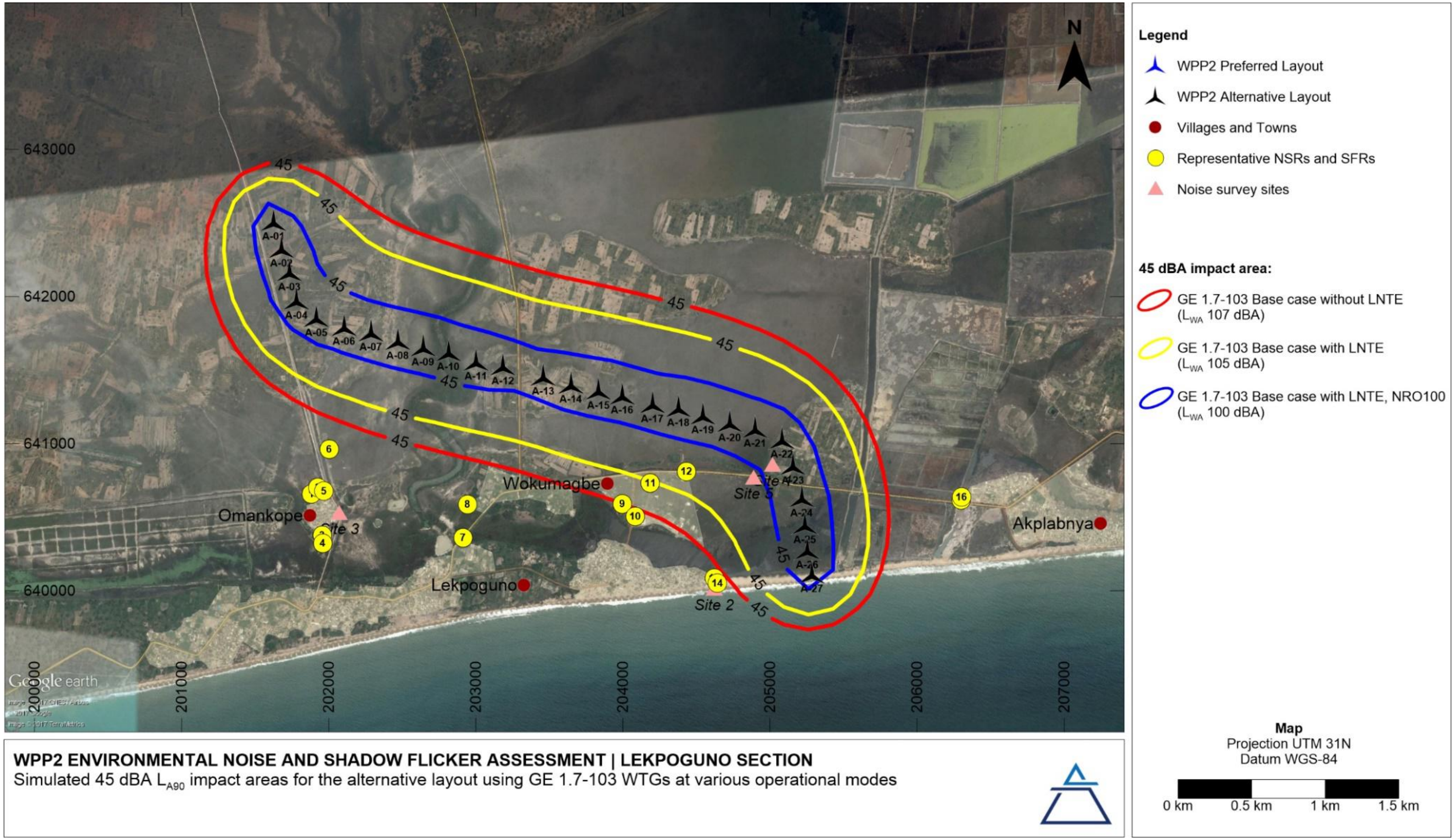


Figure 15: Simulated 45 dBA L_{A90} impact areas for the WPP2 alternative layout, Lekpoguno Section | GE 1.7-103 WTGs

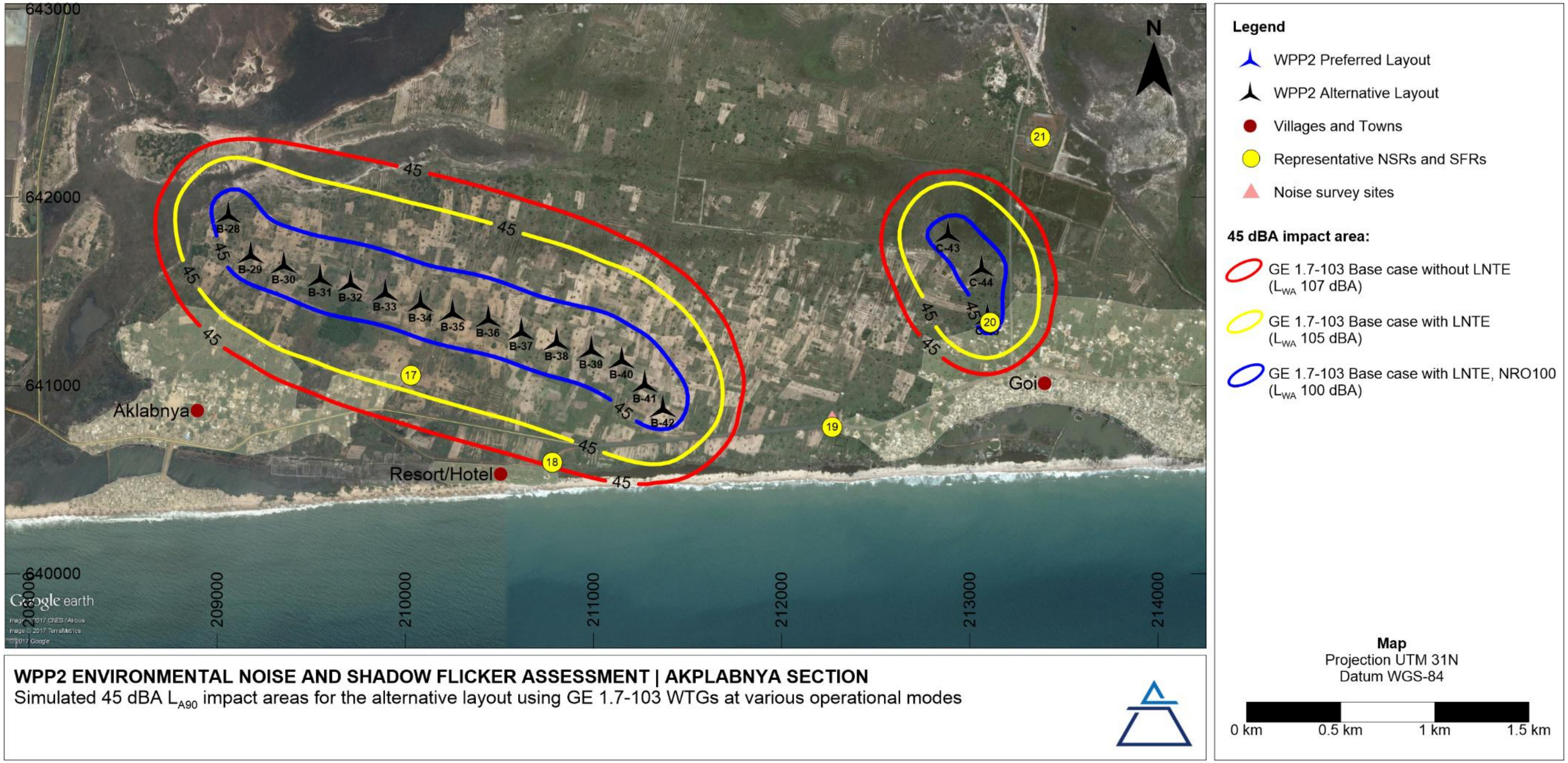


Figure 16: Simulated 45 dBA L_{A90} impact areas for the WPP2 alternative layout, Akplabnya Section | GE 1.7-103 WTGs

7.1.3 Main Findings

In summary:

- 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 around WTG arrays within which permanent residences, educational, and institutional activities must be restricted.

7.2 SHADOW FLICKER

Shadow flicker as a result of WPP2 during its operational phase was calculated with the WindPRO SHADOW module. Model parameters discussed in Section 5.2 were applied in the calculations for the following two scenarios:

1. Preferred layout
2. Alternative layout using

Real estimates of shadow impacts were calculated. Results are presented in tabular form (Table 12) and as isopleths of real shadow hours per year in Figure 18 for the Lekpoguno section of WPP2 and in Figure 19 for the Akplabnya section. The impact area of a single GE 1.7-103 WTG at an 80-m hub height within the WPP2 project area is shown in Figure 17. For detailed WindPRO SHADOW reports, refer to Annex C.

Shadow impacts lie in the east-west plane, more or less parallel to the coastline. The maximum shadow impact of 453 hours per year occurs approximately 50 m to the north-northeast of the WTG (Figure 17). SFRs within 440 m west-southwest or 270 m east-southeast of WTGs may be affected by more than the 30 real shadow hours per year criterion[3].

7.2.1.1 WPP2 Preferred Layout

From the simulation results for the preferred layout (Figure 18), 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 calendar plots in Figure 20 show the time of year and day a specific WTG will cast a shadow on a specific SFR.

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.

7.2.1.2 WPP2 Alternative Layout

Fewer residential dwellings and community locations will be affected by shadow flicker from the alternative layout than the preferred layout. Some residents of the Wokumagbe community (in the vicinity of SFR12) may be exposed to shadow flicker in exceedance of 30 hours per year as a result of WTG nos. 22 to 25. The northern part of Goi will be most affected by shadows cast by WTG no. 45 from 10:30 to 2:30 from April to September every year.

7.2.1.3 Main Findings

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.

[3] Currently, all SFRs lie to the south of WTG arrays.

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 may need to be relocated.

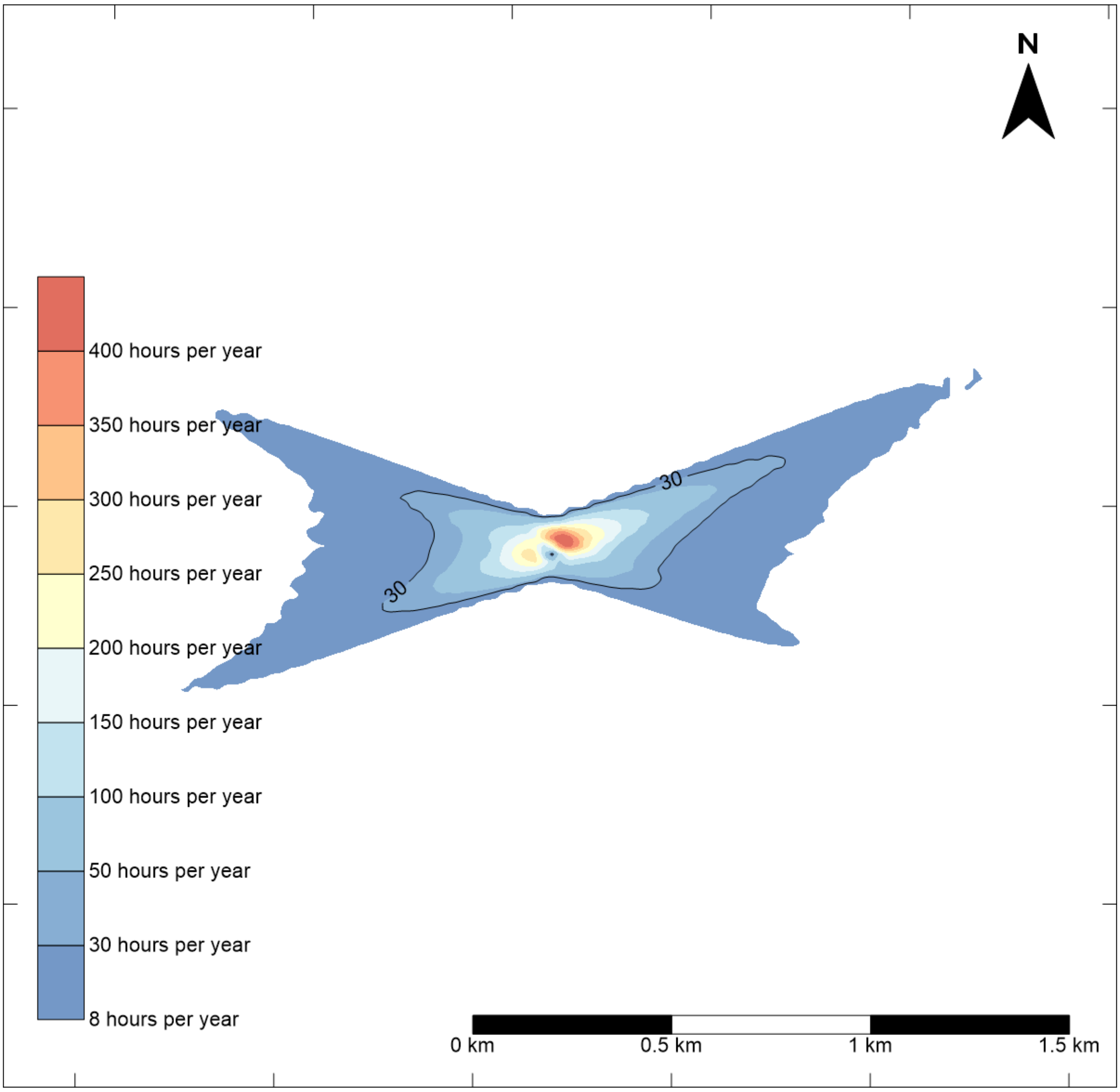


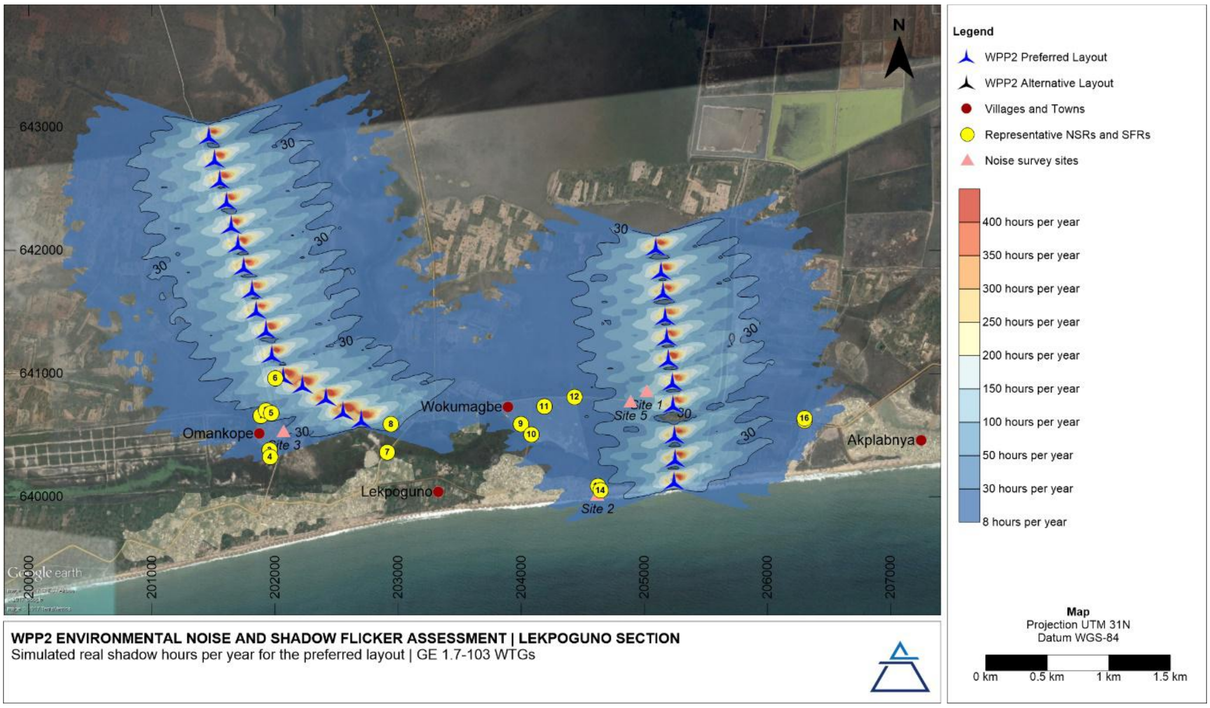
Figure 17: Real shadow impact of a single GE 1.7-103 WTG at an 80-m hub height

Table 12: Simulated shadow hours per year at discrete SFRs

Ref. no.	Description	Preferred Layout		Alternative layout	
		Distance to WTG	***Real shadow hours per year[(a)]***	***Distance to WTG***	***Real shadow hours per year[(a)]***
1	Omankope, Christ the Supreme Ministry Church	372	26:09:00	1 172	0:44:00
2	Omankope	313	26:18:00	1 122	1:18:00
3	Omankope, Panya Guest House	599	10:53	1 431	0:01
4	Omankope, Mozoma Disco Christo Church	646	9:33	1 479	0:01
5	Omankope	319	40:36:00	1 139	1:02:00
6	Omankope, Presbyterian Primary School	68	333:50:00	853	2:31:00
7	Lekpoguno	345	0:11	1 210	0:49
8	Wokumagbe	247	49:02:00	982	1:55:00
9	Wokumagbe, Baptist Church	1 248	12:06	721	12:21
10	Wokumagbe, D/A Basic School	1 160	14:12	785	10:59
11	Wokumagbe, K3 International Primary School	1 047	19:09	551	19:19
12	Wokumagbe	803	27:33:00	412	35:23:00
13	Lekpoguno	618	25:05:00	664	20:48:00
14	Lekpoguno	601	20:49	648	23:37
15	Akplabnya	1 062	15:51	1 074	14:11
16	Akplabnya	1 066	14:33	1 079	11:24
17	Akplabnya	405	25:21:00	403	26:02:00
18	Resort/hotel	653	9:26	649	0:03
19	Goi	88	15:47	907	5:29
20	Goi	979	14:23	52	11:43
21	Residence	1 839	0:00	697	0:00

Notes:

(a) Assessment criterion 30 real shadow hours per year. Shaded cells indicate exceedance of criterion.



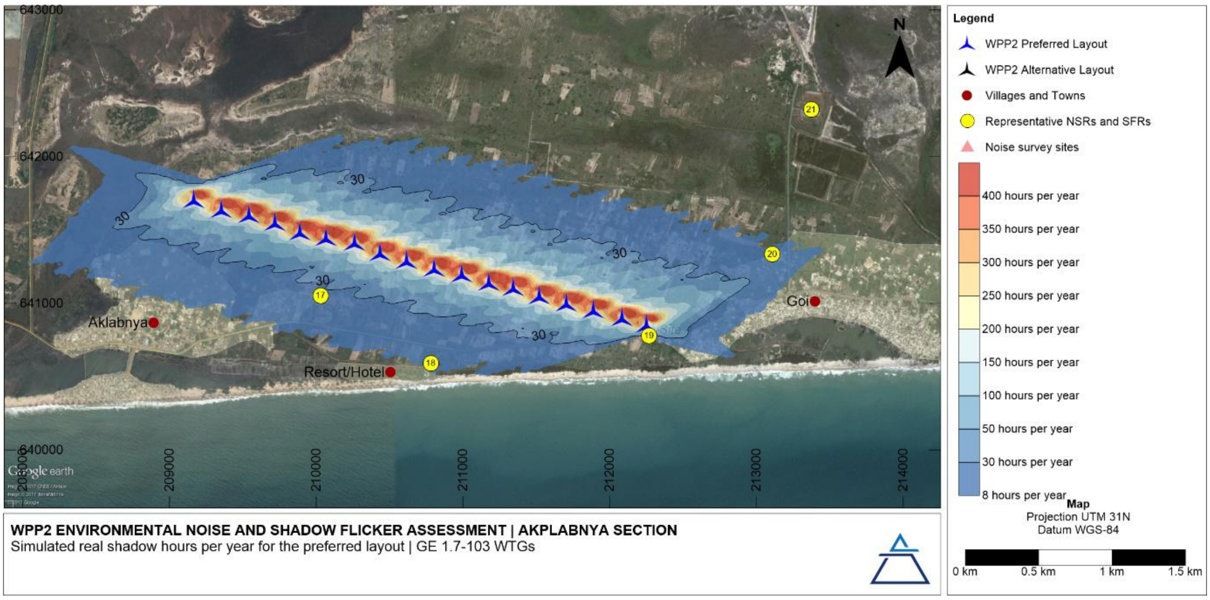
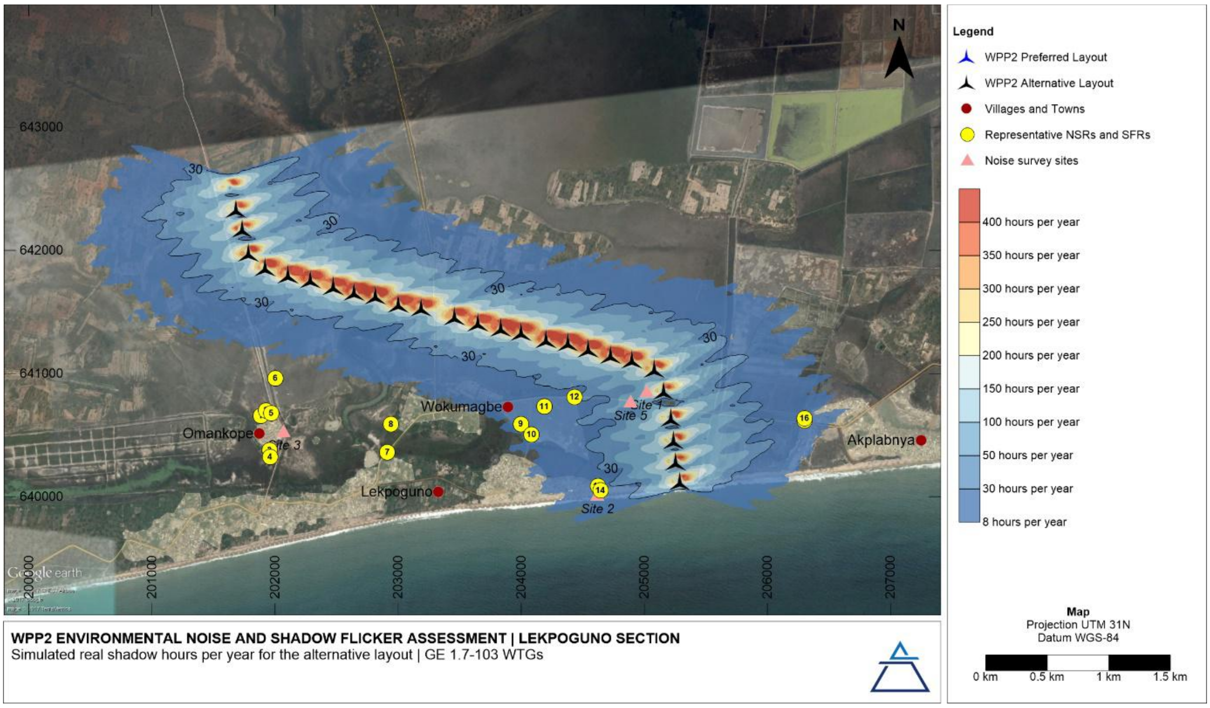


Figure 18: Simulated real shadow hours per year for the WPP2 preferred layout



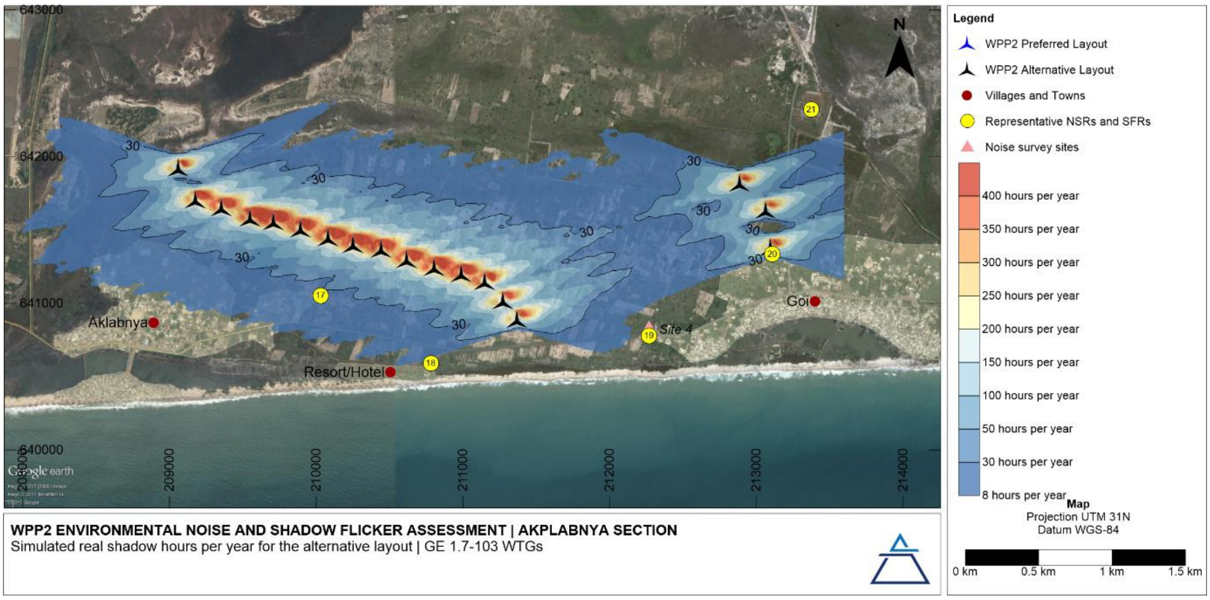


Figure 19: Simulated real shadow hours per year for the WPP2 alternative layout

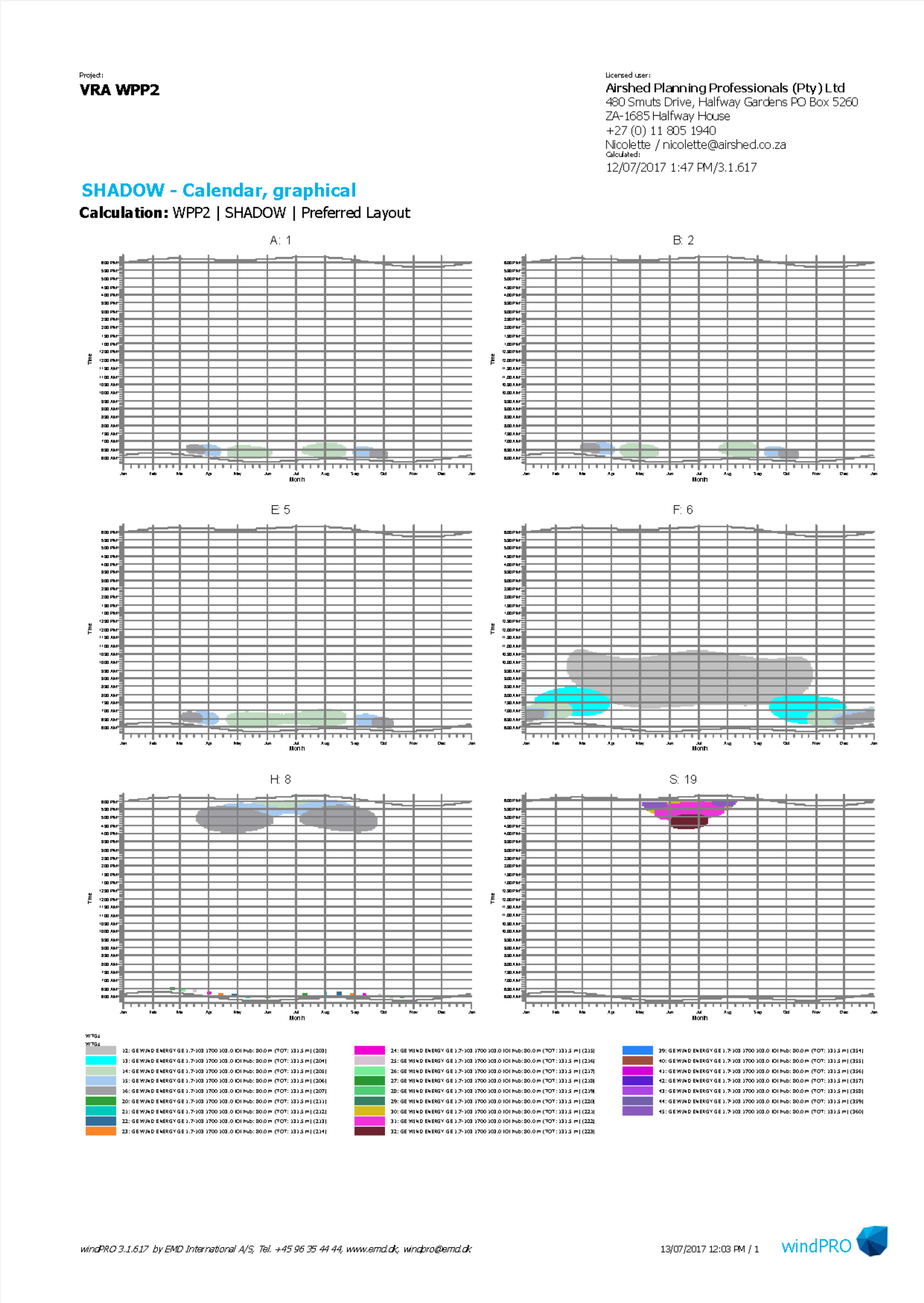


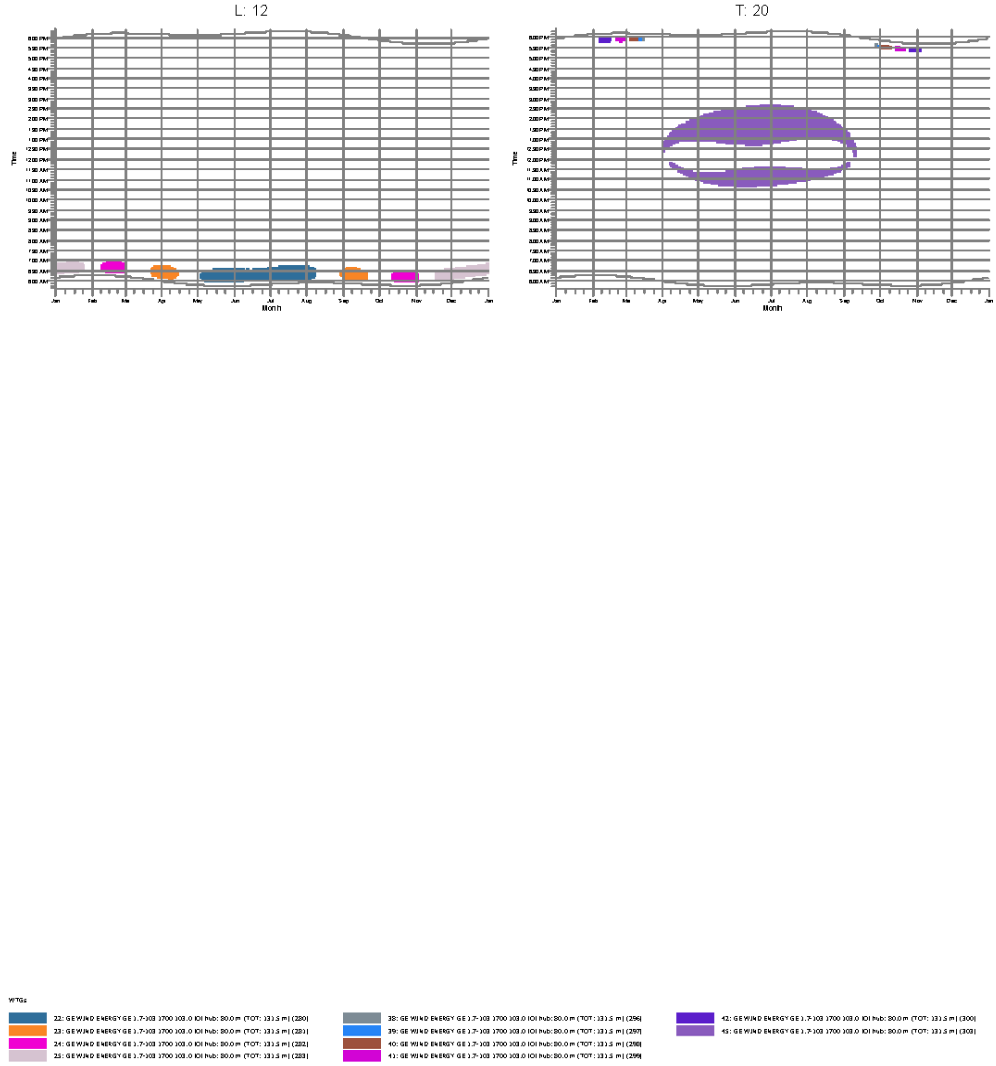
Figure 20: Calendar shadow flicker results for Omankope, Wokumagbe and Goi for the preferred layout of WPP2

Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
12/07/2017 2:27 PM/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Alternative Layout



windPRO 3.1.617 by EMD International A/S, Tel. +45 96 35 44 44, www.emd.dk, windpro@emd.dk 13/07/2017 12:09 PM / 1 windPRO

Figure 21: Calendar shadow flicker results for Wokumagbe and Goi for the alternative layout of WPP2

8. SIGNIFICANCE ASSESSMENT AND MITIGATION MEASURES

8.1 ENVIRONMENTAL NOISE

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. Whereas the significance of construction and decommissioning phase impacts are hereafter assessed based on 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.

To determine the significance of noise impacts, the assessment of the CSIR's prescribed methodology was adopted (refer to Chapter 1 of the ESIA report). It allows for the assessment of direct, indirect as well as cumulative impacts, without and with mitigation and management.

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 impact with proposed developments within 20 km are however also considered if applicable.

The significance of environmental noise impacts associated with the proposed **construction** of WPP2 is considered *medium* for both the preferred and alterative layout (Table 13 and Table 15) since there are several NSRs within 500 m of WTGs. 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. Such measures proposed for adoption in the WPP2 environmental management plan are discussed in detail in Section 8.1.1, and entails general good practice for managing environmental noise impacts from these phases and the relocation of the Omankope Presbyterian Primary School.

Operational phase noise impacts associated with the preferred and alternative layout are anticipated to be of *medium* significance (Table 14). 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. Specific measures for the mitigation and management of noise during the operational phase are discussed in more detail in Section 8.1.2. With these measures implemented, the significance of the residual impact can be reduced to *low*.

The significance of environmental noise impacts associated with the **decommissioning** of WPP2 is considered *low* for both the preferred and alterative layout. 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 in Section 8.1.1, and entails general good practice for managing environmental noise impacts.

8.1.1 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.

8.1.1.1 Compulsory Measures

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. Once the source or sources of noise resulting in complaints have been identified, appropriate good practice measures (Section 8.1.1.2) must be implemented.

8.1.1.2 Good Practice Measures

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.

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 any 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.

8.1.1.3 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.

8.1.2 Operational Phase

The main impact of the operational phase is disturbance as a result of increased environmental noise levels caused by operating WTGs.

The impact for both alternatives is local in extent, long-term in duration, and highly reversible and with highly likely probability. Without mitigation, the impact significance rating is medium. It can be reduced to low significance if the recommended management and mitigation measures are adopted and adhered to.

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).

The measures recommended and discussed below are compulsory for WPP2.

8.1.2.1 WTG Design

It is recommended that the GE 1.7-103 WTG *with the LNTE* be selected for WPP2.

8.1.2.2 Reduced Noise Operating Modes

To reduce and minimise noise impacts on NSRs, reduced operational modes are recommended for the following WTGs:

- WPP2 preferred layout, 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 alternative layout, 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

Isophones for WPP2 given the recommendations above, are included in Figure 13to Figure 16.

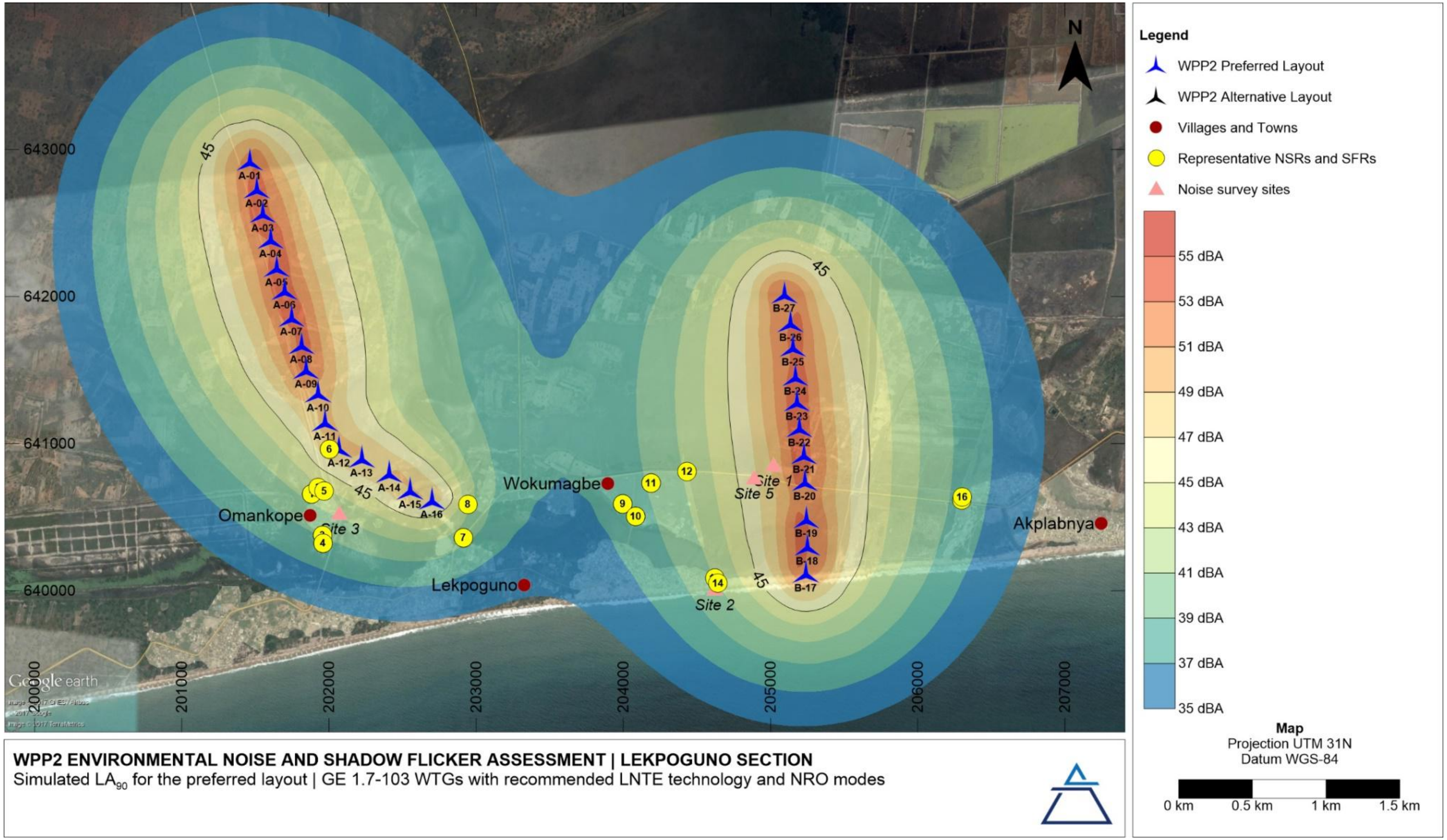


Figure 22: Simulated L_{A90} for the WPP2 preferred layout, Lekpoguno Section | GE 1.7-103 WTGs with recommended LNTE technology and NRO modes

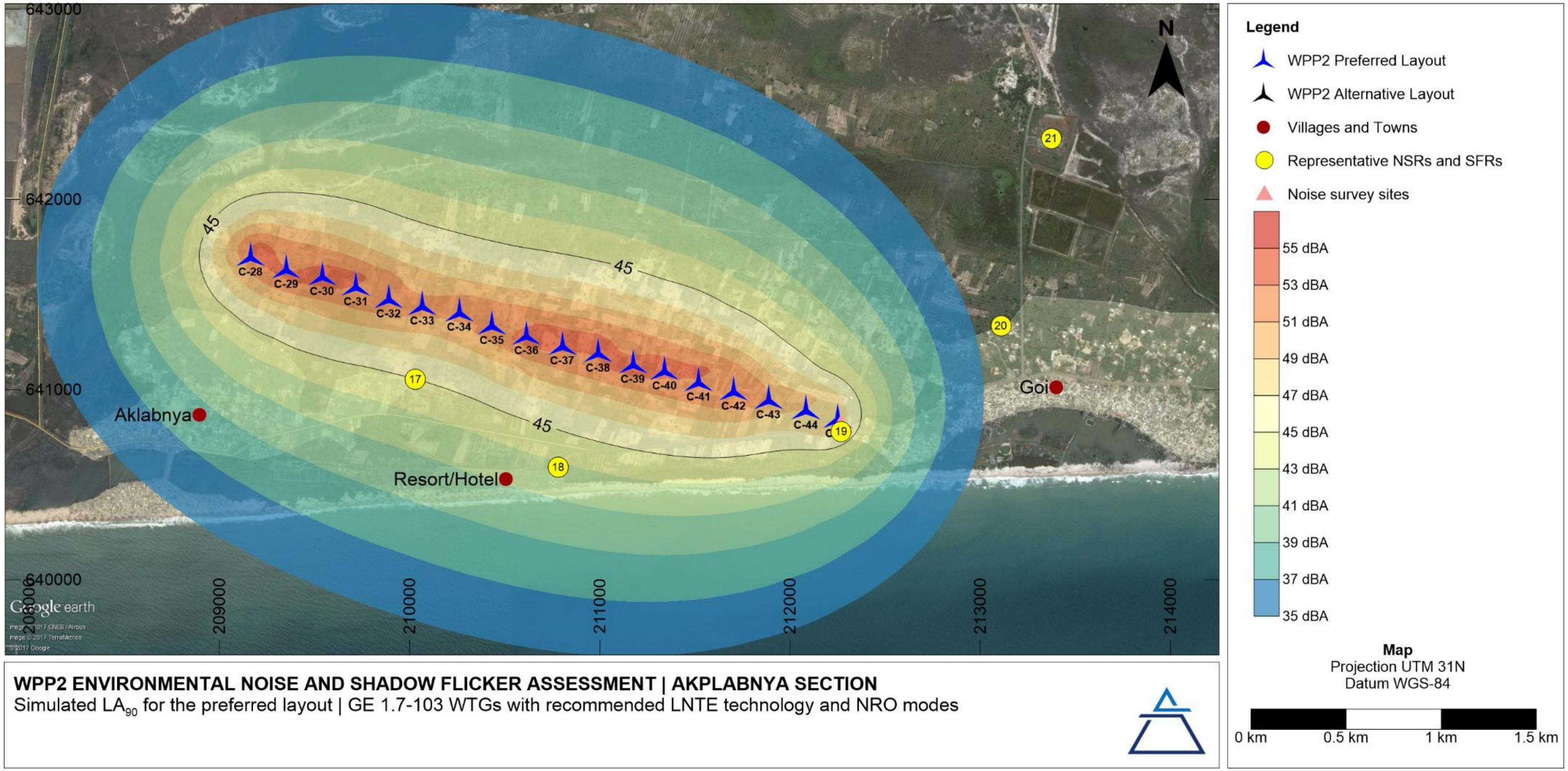


Figure 23: Simulated L_{A90} for the WPP2 preferred layout, Akplabnya Section | GE 1.7-103 WTGs with recommended LNTE technology and NRO modes

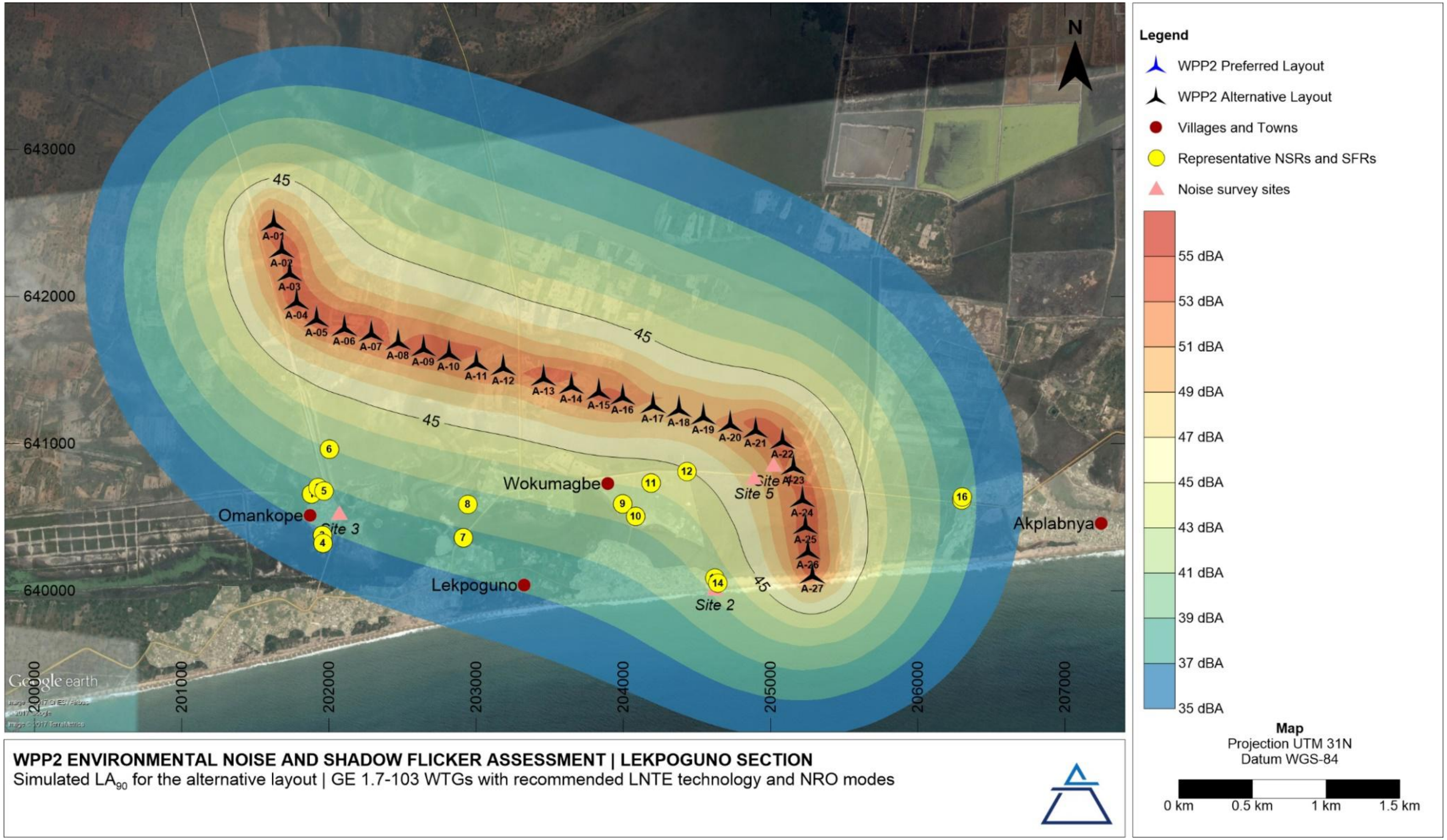


Figure 24: Simulated L_{A90} for the WPP2 alternative layout, Lekpoguno Section | GE 1.7-103 WTGs with recommended LNTE technology and NRO modes

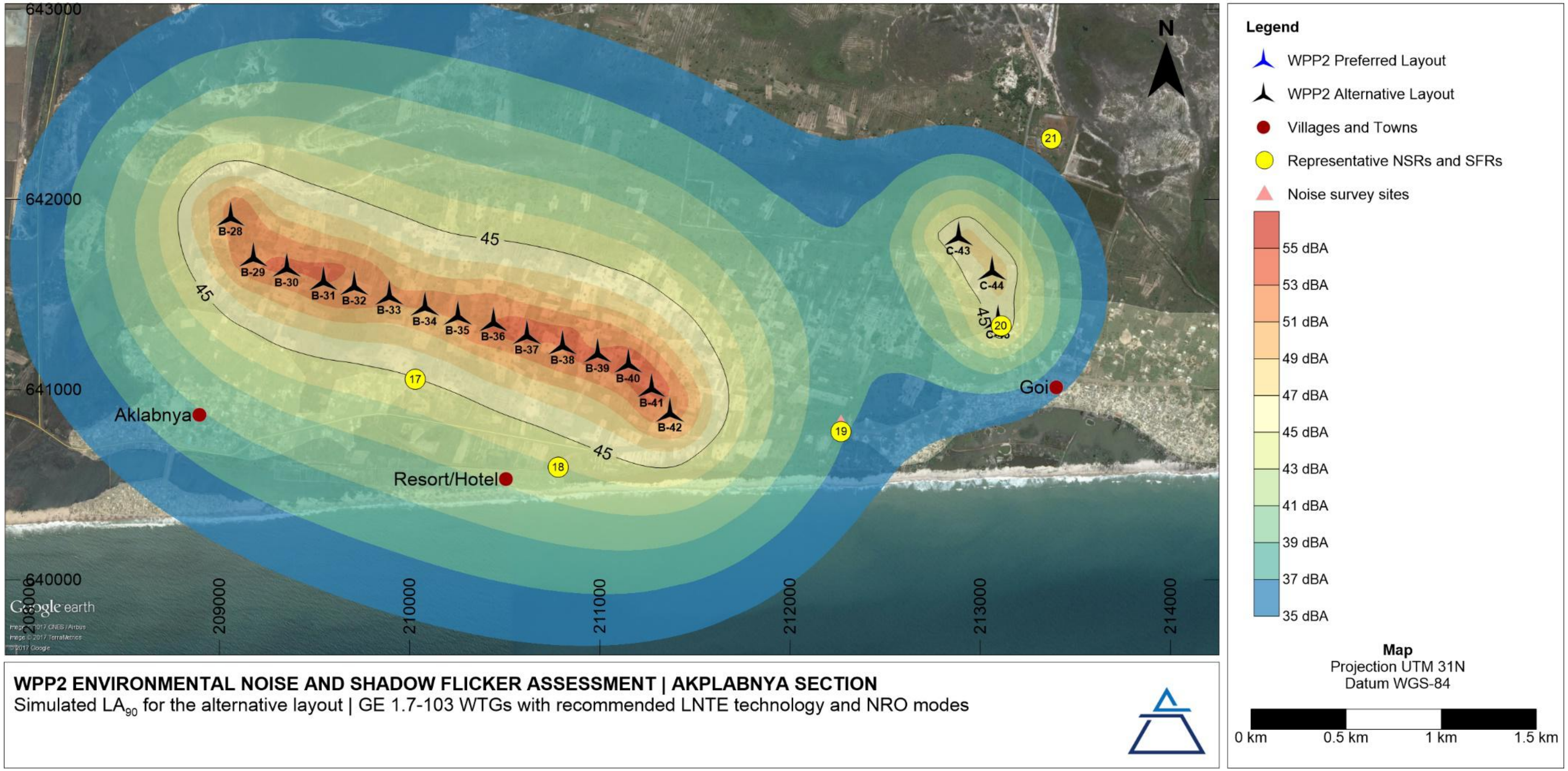


Figure 25: Simulated L_{A90} for the WPP2 alternative layout, Akplabnya Section | GE 1.7-103 WTGs with recommended LNTE technology and NRO modes

8.1.2.3 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 26 and Figure 27 for the Lekpoguno and Akplabnya section of WPP2 respectively and assumes that NRO modes recommended in Section 8.1.2.2 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.

8.1.2.4 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 facilitate 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, one station should be established at Wokumagbe (near NSR12), and 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.

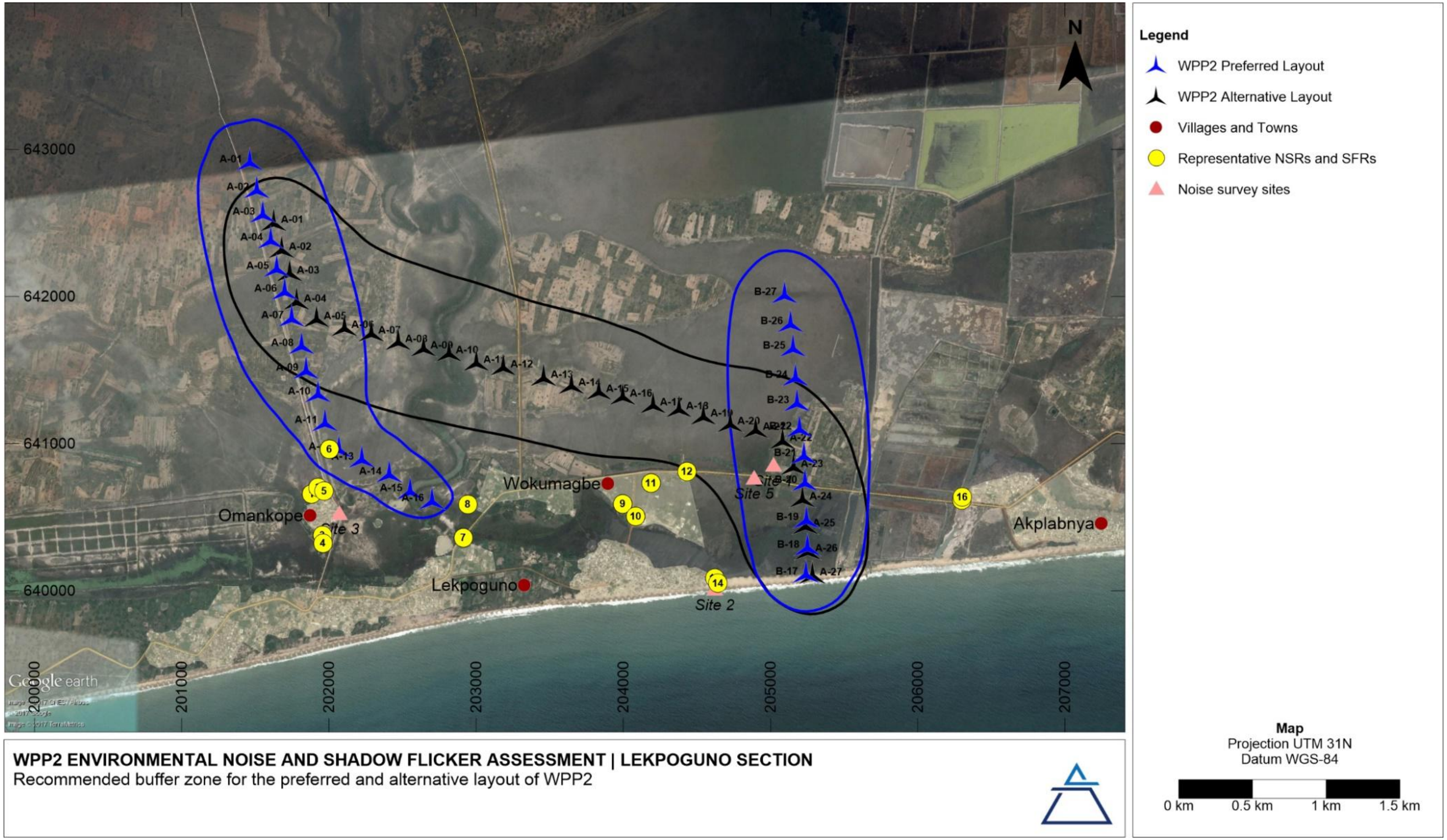


Figure 26: Recommended buffer zone for the Lekpoguno section of WPP2, for noise impact mitigation and management

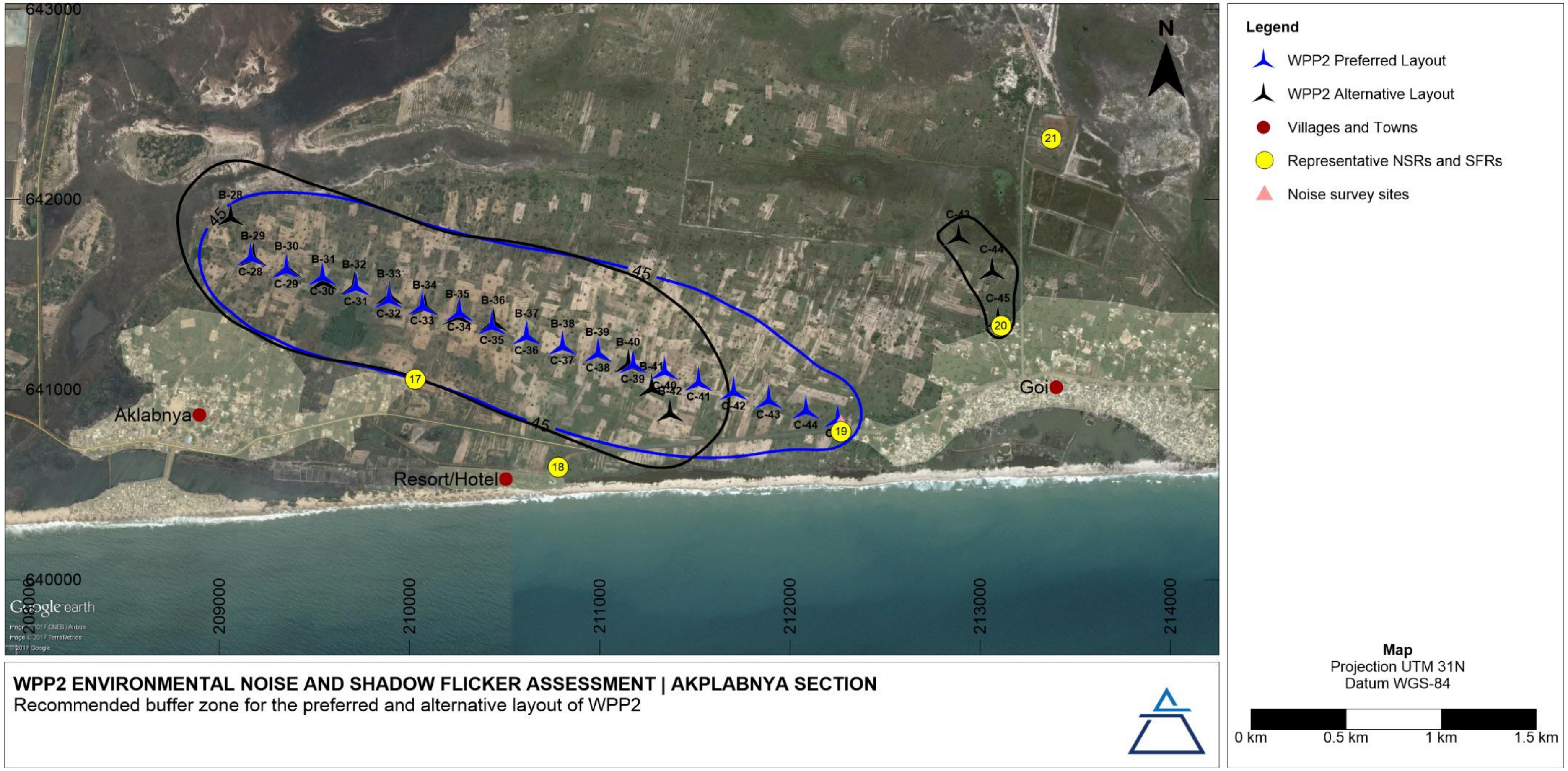


Figure 27: Recommended buffer zone for the Akplabnya section of WPP2, for noise impact mitigation and management

8.2 SHADOW FLICKER IMPACT SIGNIFICANCE AND MITIGATION MEASURES

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 (Table 14). 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 must 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.

8.3 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 (Figure 28). 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 may need to be extended.

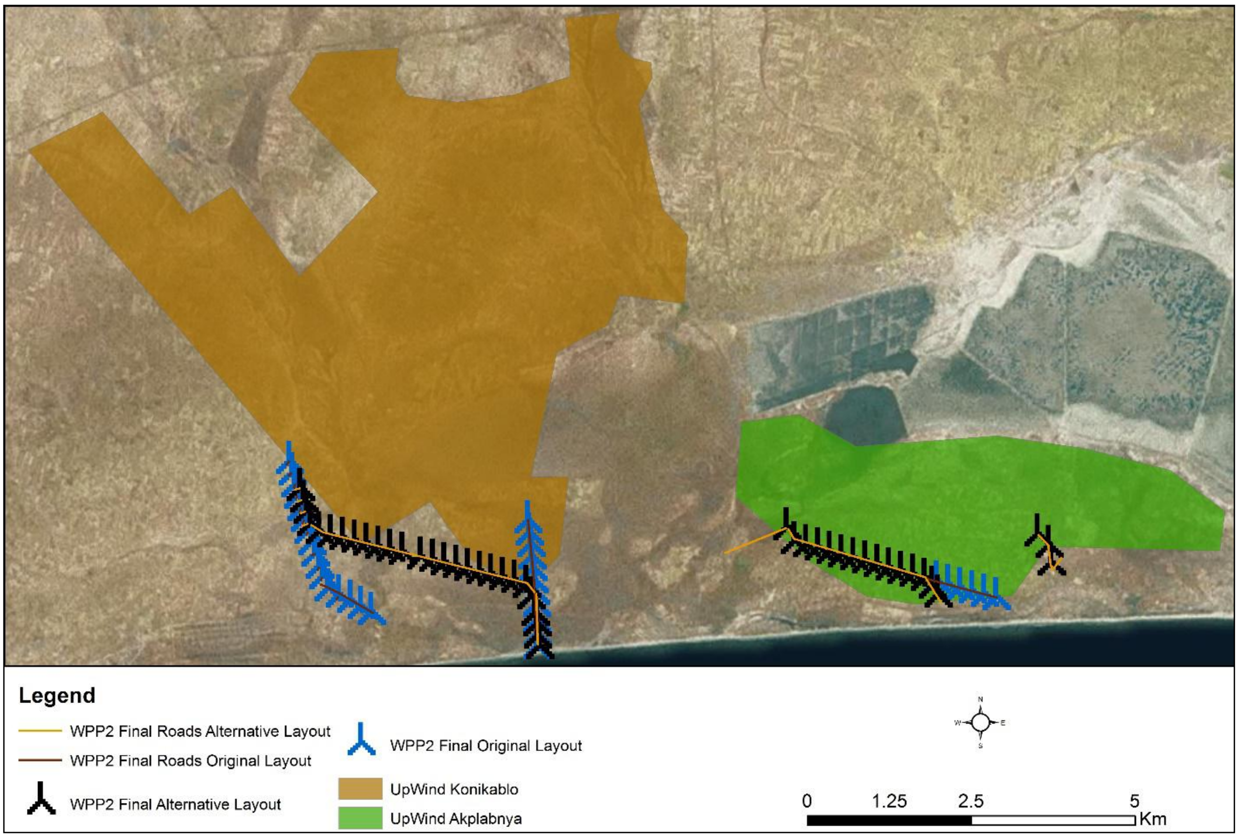


Figure 28: WPP2 in relation to the extent of the proposed Upwind WEF

Table 13: 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?**	**Potential Mitigation Measures**	**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	*Compulsory*: - Relocate Omankope Presbyterian Primary School - Limit activities to day-time hours, complaints register and investigation through short term monitoring. - Good practice - Basic good practice noise and, traffic management.	Medium	Low	Medium
		Alternative layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory:* - Limit activities to day-time hours, complaints register and investigation through short term monitoring. - Good practice - Basic good practice noise and, traffic management.	Medium	Low	Medium

Table 14: 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?**	**Potential Mitigation Measures**	**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	*Compulsory*: - Select GE 1.7-103 WTG with LNTE - Apply NRO modes - Relocation of permanent residences and community buildings within buffer zone. - Maintaining buffer around WEF.	Medium	Low	Medium
		Alternative layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory*: - Select GE 1.7-103 WTG with LNTE - Apply NRO modes - Relocation of permanent residences and community buildings within buffer zone. - Maintaining buffer around WEF.	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	*Compulsory*: - Maintaining buffer and relocations as recommended for noise. - Good Practice: - Curtailing WTG operation at Omankope (WTG A-12 to A-16), Wokumagbe (WTG A-16) and Goi (WTG C-44 to C-45).	Medium	Low	Medium
		Alternative layout	Negative	Local	Long-term	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory*: - Maintaining buffer and relocations as recommended for noise. - Good Practice: - Curtailing WTG operation at Wokumagbe (WTG A-12) and Goi (WTG C-44 to C-45).	Medium	Low	Medium

Table 15: 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?**	**Potential Mitigation Measures**	**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	*Compulsory*: - Limit activities to day-time hours, complaints register and investigation through short term monitoring. - Good practice - Basic good practice noise and, traffic management.	Low	Low	Medium
		Alternative layout	Negative	Local	Temporary	Medium	Highly likely	Highly reversible	Low	No	Yes	*Compulsory*: - Limit activities to day-time hours, complaints register and investigation through short term monitoring. - Good practice - Basic good practice noise and, traffic management.	Low	Low	Medium

9. CONCLUSIONS

9.1 ENVIRONMENTAL NOISE

Given the findings of the environmental noise study it is concluded that the significance of environmental noise impacts during all project phases are considered *medium* but should be reduced to *low* with the implementation of management and mitigation measures recommended in this report as a condition of project approval.

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. It will however be necessary to relocate the Omankope Presbyterian Primary School should the preferred layout be selected.

The *medium significance* rating for the **operational phase** is based on the finding that exceedance of noise impact guidelines may occur between 2 to 5 rotor diameters from the WTG arrays. Given available satellite imagery, several residential structures fall within this distance from WPP2. To manage and mitigate noise impacts it is recommended that the LNTE GE 1.7-103 WTG be selected and specific WTGs be operated at NRO modes. It is further necessary to establish and maintain the buffer zone of between 2 and 5 rotor diameters around WTG arrays, within which permanent residences should be relocated and not be permitted in future (refer to Figure 26 and Figure 27 for the buffer zone delineation).

It is also concluded that, from an environmental noise perspective, the alternative layout is the preferred option since it will affect a smaller number of NSRs.

9.2 SHADOW FLICKER

It is concluded that shadow flicker impacts, only of concern during the operational phase are *of medium* significance (for the preferred and alternative layout) and must be reduced by implementing the appropriate mitigation measures as a condition for project approval.

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.

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 will need to be relocated.

By adhering to the buffer zone and relocations recommended to mitigate noise impacts, shadow flicker impacts will also be avoided.

10. REFERENCES

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11. ANNEX A – CALIBRATION CERTIFICATES

nmisa
National Metrology Institute of South Africa

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Certificate of Conformance

Calibration of:	SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
Manufacturer:	BRÜEL & KJÆR
Model number:	2250, 4950
Serial number:	2731851, 2709293
Calibrated for:	AIRSHED PLANNING PROFESSIONALS (PTY) LTD Johannesburg
Calibration procedure:	AV\AS-0007 AV\AS-0010
Period of calibration:	26 – 27 January 2016

1 PROCEDURE

The sound level meter was electrically calibrated according to the relevant clauses of SANS 656 and 658 specifications. The microphone with the sound level meter was acoustically calibrated according to the relevant clauses of SANS 656 specifications. The instrument complete with filters was electrically calibrated according to IEC 61260 specification.

The results of the measurements are traceable to the national measurement standards.

The following equipment was used:

Brüel & Kjær 4226 Multi-function calibrator	(AS-131)
Inline Capacitor	(AS-98)
Brüel & Kjær 3630 Calibration platform	(AS-109)

Calibrated by **R Nel** **Metrologist (Technical Signatory)**	Checked by **ML Temba** **Metrologist**	For Chief Executive Officer
Date of Issue **27 January 2016**	**Page 1 of 3**	Certificate number **AV\AS-4534**

Your measure of excellence

CALIBRATION OF A SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
(2731851, 2709293)

2 RESULTS

2.1 The following parameters of the sound level meter were calibrated and conformed to the SANS 656 and SANS 658 specifications, type 1:

Indication under reference conditions (SANS 656 clause 11.2)		U = 0,20 dB
Electrical self generated noise		
A-weighted	(12,4 dB)	U = 0,30 dB
C-weighted	(13,2 dB)	U = 0,30 dB
Linear	(18,9 dB)	U = 0,30 dB
Linearity range (SANS clause 9.9, table 11)		
31,5 Hz		U = 0,12 dB
1 kHz		U = 0,12 dB
8 kHz		U = 0,12 dB
Frequency Weightings (SANS 656 clauses 8.1, 11.2, tables 4 & 5)		
A-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
C-weighting	(25 Hz – 16 kHz)	U = 0,12 dB
Linear	(25 Hz – 16 kHz)	U = 0,12 dB
Time weightings (SANS 656 clauses 9.2, 9.3, 9.5, 11.4, table 9, 7 & 10)		
Slow and Fast		U = 0,11 dB
Impulse		U = 0,11 dB
Peak		U = 0,09 dB
Time averaging, L_{Aeq} (SANS 658 clause 11.3.3, table 4)		U = 0,12 dB
Impulse weighted time averaging, L_{AIeq} (SANS 658 Annex C, table C1)		U = 0,12 dB
Overload indication (SANS 656 clause 11.3)		U = 0,31 dB

2.2 The following parameter of the microphone with the sound level meter were calibrated and conformed to the SANS 656 specifications, type 1:

Frequency response (SANS 656 clauses 8.1, tables 4 & 5) 31,5 Hz – 12,5 kHz	U = 0,20 dB @ 1 kHz

Calibrated by	Checked by	For Chief Executive Officer
R Nel Metrologist (Technical Signatory)	ML Temba Metrologist	
Date of Issue 27 January 2016	Page 2 of 3	Certificate number AVAS-4534

CALIBRATION OF A SOUND LEVEL METER, OCTAVE BAND FILTER, THIRD OCTAVE BAND FILTER & MICROPHONE
(2731851, 2709293)

2.3 The following parameter of the octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation (IEC 61260 clause 4.4, 5.3) 16 Hz - 8 kHz — $U = 0{,}12$ dB @ f_m

2.4 The following parameter of the third octave band filter was calibrated and conformed to the IEC 61260 specification, class 0 base 2:

Relative attenuation (IEC 61260 clause 4.4, 5.3) 12,5 Hz - 16 kHz — $U = 0{,}12$ dB @ f_m

3 REMARKS

3.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

3.2 The reported expanded uncertainty of measurement, U, is stated as the standard uncertainty of measurement multiplied by a coverage factor of $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %. The reported expanded uncertainty of measurements is at the reference points.

3.3 Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

3.4 The calibrations were carried out at an ambient temperature of 23 °C ± 2 °C and a relative humidity of 50 %RH ± 20 %RH.

3.5 Only parameters given in 2.1, 2.2, 2.3 and 2.4 were calibrated.

3.6 The above statement of conformance is based on the measurement value(s) obtained, extended by the estimated uncertainty of measurement, being within the appropriate specification limit(s).

3.7 The firmware version of the sound measuring device at the time of calibration was: 4.4.0.44; BZ7130 v4.4; BZ7131 v4.4; BZ7132 v4.4

---------- *end of certificate* ----------

Calibrated by	Checked by	For Chief Executive Officer
R Nel Metrologist (Technical Signatory)	ML Temba Metrologist	
Date of Issue 27 January 2016	Page 3 of 3	Certificate number AV\AS-4534

12. ANNEX B – WINDPRO DECIBEL REPORTS

12.1 WPP2 PREFERRED LAYOUT

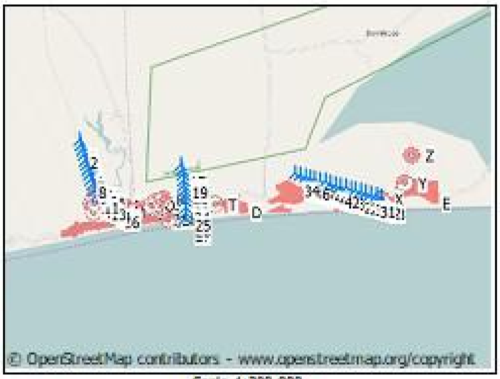
Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
11/12/2017 3:40 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Base

Noise calculation model:
ISO 9613-2 General
Wind speed:
Highest noise value
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exceedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)



Scale 1:200 000
New WTG
Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	201 463	642 934	17.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
2	201 510	642 746	14.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
3	201 551	642 578	7.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
4	201 604	642 404	10.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
5	201 645	642 209	14.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
6	201 699	642 055	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
7	201 746	641 874	-0.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
8	201 813	641 686	4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
9	201 846	641 518	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
10	201 927	641 357	5.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
11	201 974	641 162	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
12	202 068	640 981	0.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
13	202 222	640 914	2.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
14	202 411	640 813	-4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
15	202 552	640 699	-1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
16	202 699	640 632	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
17	205 094	642 033	-1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
18	205 137	641 835	0.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
19	205 153	641 668	-2.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
20	205 169	641 470	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
21	205 180	641 298	-0.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
22	205 196	641 120	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
23	205 228	640 938	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
24	205 233	640 755	0.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
25	205 244	640 503	-1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
26	205 249	640 315	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
27	205 239	640 132	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
28	211 341	641 116	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
29	211 520	641 058	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
30	211 704	641 009	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
31	211 887	640 964	6.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
32	212 084	640 910	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
33	212 290	640 865	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
34	209 164	641 715	1.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
35	209 352	641 650	3.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
36	209 540	641 613	3.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
37	209 718	641 559	3.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
38	209 890	641 495	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
39	210 067	641 457	5.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
40	210 261	641 425	4.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
41	210 433	641 355	2.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
42	210 615	641 301	4.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
43	210 803	641 248	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
44	210 991	641 210	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
45	211 174	641 151	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No

Calculation Results

Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
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Calculated:
11/12/2017 3:40 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Base

Sound level

Noise sensitive area						Demands		Sound level		Demands fulfilled ?		
No.	Name	Easting	Northing	Z	Imission height	Noise	Distance	From WTGs	Distance to noise demand	Noise	Distance	All
				[m]	[m]	[dB(A)]	[m]	[dB(A)]	[m]			
A	Noise sensitive area: User defined (9)	201 968	640 678	2.7	1.0	45.0	300	48.8	-252	**No**	Yes	**No**
B	Noise sensitive area: User defined (10)	202 913	640 361	7.0	1.0	45.0	300	45.8	-44	**No**	Yes	**No**
C	Noise sensitive area: User defined (11)	204 643	640 051	1.8	1.0	45.0	300	43.2	145	Yes	Yes	Yes
D	Noise sensitive area: User defined (12)	206 302	640 637	0.1	1.0	45.0	300	40.4	483	Yes	Yes	Yes
E	Noise sensitive area: User defined (13)	212 269	640 780	4.0	1.0	45.0	300	53.7	-302	**No**	**No**	**No**
F	Noise sensitive area: User defined (16)	210 030	641 054	2.7	1.0	45.0	300	48.1	-258	**No**	Yes	**No**
G	Noise sensitive area: User defined (17)	202 943	640 588	2.6	1.0	45.0	300	47.9	-147	**No**	**No**	**No**
H	01	201 883	640 658	4.0	1.0	45.0	300	47.6	-184	**No**	Yes	**No**
I	02	201 927	640 701	2.0	1.0	45.0	300	48.7	-245	**No**	Yes	**No**
J	03	201 956	640 377	1.3	1.0	45.0	300	44.9	8	Yes	Yes	Yes
K	04	201 959	640 324	0.4	1.0	45.0	300	44.4	52	Yes	Yes	Yes
L	06	202 003	640 962	0.9	1.0	45.0	300	55.5	-490	**No**	**No**	**No**
M	07	202 913	640 361	-0.8	1.0	45.0	300	45.8	-44	**No**	Yes	**No**
N	08	202 943	640 588	1.0	1.0	45.0	300	47.9	-147	**No**	**No**	**No**
O	09	203 996	640 591	0.5	1.0	45.0	300	40.7	627	Yes	Yes	Yes
P	10	204 084	640 506	-1.9	1.0	45.0	300	40.8	556	Yes	Yes	Yes
Q	11	204 187	640 732	0.7	1.0	45.0	300	41.7	415	Yes	Yes	Yes
R	12	204 432	640 811	1.3	1.0	45.0	300	43.5	160	Yes	Yes	Yes
S	14	204 643	640 051	2.0	1.0	45.0	300	43.2	145	Yes	Yes	Yes
T	15	206 300	640 617	0.1	1.0	45.0	300	40.4	482	Yes	Yes	Yes
U	16	206 302	640 637	0.2	1.0	45.0	300	40.4	482	Yes	Yes	Yes
V	17	210 030	641 054	0.8	1.0	45.0	300	48.1	-258	**No**	Yes	**No**
W	18	210 781	640 592	-2.4	1.0	45.0	300	45.2	-22	**No**	Yes	**No**
X	19	212 269	640 780	2.7	1.0	45.0	300	53.8	-303	**No**	**No**	**No**
Y	20	213 109	641 335	3.4	1.0	45.0	300	38.2	591	Yes	Yes	Yes
Z	21	213 374	642 321	0.3	1.0	45.0	300	33.5	1 404	Yes	Yes	Yes
AA	05	201 968	640 678	1.5	1.0	45.0	300	48.8	-252	**No**	Yes	**No**
AB	13	204 622	640 086	0.3	1.0	45.0	300	43.2	150	Yes	Yes	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	2281	2906	3522	5356	10999	7090	2649	2314	2281	2604	2657	2045	2953	2774	3450	3573	3502	3650	4292	5363	5356	8771
2	2088	2720	3347	5235	10917	6990	2473	2121	2087	2411	2463	1851	2767	2590	3290	3412	3350	3504	4132	5242	5235	8686
3	1915	2555	3195	5133	10848	6905	2319	1949	1915	2238	2291	1678	2602	2429	3151	3273	3219	3380	3994	5138	5133	8615
4	1734	2385	3030	5019	10767	6808	2154	1768	1733	2057	2110	1496	2426	2256	3001	3123	3076	3245	3843	5024	5019	8533
5	1535	2191	2863	4915	10699	6724	1988	1569	1534	1858	1911	1298	2241	2077	2854	2975	2940	3118	3694	4920	4915	8464
6	1373	2033	2718	4817	10626	6639	1845	1409	1373	1697	1750	1134	2084	1924	2724	2844	2818	3003	3562	4821	4817	8391
7	1187	1851	2562	4721	10559	6560	1694	1223	1187	1511	1564	947	1911	1757	2590	2709	2695	2889	3423	4725	4721	8325
8	992	1662	2391	4610	10474	6464	1530	1030	991	1316	1369	748	1722	1576	2442	2559	2559	2761	3268	4613	4610	8242
9	821	1495	2264	4542	10427	6408	1415	861	821	1146	1199	578	1574	1438	2341	2456	2469	2681	3158	4544	4542	8197
10	656	1340	2107	4434	10336	6310	1271	700	656	980	1033	402	1401	1274	2206	2319	2345	2564	3014	4435	4434	8109
11	464	1149	1966	4360	10280	6248	1127	512	463	785	838	**202**	1234	1126	2101	2210	2254	2483	2891	4360	4360	8057
12	314	965	1799	4247	10181	6144	959	372	313	614	666	**68**	1048	959	1967	2071	2134	2370	2738	4248	4248	7962
13	347	841	1631	4088	10025	5988	791	425	364	599	646	**225**	885	791	1803	1906	1973	2212	2570	4088	4089	7809
14	431	662	1418	3894	9836	5798	578	550	496	630	666	434	676	578	1601	1701	1778	2021	2359	3894	3895	7623
15	511	495	1242	3749	9695	5656	407	670	625	677	701	608	495	407	1448	1544	1636	1884	2189	3749	3751	7487
16	638	345	1080	3600	9548	5510	**248**	817	776	786	802	771	345	**247**	1297	1390	1491	1742	2029	3601	3603	7343
17	3372	2661	1968	1842	7264	3370	1390	3493	3435	3548	3570	3271	2748	2591	1812	1831	1586	1390	2033	1861	1847	5033
18	3330	2567	1795	1671	7190	3258	1243	3460	3404	3499	3518	3253	2668	2523	1687	1695	1455	1243	1851	1684	1671	4955
19	3286	2481	1647	1544	7151	3191	1120	3422	3368	3448	3465	3228	2593	2460	1581	1579	1345	1120	1696	1556	1544	4916
20	3239	2388	1474	1406	7113	3124	988	3384	3332	3393	3408	3206	2513	2394	1465	1451	1228	988	1513	1417	1406	4879
21	3205	2315	1325	1302	7087	3078	892	3358	3307	3352	3364	3194	2452	2346	1378	1352	1142	892	1357	1311	1302	4857
22	3181	2256	1180	1207	7060	3035	824	3345	3295	3324	3333	3197	2406	2315	1311	1270	1081	824	1204	1214	1207	4835
23	3182	2224	1045	1115	7021	2986	804	3357	3309	3320	3326	3225	2386	2312	1280	1223	1061	806	1062	1119	1115	4804
24	3167	2180	906	1075	7013	2975	767	3352	3307	3299	3303	3237	2354	2296	1248	1176	1047	803	919	1076	1075	4806
25	3167	2144	749	1062	7008	2971	719	3365	3323	3290	3290	3273	2335	2303	1251	1160	1082	868	752	1062	1066	4818
26	3177	2125	661	1093	7012	2963	702	3384	3345	3294	3290	3310	2337	2322	1283	1181	1141	956	661	1093	1101	4837
27	3182	2107	601	1167	7037	2982	710	3397	3360	3292	3285	3340	2337	2340	1325	1214	1211	1054	601	1167	1177	4879
28	9285	8267	6782	3929	970	1312	6842	9469	9423	9414	9415	9339	8462	8414	7364	7282	7164	6916	6782	5065	5061	1312
29	9460	8439	6950	4101	782	1490	7013	9645	9600	9588	9589	9517	8635	8590	7538	7456	7340	7092	6950	5238	5235	1490
30	9640	8616	7125	4279	594	1674	7191	9827	9781	9768	9769	9701	8814	8771	7719	7636	7522	7274	7125	5418	5414	1674
31	9822	8794	7301	4459	409	1859	7369	10009	9964	9948	9949	9884	8994	8952	7900	7817	7704	7457	7301	5598	5595	1859

To be continued on next page...

Project:
VRA WPP2

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Calculated:
11/12/2017 3:40 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Base

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
32	10016	8986	7491	4652	**215**	2059	7561	10204	10159	10142	10142	10081	9188	9147	8094	8010	7899	7653	7491	5792	5789	2059
33	10180	9147	7650	4816	**86**	2228	7723	10369	10324	10305	10305	10247	9350	9311	8258	8174	8064	7818	7650	5955	5952	2228
34	7192	6227	4818	2028	3224	348	4813	7358	7308	7331	7338	7201	6396	6322	5289	5222	5073	4818	4818	3067	3058	1089
35	7367	6395	4973	2160	3026	397	4981	7535	7486	7505	7511	7382	6567	6497	5460	5391	5246	4991	4974	3223	3214	903
36	7547	6571	5140	2312	2835	447	5156	7717	7668	7684	7690	7565	6745	6677	5638	5568	5425	5171	5140	3390	3382	743
37	7715	6734	5294	2454	2650	473	5316	7886	7838	7851	7856	7738	6909	6844	5803	5731	5592	5338	5294	3545	3538	594
38	7877	6891	5442	2592	2466	418	5470	8050	8002	8012	8017	7905	7068	7006	5963	5889	5754	5500	5442	3695	3689	462
39	8048	7059	5603	2749	2286	404	5636	8223	8175	8183	8187	8079	7238	7177	6133	6058	5925	5672	5603	3860	3853	405
40	8237	7244	5783	2926	2092	436	5820	8413	8365	8370	8374	8271	7424	7365	6320	6245	6113	5861	5783	4042	4036	437
41	8400	7402	5935	3076	1907	502	5977	8578	8531	8533	8536	8439	7585	7529	6482	6405	6277	6025	5935	4198	4192	503
42	8577	7574	6102	3242	1716	635	6149	8756	8709	8708	8711	8619	7759	7705	6657	6579	6453	6203	6102	4369	4364	635
43	8759	7752	6275	3417	1521	797	6327	8940	8893	8890	8892	8805	7940	7888	6839	6760	6636	6386	6275	4547	4543	797
44	8943	7933	6453	3596	1331	974	6508	9125	9079	9074	9076	8992	8123	8072	7023	6943	6821	6572	6453	4729	4724	974
45	9121	8106	6623	3769	1139	1148	6681	9304	9258	9251	9252	9173	8299	8250	7200	7119	7000	6751	6623	4903	4899	1148

WTG	W	X	Y	Z	AA	AB
1	9607	11018	11755	11926	2312	4253
2	9518	10937	11684	11871	2118	4094
3	9442	10868	11625	11826	1946	3955
4	9354	10787	11554	11770	1764	3805
5	9278	10720	11498	11730	1565	3657
6	9200	10647	11433	11679	1403	3525
7	9126	10580	11376	11637	1216	3387
8	9035	10495	11302	11579	1020	3233
9	8983	10449	11264	11556	849	3123
10	8887	10358	11182	11488	680	2980
11	8826	10302	11136	11459	484	2858
12	8722	10203	11047	11385	319	2706
13	8565	10047	10895	11240	347	2538
14	8373	9858	10711	11067	463	2328
15	8230	9718	10577	10943	584	2159
16	8082	9571	10433	10807	733	1999
17	5867	7284	8046	8285	3407	2004
18	5780	7210	7988	8252	3373	1823
19	5730	7172	7963	8247	3335	1669
20	5680	7134	7941	8249	3297	1488
21	5646	7108	7930	8258	3271	1334
22	5610	7082	7916	8266	3258	1183
23	5564	7043	7891	8263	3270	1045
24	5550	7036	7897	8290	3266	906
25	5538	7030	7909	8331	3281	749
26	5539	7035	7926	8369	3301	668
27	5561	7060	7962	8425	3316	618
28	767	987	1782	2363	9383	6797
29	873	799	1613	2243	9559	6966
30	1012	610	1443	2124	9741	7141
31	1167	424	1277	2013	9923	7318
32	1341	**226**	1109	1912	10119	7508
33	1494	**88**	979	1839	10284	7668
34	1968	3242	3963	4253	7271	4825
35	1778	3044	3770	4077	7448	4982
36	1607	2853	3579	3898	7630	5150
37	1437	2668	3399	3735	7800	5304
38	1269	2484	3223	3581	7964	5453
39	1122	2304	3044	3418	8136	5615
40	982	2109	2850	3240	8326	5795
41	839	1924	2677	3096	8492	5947
42	728	1734	2494	2941	8670	6115
43	656	1538	2307	2786	8854	6290
44	653	1348	2121	2629	9039	6468
45	683	1156	1944	2492	9218	6638

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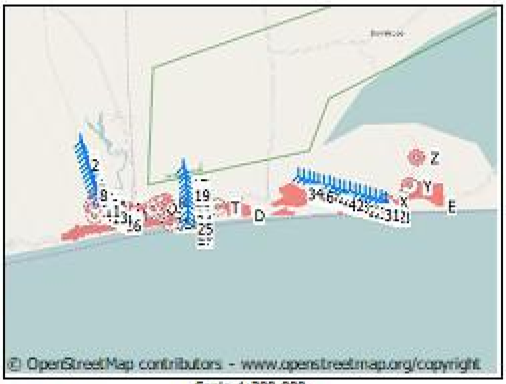
11/12/2017 3:43 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Base LNTE

Noise calculation model:
ISO 9613-2 General
Wind speed:
Highest noise value
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)



Scale 1:200 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Noise data Creator	Name	Wind speed	LwA,ref	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	
1	201 463	642 934	17.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
2	201 510	642 746	14.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
3	201 551	642 578	7.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
4	201 604	642 404	10.4	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
5	201 645	642 209	14.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
6	201 699	642 055	2.8	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
7	201 746	641 874	-0.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
8	201 813	641 686	4.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
9	201 846	641 518	3.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
10	201 927	641 357	5.8	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
11	201 974	641 162	0.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
12	202 068	640 981	0.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
13	202 222	640 914	2.6	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
14	202 411	640 813	-4.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
15	202 552	640 699	-1.3	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
16	202 699	640 632	2.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
17	205 094	642 033	-1.3	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
18	205 137	641 835	0.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
19	205 153	641 668	-2.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
20	205 169	641 470	1.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
21	205 180	641 298	-0.6	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
22	205 196	641 120	1.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
23	205 228	640 938	3.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
24	205 233	640 755	0.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
25	205 244	640 503	-1.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
26	205 249	640 315	1.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
27	205 239	640 132	1.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
28	211 341	641 116	1.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
29	211 520	641 058	2.8	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
30	211 704	641 009	1.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
31	211 887	640 964	6.4	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
32	212 084	640 910	3.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
33	212 250	640 865	1.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
34	209 164	641 715	1.4	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
35	209 352	641 650	3.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
36	209 540	641 613	3.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
37	209 718	641 559	3.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
38	209 890	641 495	3.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
39	210 067	641 457	5.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
40	210 261	641 425	4.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
41	210 433	641 355	2.6	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
42	210 615	641 301	4.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
43	210 803	641 248	2.8	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
44	210 991	641 210	1.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
45	211 174	641 151	3.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No

Calculation Results

Project:
VRA WPP2

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Calculated:
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DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Base LNTE

Sound level

Noise sensitive area						Demands		Sound level		Demands fulfilled ?		
No.	Name	Easting	Northing	Z	Imission height	Noise	Distance	From WTGs	Distance to noise demand	Noise	Distance	All
				[m]	[m]	[dB(A)]	[m]	[dB(A)]	[m]			
A	Noise sensitive area: User defined (9)	201 968	640 678	2.7	1.0	45.0	300	46.8	-106	**No**	Yes	**No**
B	Noise sensitive area: User defined (10)	202 913	640 361	7.0	1.0	45.0	300	43.8	59	Yes	Yes	Yes
C	Noise sensitive area: User defined (11)	204 643	640 051	1.8	1.0	45.0	300	41.2	269	Yes	Yes	Yes
D	Noise sensitive area: User defined (12)	206 302	640 637	0.1	1.0	45.0	300	38.4	636	Yes	Yes	Yes
E	Noise sensitive area: User defined (13)	212 269	640 780	4.0	1.0	45.0	300	51.7	-202	**No**	**No**	**No**
F	Noise sensitive area: User defined (16)	210 030	641 054	2.7	1.0	45.0	300	46.1	-83	**No**	Yes	**No**
G	Noise sensitive area: User defined (17)	202 943	640 588	2.6	1.0	45.0	300	45.9	-40	**No**	**No**	**No**
H	01	201 883	640 658	4.0	1.0	45.0	300	45.6	-39	**No**	Yes	**No**
I	02	201 927	640 701	2.0	1.0	45.0	300	46.7	-100	**No**	Yes	**No**
J	03	201 956	640 377	1.3	1.0	45.0	300	42.9	154	Yes	Yes	Yes
K	04	201 959	640 324	0.4	1.0	45.0	300	42.4	198	Yes	Yes	Yes
L	06	202 003	640 962	0.9	1.0	45.0	300	53.5	-343	**No**	**No**	**No**
M	07	202 913	640 361	-0.8	1.0	45.0	300	43.8	59	Yes	Yes	Yes
N	08	202 943	640 588	1.0	1.0	45.0	300	45.9	-40	**No**	**No**	**No**
O	09	203 996	640 591	0.5	1.0	45.0	300	38.7	796	Yes	Yes	Yes
P	10	204 084	640 506	-1.9	1.0	45.0	300	38.8	722	Yes	Yes	Yes
Q	11	204 187	640 732	0.7	1.0	45.0	300	39.7	585	Yes	Yes	Yes
R	12	204 432	640 811	1.3	1.0	45.0	300	41.5	330	Yes	Yes	Yes
S	14	204 643	640 051	2.0	1.0	45.0	300	41.2	269	Yes	Yes	Yes
T	15	206 300	640 617	0.1	1.0	45.0	300	38.4	635	Yes	Yes	Yes
U	16	206 302	640 637	0.2	1.0	45.0	300	38.4	636	Yes	Yes	Yes
V	17	210 030	641 054	0.8	1.0	45.0	300	46.1	-83	**No**	Yes	**No**
W	18	210 781	640 592	-2.4	1.0	45.0	300	43.2	155	Yes	Yes	Yes
X	19	212 269	640 780	2.7	1.0	45.0	300	51.8	-202	**No**	**No**	**No**
Y	20	213 109	641 335	3.4	1.0	45.0	300	36.2	693	Yes	Yes	Yes
Z	21	213 374	642 321	0.3	1.0	45.0	300	31.5	1 523	Yes	Yes	Yes
AA	05	201 968	640 678	1.5	1.0	45.0	300	46.8	-106	**No**	Yes	**No**
AB	13	204 622	640 086	0.3	1.0	45.0	300	41.2	276	Yes	Yes	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	2281	2906	3522	5356	10999	7090	2649	2314	2281	2604	2657	2045	2953	2774	3450	3573	3502	3650	4292	5363	5356	8771
2	2088	2720	3347	5235	10917	6990	2473	2121	2087	2411	2463	1851	2767	2590	3290	3412	3350	3504	4132	5242	5235	8686
3	1915	2555	3195	5133	10848	6905	2319	1949	1915	2238	2291	1678	2602	2429	3151	3273	3219	3380	3994	5138	5133	8615
4	1734	2385	3030	5019	10767	6808	2154	1768	1733	2057	2110	1496	2426	2256	3001	3123	3076	3245	3843	5024	5019	8533
5	1535	2191	2863	4915	10699	6724	1988	1569	1534	1858	1911	1298	2241	2077	2854	2975	2940	3118	3694	4920	4915	8464
6	1373	2033	2718	4817	10626	6639	1845	1409	1373	1697	1750	1134	2084	1924	2724	2844	2818	3003	3562	4821	4817	8391
7	1187	1851	2562	4721	10559	6560	1694	1223	1187	1511	1564	947	1911	1757	2590	2709	2695	2889	3423	4725	4721	8325
8	992	1662	2391	4610	10474	6464	1530	1030	991	1316	1369	748	1722	1576	2442	2559	2559	2761	3268	4613	4610	8242
9	821	1495	2264	4542	10427	6408	1415	861	821	1146	1199	578	1574	1438	2341	2456	2469	2681	3158	4544	4542	8197
10	656	1340	2107	4434	10336	6310	1271	700	656	980	1033	402	1401	1274	2206	2319	2345	2564	3014	4435	4434	8109
11	464	1149	1966	4360	10280	6248	1127	512	463	785	838	**202**	1234	1126	2101	2210	2254	2483	2891	4360	4360	8057
12	314	965	1799	4247	10181	6144	959	372	313	614	666	**68**	1048	959	1967	2071	2134	2370	2738	4248	4248	7962
13	347	841	1631	4088	10025	5988	791	425	364	599	646	**225**	885	791	1803	1906	1973	2212	2570	4088	4089	7809
14	431	662	1418	3894	9836	5798	578	550	496	630	666	434	676	578	1601	1701	1778	2021	2359	3894	3895	7623
15	511	495	1242	3749	9695	5656	407	670	625	677	701	608	495	407	1448	1544	1636	1884	2189	3749	3751	7487
16	638	345	1080	3600	9548	5510	**248**	817	776	786	802	771	345	**247**	1297	1390	1491	1742	2029	3601	3603	7343
17	3372	2661	1968	1842	7264	3370	1390	3493	3435	3548	3570	3271	2748	2591	1812	1831	1586	1390	2033	1861	1847	5033
18	3330	2567	1795	1671	7190	3258	1243	3460	3404	3499	3518	3253	2668	2523	1687	1695	1455	1243	1851	1684	1671	4955
19	3286	2481	1647	1544	7151	3191	1120	3422	3368	3448	3465	3228	2593	2460	1581	1579	1345	1120	1696	1556	1544	4916
20	3239	2388	1474	1406	7113	3124	988	3384	3332	3393	3408	3206	2513	2394	1465	1451	1228	988	1513	1417	1406	4879
21	3205	2315	1325	1302	7087	3078	892	3358	3307	3352	3364	3194	2452	2346	1378	1352	1142	892	1357	1311	1302	4857
22	3181	2256	1180	1207	7060	3035	824	3345	3295	3324	3333	3197	2406	2315	1311	1270	1081	824	1204	1214	1207	4835
23	3182	2224	1045	1115	7021	2986	804	3357	3309	3320	3326	3225	2386	2312	1280	1223	1061	806	1062	1119	1115	4804
24	3167	2180	906	1075	7013	2975	767	3352	3307	3299	3303	3237	2354	2296	1248	1176	1047	803	919	1076	1075	4806
25	3167	2144	749	1062	7008	2971	719	3365	3323	3290	3290	3273	2335	2303	1251	1160	1082	868	752	1062	1066	4818
26	3177	2125	661	1093	7012	2963	702	3384	3345	3294	3290	3310	2337	2322	1283	1181	1141	956	661	1093	1101	4837
27	3182	2107	601	1167	7037	2982	710	3397	3360	3292	3285	3340	2337	2340	1325	1214	1211	1054	601	1167	1177	4879
28	9285	8267	6782	3929	970	1312	6842	9469	9423	9414	9415	9339	8462	8414	7364	7282	7164	6916	6782	5065	5061	1312
29	9460	8439	6950	4101	782	1490	7013	9645	9600	9588	9589	9517	8635	8590	7538	7456	7340	7092	6950	5238	5235	1490
30	9640	8616	7125	4279	594	1674	7191	9827	9781	9768	9769	9701	8814	8771	7719	7636	7522	7274	7125	5418	5414	1674
31	9822	8794	7301	4459	409	1859	7369	10009	9964	9948	9949	9884	8994	8952	7900	7817	7704	7457	7301	5598	5595	1859

To be continued on next page...

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DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Base LNTE

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
32	10016	8986	7491	4652	**215**	2059	7561	10204	10159	10142	10142	10081	9188	9147	8094	8010	7899	7653	7491	5792	5789	2059
33	10180	9147	7650	4816	**86**	2228	7723	10369	10324	10305	10305	10247	9350	9311	8258	8174	8064	7818	7650	5955	5952	2228
34	7192	6227	4818	2028	3224	348	4813	7358	7308	7331	7338	7201	6396	6322	5289	5222	5073	4818	4818	3067	3058	1089
35	7367	6395	4973	2160	3026	397	4981	7535	7486	7505	7511	7382	6567	6497	5460	5391	5246	4991	4974	3223	3214	903
36	7547	6571	5140	2312	2835	447	5156	7717	7668	7684	7690	7565	6745	6677	5638	5568	5425	5171	5140	3390	3382	743
37	7715	6734	5294	2454	2650	473	5316	7886	7838	7851	7856	7738	6909	6844	5803	5731	5592	5338	5294	3545	3538	594
38	7877	6891	5442	2592	2466	418	5470	8050	8002	8012	8017	7905	7068	7006	5963	5889	5754	5500	5442	3695	3689	462
39	8048	7059	5603	2749	2286	404	5636	8223	8175	8183	8187	8079	7238	7177	6133	6058	5925	5672	5603	3860	3853	405
40	8237	7244	5783	2926	2092	436	5820	8413	8365	8370	8374	8271	7424	7365	6320	6245	6113	5861	5783	4042	4036	437
41	8400	7402	5935	3076	1907	502	5977	8578	8531	8533	8536	8439	7585	7529	6482	6405	6277	6025	5935	4198	4192	503
42	8577	7574	6102	3242	1716	635	6149	8756	8709	8708	8711	8619	7759	7705	6657	6579	6453	6203	6102	4369	4364	635
43	8759	7752	6275	3417	1521	797	6327	8940	8893	8890	8892	8805	7940	7888	6839	6760	6636	6386	6275	4547	4543	797
44	8943	7933	6453	3596	1331	974	6508	9125	9079	9074	9076	8992	8123	8072	7023	6943	6821	6572	6453	4729	4724	974
45	9121	8106	6623	3769	1139	1148	6681	9304	9258	9251	9252	9173	8299	8250	7200	7119	7000	6751	6623	4903	4899	1148

WTG	W	X	Y	Z	AA	AB
1	9607	11018	11755	11926	2312	4253
2	9518	10937	11684	11871	2118	4094
3	9442	10868	11625	11826	1946	3955
4	9354	10787	11554	11770	1764	3805
5	9278	10720	11498	11730	1565	3657
6	9200	10647	11433	11679	1403	3525
7	9126	10580	11376	11637	1216	3387
8	9035	10495	11302	11579	1020	3233
9	8983	10449	11264	11556	849	3123
10	8887	10358	11182	11488	680	2980
11	8826	10302	11136	11459	484	2858
12	8722	10203	11047	11385	319	2706
13	8565	10047	10895	11240	347	2538
14	8373	9858	10711	11067	463	2328
15	8230	9718	10577	10943	584	2159
16	8082	9571	10433	10807	733	1999
17	5867	7284	8046	8285	3407	2004
18	5780	7210	7988	8252	3373	1823
19	5730	7172	7963	8247	3335	1669
20	5680	7134	7941	8249	3297	1488
21	5646	7108	7930	8258	3271	1334
22	5610	7082	7916	8266	3258	1183
23	5564	7043	7891	8263	3270	1045
24	5550	7036	7897	8290	3266	906
25	5538	7030	7909	8331	3281	749
26	5539	7035	7926	8369	3301	668
27	5561	7060	7962	8425	3316	618
28	767	987	1782	2363	9383	6797
29	873	799	1613	2243	9559	6966
30	1012	610	1443	2124	9741	7141
31	1167	424	1277	2013	9923	7318
32	1341	**226**	1109	1912	10119	7508
33	1494	**88**	979	1839	10284	7668
34	1968	3242	3963	4253	7271	4825
35	1778	3044	3770	4077	7448	4982
36	1607	2853	3579	3898	7630	5150
37	1437	2668	3399	3735	7800	5304
38	1269	2484	3223	3581	7964	5453
39	1122	2304	3044	3418	8136	5615
40	982	2109	2850	3240	8326	5795
41	839	1924	2677	3096	8492	5947
42	728	1734	2494	2941	8670	6115
43	656	1538	2307	2786	8854	6290
44	653	1348	2121	2629	9039	6468
45	683	1156	1944	2492	9218	6638

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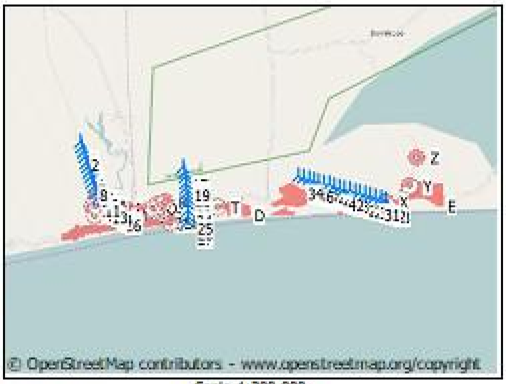
13/12/2017 3:47 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Mitigated
Noise calculation model:
ISO 9613-2 General
Wind speed:
Highest noise value
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)



Scale 1:200 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Noise data Creator	Name	Wind speed	LwA,ref	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	
1	201 463	642 934	17.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
2	201 510	642 746	14.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
3	201 551	642 578	7.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
4	201 604	642 404	10.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
5	201 646	642 209	14.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
6	201 699	642 055	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
7	201 746	641 874	-0.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
8	201 813	641 686	4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
9	201 846	641 518	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
10	201 927	641 357	5.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
11	201 974	641 162	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
12	202 068	640 981	0.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
13	202 222	640 914	2.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
14	202 411	640 813	-4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
15	202 552	640 699	-1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
16	202 699	640 632	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
17	205 094	642 033	-1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
18	205 137	641 835	0.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
19	205 153	641 668	-2.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
20	205 169	641 470	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
21	205 180	641 298	-0.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
22	205 196	641 120	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
23	205 228	640 938	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
24	205 233	640 795	0.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
25	205 244	640 503	-1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
26	205 249	640 315	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
27	205 239	640 132	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
28	211 341	641 116	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
29	211 520	641 058	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
30	211 704	641 009	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
31	211 887	640 964	6.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
32	212 084	640 910	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
33	212 290	640 865	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
34	209 164	641 715	1.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
35	209 352	641 660	3.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
36	209 540	641 613	3.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
37	209 718	641 559	3.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
38	209 890	641 495	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO103	7.0	102.9	No
39	210 067	641 457	5.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO103	7.0	102.9	No
40	210 261	641 425	4.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO103	7.0	102.9	No
41	210 433	641 355	2.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO103	7.0	102.9	No
42	210 615	641 301	4.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
43	210 803	641 248	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
44	210 991	641 210	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
45	211 174	641 151	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No

Calculation Results

Project:
VRA WPP2

Licensed user:
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480 Smuts Drive, Halfway Gardens PO Box 5260
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Nicolette / nicolette@airshed.co.za
Calculated:
13/12/2017 3:47 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Mitigated

Sound level

Noise sensitive area						Demands		Sound level	Demands fulfilled ?		
No.	Name	Easting	Northing	Z [m]	Imission height [m]	Noise [dB(A)]	Distance [m]	From WTGs [dB(A)]	Noise	Distance	All
A	Noise sensitive area: User defined (9)	201 968	640 678	2.7	1.0	45.0	300	42.7	Yes	Yes	Yes
B	Noise sensitive area: User defined (10)	202 913	640 361	7.0	1.0	45.0	300	39.6	Yes	Yes	Yes
C	Noise sensitive area: User defined (11)	204 643	640 051	1.8	1.0	45.0	300	41.0	Yes	Yes	Yes
D	Noise sensitive area: User defined (12)	206 302	640 637	0.1	1.0	45.0	300	38.3	Yes	Yes	Yes
E	Noise sensitive area: User defined (13)	212 269	640 780	4.0	1.0	45.0	300	47.2	**No**	**No**	**No**
F	Noise sensitive area: User defined (16)	210 030	641 054	2.7	1.0	45.0	300	44.9	Yes	Yes	Yes
G	Noise sensitive area: User defined (17)	202 943	640 588	2.6	1.0	45.0	300	41.5	Yes	**No**	**No**
H	01	201 883	640 658	4.0	1.0	45.0	300	41.7	Yes	Yes	Yes
I	02	201 927	640 701	2.0	1.0	45.0	300	42.6	Yes	Yes	Yes
J	03	201 956	640 377	1.3	1.0	45.0	300	39.1	Yes	Yes	Yes
K	04	201 959	640 324	0.4	1.0	45.0	300	38.6	Yes	Yes	Yes
L	06	202 003	640 962	0.9	1.0	45.0	300	48.9	**No**	**No**	**No**
M	07	202 913	640 361	-0.8	1.0	45.0	300	39.6	Yes	Yes	Yes
N	08	202 943	640 588	1.0	1.0	45.0	300	41.5	Yes	**No**	**No**
O	09	203 996	640 591	0.5	1.0	45.0	300	37.9	Yes	Yes	Yes
P	10	204 084	640 506	-1.9	1.0	45.0	300	38.2	Yes	Yes	Yes
Q	11	204 187	640 732	0.7	1.0	45.0	300	39.2	Yes	Yes	Yes
R	12	204 432	640 811	1.3	1.0	45.0	300	41.3	Yes	Yes	Yes
S	14	204 643	640 051	2.0	1.0	45.0	300	41.0	Yes	Yes	Yes
T	15	206 300	640 617	0.1	1.0	45.0	300	38.3	Yes	Yes	Yes
U	16	206 302	640 637	0.2	1.0	45.0	300	38.3	Yes	Yes	Yes
V	17	210 030	641 054	0.8	1.0	45.0	300	44.9	Yes	Yes	Yes
W	18	210 781	640 592	-2.4	1.0	45.0	300	42.7	Yes	Yes	Yes
X	19	212 269	640 780	2.7	1.0	45.0	300	47.2	**No**	**No**	**No**
Y	20	213 109	641 335	3.4	1.0	45.0	300	33.9	Yes	Yes	Yes
Z	21	213 374	642 321	0.3	1.0	45.0	300	29.8	Yes	Yes	Yes
AA	05	201 968	640 678	1.5	1.0	45.0	300	42.7	Yes	Yes	Yes
AB	13	204 622	640 086	0.3	1.0	45.0	300	41.0	Yes	Yes	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	2281	2906	3522	5356	10999	7090	2649	2314	2281	2604	2657	2045	2953	2774	3450	3573	3502	3650	4292	5363	5356	8771
2	2088	2720	3347	5235	10917	6990	2473	2121	2087	2411	2463	1851	2767	2590	3290	3412	3350	3504	4132	5242	5235	8686
3	1915	2555	3195	5133	10848	6905	2319	1949	1915	2238	2291	1678	2602	2429	3151	3273	3219	3380	3994	5138	5133	8615
4	1734	2385	3030	5019	10767	6808	2154	1768	1733	2057	2110	1496	2426	2256	3001	3123	3076	3245	3843	5024	5019	8533
5	1535	2191	2863	4915	10699	6724	1988	1569	1534	1858	1911	1298	2241	2077	2854	2975	2940	3118	3694	4920	4915	8464
6	1373	2033	2718	4817	10626	6639	1845	1409	1373	1697	1750	1134	2084	1924	2724	2844	2818	3003	3562	4821	4817	8391
7	1187	1851	2562	4721	10559	6560	1694	1223	1187	1511	1564	947	1911	1757	2590	2709	2695	2889	3423	4725	4721	8325
8	992	1662	2391	4610	10474	6464	1530	1030	991	1316	1369	748	1722	1576	2442	2559	2559	2761	3268	4613	4610	8242
9	821	1495	2264	4542	10427	6408	1415	861	821	1146	1199	578	1574	1438	2341	2456	2469	2681	3158	4544	4542	8197
10	656	1340	2107	4434	10336	6310	1271	700	656	980	1033	402	1401	1274	2206	2319	2345	2564	3014	4435	4434	8109
11	464	1149	1966	4360	10280	6248	1127	512	463	785	838	**202**	1234	1126	2101	2210	2254	2483	2891	4360	4360	8057
12	314	965	1799	4247	10181	6144	959	372	313	614	666	**68**	1048	959	1967	2071	2134	2370	2738	4248	4248	7962
13	347	841	1631	4088	10025	5988	791	425	364	599	646	**225**	885	791	1803	1906	1973	2212	2570	4088	4089	7809
14	431	662	1418	3894	9836	5798	578	550	496	630	666	434	676	578	1601	1701	1778	2021	2359	3894	3895	7623
15	511	495	1242	3749	9695	5656	407	670	625	677	701	608	495	407	1448	1544	1636	1884	2189	3749	3751	7487
16	638	345	1080	3600	9548	5510	**248**	817	776	786	802	771	345	**247**	1297	1390	1491	1742	2029	3601	3603	7343
17	3372	2661	1968	1842	7264	3370	1390	3493	3435	3548	3570	3271	2748	2591	1812	1831	1586	1390	2033	1861	1847	5033
18	3330	2567	1795	1671	7190	3258	1243	3460	3404	3499	3518	3253	2668	2523	1687	1695	1455	1243	1851	1684	1671	4955
19	3286	2481	1647	1544	7151	3191	1120	3422	3368	3448	3465	3228	2593	2460	1581	1579	1345	1120	1696	1556	1544	4916
20	3239	2388	1474	1406	7113	3124	988	3384	3332	3393	3408	3206	2513	2394	1465	1451	1228	988	1513	1417	1406	4879
21	3205	2315	1325	1302	7087	3078	892	3358	3307	3352	3364	3194	2452	2346	1378	1352	1142	892	1357	1311	1302	4857
22	3181	2256	1180	1207	7060	3035	824	3345	3295	3324	3333	3197	2406	2315	1311	1270	1081	824	1204	1214	1207	4835
23	3182	2224	1045	1115	7021	2986	804	3357	3309	3320	3326	3225	2386	2312	1280	1223	1061	806	1062	1119	1115	4804
24	3167	2180	906	1075	7013	2975	767	3352	3307	3299	3303	3237	2354	2296	1248	1176	1047	803	919	1076	1075	4806
25	3167	2144	749	1062	7008	2971	719	3365	3323	3290	3290	3273	2335	2303	1251	1160	1082	868	752	1062	1066	4818
26	3177	2125	661	1093	7012	2963	702	3384	3345	3294	3290	3310	2337	2322	1283	1181	1141	956	661	1093	1101	4837
27	3182	2107	601	1167	7037	2982	710	3397	3360	3292	3285	3340	2337	2340	1325	1214	1211	1054	601	1167	1177	4879
28	9285	8267	6782	3929	970	1312	6842	9469	9423	9414	9415	9339	8462	8414	7364	7282	7164	6916	6782	5065	5061	1312
29	9460	8439	6950	4101	782	1490	7013	9645	9600	9588	9589	9517	8635	8590	7538	7456	7340	7092	6950	5238	5235	1490
30	9640	8616	7125	4279	594	1674	7191	9827	9781	9768	9769	9701	8814	8771	7719	7636	7522	7274	7125	5418	5414	1674
31	9822	8794	7301	4459	409	1859	7369	10009	9964	9948	9949	9884	8994	8952	7900	7817	7704	7457	7301	5598	5595	1859
32	10016	8986	7491	4652	**215**	2059	7561	10204	10159	10142	10142	10081	9188	9147	8094	8010	7899	7653	7491	5792	5789	2059
33	10180	9147	7650	4816	**86**	2228	7723	10369	10324	10305	10305	10247	9350	9311	8258	8174	8064	7818	7650	5955	5952	2228

To be continued on next page...

Project:
VRA WPP2

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Calculated:
13/12/2017 3:47 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | Mitigated

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
34	7192	6227	4818	2028	3224	348	4813	7358	7308	7331	7338	7201	6396	6322	5289	5222	5073	4818	4818	3067	3058	1089
35	7367	6395	4973	2160	3026	397	4981	7535	7486	7505	7511	7382	6567	6497	5460	5391	5246	4991	4974	3223	3214	903
36	7547	6571	5140	2312	2835	447	5156	7717	7668	7684	7690	7565	6745	6677	5638	5568	5425	5171	5140	3390	3382	743
37	7715	6734	5294	2454	2650	473	5316	7886	7838	7851	7856	7738	6909	6844	5803	5731	5592	5338	5294	3545	3538	594
38	7877	6891	5442	2592	2466	418	5470	8050	8002	8012	8017	7905	7068	7006	5963	5889	5754	5500	5442	3695	3689	462
39	8048	7059	5603	2749	2286	404	5636	8223	8175	8183	8187	8079	7238	7177	6133	6058	5925	5672	5603	3860	3853	405
40	8237	7244	5783	2926	2092	436	5820	8413	8365	8370	8374	8271	7424	7365	6320	6245	6113	5861	5783	4042	4036	437
41	8400	7402	5935	3076	1907	502	5977	8578	8531	8533	8536	8439	7585	7529	6482	6405	6277	6025	5935	4198	4192	503
42	8577	7574	6102	3242	1716	635	6149	8756	8709	8708	8711	8619	7759	7705	6657	6579	6453	6203	6102	4369	4364	635
43	8759	7752	6275	3417	1521	797	6327	8940	8893	8890	8892	8805	7940	7888	6839	6760	6636	6386	6275	4547	4543	797
44	8943	7933	6453	3596	1331	974	6508	9125	9079	9074	9076	8992	8123	8072	7023	6943	6821	6572	6453	4729	4724	974
45	9121	8106	6623	3769	1139	1148	6681	9304	9258	9251	9252	9173	8299	8250	7200	7119	7000	6751	6623	4903	4899	1148

WTG	W	X	Y	Z	AA	AB
1	9607	11018	11755	11926	2312	4253
2	9518	10937	11684	11871	2118	4094
3	9442	10868	11625	11826	1946	3955
4	9354	10787	11554	11770	1764	3805
5	9278	10720	11498	11730	1565	3657
6	9200	10647	11433	11679	1403	3525
7	9126	10580	11376	11637	1216	3387
8	9035	10495	11302	11579	1020	3233
9	8983	10449	11264	11556	849	3123
10	8887	10358	11182	11488	680	2980
11	8826	10302	11136	11459	484	2858
12	8722	10203	11047	11385	319	2706
13	8565	10047	10895	11240	347	2538
14	8373	9858	10711	11067	463	2328
15	8230	9718	10577	10943	584	2159
16	8082	9571	10433	10807	733	1999
17	5867	7284	8046	8285	3407	2004
18	5780	7210	7988	8252	3373	1823
19	5730	7172	7963	8247	3335	1669
20	5680	7134	7941	8249	3297	1488
21	5646	7108	7930	8258	3271	1334
22	5610	7082	7916	8266	3258	1183
23	5564	7043	7891	8263	3270	1045
24	5550	7036	7897	8290	3266	906
25	5538	7030	7909	8331	3281	749
26	5539	7035	7926	8369	3301	668
27	5561	7060	7962	8425	3316	618
28	767	987	1782	2363	9383	6797
29	873	799	1613	2243	9559	6966
30	1012	610	1443	2124	9741	7141
31	1167	424	1277	2013	9923	7318
32	1341	**226**	1109	1912	10119	7508
33	1494	**88**	979	1839	10284	7668
34	1968	3242	3963	4253	7271	4825
35	1778	3044	3770	4077	7448	4982
36	1607	2853	3579	3898	7630	5150
37	1437	2668	3399	3735	7800	5304
38	1269	2484	3223	3581	7964	5453
39	1122	2304	3044	3418	8136	5615
40	982	2109	2850	3240	8326	5795
41	839	1924	2677	3096	8492	5947
42	728	1734	2494	2941	8670	6115
43	656	1538	2307	2786	8854	6290
44	653	1348	2121	2629	9039	6468
45	683	1156	1944	2492	9218	6638

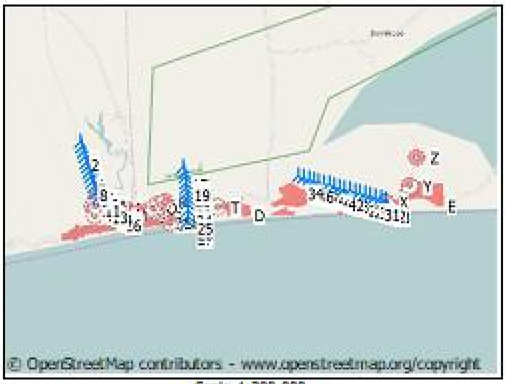
Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
11/12/2017 3:46 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | NRO100

Noise calculation model:
ISO 9613-2 General
Wind speed:
Highest noise value
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)



Scale 1:200 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Noise data Creator	Name	Wind speed	LwA,ref	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	
1	201 463	642 934	17.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
2	201 510	642 746	14.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
3	201 551	642 578	7.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
4	201 604	642 404	10.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
5	201 646	642 209	14.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
6	201 699	642 055	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
7	201 746	641 874	-0.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
8	201 813	641 686	4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
9	201 846	641 518	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
10	201 927	641 357	5.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
11	201 974	641 162	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
12	202 068	640 981	0.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
13	202 222	640 914	2.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
14	202 411	640 813	-4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
15	202 552	640 699	-1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
16	202 699	640 632	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
17	205 094	642 033	-1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
18	205 137	641 835	0.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
19	205 153	641 668	-2.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
20	205 169	641 470	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
21	205 180	641 298	-0.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
22	205 196	641 120	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
23	205 228	640 938	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
24	205 233	640 795	0.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
25	205 244	640 503	-1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
26	205 249	640 315	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
27	205 239	640 132	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
28	211 341	641 116	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
29	211 520	641 058	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
30	211 704	641 009	1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
31	211 887	640 964	6.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
32	212 084	640 910	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
33	212 290	640 865	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
34	209 164	641 715	1.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
35	209 352	641 650	3.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
36	209 540	641 613	3.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
37	209 718	641 559	3.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
38	209 890	641 495	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
39	210 067	641 457	5.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
40	210 261	641 425	4.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
41	210 433	641 355	2.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
42	210 615	641 301	4.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
43	210 803	641 248	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
44	210 991	641 210	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No
45	211 174	641 151	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	UNTE NRO100	7.0	100.0	No

Calculation Results

APPENDIX 7 - NOISE AND SHADOW IMPACT ASSESSMENT STUDY

Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
11/12/2017 3:46 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | NRO100

Sound level

Noise sensitive area						Demands		Sound level	Demands fulfilled ?		
No.	Name	Easting	Northing	Z [m]	Imission height [m]	Noise [dB(A)]	Distance [m]	From WTGs [dB(A)]	Noise	Distance	All
A	Noise sensitive area: User defined (9)	201 968	640 678	2.7	1.0	45.0	300	41.8	Yes	Yes	Yes
B	Noise sensitive area: User defined (10)	202 913	640 361	7.0	1.0	45.0	300	38.8	Yes	Yes	Yes
C	Noise sensitive area: User defined (11)	204 643	640 051	1.8	1.0	45.0	300	36.2	Yes	Yes	Yes
D	Noise sensitive area: User defined (12)	206 302	640 637	0.1	1.0	45.0	300	33.4	Yes	Yes	Yes
E	Noise sensitive area: User defined (13)	212 269	640 780	4.0	1.0	45.0	300	46.7	**No**	**No**	**No**
F	Noise sensitive area: User defined (16)	210 030	641 054	2.7	1.0	45.0	300	41.1	Yes	Yes	Yes
G	Noise sensitive area: User defined (17)	202 943	640 588	2.6	1.0	45.0	300	40.9	Yes	**No**	**No**
H	01	201 883	640 658	4.0	1.0	45.0	300	40.6	Yes	Yes	Yes
I	02	201 927	640 701	2.0	1.0	45.0	300	41.7	Yes	Yes	Yes
J	03	201 956	640 377	1.3	1.0	45.0	300	37.9	Yes	Yes	Yes
K	04	201 959	640 324	0.4	1.0	45.0	300	37.4	Yes	Yes	Yes
L	06	202 003	640 962	0.9	1.0	45.0	300	48.5	**No**	**No**	**No**
M	07	202 913	640 361	-0.8	1.0	45.0	300	38.8	Yes	Yes	Yes
N	08	202 943	640 588	1.0	1.0	45.0	300	40.9	Yes	**No**	**No**
O	09	203 996	640 591	0.5	1.0	45.0	300	33.7	Yes	Yes	Yes
P	10	204 084	640 506	-1.9	1.0	45.0	300	33.8	Yes	Yes	Yes
Q	11	204 187	640 732	0.7	1.0	45.0	300	34.7	Yes	Yes	Yes
R	12	204 432	640 811	1.3	1.0	45.0	300	36.5	Yes	Yes	Yes
S	14	204 643	640 051	2.0	1.0	45.0	300	36.2	Yes	Yes	Yes
T	15	206 300	640 617	0.1	1.0	45.0	300	33.4	Yes	Yes	Yes
U	16	206 302	640 637	0.2	1.0	45.0	300	33.4	Yes	Yes	Yes
V	17	210 030	641 054	0.8	1.0	45.0	300	41.1	Yes	Yes	Yes
W	18	210 781	640 592	-2.4	1.0	45.0	300	38.2	Yes	Yes	Yes
X	19	212 269	640 780	2.7	1.0	45.0	300	46.8	**No**	**No**	**No**
Y	20	213 109	641 335	3.4	1.0	45.0	300	31.2	Yes	Yes	Yes
Z	21	213 374	642 321	0.3	1.0	45.0	300	26.5	Yes	Yes	Yes
AA	05	201 968	640 678	1.5	1.0	45.0	300	41.8	Yes	Yes	Yes
AB	13	204 622	640 086	0.3	1.0	45.0	300	36.2	Yes	Yes	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	2281	2906	3522	5356	10999	7090	2649	2314	2281	2604	2657	2045	2953	2774	3450	3573	3502	3650	4292	5363	5356	8771
2	2088	2720	3347	5235	10917	6990	2473	2121	2087	2411	2463	1851	2767	2590	3290	3412	3350	3504	4132	5242	5235	8686
3	1915	2555	3195	5133	10848	6905	2319	1949	1915	2238	2291	1678	2602	2429	3151	3273	3219	3380	3994	5138	5133	8615
4	1734	2385	3030	5019	10767	6808	2154	1768	1733	2057	2110	1496	2426	2256	3001	3123	3076	3245	3843	5024	5019	8533
5	1535	2191	2863	4915	10699	6724	1988	1569	1534	1858	1911	1298	2241	2077	2854	2975	2940	3118	3694	4920	4915	8464
6	1373	2033	2718	4817	10626	6639	1845	1409	1373	1697	1750	1134	2084	1924	2724	2844	2818	3003	3562	4821	4817	8391
7	1187	1851	2562	4721	10559	6560	1694	1223	1187	1511	1564	947	1911	1757	2590	2709	2695	2889	3423	4725	4721	8325
8	992	1662	2391	4610	10474	6464	1530	1030	991	1316	1369	748	1722	1576	2442	2559	2559	2761	3268	4613	4610	8242
9	821	1495	2264	4542	10427	6408	1415	861	821	1146	1199	578	1574	1438	2341	2456	2469	2681	3158	4544	4542	8197
10	656	1340	2107	4434	10336	6310	1271	700	656	980	1033	402	1401	1274	2206	2319	2345	2564	3014	4435	4434	8109
11	464	1149	1966	4360	10280	6248	1127	512	463	785	838	**202**	1234	1126	2101	2210	2254	2483	2891	4360	4360	8057
12	314	965	1799	4247	10181	6144	959	372	313	614	666	**68**	1048	959	1967	2071	2134	2370	2738	4248	4248	7962
13	347	841	1631	4088	10025	5988	791	425	364	599	646	**225**	885	791	1803	1906	1973	2212	2570	4088	4089	7809
14	431	662	1418	3894	9836	5798	578	550	496	630	666	434	676	578	1601	1701	1778	2021	2359	3894	3895	7623
15	511	495	1242	3749	9695	5656	407	670	625	677	701	608	495	407	1448	1544	1636	1884	2189	3749	3751	7487
16	638	345	1080	3600	9548	5510	**248**	817	776	786	802	771	345	**247**	1297	1390	1491	1742	2029	3601	3603	7343
17	3372	2661	1968	1842	7264	3370	1390	3493	3435	3548	3570	3271	2748	2591	1812	1831	1586	1390	2033	1861	1847	5033
18	3330	2567	1795	1671	7190	3258	1243	3460	3404	3499	3518	3253	2668	2523	1687	1695	1455	1243	1851	1684	1671	4955
19	3286	2481	1647	1544	7151	3191	1120	3422	3368	3448	3465	3228	2593	2460	1581	1579	1345	1120	1696	1556	1544	4916
20	3239	2388	1474	1406	7113	3124	988	3384	3332	3393	3408	3206	2513	2394	1465	1451	1228	988	1513	1417	1406	4879
21	3205	2315	1325	1302	7087	3078	892	3358	3307	3352	3364	3194	2452	2346	1378	1352	1142	892	1357	1311	1302	4857
22	3181	2256	1180	1207	7060	3035	824	3345	3295	3324	3333	3197	2406	2315	1311	1270	1081	824	1204	1214	1207	4835
23	3182	2224	1045	1115	7021	2986	804	3357	3309	3320	3326	3225	2386	2312	1280	1223	1061	806	1062	1119	1115	4804
24	3167	2180	906	1075	7013	2975	767	3352	3307	3299	3303	3237	2354	2296	1248	1176	1047	803	919	1076	1075	4806
25	3167	2144	749	1062	7008	2971	719	3365	3323	3290	3290	3273	2335	2303	1251	1160	1082	868	752	1062	1066	4818
26	3177	2125	661	1093	7012	2963	702	3384	3345	3294	3290	3310	2337	2322	1283	1181	1141	956	661	1093	1101	4837
27	3182	2107	601	1167	7037	2982	710	3397	3360	3292	3285	3340	2337	2340	1325	1214	1211	1054	601	1167	1177	4879
28	9285	8267	6782	3929	970	1312	6842	9469	9423	9414	9415	9339	8462	8414	7364	7282	7164	6916	6782	5065	5061	1312
29	9460	8439	6950	4101	782	1490	7013	9645	9600	9588	9589	9517	8635	8590	7538	7456	7340	7092	6950	5238	5235	1490
30	9640	8616	7125	4279	594	1674	7191	9827	9781	9768	9769	9701	8814	8771	7719	7636	7522	7274	7125	5418	5414	1674
31	9822	8794	7301	4459	409	1859	7369	10009	9964	9948	9949	9884	8994	8952	7900	7817	7704	7457	7301	5598	5595	1859
32	10016	8986	7491	4652	**215**	2059	7561	10204	10159	10142	10142	10081	9188	9147	8094	8010	7899	7653	7491	5792	5789	2059
33	10180	9147	7650	4816	**86**	2228	7723	10369	10324	10305	10305	10247	9350	9311	8258	8174	8064	7818	7650	5955	5952	2228

To be continued on next page...

Project:
VRA WPP2

Licensed user:
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Calculated:
11/12/2017 3:46 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Preferred Layout | NRO100

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
34	7192	6227	4818	2028	3224	348	4813	7358	7308	7331	7338	7201	6396	6322	5289	5222	5073	4818	4818	3067	3058	1089
35	7367	6395	4973	2160	3026	397	4981	7535	7486	7505	7511	7382	6567	6497	5460	5391	5246	4991	4974	3223	3214	903
36	7547	6571	5140	2312	2835	447	5156	7717	7668	7684	7690	7565	6745	6677	5638	5568	5425	5171	5140	3390	3382	743
37	7715	6734	5294	2454	2650	473	5316	7886	7838	7851	7856	7738	6909	6844	5803	5731	5592	5338	5294	3545	3538	594
38	7877	6891	5442	2592	2466	418	5470	8050	8002	8012	8017	7905	7068	7006	5963	5889	5754	5500	5442	3695	3689	462
39	8048	7059	5603	2749	2286	404	5636	8223	8175	8183	8187	8079	7238	7177	6133	6058	5925	5672	5603	3860	3853	405
40	8237	7244	5783	2926	2092	436	5820	8413	8365	8370	8374	8271	7424	7365	6320	6245	6113	5861	5783	4042	4036	437
41	8400	7402	5935	3076	1907	502	5977	8578	8531	8533	8536	8439	7585	7529	6482	6405	6277	6025	5935	4198	4192	503
42	8577	7574	6102	3242	1716	635	6149	8756	8709	8708	8711	8619	7759	7705	6657	6579	6453	6203	6102	4369	4364	635
43	8759	7752	6275	3417	1521	797	6327	8940	8893	8890	8892	8805	7940	7888	6839	6760	6636	6386	6275	4547	4543	797
44	8943	7933	6453	3596	1331	974	6508	9125	9079	9074	9076	8992	8123	8072	7023	6943	6821	6572	6453	4729	4724	974
45	9121	8106	6623	3769	1139	1148	6681	9304	9258	9251	9252	9173	8299	8250	7200	7119	7000	6751	6623	4903	4899	1148

WTG	W	X	Y	Z	AA	AB
1	9607	11018	11755	11926	2312	4253
2	9518	10937	11684	11871	2118	4094
3	9442	10868	11625	11826	1946	3955
4	9354	10787	11554	11770	1764	3805
5	9278	10720	11498	11730	1565	3657
6	9200	10647	11433	11679	1403	3525
7	9126	10580	11376	11637	1216	3387
8	9035	10495	11302	11579	1020	3233
9	8983	10449	11264	11556	849	3123
10	8887	10358	11182	11488	680	2980
11	8826	10302	11136	11459	484	2858
12	8722	10203	11047	11385	319	2706
13	8565	10047	10895	11240	347	2538
14	8373	9858	10711	11067	463	2328
15	8230	9718	10577	10943	584	2159
16	8082	9571	10433	10807	733	1999
17	5867	7284	8046	8285	3407	2004
18	5780	7210	7988	8252	3373	1823
19	5730	7172	7963	8247	3335	1669
20	5680	7134	7941	8249	3297	1488
21	5646	7108	7930	8258	3271	1334
22	5610	7082	7916	8266	3258	1183
23	5564	7043	7891	8263	3270	1045
24	5550	7036	7897	8290	3266	906
25	5538	7030	7909	8331	3281	749
26	5539	7035	7926	8369	3301	668
27	5561	7060	7962	8425	3316	618
28	767	987	1782	2363	9383	6797
29	873	799	1613	2243	9559	6966
30	1012	610	1443	2124	9741	7141
31	1167	424	1277	2013	9923	7318
32	1341	**226**	1109	1912	10119	7508
33	1494	**88**	979	1839	10284	7668
34	1968	3242	3963	4253	7271	4825
35	1778	3044	3770	4077	7448	4982
36	1607	2853	3579	3898	7630	5150
37	1437	2668	3399	3735	7800	5304
38	1269	2484	3223	3581	7964	5453
39	1122	2304	3044	3418	8136	5615
40	982	2109	2850	3240	8326	5795
41	839	1924	2677	3096	8492	5947
42	728	1734	2494	2941	8670	6115
43	656	1538	2307	2786	8854	6290
44	653	1348	2121	2629	9039	6468
45	683	1156	1944	2492	9218	6638

Project:
VRA WPP2

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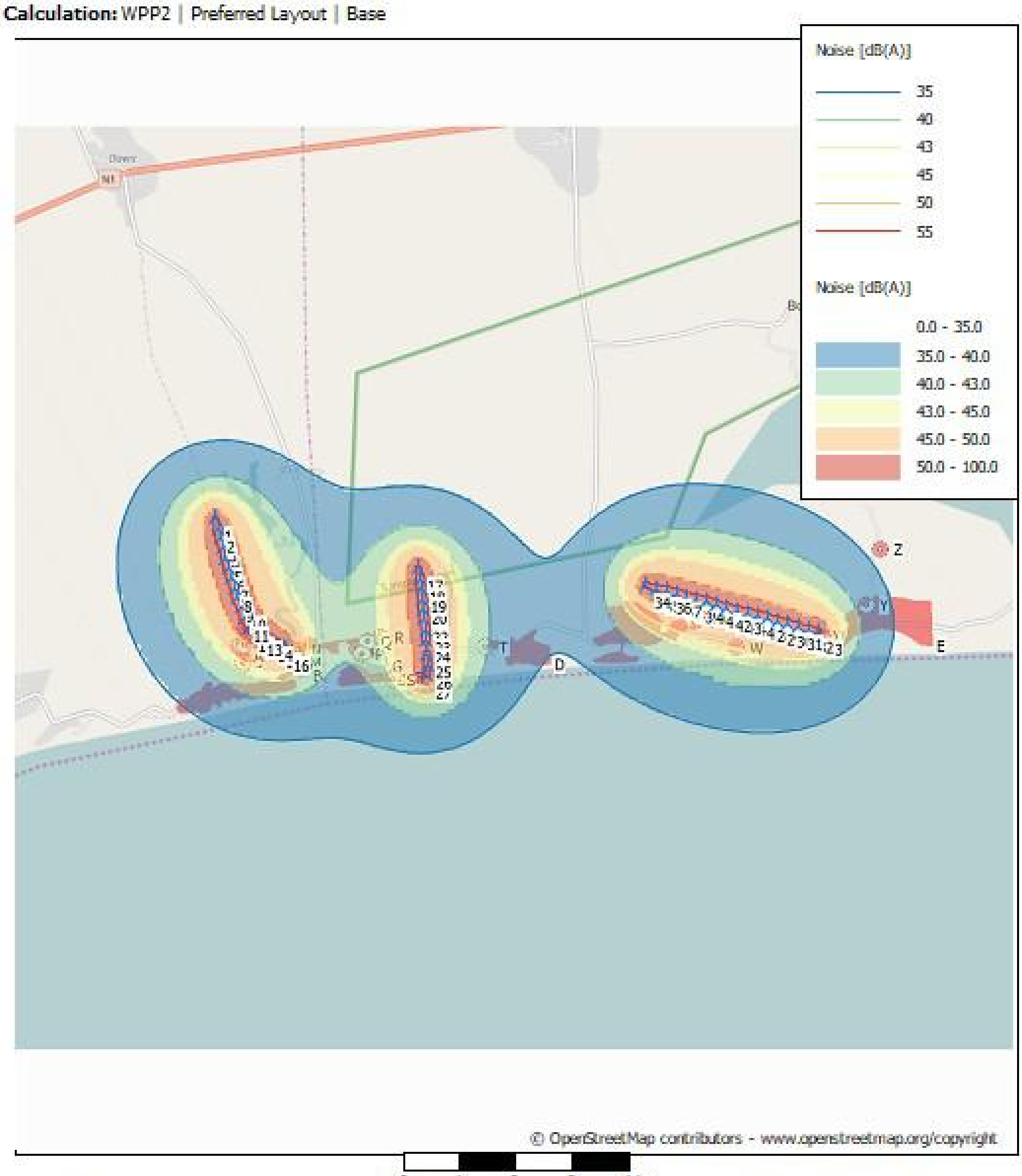
Calculated:
11/12/2017 3:40 PM/3.1.617

DECIBEL - Map Highest noise value

Calculation: WPP2 | Preferred Layout | Base



Map: Open Street Map 001 , Print scale 1:100 000, Map center UTM (north)-WGS84 Zone: 31 East: 206 857 North: 641 533
New WTG   Noise sensitive area
Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value
Height above sea level from active line object

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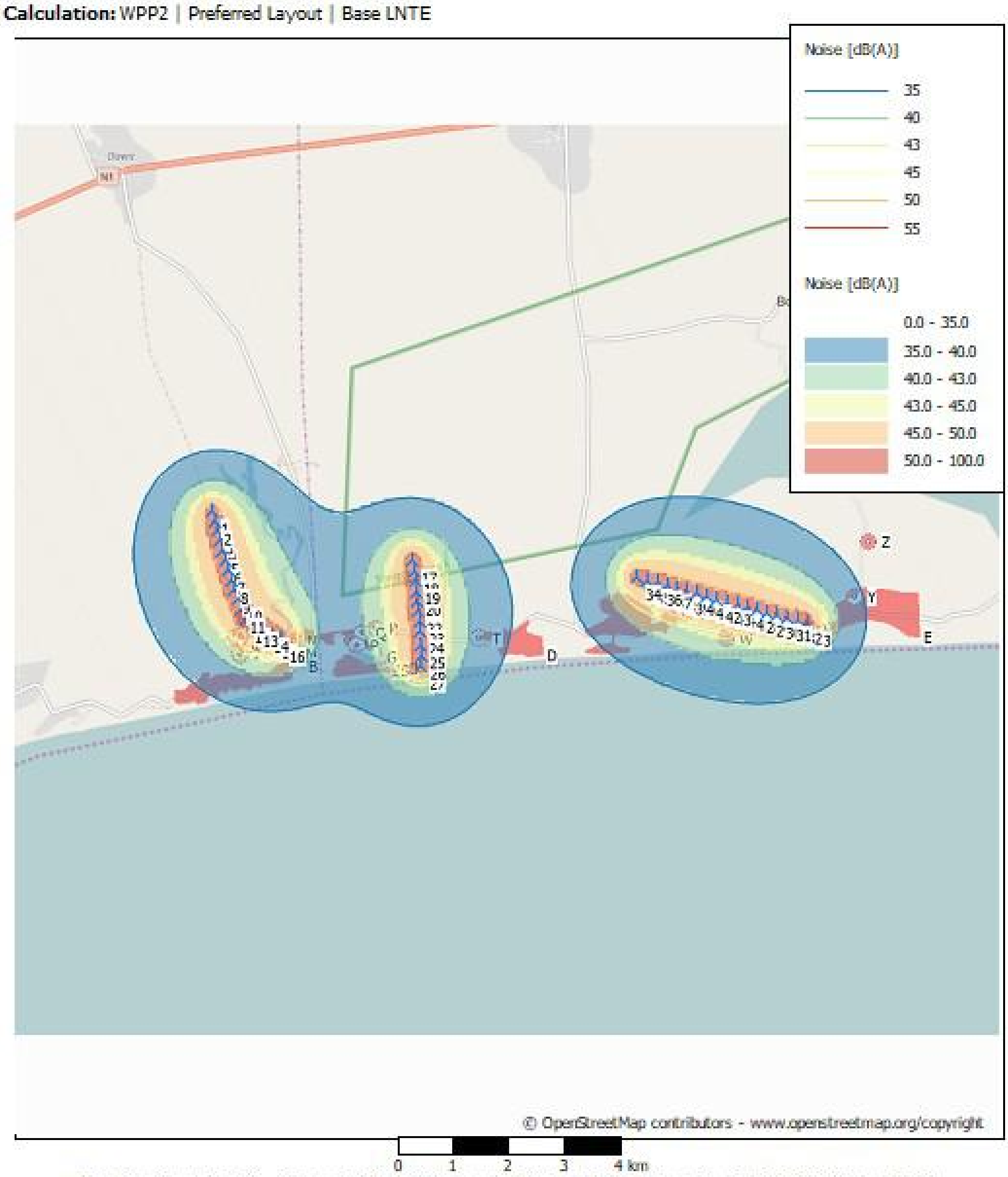
Calculated:
11/12/2017 3:43 PM/3.1.617

DECIBEL - Map Highest noise value

Calculation: WPP2 | Preferred Layout | Base LNTE



Map: Open Street Map 001 , Print scale 1:100 000, Map center UTM (north)-WGS84 Zone: 31 East: 206 857 North: 641 533

New WTG — Noise sensitive area

Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value
Height above sea level from active line object

Project:
VRA WPP2

Licensed user:
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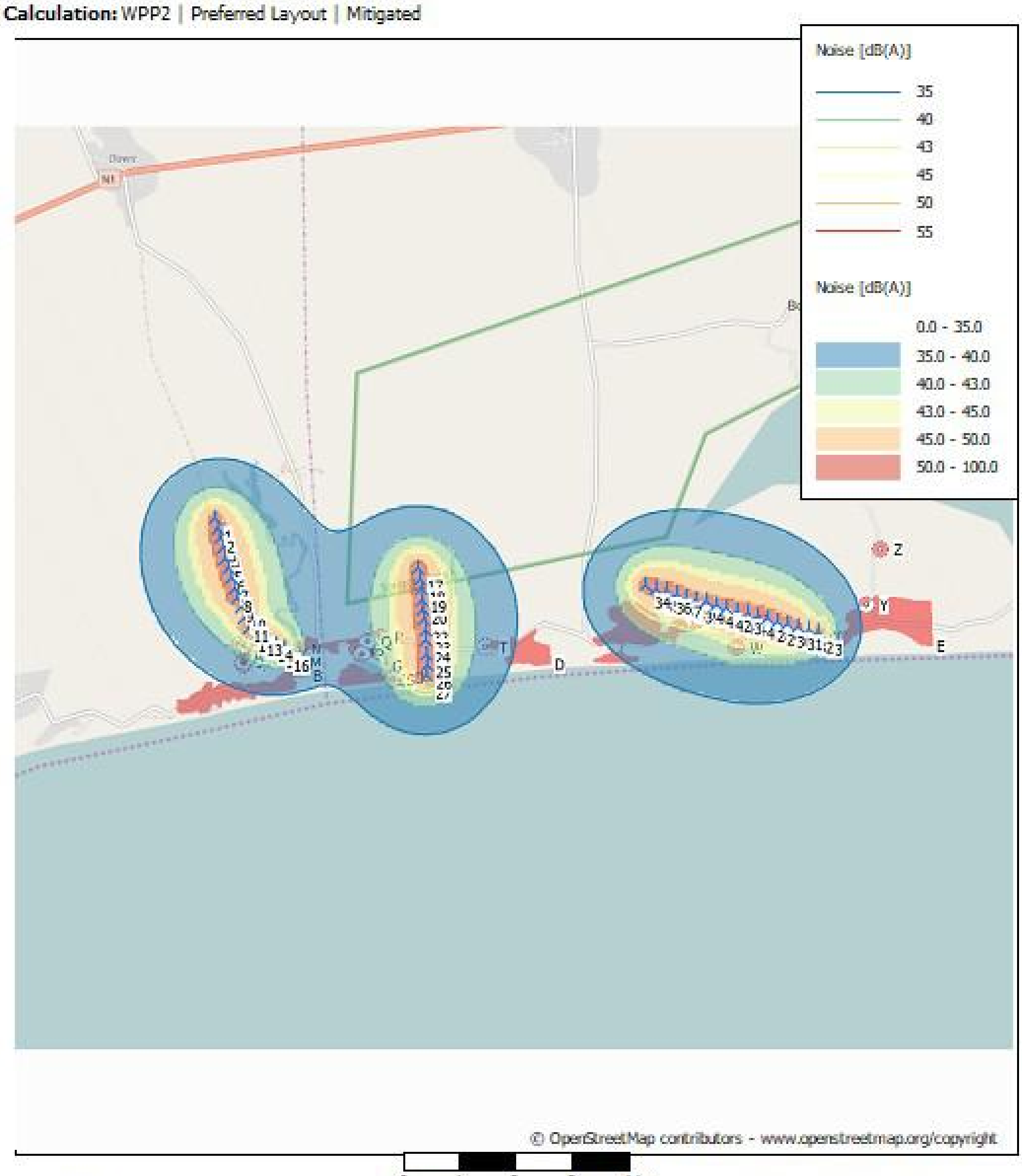
Calculated:
13/12/2017 3:47 PM/3.1.617

DECIBEL - Map Highest noise value

Calculation: WPP2 | Preferred Layout | Mitigated



Map: Open Street Map 001 , Print scale 1:100 000, Map center UTM (north)-WGS84 Zone: 31 East: 206 857 North: 641 533
New WTG   Noise sensitive area
Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value
Height above sea level from active line object

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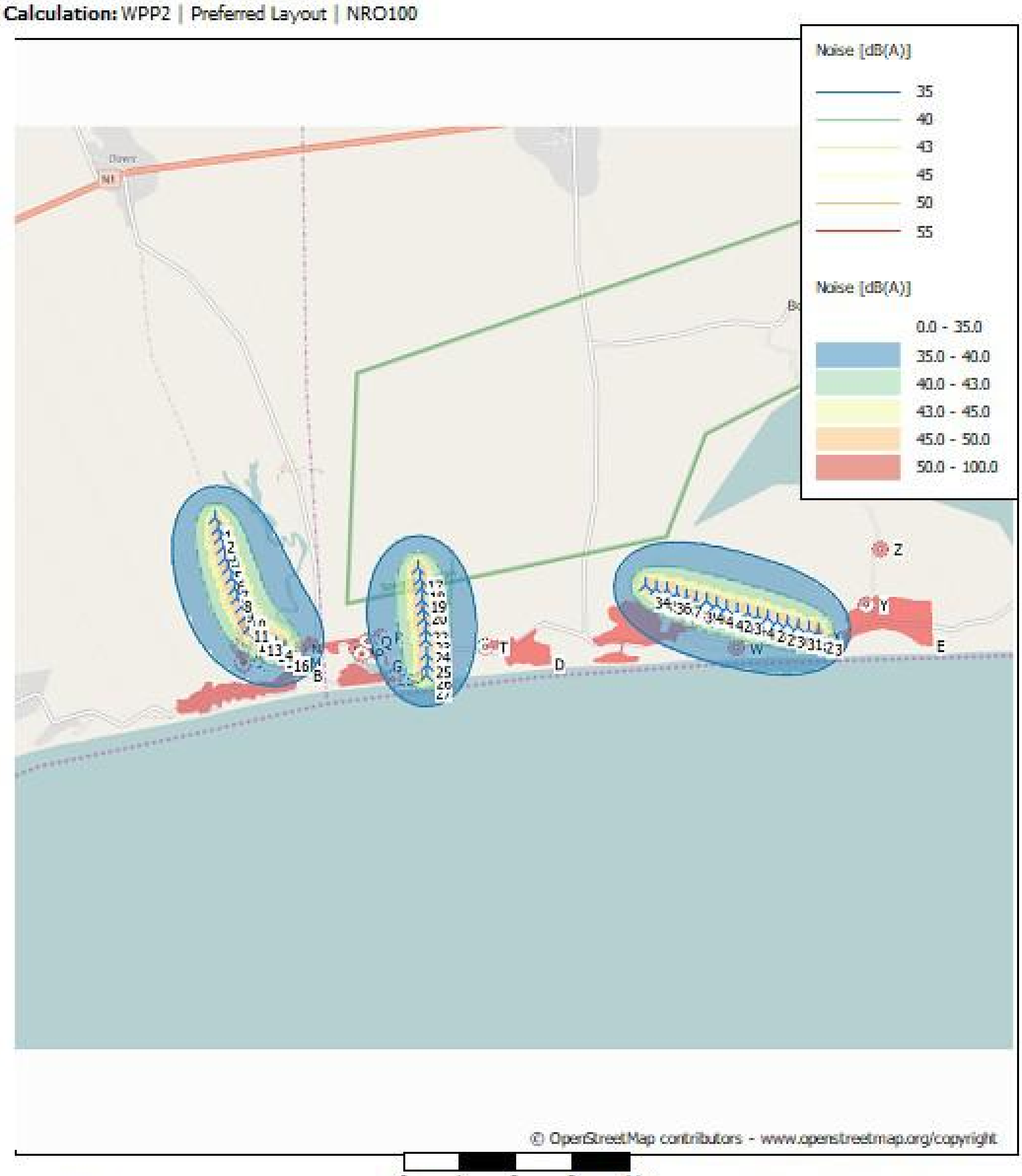
Calculated:
11/12/2017 3:46 PM/3.1.617

DECIBEL - Map Highest noise value

Calculation: WPP2 | Preferred Layout | NRO100



Map: Open Street Map 001 , Print scale 1:100 000, Map center UTM (north)-WGS84 Zone: 31 East: 206 857 North: 641 533
New WTG   Noise sensitive area
Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value
Height above sea level from active line object

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12.2 WPP2 ALTERNATIVE LAYOUT

Project:
VRA WPP2

Licensed user:
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Calculated:
11/12/2017 3:57 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Base
Noise calculation model:
ISO 9613-2 General
Wind speed:
Highest noise value
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:200 000
New WTG   Noise sensitive area

WTGs

					WTG type						Noise data				
	Easting	Northing	Z [m]	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	201 626	642 523	8.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
2	201 680	642 340	11.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
3	201 734	642 179	4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
4	201 782	641 986	0.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
5	201 917	641 868	3.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
6	202 105	641 809	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
7	202 287	641 771	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
8	202 470	641 712	9.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
9	202 642	641 669	-5.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
10	202 814	641 637	-1.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
11	203 002	641 572	-3.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
12	203 185	641 540	2.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
13	203 489	641 470	4.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
14	203 647	641 417	0.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
15	203 835	641 374	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
16	203 996	641 342	-1.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
17	204 201	641 282	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
18	204 378	641 256	1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
19	204 544	641 207	-1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
20	204 727	641 154	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
21	204 899	641 116	-1.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
22	205 082	641 041	2.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
23	205 157	640 864	1.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
24	205 216	640 643	-3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
25	205 238	640 461	-0.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
26	205 254	640 289	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
27	205 286	640 128	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
28	209 089	641 927	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
29	209 177	641 712	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
30	209 354	641 658	3.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
31	209 548	641 589	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
32	209 709	641 562	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
33	209 892	641 513	3.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
34	210 080	641 454	5.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
35	210 262	641 406	3.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
36	210 440	641 374	3.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
37	210 617	641 304	4.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
38	210 805	641 250	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
39	210 988	641 207	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
40	211 149	641 154	2.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
41	211 273	641 025	0.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
42	211 360	640 896	1.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
43	212 885	641 825	-3.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
44	213 062	641 642	0.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No
45	213 094	641 384	5.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	Normal Operation	7.0	107.0	No

Calculation Results

windPRO 3.1.617 by EMD International A/S, Tel. +45 96 35 44 44, www.emd.dk, windpro@emd.dk   13/12/2017 4:51 PM / 1   windPRO

Project:
VRA WPP2

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Nicolette / nicolette@airshed.co.za
Calculated:
11/12/2017 3:57 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Base

Sound level

Noise sensitive area						Demands		Sound level	Demands fulfilled ?		
No.	Name	Easting	Northing	Z [m]	Imission height [m]	Noise [dB(A)]	Distance [m]	From WTGs [dB(A)]	Noise	Distance	All
A	Noise sensitive area: User defined (9)	201 927	640 701	2.7	1.0	45.0	300	40.8	Yes	Yes	Yes
B	Noise sensitive area: User defined (10)	202 913	640 361	7.0	1.0	45.0	300	40.9	Yes	Yes	Yes
C	Noise sensitive area: User defined (11)	204 622	640 086	1.8	1.0	45.0	300	44.3	Yes	Yes	Yes
D	Noise sensitive area: User defined (12)	206 300	640 617	0.1	1.0	45.0	300	40.1	Yes	Yes	Yes
E	Noise sensitive area: User defined (13)	213 109	641 335	4.0	1.0	45.0	300	54.7	**No**	**No**	**No**
F	Noise sensitive area: User defined (16)	210 030	641 054	2.7	1.0	45.0	300	48.1	**No**	Yes	**No**
G	Noise sensitive area: User defined (17)	204 432	640 811	2.6	1.0	45.0	300	48.6	**No**	Yes	**No**
H	01	201 883	640 658	4.0	1.0	45.0	300	40.4	Yes	Yes	Yes
I	02	201 927	640 701	2.0	1.0	45.0	300	40.8	Yes	Yes	Yes
J	03	201 956	640 377	1.3	1.0	45.0	300	38.9	Yes	Yes	Yes
K	04	201 959	640 324	0.4	1.0	45.0	300	38.6	Yes	Yes	Yes
L	06	202 003	640 962	0.9	1.0	45.0	300	43.0	Yes	Yes	Yes
M	07	202 913	640 361	-0.8	1.0	45.0	300	40.9	Yes	Yes	Yes
N	08	202 943	640 588	1.0	1.0	45.0	300	42.5	Yes	Yes	Yes
O	09	203 996	640 591	0.5	1.0	45.0	300	45.0	Yes	Yes	Yes
P	10	204 084	640 506	-1.9	1.0	45.0	300	44.6	Yes	Yes	Yes
Q	11	204 187	640 732	0.7	1.0	45.0	300	46.8	**No**	Yes	**No**
R	12	204 432	640 811	1.3	1.0	45.0	300	48.6	**No**	Yes	**No**
S	14	204 643	640 051	2.0	1.0	45.0	300	44.2	Yes	Yes	Yes
T	15	206 300	640 617	0.1	1.0	45.0	300	40.1	Yes	Yes	Yes
U	16	206 302	640 637	0.2	1.0	45.0	300	40.1	Yes	Yes	Yes
V	17	210 030	641 054	0.8	1.0	45.0	300	48.1	**No**	Yes	**No**
W	18	210 781	640 592	-2.4	1.0	45.0	300	45.2	**No**	Yes	**No**
X	19	212 269	640 780	2.7	1.0	45.0	300	40.5	Yes	Yes	Yes
Y	20	213 109	641 335	3.4	1.0	45.0	300	54.7	**No**	**No**	**No**
Z	21	213 374	642 321	0.3	1.0	45.0	300	39.9	Yes	Yes	Yes
AA	05	201 968	640 678	1.5	1.0	45.0	300	40.8	Yes	Yes	Yes
AB	13	204 622	640 086	0.3	1.0	45.0	300	44.3	Yes	Yes	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	1847	2505	3103	5042	10764	6817	2227	1882	1847	2171	2224	1606	2516	2340	3057	3179	3125	3287	3900	5047	5042	8531
2	1658	2320	2932	4926	10683	6719	2056	1695	1658	1983	2036	1416	2332	2160	2902	3024	2978	3148	3744	4931	4926	8448
3	1491	2157	2779	4821	10607	6631	1903	1529	1491	1816	1869	1247	2167	1998	2764	2885	2848	3025	3604	4826	4821	8372
4	1293	1962	2610	4717	10535	6544	1736	1332	1293	1618	1671	1047	1980	1817	2617	2736	2712	2899	3454	4721	4717	8300
5	1167	1806	2431	4555	10388	6390	1557	1210	1167	1491	1544	910	1806	1641	2440	2560	2539	2728	3276	4558	4555	8154
6	1122	1658	2255	4358	10195	6195	1379	1172	1122	1439	1492	853	1658	1481	2249	2370	2344	2532	3087	4361	4358	7961
7	1129	1543	2102	4172	10010	6008	1226	1184	1129	1433	1484	858	1543	1353	2077	2197	2165	2350	2917	4175	4172	7776
8	1148	1422	1938	3980	9822	5818	1067	1207	1148	1431	1479	884	1422	1219	1893	2015	1977	2159	2735	3983	3980	7588
9	1198	1336	1794	3803	9647	5642	939	1264	1204	1463	1509	953	1336	1122	1731	1853	1807	1985	2573	3806	3803	7413
10	1278	1280	1659	3628	9472	5467	839	1351	1289	1524	1567	1055	1280	1057	1578	1700	1644	1817	2421	3632	3628	7239
11	1367	1215	1494	3430	9279	5271	733	1445	1384	1589	1627	1171	1215	986	1397	1519	1453	1620	2238	3433	3430	7047
12	1490	1210	1369	3245	9095	5085	702	1573	1512	1692	1727	1316	1210	982	1249	1370	1287	1445	2084	3249	3245	6862
13	1668	1237	1191	2963	8816	4804	707	1773	1714	1859	1888	1542	1236	1022	1030	1149	1037	1175	1848	2966	2963	6584
14	1803	1276	1089	2767	8624	4610	667	1920	1863	1985	2011	1706	1286	1087	896	1010	872	991	1690	2771	2767	6393
15	1953	1329	1025	2575	8433	4417	599	2079	2023	2127	2150	1878	1370	1189	799	903	732	820	1550	2578	2575	6203
16	2088	1399	998	2411	8270	4253	546	2221	2166	2257	2277	2029	1461	1295	751	840	639	686	1443	2415	2411	6041
17	2260	1495	982	2198	8062	4043	473	2400	2347	2420	2438	2221	1583	1437	721	785	551	525	1309	2202	2198	5834
18	2420	1612	1007	2021	7884	3864	445	2565	2513	2576	2592	2393	1716	1583	767	805	557	448	1233	2025	2021	5656
19	2567	1719	1033	1848	7715	3692	412	2718	2666	2718	2732	2553	1838	1717	825	839	595	412	1160	1852	1848	5488
20	2731	1848	1022	1657	7529	3504	452	2887	2837	2878	2890	2731	1980	1872	923	913	685	452	1106	1662	1657	5304
21	2890	1984	1039	1482	7356	3329	558	3051	3001	3035	3045	2900	2125	2026	1045	1018	809	558	1095	1487	1482	5131
22	3055	2121	1053	1285	7170	3140	690	3222	3173	3196	3204	3080	2273	2186	1175	1132	947	689	1083	1290	1285	4948
23	3103	2134	944	1167	7090	3053	718	3281	3234	3238	3243	3156	2300	2231	1193	1131	979	727	962	1169	1167	4877
24	3143	2141	815	1084	7032	2993	725	3333	3290	3271	3273	3229	2320	2274	1221	1141	1033	802	824	1084	1086	4831
25	3161	2131	721	1074	7016	2975	706	3361	3319	3283	3282	3273	2327	2298	1249	1155	1085	879	722	1074	1079	4829
26	3183	2128	656	1096	7009	2959	706	3391	3352	3299	3295	3320	2342	2330	1294	1190	1155	974	656	1096	1104	4837
27	3230	2155	648	1126	6990	2935	757	3444	3408	3339	3333	3387	2385	2388	1371	1260	1254	1094	648	1126	1136	4833
28	7128	6178	4797	2063	3392	532	4760	7287	7236	7270	7278	7121	6342	6260	5236	5174	5016	4759	4798	3054	3043	1306
29	7204	6238	4828	2037	3211	350	4825	7370	7320	7343	7350	7213	6408	6334	5301	5234	5085	4830	4829	3078	3069	1077
30	7370	6399	4978	2165	3026	404	4985	7538	7489	7508	7515	7384	6571	6500	5463	5395	5250	4995	4978	3227	3219	907
31	7551	6573	5140	2308	2821	429	5157	7721	7672	7688	7693	7571	6747	6680	5641	5570	5429	5174	5140	3390	3382	720
32	7707	6726	5286	2446	2659	476	5308	7878	7829	7843	7848	7729	6901	6836	5795	5723	5584	5330	5286	3537	3530	601
33	7881	6896	5448	2600	2470	437	5476	8054	8006	8017	8021	7908	7073	7010	5967	5894	5758	5505	5449	3702	3695	480
34	8060	7071	5615	2761	2273	403	5648	8235	8187	8195	8199	8092	7250	7189	6145	6070	5937	5684	5615	3871	3865	403

To be continued on next page...

Project:
VRA WPP2

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Calculated:
11/12/2017 3:57 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Base

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
35	8226	7232	5770	2913	2094	416	5808	8402	8354	8359	8363	8261	7413	7354	6309	6233	6102	5850	5770	4030	4024	416
36	8409	7412	5946	3087	1905	519	5987	8587	8539	8542	8545	8447	7595	7538	6491	6415	6286	6034	5946	4208	4203	520
37	8579	7576	6104	3245	1715	638	6151	8758	8711	8711	8713	8621	7762	7707	6659	6582	6455	6205	6104	4371	4366	638
38	8761	7754	6278	3419	1520	800	6329	8942	8895	8892	8895	8807	7942	7890	6841	6762	6638	6388	6278	4549	4545	800
39	8940	7929	6449	3592	1333	970	6504	9121	9075	9070	9072	8988	8119	8069	7019	6939	6817	6568	6449	4725	4720	970
40	9096	8082	6599	3744	1163	1123	6656	9279	9233	9226	9227	9148	8274	8226	7175	7095	6975	6726	6599	4879	4875	1124
41	9211	8189	6701	3852	1007	1243	6764	9397	9351	9339	9340	9270	8386	8341	7290	7207	7092	6844	6701	4989	4986	1243
42	9301	8273	6779	3938	886	1349	6848	9489	9444	9428	9428	9367	8473	8432	7380	7296	7184	6938	6779	5077	5074	1349
43	10890	9898	8431	5571	504	2957	8474	11064	11015	11024	11029	10916	10079	10019	8974	8899	8766	8513	8431	6695	6689	2957
44	11045	10044	8568	5710	**251**	3089	8619	11222	11175	11178	11181	11080	10230	10174	9127	9050	8922	8670	8568	6840	6835	3089
45	11054	10041	8556	5703	**51**	3082	8615	11235	11188	11184	11186	11100	10233	10183	9133	9053	8931	8681	8556	6838	6833	3082

WTG	W	X	Y	Z	AA	AB
1	9356	10784	11544	11749	1876	3862
2	9267	10703	11473	11694	1687	3706
3	9185	10628	11406	11641	1519	3567
4	9106	10556	11345	11597	1321	3417
5	8956	10409	11205	11466	1191	3239
6	8761	10216	11015	11281	1139	3050
7	8575	10031	10830	11100	1139	2879
8	8386	9843	10646	10921	1150	2697
9	8210	9668	10472	10752	1199	2535
10	8035	9494	10299	10582	1279	2382
11	7840	9301	10110	10399	1367	2199
12	7655	9116	9926	10219	1491	2045
13	7375	8837	9651	9951	1688	1808
14	7181	8645	9462	9769	1834	1650
15	6990	8455	9274	9586	1993	1509
16	6826	8292	9113	9429	2134	1403
17	6617	8084	8909	9232	2313	1269
18	6437	7905	8731	9059	2478	1195
19	6267	7736	8565	8899	2630	1124
20	6080	7551	8384	8725	2800	1073
21	5905	7377	8213	8560	2964	1067
22	5717	7192	8033	8390	3135	1060
23	5630	7112	7966	8345	3195	944
24	5565	7054	7923	8328	3248	815
25	5545	7039	7920	8346	3277	721
26	5535	7032	7924	8371	3309	664
27	5514	7013	7915	8380	3363	665
28	2179	3409	4093	4333	7200	4803
29	1956	3230	3950	4241	7283	4836
30	1781	3044	3769	4074	7451	4987
31	1586	2839	3570	3896	7634	5150
32	1446	2677	3408	3743	7791	5297
33	1281	2488	3222	3575	7968	5459
34	1111	2291	3032	3406	8149	5627
35	971	2112	2858	3254	8316	5782
36	853	1923	2670	3083	8500	5959
37	731	1733	2492	2939	8672	6118
38	659	1538	2305	2783	8856	6292
39	649	1350	2125	2633	9035	6464
40	671	1181	1968	2513	9193	6614
41	655	1026	1862	2469	9311	6717
42	662	907	1794	2460	9404	6796
43	2438	1213	539	697	10977	8444
44	2511	1172	311	747	11136	8583
45	2445	1023	**52**	977	11149	8571

Project:
VRA WPP2

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Calculated:
11/12/2017 4:12 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Base LNTE

Noise calculation model:
ISO 9613-2 General
Wind speed:
Highest noise value
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:200 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	201 626	642 523	8.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
2	201 680	642 340	11.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
3	201 734	642 179	4.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
4	201 782	641 986	-0.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
5	201 917	641 868	3.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
6	202 105	641 809	2.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
7	202 287	641 771	1.8	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
8	202 470	641 712	9.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
9	202 642	641 669	-5.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
10	202 814	641 637	-1.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
11	203 002	641 572	-3.4	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
12	203 185	641 540	2.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
13	203 459	641 470	4.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
14	203 647	641 417	0.3	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
15	203 835	641 374	3.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
16	203 996	641 342	-1.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
17	204 201	641 282	3.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
18	204 378	641 256	1.3	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
19	204 544	641 207	-1.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
20	204 727	641 154	0.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
21	204 899	641 116	-1.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
22	205 082	641 041	2.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
23	205 157	640 864	1.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
24	205 216	640 643	-3.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
25	205 238	640 461	-0.3	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
26	205 254	640 289	1.8	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
27	205 286	640 128	1.8	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
28	209 059	641 927	0.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
29	209 177	641 712	1.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
30	209 354	641 658	3.4	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
31	209 548	641 589	3.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
32	209 709	641 562	2.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
33	209 892	641 513	3.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
34	210 080	641 454	5.2	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
35	210 252	641 406	3.9	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
36	210 440	641 374	3.3	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
37	210 617	641 304	4.1	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
38	210 805	641 250	2.8	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
39	210 988	641 207	1.7	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
40	211 149	641 154	2.3	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
41	211 273	641 025	0.5	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
42	211 369	640 896	1.4	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
43	212 885	641 825	-3.6	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
44	213 062	641 642	0.6	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
45	213 094	641 384	5.0	GE WIND ENERGY GE ...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No

Calculation Results

Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
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Calculated:
11/12/2017 4:12 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Base LNTE

Sound level

Noise sensitive area						Demands		Sound level	Demands fulfilled ?		
No.	Name	Easting	Northing	Z [m]	Imission height [m]	Noise [dB(A)]	Distance [m]	From WTGs [dB(A)]	Noise	Distance	All
A	Noise sensitive area: User defined (9)	201 927	640 701	2.7	1.0	45.0	300	38.8	Yes	Yes	Yes
B	Noise sensitive area: User defined (10)	202 913	640 361	7.0	1.0	45.0	300	38.9	Yes	Yes	Yes
C	Noise sensitive area: User defined (11)	204 622	640 086	1.8	1.0	45.0	300	42.3	Yes	Yes	Yes
D	Noise sensitive area: User defined (12)	206 300	640 617	0.1	1.0	45.0	300	38.1	Yes	Yes	Yes
E	Noise sensitive area: User defined (13)	213 109	641 335	4.0	1.0	45.0	300	52.7	**No**	**No**	**No**
F	Noise sensitive area: User defined (16)	210 030	641 054	2.7	1.0	45.0	300	46.1	**No**	Yes	**No**
G	Noise sensitive area: User defined (17)	204 432	640 811	2.6	1.0	45.0	300	46.6	**No**	Yes	**No**
H	01	201 883	640 658	4.0	1.0	45.0	300	38.4	Yes	Yes	Yes
I	02	201 927	640 701	2.0	1.0	45.0	300	38.8	Yes	Yes	Yes
J	03	201 956	640 377	1.3	1.0	45.0	300	36.9	Yes	Yes	Yes
K	04	201 959	640 324	0.4	1.0	45.0	300	36.6	Yes	Yes	Yes
L	06	202 003	640 962	0.9	1.0	45.0	300	41.0	Yes	Yes	Yes
M	07	202 913	640 361	-0.8	1.0	45.0	300	38.9	Yes	Yes	Yes
N	08	202 943	640 588	1.0	1.0	45.0	300	40.5	Yes	Yes	Yes
O	09	203 996	640 591	0.5	1.0	45.0	300	43.0	Yes	Yes	Yes
P	10	204 084	640 506	-1.9	1.0	45.0	300	42.6	Yes	Yes	Yes
Q	11	204 187	640 732	0.7	1.0	45.0	300	44.8	Yes	Yes	Yes
R	12	204 432	640 811	1.3	1.0	45.0	300	46.6	**No**	Yes	**No**
S	14	204 643	640 051	2.0	1.0	45.0	300	42.2	Yes	Yes	Yes
T	15	206 300	640 617	0.1	1.0	45.0	300	38.1	Yes	Yes	Yes
U	16	206 302	640 637	0.2	1.0	45.0	300	38.1	Yes	Yes	Yes
V	17	210 030	641 054	0.8	1.0	45.0	300	46.1	**No**	Yes	**No**
W	18	210 781	640 592	-2.4	1.0	45.0	300	43.2	Yes	Yes	Yes
X	19	212 269	640 780	2.7	1.0	45.0	300	38.5	Yes	Yes	Yes
Y	20	213 109	641 335	3.4	1.0	45.0	300	52.7	**No**	**No**	**No**
Z	21	213 374	642 321	0.3	1.0	45.0	300	37.9	Yes	Yes	Yes
AA	05	201 968	640 678	1.5	1.0	45.0	300	38.8	Yes	Yes	Yes
AB	13	204 622	640 086	0.3	1.0	45.0	300	42.3	Yes	Yes	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	1847	2505	3103	5042	10764	6817	2227	1882	1847	2171	2224	1606	2516	2340	3057	3179	3125	3287	3900	5047	5042	8531
2	1658	2320	2932	4926	10683	6719	2056	1695	1658	1983	2036	1416	2332	2160	2902	3024	2978	3148	3744	4931	4926	8448
3	1491	2157	2779	4821	10607	6631	1903	1529	1491	1816	1869	1247	2167	1998	2764	2885	2848	3025	3604	4826	4821	8372
4	1293	1962	2610	4717	10535	6544	1736	1332	1293	1618	1671	1047	1980	1817	2617	2736	2712	2899	3454	4721	4717	8300
5	1167	1806	2431	4555	10388	6390	1557	1210	1167	1491	1544	910	1806	1641	2440	2560	2539	2728	3276	4558	4555	8154
6	1122	1658	2255	4358	10195	6195	1379	1172	1122	1439	1492	853	1658	1481	2249	2370	2344	2532	3087	4361	4358	7961
7	1129	1543	2102	4172	10010	6008	1226	1184	1129	1433	1484	858	1543	1353	2077	2197	2165	2350	2917	4175	4172	7776
8	1148	1422	1938	3980	9822	5818	1067	1207	1148	1431	1479	884	1422	1219	1893	2015	1977	2159	2735	3983	3980	7588
9	1198	1336	1794	3803	9647	5642	939	1264	1204	1463	1509	953	1336	1122	1731	1853	1807	1985	2573	3806	3803	7413
10	1278	1280	1659	3628	9472	5467	839	1351	1289	1524	1567	1055	1280	1057	1578	1700	1644	1817	2421	3632	3628	7239
11	1367	1215	1494	3430	9279	5271	733	1445	1384	1589	1627	1171	1215	986	1397	1519	1453	1620	2238	3433	3430	7047
12	1490	1210	1369	3245	9095	5085	702	1573	1512	1692	1727	1316	1210	982	1249	1370	1287	1445	2084	3249	3245	6862
13	1668	1237	1191	2963	8816	4804	707	1773	1714	1859	1888	1542	1236	1022	1030	1149	1037	1175	1848	2966	2963	6584
14	1803	1276	1089	2767	8624	4610	667	1920	1863	1985	2011	1706	1286	1087	896	1010	872	991	1690	2771	2767	6393
15	1953	1329	1025	2575	8433	4417	599	2079	2023	2127	2150	1878	1370	1189	799	903	732	820	1550	2578	2575	6203
16	2088	1399	998	2411	8270	4253	546	2221	2166	2257	2277	2029	1461	1295	751	840	639	686	1443	2415	2411	6041
17	2260	1495	982	2198	8062	4043	473	2400	2347	2420	2438	2221	1583	1437	721	785	551	525	1309	2202	2198	5834
18	2420	1612	1007	2021	7884	3864	445	2565	2513	2576	2592	2393	1716	1583	767	805	557	448	1233	2025	2021	5656
19	2567	1719	1033	1848	7715	3692	412	2718	2666	2718	2732	2553	1838	1717	825	839	595	412	1160	1852	1848	5488
20	2731	1848	1022	1657	7529	3504	452	2887	2837	2878	2890	2731	1980	1872	923	913	685	452	1106	1662	1657	5304
21	2890	1984	1039	1482	7356	3329	558	3051	3001	3035	3045	2900	2125	2026	1045	1018	809	558	1095	1487	1482	5131
22	3055	2121	1053	1285	7170	3140	690	3222	3173	3196	3204	3080	2273	2186	1175	1132	947	689	1083	1290	1285	4948
23	3103	2134	944	1167	7090	3053	718	3281	3234	3238	3243	3156	2300	2231	1193	1131	979	727	962	1169	1167	4877
24	3143	2141	815	1084	7032	2993	725	3333	3290	3271	3273	3229	2320	2274	1221	1141	1033	802	824	1084	1086	4831
25	3161	2131	721	1074	7016	2975	706	3361	3319	3283	3282	3273	2327	2298	1249	1155	1085	879	722	1074	1079	4829
26	3183	2128	656	1096	7009	2959	706	3391	3352	3299	3295	3320	2342	2330	1294	1190	1155	974	656	1096	1104	4837
27	3230	2155	648	1126	6990	2935	757	3444	3408	3339	3333	3387	2385	2388	1371	1260	1254	1094	648	1126	1136	4833
28	7128	6178	4797	2063	3392	532	4760	7287	7236	7270	7278	7121	6342	6260	5236	5174	5016	4759	4798	3054	3043	1306
29	7204	6238	4828	2037	3211	350	4825	7370	7320	7343	7350	7213	6408	6334	5301	5234	5085	4830	4829	3078	3069	1077
30	7370	6399	4978	2165	3026	404	4985	7538	7489	7508	7515	7384	6571	6500	5463	5395	5250	4995	4978	3227	3219	907
31	7551	6573	5140	2308	2821	429	5157	7721	7672	7688	7693	7571	6747	6680	5641	5570	5429	5174	5140	3390	3382	720
32	7707	6726	5286	2446	2659	476	5308	7878	7829	7843	7848	7729	6901	6836	5795	5723	5584	5330	5286	3537	3530	601
33	7881	6896	5448	2600	2470	437	5476	8054	8006	8017	8021	7908	7073	7010	5967	5894	5758	5505	5449	3702	3695	480
34	8060	7071	5615	2761	2273	403	5648	8235	8187	8195	8199	8092	7250	7189	6145	6070	5937	5684	5615	3871	3865	403

To be continued on next page...

Project:
VRA WPP2

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Calculated:
11/12/2017 4:12 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Base LNTE

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
35	8226	7232	5770	2913	2094	416	5808	8402	8354	8359	8363	8261	7413	7354	6309	6233	6102	5850	5770	4030	4024	416
36	8409	7412	5946	3087	1905	519	5987	8587	8539	8542	8545	8447	7595	7538	6491	6415	6286	6034	5946	4208	4203	520
37	8579	7576	6104	3245	1715	638	6151	8758	8711	8711	8713	8621	7762	7707	6659	6582	6455	6205	6104	4371	4366	638
38	8761	7754	6278	3419	1520	800	6329	8942	8895	8892	8895	8807	7942	7890	6841	6762	6638	6388	6278	4549	4545	800
39	8940	7929	6449	3592	1333	970	6504	9121	9075	9070	9072	8988	8119	8069	7019	6939	6817	6568	6449	4725	4720	970
40	9096	8082	6599	3744	1163	1123	6656	9279	9233	9226	9227	9148	8274	8226	7175	7095	6975	6726	6599	4879	4875	1124
41	9211	8189	6701	3852	1007	1243	6764	9397	9351	9339	9340	9270	8386	8341	7290	7207	7092	6844	6701	4989	4986	1243
42	9301	8273	6779	3938	886	1349	6848	9489	9444	9428	9428	9367	8473	8432	7380	7296	7184	6938	6779	5077	5074	1349
43	10890	9898	8431	5571	504	2957	8474	11064	11015	11024	11029	10916	10079	10019	8974	8899	8766	8513	8431	6695	6689	2957
44	11045	10044	8568	5710	**251**	3089	8619	11222	11175	11178	11181	11080	10230	10174	9127	9050	8922	8670	8568	6840	6835	3089
45	11054	10041	8556	5703	**51**	3082	8615	11235	11188	11184	11186	11100	10233	10183	9133	9053	8931	8681	8556	6838	6833	3082

WTG	W	X	Y	Z	AA	AB
1	9356	10784	11544	11749	1876	3862
2	9267	10703	11473	11694	1687	3706
3	9185	10628	11406	11641	1519	3567
4	9106	10556	11345	11597	1321	3417
5	8956	10409	11205	11466	1191	3239
6	8761	10216	11015	11281	1139	3050
7	8575	10031	10830	11100	1139	2879
8	8386	9843	10646	10921	1150	2697
9	8210	9668	10472	10752	1199	2535
10	8035	9494	10299	10582	1279	2382
11	7840	9301	10110	10399	1367	2199
12	7655	9116	9926	10219	1491	2045
13	7375	8837	9651	9951	1688	1808
14	7181	8645	9462	9769	1834	1650
15	6990	8455	9274	9586	1993	1509
16	6826	8292	9113	9429	2134	1403
17	6617	8084	8909	9232	2313	1269
18	6437	7905	8731	9059	2478	1195
19	6267	7736	8565	8899	2630	1124
20	6080	7551	8384	8725	2800	1073
21	5905	7377	8213	8560	2964	1067
22	5717	7192	8033	8390	3135	1060
23	5630	7112	7966	8345	3195	944
24	5565	7054	7923	8328	3248	815
25	5545	7039	7920	8346	3277	721
26	5535	7032	7924	8371	3309	664
27	5514	7013	7915	8380	3363	665
28	2179	3409	4093	4333	7200	4803
29	1956	3230	3950	4241	7283	4836
30	1781	3044	3769	4074	7451	4987
31	1586	2839	3570	3896	7634	5150
32	1446	2677	3408	3743	7791	5297
33	1281	2488	3222	3575	7968	5459
34	1111	2291	3032	3406	8149	5627
35	971	2112	2858	3254	8316	5782
36	853	1923	2670	3083	8500	5959
37	731	1733	2492	2939	8672	6118
38	659	1538	2305	2783	8856	6292
39	649	1350	2125	2633	9035	6464
40	671	1181	1968	2513	9193	6614
41	655	1026	1862	2469	9311	6717
42	662	907	1794	2460	9404	6796
43	2438	1213	539	697	10977	8444
44	2511	1172	311	747	11136	8583
45	2445	1023	**52**	977	11149	8571

Project:
VRA WPP2

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Calculated:
13/12/2017 3:51 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Mitigated

Noise calculation model:
ISO 9613-2 General
Wind speed:
Highest noise value
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:200 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Noise data Creator	Name	Wind speed	LwA,ref	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	
1	201 626	642 523	8.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
2	201 680	642 340	11.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
3	201 734	642 179	4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
4	201 782	641 986	0.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
5	201 917	641 868	3.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
6	202 105	641 809	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
7	202 287	641 771	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
8	202 470	641 712	9.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
9	202 642	641 669	-5.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
10	202 814	641 637	-1.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
11	203 002	641 572	-3.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
12	203 185	641 540	2.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
13	203 493	641 470	4.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
14	203 647	641 417	0.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
15	203 835	641 374	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
16	203 996	641 342	-1.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
17	204 201	641 282	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO101	7.0	100.9	No
18	204 378	641 296	1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO101	7.0	100.9	No
19	204 544	641 207	-1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO101	7.0	100.9	No
20	204 727	641 154	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO101	7.0	100.9	No
21	204 899	641 116	-1.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
22	205 082	641 041	2.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
23	205 157	640 864	1.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
24	205 216	640 643	-3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
25	205 238	640 461	-0.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
26	205 254	640 289	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
27	205 286	640 128	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
28	209 093	641 927	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
29	209 177	641 712	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
30	209 354	641 658	3.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
31	209 548	641 589	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
32	209 709	641 562	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
33	209 892	641 513	3.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO102	7.0	101.9	No
34	210 080	641 454	5.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO102	7.0	101.9	No
35	210 252	641 406	3.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO102	7.0	101.9	No
36	210 440	641 374	3.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
37	210 617	641 304	4.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
38	210 805	641 250	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
39	210 988	641 207	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
40	211 149	641 154	2.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
41	211 273	641 025	0.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
42	211 369	640 896	1.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE	8.0	105.0	No
43	212 885	641 825	-3.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
44	213 062	641 642	0.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
45	213 094	641 384	5.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No

Calculation Results

Project:
VRA WPP2

Licensed user:
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Calculated:
13/12/2017 3:51 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Mitigated

Sound level

Noise sensitive area						Demands		Sound level		Demands fulfilled ?		
No.	Name	Easting	Northing	Z	Imission height	Noise	Distance	From WTGs	Distance to noise demand	Noise	Distance	All
				[m]	[m]	[dB(A)]	[m]	[dB(A)]	[m]			
A	Noise sensitive area: User defined (9)	201 927	640 701	2.7	1.0	45.0	300	38.7	647	Yes	Yes	Yes
B	Noise sensitive area: User defined (10)	202 913	640 361	7.0	1.0	45.0	300	38.6	739	Yes	Yes	Yes
C	Noise sensitive area: User defined (11)	204 622	640 086	1.8	1.0	45.0	300	41.8	258	Yes	Yes	Yes
D	Noise sensitive area: User defined (12)	206 300	640 617	0.1	1.0	45.0	300	37.7	653	Yes	Yes	Yes
E	Noise sensitive area: User defined (13)	213 109	641 335	4.0	1.0	45.0	300	47.7	-54	**No**	**No**	**No**
F	Noise sensitive area: User defined (16)	209 047	641 384	2.7	1.0	45.0	300	45.0	-1	Yes	Yes	Yes
G	Noise sensitive area: User defined (17)	204 432	640 811	2.6	1.0	45.0	300	44.8	14	Yes	Yes	Yes
H	01	201 883	640 658	4.0	1.0	45.0	300	38.3	702	Yes	Yes	Yes
I	02	201 927	640 701	2.0	1.0	45.0	300	38.7	646	Yes	Yes	Yes
J	03	201 956	640 377	1.3	1.0	45.0	300	36.7	945	Yes	Yes	Yes
K	04	201 959	640 324	0.4	1.0	45.0	300	36.4	995	Yes	Yes	Yes
L	06	202 003	640 962	0.9	1.0	45.0	300	40.9	375	Yes	Yes	Yes
M	07	202 913	640 361	-0.8	1.0	45.0	300	38.6	739	Yes	Yes	Yes
N	08	202 943	640 588	1.0	1.0	45.0	300	40.2	510	Yes	Yes	Yes
O	09	203 996	640 591	0.5	1.0	45.0	300	41.9	319	Yes	Yes	Yes
P	10	204 084	640 506	-1.9	1.0	45.0	300	41.5	399	Yes	Yes	Yes
Q	11	204 187	640 732	0.7	1.0	45.0	300	43.4	164	Yes	Yes	Yes
R	12	204 432	640 811	1.3	1.0	45.0	300	44.8	15	Yes	Yes	Yes
S	14	204 643	640 051	2.0	1.0	45.0	300	41.8	254	Yes	Yes	Yes
T	15	206 300	640 617	0.1	1.0	45.0	300	37.7	653	Yes	Yes	Yes
U	16	206 302	640 637	0.2	1.0	45.0	300	37.7	657	Yes	Yes	Yes
V	17	210 030	641 054	0.8	1.0	45.0	300	44.8	12	Yes	Yes	Yes
W	18	210 781	640 592	-2.4	1.0	45.0	300	42.9	163	Yes	Yes	Yes
X	19	212 269	640 780	2.7	1.0	45.0	300	37.2	614	Yes	Yes	Yes
Y	20	213 109	641 335	3.4	1.0	45.0	300	47.7	-53	**No**	**No**	**No**
Z	21	213 374	642 321	0.3	1.0	45.0	300	33.7	587	Yes	Yes	Yes
AA	05	201 968	640 678	1.5	1.0	45.0	300	38.7	655	Yes	Yes	Yes
AB	13	204 622	640 086	0.3	1.0	45.0	300	41.8	258	Yes	Yes	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	1847	2505	3103	5042	10764	6817	2227	1882	1847	2171	2224	1606	2516	2340	3057	3179	3125	3287	3900	5047	5042	8531
2	1658	2320	2932	4926	10683	6719	2056	1695	1658	1983	2036	1416	2332	2160	2902	3024	2978	3148	3744	4931	4926	8448
3	1491	2157	2779	4821	10607	6631	1903	1529	1491	1816	1869	1247	2167	1998	2764	2885	2848	3025	3604	4826	4821	8372
4	1293	1962	2610	4717	10535	6544	1736	1332	1293	1618	1671	1047	1980	1817	2617	2736	2712	2899	3454	4721	4717	8300
5	1167	1806	2431	4555	10388	6390	1557	1210	1167	1491	1544	910	1806	1641	2440	2560	2539	2728	3276	4558	4555	8154
6	1122	1658	2255	4358	10195	6195	1379	1172	1122	1439	1492	853	1658	1481	2249	2370	2344	2532	3087	4361	4358	7961
7	1129	1543	2102	4172	10010	6008	1226	1184	1129	1433	1484	858	1543	1353	2077	2197	2165	2350	2917	4175	4172	7776
8	1148	1422	1938	3980	9822	5818	1067	1207	1148	1431	1479	884	1422	1219	1893	2015	1977	2159	2735	3983	3980	7588
9	1198	1336	1794	3803	9647	5642	939	1264	1204	1463	1509	953	1336	1122	1731	1853	1807	1985	2573	3806	3803	7413
10	1278	1280	1659	3628	9472	5467	839	1351	1289	1524	1567	1055	1280	1057	1578	1700	1644	1817	2421	3632	3628	7239
11	1367	1215	1494	3430	9279	5271	733	1445	1384	1589	1627	1171	1215	986	1397	1519	1453	1620	2238	3433	3430	7047
12	1490	1210	1369	3245	9095	5085	702	1573	1512	1692	1727	1316	1210	982	1249	1370	1287	1445	2084	3249	3245	6862
13	1668	1237	1191	2963	8816	4804	707	1773	1714	1859	1888	1542	1236	1022	1030	1149	1037	1175	1848	2966	2963	6584
14	1803	1276	1089	2767	8624	4610	667	1920	1863	1985	2011	1706	1286	1087	896	1010	872	991	1690	2771	2767	6393
15	1953	1329	1025	2575	8433	4417	599	2079	2023	2127	2150	1878	1370	1189	799	903	732	820	1550	2578	2575	6203
16	2088	1399	998	2411	8270	4253	546	2221	2166	2257	2277	2029	1461	1295	751	840	639	686	1443	2415	2411	6041
17	2260	1495	982	2198	8062	4043	473	2400	2347	2420	2438	2221	1583	1437	721	785	551	525	1309	2202	2198	5834
18	2420	1612	1007	2021	7884	3864	445	2565	2513	2576	2592	2393	1716	1583	767	805	557	448	1233	2025	2021	5656
19	2567	1719	1033	1848	7715	3692	412	2718	2666	2718	2732	2553	1838	1717	825	839	595	412	1160	1852	1848	5488
20	2731	1848	1022	1657	7529	3504	452	2887	2837	2878	2890	2731	1980	1872	923	913	685	452	1106	1662	1657	5304
21	2890	1984	1039	1482	7356	3329	558	3051	3001	3035	3045	2900	2125	2026	1045	1018	809	558	1095	1487	1482	5131
22	3055	2121	1053	1285	7170	3140	690	3222	3173	3196	3204	3080	2273	2186	1175	1132	947	689	1083	1290	1285	4948
23	3103	2134	944	1167	7090	3053	718	3281	3234	3238	3243	3156	2300	2231	1193	1131	979	727	962	1169	1167	4877
24	3143	2141	815	1084	7032	2993	725	3333	3290	3271	3273	3229	2320	2274	1221	1141	1033	802	824	1084	1086	4831
25	3161	2131	721	1074	7016	2975	706	3361	3319	3283	3282	3273	2327	2298	1249	1155	1085	879	722	1074	1079	4829
26	3183	2128	656	1096	7009	2959	706	3391	3352	3299	3295	3320	2342	2330	1294	1190	1155	974	656	1096	1104	4837
27	3230	2155	648	1126	6990	2935	757	3444	3408	3339	3333	3387	2385	2388	1371	1260	1254	1094	648	1126	1136	4833
28	7128	6178	4797	2063	3392	532	4760	7287	7236	7270	7278	7121	6342	6260	5236	5174	5016	4759	4798	3054	3043	1306
29	7204	6238	4828	2037	3211	350	4825	7370	7320	7343	7350	7213	6408	6334	5301	5234	5085	4830	4829	3078	3069	1077
30	7370	6399	4978	2165	3026	404	4985	7538	7489	7508	7515	7384	6571	6500	5463	5395	5250	4995	4978	3227	3219	907
31	7551	6573	5140	2308	2821	429	5157	7721	7672	7688	7693	7571	6747	6680	5641	5570	5429	5174	5140	3390	3382	720
32	7707	6726	5286	2446	2659	476	5308	7878	7829	7843	7848	7729	6901	6836	5795	5723	5584	5330	5286	3537	3530	601

To be continued on next page...

Project:
VRA WPP2

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Calculated:
13/12/2017 3:51 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | Mitigated

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
33	7881	6896	5448	2600	2470	437	5476	8054	8006	8017	8021	7908	7073	7010	5967	5894	5758	5505	5449	3702	3695	480
34	8060	7071	5615	2761	2273	403	5648	8235	8187	8195	8199	8092	7250	7189	6145	6070	5937	5684	5615	3871	3865	403
35	8226	7232	5770	2913	2094	416	5808	8402	8354	8359	8363	8261	7413	7354	6309	6233	6102	5850	5770	4030	4024	416
36	8409	7412	5946	3087	1905	519	5987	8587	8539	8542	8545	8447	7595	7538	6491	6415	6286	6034	5946	4208	4203	520
37	8579	7576	6104	3245	1715	638	6151	8758	8711	8711	8713	8621	7762	7707	6659	6582	6455	6205	6104	4371	4366	638
38	8761	7754	6278	3419	1520	800	6329	8942	8895	8892	8895	8807	7942	7890	6841	6762	6638	6388	6278	4549	4545	800
39	8940	7929	6449	3592	1333	970	6504	9121	9075	9070	9072	8988	8119	8069	7019	6939	6817	6568	6449	4725	4720	970
40	9096	8082	6599	3744	1163	1123	6656	9279	9233	9226	9227	9148	8274	8226	7175	7095	6975	6726	6599	4879	4875	1124
41	9211	8189	6701	3852	1007	1243	6764	9397	9351	9339	9340	9270	8386	8341	7290	7207	7092	6844	6701	4989	4986	1243
42	9301	8273	6779	3938	886	1349	6848	9489	9444	9428	9428	9367	8473	8432	7380	7296	7184	6938	6779	5077	5074	1349
43	10890	9898	8431	5571	504	2957	8474	11064	11015	11024	11029	10916	10079	10019	8974	8899	8766	8513	8431	6695	6689	2957
44	11045	10044	8568	5710	**251**	3089	8619	11222	11175	11178	11181	11080	10230	10174	9127	9050	8922	8670	8568	6840	6835	3089
45	11054	10041	8556	5703	**51**	3082	8615	11235	11188	11184	11186	11100	10233	10183	9133	9053	8931	8681	8556	6838	6833	3082

WTG	W	X	Y	Z	AA	AB
1	9356	10784	11544	11749	1876	3862
2	9267	10703	11473	11694	1687	3706
3	9185	10628	11406	11641	1519	3567
4	9106	10556	11345	11597	1321	3417
5	8956	10409	11205	11466	1191	3239
6	8761	10216	11015	11281	1139	3050
7	8575	10031	10830	11100	1139	2879
8	8386	9843	10646	10921	1150	2697
9	8210	9668	10472	10752	1199	2535
10	8035	9494	10299	10582	1279	2382
11	7840	9301	10110	10399	1367	2199
12	7655	9116	9926	10219	1491	2045
13	7375	8837	9651	9951	1688	1808
14	7181	8645	9462	9769	1834	1650
15	6990	8455	9274	9586	1993	1509
16	6826	8292	9113	9429	2134	1403
17	6617	8084	8909	9232	2313	1269
18	6437	7905	8731	9059	2478	1195
19	6267	7736	8565	8899	2630	1124
20	6080	7551	8384	8725	2800	1073
21	5905	7377	8213	8560	2964	1067
22	5717	7192	8033	8390	3135	1060
23	5630	7112	7966	8345	3195	944
24	5565	7054	7923	8328	3248	815
25	5545	7039	7920	8346	3277	721
26	5535	7032	7924	8371	3309	664
27	5514	7013	7915	8380	3363	665
28	2179	3409	4093	4333	7200	4803
29	1956	3230	3950	4241	7283	4836
30	1781	3044	3769	4074	7451	4987
31	1586	2839	3570	3896	7634	5150
32	1446	2677	3408	3743	7791	5297
33	1281	2488	3222	3575	7968	5459
34	1111	2291	3032	3406	8149	5627
35	971	2112	2858	3254	8316	5782
36	853	1923	2670	3083	8500	5959
37	731	1733	2492	2939	8672	6118
38	659	1538	2305	2783	8856	6292
39	649	1350	2125	2633	9035	6464
40	671	1181	1968	2513	9193	6614
41	655	1026	1862	2469	9311	6717
42	662	907	1794	2460	9404	6796
43	2438	1213	539	697	10977	8444
44	2511	1172	311	747	11136	8583
45	2445	1023	**52**	977	11149	8571

Project:
VRA WPP2

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Calculated:
11/12/2017 4:16 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | NRO100

Noise calculation model:
ISO 9613-2 General
Wind speed:
Highest noise value
Ground attenuation:
General, terrain specific
Ground factor for porous ground: 1.0
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
1: WTG noise is compared to demand (DK, DE, SE, NL etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 5.0 dB(A)
Height above ground level, when no value in NSA object:
1.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)

Scale 1:200 000
New WTG   Noise sensitive area

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data Creator	Name	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones
1	201 626	642 523	8.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
2	201 680	642 340	11.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
3	201 734	642 179	4.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
4	201 782	641 986	-0.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
5	201 917	641 868	3.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
6	202 105	641 809	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
7	202 287	641 771	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
8	202 470	641 712	9.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
9	202 642	641 669	-5.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
10	202 814	641 637	-1.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
11	203 002	641 572	-3.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
12	203 185	641 540	2.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
13	203 489	641 470	4.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
14	203 647	641 417	0.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
15	203 835	641 374	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
16	203 996	641 342	-1.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
17	204 201	641 282	3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
18	204 378	641 296	1.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
19	204 544	641 207	-1.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
20	204 727	641 154	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
21	204 899	641 116	-1.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
22	205 082	641 041	2.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
23	205 157	640 864	1.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
24	205 216	640 643	-3.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
25	205 238	640 461	-0.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
26	205 294	640 289	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
27	205 286	640 128	1.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
28	209 090	641 927	0.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
29	209 177	641 712	1.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
30	209 354	641 658	3.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
31	209 548	641 589	3.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
32	209 709	641 562	2.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
33	209 892	641 513	3.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
34	210 080	641 454	5.2	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
35	210 252	641 406	3.9	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
36	210 440	641 374	3.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
37	210 617	641 304	4.1	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
38	210 805	641 250	2.8	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
39	210 988	641 207	1.7	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
40	211 140	641 154	2.3	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
41	211 273	641 025	0.5	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
42	211 369	640 896	1.4	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
43	212 885	641 825	-3.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
44	213 062	641 642	0.6	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No
45	213 094	641 384	5.0	GE WIND ENERGY GE 1....	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	USER	LNTE NRO100	7.0	100.0	No

Calculation Results

Project:
VRA WPP2

Licensed user:
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Nicolette / nicolette@airshed.co.za
Calculated:
11/12/2017 4:16 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | NRO100

Sound level

Noise sensitive area						Demands		Sound level	Demands fulfilled ?		
No.	Name	Easting	Northing	Z [m]	Imission height [m]	Noise [dB(A)]	Distance [m]	From WTGs [dB(A)]	Noise	Distance	All
A	Noise sensitive area: User defined (9)	201 927	640 701	2.7	1.0	45.0	300	33.8	Yes	Yes	Yes
B	Noise sensitive area: User defined (10)	202 913	640 361	7.0	1.0	45.0	300	33.9	Yes	Yes	Yes
C	Noise sensitive area: User defined (11)	204 622	640 086	1.8	1.0	45.0	300	37.3	Yes	Yes	Yes
D	Noise sensitive area: User defined (12)	206 300	640 617	0.1	1.0	45.0	300	33.1	Yes	Yes	Yes
E	Noise sensitive area: User defined (13)	213 109	641 335	4.0	1.0	45.0	300	47.7	**No**	**No**	**No**
F	Noise sensitive area: User defined (16)	210 030	641 054	2.7	1.0	45.0	300	41.1	Yes	Yes	Yes
G	Noise sensitive area: User defined (17)	204 432	640 811	2.6	1.0	45.0	300	41.6	Yes	Yes	Yes
H	01	201 883	640 658	4.0	1.0	45.0	300	33.4	Yes	Yes	Yes
I	02	201 927	640 701	2.0	1.0	45.0	300	33.8	Yes	Yes	Yes
J	03	201 956	640 377	1.3	1.0	45.0	300	31.9	Yes	Yes	Yes
K	04	201 959	640 324	0.4	1.0	45.0	300	31.6	Yes	Yes	Yes
L	06	202 003	640 962	0.9	1.0	45.0	300	36.0	Yes	Yes	Yes
M	07	202 913	640 361	-0.8	1.0	45.0	300	33.9	Yes	Yes	Yes
N	08	202 943	640 588	1.0	1.0	45.0	300	35.5	Yes	Yes	Yes
O	09	203 996	640 591	0.5	1.0	45.0	300	38.0	Yes	Yes	Yes
P	10	204 084	640 506	-1.9	1.0	45.0	300	37.6	Yes	Yes	Yes
Q	11	204 187	640 732	0.7	1.0	45.0	300	39.8	Yes	Yes	Yes
R	12	204 432	640 811	1.3	1.0	45.0	300	41.6	Yes	Yes	Yes
S	14	204 643	640 051	2.0	1.0	45.0	300	37.2	Yes	Yes	Yes
T	15	206 300	640 617	0.1	1.0	45.0	300	33.1	Yes	Yes	Yes
U	16	206 302	640 637	0.2	1.0	45.0	300	33.1	Yes	Yes	Yes
V	17	210 030	641 054	0.8	1.0	45.0	300	41.1	Yes	Yes	Yes
W	18	210 781	640 592	-2.4	1.0	45.0	300	38.2	Yes	Yes	Yes
X	19	212 269	640 780	2.7	1.0	45.0	300	33.5	Yes	Yes	Yes
Y	20	213 109	641 335	3.4	1.0	45.0	300	47.7	**No**	**No**	**No**
Z	21	213 374	642 321	0.3	1.0	45.0	300	32.9	Yes	Yes	Yes
AA	05	201 968	640 678	1.5	1.0	45.0	300	33.8	Yes	Yes	Yes
AB	13	204 622	640 086	0.3	1.0	45.0	300	37.3	Yes	Yes	Yes

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	1847	2505	3103	5042	10764	6817	2227	1882	1847	2171	2224	1606	2516	2340	3057	3179	3125	3287	3900	5047	5042	8531
2	1658	2320	2932	4926	10683	6719	2056	1695	1658	1983	2036	1416	2332	2160	2902	3024	2978	3148	3744	4931	4926	8448
3	1491	2157	2779	4821	10607	6631	1903	1529	1491	1816	1869	1247	2167	1998	2764	2885	2848	3025	3604	4826	4821	8372
4	1293	1962	2610	4717	10535	6544	1736	1332	1293	1618	1671	1047	1980	1817	2617	2736	2712	2899	3454	4721	4717	8300
5	1167	1806	2431	4555	10388	6390	1557	1210	1167	1491	1544	910	1806	1641	2440	2560	2539	2728	3276	4558	4555	8154
6	1122	1658	2255	4358	10195	6195	1379	1172	1122	1439	1492	853	1658	1481	2249	2370	2344	2532	3087	4361	4358	7961
7	1129	1543	2102	4172	10010	6008	1226	1184	1129	1433	1484	858	1543	1353	2077	2197	2165	2350	2917	4175	4172	7776
8	1148	1422	1938	3980	9822	5818	1067	1207	1148	1431	1479	884	1422	1219	1893	2015	1977	2159	2735	3983	3980	7588
9	1198	1336	1794	3803	9647	5642	939	1264	1204	1463	1509	953	1336	1122	1731	1853	1807	1985	2573	3806	3803	7413
10	1278	1280	1659	3628	9472	5467	839	1351	1289	1524	1567	1055	1280	1057	1578	1700	1644	1817	2421	3632	3628	7239
11	1367	1215	1494	3430	9279	5271	733	1445	1384	1589	1627	1171	1215	986	1397	1519	1453	1620	2238	3433	3430	7047
12	1490	1210	1369	3245	9095	5085	702	1573	1512	1692	1727	1316	1210	982	1249	1370	1287	1445	2084	3249	3245	6862
13	1668	1237	1191	2963	8816	4804	707	1773	1714	1859	1888	1542	1236	1022	1030	1149	1037	1175	1848	2966	2963	6584
14	1803	1276	1089	2767	8624	4610	667	1920	1863	1985	2011	1706	1286	1087	896	1010	872	991	1690	2771	2767	6393
15	1953	1329	1025	2575	8433	4417	599	2079	2023	2127	2150	1878	1370	1189	799	903	732	820	1550	2578	2575	6203
16	2088	1399	998	2411	8270	4253	546	2221	2166	2257	2277	2029	1461	1295	751	840	639	686	1443	2415	2411	6041
17	2260	1495	982	2198	8062	4043	473	2400	2347	2420	2438	2221	1583	1437	721	785	551	525	1309	2202	2198	5834
18	2420	1612	1007	2021	7884	3864	445	2565	2513	2576	2592	2393	1716	1583	767	805	557	448	1233	2025	2021	5656
19	2567	1719	1033	1848	7715	3692	412	2718	2666	2718	2732	2553	1838	1717	825	839	595	412	1160	1852	1848	5488
20	2731	1848	1022	1657	7529	3504	452	2887	2837	2878	2890	2731	1980	1872	923	913	685	452	1106	1662	1657	5304
21	2890	1984	1039	1482	7356	3329	558	3051	3001	3035	3045	2900	2125	2026	1045	1018	809	558	1095	1487	1482	5131
22	3055	2121	1053	1285	7170	3140	690	3222	3173	3196	3204	3080	2273	2186	1175	1132	947	689	1083	1290	1285	4948
23	3103	2134	944	1167	7090	3053	718	3281	3234	3238	3243	3156	2300	2231	1193	1131	979	727	962	1169	1167	4877
24	3143	2141	815	1084	7032	2993	725	3333	3290	3271	3273	3229	2320	2274	1221	1141	1033	802	824	1084	1086	4831
25	3161	2131	721	1074	7016	2975	706	3361	3319	3283	3282	3273	2327	2298	1249	1155	1085	879	722	1074	1079	4829
26	3183	2128	656	1096	7009	2959	706	3391	3352	3299	3295	3320	2342	2330	1294	1190	1155	974	656	1096	1104	4837
27	3230	2155	648	1126	6990	2935	757	3444	3408	3339	3333	3387	2385	2388	1371	1260	1254	1094	648	1126	1136	4833
28	7128	6178	4797	2063	3392	532	4760	7287	7236	7270	7278	7121	6342	6260	5236	5174	5016	4759	4798	3054	3043	1306
29	7204	6238	4828	2037	3211	350	4825	7370	7320	7343	7350	7213	6408	6334	5301	5234	5085	4830	4829	3078	3069	1077
30	7370	6399	4978	2165	3026	404	4985	7538	7489	7508	7515	7384	6571	6500	5463	5395	5250	4995	4978	3227	3219	907
31	7551	6573	5140	2308	2821	429	5157	7721	7672	7688	7693	7571	6747	6680	5641	5570	5429	5174	5140	3390	3382	720
32	7707	6726	5286	2446	2659	476	5308	7878	7829	7843	7848	7729	6901	6836	5795	5723	5584	5330	5286	3537	3530	601
33	7881	6896	5448	2600	2470	437	5476	8054	8006	8017	8021	7908	7073	7010	5967	5894	5758	5505	5449	3702	3695	480
34	8060	7071	5615	2761	2273	403	5648	8235	8187	8195	8199	8092	7250	7189	6145	6070	5937	5684	5615	3871	3865	403

To be continued on next page...

Project:
VRA WPP2

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Calculated:
11/12/2017 4:16 PM/3.1.617

DECIBEL - Main Result

Calculation: WPP2 | Alternative Layout | NRO100

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K
35	8226	7232	5770	2913	2094	416	5808	8402	8354	8359	8363
36	8409	7412	5946	3087	1905	519	5987	8587	8539	8542	8545
37	8579	7576	6104	3245	1715	638	6151	8758	8711	8711	8713
38	8761	7754	6278	3419	1520	800	6329	8942	8895	8892	8895
39	8940	7929	6449	3592	1333	970	6504	9121	9075	9070	9072
40	9096	8082	6599	3744	1163	1123	6656	9279	9233	9226	9227
41	9211	8189	6701	3852	1007	1243	6764	9397	9351	9339	9340
42	9301	8273	6779	3938	886	1349	6848	9489	9444	9428	9428
43	10890	9898	8431	5571	504	2957	8474	11064	11015	11024	11029
44	11045	10044	8568	5710	**251**	3089	8619	11222	11175	11178	11181
45	11054	10041	8556	5703	**51**	3082	8615	11235	11188	11184	11186

WTG	L	M	N	O	P	Q	R	S	T	U	V
35	8261	7413	7354	6309	6233	6102	5850	5770	4030	4024	416
36	8447	7595	7538	6491	6415	6286	6034	5946	4208	4203	520
37	8621	7762	7707	6659	6582	6455	6205	6104	4371	4366	638
38	8807	7942	7890	6841	6762	6638	6388	6278	4549	4545	800
39	8988	8119	8069	7019	6939	6817	6568	6449	4725	4720	970
40	9148	8274	8226	7175	7095	6975	6726	6599	4879	4875	1124
41	9270	8386	8341	7290	7207	7092	6844	6701	4989	4986	1243
42	9367	8473	8432	7380	7296	7184	6938	6779	5077	5074	1349
43	10916	10079	10019	8974	8899	8766	8513	8431	6695	6689	2957
44	11080	10230	10174	9127	9050	8922	8670	8568	6840	6835	3089
45	11100	10233	10183	9133	9053	8931	8681	8556	6838	6833	3082

WTG	W	X	Y	Z	AA	AB
1	9356	10784	11544	11749	1876	3862
2	9267	10703	11473	11694	1687	3706
3	9185	10628	11406	11641	1519	3567
4	9106	10556	11345	11597	1321	3417
5	8956	10409	11205	11466	1191	3239
6	8761	10216	11015	11281	1139	3050
7	8575	10031	10830	11100	1139	2879
8	8386	9843	10646	10921	1150	2697
9	8210	9668	10472	10752	1199	2535
10	8035	9494	10299	10582	1279	2382
11	7840	9301	10110	10399	1367	2199
12	7655	9116	9926	10219	1491	2045
13	7375	8837	9651	9951	1688	1808
14	7181	8645	9462	9769	1834	1650
15	6990	8455	9274	9586	1993	1509
16	6826	8292	9113	9429	2134	1403
17	6617	8084	8909	9232	2313	1269
18	6437	7905	8731	9059	2478	1195
19	6267	7736	8565	8899	2630	1124
20	6080	7551	8384	8725	2800	1073
21	5905	7377	8213	8560	2964	1067
22	5717	7192	8033	8390	3135	1060
23	5630	7112	7966	8345	3195	944
24	5565	7054	7923	8328	3248	815
25	5545	7039	7920	8346	3277	721
26	5535	7032	7924	8371	3309	664
27	5514	7013	7915	8380	3363	665
28	2179	3409	4093	4333	7200	4803
29	1956	3230	3950	4241	7283	4836
30	1781	3044	3769	4074	7451	4987
31	1586	2839	3570	3896	7634	5150
32	1446	2677	3408	3743	7791	5297
33	1281	2488	3222	3575	7968	5459
34	1111	2291	3032	3406	8149	5627
35	971	2112	2858	3254	8316	5782
36	853	1923	2670	3083	8500	5959
37	731	1733	2492	2939	8672	6118
38	659	1538	2305	2783	8856	6292
39	649	1350	2125	2633	9035	6464
40	671	1181	1968	2513	9193	6614
41	655	1026	1862	2469	9311	6717
42	662	907	1794	2460	9404	6796
43	2438	1213	539	697	10977	8444
44	2511	1172	311	747	11136	8583
45	2445	1023	**52**	977	11149	8571

Project:
VRA WPP2

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480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
11/12/2017 3:57 PM/3.1.617

DECIBEL - Map Highest noise value

Calculation: WPP2 | Alternative Layout | Base

Map: Open Street Map 001 , Print scale 1:125 000, Map center UTM (north)-WGS84 Zone: 31 East: 207 360 North: 641 325

New WTG   Noise sensitive area

Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value

Height above sea level from active line object

Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
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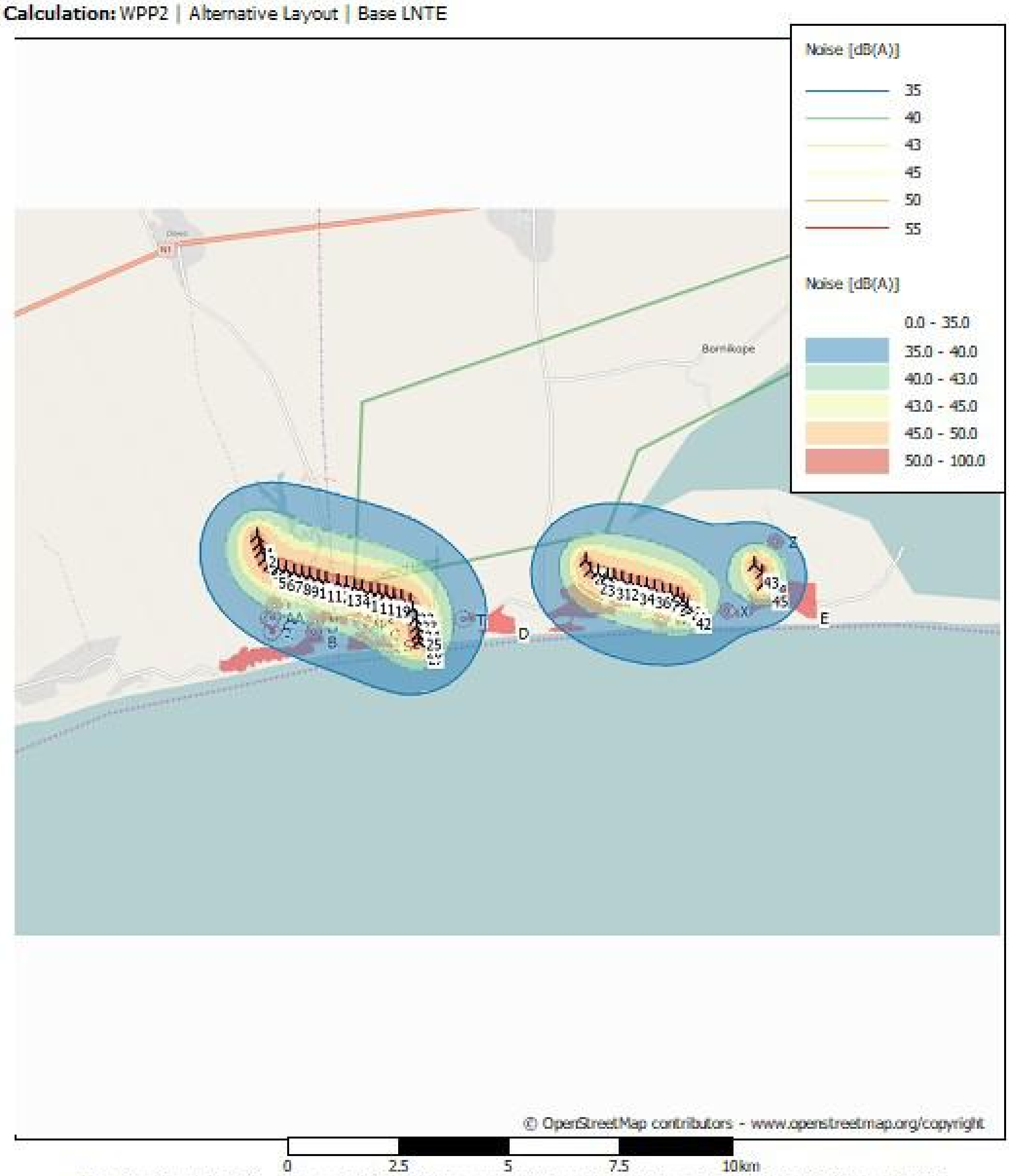
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
11/12/2017 4:12 PM/3.1.617

DECIBEL - Map Highest noise value

Calculation: WPP2 | Alternative Layout | Base LNTE



Map: Open Street Map 001 , Print scale 1:125 000, Map center UTM (north)-WGS84 Zone: 31 East: 207 360 North: 641 325

New WTG   Noise sensitive area

Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value

Height above sea level from active line object

windPRO 3.1.617 by EMD International A/S, Tel. +45 96 35 44 44, www.emd.dk, windpro@emd.dk   13/12/2017 4:52 PM / 1   windPRO

Project:
VRA WPP2

Licensed user:
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Nicolette / nicolette@airshed.co.za
Calculated:
13/12/2017 3:51 PM/3.1.617

DECIBEL - Map Highest noise value

Calculation: WPP2 | Alternative Layout | Mitigated

Map: Open Street Map 001 , Print scale 1:125 000, Map center UTM (north)-WGS84 Zone: 31 East: 207 360 North: 641 325

New WTG   Noise sensitive area

Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value
Height above sea level from active line object

windPRO 3.1.617 by EMD International A/S, Tel. +45 96 35 44 44, www.emd.dk, windpro@emd.dk   14/12/2017 7:15 AM / 1   windPRO

Project:
VRA WPP2

Licensed user:
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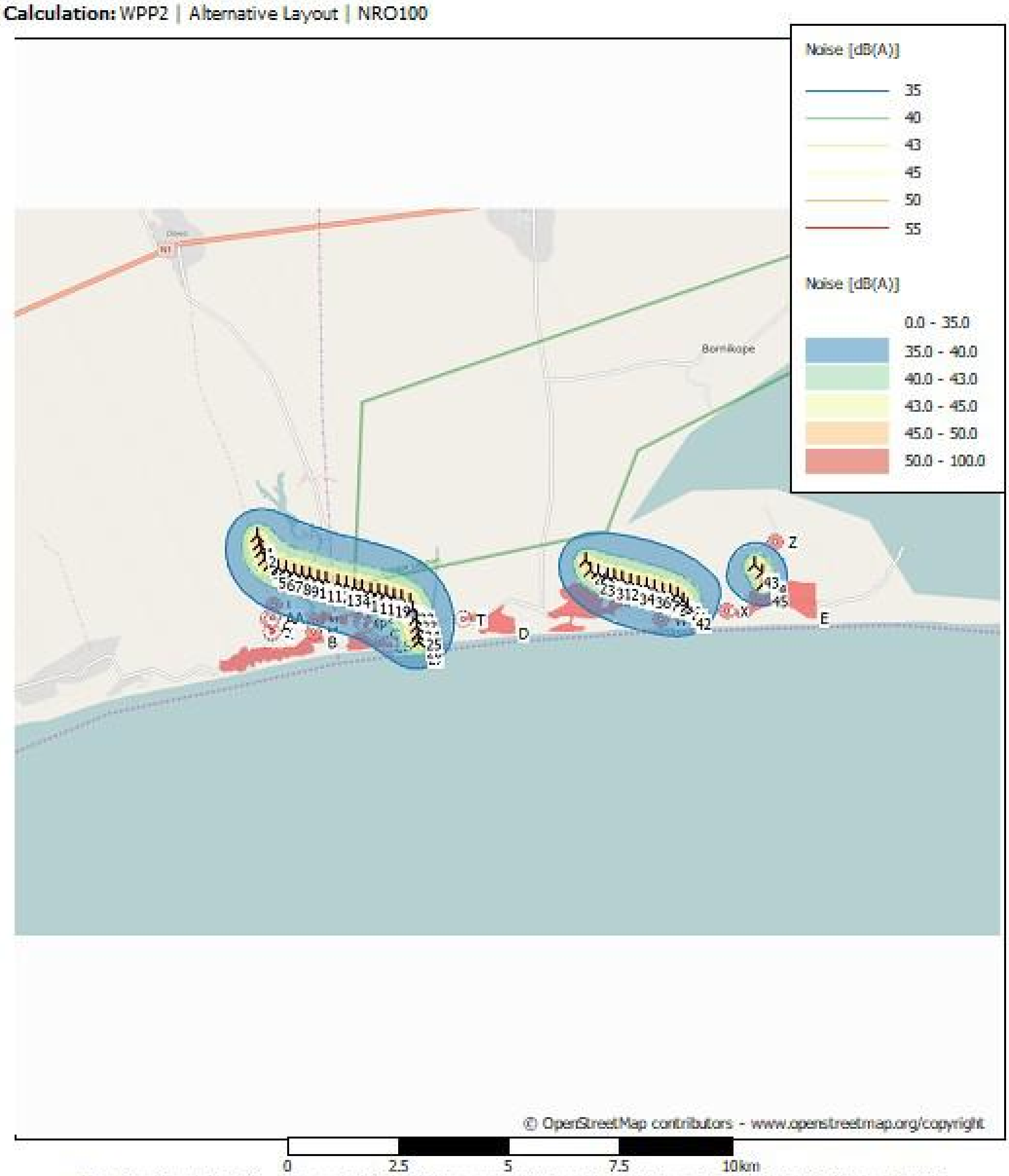
Nicolette / nicolette@airshed.co.za
Calculated:
11/12/2017 4:16 PM/3.1.617

DECIBEL - Map Highest noise value

Calculation: WPP2 | Alternative Layout | NRO100



Map: Open Street Map 001 , Print scale 1:125 000, Map center UTM (north)-WGS84 Zone: 31 East: 207 360 North: 641 325
New WTG   Noise sensitive area
Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value
Height above sea level from active line object

13. ANNEX C – WINDPRO SHADOW REPORTS

Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
12/07/2017 1:47 PM/3.1.617

SHADOW - Main Result

Calculation: WPP2 | SHADOW | Preferred Layout

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9.90	9.70	8.60	8.90	8.30	5.40	4.90	4.20	5.90	8.00	9.80	10.40

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
96	53	61	35	61	131	604	3 530	3 215	736	123	114	8 759

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window.
The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (SRTM: Shuttle DTM
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 50.0 m

Scale 1:200 000
New WTG   Shadow receptor

All coordinates are in
UTM (north)-WGS84 Zone: 31

WTGs

	Easting	Northing	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data Calculation distance [m]	RPM [RPM]
1	201 463	642 934	17.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
2	201 510	642 746	14.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
3	201 551	642 578	7.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
4	201 604	642 404	10.4	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
5	201 645	642 209	14.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
6	201 699	642 055	2.8	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
7	201 746	641 874	-0.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
8	201 813	641 686	4.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
9	201 846	641 518	3.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
10	201 927	641 357	5.8	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
11	201 974	641 162	0.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
12	202 068	640 981	0.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
13	202 222	640 914	2.6	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
14	202 411	640 813	-4.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
15	202 552	640 699	-1.3	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
16	202 699	640 632	2.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
17	205 094	642 033	-1.3	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
18	205 137	641 835	0.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
19	205 153	641 668	-2.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
20	205 169	641 470	1.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
21	205 180	641 298	-0.6	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
22	205 196	641 120	1.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
23	205 228	640 938	3.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
24	205 233	640 755	0.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
25	205 244	640 503	-1.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
26	205 249	640 315	1.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
27	205 239	640 132	1.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
28	211 341	641 116	1.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
29	211 520	641 058	2.8	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
30	211 704	641 009	1.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
31	211 887	640 964	6.4	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
32	212 084	640 910	3.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
33	212 250	640 865	1.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
34	209 164	641 715	1.4	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
35	209 352	641 650	3.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5

To be continued on next page...

Project:
VRA WPP2

Licensed user:
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480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
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Nicolette / nicolette@airshed.co.za
Calculated:
12/07/2017 1:47 PM/3.1.617

SHADOW - Main Result

Calculation: WPP2 | SHADOW | Preferred Layout

...continued from previous page

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
36	209 540	641 613	3.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
37	209 718	641 559	3.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
38	209 890	641 495	3.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
39	210 067	641 457	5.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
40	210 261	641 425	4.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
41	210 433	641 355	2.6	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
42	210 615	641 301	4.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
43	210 803	641 248	2.8	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
44	210 991	641 210	1.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
45	211 174	641 151	3.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5

Shadow receptor-Input

No.	Name	Easting	Northing	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	1	201 883	640 658	4.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
B	2	201 927	640 701	2.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
C	3	201 956	640 377	1.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
D	4	201 959	640 324	0.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
E	5	201 968	640 678	1.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
F	6	202 003	640 962	0.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
G	7	202 913	640 361	-0.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H	8	202 943	640 588	1.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
I	9	203 996	640 591	0.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
J	10	204 084	640 506	-1.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
K	11	204 187	640 732	0.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
L	12	204 432	640 811	1.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
M	13	204 622	640 086	0.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
N	14	204 643	640 051	2.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
O	15	206 300	640 617	0.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
P	16	206 302	640 637	0.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Q	17	210 030	641 054	0.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
R	18	210 781	640 592	-2.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
S	19	212 269	640 780	2.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
T	20	213 109	641 335	3.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
U	21	213 374	642 321	0.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case: Shadow hours per year	Shadow days per year	Max shadow hours per day	Shadow, expected values: Shadow hours per year
		[h/year]	[days/year]	[h/day]	[h/year]
A	1	77:21	161	0:40	26:09
B	2	80:29	149	0:46	26:18
C	3	31:52	90	0:28	10:53
D	4	28:53	69	0:28	9:33
E	5	122:24	202	0:51	40:36
F	6	939:49	365	3:52	333:50
G	7	0:33	33	0:01	0:11
H	8	242:26	202	1:41	49:02
I	9	38:05	249	0:18	12:06
J	10	43:52	235	0:18	14:12
K	11	56:49	274	0:20	19:09
L	12	80:40	234	0:28	27:33
M	13	74:42	156	0:36	25:05
N	14	62:05	137	0:37	20:49
O	15	45:25	221	0:16	15:51
P	16	44:50	218	0:16	14:33
Q	17	75:34	207	0:39	25:21
R	18	28:08	134	0:18	9:26

To be continued on next page...

Project:
VRA WPP2

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480 Smuts Drive, Halfway Gardens PO Box 5260
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Nicolette / nicolette@airshed.co.za
Calculated:
12/07/2017 1:47 PM/3.1.617

SHADOW - Main Result

Calculation: WPP2 | SHADOW | Preferred Layout

...continued from previous page

		Shadow, worst case			Shadow, expected values
No.	Name	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
S	19	94:20	98	1:36	15:47
T	20	25:22	163	0:16	14:23
U	21	0:00	0	0:00	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (192)	0:00	0:00
2	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (193)	0:00	0:00
3	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (194)	0:00	0:00
4	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (195)	0:00	0:00
5	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (196)	0:00	0:00
6	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (197)	0:00	0:00
7	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (198)	0:00	0:00
8	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (199)	0:00	0:00
9	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (200)	0:00	0:00
10	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (201)	0:30	0:05
11	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (202)	0:22	0:04
12	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (203)	708:34	255:09
13	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (204)	213:56	57:04
14	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (205)	241:03	68:50
15	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (206)	172:28	41:21
16	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (207)	275:08	70:44
17	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (208)	0:00	0:00
18	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (209)	0:00	0:00
19	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (210)	0:00	0:00
20	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (211)	0:06	0:01
21	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (212)	0:04	0:01
22	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (213)	39:40	11:25
23	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (214)	47:19	14:13
24	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (215)	37:06	11:21
25	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (216)	44:48	14:14
26	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (217)	80:51	28:30
27	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (218)	57:40	21:39
28	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (219)	21:13	4:30
29	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (220)	38:49	7:25
30	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (221)	64:57	13:34
31	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (222)	71:52	16:13
32	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (223)	43:02	14:38
33	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (224)	2:49	0:55
34	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (349)	0:00	0:00
35	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (350)	0:00	0:00
36	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (351)	0:00	0:00
37	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (352)	0:00	0:00
38	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (353)	0:00	0:00
39	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (354)	0:04	0:00
40	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (355)	0:25	0:04
41	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (356)	0:43	0:07
42	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (357)	43:07	14:10
43	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (358)	21:22	6:42
44	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (359)	14:27	4:03
45	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (360)	14:47	3:42

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

Project:
VRA WPP2

Licensed user:
Airshed Planning Professionals (Pty) Ltd
480 Smuts Drive, Halfway Gardens PO Box 5260
ZA-1685 Halfway House
+27 (0) 11 805 1940
Nicolette / nicolette@airshed.co.za
Calculated:
12/07/2017 1:47 PM/3.1.617

SHADOW - Map

Calculation: WPP2 | SHADOW | Preferred Layout

Map: Open Street Map 001 , Print scale 1:100 000, Map center UTM (north)-WGS84 Zone: 31 East: 206 940 North: 641 550
New WTG Shadow receptor
Flicker map level: Project Wizard Elevation Data Grid (SRTM: Shuttle DTM 1 arc-second)

windPRO 3.1.617 by EMD International A/S, Tel. +45 96 35 44 44, www.emd.dk, windpro@emd.dk 13/07/2017 3:23 PM / 1 windPRO

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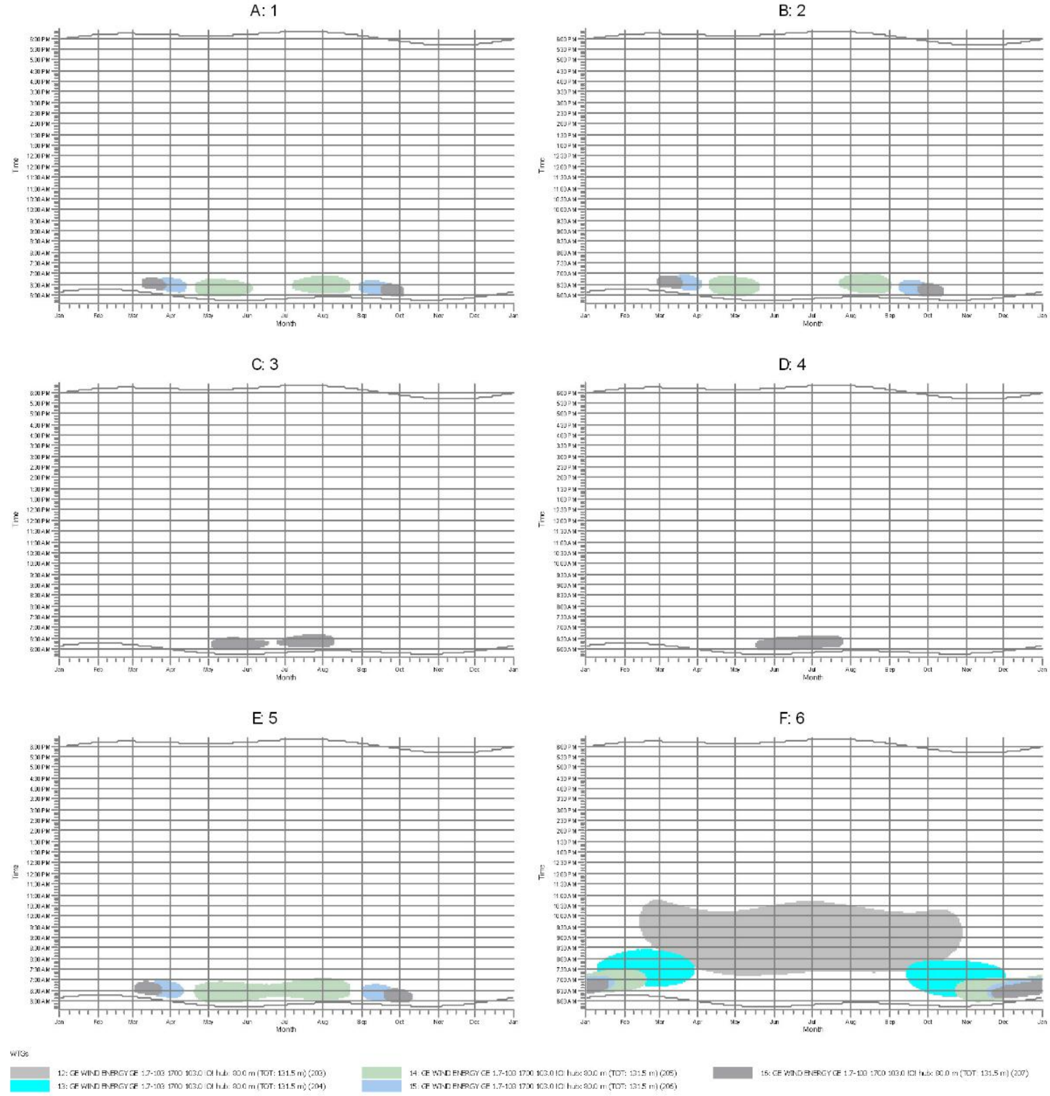
Calculated:
12/07/2017 1:47 PM/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Preferred Layout



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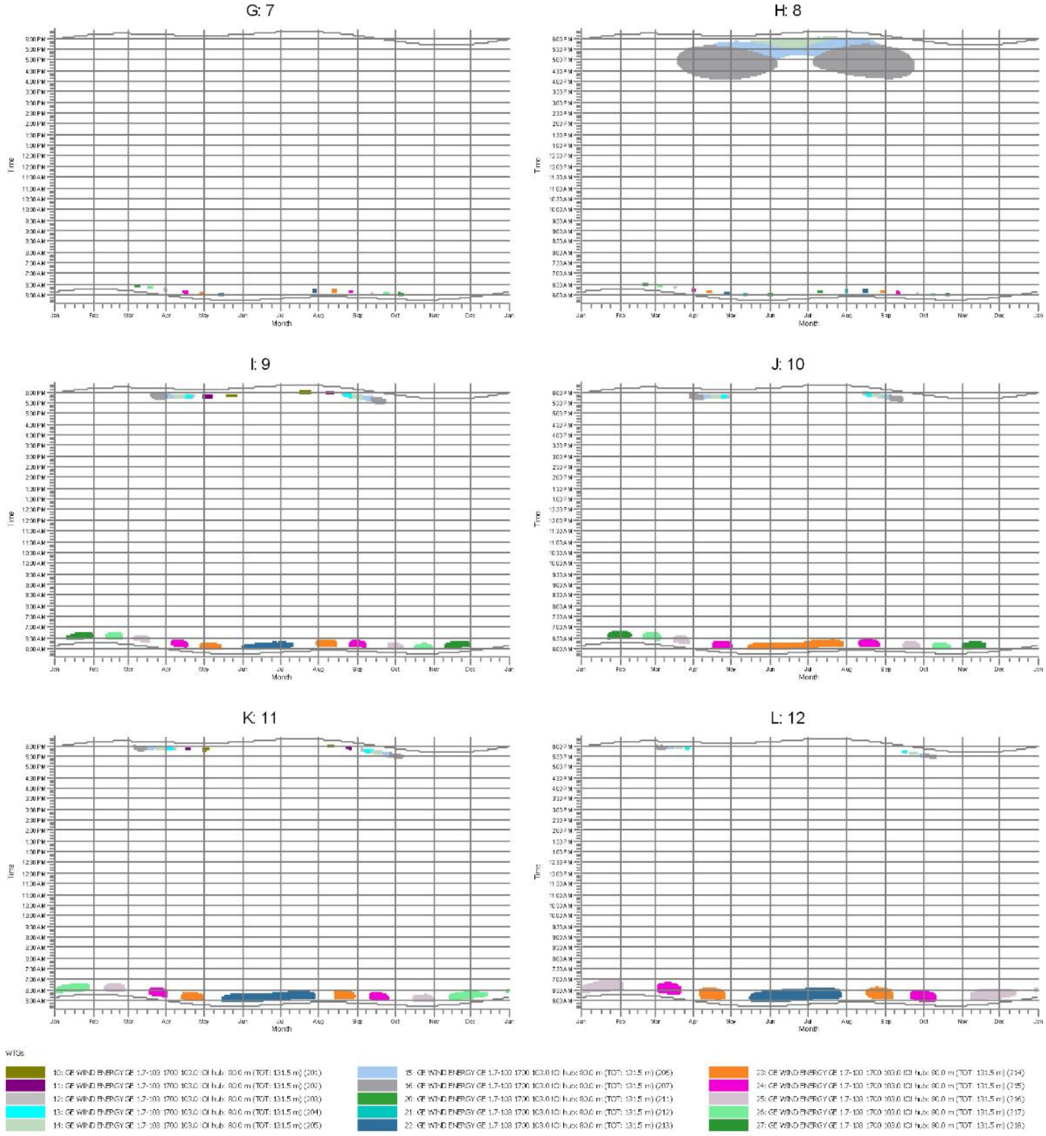
Calculated:
12/07/2017 1:47 PM/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Preferred Layout



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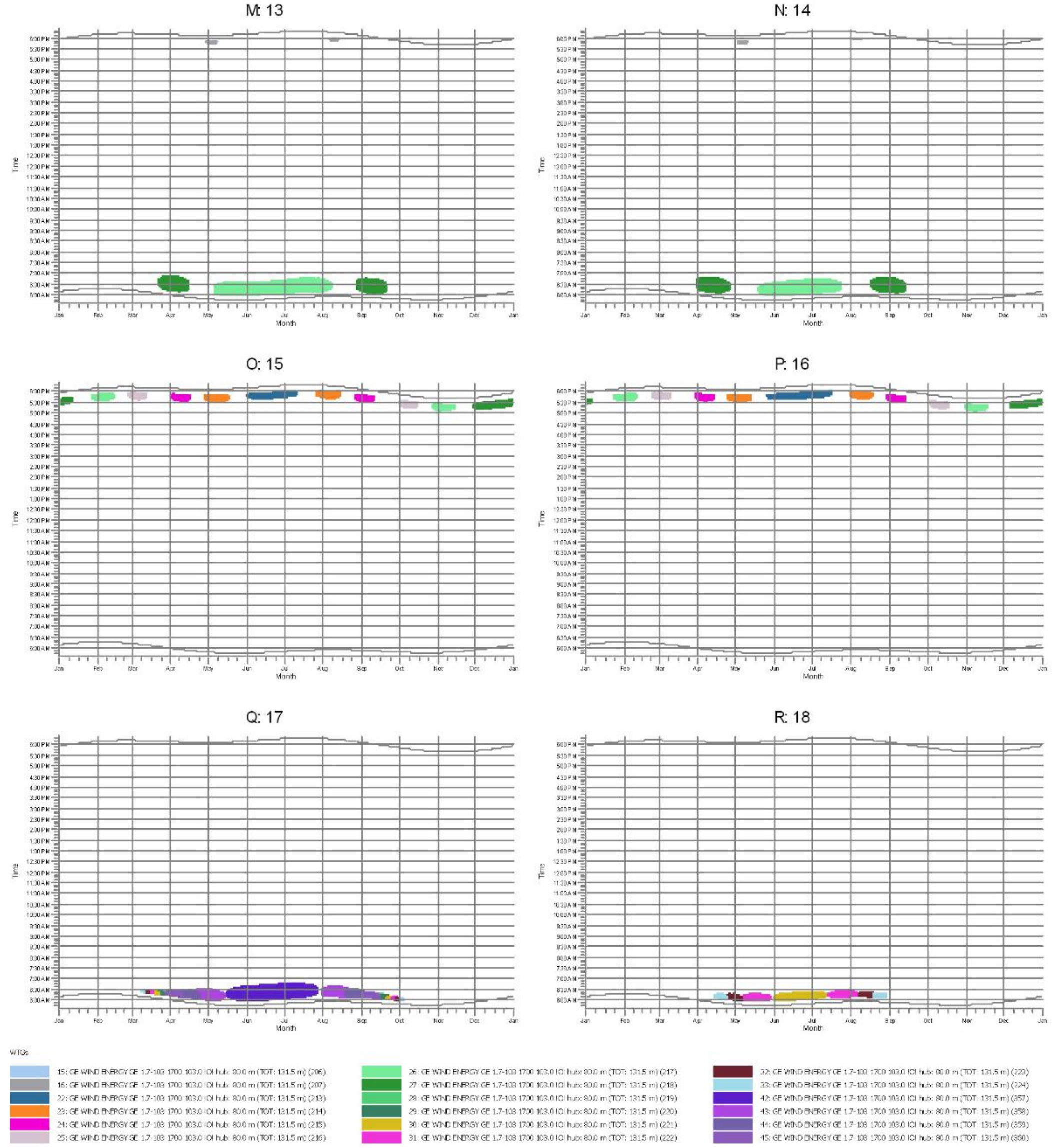
12/07/2017 1:47 PM/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Preferred Layout



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Calculated:
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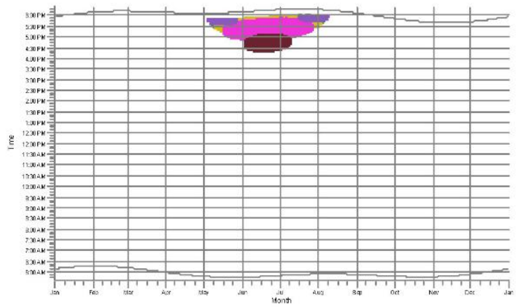
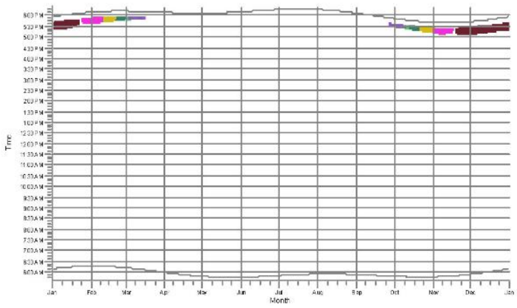
SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Preferred Layout

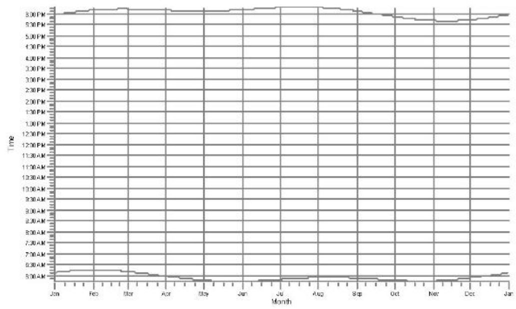
S: 19



T: 20



U: 21



WTGs

- 28: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (219)
- 29: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (220)
- 30: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (221)
- 31: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (222)
- 32: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (223)
- 39: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (354)
- 40: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (355)
- 41: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (356)
- 42: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (357)
- 43: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (358)
- 44: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (359)
- 45: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (360)

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VRA WPP2

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SHADOW - Main Result

Calculation: WPP2 | SHADOW | Alternative Layout

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9.90	9.70	8.60	8.90	8.30	5.40	4.90	4.20	5.90	8.00	9.80	10.40

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
96	53	61	35	61	131	604	3 530	3 215	736	123	114	8 759

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Project Wizard Elevation Data Grid (SRTM: Shuttle DTM
Obstacles used in calculation
Eye height: 1.5 m
Grid resolution: 50.0 m

Scale 1:200 000
New WTG   Shadow receptor

All coordinates are in
UTM (north)-WGS84 Zone: 31

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	201 626	642 523	8.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
2	201 680	642 340	11.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
3	201 734	642 179	4.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
4	201 782	641 986	-0.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
5	201 917	641 868	3.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
6	202 105	641 809	2.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
7	202 287	641 771	1.8	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
8	202 470	641 712	9.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
9	202 642	641 669	-5.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
10	202 814	641 637	-1.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
11	203 002	641 572	-3.4	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
12	203 185	641 540	2.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
13	203 459	641 470	4.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
14	203 647	641 417	0.3	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
15	203 835	641 374	3.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
16	203 996	641 342	-1.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
17	204 201	641 282	3.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
18	204 378	641 256	1.3	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
19	204 544	641 207	-1.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
20	204 727	641 154	0.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
21	204 899	641 116	-1.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
22	205 082	641 041	2.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
23	205 157	640 864	1.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
24	205 216	640 643	-3.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
25	205 238	640 461	-0.3	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
26	205 254	640 289	1.8	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
27	205 286	640 128	1.8	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
28	209 059	641 927	0.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
29	209 177	641 712	1.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
30	209 354	641 658	3.4	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
31	209 548	641 589	3.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
32	209 709	641 562	2.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
33	209 892	641 513	3.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
34	210 080	641 454	5.2	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
35	210 252	641 406	3.9	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5

To be continued on next page...

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Calculated:
12/07/2017 2:27 PM/3.1.617

SHADOW - Main Result

Calculation: WPP2 | SHADOW | Alternative Layout

...continued from previous page

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
36	210 440	641 374	3.3	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
37	210 617	641 304	4.1	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
38	210 805	641 250	2.8	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
39	210 988	641 207	1.7	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
40	211 149	641 154	2.3	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
41	211 273	641 025	0.5	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
42	211 369	640 896	1.4	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
43	212 885	641 825	-3.6	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
44	213 062	641 642	0.6	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5
45	213 094	641 384	5.0	GE WIND ENERGY GE 1.7-10...	Yes	GE WIND ENERGY	GE 1.7-103-1 700	1 700	103.0	80.0	2 500	17.5

Shadow receptor-Input

No.	Name	Easting	Northing	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	1	201 883	640 658	4.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
B	2	201 927	640 701	2.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
C	3	201 956	640 377	1.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
D	4	201 959	640 324	0.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
E	5	201 968	640 678	1.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
F	6	202 003	640 962	0.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
G	7	202 913	640 361	-0.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H	8	202 943	640 588	1.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
I	9	203 996	640 591	0.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
J	10	204 084	640 506	-1.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
K	11	204 187	640 732	0.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
L	12	204 432	640 811	1.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
M	13	204 622	640 086	0.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
N	14	204 643	640 051	2.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
O	15	206 300	640 617	0.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
P	16	206 302	640 637	0.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
Q	17	210 030	641 054	0.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
R	18	210 781	640 592	-2.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
S	19	212 269	640 780	2.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
T	20	213 109	641 335	3.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
U	21	213 374	642 321	0.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case: Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
A	1	2:15	65	0:03	0:44
B	2	4:03	88	0:04	1:18
C	3	0:06	6	0:01	0:01
D	4	0:04	4	0:01	0:01
E	5	3:03	82	0:04	1:02
F	6	7:12	95	0:08	2:31
G	7	2:26	90	0:03	0:49
H	8	5:41	124	0:06	1:55
I	9	36:53	207	0:15	12:21
J	10	32:34	165	0:16	10:59
K	11	56:26	229	0:21	19:19
L	12	102:52	251	0:33	35:23
M	13	60:50	134	0:35	20:48
N	14	69:51	136	0:36	23:37
O	15	38:08	198	0:16	14:11
P	16	32:46	168	0:16	11:24
Q	17	77:38	213	0:39	26:02
R	18	0:10	10	0:01	0:03

To be continued on next page...

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Calculated:
12/07/2017 2:27 PM/3.1.617

SHADOW - Main Result

Calculation: WPP2 | SHADOW | Alternative Layout

...continued from previous page

No. Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values Shadow hours per year [h/year]
S 19	25:53	109	0:21	5:29
T 20	265:01	215	2:39	83:43
U 21	0:00	0	0:00	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (259)	0:00	0:00
2	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (260)	0:00	0:00
3	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (261)	0:00	0:00
4	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (262)	0:00	0:00
5	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (263)	0:00	0:00
6	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (264)	0:00	0:00
7	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (265)	0:00	0:00
8	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (266)	0:00	0:00
9	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (267)	0:00	0:00
10	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (268)	0:00	0:00
11	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (269)	0:00	0:00
12	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (270)	0:00	0:00
13	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (271)	4:04	1:29
14	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (272)	4:27	1:24
15	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (273)	2:33	0:54
16	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (274)	0:56	0:18
17	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (275)	0:57	0:15
18	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (276)	0:46	0:08
19	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (277)	4:38	1:21
20	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (278)	5:04	1:16
21	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (279)	5:46	1:16
22	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (280)	56:35	17:46
23	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (281)	44:53	14:20
24	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (282)	37:16	11:21
25	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (283)	48:11	15:36
26	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (284)	94:35	33:16
27	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (285)	45:55	16:28
28	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (286)	0:00	0:00
29	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (287)	0:00	0:00
30	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (288)	0:00	0:00
31	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (289)	0:00	0:00
32	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (290)	0:00	0:00
33	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (291)	0:00	0:00
34	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (292)	0:04	0:00
35	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (293)	0:18	0:03
36	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (294)	0:50	0:09
37	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (295)	41:48	13:42
38	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (296)	21:15	6:39
39	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (297)	14:28	4:04
40	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (298)	14:09	3:37
41	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (299)	13:12	3:06
42	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (300)	14:08	3:58
43	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (301)	0:00	0:00
44	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (302)	0:00	0:00
45	GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (303)	263:08	82:51

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

Project:
VRA WPP2

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480 Smuts Drive, Halfway Gardens PO Box 5260
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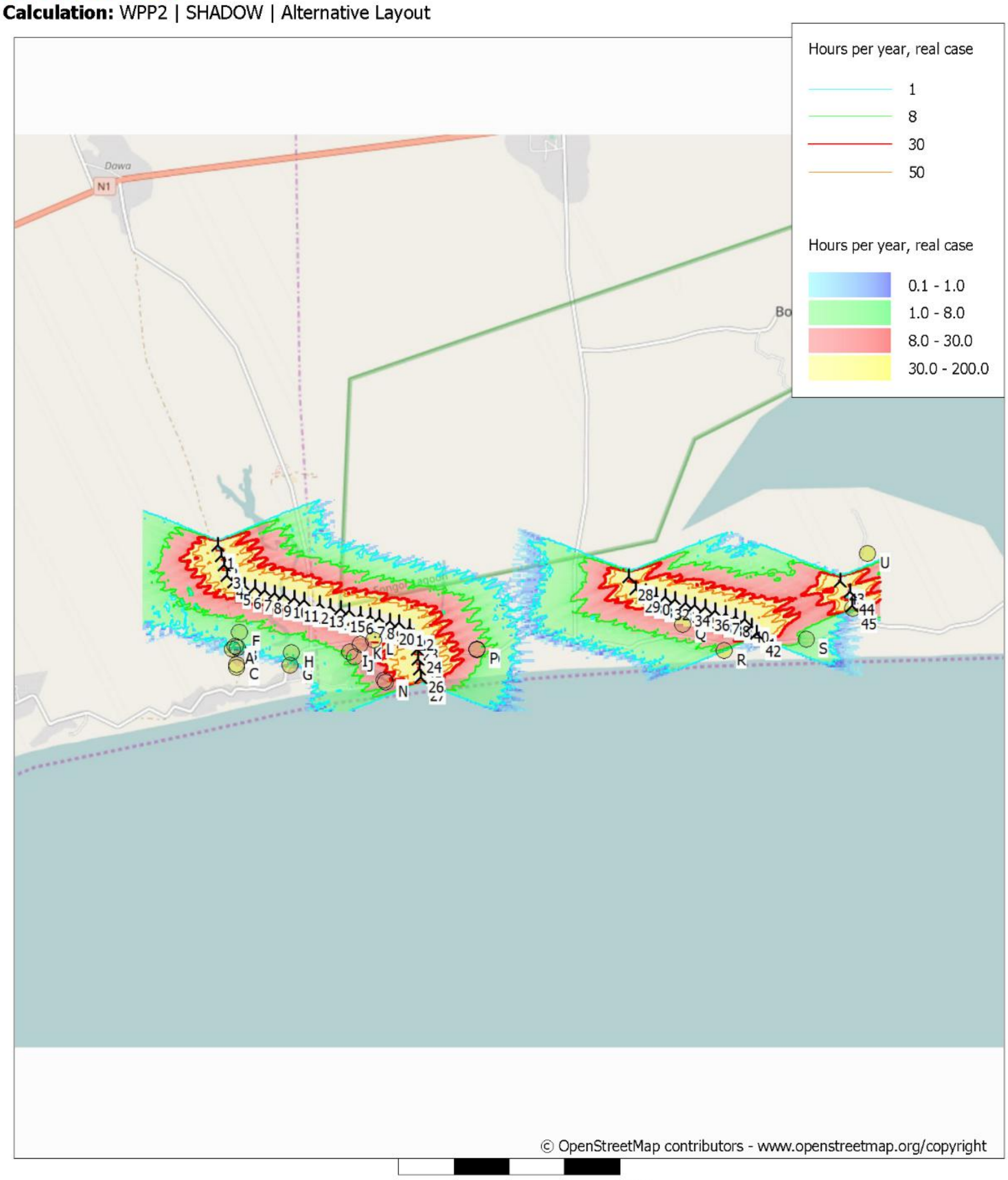
Nicolette / nicolette@airshed.co.za
Calculated:
12/07/2017 2:27 PM/3.1.617

SHADOW - Map

Calculation: WPP2 | SHADOW | Alternative Layout



Map: Open Street Map 001 , Print scale 1:100 000, Map center UTM (north)-WGS84 Zone: 31 East: 206 940 North: 641 550
New WTG Shadow receptor
Flicker map level: Project Wizard Elevation Data Grid (SRTM: Shuttle DTM 1 arc-second)

windPRO 3.1.617 by EMD International A/S, Tel. +45 96 35 44 44, www.emd.dk, windpro@emd.dk 13/07/2017 3:25 PM / 1 windPRO

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Calculated:
12/07/2017 2:27 PM/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Alternative Layout

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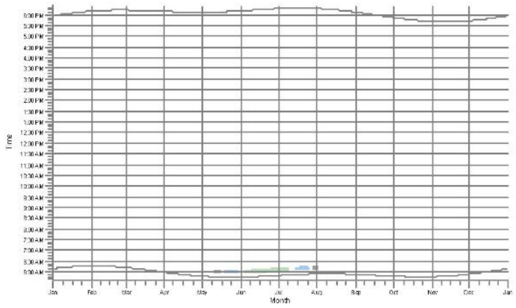

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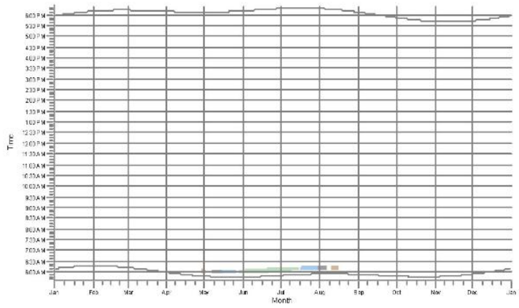

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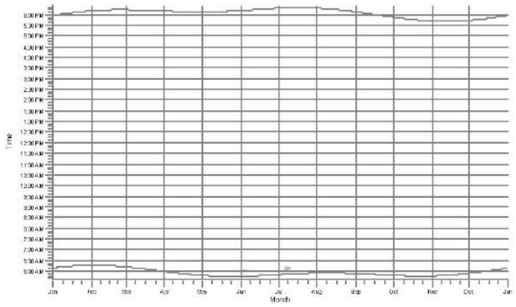

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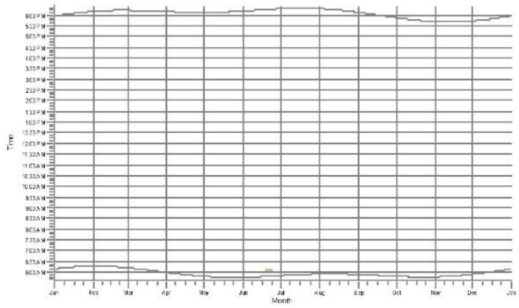

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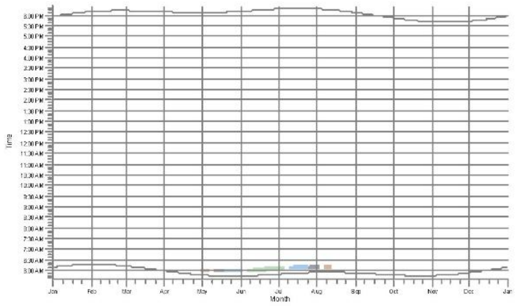

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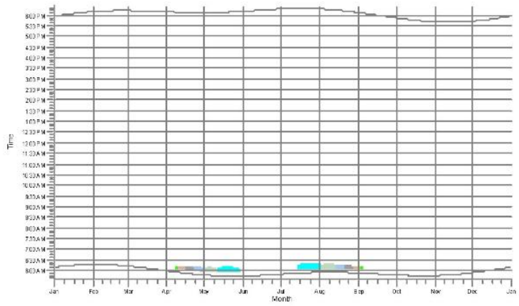

WTGs

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14: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (272)
15: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (273)
16: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (274)
17: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (275)
18: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (276)

windPRO 3.1.617 by EMD International A/S, Tel. +45 96 35 44 44, www.emd.dk, windpro@emd.dk

13/07/2017 3:24 PM / 1

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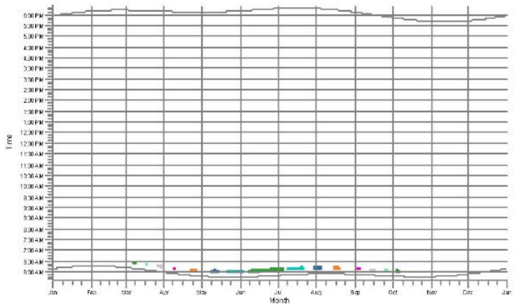
SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Alternative Layout

G: 7



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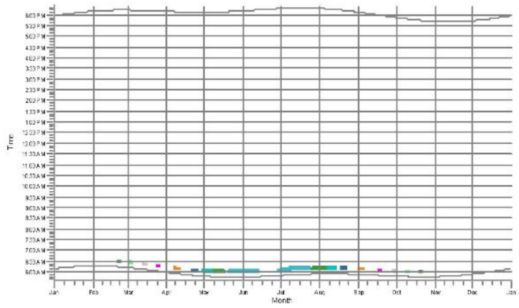

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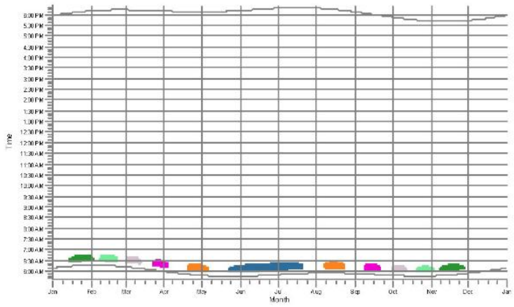

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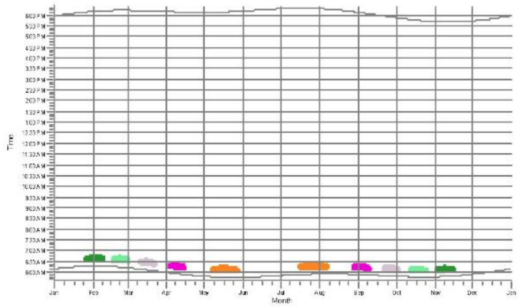

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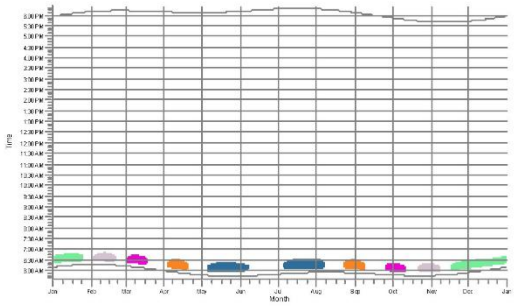
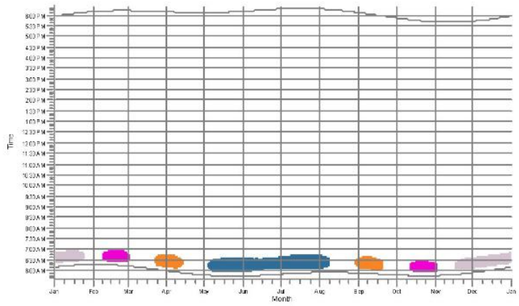


L: 12



WTGs

19: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (277)
20: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (278)
21: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (279)
22: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (280)
23: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (281)
24: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (282)
25: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (283)
26: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (284)
27: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (285)

Project:
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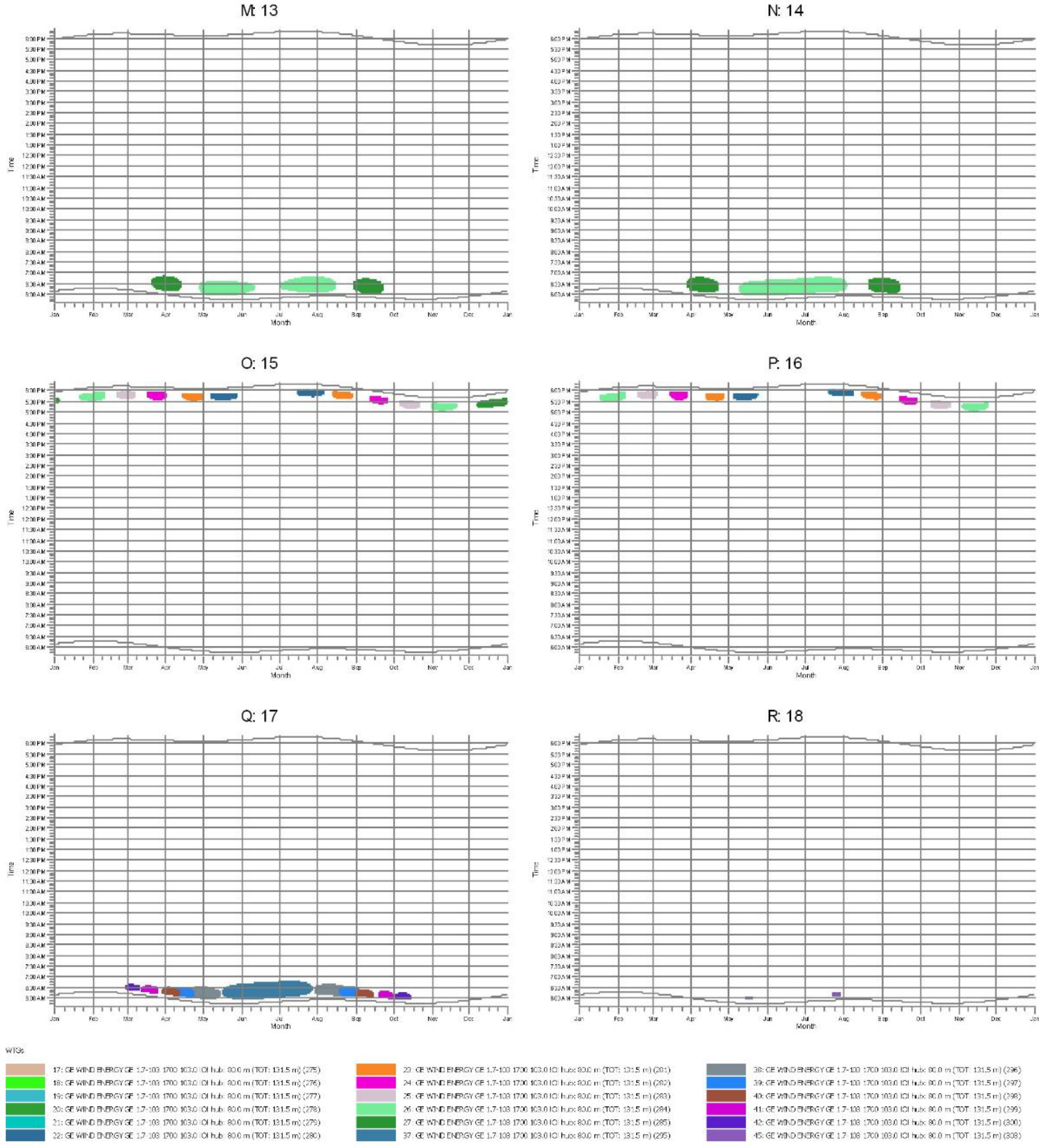
Calculated:
12/07/2017 2:27 PM/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Alternative Layout



Project:
VRA WPP2

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12/07/2017 2:27 PM/3.1.617

SHADOW - Calendar, graphical

Calculation: WPP2 | SHADOW | Alternative Layout

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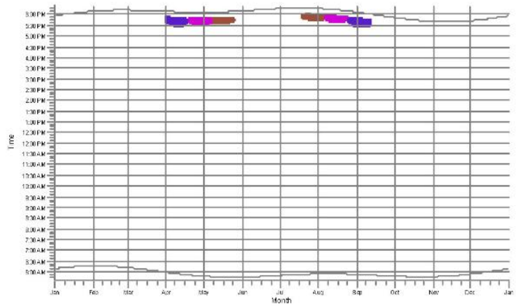

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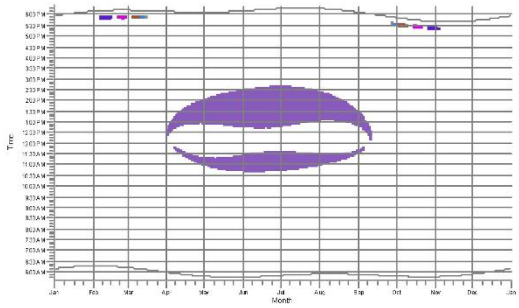
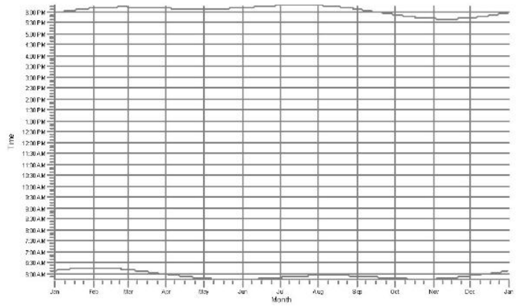


U: 21



WTGs

- 34: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (292)
- 35: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (293)
- 36: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (294)
- 37: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (295)
- 38: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (296)
- 39: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (297)
- 40: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (298)
- 41: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (299)
- 42: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (300)
- 45: GE WIND ENERGY GE 1.7-103 1700 103.0 !O! hub: 80.0 m (TOT: 131.5 m) (303)

14. ANNEX D – NOISE SURVEY DATA

14.1 FIELDWORK PHOTOGRAPHS

Figure 29: Photographs of noise survey site 1

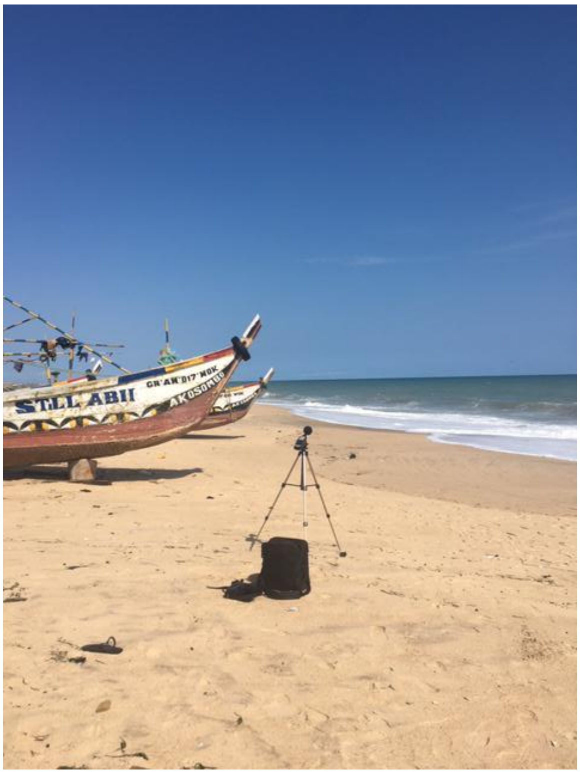


Figure 30: Photographs of noise survey site 2

Figure 31: Photographs of noise survey site 3

Figure 32: Photographs of noise survey site 4

14.2 DETAILED SURVEY RESULTS

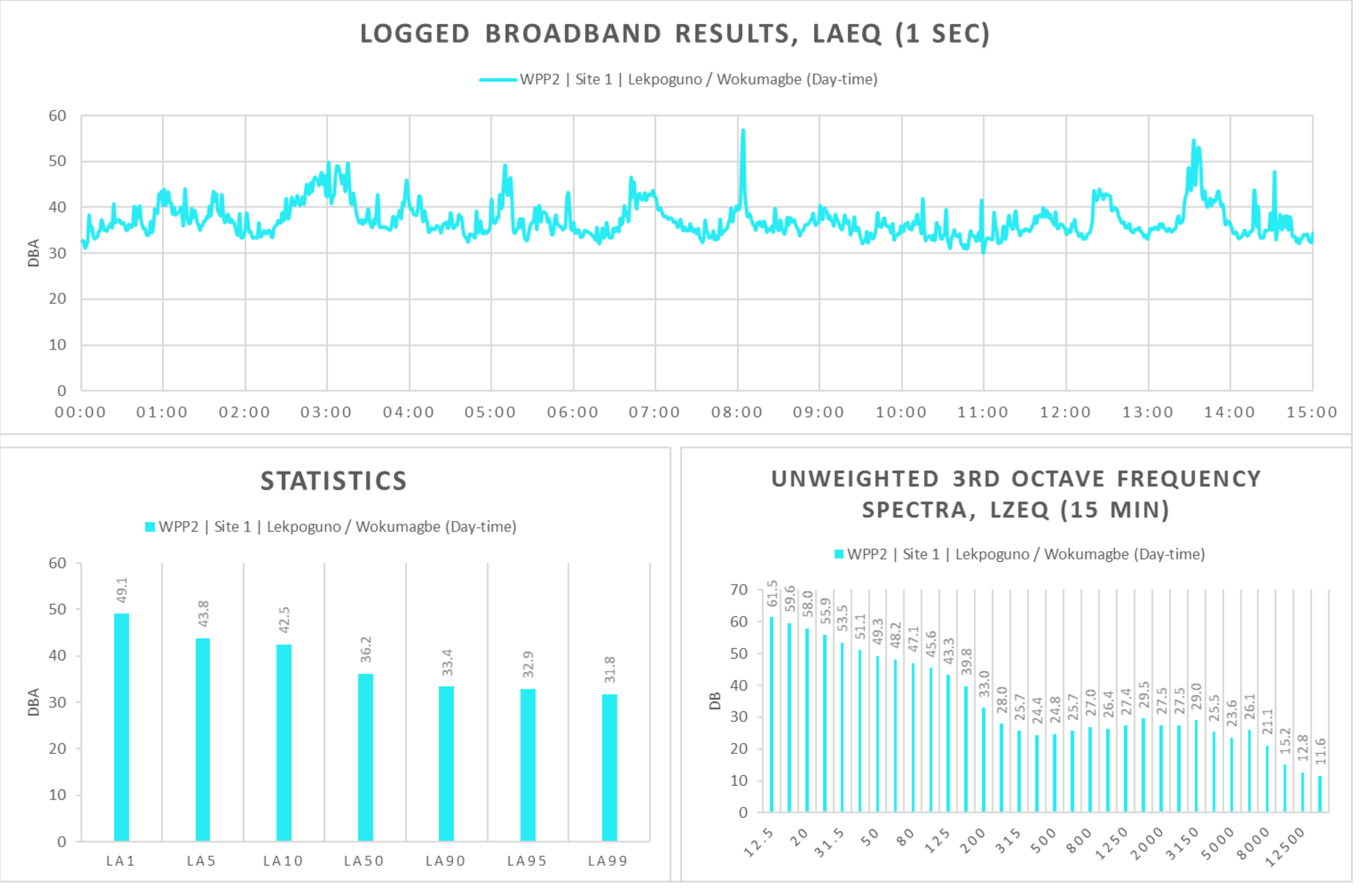


Figure 33: Detail day-time survey results, WPP2, site 1

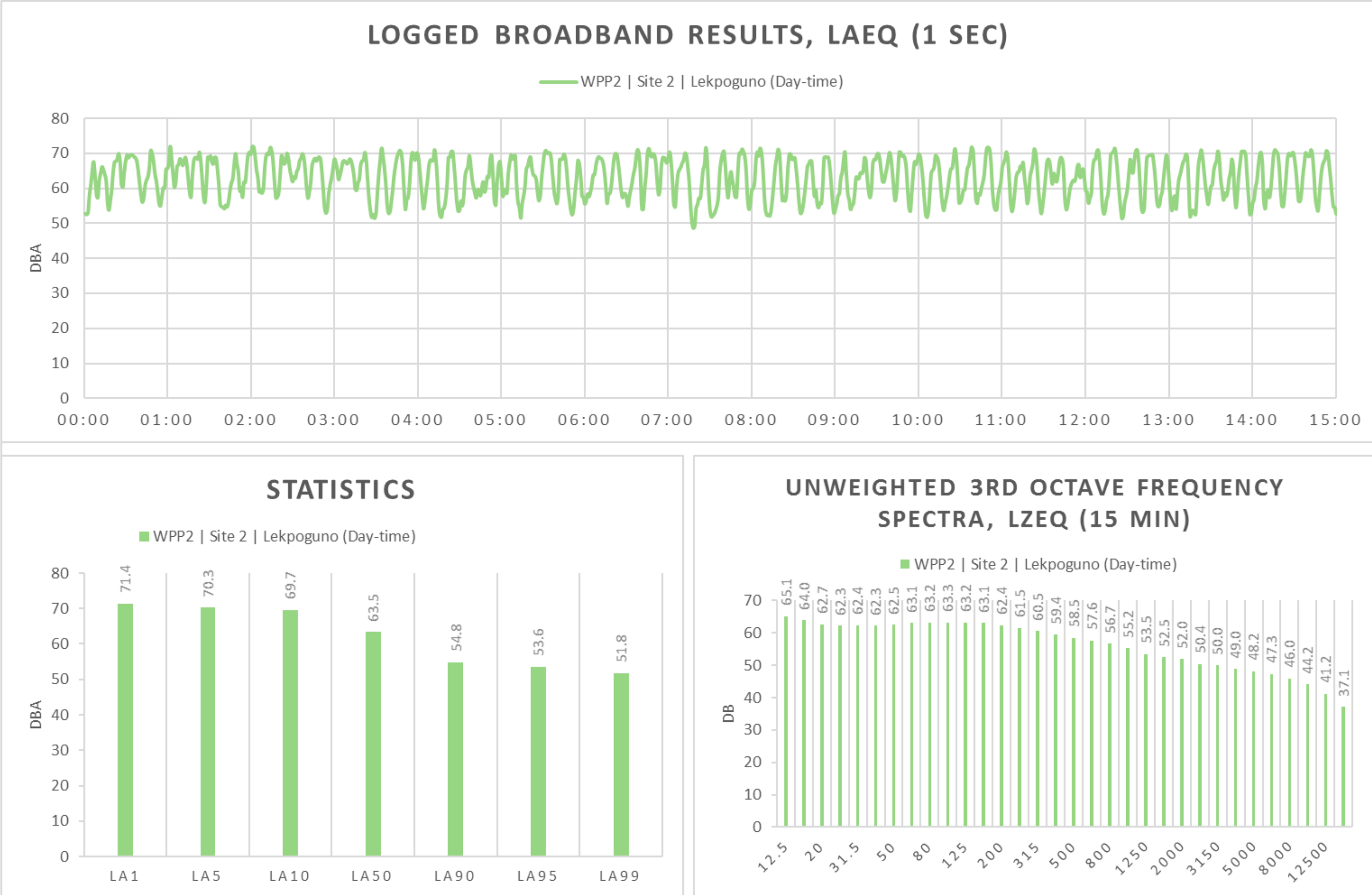


Figure 34: Detail day-time survey results, WPP2, site 2

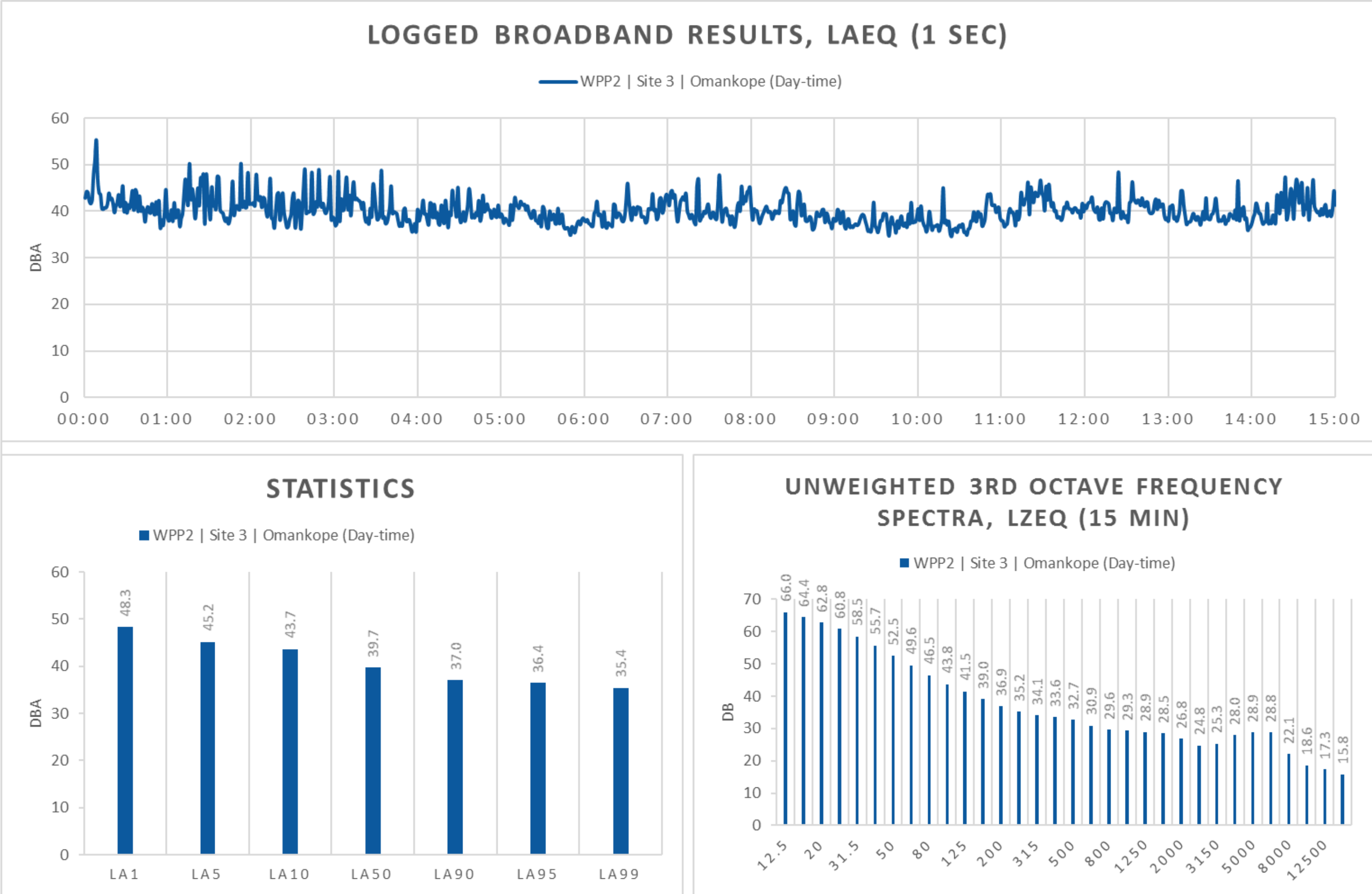


Figure 35: Detail day-time survey results, WPP2, site 3

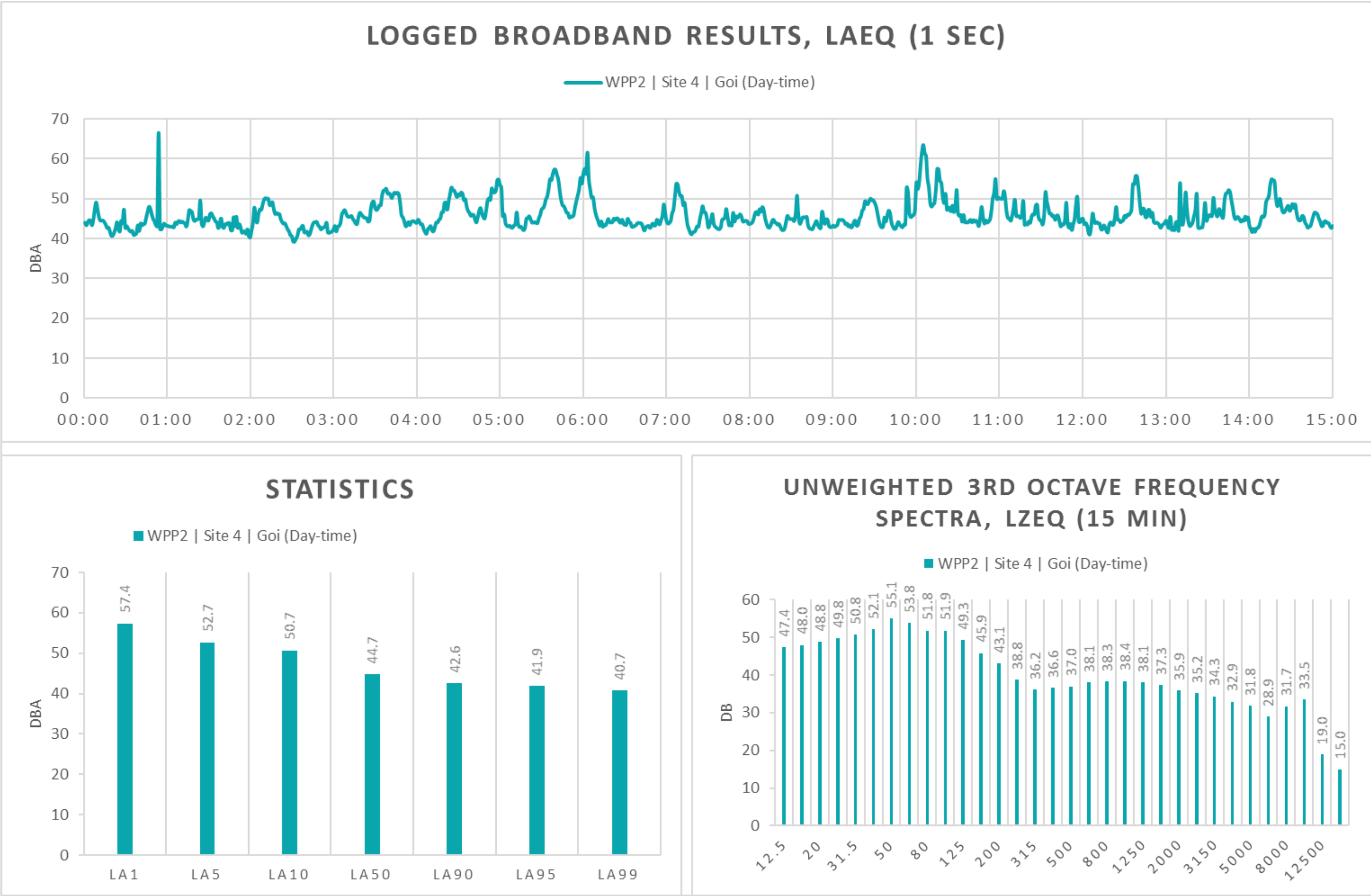


Figure 36: Detail day-time survey results, WPP2, site 4

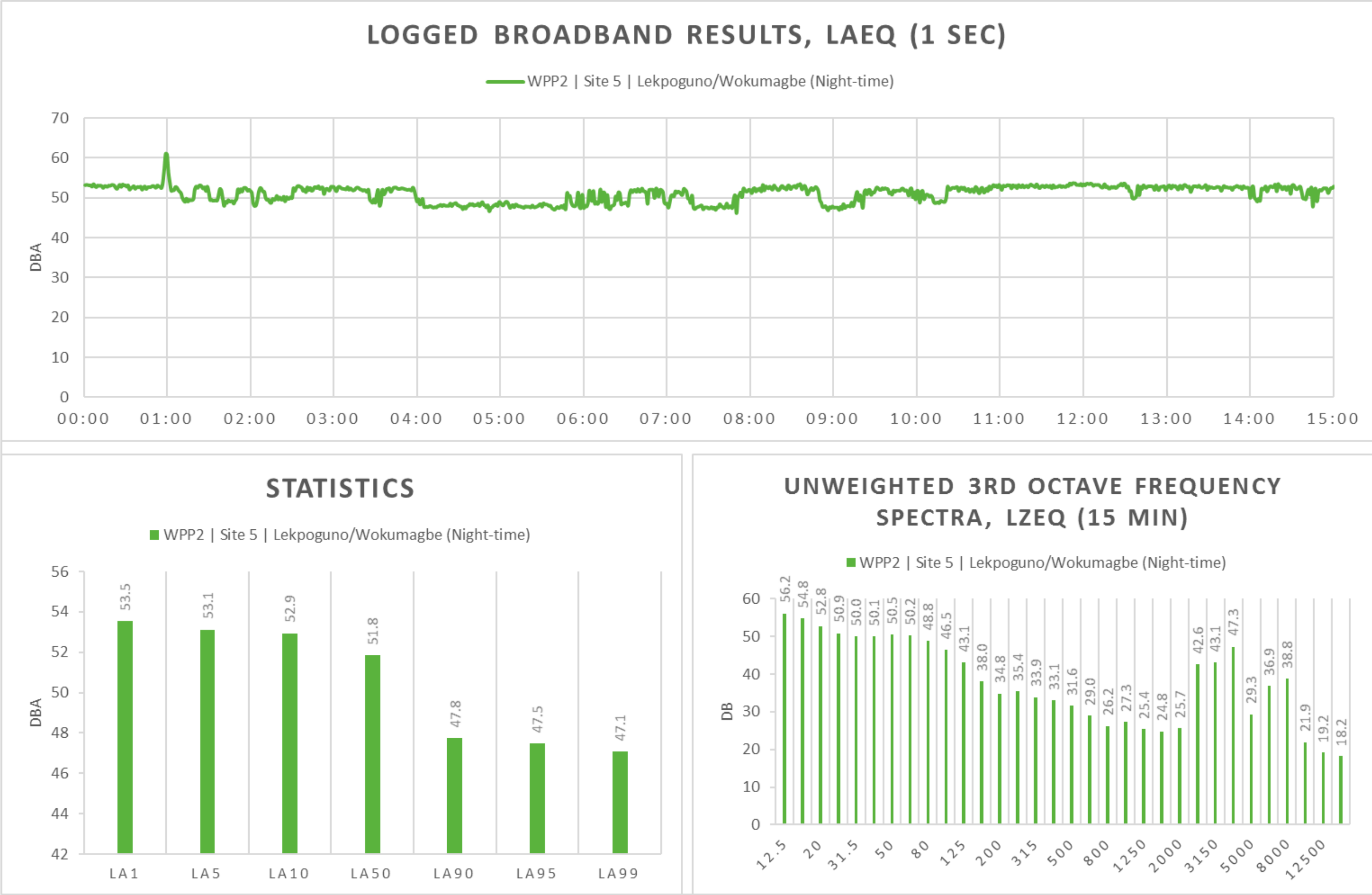


Figure 37: Detail night-time survey results, WPP2, site 5

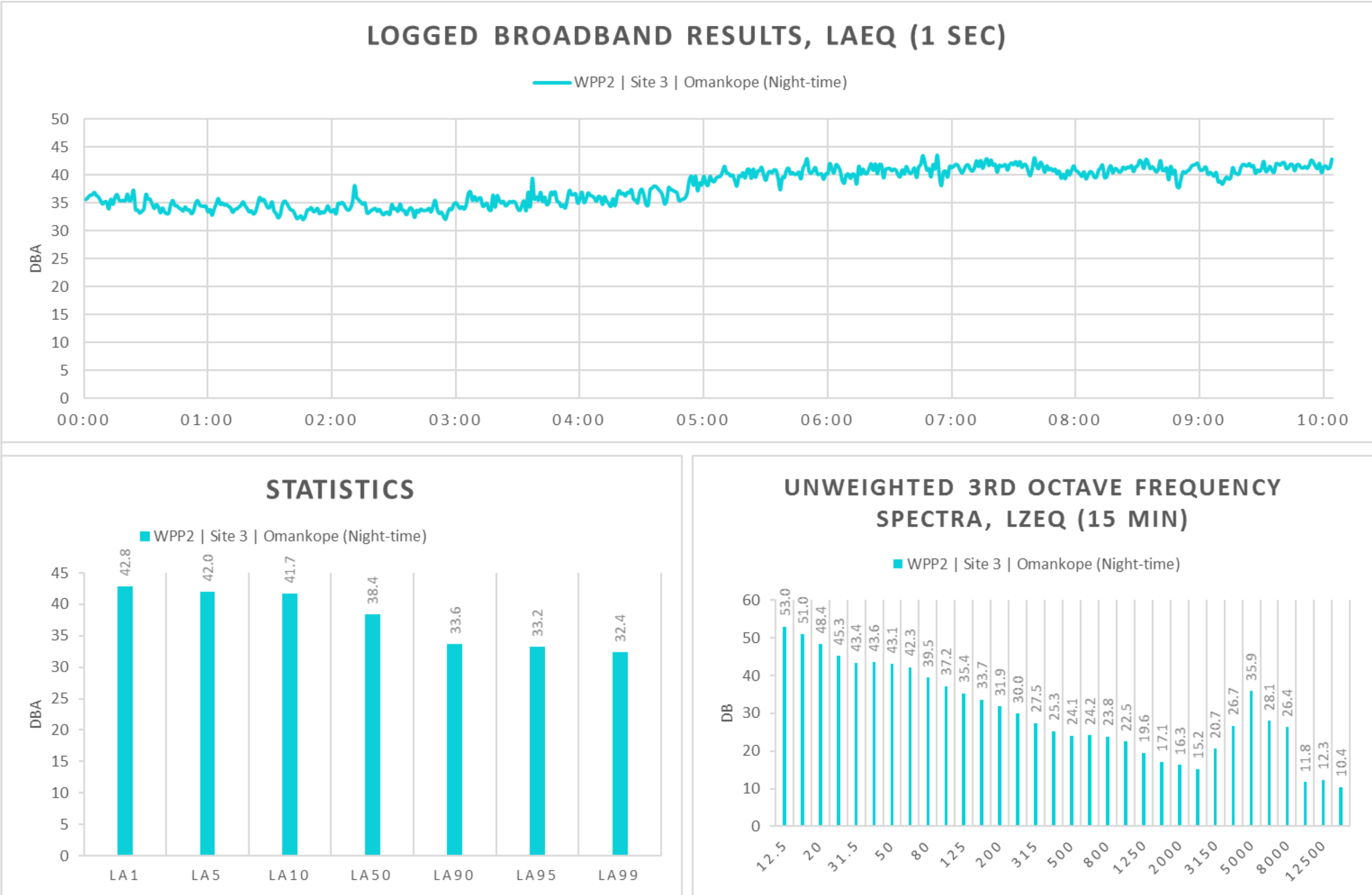


Figure 38: Detail night-time survey results, WPP2, site 3

Environmental & Social Impact Assessment

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

APPENDIX 8:

Visual Impact Assessment Study

VISUAL IMPACT ASSESSMENT:

Scoping and Environmental and Social Impact Assessment for the proposed Development of the 76.5MW Wind Power Project situated at Wokumagbe/Goi in the Greater Accra District of Ghana

Report prepared for:	*Report prepared by:*
Seljen Consult Limited P. O. Box AT 140 Achimota-Accra Ghana-West Africa CSIR – Environmental Management Services P O Box 320 Stellenbosch, 7599 South Africa	SRK Consulting (South Africa) (Pty) Ltd Postnet Suite #206 Rondebosch, 7701 South Africa

DECEMBER 2017

EXECUTIVE SUMMARY

Scott Masson from SRK Consulting (South Africa) (Pty) Ltd (SRK) was appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a specialist study on the visual and aesthetic impacts (Visual Impact Assessment (VIA)) of the project through the proposed construction, operation and decommissioning of a 76.5 Megawatt (MW) Wind Energy Facility (WEF) ("WPP2") in Wokumagbe and Goi areas in the Greater Accra Region, Ghana. Two layout alternatives were considered in the VIA.

The primary aims of the VIA are to describe the visual baseline, assess the visual impacts of the WEF and identify effective and practicable mitigation measures. The focus of the VIA study is on the very visible wind turbines.

The basis for the visual character of the study area is provided by the topography, vegetation and land use of the area, giving rise to a generally flat landscape with a mosaic of waterbodies, mud flats and salt marshes with low-intensity cultivated fields and villages on higher ground, with significant influence from the sea. The open topography, varied vegetation and traditional forms of crop farming integrated into the landscape are visually appealing, but not necessarily regionally distinctive. In this sense there is an element of sameness and predictability about the visual quality of the area. However, the Songor Lagoon and other open waterbodies are distinct natural features in the landscape. The area's sense of place is also highly influenced by the coast.

The visibility of WPP2 is high, due to the high visibility of the turbines in a flat landscape and the close proximity of receptors to the turbines. Potential visual receptors include residents of surrounding villages, visitors to Songor lagoon, road users, farmers, saltworks employees and fishermen.

Visual impacts will be generated in the Construction, Operations and Decommissioning Phases of the project. Table A below summarises:

- The impacts assessed in the VIA;

- Their significance before and following the implementation of essential mitigation measures; and
- The key mitigation measures on which the significance rating is based (where applicable).

Note that the impact ratings for the layout alternatives in Table A are the same.

Table A: Summary of Impacts

Impact	**Significance rating**		**Key mitigation/optimisation measures (summarised)**
	Without	***With***	
CONSTRUCTION PHASE IMPACTS			
Altered Sense of Place and Visual Intrusion from Construction Activities	Medium (-ve)	Low (-ve)	• Limit and phase vegetation clearance; • 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 and screen the yard; • 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; and • Set targets for the use of local labour to give locals a sense of ownership and pride in the project.
Altered Sense of Place from Increased Traffic	Medium (-ve)	Low (-ve)	• Limit construction activities to Mondays to Saturdays between the hours of 07h00 and 18h00; and • Maintain all vehicles and equipment in good working order.
OPERATIONS PHASE IMPACTS			
Altered Sense of Place and Visual Intrusion from the WEF	High (-ve)	High (-ve)	• 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.
Altered Sense of Place and Visual Character caused by Light Pollution at	Medium (-ve)	Low (-ve)	• 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

Impact	**Significance rating**		**Key mitigation/optimisation measures (summarised)**
	Without	***With***	
Night			light spillage and trespass; and • Avoid working at night unless absolutely necessary
Altered Sense of Place from Shadow Flicker	High (-ve)	Low (-ve)	• Calculate the effects of shadow flicker on those residents located within 1 km of the wind turbines.
DECOMMISSIONING PHASE IMPACTS			
Altered Sense of Place and Visual Intrusion from Decommissioning Activities	Medium (-ve)	Low (-ve)	• 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 and screen the yard; • Keep all activities, material and machinery contained within an area that is as small as possible; and • Rehabilitate disturbed areas incrementally.
Altered Sense of Place from Increased Traffic	Medium (-ve)	Low (-ve)	• Limit decommissioning activities to Mondays to Saturdays between the hours of 07h00 and 18h00; and • Maintain all vehicles and equipment in good working order.

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.

LIST OF ABBREVIATIONS

EHS	Environmental, Health and Safety
ESIA	Environmental and Social Impact Assessment
GIS	Geographic Information Systems
SRK	SRK Consulting (South Africa) (Pty) Ltd
VAC	Visual Absorption Capacity
VIA	Visual Impact Assessment
VRA	Volta River Authority
WEF	Wind Energy Facility

GLOSSARY

DEFINITIONS	
Aspect	The direction a slope faces with respect to the sun.
Landscape Integrity	The relative intactness of the existing landscape or townscape, whether natural, rural or urban, and with an absence of intrusions or discordant structures (Oberholzer, 2005).
Nacelle	The casing that houses all of the generating components in a wind turbine.
Sense of Place	The unique quality or character of a place, whether natural, rural or urban. Relates to uniqueness, distinctiveness or strong identity. Sometimes referred to as genius loci meaning 'spirit of the place' (Oberholzer, 2005).
Viewshed	The topographically defined area from which the project could be visible.
Visibility	The area from which the project components would actually be visible and which depends upon topography, vegetation cover, built structures and distance.
Visual Absorption Capacity	The potential for the area to conceal the proposed development.
Visual Character	The elements that make up the landscape including geology, vegetation and land-use of the area.
Visual Exposure	The zone of visual influence or viewshed. Visual exposure tends to diminish exponentially with distance.
Visual Impact	A description of the effect of an aspect of the development on a specified

	component of the visual, aesthetic or scenic environment within a defined time and space (Oberholzer, 2005).
Visual Intrusion	The nature of intrusion of an object on the visual quality of the environment resulting in its compatibility (absorbed into the landscape elements) or discord (contrasts with the landscape elements) with the landscape and surrounding land uses.
Visual Quality	The experience of the environment with its particular natural and cultural attributes.
Visual Receptors	Individuals, groups or communities who are subject to the visual influence of a particular project (Oberholzer, 2005).

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VISUAL IMPACT ASSESSMENT

1. INTRODUCTION & METHODOLOGY

Scott Masson from SRK Consulting (South Africa) (Pty) Ltd (SRK) was appointed by the Council for Scientific and Industrial Research (CSIR) to conduct a specialist study on the visual and aesthetic impacts (Visual Impact Assessment (VIA)) of the project through the proposed construction, operation and decommissioning of a 76.5 Megawatt (MW) Wind Energy Facility (WEF) ("WPP2") in Wokumagbe and Goi areas in the Greater Accra Region, Ghana (Figure 1).

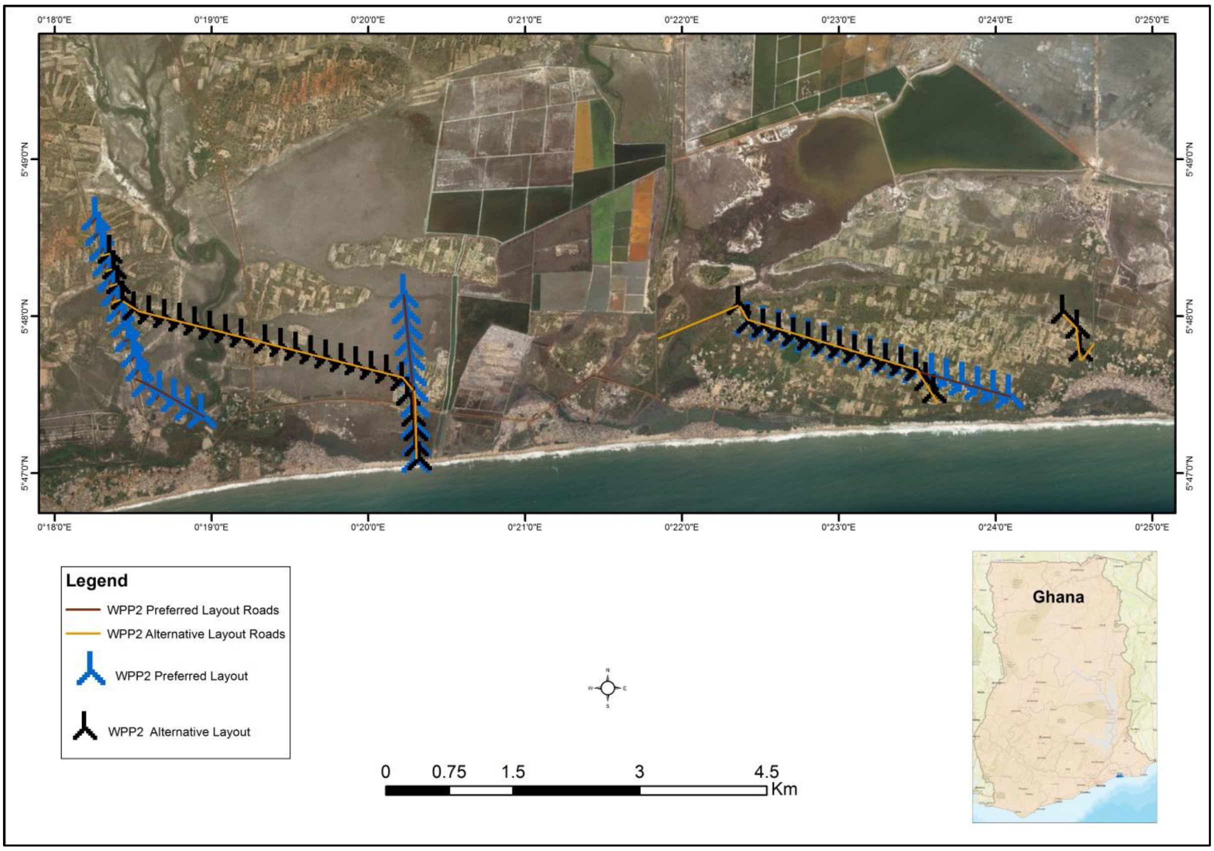


Figure 1: Location of the site for WPP2 with preferred and alternative layouts

The primary aims of the VIA are to describe the visual baseline, assess the visual impacts of the project and identify effective and practicable mitigation measures. More specifically, the aims are to:

- Determine the character and sensitivity of the visual environment;
- Identify visual resources and key viewing corridors / viewpoints;
- Determine and groundtruth the existing visual character and visual quality in order to understand the sensitivity of the landscape;
- Identify potential impacts of the project on the visual environment through analysis and synthesis of the following factors:
    - Visual exposure;
    - Visual absorption capacity;
    - Sensitivity of viewers (visual receptors);
    - Viewing distance and visibility; and
    - Landscape integrity;
- Assess the impacts of the project on the visual environment and sense of place using the prescribed impact assessment methodology; and
- Recommend practicable mitigation measures to avoid and/or minimise / reduce impacts and enhance benefits. Assess the effectiveness of proposed mitigation measures using the prescribed impact assessment methodology.

2. TERMS OF REFERENCE

The following broad terms of reference were specified for the visual specialist study:

- A desktop review of any existing data and literature relevant to the specialist field of expertise which will inform the rest of the assessment process in terms of documentation (e.g., legislation, national and international examples of similar developments) and availability of data (sensitive landscapes and visual receptors, spatial data for visibility analyses and landscape assessment). The desktop review also provides a basis for evaluating the confidence levels for the overall assessment.

- A desktop analysis using GIS and available spatial data was used during the preliminary study to determine:
    - Potential sensitive visual receptors (viewpoints, residences, tourists);
    - Preliminary zone of visual influence; and
    - Principal representative viewpoints.
- A photographic survey which used results of the desktop analyses to provide the following:
    - Photographic record of the visual baseline for views from principal viewpoints.
    - The actual zone of visual influence by determining the effect of vegetation, buildings and topography on visibility in the study area.
    - Identification of sensitive receptors (viewers and landscape elements that will be affected by the proposed development).
- The landscape baseline incorporated results from the desktop review and field survey to provide a description of the existing character and condition of the landscape. Factors such as geology, topography, land cover and human settlements that combine in particular ways to form the landscape are described, as well as the ways they combine to create unique landscape types within the study area. `

- The visual baseline information gathered during the field survey on the influence of vegetation and topography on the potential visibility of the wind farm provides a basis for determining the Zone of Visual Influence and the practical extents of the area for which the visibility analyses was done. The visual absorption capacity (VAC) for the area was determined to aid in site selection and mitigation.

- The following criteria should were used to assess the magnitude and significance of the potential visual impact of a development:

- Potential visibility of the development;
- Sensitivity of visual receptors to changes in the quality of their views;
- Distance of the development from sensitive viewers (visual exposure); and
- Compatibility of the development with the 'sense of place' of the area (visual intrusion).

- Photo-montage and 3D modelling were used to compare existing visual conditions with probable scenarios if the development is introduced to the landscape.

- Develop a monitoring programme to be included in the EMP, if applicable.

3. PROJECT DESCRIPTION

This project referred to as WPP2 will have the following main components which will impact on the visual and aesthetic aspects:

- **<u>Wind turbine area:</u>**
  - Wind turbines; and
  - 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>**
  - Transmission lines;
  - On-site substation;
  - Access roads;
  - Internal gravel roads;
  - Fencing;
  - Stormwater channels; and
  - Temporary work area during the construction phase (i.e. laydown area).

The proposed project will include 45 individual wind turbines with an approximate generation capacity of 1.7 MW each. The turbines will have a hub height of up to 80 m and a rotor diameter of 103 m. A detailed description of the proposed project can be found in Chapter 3 of the ESIA report.

4. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

There are very few guidelines that provide direction for visual assessment and none for Ghana. In their absence, this VIA has been guided by the international Landscape Institute's "Guideline for Landscape and Visual Impact Assessments" (2013) and the South African Department of Environmental Affairs and Development Planning's "Guideline for Involving Visual and Aesthetic Specialists in EIA Processes" (2005), both of which have been considered in the VIA study.

The World Bank Group's Environmental, Health and Safety (EHS) Guidelines for Wind Energy (2015) identify environmental issues specific to wind energy projects. Guidelines for landscape and visual impacts are provided, as follows:

- A WEF may have an impact on viewscapes, especially if visible from or located near residential areas or tourism sites. Visual impacts typically concern the turbines (e.g. colour, height, and number of turbines).

- Impacts may also arise in relation to the WEF's interaction with the character of the surrounding landscape. Impacts on Legally Protected and Internationally Recognized Areas of importance to biodiversity and cultural heritage features are also a consideration. Preparing zone of visual influence maps and photomontages from key viewpoints is recommended to inform both the assessment and the consultation processes.

- Avoidance and minimisation measures to address landscape and visual impacts are largely associated with the siting and layout of wind turbines and associated infrastructure (e.g. access tracks, substations).

- Consideration should be given to turbine layout, size, and scale in relation to the surrounding landscape character and surrounding visual receptors (e.g., residential properties, users of recreational areas/routes).

- Consideration should also be given to the proximity of turbines to settlements, residential areas, and other visual receptors, to minimise visual impacts and impacts on residential amenity, where possible. All relevant viewing angles should be considered when considering turbine locations, including viewpoints from nearby settlements.

- Other factors can be considered in relation to minimizing visual impacts:

    - Incorporate community input into wind energy facility layout and siting;
    - Maintain a uniform size and design of turbines (e.g., type of turbine and tower, as well as height);
    - Adhere to country-specific standards for marking turbines, including aviation/navigational and environmental requirements, where available;

- Minimize presence of ancillary structures on the site by minimizing site infrastructure, including the number of roads, as well as by burying collector system power lines, avoiding stockpiling of excavated material or construction debris, and removing inoperative turbines; and
- Erosion measures should be implemented and cleared land should be promptly re-vegetated with local seed stock of native species.

The EHS Guidelines for Wind Energy has been considered in the VIA study.

5. METHODOLOGY

5.1 APPROACH TO THE VIA STUDY

Wind turbines are significant vertical elements in the landscape and the default is that the associated visual impact is always anticipated to be high. 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'.

Given the nature of visual issues, assessing the visual impacts of WEFs in absolute and objective terms is not achievable. Thus, qualitative as well as quantitative techniques are required. In this VIA, emphasis is placed on ensuring that the methodology and rating criteria are clearly stated and transparent.

The approach adopted for the VIA study is intended to be as accurate and thorough as possible. Analytical techniques are selected so as to endorse the reliability and credibility of the assessment.

The approach to and reporting of the VIA study comprise three major, phased elements (as depicted in Figure 2 below):

1. A description of the visual context (baseline);

2. The identification and discussion of the potential visual impacts; and

3. An assessment of those potential impacts.

Visual impacts are assessed as one of many interrelated effects on people (i.e. the viewers and the impact of an introduced object into a particular view or scene) (Young, 2010). In order to assess the visual impact the project has on the affected environment, the visual context (baseline) in which the project is located must be described. The inherent value of the visual landscape to viewers is informed by geology / topography, vegetation and land-use and is expressed *as Visual Character* (overall impression of the landscape), *Visual Quality* (how the landscape is experienced) and *Sense of Place* (uniqueness and identity).

Visual impact is measured as the change to the existing visual environment caused by the project as perceived by the viewers (Young, 2010). The visual impact(s) may be negative, positive or neutral (i.e. the visual quality is maintained). The magnitude or intensity of the visual impacts is determined through analysis and synthesis of the visual absorption capacity (VAC) of the landscape (potential of the landscape to absorb the project), zone of visual influence or exposure, visibility (viewing distances), compatibility of the project with landscape integrity (congruence), and the sensitivity of the viewers (receptors).

Sources of visual impacts are identified for the construction, operations and decommissioning phases of the project. The significance of those visual impacts is then assessed using the prescribed impact rating methodology.

Mitigation measures recommended to avoid and/or reduce the significance of negative impacts, or to optimise positive impacts, are identified for the project. Impact significance is re-assessed assuming the effective implementation of mitigation measures.

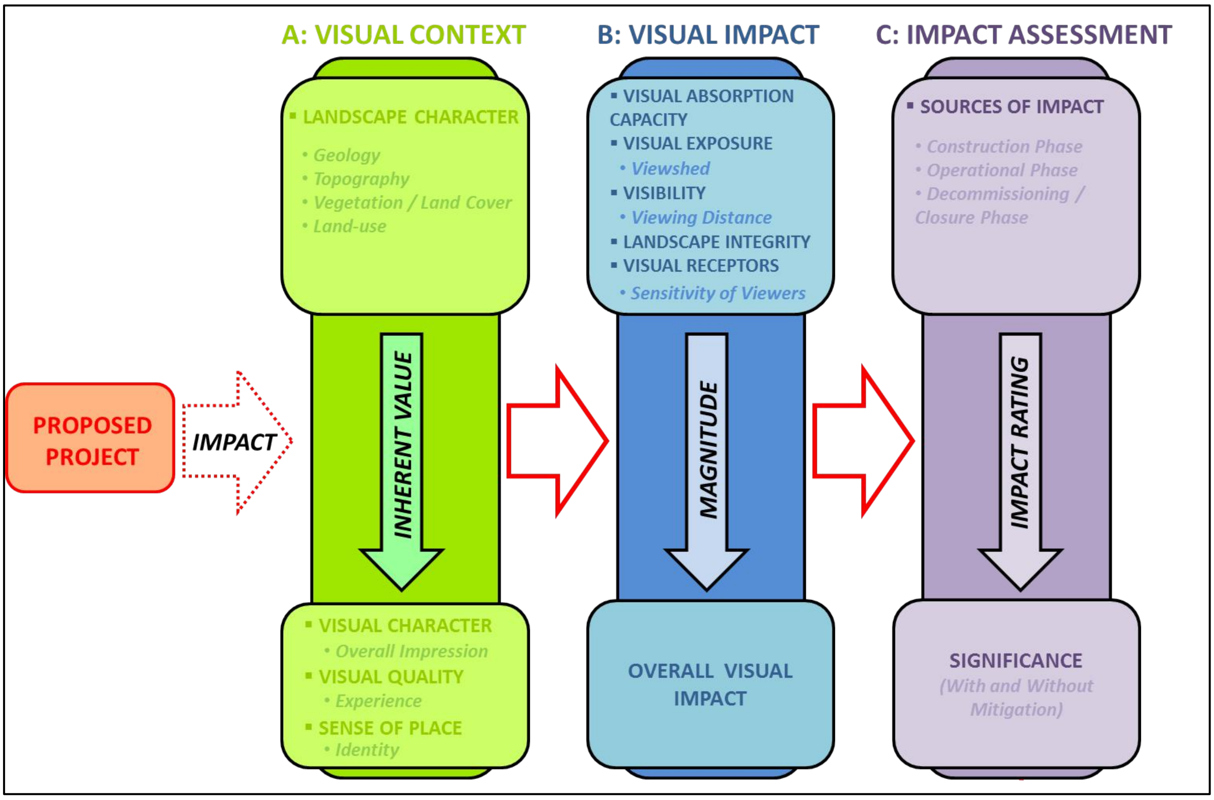


Figure 2: Schematic Approach to the VIA study

5.2 METHOD

The following method was used to assess the visual baseline for the project:

- Collect and review visual data, including data on topography, vegetation cover, land-use, and other background information;
- Undertake fieldwork (16 – 20 October 2016), comprising an extensive reconnaissance of the study area, particularly the project site and key viewpoints. The objectives of the fieldwork were to:
    - Familiarise the specialist with the site and its surroundings;
    - Identify key viewpoints / corridors; and

  - Determine and groundtruth the existing visual character and quality in order to understand the sensitivity of the landscape;

Visual 'sampling' using photography was undertaken to illustrate the likely zone of influence and visibility. The location of the viewpoints was recorded with a GPS.

- Undertake a mapping exercise using ArcGIS to identify:

  - Potential visual resources; and
  - Potential visual receptors.

The following method was used to assess the visual impact of the project:

- Make field observations at key viewpoints to determine the likely distance at which visual impacts will become indistinguishable;

- Rate impacts on the visual environment and sense of place based on a professional opinion and the prescribed impact rating methodology (refer to Chapter 2 of the ESIA report); and

- Recommend mitigation measures to and/or reduce the significance of negative impacts or optimise positive impacts.

5.3 ASSUMPTIONS AND LIMITATIONS

As is standard practice, the VIA study is based on a number of assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report.

- VIA is not, by nature, a purely objective, quantitative process, and depends to some extent on subjective judgments. Where subjective judgments are required, appropriate criteria and motivations for these are clearly stated;

- The assessment is based on technical information supplied to SRK, which is assumed to be accurate. This includes the proposed locations, dimensions and layouts of the project;

- Contour detail at the scale required to generate a viewshed was not available at the time of the assessment;

- A study by Visual Resource Analysis at Argonne National Laboratory (Sullivan, date unknown) determined that, under favourable viewing conditions, WEFs are judged to be major foci of visual attention at up to 19 km, the facilities would be unlikely to be missed by casual observers at up to 32 km and could be major sources of visual contrast at up to 16 km. For the purposes of this study, a radius of 30 km is used to define the study area for WPP2;

- The focus of the VIA study will be on the very visible wind turbines;

- Simulations of the turbines were produced for the preferred layout only as the visual intrusion of both alternatives is considered to be similar;

- The photograph simulations are only intended to provide stakeholders with an indication of the visibility of the turbines in the landscape. The representation of the turbines in the simulated photographs is based on the accuracy of the information provided by the client and the computer software (ArcGIS, AutoCAD, Google Earth, Sketchup and Adobe Photoshop) used to generate the simulated photographs; and

- This study does not motivate for or against the project, but rather seeks to give insight into the visual character and quality of the area.

6. DESCRIPTION OF THE AFFECTED VISUAL ENVIRONMENT

The following description of the affected environment focuses on the *Visual Character* of the area surrounding and including the project area and discusses the *Visual Quality* and *Sense of Place*[1]. A more comprehensive baseline description of the area is provided in Chapter 4 of the ESIA Report. This baseline information provides the context for the visual analysis.

6.1 LANDSCAPE CHARACTER

Landscape character is the description of the pattern of the landscape, resulting from particular combinations of natural (physical and biological) and cultural (land use) characteristics. It focuses on the inherent nature of the land rather than the response of a viewer (Young, 2000). Each of the key characteristics is discussed below.

6.1.1 Topography

The topography of the area, together with the tropical climate and the proximity to the coast, provide the framework for the basic landscape features and visual elements of the study area.

WPP2 is located on a relatively flat depositional coastline characterised by sandy beaches and with surrounding floodplains and closed lagoons behind narrow sand bars. From the coastline, the topography rises gently across coastal plains consisting of waterways, mudflats and salt marshes to a ridgeline in the north (Figure 3).

The WEF is located west of Songor Lagoon and the Volta River Estuary. Songor Lagoon, a declared Ramsar site, is an extensive shallow brack-water lagoon closed to the sea. In 2011, UNESCO declared the Songor Biosphere Reserve as part of the World Network of Biosphere Reserves (www.birdlife.org).

According to the project Draft Feasibility Study (Lahmeyer International, 2015), the soils throughout the coastal savannah zone are predominantly black tropical earths, tropical grey earths,

[1] These terms are explained in the relevant sections below.

acid vleisols and sodium vleisols. Except for tropical black earths, known locally as Akuse clays, most of these soils have only limited agricultural potential.

Figure 3: Topography of the study area from the coast (left) rising gently to a ridgeline (right)

6.1.2 Vegetation

The main vegetation type in the study area is saline marsh and waterlogged grassland (birdlife.org) (Figure 4).

On higher ground, terrestrial vegetation largely consists of degraded coastal savanna, characterised by farmland, secondary vegetation on abandoned farms and eroded lands with small shrubs and isolated trees (Figure 4) such as *Borassus aethiopum* (fan palm), *Mangifera indica* (mango), *Ceiba pentandra* (silk cotton tree) and *Adansonia digitate* (baobab) (www.birdlife.org).

Figure 4: Mosaic of grassland and crop fields (left) and savanna vegetation (right)

6.1.3 Land Use

Anthropogenic activities in and around the project area comprise mainly crop farming, fishing and intensive salt extraction.

Agricultural activity (mostly small crops) is at a subsistence level, in small fields generally located on higher (dry) ground. The patchwork of fields is interspersed with trees and shrubby vegetation.

Landscape degradation is widespread, caused by extensive drainage/damming and cultivation for agriculture, heavy grazing by cattle and livestock, an unsustainable level of salt extraction (Figure 5) and rubbish dumping.

The villages of Ayitepa, Lekpoguno, Akplabnya and Goi are the most significant settlements in the study area. A surfaced (tarred) road provides access to the area from the N1 (via Sege).

Figure 5: Village of Akplabnya (left) and damming for salt extraction (right)

6.2 VISUAL CHARACTER

Visual character is descriptive and non-evaluative, which implies that it is based on defined attributes that are neither positive nor negative. A change in visual character cannot be described as having positive or negative attributes until the viewer's response to that change has been taken into consideration. The probable change caused by the project is assessed against the existing degree of change caused by previous development.

Typical character attributes, used to describe the visual character of the affected area and to give an indication of potential value to the viewer, are provided in Table 1.

The basis for the visual character of the overall area is provided by the topography, vegetation and land use of the study area, giving rise to a generally flat landscape with a mosaic of waterbodies, mud flats and salt marshes with low-intensity cultivated fields and villages on higher ground, and significant influence from the sea and coastline.

The WPP2 area can be described as a *modified rural landscape* associated with the interface between the coastline, the villages and the extensive cultivated fields and rustic salt extraction pans further inland.

6.3 VISUAL QUALITY

Aesthetic value is an emotional response derived from our experience and perceptions. As such, it is subjective and difficult to quantify in absolute terms. Studies in perceptual psychology have shown that humans prefer landscapes with higher complexity (Crawford, 1994). Landscape quality can be said to increase when:

- Topographic ruggedness and relative relief increases;
- Water forms are present;
- Diverse patterns of grasslands, shrubs and trees occur;
- Natural landscape increases and man-made landscape decreases; and
- Where land-use compatibility increases.

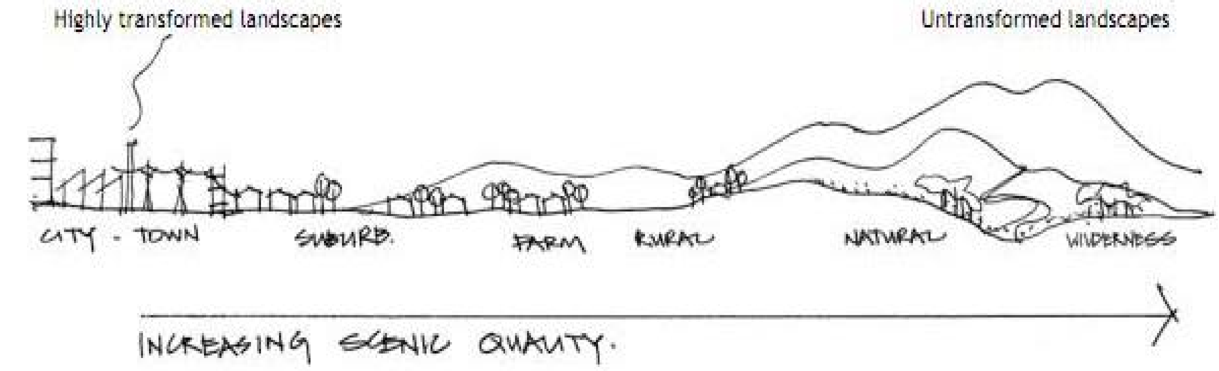
The visual quality of the study area is largely ascribable to the diverse patterns of grassland and salt marsh interspersed with irregularly shaped fields and wetlands. Views over the ocean contribute to a sense of ‘openness’ and underpin the visual quality of the area. The open topography, varied vegetation and traditional forms of crop farming that have been integrated into the landscape are visually appealing, but not necessarily regionally distinctive.

The visual quality at WPP2 is overwhelmingly rural but the presence of waterbodies (Songor Lagoon) and the coastline provides visual interest.

Some elements detract slightly from visual quality in the project area, notably the degraded (and abandoned) farmlands, the salt works and eroded areas. Nevertheless the visual quality of the study area is considered to be *high*.

Table 1: Typical Visual Character Attributes

Highly Transformed Landscape – Urban/Industrial	Transition Landscape	Modified Rural Landscape	Natural Transition Landscape	Untransformed Landscape – Natural
Substantially developed landscape. High levels of visual impact associated with buildings, factories, roads and other related infrastructure (e.g. powerlines).	Transitional landscape associated with the interface between, rural, agricultural area and more developed suburban or urban zones.	Typical character is rural landscape, defined by field patterns, forestry plantations and agricultural areas and associated small-scale roads and buildings.	A changing landscape character associated with the interface between natural areas and modified rural / pastoral or agricultural zones.	No / minimal impact associated with the actions of man. National parks, coastlines, pristine forest areas.



Source: *CNDV, 2006*



http://www.shandinglu.org http://www.nightjartravel.com http://www.boschkloof.com

6.4 SENSE OF PLACE

Our sense of a place depends not only on spatial form and quality, but also on culture, temperament, status, experience and the current purpose of the observer (Lynch, 1992). Central to the idea of 'sense of place' or *Genius Loci* is identity. An area will have a stronger sense of place if it can easily be identified, that is to say if it is unique and distinct from other places. Lynch defines 'sense of place' as "the extent to which a person can recognise or recall a place as being distinct from other places – as having a vivid or unique, or at least a particular, character of its own" (Lynch, 1992:131).

It is often the case that sense of place is linked directly to visual quality and that areas/spaces with high visual quality have a strong sense of place. However, this is not an inviolate relationship and it is plausible that areas of low visual quality may have a strong sense of place or – more commonly – that areas of high visual quality have a weak sense of place. The defining feature of sense of place is uniqueness, generally real or biophysical (e.g. trees in an otherwise treeless expanse), but sometimes perceived (e.g. visible but unspectacular sacred sites and places which evoke defined responses in receptors). Tourism can sometimes serve as an indicator of sense of place insofar as it is often the uniqueness (and accessibility) of a space/place which attracts tourists.

Land uses or activities that occur in an area contribute to the sense of place which is fairly similar to the wider region. In this sense, there is an element of sameness and predictability about the visual quality of the area. However, the Songor Lagoon and other open waterbodies are distinct natural features in the landscape. The area's sense of place is also highly influenced by the coast.

7. ANALYSIS OF THE MAGNITUDE OF THE VISUAL IMPACT

The following section outlines the analysis that was undertaken to determine the magnitude or intensity of the overall visual impact resulting from the project. Various factors were considered in the assessment, including:

- Visual exposure;
- Visual absorption capacity;
- Potential visual receptors;
- Visibility and viewing distance; and
- Integrity with existing landscape.

The analysis of the magnitude or intensity of the visual impact, as described in this section, is summarized and integrated in Table 7 and forms the basis for the assessment and rating of the impact as documented in Section 8.

7.1 VISUAL EXPOSURE

Visual exposure is determined by the zone of visual influence. Visual exposure analysis assumes maximum visibility of the project in an environment stripped bare of vegetation and structures. It is therefore important to remember that the project is not necessarily visible from all points within the zone of visual influence as views may be obstructed by elements such as trees, dense scrub, built structures and/or localised variations or irregularities in topography.

Overall, the visual exposure of the WEF (for the preferred layout and alternative layout) will be *high* as the wind turbines will be exposed across an extensive area. The turbines, with a vertical height of 80 m (from ground level to turbine nacelle), will be clearly visible in a relatively flat landscape rising gently to the north-north-west (represented in Figure 6 and Figure 7). A ridgeline will limit the zone of visual influence to approximately 15 km to the north.

The viewing distance and likely visibility of the turbines are discussed in Section 7.4.

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Figure 6: Visual Exposure (Preferred Layout)

Figure 7: Visual Exposure (Alternative Layout)

7.2 VISUAL ABSORPTION CAPACITY

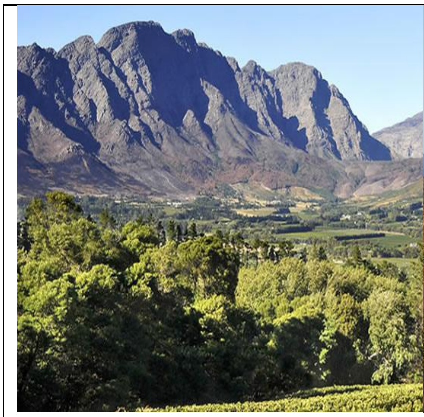
The VAC is the potential for the area to conceal the proposed project. Criteria used to determine the VAC of the affected area are defined in Table 2. The VAC of the area is increased by:

- Local topographical variations in a flat and open landscape which provide limited screening;
- Vegetation (and crops) of the study area is generally low, but isolated stands of shrubs and trees provide limited screening. The large stands of mangroves provide more effective screening; and
- Existing urban fabric along the coastline.

Overall, the area is rated as having a low VAC due to the relatively flat landscape (including vegetation) providing ineffective screening of the wind turbines.

Table 2: Visual Absorption Capacity Criteria

High	Moderate	Low
The area is able to absorb the visual impact as it has: • Undulating topography and relief • Good screening vegetation (high and dense) • Is highly urbanised in character (existing development is of a scale and density to absorb the visual impact).	The area is moderately able to absorb the visual impact, as it has: • Moderately undulating topography and relief • Some or partial screening vegetation • A relatively urbanised character (existing development is of a scale and density to absorb the visual impact to some extent.	The area is not able to absorb the visual impact as it has: • Flat topography • Low growing or sparse vegetation • Is not urbanised (existing development is not of a scale and density to absorb the visual impact to some extent.)



http://www.franschhoek.co.za

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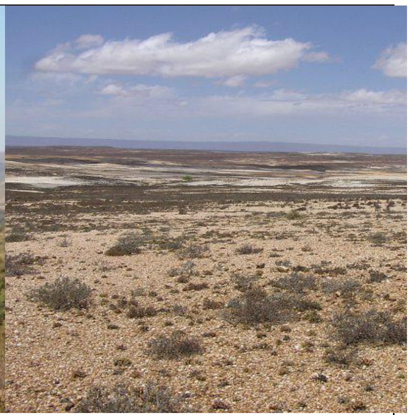

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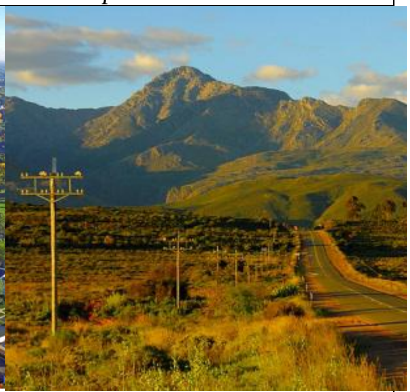


http://fortheinterim.com

7.3 VISUAL RECEPTORS

Receptors are important insofar as they inform visual sensitivity. The sensitivity of viewers is determined by the number of viewers and by how likely they are to be impacted upon. Potential viewers include the following:

- **Residents:** Residents within the study area are concentrated along the coastline. Visibility from individual households within the larger villages is likely to be lower, since the peri-urban fabric of structures obstructs views beyond the very immediate foreground.

  Village residents spend a large proportion of their day outdoors, often at or beyond the village edge (where there are no screening structures), which increases their sensitivity as visual receptors. Viewers from the abovementioned villages are considered highly sensitive receptors.

- **Visitors/tourists:** Visitors to the Songor Lagoon protected area are particularly sensitive receptors. These receptors will have clear views of the WEF across the open water body and flat landscape.

- **Road users:** The Sege Road from the N1 is the main access road to the study area. There is another access road along the coast from Tema. It is assumed that many of the users of these roads include pedestrians, cyclists and motorcyclists travelling between the villages in the area. A number of less significant unsurfaced roads also fall within the viewshed. It is also assumed that the number of motorists travelling along these roads is low; motorists are transient (and moving at speed) and so are exposed to visual impacts for a relatively short period. In summary, road-users, are considered moderately sensitive receptors.

- **Farmers, saltworks employees and fishermen:** Farmers in the project area work in cultivated open fields where the screening effects of vegetation are curtailed and visibility is raised. Employees at the salt extraction pans at Songor Lagoon will have clear views of the turbines. Although fishermen will have clear views of many of the turbines, views from the open ocean towards the coast are generally less meaningful (except in/from very busy water ways). Note again that farmers, saltwork employees and fishermen mostly are residents in the villages described above.

The sensitivity of viewers or visual receptors potentially affected by the visual impact of the project is considered to be *moderate*.

7.4 VIEWING DISTANCE AND VISIBILITY

The distance of a viewer from an object is an important determinant of the magnitude of the visual impact. This is because the visual impact of an object diminishes/attenuates as the distance between the viewer and the object increases. Thus the visual impact at 1 000 m would, nominally, be 25% of the impact as viewed from 500 m. At 2 000 m it would be 10% of the impact at 500 m (Hull and Bishop, 1988 in Young, 2000).

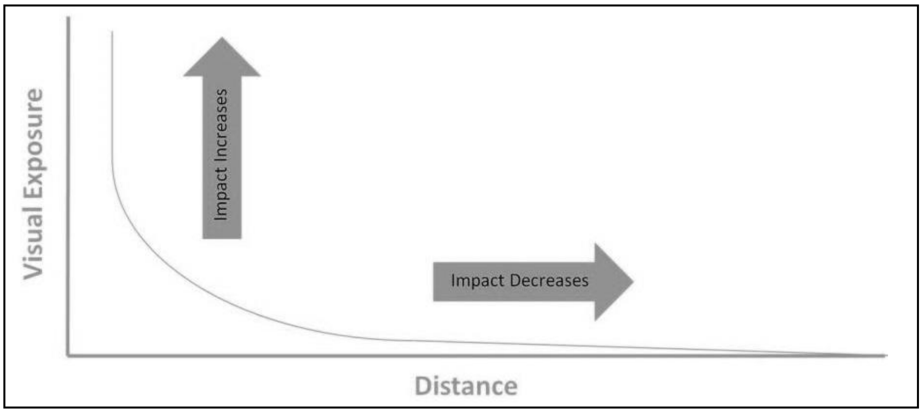


Figure 8: Visual Exposure vs Distance (Adapted from Hull and Bishop, 1998)

Three basic distance categories can be defined for a project of this scale (as discussed in Table 3):

- Foreground;
- Middleground; and
- Background.

A range of viewpoints were selected in order to identify potential receptors and to provide an indication of the likely visibility of the project. The viewpoints were not randomly selected, but were chosen because they are likely to best represent the visibility of the project to receptors.

Table 3: Distance Categories

FOREGROUND (0 – 5 km)	The zone where the turbines will dominate the frame of view. The WEF will be *highly visible* unless obscured.
MIDDLEGROUND (5 – 15 km)	The zone where colour and line are still readily discernible. The turbines will be *moderately visible* but will still be easily recognisable.
BACKGROUND (> 15 km)	This zone stretches from 15 km to the point from where the turbines can no longer be seen. Objects in this zone can be classified as *marginally visible*.

The selected viewpoints are shown in Figure 9 to Figure 10, and views from these viewpoints are shown in the accompanying photographs included as Appendix A. The criteria used to determine the visibility of the project are set out in Table 4 and the visibility of from each viewpoint is summarised in Table 5.

The visibility of the project can be summarised as follows:

- The turbines (for both alternatives) at Lekpoguno (Figure 9) will be highly visible to the residents of Lekpoguno and Akplabnya, users of the Tema coastal road, farmers and saltworks employees. These receptors are all within 1 km of the WEF and the turbines, especially those turbines within 400 m of households (refer to Preferred Alternative layout), may be visually overpowering to these receptors; and

- The turbines (for both alternatives) between Akplabnya and Goi (Figure 10) will be highly visible to the residents of Akplabnya and Goi, users of the road between these villages, farmers and saltworks employees. These receptors are all within 1 km of the WEF and the turbines, especially those turbines within 400 m of households (refer to both alternative layouts), may be visually overpowering to these receptors.

Overall, the visibility of the project components is *high*, due to the high visibility of the turbines in a flat landscape, the low VAC, and the close proximity of receptors to the turbines.

Table 4: Visibility Criteria

NOT VISIBLE	**Project cannot be seen**	
MARGINALLY VISIBLE	Project is only just visible / partially visible (usually in background zone)	
VISIBLE	Project is visible although parts may be partially obscured (usually in middleground zone)	
HIGHLY VISIBLE	Project is clearly visible (usually in foreground or middleground zone)	

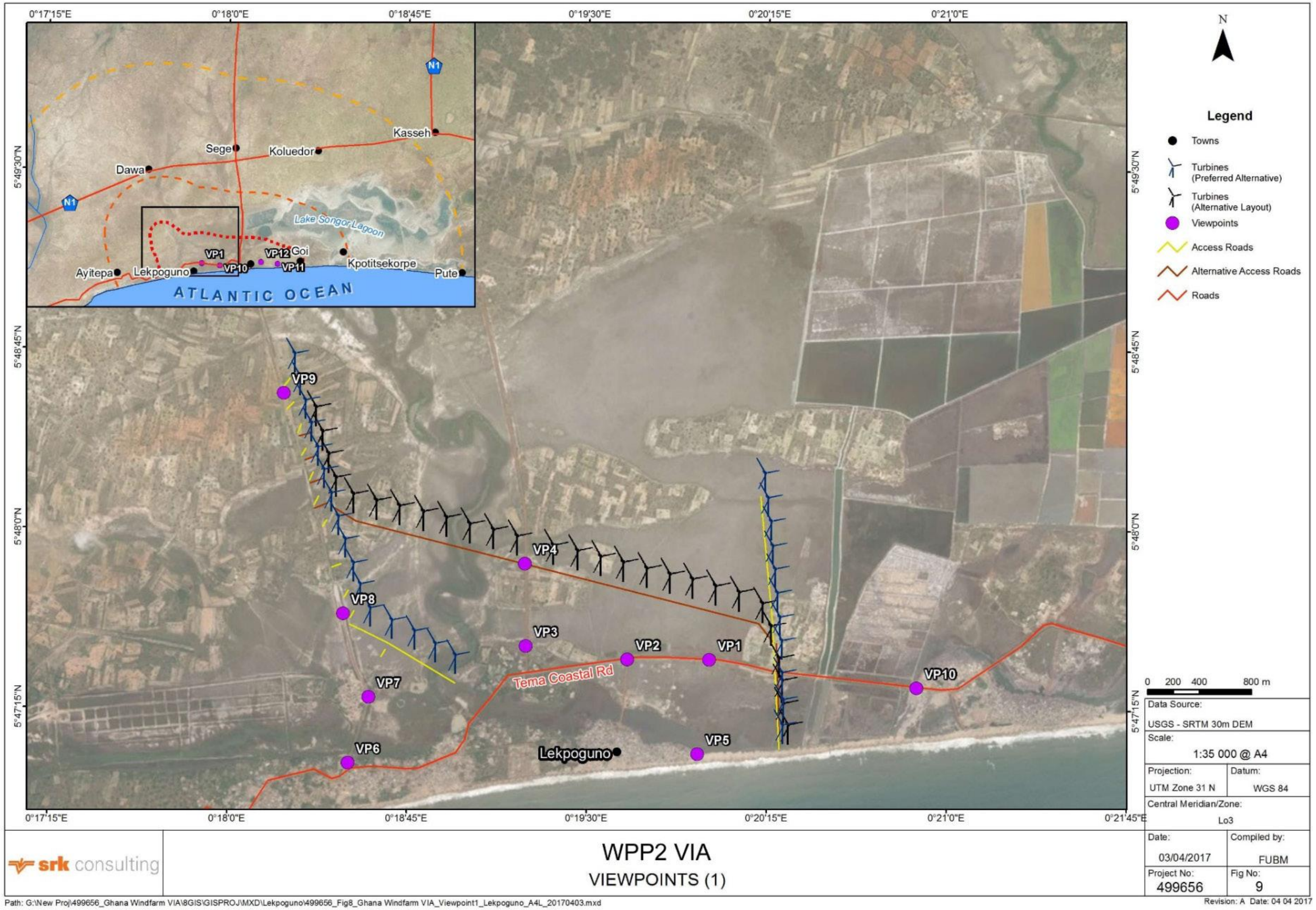


Figure 9: Viewpoints (1)

Figure 10: Viewpoints (2)

Table 5: Visibility from Viewpoints

Viewpoint #	Location	Co-ordinates	Direction of view from the viewpoint	Distance from the viewpoint to the nearest turbine	Time Photograph Taken	Potential Significant Receptors and Visibility
1a	Road between Lekpoguno and Akplabnya	5°47'27.45"N; 0°20'0.93"E	East	410 m	13h30	• Users of coastal road between Lekpoguno and Akplabnya – *Highly Visible*
1b			North			
2	Road to Lekpoguno	5°47'27.41"N; 0°19'40.44"E	South	550 m	13h50	• Road users and residents of Lekpoguno - *Highly Visible*
3	Road to Dawa	5°47'30.69"N; 0°19'15.01"E	North-west	630 m	13h55	• Road users and farmers - *Highly Visible*
4a	Road to Dawa	5°47'51.33"N; 0°19'14.71"E	West	120 m	14h00	• Road users and farmers - *Highly Visible*
4b			East			
5	Lekpoguno (east)	5°47'3.79"N; 0°19'58.05"E	North-east	620 m	14h20	• Residents of Lekpoguno - *Highly Visible*
5b			North-west			
6	Lekpoguno (west)	5°47'1.28"N; 0°18'30.60"E	North	970 m	15h00	• Residents of Lekpoguno - *Visible*
7	Road from Lekpoguno (west)	5°47'17.80"N; 0°18'35.73"E	East	480 m	15h06	• Road users and residents of Lekpoguno – *Highly Visible*
8	Road from Lekpoguno	5°47'38.67"N; 0°18'29.22"E	North-east	130 m	15h10	• Road users and farmers – *Highly Visible*
9	Road from Lekpoguno	5°48'33.79"N; 0°18'14.21"E	South	90 m	15h16	• Road users and farmers – *Highly Visible*

Viewpoint #	**Location**	**Co-ordinates**	**Direction of view from the viewpoint**	**Distance from the viewpoint to the nearest turbine**	**Time Photograph Taken**	**Potential Significant Receptors and Visibility**
10	Saltworks west of Akplabnya	5°47'20.54"N; 0°20'52.80"E	West	1000 m	15h40	• Residents of Akplabnya and saltworks employees – *Highly Visible*
11	Road between Aklabnya and Goi	5°47'25.72"N; 0°23'37.77"E	North-west	180 m	16h00	• Road users, residents of Akplabnya and Goi and farmers – *Highly Visible*
12	Road between Aklabnya and Goi	5°47'31.20"N; 0°22'50.53"E	North-west	600 m	16h30	• Road users, residents of Aklabnya and Goi and farmers – *Highly Visible*

7.5 LANDSCAPE INTEGRITY

Landscape (or townscape) integrity refers to the compatibility of the development/visual intrusion with the existing landscape. The landscape integrity of the project is rated based on the relevant criteria listed in Table 6.

Table 6: Landscape Integrity Criteria

HIGH	MODERATE	LOW
The project: • Is consistent with the existing land use of the area; • Is highly sensitive to the natural environment; • Is consistent with the urban texture and layout; • The buildings and structures are congruent / sensitive to the existing architecture / buildings; and • The scale and size of the development is similar to nearby existing development.	The project: • Is moderately consistent with the existing land use of the area; • Is moderately sensitive to the natural environment; • Is moderately consistent with the urban texture and layout; • The buildings and structures are moderately congruent / sensitive to the existing architecture / buildings; and • The scale and size of the development is moderately similar to nearby existing development.	The project: • Is not consistent with the existing land use of the area; • Is not sensitive to the natural environment; • Is very different to the urban texture and layout; • The buildings and structures are not congruent / sensitive to the existing architecture / buildings; and • The scale and size of the development is different to nearby existing development.

Overall, WPP2 is generally considered to be moderately consistent with the surrounding landscape 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 character of the study area. The project is therefore considered to have *low to moderate* landscape integrity.

A number of key viewpoints have been selected and simulated images of the turbines have been superimposed on the photographs taken from these viewpoints (Appendix B). The superimposed images show the dominance of the wind turbines in the landscape providing an indication of the visual intrusion of WPP2 on the surrounding area.

7.6 MAGNITUDE OF THE OVERALL VISUAL IMPACT

Based on the above criteria, the magnitude or intensity of the overall visual impact that is expected to result from the project has been rated. Table 7 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: 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 to Moderate	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.

8. IMPACT ASSESSMENT AND MITIGATION MEASURES

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 section describes the potential visual impacts during the construction, operations and decommissioning phases and assesses them utilising the impact rating methodology provided by the CSIR. Refer to the impact summary tables for the high level assessment of potential impacts (Table 8, Table 9 and Table 10).

8.1 CONSTRUCTION PHASE

8.1.1 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** (Table 8).

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 30 km/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.

8.1.2 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** (Table 8).

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.

8.2 OPERATIONS PHASE

8.2.1 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.

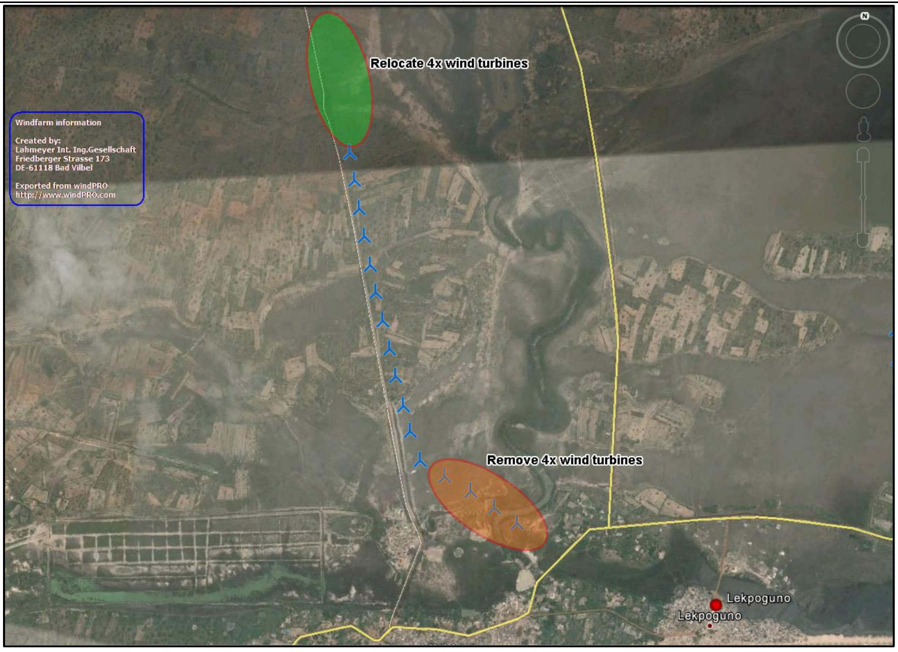
The impact for **both alternatives** is assessed to be of **high** significance with and without the implementation of mitigation (Table 9).

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 11).

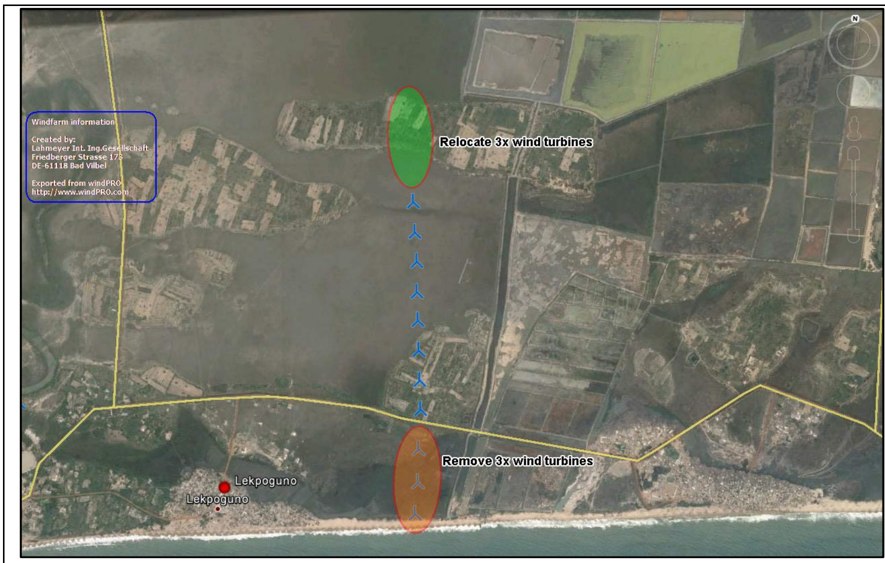
Figure 11: Markings on the tower (or nacelle / blades) increase the visual intrusion of the turbine

For the Preferred Layout, a non-essential however and as best practice layout change suggested would be for Volta River Authority (VRA) to consider relocating a number of proposed turbines According to Figures 12 to 14.



srk consulting	VIA SCOPING PHASE INPUT Lekpoguno-Aklabnya WEF	Project No. 499656

Figure 12: Suggested layout amendments of Lekpoguno-Aklabnya WEF (1)



srk consulting	VIA SCOPING PHASE INPUT Lekpoguno-Aklabnya WEF	Project No. 499656

Figure 13: Suggested layout amendments of Lekpoguno-Aklabnya WEF (2)

srk consulting	VIA SCOPING PHASE INPUT Lekpoguno-Aklabnya WEF	Project No. 499656

Figure 14: Suggested layout amendments of Lekpoguno-Aklabnya WEF (3)

8.2.2 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** (Table 9).

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.

8.2.3 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** (Table 9).

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).

8.3 DECOMMISSIONING PHASE

8.3.1 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** (Table 10).

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.

8.3.2 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** (Table 10).

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.

8.3.3 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 15). 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.

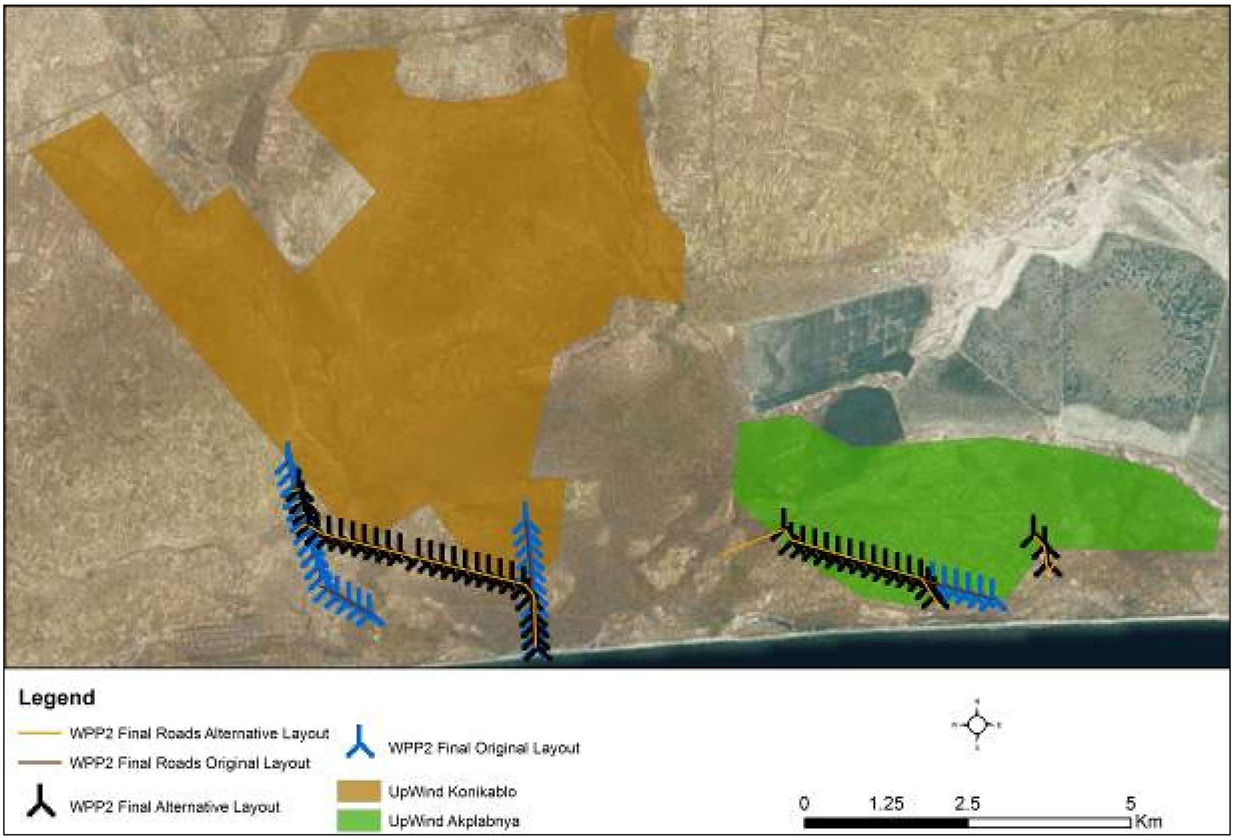


Figure 15: WPP2 in relation to the extent of the proposed Upwind WEF

Table 8: 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?**	**Essential Mitigation Measures**	**Significance of Impact and Risk**		**Confidence Level**
													Without Mitigation/ Management	***With Mitigation/ Management (Residual Impact/ Risk)***	
Earthworks and vegetation clearance Construction activities and presence of heavy construction vehicles and equipment Dust generation	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	• Limit and phase vegetation clearance and the footprint of construction activitie to what is absolutely essential; • Utilise existing access roads as far as possible; • Avoid excavation, handling and transport of materials which may generate dus 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 containe 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.	Medium	Low	High
Construction traffic	Altered sense of place from increased traffic	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	• 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.	Medium	Low	High

Table 9: 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?**	**Potential Mitigation Measures**	**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	• 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, nacelle and blades and avoid any markings on the turbine.	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	• Clarify the requirements of the Ghana Civil Aviation Authority and clarify if pilo 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.	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	• 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).	High	Low	High

Table 10: 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?**	**Essential Mitigation Measures**	**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 Dust generation	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	• 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 Construction Phase.	Medium	Low	High
Traffic	Altered sense of place from increased traffic	Preferred Layout and Alternative Layout	Negative	Local	Temporary	Medium-Low	Definite	High	Moderate	No	Yes	• 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.	Medium	Low	High

9. CONCLUSION AND RECOMMENDATIONS

The following findings are pertinent:

- The basis for the **visual character** of the overall area is provided by the topography, vegetation and land use of the area, giving rise to a generally flat landscape with a mosaic of waterbodies, mud flats and salt marshes with low-intensity cultivated fields and villages on higher ground, with significant influence from the sea.

- The WPP2 area can be described as a modified rural landscape associated with the interface between the coastline, the villages and the extensive cultivated fields and rustic salt extraction pans further inland.

- The **visual quality** of the overall area is largely ascribable to the diverse patterns of grassland interspersed with irregularly shaped fields and wetlands. Views over the ocean contribute to a sense of ‘openness’ and underpin the visual quality of the area. The open topography, varied vegetation and traditional forms of crop farming that have been integrated into the landscape are visually appealing, but not necessarily regionally distinctive.

- The visual quality at WPP2 is overwhelmingly rural but the presence of waterbodies (Songor Lagoon) and the coastline provides visual interest.

- Some elements detract slightly from visual quality in the project area, notably the degraded (and abandoned) farmlands, the salt works and eroded areas. Nevertheless the visual quality of the study area is considered to be high.

- Land uses or activities that occur in an area contribute to the **sense of place**, which is expected to be fairly similar to the wider region. In this sense there is an element of sameness and predictability about the visual quality of the area. However, the Songor Lagoon and other open waterbodies are distinct natural features in the landscape. The area’s sense of place is also highly influenced by the coast.

- The **visual exposure** of the WEF will be high as the wind turbines will be exposed across an extensive area.

- The area is rated as having a low VAC due to the relatively flat landscape providing ineffective screening of the wind turbines.

- Potential **visual receptors** of the project include residents of surrounding villages, visitors to Songor lagoon, road users, farmers, saltworks employees and fishermen. The sensitivity of viewers or visual receptors potentially affected by the visual impact of the project is considered to be moderate.

- The **visibility** of the project components is high, due to the high visibility of the turbines in a flat landscape and the close proximity of receptors to the turbines.

- The project is considered to have low **landscape integrity** as the turbines will be of a scale very different to the current nature of the study area.

- Visual impacts will be generated by **construction activities**. 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 nature of the surrounding area.

- The increased number of **construction vehicles** on the road and the related noise impacts will reduce the sense of place to neighbouring receptors. The loss of 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.

- 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 **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).

- 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.

- **Shadow flicker** is the flicker of the sun through the turbine blades and is considered significant within 1 km of a turbine, unless localised elements screen flicker.

- Visual impacts will be generated by **decommissioning activities**. 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 nature of the surrounding area.

- The increased number of **heavy vehicles** on the road and the related noise impacts will reduce the sense of place to neighbouring receptors. The loss of 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.

- Due to the close proximity of the WPP2 and the UpWind WEF, these developments 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.

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11. APPENDICES

Appendix A – Viewpoint Photographs

Appendix B – Photograph Simulations

APPENDIX A: Viewpoint Photographs

Viewpoint 1a

Viewpoint 1b

Viewpoint 2

Viewpoint 3

Viewpoint 4a

Viewpoint 4b

Viewpoint 5a

Viewpoint 5b

Viewpoint 6

Viewpoint 7

Viewpoint 8

Viewpoint 9

Viewpoint 10

Viewpoint 11

Viewpoint 12

APPENDIX B: Photograph Simulations

Viewpoint 1 (Alternative Layout)

Viewpoint 5 (Preferred Alternative)

Viewpoint 5 (Alternative Layout)

Viewpoint 5 (Preferred Alternative)

Viewpoint 5 (Alternative Layout)

Viewpoint 8 (Preferred Alternative)

Viewpoint 8 (Alternative Layout)

Viewpoint 11 (Preferred Alternative)

Viewpoint 12 (Preferred Alternative)

SPECIALIST EXPERTISE

SCOTT MASSON

Profession	Senior Environmental Consultant and VIA Specialist
Education	MLA, L. Arch, Cape Town, 2008
	BSc (Hons), Environmental Management, Cape Town, 2004
	BSc, Environmental Management, Cape Town, 2003
Registrations / Affiliations	Certified Environmental Assessment Practitioner of South Africa
	Professionally Registered Landscape Architect

Specialisation	Visual impact assessments (VIA), environmental impact assessment, environmental planning and site sensitivity studies; and landscape architectural design and planning

Expertise

Scott has been involved in the field of environmental and landscape architecture for the past 9 years. His expertise includes:

- environmental impact assessments and environmental management plans;
- visual impact assessments;
- integrated waste and water management plans;
- environmental audits and due diligence;
- environmental control officer work;
- environmental planning and sensitivity studies; and
- landscape architectural planning and design.

Employment	
2011 – present	SRK Consulting (Pty) Ltd, Environmental Consultant, Cape Town
2009 – 2011	Megan Anderson Landscape Architects, Candidate Landscape Architect

Publications	I have been interviewed and quoted in numerous environmental and sustainability articles published in the press and sector specific journals including *Civil Engineering Contractor*. *Position IT, Cape Business News* and *To Build*.

Visual Impact Assessment (VIA)

- CSIR, VIA for two wind energy facilities in the Greater Accra District, Ghana, 2016 - ongoing
- Mineral Sands Resources (Pty) Ltd, VIA for the extension of Tormin Mine, Western Cape, 2016 – ongoing
- Tronox Mineral Sands (Pty) Ltd, VIA for the Slimes Dam 6 at Tronox Namakwa Sands Mine, Western Cape, 2016
- Department of Forestry, Fisheries and Agriculture, VIA for a proposed Aquaculture Development Zone in Saldanha Bay, Western Cape, 2016
- Matzikama Municipality, VIA for the proposed construction of four abalone farms in Doringbaai, Western Cape, 2015 - 2016
- Eskom, VIA for the proposed Merino substation and Bon-Chretien-Merino powerline in Ceres, Western Cape, 2016
- Transnet Capital Projects, VIA for the construction of additional substations, transmission infrastructures and area lighting masts near the Port of Saldanha, Western Cape, 2015-2016
- EFG Engineers, VIA for a the proposed bypass road in Hermanus, Western Cape, 2015-2016
- Liesbeek Leisure Club (Pty) Ltd, VIA for a the proposed redevelopment of the River Club, Western Cape, 2015-2016
- Eskom, VIA for the proposed TISF at Koeberg, Western Cape, 2015-2016
- Tronox Mineral Sands (Pty) Ltd, VIA for a the proposed expansion of the Namakwa Sands Mine, Brand-se-Baai, Western Cape, 2012-2013
- Vale, VIA for a proposed phosphate mine in Mozambique, 2011-2012
- Courtrai Developments, VIA for a proposed retirement village in Paarl, 2011
- CSIR Environmental, VIA for an EIA proposal for four wind energy facilities, Swellendam, Mossel Bay, Heidelberg and Albertinia, Western Cape, 2010
- CSIR Environmental, VIA for a proposed eco-residential estate and nature reserve, Jacobsbaai, Western Cape, 2010
- Vodacom, VIA for a proposed cell phone mast at Hermanus golf course, on Graymead farm near Villiersdorp and on a farm in Klipdale, 2009.

SPECIALIST DECLARATION

I, **Scott Masson**, as the appointed independent specialist, hereby declare that:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of any Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Acts, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that the comments of all interested and affected parties on the specialist input/study will be considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence.

Signature of the Specialist:

Name of Specialist: Scott Masson

Date: 26 September 2017

Environmental & Social Impact Assessment

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

APPENDIX 9:

Public Participation Process

TABLE OF CONTENTS

List of participants at the public forum for WPP2 October 2016	Appendix 9.1

SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: WIND POWER PROJECT
Project Proponent: VOLTA RIVER AUTHORITY
Types of Stakeholder: STATE AGENCIES

Date: 13-04-2016
Time: 15:00
Venue: ADA WEST ASSEMBLY HALL

Name	Agency	Position	Contact Number	Email
Amos Dotse Kwao	Aleplabanya	Assemblyman	0243283878	
Ben A. Tackey	VRA	Mgr. Env	0243344777	ben.tackey@vra.com
Dickson Agyeman	Wildlife Songor Ramsar Site	Park Manager	0244843406	yaw65 2006 @ yahoo.com
Alimakese Rockson Joseph	Lolonya	Assemblyman	0246772401	
John Akwafo Tsiri	Goi	Assemblyman	0242046358	Johntsiri@gmail.com
Jonathan D. Okutu	Goi	Opinion leader	0243244508	
Felix K. Worlanyo	PPD	S.T.O.	0245540280	[illegible]@yahoo.com
Godwin Dzivor	~~AWDA~~	SEO	0205853082	godwindzivor@gmail.com
Abigail Teye	A.W.D.A	S.S.D.O	0247166207	teyea@yahoo.com
Ben Apreku	AWDA	B1	0243846909	ben [illegible].com
Senyo Agbemasu	AWDA	ADHB	0244411868	ramagbe@yahoo.com
Lydia Cape	CSIR	Project leader	0027218882429	lcape@csir.co.za

SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: WIND POWER PROJECT
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Date: 13-04-2016
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Amos Dotse Kwao	Aleplabanya	Assemblyman	0243283878	
Ben A. Tackey	VRA	Mgr. Env	0243344777	ben.tackey@vra.com
Dickson Agyeman	Wildlife Songor Ramsar Site	Park Manager	0244843406	yaw65 2006 @ yahoo.com
Alimakese Rockson Joseph	Lolonya	Assemblyman	0246772401	
John Akwafo Tsiri	Goi	Assemblyman	0242046358	Johntsiri@gmail.com
Jonathan D. Okutu	Goi	Opinion leader	0243244508	
Felix K. Worlanyo	PPD	S.T.O.	0245540280	[illegible]@yahoo.com
Godwin Dzivor	~~AWDA~~	SEO	0205853082	godwindzivor@gmail.com
Abigail Teye	A.W.D.A	S.S.D.O	0247166207	teyea@yahoo.com
Ben Apreku	AWDA	B1	0243846909	ben [illegible].com
Senyo Agbemasu	AWDA	ADHB	0244411868	ramagbe@yahoo.com
Lydia Cape	CSIR	Project leader	0027218882429	lcape@csir.co.za

Name	Agency	Position	Contact Number	Email
ABULELE ADAMS	CSIR	PROJECT MANAGER	+27722398220	aadams1@csir.co.za
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Kofi Gatu	SELJEN Con	Tech. Director	0208474557	kofi.gatu@gmail.com
Daniel Borkeley	AWDA	E.O	0240897980	[illegible]@gmail.com
Frank Cudjoe	SELJEN Consult	Comp Action Plan	0242807385	Cudjoefrank28@yahoo.com
REUBEN ADASE	AGRIC	DISTRICT DIRECTOR	0242116573	reudase@yahoo.com
YVONNE ARHIN	AWDA	Procurement	0242934631	yvonne.arhin@yahoo.com
Bernice Okornoe	AWDA	✓	0272188665	bbokornoe@yahoo.com
STEPHEN CHARWETEY	WOKUMAGBE	ASSEMBLY MEMBER	0502716326	K3ent2000@yahoo.com
SUMAILA TETTEH-KPAKPAH	"	OPINION LEADER	0242731752	
ASIEDU ASARE	AWDA	Tech. ENGINEER	0242963975	eugeneasiedu12@yahoo.com
Bosompem Cleopatra	AWDA	Works dept	0249391316	cleopatrab566@gmail.com
Dornu Reuben	AWDA	WORKS DEPT.	0242604798	dornureuben@yahoo.com

Stakeholder database:

Stakeholder	Name	Position
Sege Constituency	Hon. Christian Corletey Otuteye	Member of Parliament, Sege
Badzorhe/Luta	Ameyaw David Narh	Assemblyman / Presiding Member
Sege Constituency	Modjifa-Tanohu J.J.F	Government Appointee
Sege Constituency	Nene Saki Keteni V	Government Appointee
Sege Constituency	Doe Caesar	Government Appointee
Sege Constituency	Maxwell Ofosu	Government Appointee
Addokope	Ben Adi Senor	Assemblyman
Bonikope	Osei Francis Lawer	Assemblyman
	Jonas Adabah	Assemblyman
Nakamkope	Moses Ayer Oklu	Assemblyman
Sege-Koni	Namor Moses Lomotey	Assemblyman
Toflokpo	James Gaduge	Assemblyman
	Gloria A. Alimo	Assemblywoman
Anyamam	Nene Narhternor II	Fish Farmer
	Samuel Okutu	Assemblyman

Stakeholder	Name	Position
Matsekope	Marmah Mortey	Assemblyman
Lolonya	Ahuakese Joseph Rockson	Assemblyman
	Nene Ogbey	Fish Farmer
Koluedor	Akoto Prince Ofoe	Assemblyman
Ada Afiaddenyigba	James Narh Lawerteh	Assemblyman
Akplabanya	Amos Dotse Kwao	Assemblyman
	Nene Alimo	Fish Farmer
	John Tekunor	Chief Fisherman
Wokumagbe	John Alipuiteye Sowa Narh	Linguist
	Nene Adjirkey Siaw VII	Chief
	Stephen Charwetey	Assemblyman
	John Sowu	Chief"s rep
	Moses Ajernor Sowu	
	Akwetey Johnson	
	Emmanuel Sowu	
	Jonathan Okutu	Opinion Leader
	John Alapui Sowu	Chief
	Kofi Samuel Akwetey	Regent
	Sumaila Tetteh Kpakpah	Opinion Leader
Omankope	Daniel Akwetey Blemano	Opinion Leader
Goi	Amos Teye Sebi	Elder
	Amartey Sebi	Clan Elder
	Simon Peter Anim	Opinion Leader
	E T Agorhom	Stool father
	Sosu Sebi	Chief's Rep
	John Akwafo Tsiri	Assemblyman
	FM Ahuakeseey Otipeseku	
	Joseph Agamah	Chief Fisherman
	Henry Mijordin Otipeseku	Chief rep
	Tetteh Goni Otipeseku	Chief's Rep

Stakeholder	Name	Position
	Isaiah Sebi	Chief's Rep
	John Tsiri	Assembly member
	Raymond Sebi	Clan Elder
	Johnathan D. Okutu	Opinion Leader
Ada West District Assembly	Foster D. K. Ayivor	District Finance Officer
	Ephraim Anku	District Internal Auditor
	Frank K. Nikoi	District Planning Officer
	Moses Klu	Asst. Internal Auditor
	Alhassan Ziblim A.	District Cordinating Director
	Exangbe A.K Divine	Dept. of Social Welfare & Community Dept.
	Annan Emmanuel	Environmental Officer
	Sroda Awo Latsu	Asst. Human Resource Manager
	Felix Gotah	Asst. Budget Analysis
	Ayiwah David Ahunah	Works Department
	Francis Cofie	Information Services Department
	Sampson Agbeve	District Planning Officer
	Bernice Okornoe	Procurement Officer
	Yvonne Arhin	Procurement
	Alfred Lartey	Assistant District Engineer
	Asiedu Asare	Technician Engineer
	Reuben Adase	Director, Dept. of Agriculture
	Gilbert Akaba	Ag. District Coordinating Director
	Abigail Teye	Social Development Officer
	Godwin Dzivor	Senior Executive Officer
	Ben Apreku	Works Department
	Senyo Abgemasu	Assistant Director IIB
	Asiedu Asare	Works Department
	Bosompem Cloeopatra	Works Department
	Orna Reuben	Works Department

Stakeholder	Name	Position
	Felix K. Worlanyo	PPD
	Daniel Barketey	Environmental Officer
District Health Directorate	Bessah Eric	Health Information Officer
National Disaster & Management Organisation	Philemon Lomotey	NADMO
	Ayertey Wilson	Dept. Coordinator
District Education Office	Jonathan Bosompem	Asst. Director Finance And Planning
Ghana Wildlife Division	Dickson Agyeman	Park Manager, Songor Wildlife Site
Ghana Police Service	Benjamin A. Buxton	District Commander
Dept. of Agriculture	Reuben Adase	District Director Agriculture
Songhor Salt Association	Noah Adjorkey	
	Kpenitse Akplakpa	
	Felicia Soti	
	Mabel Adzanyo	
	Amartey Ayertey Azizakponye	
	Margarette Apayo	
	Margarette Petti Afful	
	Salomey Korley	
	Hawa Kanter	
	Victoria Kpodo	
	GraceAdjoge	
	Beatrice Akpoyoo	
	Korlekey Adam Balm	
	Charity Atitiatey	
	Regina Akwer	
	Evelyn Adjonyho	
	Janet Siadah	
	Mary Akuteye	
	Margarette Larweh	
	Joshua Anguler Koloh	

Stakeholder	Name	Position
	Francis Atsutser	
	Amarkie Ayitey Azizakponye	
	Nartey Nartey James	Technical assistant
	Margaret Apafo	
	Doris Mensah	
Kesse Ola Kope	Nene Teye Sowu I	Chief
The Media	Noah Dameh	Journalist
Local Council Of Churches	Rev. Sophia O. Kitcher	Secretary
Ada Wawado	Nene Angble II	
Sege Sankope	Nene Korletey Angbley	
Wassah Kussei	Nametey Christian	Opinion Leader
Big Ada Mawado	Nene Amgble II	Chief

EPA's Response to the Project Registration	Appendix 9.2

Tel: (0302) 664697 / 664698 / 662465
667524 / 0289673960 / 1 / 2
Fax: 233 (0302) 662690
Email: info@epa.gov.gh

Environmental Protection Agency
P. O. Box MB 326
Ministries Post Office
Accra
Website: http://www.epa.gov.gh

CHIEF EXECUTIVE'S OFFICE RECEIVED 0 2 MAR 2016 VOLTA RIVER AUTHORITY

VOLTA RIVER AUTHORITY RECEIVED 0 3 MAR 2016 D.C.E. (E & O)

Our Ref: CE: 5641/01/02

February 26, 2016

The Chief Executive
Volta River Authority
P.O. Box MB 77
Accra-Ghana

Dear Sir,

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
PROPOSED 75MW WIND POWER PROJECT LOCATED AT ANLOGA EXTENSION (ANLOGA, SROGBE AND ANYANUI) IN THE KETA MUNICIPALITY OF THE VOLTA REGION

We acknowledge receipt of the completed Environmental Assessment Registration Form (EA2) submitted to the Agency for the purpose of obtaining environmental approval for the above proposal in accordance with the Environmental Assessment Regulations 1999 (LI 1652).

The proposal falls in the category of undertakings (Regulation 3) for which Environmental Impact Assessment (EIA) is required to help understand the likely implications of the proposal, the relevant alternatives and mitigations to consider in order to ensure, sound decision-making and sustainable development of the projects.

In line with Regulations 11 of LI 1652 however, you are advised to carry out a scoping exercise to generate the relevant terms of reference (TOR) to guide satisfactory EIA study of the proposal.

Please note that scoping is meant to focus the EIA on the key issues, concerns and decision areas and solicit input and guidance of all relevant stakeholders on the TOR. Scoping notices must be served as appropriate to facilitate stakeholder involvement (see attached sample). Ten (10) hard copies of the scoping report must be submitted for study and agreement on the TOR, prior to the EIA studies.

It is important that the Scoping Report and Environmental Impact Statement contains information on the consultants who prepared the reports. This should include the names, address, email, telephone experience and their specific contribution to the study. Failure to provide this information would render the submission incomplete.

Do not hesitate to consult with the EPA Head Office (Room 305) and the EPA Central Regional Office, Cape Coast for any further guidance you may require in this regard.

Yours faithfully,

John Doghle
PO/EAA Division
For: Executive Director

(3) DESD 4/3/16

(2) DCE (E&O)

cc: The Regional Director, EPA, Volta Region, Ho

Copied

(4) Mgr. ES
Fyfa. PLS. 4/3/16

Energy Commission Provisional License, dated 27 July 2015	**Appendix 9.3**

ENERGY COMMISSION

PROVISIONAL

This is to certify that

VOLTA RIVER AUTHORITY (VRA)

Has been granted a:

PROVISIONAL GENERATION AND WHOLESALE SUPPLY LICENCE

To Generate and Supply Electricity from Wind energy at Anloga and Anyanui in the Keta District of the Volta Region

Licence Number: **EC/GWSL/07-15-073**

Licence valid until : **26TH JULY 2016**

Kwame Ampofo (Dr.)
Board Chairman

Michael Opam
Ag. Executive Secretary

Date: **27TH JULY 2015**

NB: THIS PROVISIONAL LICENCE IS A CONDITIONAL LICENCE AND DOES NOT MANDATE THE HOLDER TO CONSTRUCT OR OPERATE ANY WIND ENERGY PLANT. REFER TO ATTACHED SCHEDULE.

Minutes of the meeting between VRA and GNPC	Appendix 9.4

MINUTES OF THE GNPC SWAOCO (SWISS AFRICAN) PROJECT TEAM MEETING WITH THE VOLTA RIVER AUTHORITY (VRA)

DATE : 1st November, 2016
VENUE : 3rd Floor Conference Room, Petroleum House, Tema
TIME : 10:37 GMT – 11:51 GMT
CHAIRMAN : Benjamin Asante, Geophysics and Exploration & Appraisal Manager

AGENDA : Discussion of the Impact of the planned Seismic Activities of the Swiss African Project on the VRA Wind Power Project in the Keta Delta area Southern Ghana

ATTENDANCE

GNPC Representatives

Benjamin Asante	Geophysics and Exploration & Appraisal Manager
Eben Apesegah	Geology Manager & Voltaian Basin Team Lead
Alex Prempeh Kwarteng	Chief Petroleum Engineer & OCTP Project Team lead
James K. Agbenorto	Chief Geologist & Keta Block Team Lead
Jochen Schade	Voltaian Basin Project Seismic Manager
Seth Foli	Senior HSE Officer
Kenneth Kofi Agbekomefa Edor	Senior HSE Officer
Edith Moses	HSE Officer
Uzziel Kumanor Tetteh	Voltaian Basin Project Engineer
Nana Adusei Poku	Senior Geomantic Engineer
Fredrick Kofi Osei-Poku	Geomantic Engineer
Joyce Akosua Odei	Voltaian Basin Secretary

VRA Representatives

Ebenezer Antwi	Principal Engineer (Renewable energy & Integrated Development)
Lloyd Kofi Sutherland	Environmental Officer
Kofi Gyekye-Adarkana	Mechanical Engineer

INTRODUCTION

The Chairman for the meeting introduced himself and welcomed both VRA representatives and GNPC staff to the meeting. All the members at the meeting introduced themselves to kick start after safety briefing from Seth Foli.

EPA DIRECTIVE

EPA upon reviewing the Scoping report submitted by VRA for the development of 75MW Wind Power Project has indicated that the location of the Wind Power Project in the Keta Municipality is within the Keta Basin, where seismic activities for Hydrocarbon Exploration are

1 | Page

to be undertaken by GNPC and its Partners. The meeting will inform both parties (VRA and GNPC) to determine the compatibility of the two projects within the Keta Block.

VRA & GNPC Presentations

GNPC and VRA gave presentations detailing project descriptions, locations, timelines, coordinates of seismic lines and wind farms. Both parties concluded that the two projects were compatible despite difference in timelines.

Presentation Highlights

- The Keta Lagoon Ramsar Site which is an environmentally sensitive area falls within the location proposed for the Keta Delta Exploration as well as the Wind Farms.
- Hydrocarbon exploration targets in the Block are Paleozoic (Devonian) for Onshore areas) and Cretaceous to Devonian for Shallow Water/ Shelf Areas.
- GNPC and partners are aiming to shoot 2D seismic data in March – July 2017.
- GNPC will use explosives as source of energy for the onshore seismic acquisition.
- Access lines will be created for transporting materials and crew. Shot holes of 12m to 15m depths will be drilled for detonation of explosives. Crops destroyed along seismic lines will be compensated for but the destruction will not be permanent as it may be for VRA's transmission lines.
- The decision of GNPC and partners to conduct exploration drilling will depend on the seismic data processing and interpretation. Exploration drilling may have a more permanent footprint on the project area
- Both parties (GNPC/ Partners and VRA) agreed to cooperate as far as necessary to let both projects deliver desirable results in a win-win relationship.
- To make the best decisions concerning both projects, GNPC and VRA resolved to apprise each other and all other stakeholders involved on project plans and updates.
- **Philomina Donkor** and **James Agbenorto** were designated as GNPC's key contact representatives for the Swiss-African Keta Delta Project.
- GNPC asked VRA to inform them of any identified impacts of their activities and security and emergency plans for effective collaboration.
- Well Location Planning for new wells will be in 2018; but old well heads from previous exploration drilling have since remained on location.
- The siting of new hydrocarbon wells and Wind Farm structures is expected to be flexible, considering smooth collaboration and information sharing between GNPC/ Partners and VRA.

▪ VRA's Renewable Energy Development Programme is to be implemented in 2 Phases. The projection of 100-150MW Wind Power is for Phase 1 (2010-2015). Projections for Phase 2 will be determined after the review of the Renewable Energy Development Programme (REDP).
▪ Anloga, Anyanui and Srogbe sites have been chosen for development of Wind Power Project-1 and Wokumagbe and Goi sites for Wind Power Project -2.
▪ Noteworthy details of the Wind Power Project-1 Wind Farm include; the Wind Power Plant Capacity of 75MW, Vestas V110 Wind turbine with a diameter of 110m and a hub height of 95m.

- There will be one (1) collector substation at the Srogbe site. The voltage level selected for the electrical internal network is 33 kV.
- The implementation of the proposed project will result in the establishment of 38 individual wind turbines with an approximate generation capacity of 2 MW.
- The average wind speed measured by VRA is approximately 6m/s and the wind direction is predominantly from the South West. The wind speed and wind direction data will inform VRA during the feasibility study for locating each of the wind turbines.
- As per the Project Status:
  - A one year wind measurements was completed in 2014,
  - The Geotechnical Study is to commence in December 2016,
  - The update of the Feasibility Study is scheduled to be completed in Q1 2017 and Land Acquisition scheduled for Q2 2017.
- Feasibility Study and Land Acquisition processes have been initiated.
- It is anticipated that GNPC/ Partners will have finished shooting seismic data before commencement of the construction of the Wind Farm physical structures.
- Geotechnical Study should take VRA about 2 months and the information on subsurface characteristics and Wind speed will influence Geotechnical decisions to be taken.
- Plans and developments on sea defence any other local government infrastructural project should be considered by VRA in the Wind Farm Project.
- Each steel tower with about 3m width and 95m hub height will have a separate turbine.
- The Feasibility study estimates the long-term energy production of the wind farm by correlating the one year wind measurement with long term meteorological data. GNPC advised that solar radiation, atmospheric pressure change and climate change issues, etc. Must be considered as part of the overall environmental studies.
- GNPC indicated that from both presentations, the projects are not likely to interfere much, since the GNPC seismic activities do not affect their site much but indicated that further enquiries and communication between the GNPC and VRA are required.
- Logistic challenges especially transportation of equipment and materials to the Wind Farm project site have been envisaged by VRA.

Action Points

1. More collaboration and exchange of contacts of key persons from GNPC and VRA to ensure that both projects remain technically compatible.
2. Both parties to go through the permitting process with EPA.
3. VRA to submit a copy of the Technical aspects of the Feasibility study to GNPC
4. VRA to exchange key contacts for the VRA Wind Power Projects with GNPC.

Closing remarks

The Chairman thanked the representatives of VRA and GNPC for a successful meeting and encouraged both organizations to continue the good work and collaborate to make both projects succeed.

Recorded by: Joyce Akosua Odei (Voltaian Basin Secretary)

………………………	………………………
James K. Agbenorto	Ebenezer Antwi
(Chief Geologist & Keta Block Team Lead)	Principal Engineer (Renewable energy & Integrated Development)

VRA Stakeholder Meeting with GNPC on Impact of Oil and Gas exploration on Wind Power Project - 1

November 1, 2016

	Name	Signature	Organisation/Position	Telephone	Email
1.	James Agbenorto	[signature]	GNPC/Chief Geologist		jk.agbenorto@gnpcghana.com
2.	Eben Apesegah	[signature]	GNPC/Geology Manager	0243253515	e.apesegah@gnpcghana.com
3.	Benjamin Kwame Asante	[signature]	GNPC/Geophysics Mgr	0208483663	bk.asante@gnpcghana.com
4.	Alex Prempeh Kwarteng	[signature]	GNPC/Chief Pet Engr	0263010494	AP.KWARTENG@GNPCGHANA.COM
5.	Edith Moses	[signature]	GNPC / HSE	0244794447	e.moses@gnpcghana.com
6.	Fredrick Osei-Poku	[signature]	GNPC/Geomatic Eng.	0246648469	fk.oseipoku@gnpcghana.com
7.	Nana Poku	NHP	GNPC/Geomatic Eng.	0541000500	na.poku@gnpcghana.com
8.	JOCHEN SCHADE	[signature]	GNPS/Seismic Project Mgr		vspseismicpm@gnpcsystems.com
9.	Nii Kotey Amasa	[signature]	GNPC/EHS	0208944221	nk.amasa@gnpcghana.com
10.	Kenneth Edor	[signature]	GNPC EHS	0244403410	kk.edor@gnpcghana.com
11.	FRANCIS OBIRI-YEBOAH	[signature]	GNPC/NSP	0241697133	obiri144@gmail.com

VRA Stakeholder Meeting with GNPC on Impact of Oil and Gas exploration on Wind Power Project - 1

November 1, 2016

	Name	Signature	Organisation/Position	Telephone	Email
12.	Mohama Tali	[signature]	GNPC / NSP	0267842069	ttufantali@gmail.com
13.	Skuggen Jerome	[signature]	GNPC / NSP	0261478207	jeromeskuggen@gmail.com
14.	Abdulai S. Nantogmah	[signature]	GNPC / Geophysicist	0244094240	as.nantogmah@gnpcghana.com
15.	UZZIEL TETTEH	[signature]	GNPC / Project Engr.	0200029951	uzziel.tetteh@gnpcghana.com
16.	Kofi Gyekye-Adarkwa	[signature]	VRA / Mech. Engineer		kofi.gyekye-adarkwa@vra.com
17.	Ebenezer Antwi	[signature]	VRA / Prin. Elect Eng	0202625133	ebenezer.antwi@vra.com
18.	Lloyd Kofi Sutherland	[signature]	VRA / Env. Officer	0241370926	lloyd.sutherland@vra.com
19.	SETH Foli	[signature]	GNPC / HSE	0503883438	s.foli@gnpcghana.com
20.	JOYCE AKOSUA ODEI	[signature]	GNPC / VOLTAIAN	0572065964	joyceacodei@gmail.com
21.					
22.					

Copies of the correspondences between VRA and Ghana Civil Aviation Authority GCAA	Appendix 9.5

Ghana Civil Aviation Authority

Our ref: GCAA/ASAS/813/Vol. 14/1 — 3rd February, 2014

Your ref:

The Chief Executive Officer
Volta River Authority
P. O. Box MB 77
Accra

ENG. SERVICES DEPT. P.O. Box 77, Accra
RECEIVED
11 FEB 2014
VOLTA RIVER AUTHORITY

Attn: Director, Environment & Sustainable Development

Dear Sir,

File

RE: WIND POWER PROJECT – PHASE 1

Reference is made to your letter dated 21st January, 2014 on the above subject matter.

The request has been considered, however, before any such approval may be issued, you are to complete and return the attached Form GCAA/SRD/ASAS – 01 to enable Ghana Civil Aviation Authority (GCAA) safety inspectors conduct the necessary aeronautical assessment of the proposed site (s).

GCAA needs to satisfy itself fully that each site for proposed construction of the wind turbine would have no substantial adverse effect on the safe and efficient use of the navigable airspace by aircraft. You are therefore requested to make copies of the attached form for each request.

Yours faithfully,

DANIEL ACQUAH
DIRECTOR, SAFETY REGULATION
FOR: DIRECTOR - GENERAL

cc: Director-General

Private Mail Bag
Kotoka International Airport
Accra, Ghana

Tel: (233)-(30) 2776171
Fax: (233)-(30) 2773293
E-mail: info@gcaa.com.gh

Sita: ACCXTYF
AFTN: DGAAYFYX
Website: www.gcaa.com.gh

Safety & Security, Our Priority

FORM GCAA /SRD/ASAS - 01

OBSTRUCTION EVALUATION APPLICATION FORM (OE/AAA)

NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION

(Failure To Provide All Requested Information May Delay Processing Of Your Notice)

FOR GCAA USE ONLY
Aeronautical Study No

1. Contact

1. Name (person, company, etc proposing this action)

2. Attn. of: ______

3. Name: ______

4. Address: ______

5. Telephone: ______ 6. Fax: ______

2. Nature of Proposal

A. Type

☐ New Construction ☐ Alteration

B. Class

☐ Permanent

☐ Temporary (____ Months, ____ Days)

3. Complete Description of Structure

Description of proposed Construction or Alteration

☐ Mast ☐ Tower ☐ Crane ☐ Building

For Other Specify……………………………………………………

……………………………………………………………………

……………………………………………………………………

For Telecommunication Mast/Tower please specify frequency & power of transmission: (a). Frequency
(b). Power

4. Location of Structure (s)

NB: For more than one (1) Structure use additional sheet(s) to indicate requirements 4&5

A. Coordinates:

Latitude: ____° ____' ____"

Longitude: ____° ____' ____"

B. Nearest City/Town/Suburb:

C. Description of site. Please attach topographical map (scale ~1:50,000) from Surveys Dept., Ghana indicating location of proposed structure(s) on the map

5. Height and Elevation (to the nearest foot)

A. Height of Structure including all installations Above ground level (AGL) or water	
B. Elevation of ground above mean sea level (amsl)	
C. Overall Height (i.e. A+B)	

Note: Upon receipt of this proposal, the GCAA inspector will assess the application and provide the applicant with a quotation. If inspection of site (s) is deemed necessary, the applicant will provide transportation to and from the site

I hereby certify that all the above statements made by me are true, complete and correct to the best of my knowledge. In addition, I agree to mark and light the structure in accordance with guidelines provided by GCAA

Date	Name and Title of Person Filing Notice	Signature

FORM GCAA /SRD/AGA - 01

[illegible]	separate acknowledgement

710/002/242/14

ENV. & SUST. DEV. DEPT.
RECEIVED
DATE 17/3/14

March 13, 2014

ENV. & SOC. IMPACT SECT.
RECEIVED
DATE 20/3/14

The Director General
Ghana Civil Aviation Authority
Private Mail Bag
Kotoka International Airport
Accra

Dear Sir,

RE: WIND POWER PROJECT – PHASE 1

We refer to your letter dated February 3 2014 and referenced GCAA/ASAS/813/Vol.14/1 on the above subject.

As required, we hereby submit eight completed Form GCAA/SRD/ASAS – 01 for each of the eight wind measurement sites with a cadastral map attached for seven sites. The cadastral map for Lekpogunu is not ready therefore there is no cadastral map attached to the filled form for Lekpogunu for your information.

We will resubmit the filled Form GCAA/SRD/ASAS-01 for the Lekpogunu site with the cadastral maps attached when it is ready.

Please contact us if you require any further information or clarification.

Yours faithfully,

INFORMATION COPY
ORIGINAL SIGNED BY
E. A. ASOMONTSI
Ing. William E. Sam-Appiah
DIRECTOR, ENGINEERING SERVICES

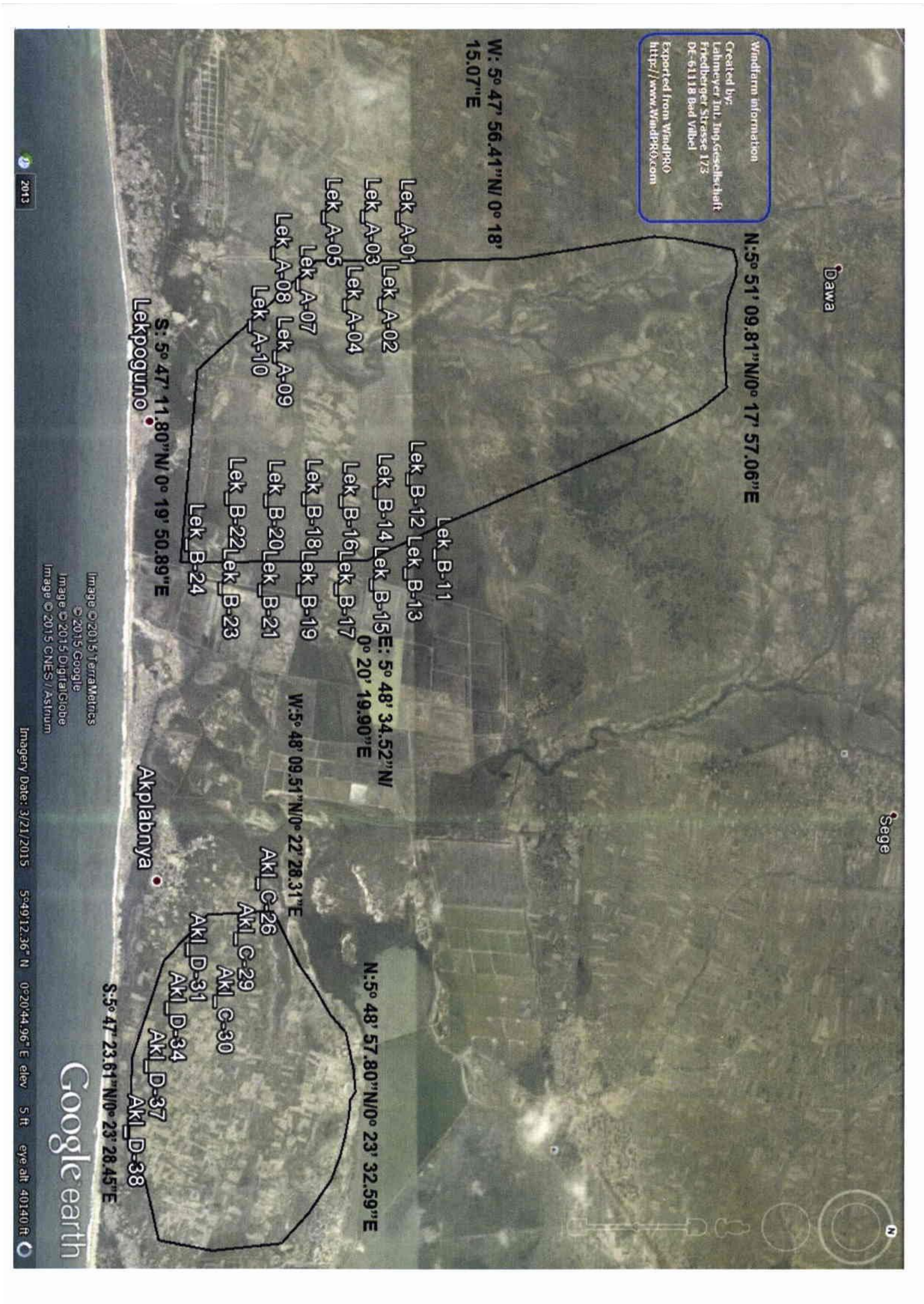
ENCL

bcc: Deputy Chief Executive (E&O)
Director, E&SD ✓ TWO 20/3/14.
Manager, System Development
Manager, Project Management
Corporate Registry

~~Mgr. ESI~~
Fying P/S. KAP 21/3/14
TWO 20/3/14

KG-A/kg-a

PBC
F. 11, PF KAP 21/3/14


Windfarm information
Created by:
Lahmeyer Int. Ing.Gesellschaft
Friedberger Strasse 173
DE-61118 Bad Vilbel
Exported from WindPRO
http://www.WindPRO.com
Dawa
Sege
N:5° 51' 09.81"N/0° 17' 57.06"E
W: 5° 47' 56.41"N/ 0° 18' 15.07"E
S: 5° 47' 11.80"N/ 0° 19' 50.89"E
E: 5° 48' 34.52"N/ 0° 20' 19.90"E
W:5° 48' 09.51"N/0° 22' 28.31"E
N:5° 48' 57.80"N/0° 23' 32.59"E
S:5° 47' 23.61"N/0° 23' 28.45"E
Lek_A-01
Lek_A-02
Lek_A-03
Lek_A-04
Lek_A-05
Lek_A-07
Lek_A-08
Lek_A-09
Lek_A-10
Lek_B-11
Lek_B-12
Lek_B-13
Lek_B-14
Lek_B-15
Lek_B-16
Lek_B-17
Lek_B-18
Lek_B-19
Lek_B-20
Lek_B-21
Lek_B-22
Lek_B-23
Lek_B-24
Akl_C-26
Akl_C-29
Akl_C-30
Akl_D-31
Akl_D-34
Akl_D-37
Akl_D-38
Lekpoguno
Akplabnya
Image © 2015 TerraMetrics
© 2015 Google
Image © 2015 DigitalGlobe
Image © 2015 CNES / Astrium
2013
Imagery Date: 3/21/2015 5°49'12.36" N 0°20'44.96" E elev 5 ft eye alt 40140 ft
Google earth


NW: 5° 50' 34.88"N/0° 42' 37.49"E
SW: 5° 46' 31.82"N/0° 42' 41.20"E
NE: 5° 50' 26.64"N/0° 48' 55.31"E
S: 5° 46' 24.76"N/0° 49' 21.56"E
SE: 5° 47' 01.68"N/0° 54' 47.04"E
Gonu
Aklofudzi
Salo
Abonokofe
Alakple
Kodzi
Anloga
W01
W03
W04
W05
W09
W08
W12
W14
C17
C19
C20
C23
C25
C28
C29
E30
E31
E32
E33
E34
E35
E36
E37
E38
© 2015 Google
Image © 2015 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2015 CNES / Astrium
Imagery Date: 3/21/2015
Google earth

VOLTA RIVER AUTHORITY

710/002/242/14

ENCL

Ghana Civil Aviation Authority

GCAA

Our ref: CAA/FIN.ADMIN/104/16

Your ref:

1st September, 2016

2619

File
KGA 10/10/2016

The Ag. Director of Engineering Services
Volta River Authority
Electro Volta House
P. O. Box MB 77
Accra

Dear Sir,

RE: APPLICATION FOR AIRSPACE SAFETY PERMIT

We refer to your letter dated 12th June, 2015 referenced 710/002/419/2015 seeking advice on the lighting and painting requirements for wind turbines which will be located at Anloga-Anyanui and Wokumagbe-Goi sites.

Please be advised that the issuance of this Permit would attract a fee of **GH¢8,000.00**.

Please arrange payment of **GH¢8,000.00** at the GCAA headquarters Cash Office and submit a duplicate of the receipt to the ASAS section of the Safety Regulations Department for further processing.

In addition, Volta River Authority would be responsible for the Inspectors transportation to and fro.

Yours faithfully,

WILLIAM AFORTUDE
AG.DIRECTOR OF FINANCE
FOR: DIRECTOR-GENERAL

KG-A 10/10/2016

Lets arrange for payment and find out about inspectors.
eke 30/09/16

CC: Director-General
Deputy Director-General (Technical)
Director of Safety Regulations
Manager, ASAS

The signed List of participants at the State agency's forum	Appendix 9.6

SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: WIND POWER PROJECT
Project Proponent: VOLTA RIVER AUTHORITY
Types of Stakeholder: STATE AGENCIES

Date: 13-04-2016
Time: 15:00
Venue: ADA KEST ASSEMBLY HALL

Name	Agency	Position	Contact Number	Email
Amos Dotse Kwasi	Aleplabanya	Assemblyman	0243283878	
Ben A. Tackey	VRA	Mgr. Env	0243344777	ben.tackey@vra.com
Dickson Agyenim	Wildlife Songor Ramsar Site	Park Manager	0244843460	yaw652006@yahoo.com
Ahulakese Rodeson Joseph	Lolonya	Assemblyman	0246772401	
John Akwafo Tsiri	Goi	Assemblyman	0242046358	Johntsiri@gmail.com
Jonathan D. Okutu	Goi	Opinion leader	0243244508	
Felix K. Worlanyo	PPD	S.T.O.	0245540280	[illegible]
Godwin Dzinor	~~AWDA~~	SEO	0205853087	godwindzinor@gmail.com
Abigail Teye	A.W.D.A	S.S.D.O	0247166207	teyea@yahoo.com
Ben Apreku	AWDA	B.I	0243846909	[illegible]
Senyo Agbemasu	AWDA	ADHB	0244411868	ramagbe@yahoo.com
Lydia Cape	CSIR	Project leader	0027218882429	lcape@csir.co.za

SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: WIND POWER PROJECT
Project Proponent: VOLTA RIVER AUTHORITY
Types of Stakeholder: STATE AGENCIES

Date: 13-04-2016
Time: 15:00
Venue: ADA KEST ASSEMBLY HALL

Name	Agency	Position	Contact Number	Email
Amos Dotse Kwasi	Aleplabanya	Assemblyman	0243283878	
Ben A. Tackey	VRA	Mgr. Env	0243344777	ben.tackey@vra.com
Dickson Agyenim	Wildlife Songor Ramsar Site	Park Manager	0244843460	yaw652006@yahoo.com
Ahulakese Rodeson Joseph	Lolonya	Assemblyman	0246772401	
John Akwafo Tsiri	Goi	Assemblyman	0242046358	Johntsiri@gmail.com
Jonathan D. Okutu	Goi	Opinion leader	0243244508	
Felix K. Worlanyo	PPD	S.T.O.	0245540280	[illegible]
Godwin Dzinor	~~AWDA~~	SEO	0205853087	godwindzinor@gmail.com
Abigail Teye	A.W.D.A	S.S.D.O	0247166207	teyea@yahoo.com
Ben Apreku	AWDA	B.I	0243846909	[illegible]
Senyo Agbemasu	AWDA	ADHB	0244411868	ramagbe@yahoo.com
Lydia Cape	CSIR	Project leader	0027218882429	lcape@csir.co.za

Name	Agency	Position	Contact Number	Email
ABULELE ADAMS	CSIR	PROJECT MANAGER	+27722398220	aadams1@csir.co.za
GILBERT AKABA	ADA WEST DA	AG DCD	0243735556	akabagilbert@ymail.com
AYERTEY WILSON	NADMO	Dep. COORDINATOR	0243437531	
Kofi Gatu	SELJEN CON	Tech. Director	0208434557	kofi.gatu@gmail.com
Daniel Barkeley	AWDA	E.O	0240897980	[illegible]@gmail.com
Frank Cudjoe	SELJEN Consult	Comp. Action Plan	0242807335	Cudjoefrank28@yahoo.com
REUBEN ADASE	AGRIC	DISTRICT DIRECTOR	024211 6573	reudase@yahoo.com
YVONNE ARHIN	AWDA	Procurement	0242934631	yvonne.arhin@yahoo.com
Bernice Okornoe	AWDA	✓	0272188665	bbokornoe@yahoo.com
STEPHEN CHARWETEY	WOKUMAGBE	ASSEMBLY MEMBER	0502716326	K3ent2000@yahoo.com
SUMAILA TETTEH-KPAKPAH	〃	OPINION LEADER	0242731752	
ASIEDU ASARE	AWDA	Tech. ENGINEER	0242963975	eugeneasiedu12@yahoo.com
Bosompem Cleopatra	AWDA	Works dept	0249391316	Cleopatrab566@gmail.com
Dornu Reuben	AWDA	WORKS DEPT.	0242604798	dornureuben@yahoo.com

SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: 150MW WIND POWER PROJECT Date: 13 - 04 - 2016
Project Proponent: …… Time: ……
Types of Stakeholder: …… Venue: ……

Name	Agency	Position	Contact Number	Email
1. Dompre Samuel	KeMA	MUN. Engineer	0242906124	dompresamuel@yahoo.com.
2 Nicholas Nai Adjei	KeMA	MCD	0246870470	guaonick@gmail.
3 Lydia Cape	CSIR	Project Manager	0027218882429	lcape@csir.co.za
4 Abulele Adams	CSIR	Project Manager	0027218882408	aadams@csir.co.za
5 Abdul-Kareem Fuseini	WILDLIFE DIVISION OF FORESTRY COMM	Site Manager	0243168865	yambafuka@yahoo.com
6 Anttoinette Aheto	KeMA	Procurement officer	0243576555	babyselikem@gmail.com
7 Kofi Gatu	SELJEN	Tech Director	0208434557	seljencon@gmail.com
8 Ebenezer Antwi	VRA	Prn. Elect. Eng.	0202625433	ebenezer.antwi@vra.com
9 Frank Cudjoe	SELJEN	Comp. Action Plan	0242807339	cudjoefrank28@yahoo.com
10 Jennifer Glover	Dept of Co-op	Asst Co-op Officer	0208831144	jennifer-glover65@yahoo.com
11 Ben A. Sackey	Mgr., ESI, VRA	Mgr. ESI	0243344779	ben.sackey@vra.com
12 Lloyd K. Sutherland	Environmental Officer, V.R.A	Env: Officer	0241370926	Lloyd.sutherland@vra.com

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SELJEN CONSULT

STAKEHOLDER ENGAGEMENT – Participants List

Title of Project: ……………………………………… Date:……………………………
Project Proponent: ……………………………………… Time:……………………………
Types of Stakeholder: ……………………………………… Venue:……………………………

	Name	Agency	Position	Contact Number	Email
13	JERRY ZIDDAH	ENV'TAL HEALTH	MUNICIPAL OFFICER	0244864163	ziddahkay@yahoo.com
14	GODWIN K. AGBENYO	NCCE	MUNICIPAL DIRECTOR	0244414336	agbenyo2009@gmail.Com
15	EDITH TAY	COMM. DEV	MUNICIPAL ~	0243226013	edithtay@yahoo.com
16	DOMINIC KPODO	NADMO	ADMINISTRATION	0242120481	nyonyokpodo@gmail.com
17	Daniel Nyatso	WORKS Estate	Asst. Chief Estate Officer	0542173584	~
18	Joana Bruce Dei	Information Services Dept Rep	Journalist	0543069765	brucejoydei@gmail.com
19	Faustina Baddoo	Dept of Soc Welfare	MSWO	0208960858	faustinabaddoo@yahoo.com
20	GIFTY TAGOE	FIRE SERVICE	2i/c / ADMIN	0548851113	tagoeturner@yahoo
21	Celestina A Attipoe	Dept. Comm. Dev	Mun. Officer	0208166286	celesti@yahoo.com
22	Aaron Teku	Mun. Works Dept.	Engineer	0246229016	aarontek2006@yahoo.com
23.	SAGODO BENJAMIN	DEPT OF AGRIC	MUN. DEVT. OFFICER	024 263 5303	bmksagodo@gmail.com

1 | Page

Comments from the EPA have been included in (letter dated September 14, 2016).	Appendix 9.7

Tel: (0302) 664697 / 664698 / 662465
667524 / 0289673960 / 1 / 2
Fax: 233 (0302) 662690
Email: info@epa.gov.gh

Environmental Protection Agency
P. O. Box MB 326
Ministries Post Office
Accra
Website: http://www.epa.gov.gh

Our Ref: CE: 5641/01/05

September 14, 2016

The Chief Executive
Volta River Authority
P.O. Box MB 37
Accra-Ghana

Dear Sir,

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
PROPOSED 75MW WIND POWER PROJECT 1 LOCATED AT ANLOGA EXTENSION (ANLOGA, SROGBE AND ANYANUI) IN THE KETA MUNICIPALITY OF THE VOLTA REGION

We acknowledge receipt of the Scoping Report on the above proposal submitted to the Agency for the purpose of obtaining environmental approval in accordance with the Environmental Assessment Regulations 1999 (LI 1652).

The report has been reviewed and found to be generally satisfactory.You are therefore advised to proceed with the Environmental Impact Assessment study taking into consideration the attached comments and submit **Eight (8) hardcopies** of a draft Environmental Impact Statement (EIS) to the Agency.

You are by this letter reminded to make payment of the processing fee invoice issued to you earlier and submit the Ecobank payment receipt to the Agency.

Do not hesitate to contact the Agency for any further clarification you may require in this regard.

Yours Faithfully

KWABENA BADU-YEBOAH
AG. DIRECTOR/EAA DIVISION
FOR: EXECUTIVE DIRECTOR

Cc
The Regional Director, EPA, Volta Region, Ho

Tel: (0302) 664697 / 664698 / 662465
667524 / 0289673960 / 1 / 2
Fax: 233 (0302) 662690
Email: info@epa.gov.gh

Environmental Protection Agency
P. O. Box MB 326
Ministries Post Office
Accra
Website: http://www.epa.gov.gh

Our Ref: CE: 5639/01/05

September 14, 2016

The Chief Executive
Volta River Authority
P.O. Box MB 37
Accra-Ghana

Dear Sir,

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
PROPOSED 75MW WIND POWER PROJECT 2 LOCATED AT WOKUMAGBE AND GOI IN THE ADA WEST DISTRICT OF THE GREATER ACCRA REGION

We acknowledge receipt of the Scoping Report on the above proposal submitted to the Agency for the purpose of obtaining environmental approval in accordance with the Environmental Assessment Regulations 1999 (LI 1652).

The report has been reviewed and found to be generally satisfactory. You are therefore advised to proceed with the Environmental Impact Assessment study and submit **Eight (8) hardcopies** of a draft Environmental Impact Statement (EIS) to the Agency.

You are by this letter reminded to make payment of the processing fee invoice issued to you earlier and submit the Ecobank payment receipt to the Agency.

Do not hesitate to contact the Agency for any further clarification you may require in this regard.

Yours Faithfully

KWABENA BADU-YEBOAH
AG. DIRECTOR/EAA DIVISION
FOR: EXECUTIVE DIRECTOR

Cc: The Regional Director, EPA, Accra East Region, Tema

SCOPING REVIEW COMMENTS: 75MW WIND POWER PROJECT 1 LOCATED AT ANLOGA EXTENSION (ANLOGA, SROGBE AND ANYANUI) IN THE KETA MUNICIPALITY OF THE VOLTA REGION.

- The project location falls within the Keta basin where seismic activities are ongoing for oil and gas. Consultation with Ghana National Petroleum Corporation (GNPC) to determine the compatibility of the two projects
- Provide the following information;
  - Attach evidence of legal acquisition of the Site to be used for the project since the report indicates that the site is yet to be acquired
  - Indicate the specific locations of turbines in the EIS
  - Carry out geotechnical survey of the proposed site and present the outcome in the EIS
- The advertisement on the scoping should have been done alongside the review. (submission). Attach a copy of the scoping notice to the EIS

ENVIRONMENTAL PROTECTION AGENCY

INVOICE FOR PROCESSING FEE

0004484

Department: EAH
Departmental Code: 107
Date: 27/9/16

EPA/HO/PAF0001

For Processing fee only

Billing Address: Volta River Authority
Company's Name:
Addresss: Adiga Extension

Phone No: 0244770526
Email Address:

Head Office
P.O. Box MB 326,
Ministries-Accra
Phone: +233-302-664697/8
+233-28-9673961-2
Email address: support@epaghana.org

NO.	DESCRIPTION	AMOUNT (Gh₵)
	Being payment of processing fee for wind power project (75 MW)	5,000.-
	TOTAL	5,000.-

Amount in words: Five thousand Ghana cedis

Issued by: Name: Maggie Adade Signature:

NOTES
1. Invoice remains valid for 90 days
2. Invoice number must be quoted at the back of any draft
3. All payments are payable to Environmental Protection Agency, Head Office
4. Use the contacts above if you have any questions concerning this invoice

Thank You

ENVIRONMENTAL PROTECTION AGENCY

INVOICE FOR PROCESSING FEE

0004485

EPA/HO/PAF0001

Department: EAQ
Departmental Code: 107
Date: 27/9/16

Billing Address: Volta River Authority
Company's Name:
Addresss: Wokumagbe

Phone No: 0244570926
Email Address:

For Processing fee only
Head Office
P.O. Box MB 326,
Ministries-Accra
Phone: +233-302-664697/8
+233-28-9673961-2
Email address: support@epaghana.org

NO.	DESCRIPTION	AMOUNT (Gh¢)
	Being payment of processing fee for wind power project (75 MW)	5,000
	TOTAL	5,000.-

Amount in words: Five thousand Ghana cedi

Issued by: Name: Marjie Adadey **Signature:** [illegible]

NOTES

1. Invoice remains valid for 90 days
2. Invoice number must be quoted at the back of any draft
3. All payments are payable to Environmental Protection Agency, Head Office
4. Use the contacts above if you have any questions concerning this invoice

Thank You

VRA to Ghana Highway Authority	Appendix 9.8

VOLTA RIVER AUTHORITY

Our Ref: 710|066|17
Your Ref:
Date: March 3, 2017

The Chief Executive Officer
Ghana Highway Authority
Post Office Box M57
Accra

Dear Sir,

VRA'S RENEWABLE ENERGY DEVELOPMENT PROGRAMME
150MW WIND POWER PROJECT

We refer to your letter referenced BD/230/Vo/4/17/1763 and dated February 19, 2017 on the above subject submitting cost estimate for the assessment of the bridges and other structures along the proposed route and also requesting for additional information.

We advise as follows:

- The height of loaded trailer: 5.5m
- The width of the load and trailer: 5.5m
- The axle configuration: refer to the attached document

We however wish to advise that we are currently at the planning stages of this project and will revert to you when the assessment of the bridges and other structures along the proposed route can be carried out more accurately with additional data from the prospective Contractor.

Thank you and we appreciate your prompt response and corporation.

Yours faithfully,

Ing. Charles K. O. Addo
Director, Engineering Services

Encl:

Received
7/03/2017

Electro Volta House - P. O. Box MB 77, Accra, Ghana. Phone: +233 30 - 2664941-9 Fax: +233 30 2662610

Comments received during the review of the BID and the Scoping Report	**Appendix 9.9**

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.
			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

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			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
			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,	Chief and Elders of	Pentecost Church,	1. They are aware of the choice of their	No Response needed.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
2016	Omankope	Omankope	community for the project	
			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 Assembly	District Finance Office, Sege Ada	1. They are aware of the project's location within the district	No Response needed.
			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.

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			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 the Ada West District Assembly	Ada West District Assembly	1. The physical construction of the project is taking too long to commence.	Projects development in the power sector is quite laborious and requires very forms of studies to come to 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

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
				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 landowners and ensure compensation is paid directly to such people.	Detailed property valuation will be done leading to the development of the Compensation Action Plan which is expected to adequately address this concern.
			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	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

Date	Stakeholder	Location	Summaries of Main Inquiries, Proposals and Concerns presented by Stakeholders	Response
			project.	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. 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.

Correspondences between VRA and Upwind International	Appendix 9.10

UpWind comments on Scoping Report

UPWIND AKPLABNYA LTD.
WATER ROAD, KANDA
HIGHWAY EXTENSION
P.O. BOX KA 16058
ACCRA, GHANA
TEL +233-30 2228 214 -120
FAX +233-30 2223 175

UPWIND
INTERNATIONAL AG
BAHNHOFSTRASSE 3
CH-8808 PFAEFFIKON
SWITZERLAND
TEL +41 44 261 07 07
FAX +41 44 261 08 74

WIND ENERGY PROJECTS
FOR GHANA

The Executive Director
Environmental Protection Agency
P.O. Box MB 326, Accra

AND

The Chief Executive
Volta River Authority
P.O. Box MB 77, Accra

Accra, September 08, 2016 Kp/Sb/Mw/Mo/re

Scoping Notice: Volta River Authority - 75 MW Wind Power Project 2

Dear Sirs,

We make reference to the VRAs' Scoping Notice regarding the 75 MW Wind Power Project 2 (Wokumagbe and Goi), published in the Ghana Graphic recently. As specified in that publication, any concerns or facts should be stated not later than September 15, 2016. We therefore present this letter within said time period.

As already stated in a similar letter, we wish to extend our compliments to VRA's engagement in the renewable energy sector. As a seasoned and specialized renewable energy developer, Upwind Akplabnya Ltd. respectively NEK Umwelttechnik AG and NEK (Ghana) Ltd., we follow with great interest the transition of Ghana's energy sector towards a more sustainable and reliable electricity generation system.

While we are generally delighted to see other wind energy project developers being active in Ghana, we however see some potential conflicts with VRA's 75 MW Wind Power Project 2 with our planned Wind Farm Akplabnya, which is located near the Songor Lagoon and the villages of Anyaman, Goi and Lolonya. As can be taken from the scoping notice, VRA's project is located around the villages of Wokumagbe and also Goi, which means that most probably, part of their project area overlaps with the Wind Farm Akplabnya. Due to this proximity or even overlap, we would like to point out the following concerns:

OVERLAP OF PROJECT AREA

Our wind energy project Akplabnya with a maximum installed capacity of 60 MW is located in the Ada West District down on the Atlantic coast and close to the Songor Lagoon. The project area is surrounded by the villages of Anyaman, Goi and Lolonya, as can been seen from the attached map. According to the scoping notice, the VRA project is located around Wokumagbe and Goi. This description leads to the assumption that at least part of the VRA project area overlaps with the project area of our Wind Farm Akplabnya. Therefore, we would kindly ask VRA to provide us with maps showing their exact project area and the approximate turbine locations so that we can verify if an overlap exists or not. Bearing in mind that we already have acquired a number of permits and authorisations for this area, we want to register our objection against a project being planned on the same spot if an overlap between the two projects exits.

YIELD LOSSES DUE TO WAKE EFFECTS

Due to the closeness of the project areas (regardless of them overlapping or not), we expect negative impacts from VRA's planned turbines on our own turbines due to wake effects. This will be especially the case for any of our turbines located directly downwind from one or more of VRA's planned turbines or standing very close to them. In this event, energy yield losses may be significant leading to less energy production for the Wind Farm Akplabnya and thereby negatively affecting the economic viability of our our project.

CUMULATIVE ENVIRONMENTAL IMPACTS

We further wish to highlight that any additional project in this specific area may lead to cumulative environmental impacts, which would need to be assessed. Such impacts may be in terms of noise emissions, shadow-flicker, zone of visual impact, bird migration and others.

In order to eliminate the above concerns and especially to determine if there is an overlap between the projects or not, we would appreciate greatly if VRA could forward to us its project specifications, i.e. such as:

- Project area with exact coordinates
- Approximate number and locations of turbines (if already available)
- Turbine type (hub height, rotor diameter)

Please find - as mentioned above - a map showing our area of development.

If you have any further questions, please don't hesitate to contact us or our environmental consultant, Mr. Moses Duphey, on 0204525838 or by email: moses_duphey@yahoo.co.uk

Sincerely Yours,

UPWIND AKPLABNYA LTD.

A. Kapp

Dr. Ch. Kapp

Attachements:

- Environmental Permit Akplabnya (CE0040020102)
- EC provisional license (EC/GWSL/02-14-038)
- Map of project area of the 60 MW Wind Farm Akplabnya

Tel: (0302) 664697 / 664698 / 662465
667524 / 0289673960 / 1 / 2
Fax: 233 (0302) 662690
Email: info@epa.gov.gh

Environmental Protection Agency
P. O. Box MB 326
Ministries Post Office
Accra
Website: http://www.epa.gov.gh

PERMIT NO. CE0040020102

ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL PERMIT

ENVIRONMENTAL ASSESSMENT REGULATIONS 1999 (LI 1652)

This is to authorize

UPWIND AKPLABNYA LIMITED

To commence the proposed construction and operation of a 60MW Wind Energy Generation Project as per the attached schedule.

Located at Akplabnya in the Ada West District of the Greater Accra Region

Date Issued: September 10, 2014

Expiry Date: March 09, 2016

....
E. Appah-Sampong
Ag. Dep. Executive Director
(Technical)
For: Executive Director.

NB: This Permit is only valid with the Seal of the Environmental Protection Agency and Conditioned upon obtaining other permits from relevant institutions among others.

ENERGY COMMISSION

This is to certify that

UPWIND AKPLABNYA LIMITED

Has been granted a:

PROVISIONAL GENERATION AND WHOLESALE SUPPLY LICENCE

To Generate and Supply Electricity from Wind Energy at Akplabnya in the Ada West District in the Greater Accra Region.

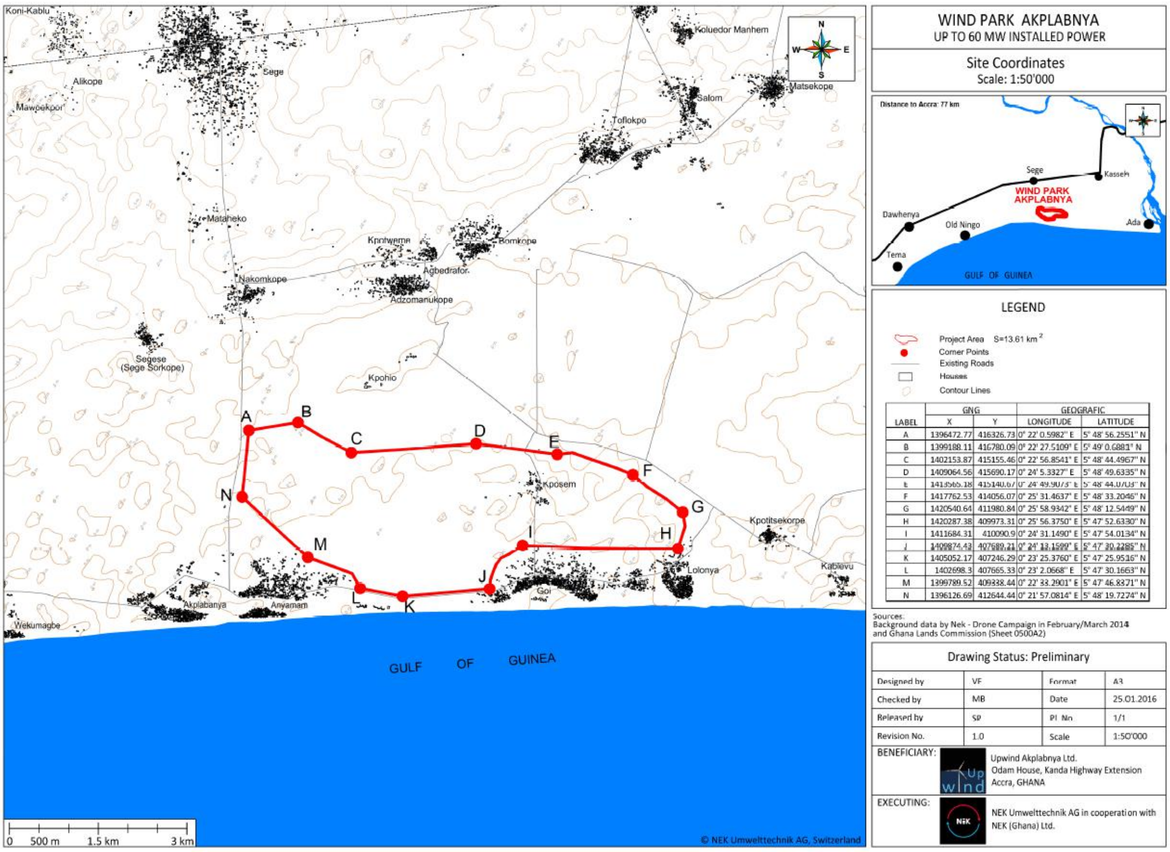
Licence Number: **EC/GWSL/02-14-038**

Licence valid until : **19TH FEBRUARY 2016**

Kwame Ampofo (Dr.)	**Michael Opam**
Board Chairman	Ag. Executive Secretary

Date: **2ND MARCH 2015**

NB: THIS PROVISIONAL LICENCE IS A CONDITIONAL LICENCE AND DOES NOT MANDATE THE HOLDER TO CONSTRUCT OR OPERATE ANY WIND ENERGY PLANT. REFER TO ATTACHED SCHEDULE.



LABEL	GNG		GEOGRAFIC	
	X	Y	LONGITUDE	LATITUDE
A	1396472.77	416326.73	0° 22' 0.5982" E	5° 48' 56.2551" N
B	1399188.11	416780.09	0° 22' 27.5109" E	5° 49' 0.6881" N
C	1402153.87	415155.46	0° 22' 56.8541" E	5° 48' 44.4967" N
D	1409064.56	415690.17	0° 24' 5.3327" E	5° 48' 49.6335" N
E	1413565.18	415140.67	0° 24' 49.9073" E	5° 48' 44.0703" N
F	1417762.53	414056.07	0° 25' 31.4637" E	5° 48' 33.2046" N
G	1420540.64	411980.84	0° 25' 58.9342" E	5° 48' 12.5449" N
H	1420287.38	409973.31	0° 25' 56.3750" E	5° 47' 52.6330" N
I	1411684.31	410090.9	0° 24' 31.1490" E	5° 47' 54.0134" N
J	1409874.43	407689.21	0° 24' 13.1599" E	5° 47' 30.2285" N
K	1405052.17	407246.29	0° 23' 25.3760" E	5° 47' 25.9516" N
L	1402698.3	407665.33	0° 23' 2.0668" E	5° 47' 30.1663" N
M	1399789.52	409338.44	0° 22' 33.2901" E	5° 47' 46.8371" N
N	1396126.69	412644.44	0° 21' 57.0814" E	5° 48' 19.7274" N

Designed by	VF	Format	A3
Checked by	MB	Date	25.01.2016
Released by	SP	Pl. No	1/1
Revision No.	1.0	Scale	1:50'000

UPWIND KONIKABLO LTD.
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WIND ENERGY PROJECTS
FOR GHANA

The Executive Director
Environmental Protection Agency
P.O. Box MB 326, Accra

AND

The Chief Executive
Volta River Authority
P.O. Box MB 77, Accra

Accra, September 07, 2016 Kp/Sb/Mw/Mo/re

Scoping Notice: Volta River Authority - 75 MW Wind Power Project 2

Dear Sirs,

We make reference to the VRAs' Scoping Notice regarding the 75 MW Wind Power Project 2 (Wokumagbe and Goi), published in Ghana Graphic recently. As specified in that publication, any concerns or facts should be stated not later than September 15, 2016. We therefore present this letter within said time period.

First of all, we wish to extend our compliments to VRA's engagement in the renewable energy sector. As a seasoned and specialized renewable energy developer, Upwind Konikablo Ltd. respectively NEK Umwelttechnik AG and NEK (Ghana) Ltd., we follow with great interest the transition of Ghana's energy sector towards a more sustainable and reliable electricity generation system.

While we are generally delighted to see other wind energy project developers being active in Ghana, we however see some potential conflicts with VRA's 75 MW Wind Power Project 2 with our operations. As can be taken from the scoping notice, this project is located around Wokumagbe and Goi. Since these villages seem to be in the very vicinity of our Konikablo wind project, we currently have the following concerns:

OVERLAP OF PROJECT AREA

Our wind energy project at Konikablo with a maximum installed capacity of 200 MW is located between the villages of Dawa, Sege, Akplabanya and Wokumagbe. We therefore expect that there is a possible conflict in terms of overlapping of project areas with the project now proposed by VRA. For better understanding, please find attached a map showing the area in question where we are developing our wind energy project and for which we have already received different required permits, land contracts and other vital authorisations. In order to exactly understand where the proposed 75 MW wind project of VRA is located, it would be appropriate if VRA could please provide us with respective maps, exact coordinates and other additional information.

YIELD LOSSES DUE TO WAKE EFFECTS

Even if the project areas of the proposed projects are not overlapping, we expect that a wind energy project, which is located nearby and / or upwind of the prevailing wind direction of the Konikablo project, will negatively impact on our energy production and operation due to wake effects. Such a circumstance would eventually negatively affect our energy yield and therefore also the financial aspects.

CUMULATIVE ENVIRONMENTAL IMPACTS

We further wish to highlight that any additional project in this specific area may lead to cumulative environmental impacts, which would need be assessed. Such impacts may be in terms of noise emissions, shadow-flicker, zone of visual impact, bird migration and others.

In order to eliminate the above concerns, we would appreciate greatly if VRA could forward to us its project specifications, i.e. such as:

- Project area with exact coordinates
- Approximate number and locations of turbines (if already available)
- Turbine type (hub height, rotor diameter)

For your reference, please find attached our EPA permit and the Provisional Generation and Wholesale Supply License from the Energy Commission. You also can find, as mentioned above, a map showing our area of development.

If you have any further questions, please don't hesitate to contact us or our environmental consultant, Mr. Moses Duphey, on 0204525838 or by email: moses_duphey@yahoo.co.uk

Sincerely Yours,

UPWIND KONIKABLO LTD.

Dr. Ch. Kapp

Attachements:

- Environmental Permit Konikablo (CE0039980102)
- EC provisional license (EC/GWSL/10-15-084)
- Map of project area of the 200 MW Wind Farm Konikablo

Tel: (0302) 664697 / 664698 / 662465
667524 / 0289673960 / 1 / 2
Fax: 233 (0302) 662690
Email: info@epa.gov.gh

Environmental Protection Agency
P. O. Box MB 326
Ministries Post Office
Accra
Website: http://www.epa.gov.gh

Permit No. CE0039980103

ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL PERMIT

ENVIRONMENTAL ASSESSMENT REGULATIONS 1999 (LI 1652)

This is to authorize

UPWIND KONIKABLO LIMITED

To commence the proposed 200MW Wind Power Generation Plant as per the attached schedule

Located at Konikablo in the Ningo Prampram District of the Greater Accra Region

....

E. Appah-Sampong
Ag. Deputy Executive Director/Technical
For: Executive Director

Date Issued: December 03, 2015

Expiry Date: June 02, 2017

NB: This Permit is only valid with the Seal of the Environmental Protection Agency and conditioned upon obtaining other permits from relevant institutions among others

ENERGY COMMISSION

This is to certify that

UPWIND KONIKABLO LIMITED

Has been granted a:

PROVISIONAL GENERATION AND WHOLESALE SUPPLY LICENCE

To Generate and Supply Electricity from Wind Energy at Konikablo in the Ningo Prampram District in the Greater Accra Region

Licence Number: **EC/GWSL/10-15-084**

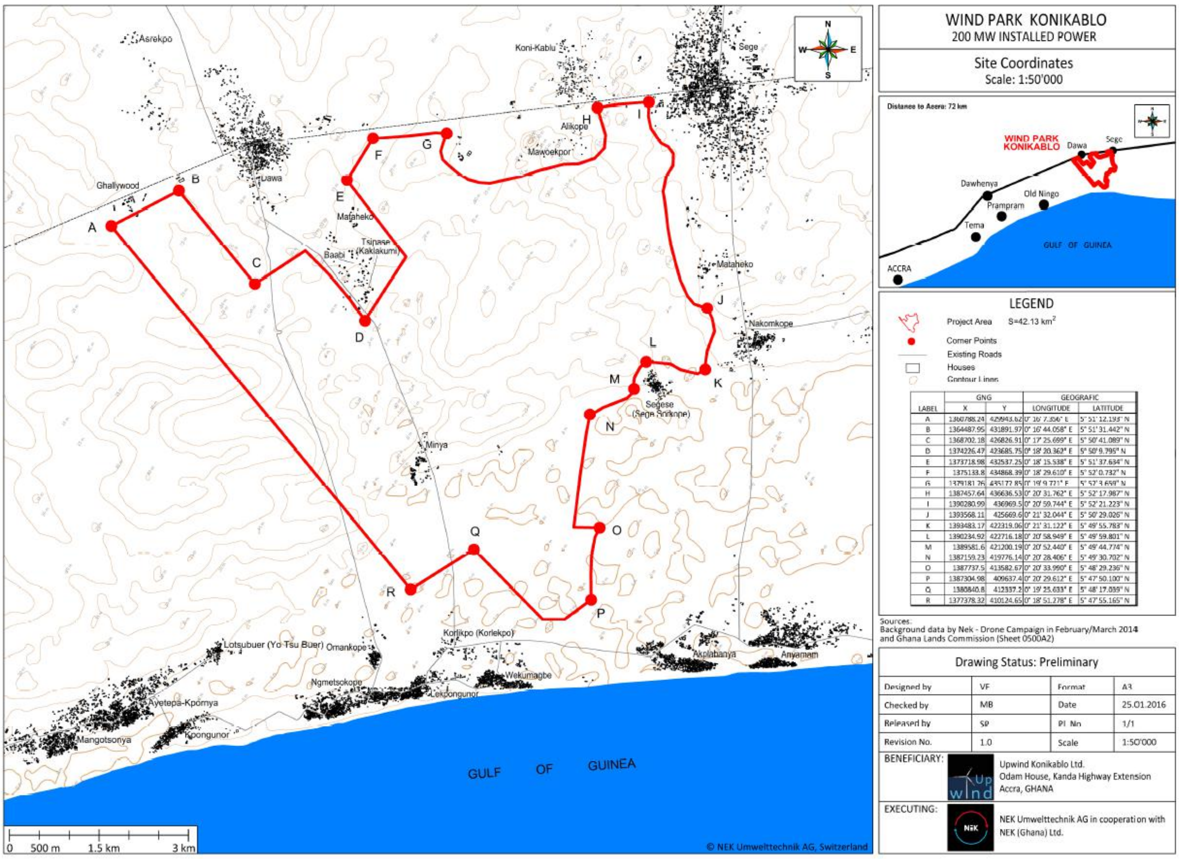
Licence valid until : **25TH OCTOBER 2016**

Kwame Ampofo (Dr.)
Board Chairman

Michael Opam
Ag. Executive Secretary

Date: **26TH OCTOBER 2015**

NB: THIS PROVISIONAL LICENCE IS A CONDITIONAL LICENCE AND DOES NOT MANDATE THE HOLDER TO CONSTRUCT OR OPERATE ANY WIND ENERGY PLANT. REFER TO ATTACHED SCHEDULE.



LABEL	GNG X	GNG Y	GEOGRAFIC LONGITUDE	GEOGRAFIC LATITUDE
A	1360788.24	429943.62	0° 16' 7.356" E	5° 51' 12.193" N
B	1364487.95	431891.97	0° 16' 44.058" E	5° 51' 31.442" N
C	1368702.18	426826.91	0° 17' 25.699" E	5° 50' 41.089" N
D	1374226.47	423685.75	0° 18' 20.362" E	5° 50' 9.795" N
E	1373718.98	432537.25	0° 18' 15.538" E	5° 51' 37.634" N
F	1375133.8	434868.39	0° 18' 29.610" E	5° 52' 0.732" N
G	1379181.76	435172.85	0° 19' 9.721" E	5° 52' 3.659" N
H	1387457.64	436636.53	0° 20' 31.762" E	5° 52' 17.987" N
I	1390280.99	436969.5	0° 20' 59.744" E	5° 52' 21.223" N
J	1393568.11	425669.6	0° 21' 32.044" E	5° 50' 29.026" N
K	1393483.17	422319.06	0° 21' 31.122" E	5° 49' 55.783" N
L	1390234.92	422716.18	0° 20' 58.949" E	5° 49' 59.801" N
M	1389581.6	421200.19	0° 20' 52.440" E	5° 49' 44.774" N
N	1387159.23	419776.14	0° 20' 28.406" E	5° 49' 30.702" N
O	1387737.5	413582.67	0° 20' 33.990" E	5° 48' 29.236" N
P	1387304.98	409637.4	0° 20' 29.612" E	5° 47' 50.100" N
Q	1380840.8	412337.2	0° 19' 25.633" E	5° 48' 17.039" N
R	1377378.32	410124.65	0° 18' 51.278" E	5° 47' 55.165" N

<u>*VRA response:*</u>

VOLTA RIVER AUTHORITY
RECEIVED
20 OCT 2016
P. O. BOX 77
AKOSOMBO
ENV & SUST. DEV. DEPT

710/002/488/16

October 18, 2016

The Chief Executive
Upwind Konikoblo Ltd.
P.O. Box KA16058
Accra,

Tel: 0302-228-214

Attn: Dr. Ch. Kapp

Dear Sir,

<u>VRA RENEWABLE ENERGY DEVELOPMENT PROGRAMME:</u>

<u>SITE OVERLAP OF UPWIND WIND ENERGY PROJECT AT WOKUMAGBE AND GOI</u>

We refer to your letters referenced Kp/Sb/Mw/Mo/re and dated September 07, 2016 and September 08, 2016 respectively on VRA's Scoping Notice for Wind Power Project – 2 (Wokumagbe - Goi).

We have noted your concern about the potential impact of our Wind Power Project- 2, and the possible overlap of our wind farms. We are investigating your concern and will schedule a meeting with you to discuss the issues you have raised as soon as practicable.

Yours faithfully,

INFORMATION COPY
ORIGINAL SIGNED BY
C. K. O. ADDO
Ing. Charles Addo
DIRECTOR, ENGINEETRING SERVICES

bcc: Deputy Chief Executive, (E&O)
Driector, Legal Service
Director, ESD
Director, E&SDD — TNO 20/10/16
Director, Real Estate and Security
Corporate Registry

Mgr. ESM
Fyi, plz.
TNO 20/10/16

KG-A/ag-e

Fyi, file for records 24/10/16

Correspondences between VRA and Ministry of Lands and Natural resources	Appendix 9.11

VOLTA RIVER AUTHORITY

Our Ref: EXE/1090/012/1074
Your Ref:
Date: November 15, 2016.

The Minister
Ministry of Lands and Natural Resources
P.O. Box M212
Accra
Tel: 0302-672336

Attn: Hon. Nii Osah Mills

Dear Sir,

VRA RENEWABLE ENERGY DEVELOPMENT PROGRAMME:

WIND ENERGY DEVELOPMENT AT WOKUMAGBE AND GOI

We refer to the Stakeholder meeting which was held at the Ada West District Assembly on October 20, 2016 for the development VRA's 75MW Wind Power Project-2 at Wokumagbe and Goi. We note that the Hon. Minister for Lands and Natural Resources was in the district and was kind enough to grace the stakeholder meeting with his presence. He gave comments on environmental and socio-economic issues related to the Wind Power Project-2 and requested that a meeting should be held with the Ministry of Lands and Natural Resources to clarify the interest of Ghana Government in the lands in the Wind Power Project-2 project area.

As part of VRA's Renewable Energy Development Programme, VRA is developing two 75MW wind energy projects; Wind Power Project – 1 at Anloga, Srogbe and Anyanui and Wind Power Project – 2 at Wokumagbe and Goi. VRA has submitted the Scoping Report for the two wind energy projects to the Environmental Protection Agency (EPA) who reviewed the reports for the development of wind energy projects. A stakeholder meeting was held at the Ada West District Assembly as part of the Environmental and Social Impact Assessment (ESIA) study for Wind Power Project -2 (Wokumagbe and Goi) to inform the community of the environmental and socio-economic impacts that the ESIA study must assess.

ectro Volta House - P. O. Box MB 77, Accra, Ghana. Phone: +233 30 - 2664941-9 Fax: +233 30 2662610

At the stakeholder meeting the Hon. Minister indicated that Ghana Government has interests in the lands in the Wind Power Project-2 project area and that these should be clarified and confirmed with the Ministry of Lands and Natural Resources.

We propose to schedule the meeting for Wednesday, November 23, 2016 at 10:00AM with the Hon. Minister for Lands and Natural Resources at the Ministry of Lands and Natural Resources to discuss the impact of the project on lands and natural resources in the project area and to confirm that the sites for Wind Power Project-2 are not within the lands acquired for other projects. We have attached a copy of the Scoping Report for Wind Power Project -2 (Wokumagbe, Goi) which includes coordinates of the proposed sites and a layout for your study.

Please contact Ing. Charles Addo, the Director of our Engineering Services Department on 0343020705/0208149315 and dengsd@vra.com or sesd@vra.com for any clarifications on the wind energy project and to confirm the suitability of the proposed meeting date and time.

Yours faithfully,

Ing. Kirk-Koffi
CHIEF EXECUTIVE

Received
17/03/17

Correspondences between VRA and Land Owners	Appendix 9.12

VOLTA RIVER AUTHORITY
RECEIVED
28 APR 2016
P. O. BOX 77,
AKOSOMBO
ENV & SUST. DEV. DEPT

ENV. & SOC. IMPACT SECT.
RECEIVED
DATE 29/4/2016

VOLTA RIVER AUTHORITY
RECEIVED
27 APR 2016
O.C.E. SERVICES

C/O ANYANUI BASIC SCHOOL
ANYANUI.

8TH MARCH, 2016

THE CHIEF EXECUTIVE OFFICER
VOLTA RIVER AUTHORITY
ACCRA.

Dear Sir,

PROTEST AGAINST LEASE OR PURCHASE AGREEMENT BETWEEN VRA AND GADAGBI FAMILY

In Ghana family properties are legacies for all family members. Similarly Clan properties are also legacies for the Clan members. These legacies are shared among family members and if it is Clan property it is shared among the clan members. Klevie Clan in the Keta Municipality have properties in various places like Anyako, Anlo- Afiadenyigba, Anloga, Akplorwotorkor, Dzita, Anyanui and Fuveme to mention only a few.

No Klevie Clan member from Anyanui can go to sell or lease Klevie Clan property in Anyako. Neither can any Klevie Clan member from Anlo- Afiadenyigba sell or lease any Klevie Clan property at Anyako. Clan members of every community are the only legitimate members to lease or sell any property of the Clan where their grandfathers have ever worked. The lease or sale can only be effected by perfect agreement of the Clan members concerned with their head of family.

We in Anyanui have Clan property and everybody knows where his grandfather had ever worked.

Similarly, those in Dzita have their Clan property shared to their grandfathers and it is still in their possession.

There is no super- Klevie Clan member or members over all other Klevie clan members who can move from community to community to sell or lease Klevie Clan property.

In view of that there is no justification for Messers William Ahiaku, Leo Daledor, David Ahiaku and others concerned from Dzita to enter into any purchase or lease agreement with VRA and Gadagbi family what so ever.

I therefore challenged the candidature of the above mentioned signatories as very very fraudulent and I declared the agreement as null and void.

It will interest you to know that there is peaceful co-existence between the Klevie Clan in Anyanui and Kportufe family. For the fact that Anyanui land is a property of Klevie Clan but passed on to Kportufe family of Anyanui long long ago. This peaceful co-existence can never warrant any land litigation at the expense of development.

There is a mutual understanding between Klevie Clan in Anyanui to co- operate with each other and have a share in any proceed emanating from the sale or lease of any part of Anyanui land.

In view of the above, I wish VRA not to continue any business with those signatories concerned to avert the ensuing land litigation which could delay VRA and the proposed development.

Yours Faithfully,

GADAGBI FAMILY PROPERTY, DZITA
Head

TIMOTHY K. HELETSI

THE HEAD OF GADAGBI FAMILY

0243587291/0263024932

CC:-

JONES- MENSAH & CO
NO. 15 SHIPPI LINK
P.O. BOX CT 368
EAST CANTONMENT
ACCRA.

KPORTUFE FAMILY
ANYANUI

REGISTRATION AND COMMENT SHEET:

Should you have any queries, comments or suggestions regarding the proposed 75MW Wind Power Project 1 (Anloga Extension) and 75MW Wind Power Project 2 (Wokumagbe and Goi) being developed by the Volta River Authority respectively in the Keta Municipality and Ada West Districts in Ghana, please note them below and return this sheet to:

Name	Email	Mobile
Kofi Gatu	seljencon@gmail.com	+233-20-843-4557 / +233-24-206-3391
Dr. James Kojo Adomako	jadomak@yahooc.com	+233-20-818-0362 / +233-54-434-0346
Frank Cudjoe	cudjoefrank@yahoo.com	+233-50-973-8415 / +233-24-280-7339

Please formally register me as stakeholder and provide further information and notifications during ESIA process		Yes	No
I would like to receive my notifications by:	Fax	Post	Email ✓

Comments: Signatories to the lease or purchase agreement are not the rightful candidates

Please fill-in your contact details below for the project database:

Title & Name	Family Head; Timothy K. Heletsi		
Organisation	–		
Telephone	–	Fax	
Mobile Phone	0243587291	Email	c/o agbenyo2009@gmail.com
Postal Address	c/o L.A/J.H.S. Anyanui – Anloga V/R		
Name Timothy K. Heletsi	Signature [signature]	Date 15th Apr. 2016	

SELJEN CONSULT | Thank you for the participation | CSIR

MARCH 2016

SCL Invitation letters to State Agencies	Appendix 9.13

SELJEN CONSULT

Experts in: Environmental Impact Assessment (EIA), Environmental Auditing and Certification to ISO Standards (9000, 14000, OHSAS 18000 Systems), Feasibility Studies, Project Proposals, Monitoring & Evaluation and Acquisition of Relevant Statutory Permits, E.g. EPA & Town and Country Planning Permits, etc

March 21, 2016

The District Coordinator,
Ada West District Assembly
Ada

Dear Sir,

75MW WIND POWER PROJECT 2 ((WOKUMAGBE AND GOI)
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY:

REQUEST FOR MEETING

We write as a follow up to our initial discussion regarding the above study which is being undertaken by Seljen Consult Limited (SCL) in collaboration with the Council for Scientific & Industrial Research (CSIR) of South Africa (CSIR-SA), who are working as sub-consultants to SCL.

SCL will wish to inform you that specialists from CSIR-SA are expected in the country from April 10-14, 2016 to assist their Ghanaian counterparts to collect scientific and socio-economic data for use in preparing the ESIA Reports. In the light of this, we will like to schedule a meeting with your outfit on **Wednesday April 13, 2016 at 2:00 p.m**. at your office to, in the first instance, take the opportunity to introduce the CSIR-SA Team to you. The meeting is also expected to provide the opportunity for the South African specialists to discuss issues of interest that will be obtained from their site visits.

We would also be most grateful if your outfit would invite representatives from the following state agencies within your District to participate in the meeting:

- Ghana National Fire Service
- Town & Country Planning Department
- Ghana Wildlife Department
- Department of Urban Roads
- Department of Agriculture
- Department of Social Welfare
- National Commission of Civic Education

ASSOCIATES: Nana Adom Boakye II, Mr. F. K. Atubrah, Afia Bemah Berfi
LOC: SECOND FLOOR, QUEENSTAR BUILDING, LAST CHANCE DZORWULU P. O. BOX AT 140, ACHIMOTA – ACCRA
TEL: +233 208 434 557 E-mail:seljencon@gmail.com
BANKERS: Bank of Africa, Ghana Limited, Ridge West- Business Office, Accra

We have attached a Background Information Document (BID) for the wind power project as information source document. All Interested & Affected Persons are required to use the comment sheet of the BID to provide their comments on the project.

Thank you.

Yours Faithfully,

Kofi Gatu
TECHNICAL DIRECTOR

SELJEN CONSULT

Experts in: Environmental Impact Assessment (EIA), Environmental Auditing and Certification to ISO Standards (9000, 14000, OHSAS 18000 Systems), Feasibility Studies, Project Proposals, Monitoring & Evaluation and Acquisition of Relevant Statutory Permits, E.g. EPA & Town and Country Planning Permits, etc

May 2, 2016

The Director
National Communication Authority,
1st Rangoon Close
P. O. Box CT 1568,
Cantonment, Accra.

Dear Sir,

150MW WIND POWER PROJECT:
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY

Seljen Consult Limited (SCL), a Ghanaian Environmental Consultancy Firm, working in collaboration with the Council for Scientific & Industrial Research (CSIR), a South African research council, is carrying out the Environmental & Social Impact Assessment (ESIA) for the under-listed wind energy facilities on behalf of the Volta River Authority (VRA):

- 75MW Wind Power Project 1 (Anloga Extension) located at Anloga, Anyanui & Srogbe communities in the Keta Municipal in the Volta Region
- 75MW Wind Power Project 2 (Wokumagbe and Goi) located in Wokumagbe and Goi communities in the Ada West District in the Greater Accra Region

A letter of Letter of Introduction, dated February 8, 2016, from VRA as well as a Project Background Information Document for the wind energy facilities are attached for your attention.

As part of the ESIA Study, SCL is required to engage with relevant stakeholders whose properties or services would be impacted upon during both project construction and operation. Inputs from consultations with such stakeholders is 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.

ASSOCIATES: Nana Adom Boakye II, Mr. F. K. Atubrah, Afia Bemah Berfi
LOC: SECOND FLOOR, QUEENSTAR BUILDING, LAST CHANCE DZORWULU P. O. BOX AT 140, ACHIMOTA – ACCRA
TEL: +233 208 434 557. E-mail: seljencon@gmail.com
BANKERS: Bank of Africa, Ghana Limited, Ridge West- Business Office, Accra

As you are aware, Electro-magnetic Interference (EMI) caused by the development of wind farms either from the Wind Turbine Generator placement in the direct line of sight of point-to-point communications, or too close to omni- (all) directional communications or radar equipment, could impact on communications equipment and therefore of critical interest to communications and radar operators. Subsequently, an "Aviation & Communication Impact Study" for the 2 wind power facilities are being investigated by SCL in order to inform the final design of the project or to generate relevant mitigative measures to eliminate or reduce impacts where appropriate.

In view of this, we are by this letter formally bringing the wind power projects to your attention and to solicit for any concerns from your outfit for consideration for input into the ESIA Report.

Your early response will be very much appreciated.

Yours Faithfully,

Kofi Gatu
TECHNICAL DIRECTOR

cc: The Director, Engineering Services
Volta River Authority,
P. O. Box MB 77,
Accra-Ghana

We have attached a Background Information Document (BID) for the wind power project as information source document. All Interested & Affected Persons are required to use the comment sheet of the BID to provide their comments on the project.

Thank you.

Yours Faithfully,

Kofi Gatu
TECHNICAL DIRECTOR