ENVIRONMENTAL IMPACT ASSESSMENT

FOR THE PROPOSED JAMAICA PUBLIC SERVICE COMPANY WIND ENERGY PROJECT AT HERMITAGE, ST. ELIZABETH, JAMAICA

December 2009

Environmental & Engineering Managers Ltd.

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EXECUTIVE SUMMARY

Introduction

The Jamaica Public Service Company Limited (JPS) received approval from the Office of Utilities Regulation (OUR) to construct four (4) 750 kW Wind Turbines at Hermitage, St. Elizabeth in response to their proposal for the Provision of Renewable Energy Based Power Generation Facilities on a Build Own and Operate (BOO) basis for the supply of electricity to the national electric grid for an initial period of twenty (20) years.

They have embarked on this initiative to provide electricity using renewable energy in keeping with the Government of Jamaica's (GOJ's) policy to reduce the country's dependence on imported fossil fuels as an energy source.

This Environmental Impact Assessment (EIA) has been prepared in accordance with Terms of Reference (TOR) approved by the National Environment and Planning Agency (NEPA). (Appendix 1).

Project Description

JPS plans to install four (4) -750kW wind turbines at Hermitage, St. Elizabeth which is situated south of Malvern near to Munro College and Munro Preparatory School.

The project is estimated to cost US$9 million with projected annual fuel savings of US$1.7 million (at 2008 fuel prices). The construction phase will last 9-12 months. The lifespan of the wind turbines is 20 years. A summary of the project description is provided in the Table below.

Summary of Project Description

Name of site	Hermitage, St. Elizabeth
Latitude/Longitude of the area	17.931661N, 77.697913W
Average Elevation	678.1 m
Average wind speed at 50m elevation	8.7 m/s
Quantity and rating of turbines	Four x 750kW
Proposed installed capacity	3 MW
Total expected annual energy production (after 10% losses)	10,161 MWh
Expected annual energy production per turbine (after 10% energy losses)	2,540 MWh
Expected capacity factor (after 10% losses)	38.6%
Land requirements	14 hectares

Project Design Elements

A wind turbine is a rotating machine which converts the kinetic energy of wind into mechanical energy which can in turn be converted to electricity. There are two main kinds of wind generators, those with a vertical axis, and those with a horizontal axis. In this case the horizontal axis wind turbine will be installed, which is the type most widely used commercially. Wind turbines can be used to generate large amounts of electricity in wind farms both onshore and offshore.

A wind turbine installation consists of sub-systems to catch the wind's energy, point the turbine into the wind, convert mechanical rotation into electrical power, and systems to start, stop, and control the turbine.

UNISON Co., Ltd. has been selected by the JPS to design, supply and construct the wind turbines for this project.

The following general and design point information was used for the plant design:

Wind Turbine elevations	Approx 690 to 720 meters above mean sea level
Winter ambient condition	17°C
Summer ambient condition	36°C
Annual humidity	Range 60 - 95 %
Design point conditions	28°C, 75 % Relative Humidity (RH)
Maximum wind speed/prevalent direction	241 km/hr / from the east
Wind speed, monthly average	22.5 km/hr
Seismic factor	In accordance with UBC 1997, Vol. 2 Seismic Zone 3 Table 16-k Seismic Importance factor I is 1.25 Table 16-k Seismic Importance factor Ip is 1.50 Wind Importance Factor Iw is 1.15 or equivalent IBC latest International Building Code

The other works to be executed include civil works (site preparation and access roads), electrical works, transportation and erection of the wind turbines and construction of the wind farm substation. Unison Co. Ltd. will also provide training to JPS personnel, test and commission the turbines, and maintain them for three (3) years. Overall Project Management, Quality Control and Assurance (QC/QA) and Environment, Health and Safety Management work will be provided for all activities.

A. Civil works
   - Site measurement
   - Site preparation
   - Access road construction
   - Crane pad construction
   - Excavation
   - Re bar fabrication
   - Concrete pouring
   - Backfilling
   - Drainage
   - Fence work
   - Restoration work
   - Waste management

B. Electrical work
   - Earthing work
   - Cabling work (power cable, communication cable)
   - Installation of switchboards at wind farm substation
   - Grid connection (24kV) to Maggotty feeder

C. Transportation (crane and wind turbine components)
   - Sea transportation
   - In-land transportation (port to jobsite)

D. Erection work
   - Main crane (250T crawler type)
   - Tail crane (50T mobile)

E. Civil works for wind farm substation

F. Testing and Commissioning work

G. Operation and maintenance (three years)

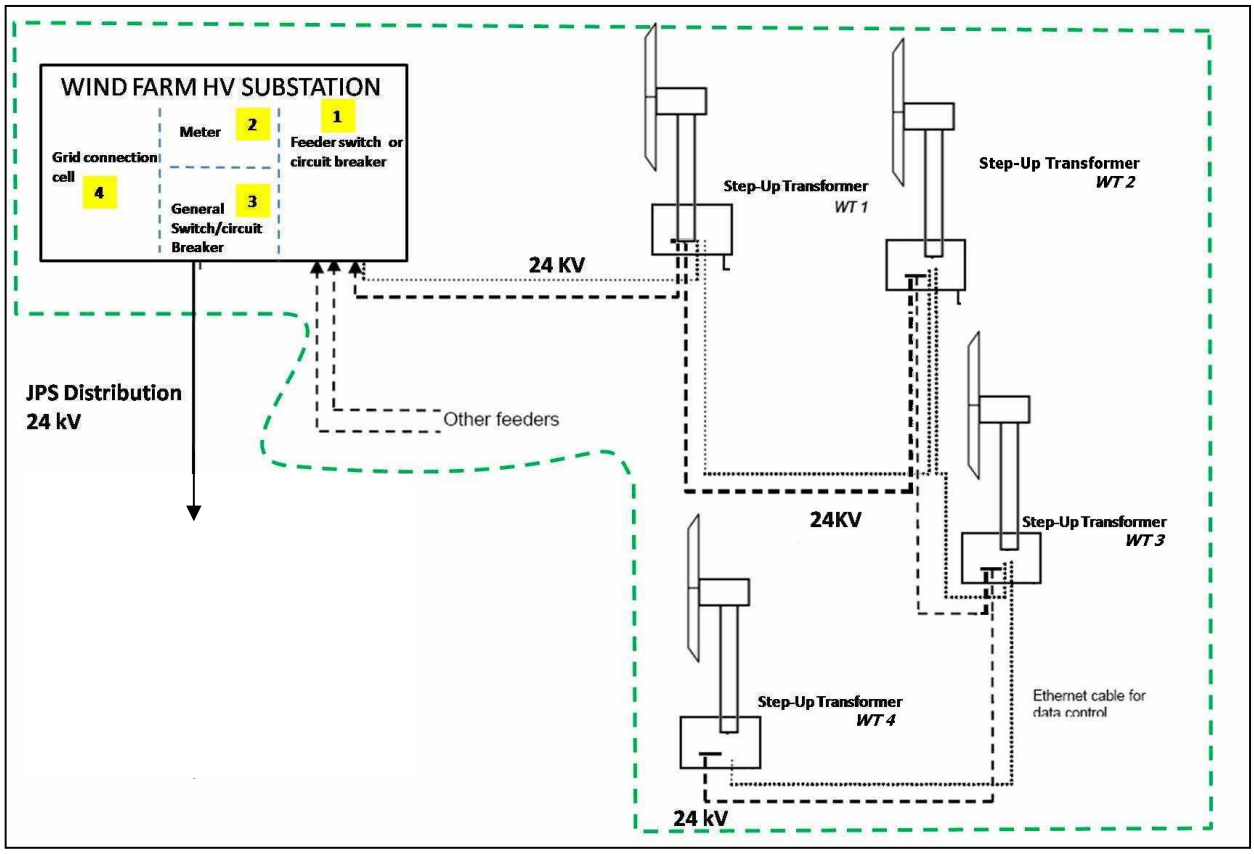
H. Training of JPS personnel

Unison Co. Ltd. has given special consideration to the following issues in the design and construction the wind turbines:

- Minimisation of adverse environmental impacts
- Disasters such as hurricanes, earthquakes and lightning strikes
- Protection of public infrastructure (roads, electrical grid, electrical poles)
- Optimisation and control construction management
- Compliance with local legislation, permits and licences

The Figure below shows a schematic of the proposed layout of the wind farm.

Proposed Layout of Wind Farm



Source: Jamaica Public Service Company Ltd.

Heavy duty equipment such as cranes will be imported by the contractor to construct the wind turbines. Special arrangements will be made at Port Esquivel, St. Catherine to offload the cranes and large components of the wind turbines.

The cranes and wind turbine components will be transported using low-boy trucks piloted by police outriders during the early morning hours (between 1:00 and 5:00 a.m.) to the site at Hermitage.

A number of traffic diversions will be required in order to facilitate the transportation as follows:

1. Traffic will need to be diverted at the Mandeville roundabout; rather than keeping left at the roundabout, the trucks will have to keep right to avoid the deep curve of the roundabout.
2. During the transportation of the equipment through Porus, traffic will need to be temporarily converted to one way. JPS will coordinate with the local police to ensure that appropriate traffic diversions are in place.
3. Due to an overhead railway at Nain, the low-boy trucks will have to divert from the main road and drive through a nearby housing scheme called Montpelier Sub-Division. JPS's Corporate Communications Department will ensure that the community is advised prior to the exercise and that the relevant safety precautions are in place.

Additionally two corners will be widened:

1. In the vicinity of the Munro Preparatory School there is a corner with a small radius of curvature which will require the road to be widened by about 1.2 m (4 feet) and the relocation of a JPS pole
2. In the district of Corby, there is a corner with a small radius of curvature which will require the road to be widened by about 1.8 m (6 feet).

JPS will provide support along the route to lift overhead power lines where required.

Roads will be constructed initially to provide access to the wind turbine sites during the construction phase. Permanent access roads will ultimately be constructed to enable access for maintenance during the operation phase.

The erection of each wind turbine will require the construction of a crane pad. The crane pad will have dimensions of 40m x 40m, occupying an area of 1600m^2 in each case. Total land area that will be cleared for crane pads (which includes the wind turbine plan area) is approximately 0.64 hectares. The crane pads are temporary and will be removed after construction of the wind turbines. A fence will be constructed around each turbine after it is erected for safety and security purposes.

The substation plan area is approximately 121m^2 and the construction lay down area for open freight storage of tools, rebar etc. is estimated to be 200 m^2. So an additional 321m^2 will be cleared.

The area to be cleared temporarily for the duration of the construction includes 0.64 hectares for the crane pads and 0.02 hectares for the construction laydown area, totalling 0.66 hectares.

The area to be permanently cleared includes 0.0121 hectares for the substation and 0.0265 hectares for the wind turbines, totalling approximately 0.04 hectares.

The lifespan of the wind turbines is 20 years. At the end of their useful life, they will be decommissioned and taken out of service.

Applicable Policies and Legislation

The national policy applicable to this project is the Energy Policy and the legislation applicable to this project include:

- Electric Lighting Act, 1890
- Jamaica Public Service Company All Island Licence, 2001
- The Office of Utilities Regulation Act, 1995
- The Natural Resources Conservation Act, 2001
- The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996
- The Natural Resources Conservation (Permits and Licences) Regulations, 1996

- The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004
- The Natural Resources Conservation, (Ambient Air Quality Standards) Regulations, 1996
- National Solid Waste Management Act 2001
- Town and Country Planning Act, 1957
- The Parish Council Building Act, 1901
- Main Roads Act, 1932

Impact Identification

The main activities to be undertaken for this project include:

- Construction Phase
  - Land Clearing
  - Construction (roads and wind turbines)
  - Transportation of heavy duty equipment, turbine parts and construction material
  - Operation of heavy duty equipment
  - Fuel storage and dispensing for heavy duty equipment
  - Stockpile of construction material
  - Commissioning
- Operation Phase
  - Turbine operation
  - Maintenance
- Decommissioning

The potential negative impacts associated with this project are presented in the Table below:

Potential Negative Impacts of Project

	ASPECT	**POTENTIAL NEGATIVE IMPACTS**
Construction phase		
1.	Noise	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
2.	Fugitive dust emissions	• Air pollution • Respiratory problems
3.	Vehicular emissions	• Air pollution • Respiratory problems
4.	Solid waste (top soil, vegetation, construction debris, garbage)	• Land and water pollution
5.	Human waste	• Land and water pollution
6.	Use of fuel	• Depletion of (oil) resources
7.	Removal of vegetation	• Habitat destruction • Disruption of ecosystems • Displacement of small farmers

	ASPECT	POTENTIAL NEGATIVE IMPACTS
8.	Soil erosion	• Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil
9.	Construction work	• Accidents causing death or injury
10.	Increased traffic movement	• Traffic congestion • Motor vehicle accidents
11.	Use of water	• Depletion of water resources
12.	Spills	• Land and water pollution
Operation Phase		
1.	Disruption of air traffic	• Plane crashes
2.	Lightning strikes	• Fires • Disruption in electricity supplies
3.	Flickering	• Health impacts – epilepsy in rare cases
4.	Diffraction/Shadowing, Reflection, Scattering	• Electromagnetic interference which can affect radar and radiocommunication
5.	Vibration	• False earthquakes detected on seismograph monitoring equipment
6.	Noise	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
7.	Oil spills/leaks	• Land and water pollution
8.	Disruption in avifauna flight patterns	• Bird and bat deaths
9.	Land use	• Alteration of development and land use in the area • Depreciation of land value
10.	Aesthetics	• Visually unattractive
Maintenance		
1.	Oil spills/leaks	• Land and water pollution
2.	Solid waste	• Land and water pollution
3.	Human waste	• Land and water pollution
4.	Maintenance work	• Accidents
Decommissioning		
1.	Solid waste	• Land and water pollution
2.	Noise from maintenance equipment	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
3.	Oil spills/leaks	• Land and water pollution
4.	Human waste	• Land and water pollution

Potentially beneficial impacts associated with the Project are presented in the following Table:

Potentially Positive Impacts

	ACTIVITY	POTENTIAL POSITIVE IMPACTS
Construction phase		
1.	Construction jobs	• Employment for locals • Increased commercial activities in the area
Operating Phase		
1.	Wind turbine operation	• A renewable source of energy is being used for electricity generation • Less pollution • Reduction in greenhouse gas emissions • Reduction in Jamaica's carbon footprint • Reduced cost to the country associated with the importation of oil • Reduced demand for foreign exchange to purchase imported oil • Promotion of the use of alternative energy • May become a tourist attraction

The following Table presents a summary of the significant aspects for the construction, operation, maintenance and decommissioning phases of the project. Most of the significant impacts identified are associated with the construction and decommissioning phases. The operations of the wind turbine have only one significant impact. In all cases the significant impacts can be mitigated.

Summary of Significant Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
Construction phase		
1.	Fugitive dust emissions & vehicular emissions • Air pollution • Respiratory problems	**NO**
2.	Noise • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	**YES**
3.	Solid waste (top soil, vegetation, construction debris, garbage) • Land and water pollution	**NO**
4.	Use of fuel • Depletion of (oil) resources	**NO**
5.	Human waste • Land and water pollution	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
6.	Removal of vegetation • Habitat destruction • Disruption of ecosystems • Displacement of small farmers	**NO**
7.	Soil erosion • Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil	**YES**
8.	Construction work • Accidents causing death or injury	**YES**
9.	Increased traffic movement • Traffic congestion • Motor vehicle accidents	**YES**
10.	Use of water • Depletion of water resources	**NO**
11.	Fuel and oil spills • Land and water pollution	**NO**
	Operation Phase	
1.	Disruption in air traffic • Plane crashes	**NO**
2.	Lightning strikes • Fires • Damage to wind turbines • Disruption in electricity supplies	**YES**
3.	Noise • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	**NO**
4.	Oil spills/leaks • Land and water pollution	**NO**
5.	Disruption in avifauna flight patterns • Bird and bat deaths	**NO**
6.	Land use • Alteration of development and land use in the area • Depreciate land value	**NO**
7.	Aesthetics • Visually unattractive	**NO**
8.	Flickering • Health impacts	**NO**
9.	Diffraction/Shadowing, Reflection, Scattering • Electromagnetic interference which can affect radar and radiocommunication	**NO**
10.	Vibration and noise • False earthquake signals	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
	Maintenance	
1.	Oil spills/leaks • Land and water pollution	**NO**
2.	Solid waste • Land pollution	**NO**
3.	Human waste • Land and water pollution	**NO**
4.	Maintenance work • Accidents causing death or injury	**NO**
	Decommissioning	
1.	Solid waste • Land and water pollution	**YES**
2.	Noise from equipment • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	**YES**
3.	Oil spills/leaks • Land and water pollution	**NO**
4.	Human waste • Land and water pollution	**NO**

Negative environmental impacts can be mitigated by implementing measures during the construction, operating, maintenance and decommissioning phases to eliminate or significantly reduce them.

Mitigation measures to address the potential negative impacts, significant or not, associated with this project are presented in the following Table.

Mitigation Measures for Negative Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
	Construction phase	
1.	Fugitive dust emissions & Vehicular emissions • Air pollution • Respiratory problems	• Cover haulage vehicles transporting aggregate, soil and cement • Cover onsite stockpiles of aggregate, cement, soil etc. • Ensure proper stock piling/storage and disposal of solid waste • Wet cleared land areas regularly • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. dust masks and ensure that they are worn • Operate well maintained vehicles and equipment
2.	Noise • Nuisance to persons • Habitat disturbance	• Advise schools and residents in the surrounding communities of construction dates and times • Ensure that construction activities are undertaken within the

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
	• Hearing impairment (temporary, permanent)	stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn
3.	Solid waste (top soil, vegetation, construction debris, garbage) • Land and water pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville • Landscape project sites with top soil excavated
4.	Human waste • Land pollution	• Use a reputable company to provide portable toilets for workers
5.	Soil erosion • Sediments in storm water runoff	• Only clear top soil from areas to be used • Place berms around stockpiles of top soil
6.	Construction work • Accidents causing death or injury	• Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures
7.	Increased traffic movement • Traffic congestion • Motor vehicle accidents	• Erect signs along main transportation route and in sensitive areas such as schools • Transport heavy equipment and wind turbine parts during off-peak traffic hours (between (2:00 to 4:00 a.m.) with police outriders • Trucks transporting construction material should be advised to comply with the speed limits • Use traffic signals or flagmen to manage traffic flows where road improvement works are being undertaken
8.	Fuel and oil spills • Land and water pollution	• Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site and dispose of waste in accordance with best practices
	Operation Phase	
1.	Lightning strikes • Fires • Damage to wind turbines • Disruption in electricity supplies	• Lightning arrestors and lightning masts are an integral part of the wind turbine installations
	Maintenance	
1.	Solid waste • Land pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville
2.	Human Waste • Land and water pollution	• Use a reputable company to provide portable toilets for workers
3.	Maintenance work • Accidents causing death or injury	• Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
Decommissioning		
1.	Solid waste • Land pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville
2.	Noise from maintenance equipment • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	• Advise schools and residents in the surrounding communities of decommissioning dates and times • Ensure that decommissioning activities are undertaken within the stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn
3.	Oil spills/leaks • Land pollution	• Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site and dispose of waste in accordance with best practices
4.	Human Waste • Land and water pollution	• Use a reputable company to provide portable toilets for workers

This project is recommended for implementation as positive impacts far outweigh the negative. Jamaica will benefit from power generated using clean, non-polluting technology while avoiding the cost associated with purchasing fuel using scarce foreign exchange.

**ENVIRONMENTAL IMPACT ASSESSMENT
FOR THE PROPOSED WIND ENERGY PROJECT AT HERMITAGE, ST. ELIZABETH, JAMAICA**

1.0 Introduction

The Jamaica Public Service Company Limited (JPS) received approval from the Office of Utilities Regulation (OUR) to construct four (4) 750 kW Wind Turbines at Hermitage, St. Elizabeth in response to their proposal for the Provision of Renewable Energy Based Power Generation Facilities on a Build Own and Operate (BOO) basis for the supply of electricity to the national electric grid for an initial period of twenty (20) years.

This Environmental Impact Assessment (EIA) has been prepared in accordance with Terms of Reference (TOR) approved by the National Environment and Planning Agency (NEPA). (Appendix 1).

1.1 Background and Project Rationale

Jamaica Public Service Company Limited (JPS) is the sole distributor of electricity in Jamaica. The company is a limited liability operation, incorporated in 1923 under the Companies Act of Jamaica with the expressed purpose of generating, transmitting and distributing electricity.

The company is 80% privately owned: Marubeni Corporation 40% and Abu Dhabi National Energy Company (TAQA) 40%. The Government of Jamaica has a 19% stake and 1% of the company's shares is owned by a number of individual and institutional investors. The company generates approximately 70% of the electrical energy it supplies to consumers and is the sole retailer of electric power in Jamaica, operating under a 20 year All-Island Electric License granted in 2001.

JPS has embarked on this initiative to provide electricity using renewable energy in keeping with the Government of Jamaica's (GOJ's) policy to reduce the country's dependence on imported fossil fuels as an energy source.

Analysis of data on fuel consumption in Barrels of Oil Equivalent (BOE) contained in the Planning Institute of Jamaica (PIOJ) Economic and Social Survey of Jamaica 2008 (ESSJ, 2008) indicated that about 99.5% of energy demand was covered by imported fuel (petroleum and coal) and only 0.5% was served from indigenous sources which consists of hydropower, wind, bagasse and fuel wood/charcoal. Contributions from other indigenous energy resources such as peat, lignite, and solar energy were negligible but were expected to increase over time with the implementation of more alternative energy initiatives and conservation measures nationally by householders, commercial and industrial entities. The major part of the imported fuel was consumed in the industrial and transportation sectors whereas about 22.8 % was used for electricity generation (ESSJ, 2008).

Information in the ESSJ, 2008 also indicated that the total electricity generation in 2008 was 4,123.3 gigawatt hours (GWh[1]). While total fuel consumption declined by 3.1% in 2008 when compared to 2007, total fuel cost rose by 42.8% to J$37.7 billion, reflecting higher crude oil prices on the international market as well as depreciation in the local exchange rate. The bulk of this cost was passed on to consumers through monthly adjustments in electricity rates. Table 1 and Figure 1 show the variation in crude oil prices for 2008 and 2009 based on the West Texas Intermediate Crude Oil Prices to which Jamaica's fuel prices are linked.

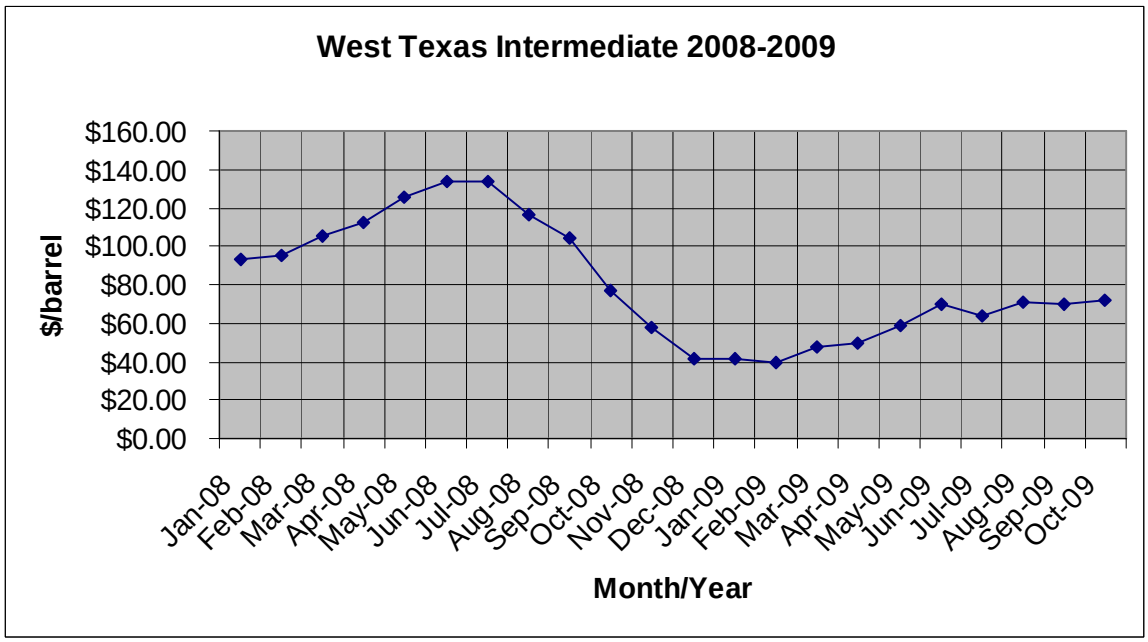
Table 1 - Spot Oil Price: West Texas Intermediate January 2008 - September 2009

Month/Year	US$/barrel
Jan-08	$92.95
Feb-08	$95.35
Mar-08	$105.56
Apr-08	$112.57
May-08	$125.39
Jun-08	$133.93
Jul-08	$133.44
Aug-08	$116.61
Sep-08	$103.90
Oct-08	$76.65
Nov-08	$57.44
Dec-08	$41.02
Jan-09	$41.74
Feb-09	$39.16
Mar-09	$47.98
Apr-09	$49.79
May-09	$59.16
Jun-09	$69.68
Jul-09	$64.09

Source: Economagic.com

[1] 1 Gigawatt hour = 1 million kilowatt hours

Figure 1 – Spot Oil Price: West Texas Intermediate January 2008 - September 2009



Source: Graph generated by Environmental & Engineering Managers Ltd. from Table 1

In order to diversify Jamaica's energy sources by using more indigenous sources and to reduce the demand for foreign exchange, the Government in its Energy Policy 2009-2030 developed by the Ministry of Energy and Mining, has set a target for renewable sources to make up at least 20% of the energy production by 2030.

Proposed targets for renewable energy sources (Jamaica's Energy Policy 2009-2030):

- **11% by 2012**
- **12.5% by 2015 and**
- **20% by 2030**

In March 2008, the Office of Utilities Regulations (OUR) issued a public tender for renewable projects as part of the Government of Jamaica's (GOJ's) policy initiative (at the time) to achieve 15% of electricity generation from renewable sources by 2015. In response to the tender JPS prepared submissions for both wind and hydropower renewable energy plants. JPS engaged the services of US-based Wind Energy Consulting & Contracting Inc. (WECC) to undertake wind studies to determine the most suitable sites for the development of wind generation facilities. The sites assessed included Palisadoes, Kingston; Munro, St. Elizabeth and Hellshire, St. Catherine. Additionally hydropower sites at Maggotty, St. Elizabeth and Great River, Hanover were also under consideration by the JPS. A Rapid Environmental Assessment (REA) was conducted of these wind and hydropower sites by Environmental & Engineering Managers Limited which formed a part of the submission to the OUR. JPS was advised by the OUR in October 2008, that two (2) of its proposed projects were successfully evaluated, namely the *3MW Wind Farm Development in Munro and 6.3MW Maggotty Hydropower Plant Expansion.* The timeline for the bidding and award process is outlined in Table 2.

Table 2 - Timeline for OUR Bids

Activity	Date
OUR invited proposals for alternative energy electricity generation	March 25, 2008
JPS responded to the RFP	July 24, 2008
Formal bid opening and notification from OUR to JPS regarding result of bid	July 24, 2008
Letter from OUR to JPS confirming bid results	Letter dated September 24, 2008
Letter of award	October 28, 2008

JPS views its role as it relates to renewable energy from the following perspectives:

1. To practically and publicly demonstrate its commitment to renewable energy development in Jamaica.
2. To increase public awareness of the possibilities and benefits of renewable energy
3. To strategically position itself for future exploitation of renewable wind energy by continuously conducting research into the identification and development of locations with renewable energy potential.
4. To contribute to lower heat rate and lower fuel cost to the consumers

The use of wind turbines to generate electricity has tremendous benefits since wind is abundant, renewable, widely distributed, clean and reduces net greenhouse gas emissions on the island. Most importantly is the fact that there are no associated fuel costs with the operation of wind turbines. Jamaica's geographic position and climate are conducive to economically feasible wind energy production since the predominant trade winds guarantee a relatively good supply of wind throughout most of the year.

The 3-megawatt (MW) turbine wind farm will be the first wind project to be built by JPS and will be used as a pilot, with plans for future expansion.

2.0 Project Description

JPS plans to install four (4) -750kW wind turbines at Hermitage, St. Elizabeth. Hermitage is situated south of Malvern near to Munro Preparatory School. Refer to Figure 2, Figure 3 and Figure 4.

The project is estimated to cost US$9 million with projected annual fuel savings of US$1.7 million (at 2008 fuel prices). The construction phase will last 9-12 months (Refer to Appendix 2 for the Gantt Chart with the Project Schedule). The lifespan of the wind turbines is 20 years.

In the future, JPS plans to increase the amount of electricity produced from renewable sources by expanding the proposed 3 MW wind farm at Hermitage by an additional 20 MW. Two meteorological stations will be installed to conduct on-site wind studies over a period of 2 years (2010 to 2012), to facilitate the selection of additional sites for wind turbines. Contingent on the results, an additional 20 to 25 turbines may be installed.

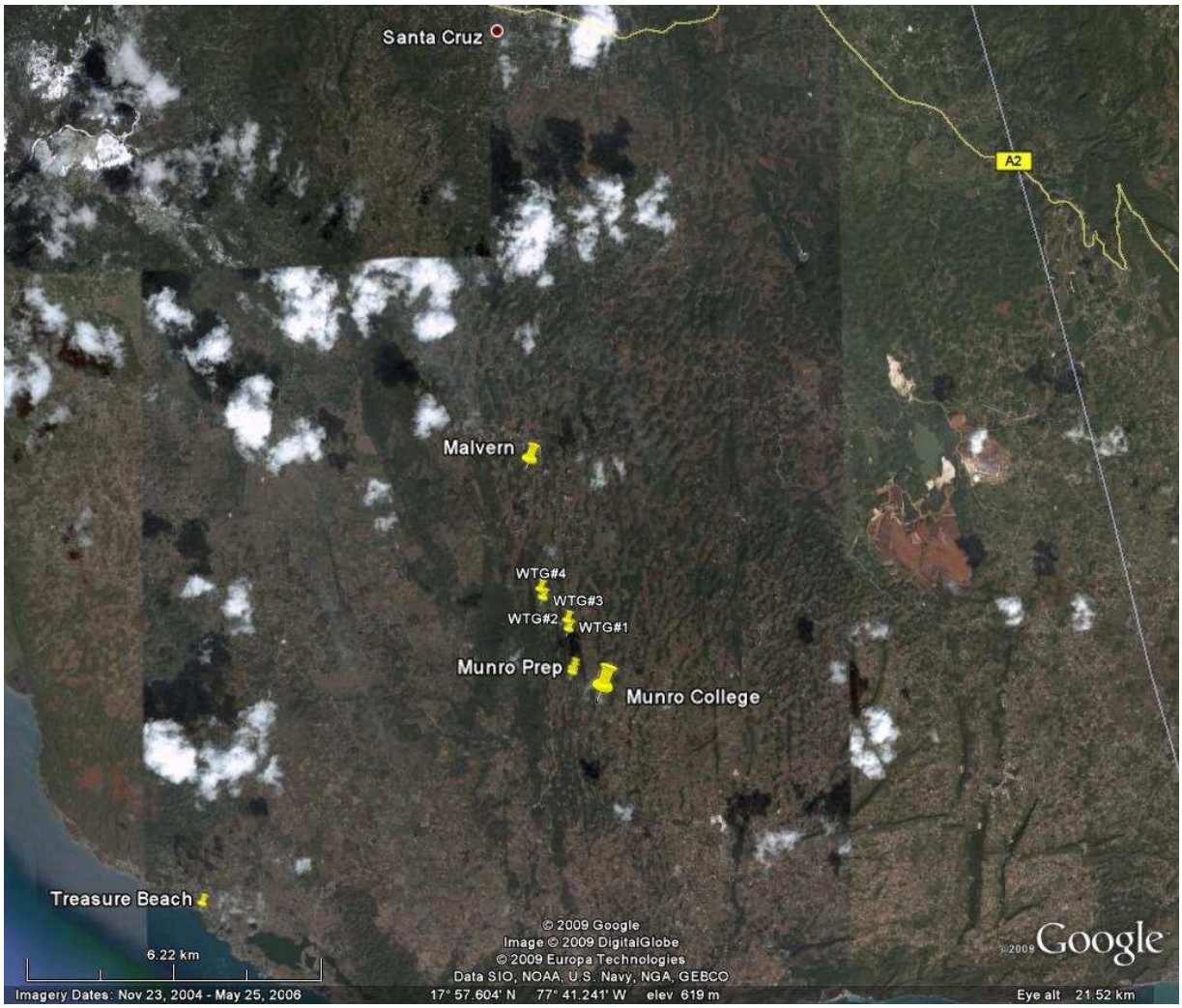
The project description is summarised at Table 4.

Figure 2 - Location of Proposed Wind Turbine Sites at Hermitage

Source: www.zonu.com/jamaica_maps/Jamaica_Political_Map_4.htm, with modifications by Environmental and Engineering Managers Limited, 2008

Figure 3 - Hermitage, St. Elizabeth

Figure 4 - Proposed Wind Turbine Sites and Surrounding Areas of Geographic Importance



Coordinates of the proposed wind turbine sites are as indicated in Table 3.

Table 3 - Coordinates of Wind Turbine Sites

WTG NO.	UTM WGS84 Zone18			JAD 2001		
	X	Y	Z	X	Y	Z
WTG #1	214773	1985150	720	676631	643034	720
WTG #2	214749	1985328	720	676605	643211	720
WTG #3	214259	1985799	690	676111	643677	690
WTG #4	214209	1985973	690	676059	643850	690

Table 4 - Summary of Project Description

Name of site	Hermitage, St. Elizabeth
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2.1 Project Design Elements

A wind turbine is a rotating machine which converts the kinetic energy of wind into mechanical energy which can in turn be converted to electricity. There are two main kinds of wind generators, those with a vertical axis, and those with a horizontal axis. In this case the horizontal axis wind turbine will be installed, which is the type most widely used commercially. Wind turbines can be used to generate large amounts of electricity in wind farms both onshore and offshore.

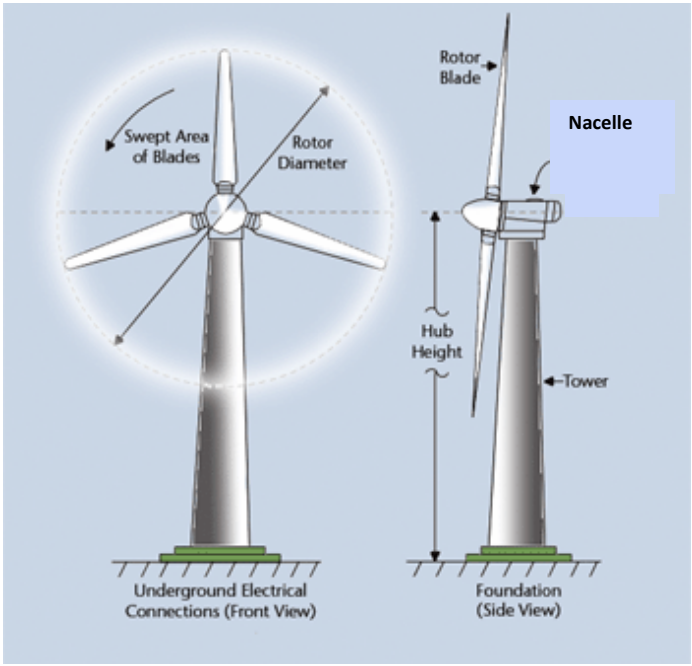
A wind turbine installation consists of sub-systems to catch the wind's energy, point the turbine into the wind, convert mechanical rotation into electrical power, and systems to start, stop, and control the turbine.

UNISON Co., Ltd. has been selected by the JPS to design, supply and construct the wind turbines for this project. The technical specifications of the wind turbines are described in Table 5 and the structure and components are illustrated at Figure 5 and Figure 6 respectively.

Table 5 - Technical Specifications of Wind Turbines

Manufacturer and Supplier	UNISON Co., Ltd.
Type	Horizontal axis, Upwind
Nominal output rating	750 kW (Model No. U50)
Hub height	50 m
Rotor diameter	50 m
Design class	IEC IA
Rotation speed	9~28 rpm
Generator type	Permanent Magnet Synchronous 12
Drive train	Direct drive system (gearless)
Operating range	
• Cut in speed	3 m/s
• Rated speed	12 m/s
• Cut out speed	25 m/s
Power control	Pitch regulation
Power converter type :	AC/DC/Ac Inverter
Controller	Programmable Logic Controller
SCADA	Web based
Lightning protection	One (1) receptor, internal ground conductor
Tower	Tubular steel tower between 45 and 65 m high (2 sections + embedded section)
Blade material	Glass fibres & epoxy resin with a thin layer of gel coating/paint which serves as protection against erosion and UV light
Hub material	Ductile cast iron material

Figure 5 - Wind Turbine Structure



Drawing of the rotor and blades of a wind turbine, courtesy of ESN

Figure 6 - Wind Turbine Components

Source: Unison Co. Ltd.

Design Considerations

The following general and design point information was used for the plant design:

Wind Turbine elevations	Approx 690 to 720 meters above mean sea level
Winter ambient condition	17°C
Summer ambient condition	36°C
Annual humidity	Range 60 - 95 %
Design point conditions	28°C, 75 % Relative Humidity (RH)
Maximum wind speed/prevalent direction	241 km/hr / from the east
Wind speed, monthly average	22.5 km/hr
Seismic factor	In accordance with UBC 1997, Vol. 2 Seismic Zone 3 Table 16-k Seismic Importance factor I is 1.25 Table 16-k Seismic Importance factor Ip is 1.50 Wind Importance Factor Iw is 1.15 or equivalent IBC latest International Building Code

Average Wind Speed (AWS) reference measurement

AWS reference data from the Sangster International Airport (SIA) and Norman Manley International Airport (NMIA) provided by JPS for a period of 32 years was used for the design of the wind farm as there was no meteorological station near to the proposed sites. Table 6 gives the location and measuring period of AWS measurements.

Table 6 – AWS at Norman Manley and Sangster International Airports (Long-term)

Station	**Coordinate (latitude / longitude)**	**Measuring height**	**Data period**	**Distance**
Sangster International Airport	(18.4724N/ 77.9262W)	9m	1977.05~2008.05 (32y)	63km
Norman Manley International Airport	(17.9429N/ 76.8116W)	9m	1977.05~2008.05 (32y)	96km

Table 7 - Summary statistics of short-term measurement at Munro College

	Norman Manley Int. Airport (NMIA)	Sangster Int. Airport (SIA)
Measurement height m	9	9
Data interval min	60 (1hour)	60 (1hour)
Measurement period yyyy.mm	1977.05~2008.05	1977.05~2008.05
Data recovery rate %	77.6	63.8
Mean wind speed at top height m/s	2.96	2.53
Weibull shape parameter (A) m/s	3.32	2.85
Weibull scale parameter (k) -	1.699	1.806

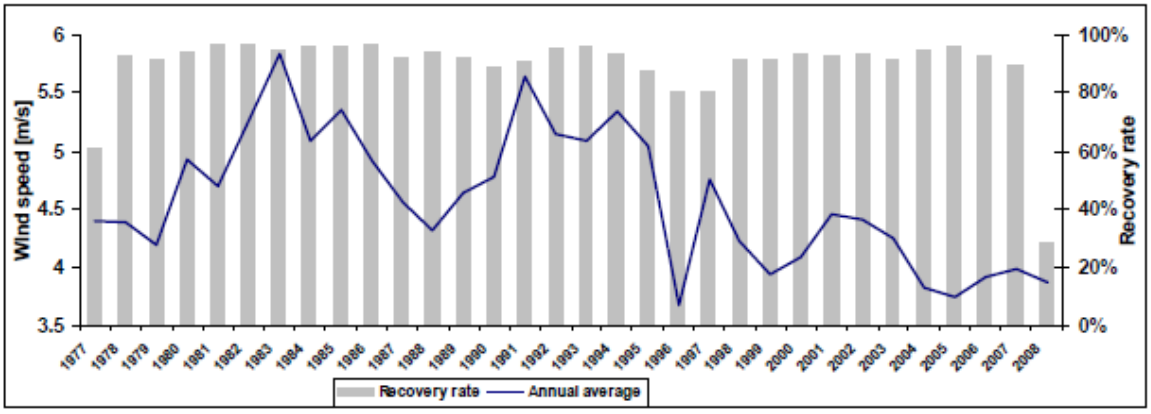
Long-term correlation

In order to get a reliable prediction of future wind conditions, it was necessary to compare the short-term data to a long-term data set and a representative period of the past. For this, correlations with consistent long-term reference data (or a suitable yield index) were required.

The meteorological station at the NMIA in Kingston was identified as a suitable long-term data source (Figure 7) to correlate with the Munro short-term wind measurement data.

The ten year period from 01/08/1996 – 31/07/2006 was referenced for the long-term correlation. In this period the average value was lower compared to the 20 years preceding 1996. The trends with recurring peaks before 1996 were not confirmed by the 10 year period after 1996. Additionally, considering the technical measurement equipment, the relocation and reconfiguration of the measurement station and having no precise information about the dates, the 10 year period after 1996 was considered the most reliable and consistent of the measurement campaign. Moreover considering the ten years (from 1996 onwards) led to a conservative approach for the long-term referencing.

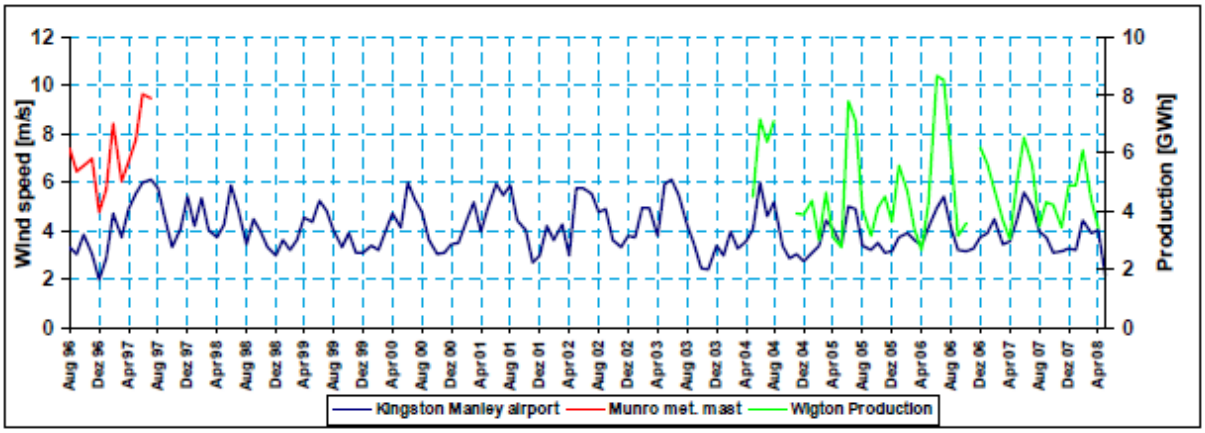
Figure 7 - Annual averages and data recovery of wind speed at Norman Manley International Airport (1977 – 2008)



Source: Unison Co. Ltd.

Figure 8 shows the concurrent time period of the Munro measurement mast (red), Wigton pooled wind energy production (green) and the long-term period of the NMIA station (blue). Munro measurement data as well as Wigton production correlated well with the NMIA data and confirmed the chosen reference period.

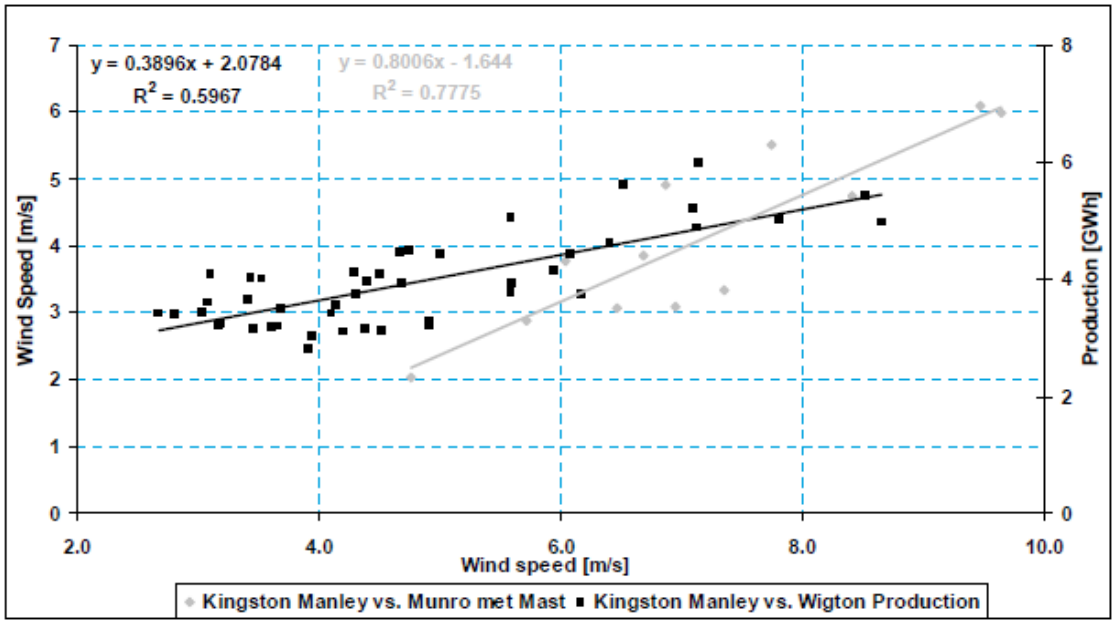
Figure 8 - Concurrent time period and considered wind speed prediction horizon, monthly averages



Source: Unison Co. Ltd.

Figure 9 presents scatter plots of the concurrent time period on the basis of monthly averages and daily averages.

Figure 9 – Norman Manley Int. Airport vs. Munro met Mast & Norman Manley Int. Airport vs. Wigton Production



Source: Unison Co. Ltd.

The correlation analysis on the basis of monthly values confirmed the interconnection of the data sets for the concurrent time period. Therefore it was assumed that both data sources followed the same long-term trends.

For Munro meteorological mast the measured mean wind speed was determined to be 7.18 m/s based on 12 months of measurement with a recovery rate of 100%. For the same period the recorded average wind speed at the NMIA station was 4.10 m/s.

For the reference period the average wind speed for NMIA was determined to be 4.13 m/s based on ten years of measurement considering a recovery rate of 91%. Inserting the long term average wind speed of the NMIA station into the regression line function led to a slightly increased speed of 7.21 m/s at 30 m above ground for the Munro long term measurement. The available measured time series of 13.2 months was analysed by calculating daily moving averages throughout an annual time period. The purpose was to find a period which represented the evaluated long term wind speed of 7.21 m/s for the Munro measurement. The time period 14/08/1996 to 13/08/1997 was identified with an average value of 7.21 m/s (average of time series) and was therefore considered as the annual long-term representative time interval.

Wigton long-term production data was also compared and correlated to 10 years of NMIA data. The evaluated long-term production at Wigton wind farm was compared to energy production estimations by the wind flow and energy calculation models. This comparison resulted in a slight underestimation of the evaluated long-term energy production at Wigton. This confirmed the assumed model parameters and indicated a conservative approach.

Energy yield calculation for job site

To calculate the gross energy of the turbines, a combination of two programmes were utilised, WindPro to design the wind farm, including wind turbine layout and electrical design and the simulation model WAsP[2] for the meteorological calculations. Both programmes are designed to supplement each other and therefore create an effective simulation tool. Wind flow modelling was carried out to determine the hub height wind speed variations over the site relative to the anemometry masts. The variation in wind speed was predicted using WAsP computational model.

The elevation of the site varies between 690m and 720m above sea level, the hub height used is 50m. Standard air density of 1.106 kg/m^3 was applied to the calculation.

The summary of energy yield for Munro site (750kW – 4 units) is shown in Table 8.

Table 8 - Summary of energy yield calculation for Munro site

WTG	Gross – AEP [MWh/y]	Net Output [MWh/y]	Capacity Factor (%)	Park Efficiency (%)	Mean Wind Speed (m/s)
1	2,395.5	2,156	35.4	100.0	7.7
2	2,468.2	2,221		99.9	7.9
3	2,708.9	2,438		99.7	8.3
4	2,777.4	2,500		99.9	8.5
Total	**10,350.0**	**9,315**	**35.4**	**99.9**	**8.1**

Source: Unison Co. Ltd.

Civil Works

The other works to be executed include civil works (site preparation and access roads), electrical works, transportation and erection of the wind turbines and construction of the wind farm substation. Unison Co. Ltd. will also provide training to JPS personnel, test and commission the turbines, and maintain them for three (3) years. Overall Project Management, Quality Control and Assurance (QC/QA) and Environment, Health and Safety Management work will be provided for all activities.

[2] WAsP – Wind Atlas Analysis and Application Programme

A. Civil works
   - Site measurement
   - Site preparation
   - Access road construction
   - Crane pad construction
   - Excavation
   - Re bar fabrication
   - Concrete pouring
   - Backfilling
   - Drainage
   - Fence work
   - Restoration work
   - Waste management

B. Electrical work
   - Earthing work
   - Cabling work (power cable, communication cable)
   - Installation of switchboards at wind farm substation
   - Grid connection (24kV) to JPS distribution

C. Transportation (crane and wind turbine components)
   - Sea transportation
   - In-land transportation (port to jobsite)

D. Erection work
   - Main crane (250T crawler type)
   - Tail crane (50T mobile)

E. Civil works for wind farm substation

F. Testing and Commissioning work

G. Operation and maintenance (three years)

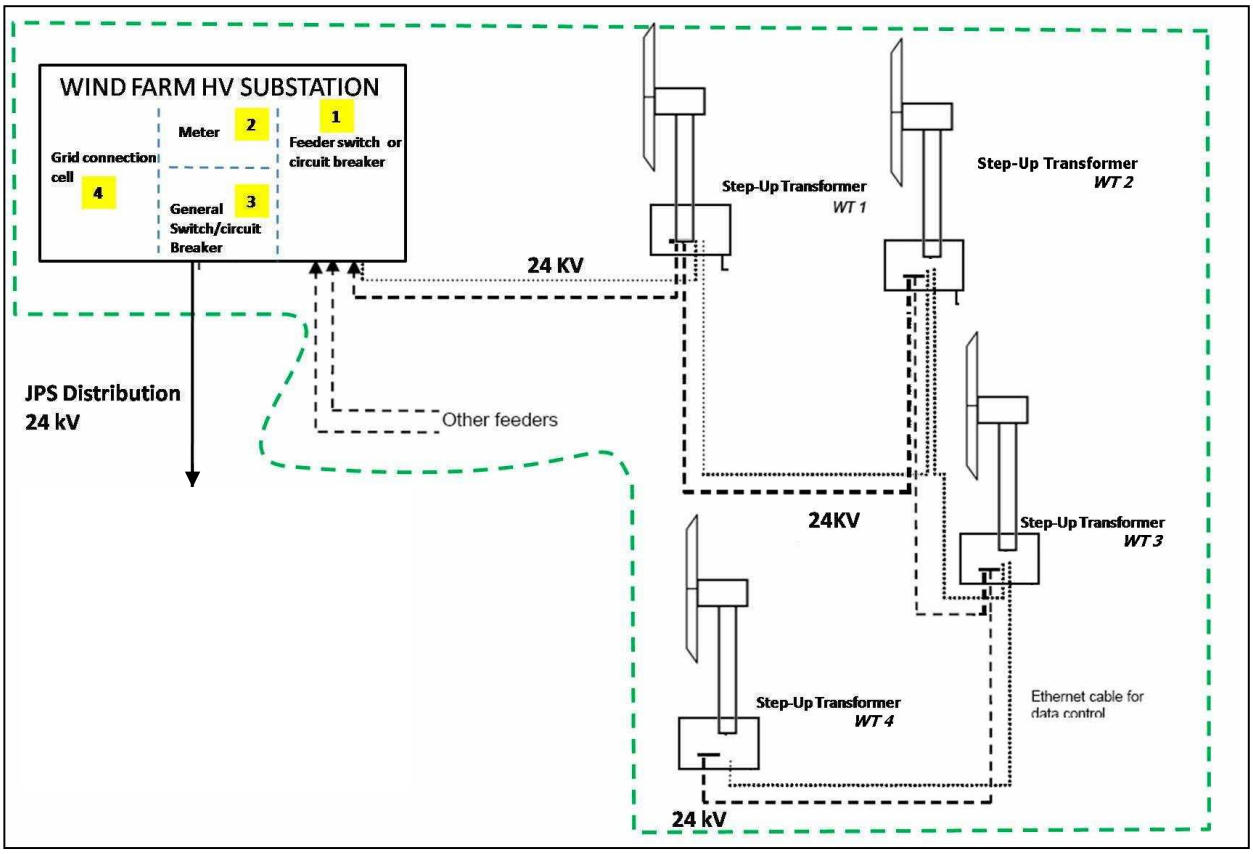
H. Training of JPS personnel

Unison Co. Ltd. has given special consideration to the following issues in the design and construction of the wind turbines:

- Minimisation of adverse environmental impacts
- Disasters such as hurricanes, earthquakes and lightning strikes
- Protection of public infrastructure (roads, electrical grid, electrical poles)
- Optimisation and control of construction management
- Compliance with local legislation, permits and licences

Figure 10 shows a schematic of the proposed layout of the wind farm.

Figure 10 - Proposed Layout of Wind Farm



Source: Jamaica Public Service Company Ltd.

2.2 Transportation and Road Widening

Heavy duty equipment such as cranes will be imported by the contractor to construct the wind turbines. Special arrangements will be made at Port Esquivel, St. Catherine to offload the cranes and large components of the wind turbines.

The cranes and wind turbine components will be transported using low-boy trucks piloted by police outriders during the early morning hours (between 1:00 and 5:00 a.m.) to the site at Hermitage.

A number of traffic diversions will be required in order to facilitate the transportation as follows:

1. Traffic will need to be diverted at the Mandeville roundabout; rather than keeping left at the roundabout, the trucks will have to keep right to avoid the deep curve of the roundabout (Figure 11).
2. During the transportation of the equipment through Porus, traffic will need to be temporarily converted to one way. JPS will coordinate with the local police to ensure that appropriate traffic diversions are in place.

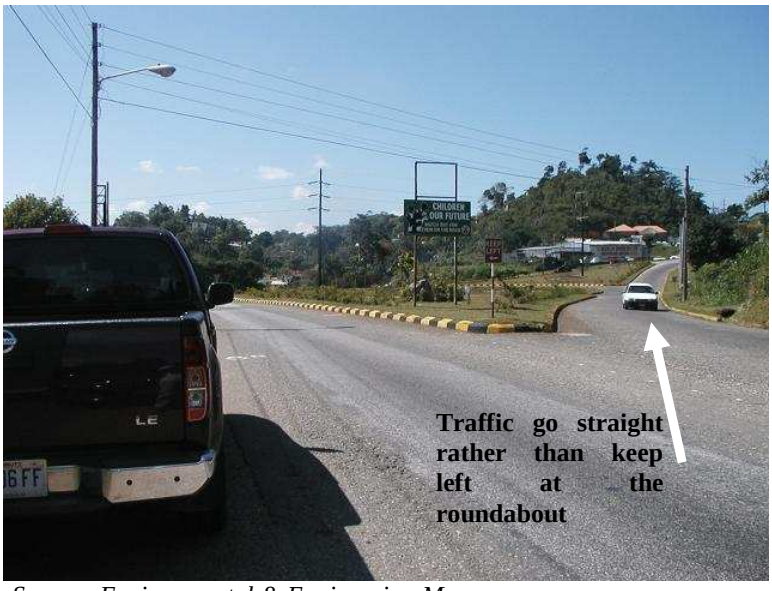
3. Due to an overhead railway at Nain, the low-boy trucks will have to divert from the main road and drive through a nearby housing scheme called Montpelier Sub-Division. JPS's Corporate Communications Department will ensure that the community is advised prior to the exercise and that the relevant safety precautions are in place.

Additionally two corners will be widened:

1. In the vicinity of the Munro Preparatory School there is a corner with a small radius of curvature which will require the road to be widened by about 1.2 m (4 feet) and the relocation of a JPS pole (Figure 13)
2. In the district of Corby, there is a corner with a small radius of curvature which will require the road to be widened by about 1.8 m (6 feet) (Figure 14).

JPS will provide support along the route to lift overhead power lines where required.

Figure 11 - Mandeville Roundabout



Source: Environmental & Engineering Managers

Figure 12 - Location Map for corners to be widened

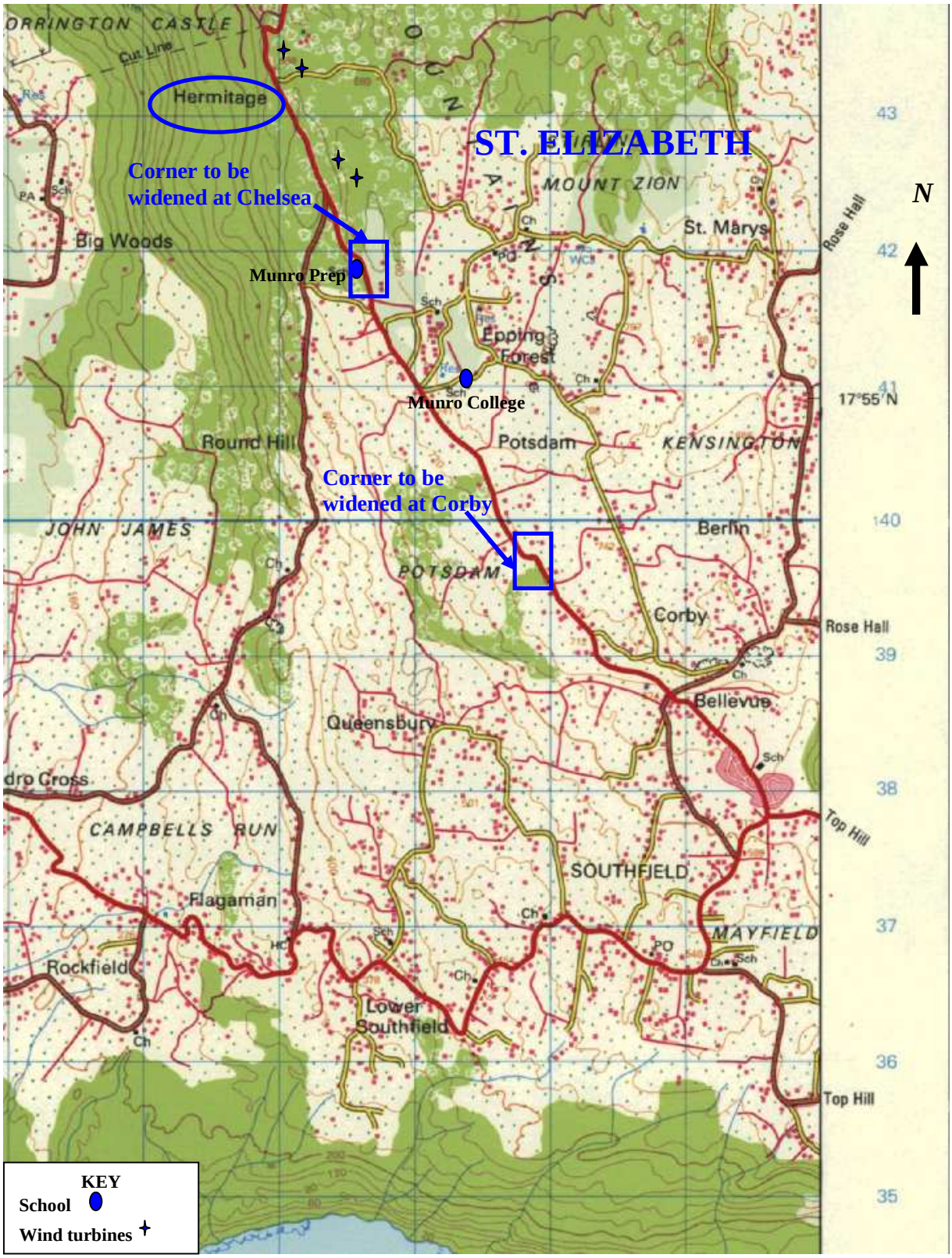


Figure 13 - Corner to be widened near Munro Prep

Source: Environmental & Engineering Managers

Figure 14 - Corner at Corby District

Source: Jamaica Public Service Company Ltd.

2.3 Access Road Construction

Roads will be constructed initially to provide access to the wind turbine sites during the construction phase. Permanent access roads will ultimately be constructed to enable access for maintenance during the operation phase.

Table 9 shows the length and area of the access roads to be constructed. Approximately 0.6 hectares of land will be cleared for access roads to the project sites.

Table 9 - Length and Area of Access Roads

Description	Length (m)	Area (m^2)	Remark
Access Road - A	647.95	3887.70	For WTG #1 & 2
Access Road - B	130.38	782.28	For WTG #3
Access Road - C	198.03	1188.18	For WTG # 4
TOTAL	**967.36**	**5858.16**	

Figure 15, Figure 16 and Figure 17 show the layout of the access roads as well as the details.

Figure 15 - Access Road Plan

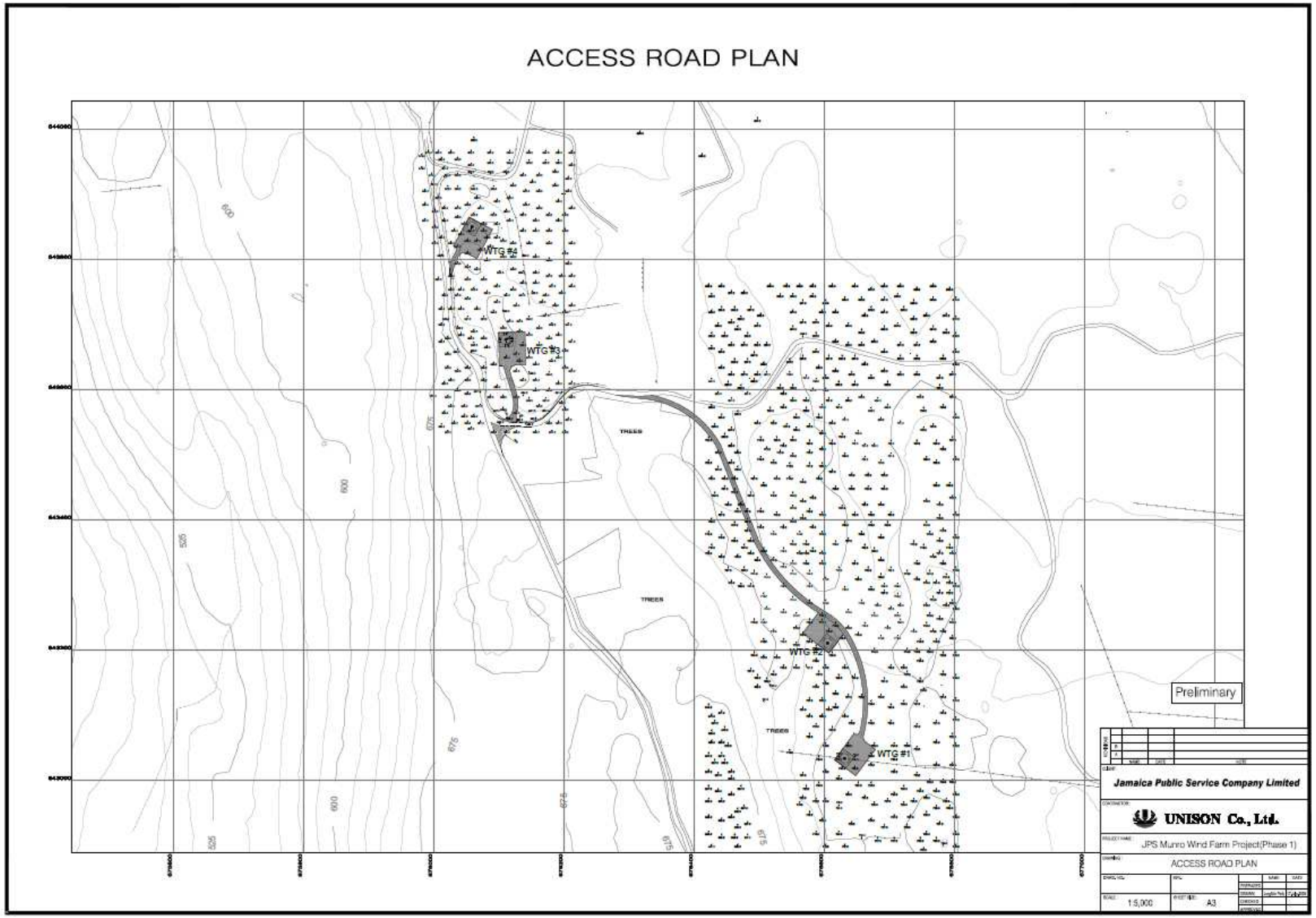


Figure 16 - Access Road Detail - 1

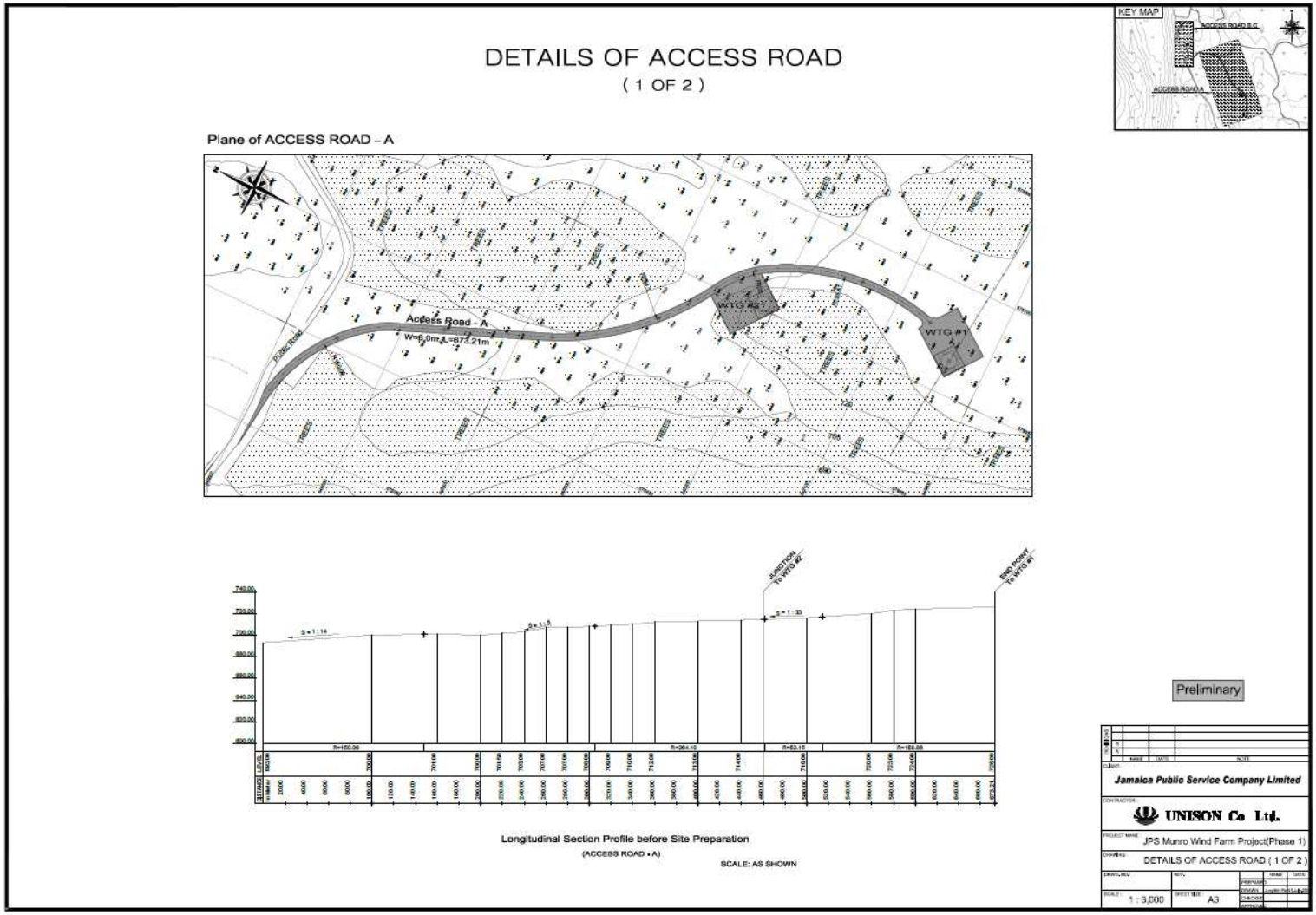
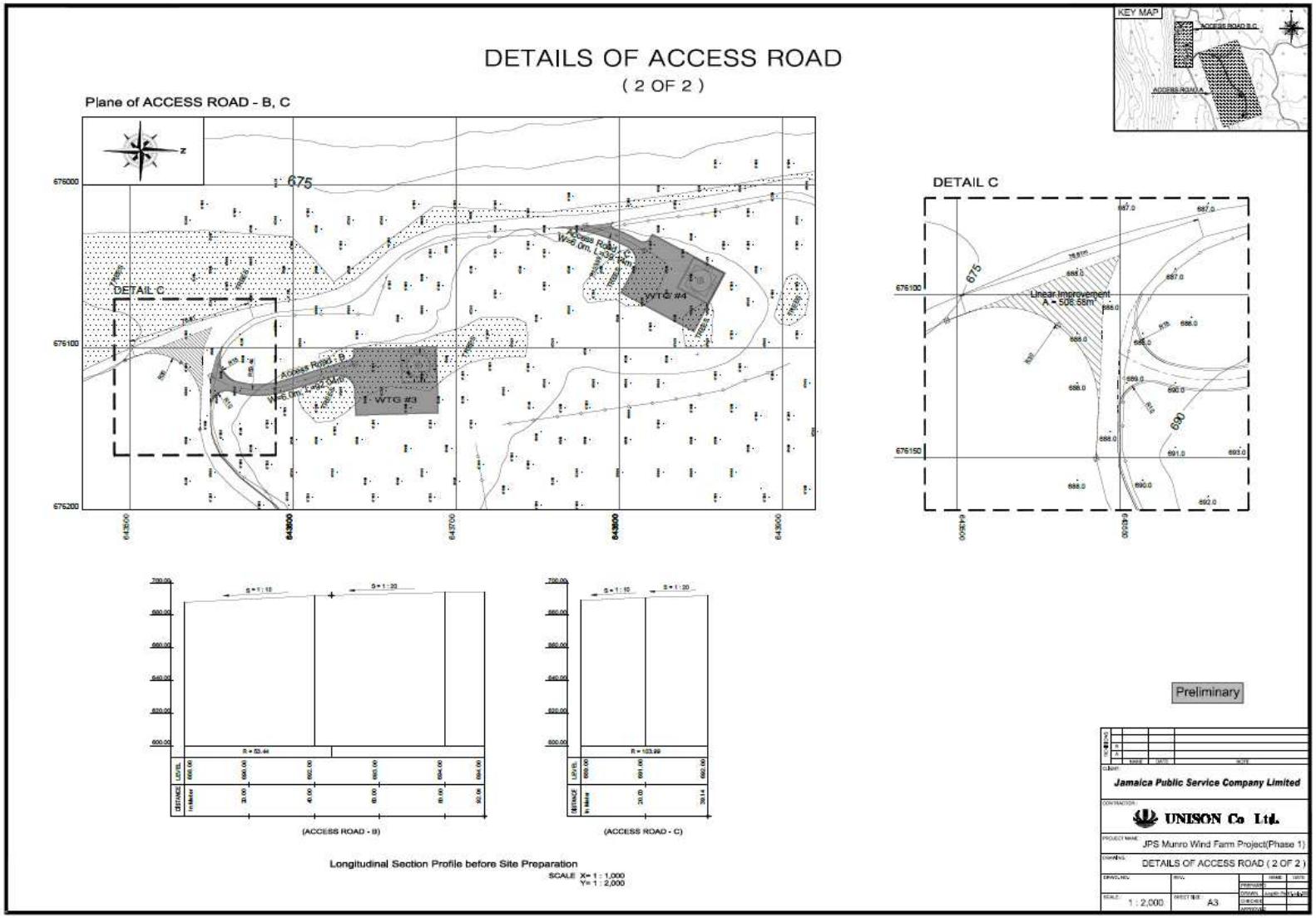


Figure 17 - Access Road Detail -2



2.4 Land clearing for Wind Turbines

The erection of each wind turbine will require the construction of a crane pad. The crane pad will have dimensions of 40m x 40m, occupying an area of 1600m^2 in each case (Figure 18 and Table 10). Total land area that will be cleared for crane pads (which includes the wind turbine plan area) is approximately 0.64 hectares. The crane pads are temporary and will be removed after construction of the wind turbines. A fence will be constructed around each turbine after it is erected for safety and security purposes.

Figure 18 - Typical Crane Pad Layout for each Wind Turbine

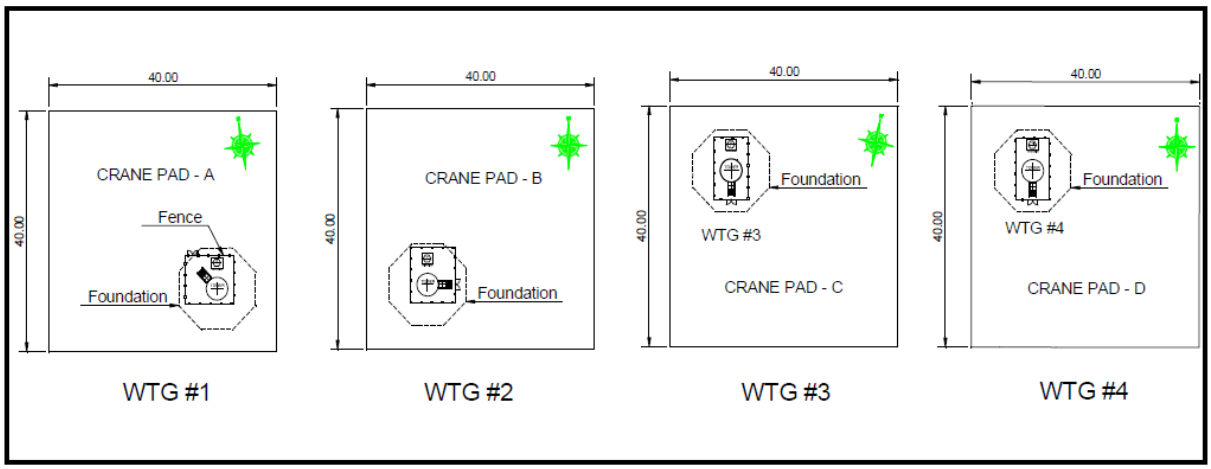


Table 10 - Dimensions of Crane Pad and Fencing around Wind Turbines

Description	Crane Pad (m^2)	Fenced Area (m^2)
WTG - 1	1600	68.64
WTG – 2	1600	70.74
WTG - 3	1600	61.24
WTG – 4	1600	61.24
Total	**6400**	**264.86**

The substation plan area is approximately 121m^2 and the construction lay down area for open freight storage of tools, steel etc. is estimated to be 200 m^2. So an additional 321m^2 will be cleared.

The area to be cleared temporarily for the duration of the construction includes 0.64 hectares for the crane pads and 0.026 hectares for the construction laydown area, totalling 0.67 hectares.

The area to be permanently cleared includes 0.0121 hectares for the substation and 0.0265 hectares for the wind turbines, totalling approximately 0.04 hectares.

2.5 The Project Team

The organisational chart for JPS is shown at Figure 19. Unison is the contractor that will undertake the Project and their organisation chart is shown at Figure 20.

Figure 19 - JPS Organisation Structure for Construction

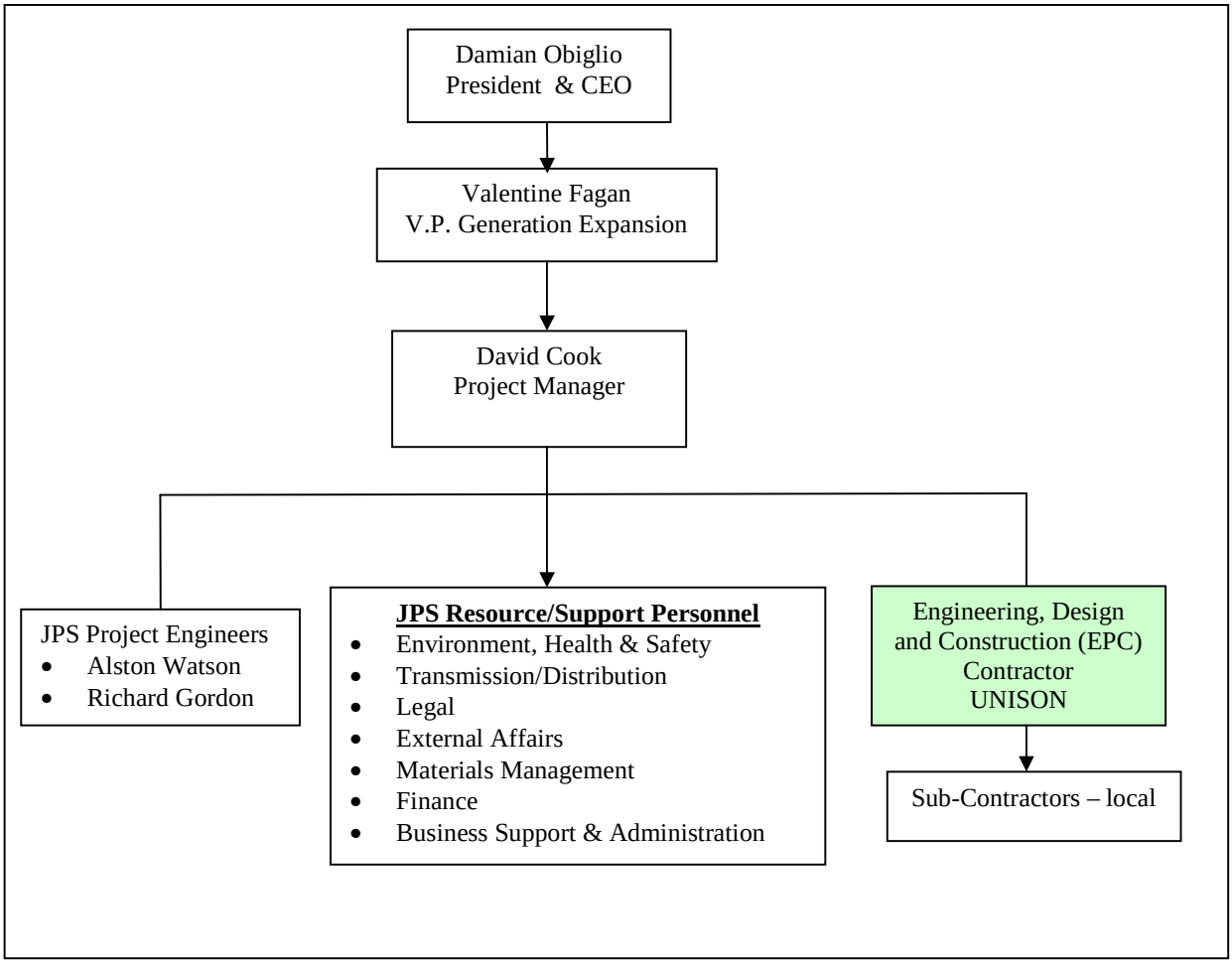
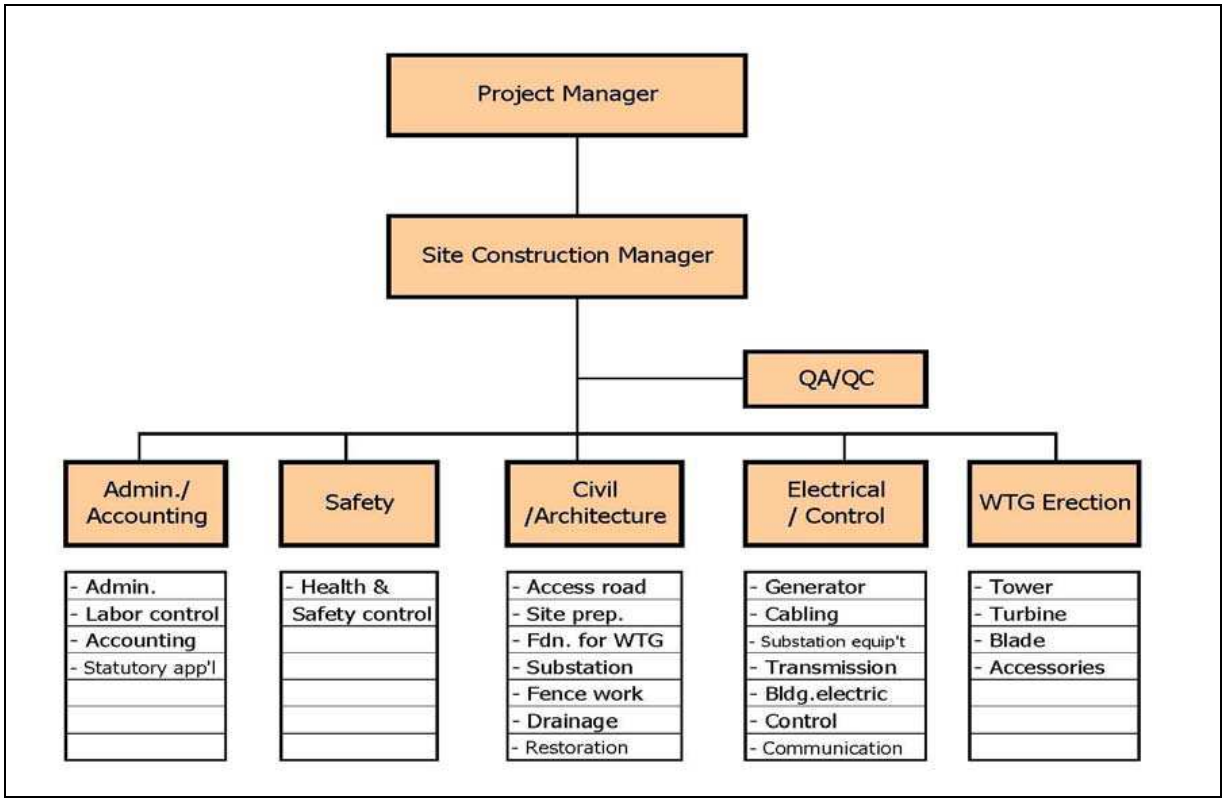


Figure 20 - Organisational Chart for the Construction Team



2.6 Decommissioning

The lifespan of the wind turbines is 20 years. At the end of their useful life, they will be decommissioned and taken out of service along with the substation.

Skilled contractors will be used to dismantle the wind turbines and the substation and every effort will be made to reuse useful parts. Where components can be sold or given away as scrap, this will be done. The remaining parts will be disposed of at an approved disposal site.

3.0 Regulatory Framework

This section on the regulatory framework highlights the policies and legislation that are applicable to wind power projects.

3.1 Applicable Policies

The national policy applicable to this project is the Energy Policy. It is currently a White Paper, approved by Cabinet and to be presented in Parliament

The National Energy Policy (2009-2030)

Jamaica has an Energy Policy because of the country's:

- Heavy oil dependence
- High demand for foreign exchange
- Underdeveloped indigenous energy sources
- Inefficient use of energy
- Increasing pollution contributing to climate change

The policy seeks to, among other things:

- Manage the energy supply,
- Diversify the energy base,
- Encourage conservation and efficiency in energy production and use,
- Make electricity available and affordable to customers
- Establish the regulatory framework to protect consumers and investors and minimise environmental effects and pollution.

The National Energy Policy 2009-2030 contains seven (7) goals one of which relates specifically to the use of renewable energy as follows:

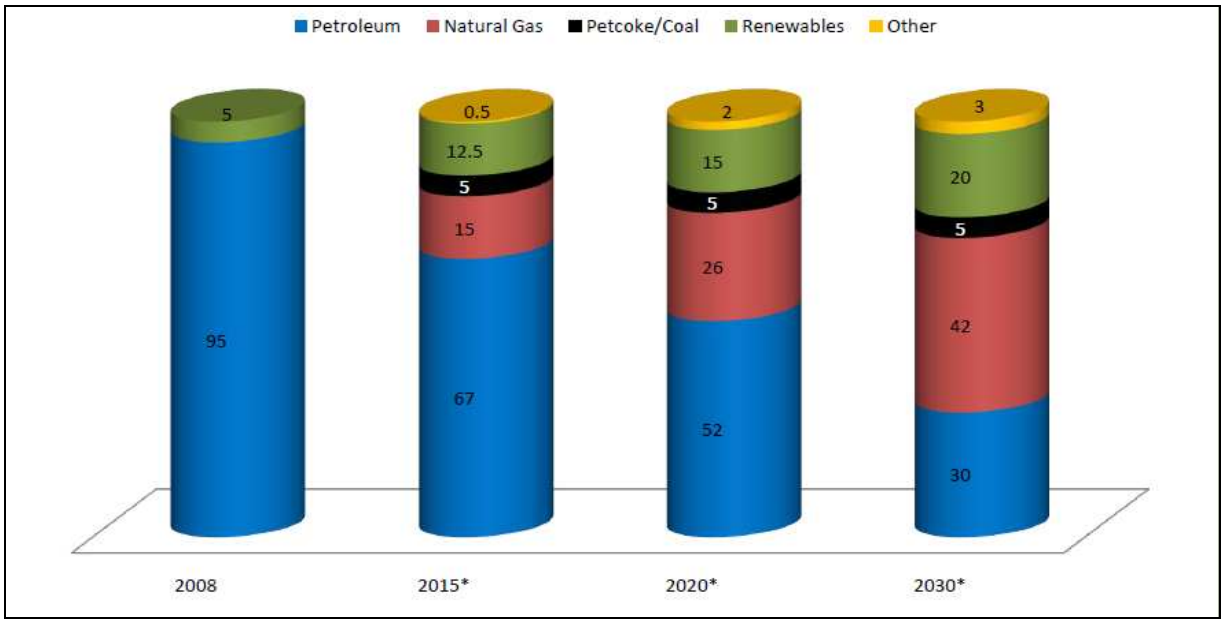
Goal 3:
Jamaica realizes its energy resource potential through the development of renewable energy sources and enhances its international competitiveness, energy security whilst reducing its carbon footprint

Opportunities for further development of indigenous renewable energy resources such as solar, hydro, wind and biofuels will be explored with the goal of increasing the percentage of renewable sources in the energy supply mix to 20% by 2030. This will reduce the country's dependence on imported oil. Increased use of renewable sources will also result in lowering the level of air pollution, a smaller carbon footprint for Jamaica and better enable compliance with international conventions on climate change.

The projected targets for increasing the percentage of renewable sources in the energy supply mix are as follows:

- 11% by 2012,
- 12.5% by 2015 and
- 20% by 2030

Figure 21 - Energy Supply Matrix 2008-2030 (%)



Excerpt from National Energy Policy 2009-2030, Ministry of Energy and Mining, 2009

This policy is applicable to this project since it proposes to generate electricity from a renewable source, in this case wind.

3.2 Applicable Legislation

The legislation applicable to this project include:

- Electric Lighting Act, 1890
- Jamaica Public Service Company All Island Licence, 2001
- The Office of Utilities Regulation Act, 1995
- The Natural Resources Conservation Act, 2001
- The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996
- The Natural Resources Conservation (Permits and Licences) Regulations, 1996
- The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004

- The Natural Resources Conservation, (Ambient Air Quality Standards) Regulations, 1996
- National Solid Waste Management Act 2001
- Town and Country Planning Act, 1957
- The Parish Council Building Act, 1901
- Main Roads Act, 1932

The Electric Lighting Act, 1890

This Act gives the Minister the power to licence entities to provide electricity for public or private use with limits and conditions.

Jamaica Public Service Company All Island Licence, 2001

The Minister, in exercise of the powers conferred by Section 3 of the Electric Lighting Act and having regard to the recommendations of the Office of Utilities Regulation (OUR) pursuant to Section 4 of the Office of Utilities Regulation Act, 1995 granted to Jamaica Public Service Company Limited (JPS) a Licence authorising them to generate, transmit, distribute and supply electricity for public and private purposes within Jamaica subject to the conditions set out in the Licence. Some of the specified conditions include:

a. Provision of an adequate, safe and efficient service based on modern standards, to all parts of the Island of Jamaica at reasonable rates so as to meet the demands of the Island and to contribute to economic development.

b. Having the exclusive right to provide service within the framework of an All-Island Electric Licence and the All-Island Electrical System. The exclusive right specified herein shall be as follows:
   i. In the first three years from the effective date of this Licence, JPS shall have the exclusive right to develop new generation capacity. Upon the expiry of this period the JPS shall have the right together with other *outside person(s*) to compete for the right to develop new generation capacity.
   ii. JPS shall have the exclusive right to transmit, distribute and supply electricity throughout Jamaica for a period of 20 years.

   Provided that no firm or corporation or the Government of Jamaica or other entity or person shall be prevented from providing a service for its or his own exclusive use.

c. Having the right to purchase electricity in bulk from private suppliers for transmission and distribution through the All-Island Electrical system. Subject to consent by both parties any dispute as to the terms and conditions on which such transactions take place may be determined by *the OUR.* The JPS shall have no obligation to connect to private suppliers unless both JPS and *Chief Electrical Inspector* agree that the private supplier's connection will not compromise the safety and protection of the System.

d. Discharging its obligations and performing the duties imposed or authorized under the relevant laws and shall enjoy the rights and exercise all powers conferred by such laws on authorized undertakers.

The Office of Utilities Regulation Act, 1995

This Act indicates that the functions of the Office of Utilities Regulation (OUR) include:

a. Regulating the provision of prescribed utility services by licensees or specified organisations;
b. Receiving and processing applications for a licence to provide a prescribed utility service and make such recommendations to the Minister in relation to the application as the Office considers necessary or desirable;
c. Conducting such research as it thinks necessary or desirable for the purposes of the performance of its functions under this Act;
d. Advising the responsible Minister on such matters relating to the prescribed utility service as it thinks fit or as may be requested by that Minister; and
e. Carrying out, on its own initiative or at the request of any person, such investigations in relation to the provision of prescribed utility services as will enable it to determine whether the interests of consumers are adequately protected.

The JPS will have to apply to the OUR for a licence to operate the four wind turbines with generating capacity of 3 MW that they propose to construct at Hermitage, St. Elizabeth.

The Natural Resources Conservation Act, 1991

This Act gives the Natural Resources Conservation Authority [NRCA](now embodied within the National Environment and Planning Agency [NEPA]) the power to take the necessary steps for the effective management of the physical environment of Jamaica so as to ensure the conservation, protection and proper use of its natural resources among other things. In performing its functions it may among other things, formulate standards and codes of practice to be observed for the improvement and maintenance of the quality of the environment generally, including the release of substances into the environment in connection with any works, activity or undertaking. Based on the powers and functions of the NRCA, this proposed project falls within their jurisdiction.

The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996

This regulation requires that effective January 1, 1997, a permit be obtained for the construction and operation of certain types of projects.

The Natural Resources Conservation (Permits and Licences) Regulations, 1996
The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004

A Permit Application and a Project Information Form are to be submitted to NEPA in accordance with this regulation for the construction and operation of prescribed activities. An Environmental Impact Assessment may also be requested by NEPA as well.

Power generation plants, including hydroelectric plants and installation for the harnessing of wind power for energy production and nuclear reaction above 1 MW is a category listed in this regulation as requiring a permit from NEPA. Since the proposed project plans to install wind turbines with a generating capacity of 3 MW at Hermitage, St. Elizabeth a permit will be required from NEPA.

The Natural Resources Conservation, (Ambient Air Quality Standards) Regulations, 1996

These regulations set the acceptable limits for common air pollutants in ambient air. Since this project proposes to construct wind power installations, controls will need to be in place to ensure that fugitive dust and heavy duty vehicular emissions during the construction phase do not contribute negatively to ambient air quality.

National Solid Waste Management Act 2001

This Act gives the National Solid Waste Management Authority (NSWMA) the power to take all steps as are necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, stored, transported, recycled, reused or disposed of in an environmentally sound manner and promote safety standards in relation to such waste. Solid waste generated as a result of construction activities will need to be collected, stored and appropriately disposed of at an approved municipal disposal site in accordance with the Act.

The Town and Country Planning Act, 1957

This legislation stipulates that in areas for which a Development Order has been prepared, planning permission is required from the Local Planning Authority before "development" as defined by the Act can be undertaken. In those areas for which no development orders have been prepared, no planning permission is required to undertake development. The Development Order is therefore the legal document guiding development in Jamaica. These orders are prepared by the Town and Country Planning Authority in consultation with the Local Planning Authority (Parish Councils & KSAC). The Town and Country Planning Authority, which is a body established under the Act can "call in" an area for which a development order has been prepared. In this instance the Town and Country Planning Authority has the jurisdiction to oversee all development applications if it so desires within the area. This Act is currently administered by NEPA and is applicable to the proposed project.

The Parish Council Building Act, 1901

Construction of buildings in towns and any areas which may be delimited by the parish councils (Local Authority) is controlled under this legislation. The Parish Councils are allowed to impose suitable conditions with regards to size, elevation and structural integrity of buildings. To date regulations cover the principal towns of all the parishes. In those areas which have been delimited under the Building Act permission is to be obtained from the Council before construction commences.

Main Roads Act, 1932

This Act gives the Minister power via notice in the Gazette to charge the Chief Technical Director to lay out, make, repair, widen, alter, deviate, maintain or manage any parochial road, or any new line of road which it is desired to be laid out and made with a view to the same becoming a parochial road. This Act is applicable as there may be need to widen two (2) corners along the transportation route for heavy equipment.

4.0 Description of the Environment

4.1 Physical Baseline

4.1.1 General Climate

Temperature

Temperatures in coastal areas are comfortably warm, becoming cooler in the hilly and mountainous regions in the centre of the island, particularly in the Blue Mountain range with a peak of 2,256 metres (7,402 feet). Apart from rapid fluctuations associated with afternoon showers and/or the passage of frontal systems, the island's temperatures remain fairly constant throughout the year under the moderating influence of the warm waters of the Caribbean Sea.

In coastal areas, daily temperatures average 26.2ºC (79.2ºF), with an average maximum of 30.3ºC (86.5ºF) and an average minimum of 22.0ºC (71.6ºF). Inland, temperature values are lower, depending on elevation but, regardless of elevation, the warmest months are June to August and the coolest December to February.

The diurnal range of temperature is much greater than the annual range and exceeds 11.0ºC (20ºF) in mountainous areas of the interior. Night-time values range from 18.9 to 25.6ºC (66 to 78.1ºF) in coastal areas. At elevations above 610 metres (2,000 feet), minimum temperatures of the order of 10ºC (50ºF) have been reported occasionally when active cold fronts reach the island.

Wind

For most of the year, the daily wind pattern is dominated by the Northeast Trades. By day on the north coast, the sea breeze combines with the Trades to give an east-northeasterly wind and along the south coast, an east-southeasterly wind. In the period December to March however, the Trades are lowest and the local wind regime is a combination of trades, sea breeze, and a northerly or northwesterly component associated with cold fronts and high-pressure areas from the United States.

By night, the trades combine with land breezes which blow offshore down the slopes of the hills near the coasts. As a result, on the north coast, night-time winds generally have a southerly component and on the south coast, a northerly component. However, winds are generally lighter inland and towards the west.

Rainfall

Of the weather parameters, rainfall is the most variable. Rainy seasons are May to June and September to November. The rainfall is regionally very different in its intensity but show a likely annual distribution. Rainfall is comparatively higher from April to November with May and October being the rainfall peak months. The driest period is usually December to March. Most of the rainfall during this period is associated with cold fronts migrating from North America. Whether during the dry or rainy season, however, other rain-producing systems are influenced by the sea breeze and orographic effects which tend to produce short-duration showers, mainly during mid-afternoon. Tropical storm and hurricane season is from June to November.

4.1.2 Climate at Proposed Sites

The climate at Hermitage follows a similar pattern to that of the country. Hermitage is located in the hilly interior of the island and experiences a tropical maritime climate. The location is relatively cool, recording an average temperature of 28-29°C with the month of January being the coolest at about 27-28°C and June being the warmest with average temperatures of 30-31°C.

In order to determine the temperature and air density at the project site, data from the Norman Manley International Airport (NMIA) and Sangster International Airport (SIA) were used. To extrapolate the basic information to the wind farm site it was assumed that the temperature lapse rate (gradient) was -0.65°C/100m. An average long-term temperature of 22.1°C corresponding to an air density of 1.086 kg/m³ was calculated for the project site (Table 11 and Table 12).

Table 11 - Average Temperature at Meteorological Stations

Meteorological Station	Altitude (m)	Measurement Period	Average Temperature (°C)	Distance to Munro (km)
Montego Bay	1.0	1977-2008	27.0	65
Kingston	3.0	1977-2008	27.9	95

Table 12- Expected temperature and density at the project site

Average Altitude (m)	Expected Temperature (°C)	Expected density (kg/m³)	Source
825	21.6	1.089	Montego Bay
825	22.6	1.086	Kingston
825	22.1	1.088	

Rainfall in the project area follows the same general pattern as the country. Monthly rainfall quantities in Potsdam, an area situated about 2 to 3 km south of the project site is shown at Table 13. Higher rainfall is experienced in May and September to October each year.

Table 13 - Rainfall Patterns at Potsdam, near Project Sites at Hermitage

Rainfall (mm)												
Month / Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2003	140	15	43	123	186	8	12	307	83	No data	60	105
2004	81	8	149	42	296	1	87	391	160	129	28	119
2005	60	16	12	189	143	148	102	61	206	672	132	86
2006	19	32	123	47	67	6	17	79	123	92	133	6
2007	33	27.3	218.4	39.4	76.1	86.2	47	148.1	20.8	137.3	251.7	0

Source: Meteorological Service, Jamaica, November 2009

4.1.3 Ambient Air Quality

The proposed project is not expected to be an air pollution source. The operation of wind turbines does not produce carbon dioxide, particulates and any other type of air pollutant as do other power sources e.g. those powered by fossil fuel. There are currently no air pollutant sources within the vicinity of the proposed project sites.

If bauxite mining occurs in the future on lands owned by Alpart across the road from the WTG # 3 and 4 sites, fugitive dust emissions may occur in the area.

4.1.4 Ambient Noise Quality

The Hermitage area has no activities that generate noise emissions, as it is rural in nature and sparsely inhabited. Currently noise emissions will likely be associated with daily school activities at Munro College and Munro Preparatory School. Other sources of noise include vehicles traversing the roadway between Munro and Malvern.

A baseline noise assessment was conducted on Monday November 23rd, 2009 between 8:00 a.m. to 2:00 p.m. It was conducted at two (2) of the proposed locations for the wind turbines (WTG 2 and WTG 4) which were monitored over a six hour (6 hour) period.

The descriptions, GPS locations in (JAD2001 and Latitude and Longitude coordinate systems) of these noise stations are listed in Table 14.

Table 14 - Station numbers and locations in JAD2001 and Latitude/Longitude

Stations	JAD 2001 (m)		Lat/Long (Decimal Degrees)	
	E	N	N	W
WTG 2	676050.408	643852.850	17.937	-77.693
WTG 4	676632.618	643209.605	17.943	-77.698

Noise level readings were taken by using Quest Technologies SoundPro DL Type 1 hand held sound level meters with real time frequency analyzer setup in an outdoor monitoring kit. The octave band analysis was conducted concurrently with the noise level measurements. Measurements were taken in the third octave which provided thirty three (33) octave bands from 12.5 Hz to 20 kHz (low, medium and high frequency bands).

The noise meters were calibrated pre and post noise assessment by using a Quest QC - 10 sound calibrator. The meters were programmed using the Quest suite Professional II (QSP II) software to collect third octave, average sound level (Leq) over the period, Lmin (the lowest level measured during the assessment) and Lmax (the highest level measured during the assessment) every ten seconds.

Average noise levels over the period were calculated within the QSP II software using the formula;

$$Average\ dBA = 20 \log 1/N \sum_{j=1}^{N} 10^{(Lj/20)}$$

where N = number of measurements, Lj = the jth sound level and j = 1, 2, 3 .... N.

Two (2) noise meters with outdoor monitoring kits were set up, one each at each location listed in Table 14. These meters were left for the entire six (6) hour assessment period in an outdoor measuring system and programmed to collect data every 10 seconds.

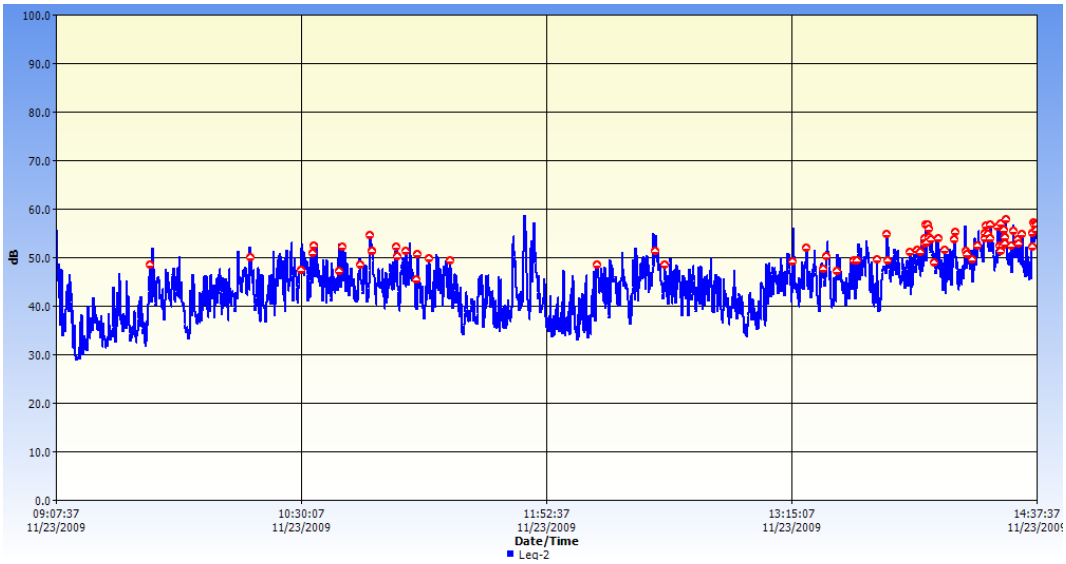
A windscreen (sponge) was placed over the microphone to prevent measurement errors due to noise caused by wind blowing across the microphone. The microphone of the meters were at a height of approximately 1.5m above ground and had an unobstructed view of the roadway (>135°). There were no vertical reflecting surfaces within 3 m (10 feet) of the microphone.

Station WTG 2

During the 6-hour period, noise levels at this station ranged from a low (Lmin) of 28.1 dBA to a high (Lmax) of 64.6 dBA. Average noise level for this period was

46.9 LAeq (6h). The fluctuation in noise levels over the 6 hour period is depicted in Figure 22.

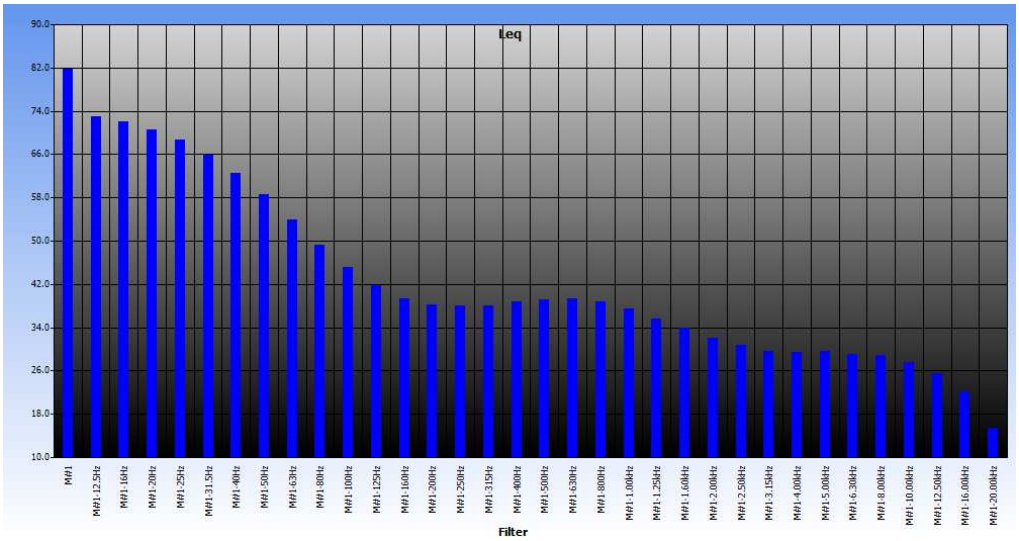
Figure 22 - Noise fluctuation (Leq) over 6 hours at Station WTG 2



Octave Band Analysis at Station WTG 2

The noise at this station during the 6 hour period was in the low frequency band centred around the geometric mean frequency of 12.5 Hz. (octave frequency range is 11 - 14 Hz) (Figure 23). Although the noise was centred around the 12.5 Hz frequency, there was also noise emitted in the 630 Hz frequency.

Figure 23 - Octave band spectrum of noise at WTG 2



L10 and L90

The two most common **Ln** values used are **L10** and **L90** and these are sometimes called the 'annoyance level' and 'background level' respectively. **L10** is almost the only statistical value used for the descriptor of the higher levels, but **L90**, is widely used to describe the ambient or background level. L10-L90 is often used to give a quantitative measure as to the spread or "how choppy" the sound was.

L10 is the noise level exceeded for 10% of the time of the measurement duration. This is often used to give an indication of the upper limit of fluctuating noise, such as that from road traffic. L90 is the noise level exceeded for 90% of the time of the measurement duration.

Figure 24 depicts the hourly L10 and L90 statistics for this station over the noise assessment period. The data shows moderate fluctuations (L10 – L90) in the noise climate at this station.

The largest fluctuations happened at 9:00 a.m. and 11:00 a.m. The overall L10 and L90 at this station for the time assessed were 50.7 dBA and 36.5 dBA respectively.

Figure 24 - L10 and L90 for Station WTG 2

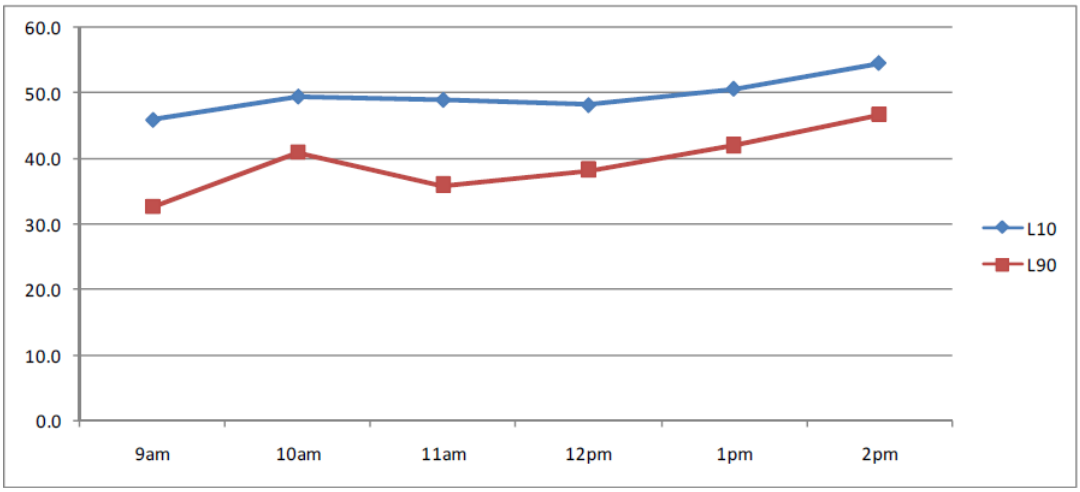
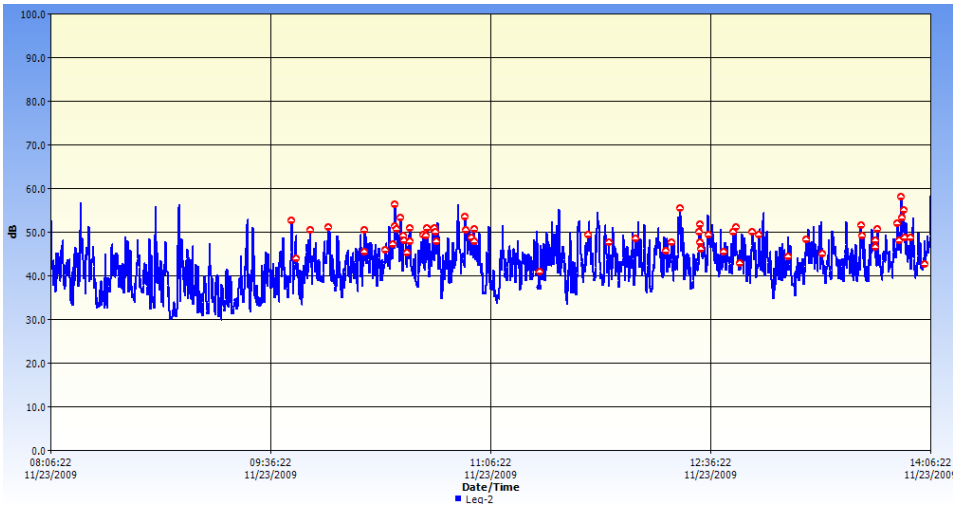


Figure 25 - Pictures depicting Station WTG 2

Station WTG 4

During the 6-hour period, noise levels at this station ranged from a low (Lmin) of 28.8 dBA to a high (Lmax) of 64.7 dBA. Average noise level for this period was 44.8 LAeq (6h). The fluctuation in noise levels over the 6 hour period is depicted in Figure 26.

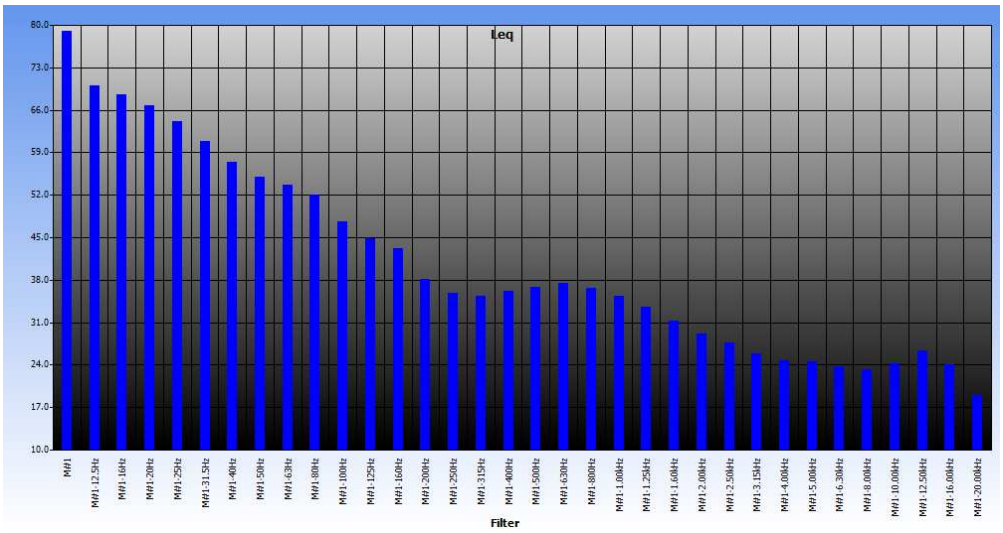
Figure 26 - Noise fluctuation (Leq) over 6 hours at Station WTG 4



Octave Band Analysis at WTG 4

The noise at this station during the 6 hour period was in the low frequency band centred around the geometric mean frequency of 12.5 Hz. (octave frequency range is 11 - 14 Hz) (Figure 27). Although the noise was centred around the 12.5 Hz frequency, there was also noise emitted in the 630 Hz frequency.

Figure 27 - Octave band spectrum of noise at Station WTG 4



L10 and L90

Figure 28 depicts the hourly L10 and L 90 statistics for this station over the noise assessment period. The data shows moderate fluctuations (L10 – L90) in the noise

climate at this station. The largest fluctuations happened at 9:00 a.m. and 11:00 a.m.

The overall L10 and L90 at this station for the time assessed were 48.5 dBA and 37.0 dBA respectively.

Figure 28 - L10 and L90 for WTG 4

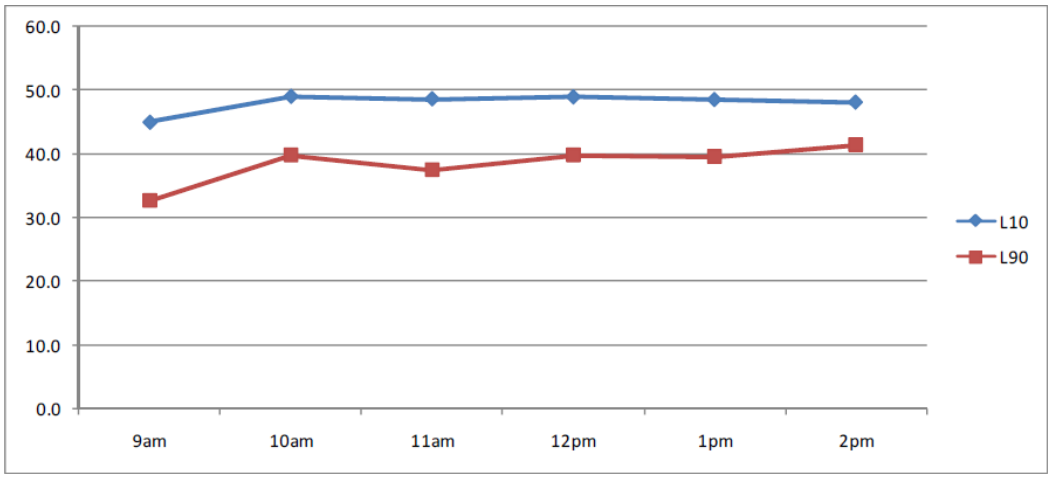


Figure 29 - Picture depicting Station WTG 4

Conclusions

1. The background noise level (L90) for both stations (WTG 2 – 36.5 dBA and WTG 4 – 37.0 dBA) during the time the assessment was conducted were typical of quiet rural areas.
2. The noise levels at both stations (WTG 2 – 46.9 dBA and WTG 4 – 44.8 dBA) if remained constant would meet the NEPA Daytime Standard of 55 dBA and the World Health Organization guideline of 50 dBA for moderate annoyance.
3. Both stations had moderate fluctuations in the noise over the monitoring period.
4. Both stations had noise with frequencies centred around the low frequency bands of 12.5 Hz.
    a. In addition to having noise centred around the low frequency of 12.5 Hz; both stations had other noise influences in the 630 Hz frequencies (low frequency).

4.1.5 Regional and Site Topography

The physical landscape of the area comprises several steeply sloping hills and valleys, which form part of the extensive Santa Cruz Mountains. The elevations of the sites are about 700 metres above sea level and the area which is rich in bauxite mineral deposits, also has extensive limestone covered terrains, large open land areas and dense vegetation (forest) in patches. The area surrounding the proposed sites is dominated by agricultural land uses, a few residential areas and scattered commercial and educational facilities.

4.1.6 Site Geology

The Newport Formation (Mn) generally accounts for much of the geological formations found in St. Elizabeth (Figure 30). This is demonstrated by the general regular NNW/SSE orientation of faults in the region with few minor connecting faults (which are regularly oriented as well where they occur) and pays homage to the homogeneity of formations to be found. The absence of the intersection of faults also indicates a greater general structural stability of the rocks in the area.

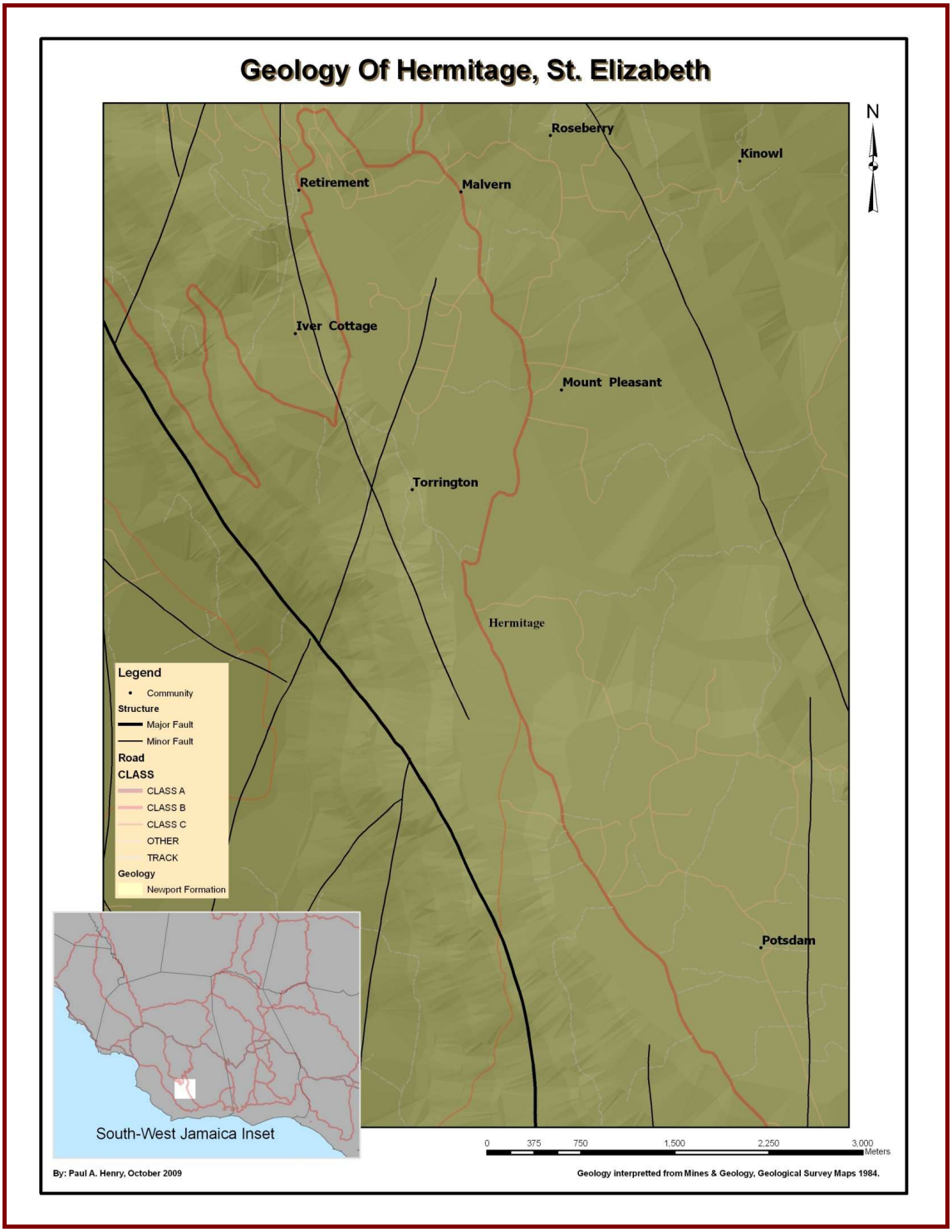
The Newport Limestone Formation is a member of the White Limestone Group which accounts for much of Jamaica's renowned limestone coverage. The Group typically encompasses all limestone formed between Mid to Lower Miocene times.

Newport Limestone in this region of interest is found to be of Lower Miocene Age according to its fossil assemblage. Despite this, the formation lacks an abundant presence of fossils. Outcrops from this locality are found to occur as

well bedded and indurated micritic rocks which typically extend as deep as 1400m and are deposited in a deep-water environment. Despite some extent of the Newport Limestone being found to be massive and dolomitized, none of that nature exists in the study area.

The major fault indicated on the geology map attests to the presence of the Montpelier New Market Belt being separated from the Clarendon Block.

Figure 30 – Geology of Hermitage, St. Elizabeth



4.1.7 Soil

There are two dominant soil types found in the Hermitage area:

- Gravelly Clay
- Clay Loam

The soil, which has a distinctive red colour has fine size particles and has a relatively smooth texture (Figure 31). The soil types found in the area have been as a result of extensive weathering of sedimentary rocks known as bauxite[3].

Figure 31 - Soil Type found in Malvern/Munro St. Elizabeth

Source: Environmental and Engineering Managers Ltd.

The preliminary soil investigation entailed the drilling, coring and sampling of two locations. Borehole 1 (BH1) was in the vicinity of the proposed location for WTG #2 and borehole 2 (BH2) was in the vicinity of the proposed location for WTG #3. The borings were made by NHL Engineering Limited using a truck mounted CME[4] drill rig with a 160 mm hollow stem auger string. The method of drilling was in accordance with the Standard Penetration Testing and Rock Coring specifications using Split Spoon Sampling technique and NX Cores respectively.

In general coring was done at intervals of 1.5m runs to the maximum depth.

The two borings were taken to a maximum depth of 8m (25feet). The soils generally encountered were highly fractured and jointed medium to hard rocks overlain by a thin layer of mottled clays. The recoveries and Rock Quality

[3] Bauxite is a sedimentary rock that is an aluminium ore. It is formed in weathered volcanic rocks.
[4] CME – Central Mine Equipment

Designation (RQD) values were both fair. Based on field observation and equipment response during coring, there was no indication of cavity presence. Additionally, no ground water was encountered during the drilling operation.

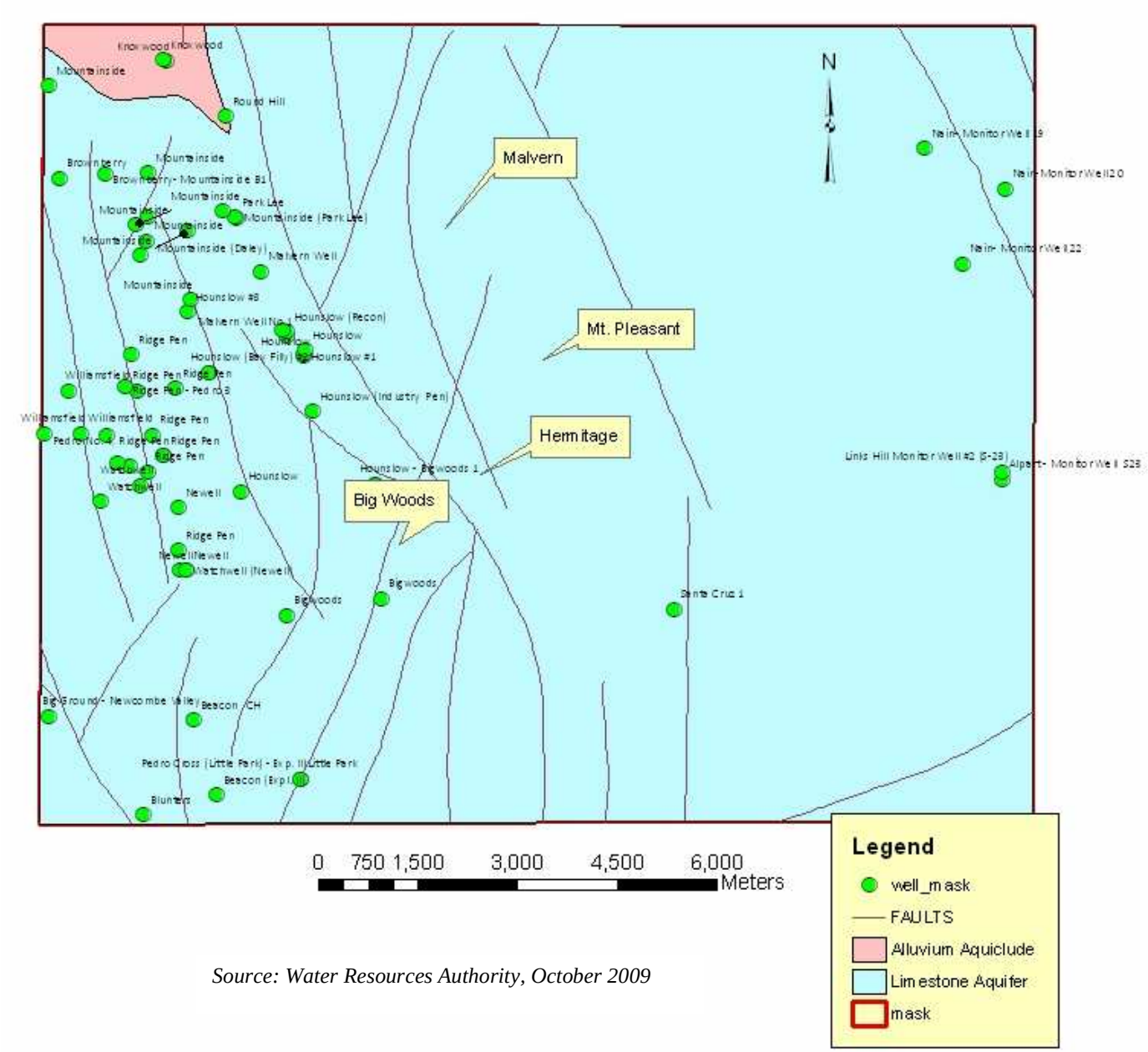
NHL Engineering Ltd. has recommended that before detailed design of foundations, each WTG location should have a drilling survey and soil analysis.

4.1.8 Hydrostratigraphy

The Hermitage area is situated on a Limestone Aquifer as shown in Figure 32. The geology of the area is Newport Formation a member of the White Limestone Group with fault alignment generally north to south. The depth to groundwater is estimated to be 150 - 200 m below ground with flows generally from north to south. There is a general absence of surface water features due to the permeability of the underlying rock. Although groundwater is at a significant depth, the karstic nature of the rocks promotes rapid transport of contaminants and makes the aquifer vulnerable.

There are no wells within 1 km of the sites for the wind turbines. About forty eight (48) wells are located in a band 3 to 6 km west, northwest and southwest of the proposed sites where the elevation of the land is below 50 m, that is, 600 to 650 m lower than the proposed location of the wind turbine sites. There are also six (6) wells about 3 to 8 km east and south east of the sites. The locations of the wells are illustrated on Figure 32.

Figure 32 - Hydrostratigraphy Map of Hermitage, St. Elizabeth Area



Source: Water Resources Authority, October 2009

Figure 33 - Base Topographical Map for Hydrostratigraphy Map

Source: Water Resources Authority, October 2009

4.2 Biological Baseline

The areas for construction of all four wind turbines can be characterized as being dominated by grass, with small forest patches occurring 60 – 100m from the sites. Therefore they can be described as fields with fringe woodland in close proximity. These habitats are however degraded with anthropogenic disturbance in the form of tree cutting, fires, livestock (goats and cattle) and cash crops generally but not limited to sweet potato and carrots. Figure 34 to Figure 43 provide pictorial representations of the landscape and vegetation in the project area.

Figure 34 - Existing Access Road to WTG #1 & #2

Source: Environmental and Engineering Managers Ltd.

Figure 35 – Proposed Location of WTG#1

Source: Environmental and Engineering Managers Ltd.

Figure 36 - Proposed Location of WTG #2

Source: Environmental and Engineering Managers Ltd.

Figure 37 - Proposed Location of WTG#3

Source: Environmental and Engineering Managers Ltd.

Figure 38 - Proposed Location of WTG#4

Source: Environmental and Engineering Managers Ltd.

Figure 39 - Crops Planted in the Vicinity of WTG#2 (September 2009)

Source: Environmental and Engineering Managers Ltd.

Figure 40 - Cow Pasture near to WTG#4

Source: Environmental and Engineering Managers Ltd.

Flora

Fourteen (14) tree species were observed within the area. Usually these species formed forest patches which were degraded from anthropogenic disturbance. No endemic and/or endangered tree species were observed in the forest patches or trees used as fencing in the environs of the wind turbines. The only endemic species observed was the cactus

Hylocereus triangularis. All other observed species were native. Table 15 provides information on the trees, shrubs and herbaceous species found at the sites.

Table 15 - Site Flora

Common Tree Species		
Red Birch	-	*Bursera simarouba*
Guango	-	*Samanea saman*
Lead Tree	-	*Leucaena leucocephala*
Maiden Plum	-	*Comocladia pinnatifolia*
Trumpet Tree	-	*Cecropia peltata*
Mango	-	*Magnifera indica*
Wild Tamarind	-	*Pithecellobium arboreum*
Bamboo	-	*Bambusa vulgaris*
Acacia sp.		
Tar Pot	-	*Clusia flava*
Ogave		
Cobywood	-	*Matayba apetala*
Coccoloba sp		
Franchipani	-	*Plumeria obtusa*
Shrubs/Herbs		
Rosemary	-	*Croton linearis*
Wild sage	-	*Lantana camara*
Susumber/Gully Bean	-	*Solanum torvum*
God Okra	-	***Hylocereus triangularis* (Endemic)**
Bromeliad	-	*Vriesea* sp.
Net Fern	-	*Glichienia* sp.

Figure 41 - Farming Opposite WTG#2 (September 2009)

Source: Environmental and Engineering Managers Ltd.

Figure 42 - Forest Patch Observed

Source: Environmental and Engineering Managers Ltd.

Figure 43 - View of Forest Patch

Source: Environmental and Engineering Managers Ltd.

Fauna

Fauna at the sites include birds, butterflies (including the swallow tail butterfly) and reptiles.

Due to the nature of the proposed project, an avifaunal census was conducted on September 26, 2009 using the Fixed Radius Point Count Census Method (Appendix 3). The results are presented in Table 16.

Table 16 - Birds in the Vicinity of the Proposed Wind Turbine Sites

Land birds Observed		
Residents		
Turkey Vulture	-	*Carthartes aura*
White-crowned Pigeon	-	*Columba leucocephala*
Mourning Dove	-	*Zenaida macroura*
Vervain Hummingbird	-	*Mellisuga minima*
Loggerhead Kingbird	-	*Tyrannus caudifasciatus*
Bananaquit	-	*Coereba flaveola*
Jamaican Oriole	-	*Icterus leucopteryx*
Black-faced Grassquit	-	*Tiaris bicolor*
Yellow-faced Grassquit	-	*Tiaris olivacea*
Antillean Palm Swift	-	*Tachornis phoenicobia*
European Starling	-	*Sturnus vulgaris*
American Kestrel	-	*Falco sparverius*
Common Ground Dove	-	*Columbina passerina*
Endemics		
Red-billed Streamertail	-	*Trochilus scitulus*
Jamaican Woodpecker	-	*Melanerpes radiolatus*
Jamaican Tody	-	*Todus todus*
Jamaican Vireo	-	*Vireo modestus*
Jamaican Euphonia	-	*Euphonia jamaica*
Yellow-shouldered Grassquit	-	*Loxipasser anoxanthus*
Migrants		
Black-throated Blue Warbler	-	*Dendroica caerulescens*
Common Yellow Throat Warbler	-	*Geothlypis trichas*
Barn Swallow	-	*Hirundo rustica*
Summer Residents		
Black-whiskered Vireo	-	*Vireo altiloquus*
Gray Kingbird	-	*Tyrannus dominicensis*

From the conducted survey 24 bird species were observed. This included six (6) endemic species, none of which are currently on the endangered species list for Jamaica. Both winter migrants and summer residents were observed indicating the timeline as being transitional for Jamaican bird species population.

Birds observed in all surveyed areas were within forest patches with only four species observed using the open areas and/or flying between patches. These included the American Kestrel, Mourning Dove, Barn Swallow and Antillean Palm Swift. Resource use was restricted to primarily forest patches surrounding the proposed sites. Table 17 provides information on the trees utilised by observed birds for nesting and feeding.

Table 17 - Trees Utilised by Observed Bird Species

Tree Species	Bird Species	Purpose / Use
Acacia spp.	Black-whiskered Vireo	Nesting
Bursera simarouba	Jamaican Euphonia, Jamaican Oriole, Yellow-shouldered Grassquit, Jamaican Vireo	Feeding
Cecropia peltata	Orangequit, Jamaican Euphonia, Jamaican Stripe-headed Tanager	Feeding
Comocladia pinnatifolia	White-crowned Pigeon	Feeding
Magnifera indica	Hummingbirds e.g. Red-billed Streamertail	Nesting
Clusia flava	Jamaican Euphonia	Feeding

The turbines will be placed in areas where there are no endangered species of plant and/or animals. Also there were no observed flight paths orthogonal to the wind turbines for any flock of bird species.

The number of generators to be installed is four and therefore the effect based on number of generators should consequently be small.

A document review was done to ascertain the incidence of bats in the vicinity of the project sites. Based on a review of information contained in the reference book *Jamaica Underground: the caves, sinkholes and underground rivers of the island by Alan G. Fincham, 1997* there are three caves found in the Munro College area, namely:

a. Pearman's Bush Cave
b. Blair's Cave
c. Munro Cave

None of the caves have any recorded information on the presence of bats within them or the presence of guano, indicating previous and/or potential occupancy by the bats and the Munro cave was believed to be blocked. Additionally, these caves are at least 1.5 km from the proposed sites for the wind turbines.

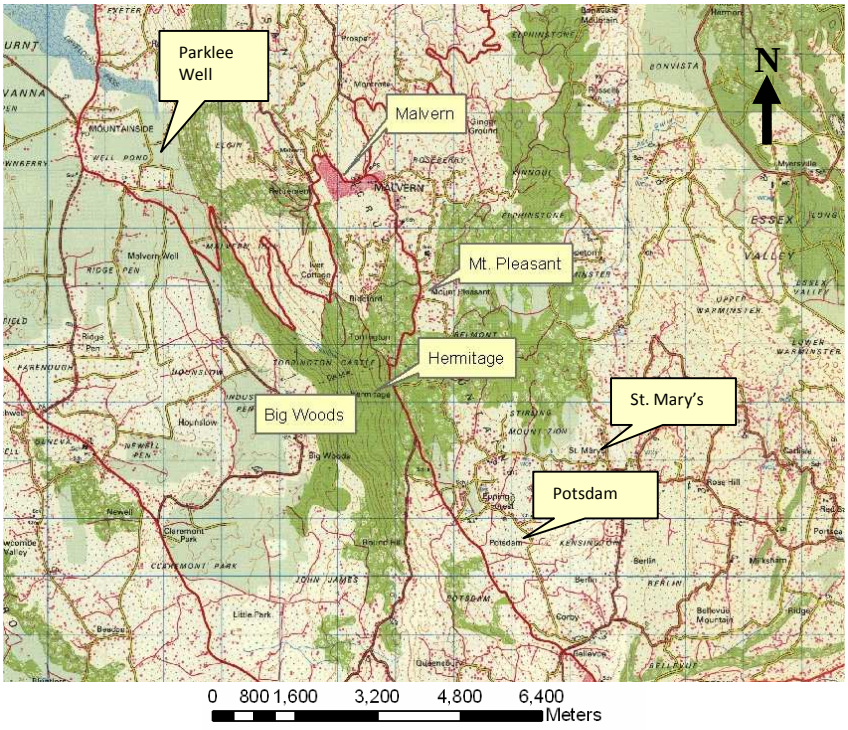
4.3 Socio-Economic Baseline

4.3.1 Demographics

At the end of 2008, the population for the parish of St. Elizabeth was estimated to be 151,121. This represented a 0.6% increase over 2006 figures, where the population was estimated at 150,100. The parish population growth rate is similar to that of the national growth rate and this has contributed to the parish population still accounting for 5.6% of the total population of Jamaica. Based on the 2001 population census data, the national male population has in recent years experienced a faster growth rate than the female. The Statistical Institute of Jamaica estimates that between 2000 and 2005 the male population grew at an average annual rate of 0.51%, compared to a 0.46% growth rate for females.

In 2001, the Malvern area had a total population of 2,820, with 57% of the total population being male (Table 18). The Malvern/Munro area comprises several communities, which includes Potsdam, Hermitage, Mount Pleasant, Fort Rose and St. Mary's. Similar to the parish growth rate, the Malvern communities have experienced marginal growth in their overall population. In the case of Hermitage, the community has no residential population. The community is used mostly for farming. However, in neighbouring communities, such as Junction and Southfield, population sizes have continued to grow due to the rapid pace of development and urbanisation, particularly in Junction.

Figure 44 - Map showing communities surrounding Hermitage



Source: Environmental and Engineering Managers Ltd.

Table 18 - Population of Malvern/Munro Communities

Munro/Malvern Communities	Enumeration Districts (EDs)	Male	Female	Total Population
Munro/Malvern	SE 44	329	328	**657**
	SE 46	246	223	**469**
	SE 47	319	265	**584**
	SE 48	362	306	**668**
	SE 49	359	83	**442**
Junction	SE 43	382	304	**686**
	SE 57	297	276	**573**
Top Hill/Southfield	SE 56	366	405	**771**
		2,660	2,190	4,850

Source: Statistical Institute of Jamaica, 2005

4.3.2 Housing

In 2001, the parish of St. Elizabeth had 38,948 housing units and 40,701 dwelling units, many of them single-family type housing and dwellings. A number of new housing units were observed during a site visit to the Malvern/Munro communities in October 2009. From the interviews carried out in the communities, it was revealed that there has been a notable increase in land subdivision within the communities with more lands being offered for sale.

4.3.3 Settlement Patterns

Settlements within the Malvern area are sparsely situated within the communities and have been largely influenced by agricultural land uses. The settlement patterns observed were typical of rural areas, where settlements were either clustered or dispersed across the landscape. In the case of the Malvern area housing and other forms of human settlements were found generally in linear patterns along access routes, but were generally located at considerable distances from each other, highlighting the dispersed pattern. In other sections, settlements were clustered together, with no distinct margins to demarcate property boundaries. In areas of the communities where new land subdivision activities were taking place, settlements were better organised along access route, with considerable attention given to future land use growth and the implementation of basic infrastructure.

In the community of Mount Pleasant (north of Hermitage), settlements were found mainly along major and minor access routes. In certain sections of the community houses were located within close proximity to each other, but land boundaries were clearly defined by property barriers, such as fences. In other areas settlement patterns have yet to emerge because of the scarcity of settlements. Settlements patterns are similar in the community of Potsdam (south

of Hermitage), where houses were located mainly along access routes and have therefore formed distinct linear patterns. In both communities some small scale clustering was evident.

Based on the observed land use, it is anticipated that in certain sections of these communities, sprawl development will become a major concern, as the constant development of clustered communities could eventually lead to a convergence of settlements. This scenario is likely to present serious challenges for the future implementation of infrastructure such as roads, water and electricity as well as further land development.

4.3.4 Land Use

The land area of the parish of St. Elizabeth is estimated to be 1,212 km^2. Residential, agricultural, and institutional land uses are the major land use types found within the parish. The land use pattern for those areas within 2 km of the project sites (area of influence) is similar with agriculture accounting for approximately 65%-70% of total land use. The few buildings within the area are a mixture of residential, commercial, and institutional, with most being residential. Malvern is the only major commercial area found within 2 km of the project site and covers an estimated area of approximately 6-8 hectares (15-20 acres).

4.3.5 Economic Activities

Agriculture

The parish of St. Elizabeth is one of the largest agricultural areas in Jamaica. It produces large quantities of cash crops such as sugar cane, cassava, corn, peas, tobacco, and a number of vegetable crops including tomatoes, lettuce, carrots etc. Pastoral farming is also carried out on a large scale in the parish. Livestock include goats, sheep, pigs, cattle and horses. In Hermitage and surrounding communities, the cultivation of cash crops is the main type of agricultural activity taking place. Land in the area owned by the Alpart bauxite company and the Crown (through the National Land Agency), have been leased to farmers for crop cultivation and animal husbandry.

Tourism

Since the early 1990s, St. Elizabeth has emerged as one of fastest growing tourist destinations on the island. The Appleton Estate rum distillery and the Black River are two of the popular tourist sites within the parish. In recent years the Great Morass has been developed to attract tourists, while popular sea food restaurants, such as Little Ochie have attracted huge local and international tourists. There is no tourism activity in the project area or neighbouring communities.

Mining

The parish of St. Elizabeth has been a major producer of bauxite since the 1960s. According to economic data, the bauxite refinery in the parish produces nearly 2 million tonnes of alumina annually for export. The economic downturn which started in the last quarter of 2008 resulted in the temporary closure of some bauxite/alumina plants across the island. The Alpart alumina refinery in St. Elizabeth was one such company affected resulting in many of the workers being made redundant. This had a negative impact on commercial businesses in the area that depended on workers for support. Alpart owns land near to the project site but there are no immediate plans to mine in the area. Even if mining was to occur in the future, they have already advised JPS that the wind turbines would not affect those activities.

4.3.6 Utilities

Electricity

The Malvern/Munro communities are fed from the Maggotty Sub-Station on feeder 31/6-210 - Black River feeder. The primary distribution circuit in these areas is a 24 kV three phase system which is the most reliable primary distribution voltage on the JPS system. Major outages that affect the areas supplied by this feeder are due to load shedding. In the event the JPS is unable to supply the full demand of power to all its customers (due to lack of adequate generating capacity) or unable to continue supplying customers due to scheduled/planned maintenance, then the company has to disconnect some of its customers. This process of disconnecting the customers is referred to as 'load shedding.'

The load shedding process is automated in the case of the loss of generating capacity in an emergency situation. For scheduled/planned maintenance, load shedding is done manually. For the automated process, certain designated loads (sets of communities) are automatically disconnected from the JPS grid. The community of Hermitage and its surrounding areas are among the first sets of communities to be so affected during the automatic load shedding process triggered by the loss of generating capacity.

Hence, although the physical distribution lines and accessories which provide electricity to these communities are in very good condition and are well maintained by JPS, the electricity supply to the communities may appear to be unreliable if the JPS conducts frequent load shedding exercises.

Some of the major customers in these areas are Munro College, Hampton High School, Munro Preparatory School and Bethlehem Teachers College.

Water

The Malvern/Munro Pumping Station is the main water source for the project sites. The station supplies water from two wells at Parklee (Figure 44). One well has a capacity of 1 million gallons of water per day and the other 0.8 million gallons of water per day. The pumping station supplies potable water to the following districts located within the vicinity of the project sites: Malvern, Munro, St. Mary's, Potsdam and Mount Pleasant.

Munro Preparatory School, the nearest building to the proposed project site, experiences unreliable supply due to low water pressure. The Principal complained of having to spend a considerable amount of money on trucked water especially in the dry season. The Principal of the school indicted the pump pressure from the Malvern pumping station is not sufficient supply the school and other areas situated on the Chelsea Hill and indicated that the water pressure is additionally affected by farmers who work in the area and tap into the water supply line. The school currently stores water in an overhead tank and an 800 gallon storage drum but proposes to construct a new water tank in the Easter term i.e. January – March 2010 to alleviate the water woes.

Telecommunications

LIME (Cable and Wireless), Digicel and Claro provide telecommunication services in the project area. Residents living in the vicinity of the project area have access to cellular and internet services provided by all three companies. LIME is however the sole provider of landline service in the area.

Television and Cable

There is no cable service provider licenced to provide service in and around the project sites based on information obtained from the Broadcasting Commission. However, ten percent (10%) of the total population surveyed in the vicinity of the project site had access to this service. Respondents may have loosely interpreted this question to also include cable channels from individual satellite dishes. The free-to-air stations, CVM and TVJ were available.

Municipal and Health Services

Police	The project area is served by the Malvern and Santa Cruz Police stations. The Malvern police station is located about 2 km from the proposed project sites and because of its proximity is the one most frequently used by residents. The Santa Cruz police station is located some 12 km from the project area.
Fire	Fire services are provided by the Santa Cruz and/or the Junction fire station. The Junction fire station is located less than 12 km from the project area.

Health Services	The Black River Hospital is the only secondary health care facility within the parish. The hospital is located approximately 25 km from the project area. Primary health care is provided by both public and private service providers. These primary health care providers can be found in Junction, Santa Cruz and Malvern.
Disposal site	The nearest municipal disposal site to the proposed sites is at Myersville in St. Elizabeth, north east of the project site, approximately 8 km by road.

4.3.7 Infrastructure

Roads

The sites for the wind turbines are located adjacent to the Munro to Malvern parochial road. This road falls within the jurisdiction of the St. Elizabeth Parish Council. It is in good condition but will likely experience increased wear and tear from the increased traffic associated with the proposed construction activities.

Schools

Munro Preparatory School is situated approximately 1km from the proposed JPS 3 MW Wind Farm. The school was founded in 1965 and currently has a population of 225 students with 19 staff members inclusive of Academic, Administrative and Ancillary staffs. The age of the student population ranges from 3 to 13 years as they have a Kindergarten Department.

Munro College is situated approximately 1.5 km from the proposed JPS 3 MW Wind Farm. Munro College is an all boys' high school located in the parish of St. Elizabeth. It stands 808 km (2,650 feet) above sea level, on the highest peak of the Santa Cruz Mountain. The school location provides a panoramic view of the Pedro Plains in the distance below.

Munro College has been at its current site since 1856 and to date it has turned out a large number of students, most of who have gone on to become leaders in their fields. It is one of the few educational institutions of its type that still offers accommodation to both on-campus boarders as well as travel-in students.

Three of Munro's buildings have been declared National Heritage Sites by the Jamaica National Heritage Trust:

- Coke Farquharson Dining Room
- The Chapel
- Pearman Calder Building

The Munro College Wind Turbine Project

The project was founded by and has been pursued throughout by the Past Students Association of Munro College. Located at an altitude of approximately 800 km on a relatively flat but actually undulating terrain, it is a favourable site for capturing wind energy.

The project that culminated in the commencement of power generation in 1996, has the following features:

- The wind turbine that is at present operating is a Vestas 27- 225 kW model rated at 225kW power capacity.
- The project was funded primarily by the Environmental Foundation of Jamaica (EFJ), but also includes a long list of local companies and individuals.

This wind turbine can actually be seen from the proposed site of WTG#3 (Figure 45)

Figure 45 - View of Wind Turbine at Munro College from Project site

Source: Environmental and Engineering Managers Ltd.

4.3.8 Community members' perception of Project

As a means of gathering detailed information on the perspective of key stakeholders on the potential impacts of the use of wind turbines to generate energy for electricity provision, questionnaires (Appendix 4) were administered in communities located within a 2 km radius of the project site at Hermitage. Forty-seven (47) questionnaires were administered from the overall target number of sixty (60); giving an acceptable response rate of seventy-eight percent (78%).

Table 19 shows the distribution of questionnaires throughout communities in the vicinity of Hermitage. The standardised questionnaires consisted of thirty-one (31) open-ended questions on key areas of the proposed project to determine the overall perspective of stakeholders on the level and types of impact locally and nationally.

Table 19 - Distribution of Questionnaire in the Vicinity of the Project Site

Community	No. of Questionnaires Administered
Potsdam	15
Mount Pleasant	15
Malvern	5
Munro/St. Mary's	12
Total	**47**

4.3.9 General Profile of Respondents

Sex Ratio and Age Distribution

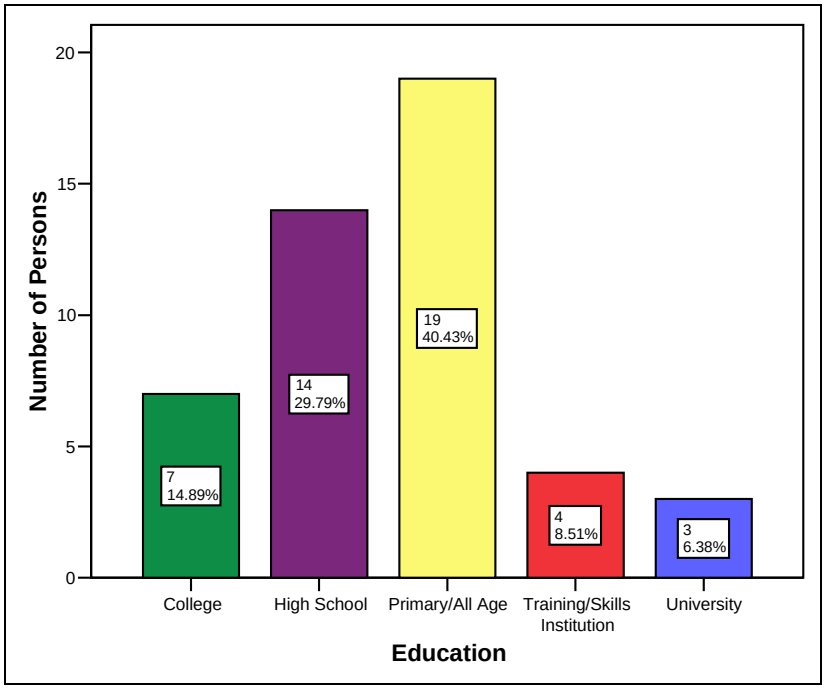
Forty-seven (47) persons were interviewed during the social impact survey. Females accounted for sixty-four percent (64%) of respondents, while males accounted for thirty-six percent (36%). Fifty-five percent (55%) of respondents were between the ages of 18-49 years, with six percent (6%) below 18 years and thirty-nine percent (39%) falling within the age group 50 and over.

Education

All respondents had been educated to at least the primary level. Forty-percent (40%) of respondents had been educated to the primary level, thirty percent (30%) to the secondary/high school level and twenty-one percent (21%) to the tertiary level (college/university). The remaining nine percent (9%) attended skills training institutions. Examination of the data revealed that seventy-nine percent (79%) of respondents educated to the primary level only were aged 50 and over;

while eighty percent (80%) of persons educated to the tertiary/college level were between the ages of 18 and 49.

Figure 46 - Highest Level of Formal Education



Source: Environmental and Engineering Managers Ltd.

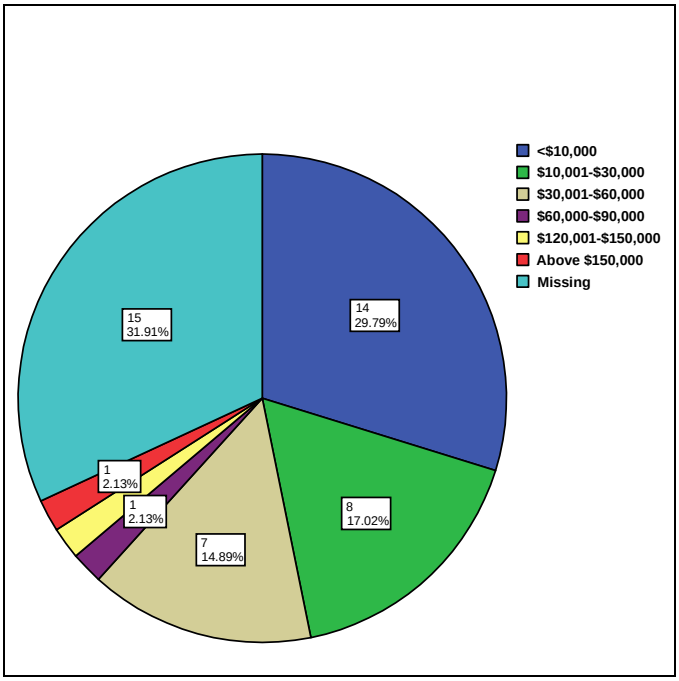
Employment and Income

Seventy-two percent (72%) of all respondents were employed; with twenty-five percent (25%) of those employed listing their occupation as farmer. However, many of the respondents indicated that they did farming as a second job. From the working population i.e. persons between the ages of 18-65, approximately twenty-one percent (21%) were unemployed or retired.

Thirty-two (32) persons responded to the question about their income; this represented approximately 68% of the total number of respondents surveyed. This resulted in approximately 32% of the total respondents being represented in the pie chart depicting income (Figure 47Figure 47) as 'missing', i.e. the total respondents that did not provide a response for the question.

From the total number of persons who responded to the question twenty-nine or ninety-one percent (91%) earned less than J$60,000 per month, with the vast majority acknowledging that earnings were seasonal, given the nature of their jobs. Fourteen persons or approximately forty-four percent (44%) indicated that they earned less than J $10,000 monthly.

Figure 47 - Income Distribution in Communities around Project Site



Source: Environmental and Engineering Managers Ltd.

Housing and Land Tenure

Land and housing ownership within the surveyed communities were found to be moderately low for a rural area. Fifty-seven percent (57%) of persons indicated that they owned the houses they occupied, while fifty-five percent (55%) acknowledged owning the land they occupied. The slight variation in land and housing ownership was attributed to the fact that much of the lands occupied were family lands that had either been sold or leased to family members. A few respondents indicated that though they did not own the land, they had received permission from the family member who owned the land to build their house on the land.

Twenty-seven percent (27%) of respondents indicated that the land and house they occupied were being rented. Other forms of tenure included lease and occupation of family lands and houses.

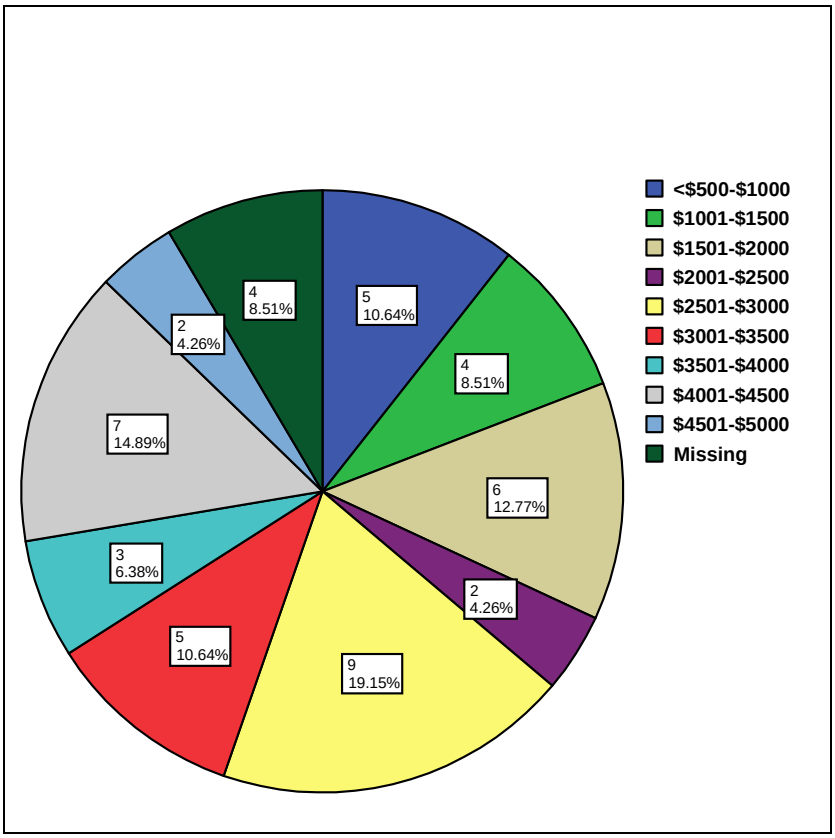
Electricity Services and Cost

Ninety-four percent (94%) of respondents indicated having electricity as the main source of lighting for their homes, with sixty percent (60%) acknowledging that their monthly electrical bills ranged between J$500-$3000. No household indicated having a bill higher than J$6000, however twenty-one percent (21%) of respondents indicated having a bill higher than J$4000. The data showed that where household occupancy was greater than two, electricity bills were above

J$1000 and the households having the highest overall electricity costs had average household sizes of five (5) persons.

Four (4) or an estimated 8% of respondents did not provide a response for the average monthly cost of their electricity bills. This is represented in Figure 48 as 'missing'.

Figure 48 - Electricity Bills

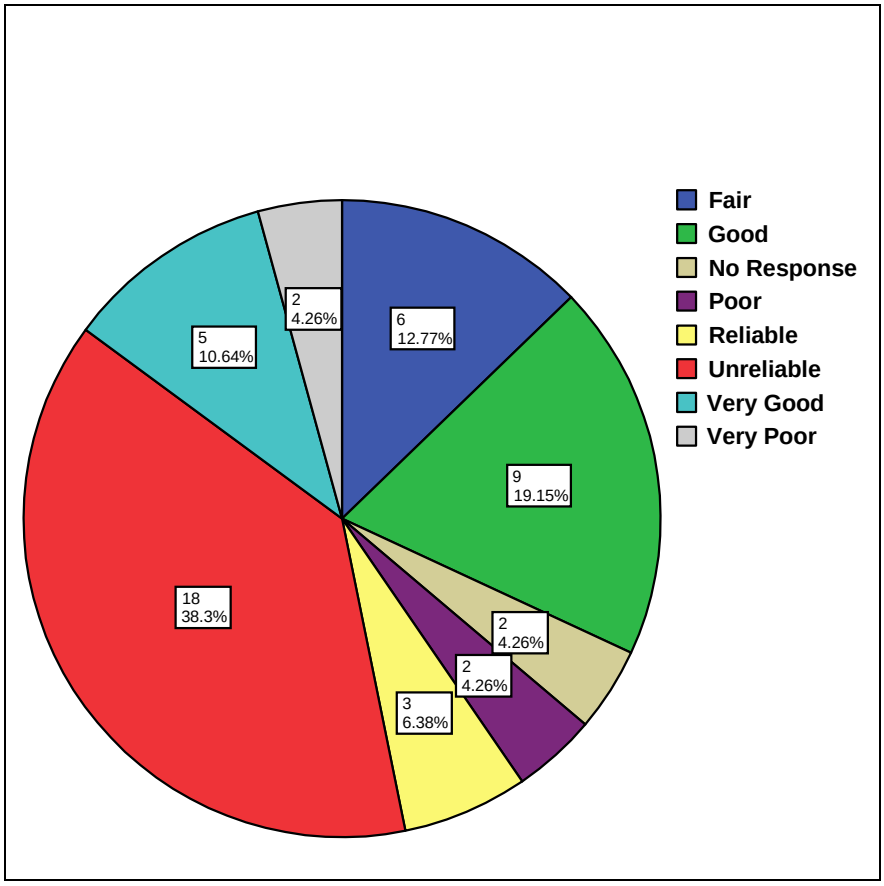


Electricity Service Reliability

Approximately forty-seven (47%) percent of persons surveyed indicated that their household electricity supply was very unreliable, poor or very poor. This compared to ten percent (10%) who thought the supply was very good, nineteen percent (19%) who deemed the service as good and nineteen percent (19%) who ranked the overall service as fair and/or reliable.

Four percent (4%) of respondents provided no response to this question.

Figure 49 – Communities' Perspective on Electricity Reliability



Persons who indicated that service was very unreliable, very poor, or poor provided the following reasons for such a classification:

1. **Frequency of Power Cuts**: All respondents indicated that they had to deal with power cuts at least once per week. In some cases, persons interviewed acknowledged that power cuts occurred as frequently as 2-3 times per week, particularly during periods of heavy rainfall. Saturdays and Sundays were the two days that were pinpointed as the days that frequent power cuts were experienced.

2. **Cost**: All respondents felt the price of electricity services was too high, and that JPS was over-charging customers for its service. More than half of the respondents indicated that even with the frequent power cuts, there were no price changes in their monthly bills.

3. **Recovery Time Period for Power Outages**: The time period taken for the resumption of electricity service to consumers following power outages within the community was found to be too long. Respondents generally felt that the

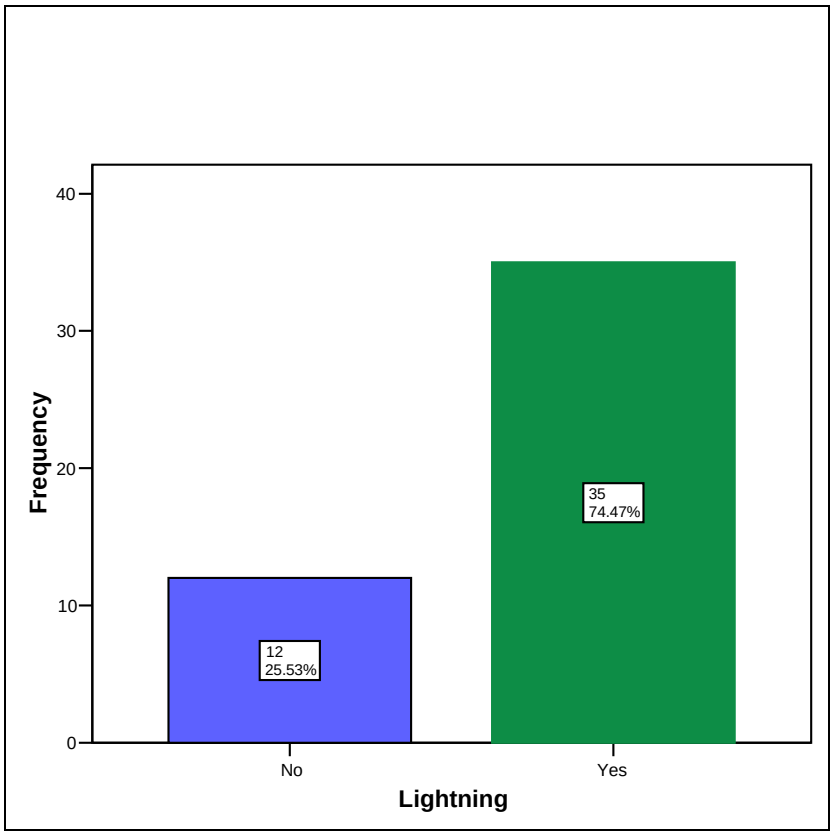
JPS was too slow in reinstating their service and indicated that power cuts often lasted for an entire day or more than 15 hours.

All respondents revealed that candles and kerosene lamps were used by their households at least once per week due to the loss of electricity supply.

Lightning

St. Elizabeth is in a lightning zone. Approximately seventy-five percent (75%) of all persons surveyed indicated that their community was affected by lightning. The frequency of lightning occurrences are however dependent predominantly on rainfall in the area; which according to residents is very frequent.

Figure 50 - Communities Affected by Lightning



Roof Mounted Antennae

From the total number of persons surveyed only nineteen percent (19%) indicated having a roof mounted antennae for their television. While only four percent (4%) indicated having a roof mounted antennae for their radio.

4.3.10 Assessment of Impacts: Community Perspective

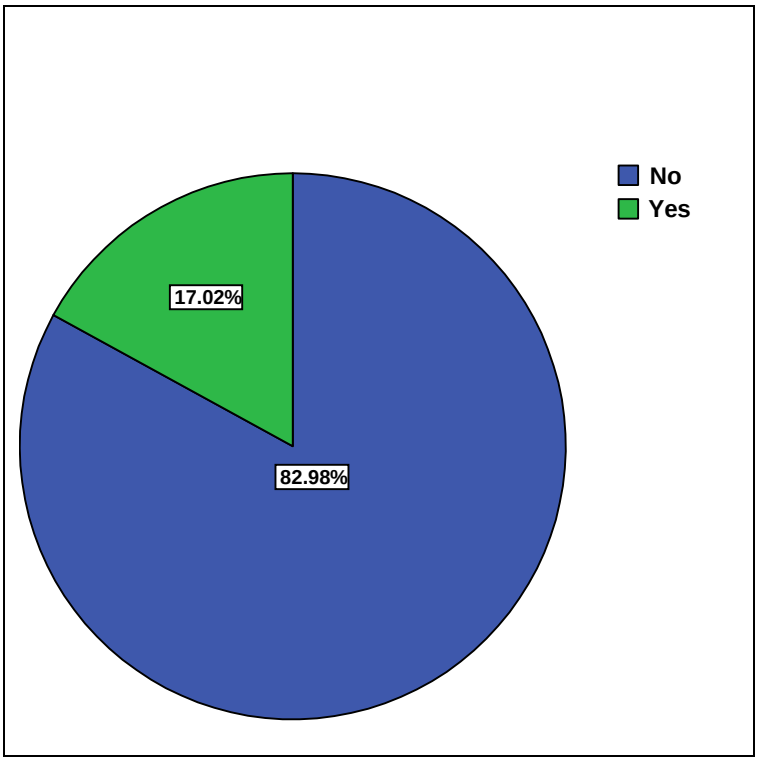
The following information was derived from the survey of persons within a 2 km radius of the proposed wind turbine sites at Hermitage. This section presents the major issues that emerged from the survey, i.e. potential negative impacts of the project and the positive impacts the project is expected to have from the point of view of community stakeholders.

Awareness of proposed wind turbine project

Analysis of the data showed that approximately eighty percent (80%) of respondents had knowledge of what a wind turbine was and its primary use and/or function. Persons, who initially indicated that they did not know what a wind turbine was nor had no knowledge of its use, were provided with the information.

Only seventeen percent (17%) of persons surveyed had any knowledge of a proposed wind turbine project by the JPS in the community. From the eight (8) persons who knew about the project, four (4) received information via 'word of mouth' in the community, two (2) got their information from the television and two (2) from the newspaper. The persons who received information from the television revealed that they were unsure whether the project was for their community, as other proposed project areas were mentioned.

Figure 51 - Community Members Awareness of Wind Turbine Project



Potential Negative Impacts

The following were given as the negative impacts of the proposed development:

1. **Noise and dust emissions**: Increase in noise levels during the construction phase of the project: all respondents indicated that the movement of vehicles and construction equipment and road construction would increase noise levels within their community. All respondents indicated that the thing they valued most about their community was its peacefulness. Construction of the wind turbines would prove to be a temporary nuisance. Persons belonging to the age group 60 and over acknowledged being afraid of the turbine. However given that the project site is not located within close proximity to any houses, this is not expected to be a major issue of concern.
   The Principal of Munro Preparatory School expressed concern about the possible impact of noise and dust pollution on the students and staff of the school. She indicated that school starts at 8:00 a.m. and ends at 2:00 p.m. and after school activities end at 4:30 p.m. She pointed out the importance of the Easter term especially for the Grade Six students who sit GSAT[5] in mid March and pointed out that they do classes until 4:15 p.m. daily.

2. **Increase in Vehicular Traffic**: The increase in large construction vehicles and equipment on the main road between Munro and Malvern will result in traffic congestion on the roads, and increased people-vehicle interaction. Many persons were concerned about the increased possibility for accidents, given the relatively narrow carriage way, and the number of students and residents that were pedestrians on the roadway without the benefit of sidewalks.

3. **Increase in vandalism and theft:** The Principal of Munro Preparatory School is concerned about the possible increase in vandalism and theft at the school due to new persons coming into the community to work on the project. The school has been vandalised on numerous occasions due to its location which is somewhat remote. The perimeter fencing around the school is in dire need of repair due to damage from hurricanes in recent years but they are unable to repair it due to lack of funding. This makes the school vulnerable to thieves.

4. **No Direct Benefits for Community**: When respondents were asked about their views on JPS undertaking the wind turbine project in their community, all respondents acknowledged that the project was a 'good idea.' However, approximately forty percent (40%) indicated that there would be no benefits to the community, as they believed JPS did not care about its' customers. The general response given by persons was that in the long-term any savings made by JPS on oil/fuel imports would not be passed on to the consumers. Respondents generally felt that the only benefits from the project would be employment for local contractors during the construction phase of the project.

[5] GSAT – Grade Six Achievement Test

There were persons who openly criticised the JPS for exploiting their consumers. A few respondents felt that this was another way in which, the company would be utilising the resources of others to benefit themselves. In general there were relatively low levels of interest in the project, as persons felt the benefits would not bring a reduction in their electricity bills.

Potential Positive Impacts

1. **Job Opportunities**: Respondents felt there would be employment opportunities for workers in the community. They acknowledged that young people in the community did not have sufficient job opportunities, and a project of this nature would provide employment for locals.

2. **Reduction in Oil/Fuel Imports and Costs**: An overall reduction in fuel costs was identified by respondents as the second most important benefit of the project. Persons felt that by using renewable energy resources to generate electricity, over-time the country would reduce its heavy dependence on oil. The majority of persons interviewed felt that this would provide the greatest benefit to the country, as reduced fuel costs for JPS would mean an increase in revenue earnings for the company, which would limit government contribution. This money respondents felt could go into other areas such as education and health.

3. **Reduction in Electricity Bills**: An overall reduction in electricity bills was identified as the most important benefits for persons within the community. Though the impact was classified by all as being a long-term impact, respondents generally felt that the project would result in an overall reduction in electricity costs.

   This response was very common amongst respondents, but largely contradicted previous comments provided by respondents during the survey. One of the most highlighted negative impacts from the survey was the view respondents held that the project would yield no direct benefits to the community (see section 'potential negative impacts'). Closer examination of the information provided during the survey indicated that persons were largely sceptical of the benefits trickling down to the community based on the project, but noted that any benefit to be derived would largely be reflected in a reduction in their electrical bills.

4. **Increased Reliability of Electricity Service/Supply**: Though residents were not entirely sure how they would directly benefit from the project, many highlighted that improvement in their electricity service is one of the benefits they anticipated as a result of the project. Approximately eighty percent (80%) of respondents felt that communities located within close proximity to the project site should benefit from the provision of electricity services to their

homes and improved reliability; given that the wind turbine was being located in their community

5. **Increased Revenue for JPS:** In general respondents felt a reduction in fuel cost for the company would lead to more revenue for the company. This, more than seventy percent (70%) of the respondents felt would provide additional benefits to JPS workers in other areas such as:
    a. Increased job opportunities
    b. Increased wages

    It was also felt that the company may be in a position to increase its charitable contributions to communities throughout the island e.g. construction of community centres.

6. **Protection of the Environment**: The use of renewable sources of energy according to forty percent (40%) of respondents would help to protect the environment. Persons interviewed disclosed that with less oil being used, there was less chance for pollution of water resources, as well as less burning of fossil fuels and therefore less air pollution.

5.0 Identification of Impacts

The purpose of this task is to identify the major environmental and socio-economic impacts associated with the construction and operation of four (4) – 750kW wind turbines at Hermitage, St. Elizabeth. Adverse impacts need to be identified so that alternative approaches and/or mitigation measures can be implemented. Positive impacts are also noted as this provides justification for the project.

The main activities to be undertaken for this project include:

- Construction Phase
  - Land Clearing
  - Construction (roads and wind turbines)
  - Transportation of heavy duty equipment, turbine parts and construction material
  - Operation of heavy duty equipment
  - Fuel storage and dispensing for heavy duty equipment
  - Stockpile of construction material
  - Commissioning
- Operation Phase
  - Turbine operation
  - Maintenance
- Decommissioning

The aspects associated with each of these activities that can cause environmental and social impacts are presented in Table 20 and Table 24.

Table 20 – Project Activities that can cause Potential Negative Impacts

	ACTIVITY	INPUTS	ASPECT
1.	Land Clearing	• Heavy duty earth moving equipment • Fuel • Labour • Land	• Noise • Fugitive dust emissions • Vehicular emissions • Use of fuel • Solid waste (top soil, vegetation) • Human waste • Removal of vegetation • Construction work • Soil erosion
2.	Transportation of heavy duty equipment, turbine parts and construction material	• Labour • Trucks • Fuel • Material	• Noise • Fugitive dust emissions • Vehicular emissions • Use of fuel

	ACTIVITY	INPUTS	ASPECT
			• Increased traffic movement
3.	Construction (roads and wind turbines)	• Heavy duty construction equipment • Fuel • Labour • Land • Water (for construction and welfare) • Construction material (aggregate, cement, steel, wind turbine parts etc.)	• Noise • Fugitive dust emissions • Vehicular emissions • Use of fuel • Use of water • Solid waste (construction debris, garbage) • Human waste • Soil erosion • Construction work
4.	Fuel storage and dispensing for heavy duty equipment	• Storage tanks/drums • Fuel	• Spills
5.	Stockpile of material	• Material (aggregate, cement)	• Fugitive dust • Erosion
6.	Turbine operation	• Turbine • Wind • Oil	• Disruption of Air traffic • Noise • Oil spills/leaks • Disruption in avifauna flight patterns • Lightning strikes • Land use • Aesthetics • Flickering • Vibration • Diffraction/Shadowing, Reflection, Scattering
7.	Maintenance	• Equipment • Labour • Lubricating Oil • Fuel	• Oil spills/leaks • Human waste • Construction/maintenance work • Vehicular emissions • Use of fuel
8.	Decommissioning	• Equipment • Labour • Oil • Fuel	• Solid waste • Noise • Oil spills/leaks • Human waste • Vehicular emissions • Use of fuel

The environmental and social impacts associated with the activities and aspects in Table 20 are discussed in detail below for each phase of the project.

Construction Phase

1. Air pollution

It is anticipated that during the site development and construction phase that air quality could be adversely affected by land clearing (for wind turbines and access roads), access road construction, road widening and the movement of heavy duty vehicles carrying construction material (e.g. sand, gravel etc.). These activities may increase the volume of fugitive dust at the project sites and in the local surroundings which in addition to causing air pollution could cause health impacts such as respiratory problems. This negative impact will be short term and can be mitigated.

The use of heavy duty vehicles and equipment fuelled by diesel is expected to result in an increase in vehicular emissions during the construction phase of the project. Diesel emissions contain over 40 different components identified as being toxic, e.g. carbon dioxide, nitrogen oxide, sulphur dioxide etc. In addition to causing air pollution, vehicular emissions contain greenhouse gases, a contributor to global warming. While there are no vehicular emission standards, one criterion for motor vehicle fitness is that there are to be no visible emissions. This negative impact will be short term.

2. Nuisance and Hearing Impairment

Land clearing, access road construction and the installation of the wind turbines may result in increased nuisance noise at the project sites and within the local area. The movement and use of heavy vehicles and equipment during the construction phase will also increase noise levels within the project area. Persons working on the site are likely to be impacted by the noise from construction related activities. Mitigation measures can be instituted to deal with the impact of noise on workers. The other potential impacts are noise on neighbouring communities from increased truck traffic and construction site activities. There are no residences in the project area as it is primarily agricultural and the nearest buildings are schools at distances of 1 and 1.5 km from the project sites. Jamaica's noise standards do not suggest any guidelines for these land uses (Table 21). However due to the distance of these institutions from the project sites, noise from construction is not expected to impact anyone outside the boundary of the project site. While truck traffic will likely increase the nuisance noise to the school, the duration is expected to last for only duration of the construction period and it is likely to be intermittent.

Table 21 – National Noise Standards

National Noise Standards				
	Jamaica NRCA 1999 Recommended		World Bank (IADB) Thermal Power Guidelines for New Plants (1998)	
	dBA		dBA	
Zone	7 a.m. – 10 p.m.	10 p.m. – 7 a.m.	7 a.m. – 10 p.m.	10 p.m. – 7 a.m.
Industrial	75	70	70	70
Commercial	65	60	70	70
Residential	55	50	55	45
Silence	45	40	-	-

3. Disturbance/Loss of Habitat

Approximately 0.66 hectares (1.6 acres) of land will be cleared for the construction of wind turbines at the four (4) locations and 0.6 hectares for the construction of access routes to the site. The project sites have sparse vegetation and are highly disturbed due to agricultural activities and the burning and felling of trees.

Construction activities associated with the installation of wind turbines and the construction of roads can alter ecosystems through the clearing of vegetation, soil movement, and increase the potential for erosion and noise. These changes can lead to habitat loss and fragmentation for forest-dependent species. This area is already degraded and as such the project will not alter the flora in the area. No trees will be removed so nesting and feeding sites for birds will not be disrupted.

4. Land and Water Pollution

The following aspects could cause land and water pollution:

- Fuel spills from fuel storage and dispensing
- Inappropriate disposal of solid waste which could consist of:
  - Top soil from land clearing
  - Garbage associated with administrative and welfare activities
  - Packaging waste
  - Construction debris
- Inappropriate disposal of human waste
- Sediments in storm water from land clearing, erosion and aggregate stockpiles

It is unlikely that there will be any pollution of water resources as there are no surface waters in the area and the groundwater resources are very deep underground. Additionally potential spills would be small in volume.

The potential for land pollution exists however if the listed aspects are not managed.

5. Traffic congestion and Motor Vehicle Accidents

During the construction of roads and installation of the wind turbines, it is anticipated that the movement of heavy vehicles and equipment will have an impact on existing traffic patterns within the vicinity of the project sites. There is one major roadway leading to the proposed sites. This roadway is used primarily by private vehicles entering and exiting residential communities, educational institutions and farms. Taxis, commercial and public vehicles such as delivery trucks and education and health inspection vehicles are others found frequenting the area. Pedestrians, many of which are students, also use this road which does not have a sidewalk. There is therefore the potential for increased motor vehicle accidents.

6. Use of Fuel

Fuel is essential to operate construction equipment and to transport material and equipment to the site. The contribution to depletion of oil resources is negligible.

7. Use of Water

Water will be trucked to the site by a contracted service. Water is essential for construction activities and welfare facilities (drinking water and sanitation). The contribution to depletion of water resources is negligible.

8. Construction related accidents

Where construction work is being done, the potential exists for accidents. Measures can be instituted to eliminate or minimise these potential impacts.

Operation Phase

1. Electromagnetic Interference

It is a known fact that tall buildings and structures may disrupt or have an impact on wireless services which are delivered via Radio Frequency (RF) Signals. More specifically, several studies have shown that the rotating blades and the support structure of a wind turbine can impact RF signals adversely.

Wind turbines can potentially impact RF signals based on **diffraction (shadowing), mirror-type reflection or scattering.**

The following systems could potentially be impacted negatively by wind turbines based on the proximity of the turbines to the RF signals used in the operation of the systems.

- Broadcasting – Radio (AM and FM) and Television (TV)
- Subscriber TV Operations (Head-end)
- Mobile Cellular Networks and other such networks
- Aeronautical Communications Systems

- Point-to-Point Radiocommunication systems
- Point-to-Multipoint Radiocommunication systems
- Satellite Uplinks and receive systems (e.g. VSATs)
- Direct-To-Home (DTH) satellite receive systems
- Radar (defence, air traffic, weather)

Wind turbine impacts on RF signals are assessed in two categories based on the nature of transmission and reception of the signal. These categories are Radiocommunication systems and Radar systems.

Impact on Radiocommunication Systems

The impact on Radiocommunication systems may be divided into two categories:

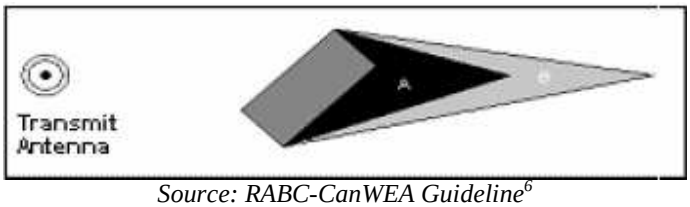
a. Impact on broadcast type systems which include radio, TV and cellular type networks, and
b. Impact on Point-to-Point systems such as microwave links connecting cellular sites, radio links referred to as Studio-to-Transmitter Link (STL) and Transmitter-to-Transmitter Link (TTL); as well as Point-To-Multipoint systems such as those used to deliver wireless cable service.

The likely impact on Radiocommunication sites by wind turbines is dependent on the proximity of the turbines to the RF signals and its alignment relative to the signal path between transmitter and receiver. Hence the impact could be due to either diffraction (shadowing), mirror-type reflection or scattering.

Diffraction (Shadowing)

Point-to-Point systems require a clear line of sight between transmitter and receiver for optimum operation. Where a wind turbine falls within the line of sight, or near to the path of a radio link, it can create shadowed areas which then block the path of the signal resulting in either complete signal loss, or a degradation of signal strength between the transmitter and receiver. The shadowed areas (shown as A and B in Figure 52) would appear in the section of the path between the wind turbine and the receiver, i.e. away from the transmitter.

Figure 52 - Diffraction



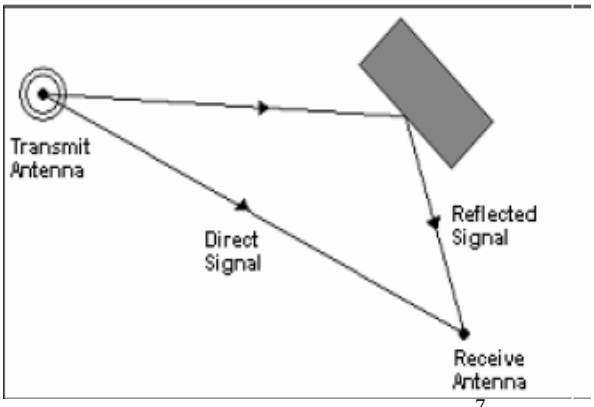
Source: RABC-CanWEA Guideline[6]

[6] Radio Advisory Board of Canada – Canadian Wind Energy Association : Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radiocommunication, Radar and Seismoacoustic Systems

Mirror-Type reflections

It is possible for an obstacle such as a wind turbine, although not in the direct path of a radio link (i.e. line of sight from transmitter to receiver) to affect the quality of the signal at the receiver. This may occur if the transmitted signal bounces off (i.e. is reflected from) the obstacle and creates an alternate path to the receiver. This alternate path is longer than the direct signal path and hence the reflected signal is delayed in time and arrives at the transmitter marginally later than the direct signal (Figure 53).

Figure 53 - Mirror Type Reflection



Source: RABC-CanWEA Guideline[7]

When the two signals are received, one with a time delay, then the delayed signal can cause a degradation of the quality of the received signal. This scenario is referred to as mirror-type reflection.

Scattering

If a RF signal reaches the rotating blades of a wind turbine, then the blades can produce a pulse scattering of the signal which would be synchronised with the rotational speed of the blades. The resulting Doppler Effect[8] produces variations in the scattered signal's phase and amplitude.

When this scattering occurs behind the turbine within an area of approximately 72 degrees in width (the front scatter zone), this effect is analogous to shadowing. The remaining 288 degrees of the arc is referred to as the back scatter zone and when this effect occurs in this area it is similar to a mirror-type reflection.

Thus the scattering effect produced by the rotating blades of wind turbines can result in either a scattering effect or a combination of both a scattering effect and the mirror-type reflection;

[7] Radio Advisory Board of Canada – Canadian Wind Energy Association : Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radiocommunication, Radar and Seismoacoustic Systems

[8] The Doppler Effect is the change in frequency of a wave for an observer moving relative to the source of the wave.

depending on the alignment of the turbine and its proximity to transmitters and receivers. If this occurs for a TV signal and the scattered signals are strong enough at a TV receiver, then this could lead to a distortion of the picture which is referred to as "ghosting."

Radar Systems

The potential impact of wind turbines on radar systems, unlike Radiocommunication systems, is not proximity dependent and therefore is not easily determined. It is recommended that each site proposed for a wind farm is reviewed with respect to any radar system within its environs since each radar has a different coverage footprint which is dependent on its location and the topographical layout of the area.

The operational performance of radars, especially weather radars, could be impacted by a wind turbine in close proximity to it. This could lead to 'blockage' which describes the scenario where a certain angular sector of the radar beam is blocked by some external object. Another potential impact of wind turbines on radar systems is referred to as 'clutter' which essentially is unwanted echoes on the radar display. If a wind turbine is in the line of sight of air traffic control radar then this could potentially impact the ability of the radar to provide air traffic services.

Consultation Zones

In order to understand the nature of the RF signal environment within the environs of the proposed site, consultations with the users of RF signals was necessary. Since the most important factor is the proximity of the turbines to the signals, the Consultation Zone must be defined i.e. the geographical area where the turbines will impact on RF signals.

The "Guidelines for Determining Consultation Zone" developed by the RABC- CanWEA indicate that for the typical RF systems (such as Broadcasting and Point-to-Point) that may be impacted by the operation of wind turbines, then for proximity reasons:

- The radius of the Consultation Zones around transmitters, receivers, cellular towers should be at least 1.0 km.
- Specifically for TV receivers, no receiver should be within the radius of the Consultation Zone R defined by:

  $R = 0.051*B*\sqrt{T}$

  Where R = radius in km, B = length of one rotor in meters, T = number of turbines in the wind farm.

Based on the specifications provided by JPS for the proposed wind turbines, the Consultation Zone is approximately 2.2 km for TV receivers.

For other RF systems such as radars, the following Consultation Zones are recommended:

a) Weather radars : A minimum of 80 km
b) Air Traffic Control radars : A minimum of 60 km for civilian traffic

Radiocommunication Systems in Jamaica

The Spectrum Management Authority (SMA), the governmental body mandated to manage the RF Spectrum on behalf of the Government of Jamaica, has details on all licensed/authorized users of the spectrum (including broadcasters) who may have Radiocommunication facilities within the proposed site of the wind farm. In addition, the Broadcasting Commission regulates Subscriber TV Operators (cable service) and therefore has relevant information on the providers of cable service within the vicinity of the proposed wind farm.

Information on licensed/authorized users of the RF Spectrum and STV Operators (cable service) within a 5 km radius of the proposed site, gathered through formal requests from the SMA and the Broadcasting Commission respectively is presented in Table 22 and Figure 54.

The SMA provided information to indicate that the following RF signal sites are within 6 km of the proposed wind farm site.

Table 22 - RF Signals within 6 km of Project Sites

Location of Radio Site	GPS Coordinates	RF Signal Range	Distance from WTG #1
Munro	17º 55.766N, 77º 40.600W	Below 500 MHz	1.82 km
Malvern	17º 58.400N, 77º 42.217W	Below 500 MHz & 1 - 10 GHz	4.33 km
Southfield	17º 54.116N 77º 40.500W	10 – 15 GHz	4.16 km
Top Hill	17º 53.550N 77º 39.817W	10 – 15 GHz	5.70 km

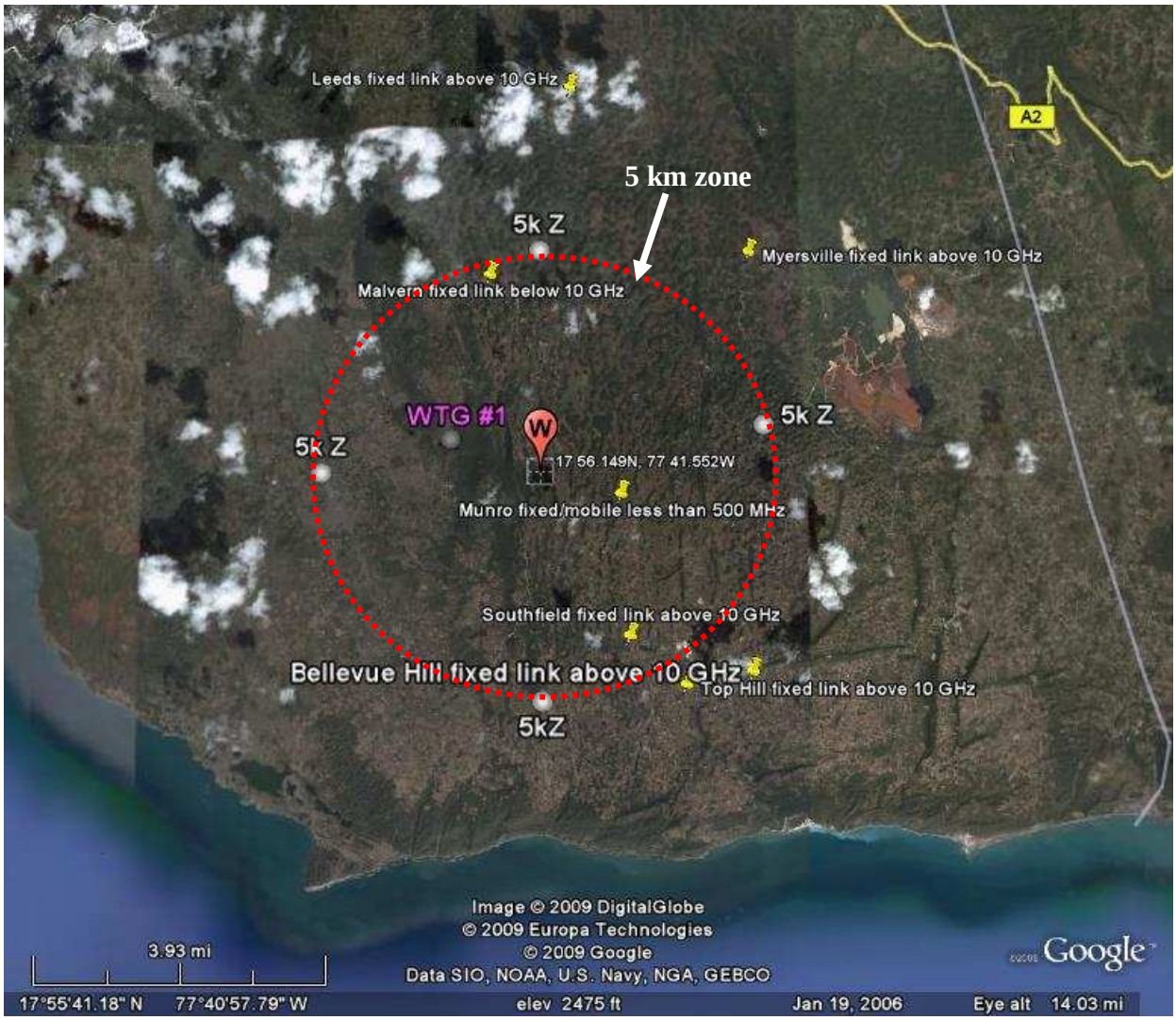
The types of radio frequency service at these sites are classified as either 'fixed or mobile service' or 'fixed link service'. Research conducted globally and the experience of existing wind farms in countries such as Australia, indicate that interference to these services caused by wind turbines would be negligible[9]. In fact, interference is likely only when the wind turbine is in the direct path of the signal being transmitted. This is very unlikely for fixed link services which require direct line of sight between the transmitter and receiver for a given signal path.

For land mobile services (2-way radio services using VHF[10] or UHF[11]), in the unlikely event a radio user should experience interference due to the proposed wind farm, then the user would be able to eliminate such interference by a marginal change in their physical position. This is

[9] Woodlawn Wind Farm EIS: http://www.woodlawnwind.com.au/_PDF/_Sections/15.pdf
[10] VHF: Very High Frequencies
[11] UHF: Ultra High Frequencies

consistent with the modus operandi for the use of such radio systems whenever a user encounters interference caused by any land-based object that may block the radio signal.

Figure 54 - RF Signals within 5 km of Project Sites



Mobile Cellular Service

The initial feedback from the major providers of mobile cellular service is that the proposed wind farm is unlikely to have an impact on the radio frequency signals used at their radio sites, based on the relative distance of their sites from the proposed site of the wind farm. However, note that this initial position is not based on any technical assessment or investigation conducted by these companies.

It is widely accepted within the telecommunications industry that voice-based digital technologies such as GSM[12] or CDMA[13], the two technologies used by the local mobile cellular companies, are quite robust and essentially are unaffected by any interference from wind turbines[14].

It is important to note that the recommended Consultation Zone for the type of services provided at the above sites is 1.0 km, as stated earlier. None of the radio sites listed in Table 22 fall within this zone. Therefore, based on the above assessment, and the fact that the radio sites are outside the recommended consultation zone, it is quite reasonable to conclude that the proposed wind farm by JPS will not have any impact on the Radiocommunication services within the immediate environs of the site.

Radio and TV Broadcasting Services

There is the potential for interference to radio and TV signals caused by wind turbines. Such interference would be due to one of two effects, either 'Shadowing' (Diffraction) or 'Reflection'; both of which have been explained earlier in this document. Generally, 'shadowing' leads to a reduction of the signal strength which may manifest itself as a degradation of picture quality, loss of colour or a buzz sound for TV reception. If a TV's signal is affected by 'reflection' then the delay in reception of the reflected signal will create a pale shadow(s) to the right of the main picture; this is called "ghosting."

In both instances, the wind turbine would have to be physically close to the radio or TV transmitter site for the transmitted signals to create the 'shadow' effect or the 'reflection' effect. Then too, the locations which would experience such interference would have to be within the 'shadow' zone of radius up to 5 km or the 'reflection' zone of a circle of radius 500 m from the wind turbine[15]. Furthermore, the glass reinforced blades of the wind turbines are essentially transparent to electromagnetic waves which significantly reduce the reflective effect that could cause interference.

Based on the information provided by the SMA, there is no radio or TV transmitter site within 5 km of the proposed wind farm site. In fact, supplemental information provided by the SMA confirms that no radio or TV transmitter site is within 10 km of the proposed wind farm site. Therefore, it can be concluded that it is very unlikely that TV reception will be affected within the environs of the proposed site for the wind farm due to interference with radio and TV transmission. However there is the possibility that TV reception could be affected by the operations of the wind turbines as the Consultation zone for TV receivers was determined as 2.2 km based on the specifications for the wind turbines to be installed by JPS.

[12] GSM: Global System for Mobile communication
[13] CDMA: Code Division Multiple Access
[14] Environmental Assessment for Kyoto Energy Park by PAMADA PTY Ltd : http://majorprojects.planning.nsw.gov.au/files/36402/17%20Section%2013%20-%20Electromagnetic%20Interference%20(EMI).pdf
[15] Ofcom: Tall Structures and their impact on broadcast and other wireless services - http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/Windfarms/tall_structures/tall_structures.pdf

In the unlikely event some TV reception is impacted by the wind turbines then the mitigation measures include:

- Installing an outdoor antenna if none exists
- Realigning the TV antenna to point directly at the TV transmitter
- The installation of more directional or higher gain antenna at the affected residences
- Relocating the antenna to a less affected position
- A combination of the above measures

The two schools in the area, Munro Preparatory and Munro College are within the 2.2 km consultation zone for free-to-air TV. At a distance of 1 and 1.5 km respectively, the schools could experience minor interference with the free-to-air TV signal. This can be easily mitigated by measures described above.

Discussions with the Principal at Munro College revealed that the school did not experience any problems with TV reception from the operation of their wind turbine.

Subscriber Television Service (Cable TV)

The Broadcasting Commission responded to the request for information indicating that based on their records, there are no licensed Subscriber Television Operators (STVO) with headend facilities within 5 km of the proposed site at Hermitage. Also, based on the field survey conducted the residences within the environs of the proposed wind farm do not have cable TV service.

The Operator licensed to provide cable services closest to the Hermitage area is McKoy's Cable Limited serving the Southfield and Junction zones which are outside of the 5 km radius.

From the above information, it can be concluded that the installation of the proposed wind turbines at Hermitage will not impact Subscriber TV (cable) services.

Radar Systems in Jamaica

The Meteorological Service Office confirmed that there is only one weather radar station in Jamaica located at Coopers Hill, St. Andrew which communicates with a receiver at the Norman Manley International Airport, Palisadoes, Kingston.

The weather radar station at Coopers Hill is approximately 90 km from the proposed site which is outside of the recommended consultation zone of 80 km within which one would assess the potential impact of the wind turbines on weather radars. Therefore, it may be concluded that the proposed wind farm at Hermitage will not have a negative impact on the weather radar operated by the Meteorological Service.

The Jamaica Civil Aviation Authority (JCAA) advised that there are three (3) air traffic monitoring and control radar stations in Jamaica at Pike in Manchester (36 km from project site); Norman Manley International Airport, Palisadoes, Kingston (97 km from project site); and at Norwood, St. James (66 km from project site).

The closest air traffic monitoring and control radar to the wind turbine sites operated by the JCAA is located at Pike in Manchester. Based on discussions with the JCAA, it is very unlikely that the operation of the wind turbine will have an impact on this radar. The other two radars are located outside of the recommended consultation zone of 60 km and hence will not be impacted by the wind turbines.

2. Seismological Monitoring Equipment

Wind turbines could potentially have a negative impact on the operation of seismological monitoring equipment depending on the proximity of the wind turbines to the equipment and the level of noise and vibration from the turbines. The noise and vibration from the turbines could be interpreted by the seismological monitors as a 'false' earthquake.

The extent to which low frequency noise and vibration from any source impacts seismological monitoring equipment will be dependent on the sensitivity of the selected technology for the monitoring equipment and any mitigating measures implemented during construction of the vault used to house the equipment.

The UWI Earthquake Unit advised that there are twelve (12) seismograph stations positioned across Jamaica in the locations shown in the table below.

Table 23 - Seismograph Stations Across Jamaica

No.	Location	Parish
1	University of the West Indies – Mona Campus	St. Andrew
2	Stony Hill, Wireless Road	St. Andrew
3	Greenwich, Newcastle	St. Andrew
4	Kempshot, Montego Bay	St. James
5	Munro College	St. Elizabeth
6	Portland Cottage – Light house	Clarendon
7	Yallahs	St. Thomas
8	Bonny Gate	St. Mary
9	Bamboo	St. Ann
10	Pike, Mount Denham	Manchester
11	Mount Airy, Negril	Westmoreland
12	Castle Mountain	Portland

Consultation zones recommended for seismological equipment is a minimum of 10 km around a single station. The seismograph located at Munro College is within 1.5 km of the proposed site for the wind farm. However, based on discussions with the UWI Earthquake Unit, the vault housing the sensors that detect earthquakes are sufficiently isolated in order to minimise the potential loss in detecatability of the seismograph and therefore the turbines at Hermitage should not have a negative impact on this monitoring site. The other monitoring stations are outside the recommended consultation zone of 10 km.

3. Shadow Flicker

Shadow flicker is defined as "the on-and-off flickering effect of a shadow caused when the sun passes behind the rotor of a wind turbine."[16] This occurs under certain specific conditions and its intensity varies depending on factors such as:

- The size of the turbine and its geographic location
- The angle and intensity of the sun
- The time of year and the number of day-light hours
- The distance from the turbines to the shadow receptors
- The height of the sun

This shadow flickering effect mainly occurs when the sun is low in the sky and the rotating blades of the turbine cast patches of shade that flicker through a narrow aperture such as a window or door opening.

A primary factor which determines the intensity of shadow flicker at a potential receptor (i.e. the facility where the shadow falls) is the distance of the wind turbine from that receptor. Shadows that are cast close to a turbine will be more intense than those at some further distance. Based on research and scientific studies, it is widely accepted that shadow flickering effects are not experienced at a distance of greater than the equivalent of 10 times the rotor diameter of the turbine; and further, only receptors that lie within 130º either side of North will be so impacted. The distance of 10 times the rotor diameter is called the zone of influence for shadow flickering. In this case the zone of influence is 500m. There are no buildings or residences within the zone of influence.

Photosensitive Epilepsy

"Photosensitive epilepsy is the name given to epilepsy in which all, or almost all, seizures are provoked by flashing or flickering light, or some shapes or patterns."[17] Generally, epilepsy affects only a very small portion (0.005%) of the general population, and photosensitive epilepsy affects only approximately 3-5% of those who suffer from epilepsy.

The factors that trigger photosensitive epilepsy include the frequency and intensity of flickering, the pattern of the image as well as the area the light stimulus occupies in the visual field. The threshold frequency for triggering a seizure varies from one individual to another but is generally between 5 to 30 Hz[18]. Research also indicates that less than 5% of photosensitive epileptics are sensitive to the lowest frequencies of 2.5 Hz to 3 Hz.

Frequency of Potential Shadow Flicker Effect

The technical specification for the proposed wind turbines to be installed by JPS indicates that the rotation speed for the turbines ranges between 9 rpm and 28 rpm. The flickering frequency of the shadow generated by the turbine will be equivalent to 3 times the wind turbine operating

[16] As defined by the UK Government
[17] http://www.epilepsy.org.uk/info/photo.html
[18] http://www.epilepsyfoundation.org/about/photosensitivity/gerba.cfm

speed, therefore at the slow end of the range this will be 0.45 Hz and at the maximum speed it will be 1.4 Hz.

The threshold frequency for triggering photosensitive epilepsy is generally 5 Hz, and for a very small percentage of persons affected it is 2.5 Hz. Based on the fact that the maximum flicker frequency anticipated by the turbines to be installed by JPS is 1.4 Hz then it may be concluded that the proposed wind farm by JPS should not trigger photosensitive epilepsy.

4. Nuisance Noise

Noise associated with the operation of the wind turbines is expected to be at a maximum level of 80-100 dB at the hub. Humans have a pain threshold of 140 dB (Appendix 5).

The noise emitted from wind turbines is largely dependent on their size and engineering design. A wind turbine generates two types of noise: aerodynamic (from the blades) and mechanical (from the rotating machinery). Concerns about noise from a wind turbine may be dependent on several factors:

- The level of intensity, frequency, frequency distribution and patterns of the noise source;
- Background sound levels;

The terrain between the emitter and receptor (

- Figure 55)
- The nature of the receptor; and
- The attitude of the receptor about the emitter

In general, the effects of noise on people can be classified into three general categories:

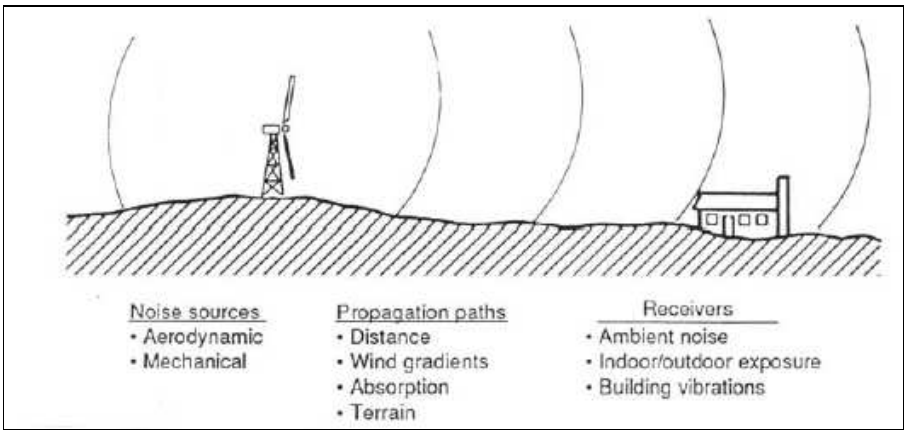
- Subjective effects including annoyance, nuisance, dissatisfaction
- Interference with activities such as speech, sleep, and learning
- Physiological effects such as anxiety, tinnitus, or hearing loss.

As technology has advanced, wind turbines have become quieter. A recent study found that wind farms add 80–110 dB to the existing low-frequency ambient noise (under 400 Hz)[19]. According to the Bruel and Kjaer Instruments used to measure sound pressure level, the threshold of pain is 140 dB for humans. With sound pressure level falling by 6 dB with every doubling of distance, communities located considerable distances from wind turbine farms are least likely to be affected by nuisance noise.

Based on international standard tests, the supplier has indicated that outside of a 200 m radius on the ground, the noise level will be less than 50 decibels. Since the nearest buildings are Munro Prep school and Munro College at approximately 1 and 1.5 km respectively, there should be no nuisance noise from the wind turbine operation.

[19] http://en.wikipedia.org/wiki/Wind_power

Figure 55 - Illustration of Noise sources, Propagation Paths and Receivers



5. Land and water pollution

Lubricating oil leaks from wind turbines could cause land and water pollution as the oil could be spread around the area by the blades of the wind turbine. It is unlikely that there will be any pollution of water resources as there are no surface waters in the area and the groundwater resources are very deep underground. Additionally the volume of oil would be small. The potential for land pollution exists however if the listed aspects are not managed.

6. Reduction of Ecological Species (Birds)

One of the major environmental impacts associated with wind turbines is the adverse effects of wind facilities on avifauna (birds and bats). In many areas across the globe where there are a number of wind farms, thousands of birds and bats die each year due to collision with wind turbine blades. The avifauna survey for the Hermitage area indicated that birds in the area stay within the forest patches beyond the boundaries of the site rather than fly between patches and therefore the flight pattern of birds should not be disrupted as well as the likelihood of bird fatalities is low. Documented research does not support the presence of bats in the area despite there being three (3) caves near to Munro College (Refer to Section 4.2).

7. Reduction in the Aesthetic Value of the Physical Landscape

Some persons feel that wind turbines reduce the aesthetic value of the landscape. This view is however subjective. In the case of wind farms, their siting influences the aesthetic appearance of a particular area, as the cluster of turbines can block areas considered scenic. Where there are single erected turbines or only a few as in this case, it is difficult to determine the extent to which the aesthetic value of a landscape is reduced. Persons from communities surrounding the project sites did not indicate that the wind turbines would be aesthetically displeasing.

8. Obstruction to Air Traffic

The height of the towers could theoretically pose obstruction to air traffic. The Jamaica Civil Aviation Authority (JCAA) was advised of the proposed project and their approval sought for the turbine sites in relation to air traffic movements. Their reports indicated that the turbines are beyond the Outer Horizontal limits of Sangster International Airport and Nain Aerodrome and would therefore not pose obstructions to air traffic. (Refer to Appendix 6).

9. Potential Land-Use Conflicts

The sites proposed for the wind turbines are owned by the Crown and are in the custody of the National Land Agency (NLA). The JPS sought and obtained permission to lease the land for these sites. The sites were previously being leased to an entity that in turn leased plots of land to small farmers to plant cash crops. The NLA gave notice to the lessee to vacate the lands who has advised the small farmers accordingly.

The use of the lands for the construction of wind turbines has been approved in principle by the Parish Council. Formal approval is pending after a permit is granted by NEPA. This inherently means that the Parish Council will need to implement appropriate restrictions for development of land in and around the project sites so that there is no conflicting land use in the future.

Lands across the road from WTG #3 and #4 are owned by Alpart. It is possible that mining of these lands will occur during the operating phase of the wind turbines. Based on the height of the wind turbines dust from mining operations should not adversely affect their operation.

Table 24 - Potential Negative Impacts of Project

	ASPECT	POTENTIAL NEGATIVE IMPACTS
Construction phase		
1.	Noise	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
2.	Fugitive dust emissions	• Air pollution • Respiratory problems
3.	Vehicular emissions	• Air pollution • Respiratory problems
4.	Solid waste (top soil, vegetation, construction debris, garbage)	• Land and water pollution
5.	Human waste	• Land and water pollution
6.	Use of fuel	• Depletion of (oil) resources
7.	Removal of vegetation	• Habitat destruction • Disruption of ecosystems • Displacement of small farmers

	ASPECT	POTENTIAL NEGATIVE IMPACTS
8.	Soil erosion	• Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil
9.	Construction work	• Accidents causing death or injury
10.	Increased traffic movement	• Traffic congestion • Motor vehicle accidents
11.	Use of water	• Depletion of water resources
12.	Spills	• Land and water pollution
Operation Phase		
1.	Disruption of air traffic	• Plane crashes
2.	Lightning strikes	• Fires • Disruption in electricity supplies
3.	Flickering	• Health impacts – epilepsy in rare cases
4.	Diffraction/Shadowing, Reflection, Scattering	• Electromagnetic interference which can affect radar and radiocommunication
5.	Vibration	• False earthquakes detected on seismograph monitoring equipment
6.	Noise	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
7.	Oil spills/leaks	• Land and water pollution
8.	Disruption in avifauna flight patterns	• Bird and bat deaths
9.	Land use	• Alteration of development and land use in the area • Depreciation of land value
10.	Aesthetics	• Visually unattractive
Maintenance		
1.	Oil spills/leaks	• Land and water pollution
2.	Solid waste	• Land and water pollution
3.	Human waste	• Land and water pollution
4.	Maintenance work	• Accidents
Decommissioning		
1.	Solid waste	• Land and water pollution
2.	Noise from maintenance equipment	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
3.	Oil spills/leaks	• Land and water pollution
4.	Human waste	• Land and water pollution

Some positive impacts associated with this project are presented at Table 25.

Table 25 - Project Activities that can be potentially beneficial

	ACTIVITY	POTENTIAL POSITIVE IMPACTS
Construction phase		
1.	Construction jobs	• Employment for locals • Increased commercial activities in the area
Operating Phase		
1.	Wind turbine operation	• A renewable source of energy is being used for electricity generation • Less pollution • Reduction in greenhouse gas emissions • Reduction in Jamaica's carbon footprint • Reduced cost to the country associated with the importation of oil • Reduced demand for foreign exchange to purchase imported oil • Promotion of the use of alternative energy • May become a tourist attraction

6.0 Significant Impacts

Negative impacts are undesirable, but not all negative impacts are equal. There are some that are considered significant based on a number of criteria. This section determines the significance of each impact according to the specific criteria presented at Table 26. The significant impact determination is presented at Table 27.

Table 26 – Significant Impact Assessment Criteria

CRITERIA	Minor	Moderate	Severe
Scale - takes into consideration the spatial/ geographic extent of the impact	On site or within project site boundaries	Beyond site boundary but within community/local area around project site (2 km)	Widespread or at a regional//national/international scale
Duration is the overall length of time an identified impact is likely to persist	Short term (less than 5 years); less than project lifespan; quickly reversible	Medium-term (5-15 years), over the lifespan of the project; reversible over time	Long-term (more than 15 years); permanent; irreversible
Intensity (Baseline Change) examines the severity of the impact on the physical, biological and socio-economic baseline of the project area and examines the change from the pre-project or current baseline conditions	Disturbance of degraded areas, with little conservation value Minor change in species occurrence or variety Limited or no adverse change to the baseline status of social, economic and environmental receptors	Moderate disturbance of areas that have potential conservation value Complete change in species occurrence Disturbance of community's environmental, social and economic fabric Potential conflict with community's development plans	Significant adverse environmental impacts (quality of land, air and water resources) Widespread disturbance of community's social and economic fabric Substantial increase in solid waste generation, increase in potential for erosion, flooding or leaching. Removal and or destruction of large quantities of flora and fauna, including endangered or threatened species; substantial interference with the movement of migratory species

CRITERIA	Minor	Moderate	Severe
Affected Numbers takes into account the number of individuals or receptor population (organisms, people etc.) that stand to be affected by the project	<5% of the population or habitat is directly exposed	5-10% of the population or habitat is directly exposed	>10% of the population or habitat is directly exposed
Secondary Effects considers the indirect effects of the project	Few indirect impacts	Moderate amount of indirect impacts	Substantial amount of indirect impacts (generational impact)
Reversibility evaluates the extent to which the affected receptor can be returned to its pre-project state after experiencing an adverse impact	Completely reversible (0-5 years); not costly	Reversible (5-15 years); may or may not be costly	Irreversible (damage cannot be reverted to original condition within a 50-100 year period)
Acceptability takes into account the willingness of stakeholders to make trade-offs, given the potential benefits of the project, limited environmental changes or the ability to mitigate adverse impacts	No risk to public health. Modification of landscape without down grading special social, economic and aesthetic values Within legal thresholds and allowable limits Some loss of biological populations and habitats	Conflict with policies or land-use plans Loss of populations of commercial biological species Community stakeholders willing to make trade-offs Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	Large scale loss of productive capacity of renewable resources Increases level of risk to public health Project needs to be redesigned Extinction of biological species, loss of diversity, rare or endangered species and critical habitats Legal thresholds and allowable limits exceeded/ breached Can lead to widespread public outcry

Table 27 - Significant Impact Determination

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
Construction phase			
1.	**Fugitive dust emissions & Vehicular emissions** • Air pollution • Respiratory problems	SCALE • The highest concentration of fugitive dust and vehicular emissions is expected to occur at the project sites. • Road construction activities may affect the local area • Fugitive dust from trucks transporting (uncovered) aggregate • High wind speeds are expected to rapidly disperse fugitive dust and diesel emissions DURATION • Short-term - This is expected to last for the duration of the construction phase (9-12 months) of the project INTENSITY (BASELINE CHANGE) • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS • <1% of the population will be affected. There are no residences in Hermitage. Two schools are within 1.5 km of the nearest wind turbine site and their pupils and staff could be affected • Biological community within the project area is already highly disturbed due to burning of vegetated areas for coal and the clearance of land for agricultural use. SECONDARY IMPACTS • Increase in greenhouse gas emissions from motor vehicles that contribute to global warming and climate change REVERSIBILITY • Completely reversible: dust will eventually settle or clear out of the atmosphere as a result of wind and rainfall and emissions will be dispersed. ACCEPTABILITY • Fugitive dust, not acceptable; must be mitigated and kept to a minimum • Stakeholders will be willing to make trade offs in respect of the temporary nuisances provided that appropriate mitigation measures are implemented.	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
2.	**Noise** • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	SCALE • Beyond site boundary but within community/ local area around project site (2 km) • Noise may affect the schools (Munro Prep and Munro College) DURATION • Short term (during work hours), quickly reversible • This impact is expected to last for the duration of the construction period (9-12 months) INTENSITY • Disturbance of community's social fabric • Nuisance noise during construction is expected to be a noticeable change in the immediate area of construction AFFECTED NUMBERS • Less than 1% of the population is directly exposed; there are no residents in Hermitage • Workers at the site could be affected by construction related noise • Students and staff at the Munro Preparatory School, the closest building to WTG#1 & #2 (approx. 1km), may experience increased noise nuisance during the work hours and for the duration of the construction period (9-12 months) • Increased truck traffic passing through communities en route to the site can cause an increase in noise nuisance intermittently over the construction period SECONDARY IMPACTS • Temporary or long term hearing impairment for persons on the construction site without hearing protection (Appendix 7) REVERSIBILITY • The effects of the temporary nuisance are completely reversible with cessation of the construction activities. ACCEPTABILITY • In general, stakeholders are willing to make trade offs in respect of temporary nuisances provided that available and appropriate mitigation measures are implemented.	**YES**
3.	**Solid waste (top soil, vegetation, construction debris, garbage)** • Land and water pollution	SCALE • Onsite (within project site boundaries) land pollution can occur • No threat to water resources as there are no ground or surface water resources at the projects site or within the surrounding communities	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Garbage may attract rodents and flies • Uncontained garbage can affect aesthetics • Uncontained top soil can be washed away during rainfall events REVERSIBILITY • Completely reversible at minimal cost ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
4.	**Use of fuel** • Depletion of (oil) resources	SCALE • National/international scale as an imported non-renewable energy source is being used DURATION • Short term, for the duration of the project INTENSITY • Contribution to global depletion of resources is negligible AFFECTED NUMBERS • Contribution to national and global demand is low SECONDARY IMPACTS • Contributes to greenhouse gas emissions • Contributes to air pollution • Contributes to high fuel bill and foreign exchange demand REVERSIBILITY • Permanent ACCEPTABILITY • Acceptable given the type of project; no alternatives available	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
5.	**Human waste** • Land and water pollution	SCALE • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Foul odours • May attract rodents and flies REVERSIBILITY • Quantity of sewage small, land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**NO**
6.	**Removal of vegetation** • Habitat destruction • Disruption of ecosystems • Displacement of small farmers	SCALE • Onsite, within project site boundaries; specific areas identified for access roads and wind turbine towers. • Regional; modification of two (2) corners en route to site to facilitate transportation of heavy equipment and large components of wind turbines • Acreage of permanently cleared land is relatively small DURATION • Long term and likely to be permanent: Roadways (0.6 ha); substation (0.012 ha); wind turbines (0.0265 ha) • Short term, for duration of project: crane pads (0.64 ha), construction laydown area (0.02ha) INTENSITY • No habitat destruction or disruption of ecosystems; negligible loss of biological populations • Disturbance of degraded areas, with little conservation value; areas are denuded of vegetation and grass dominates the	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		selected sites • Minor change in species occurrence or variety • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS • <5% of the population or habitat will be directly exposed as there are no residences in Hermitage • There will be no effect on birds as the areas to be cleared have no trees • The effect on vegetation will be negligible as the project area is dominated by grass and the area is highly disturbed SECONDARY IMPACTS • Modification of landscape • The cash crop farming activities of a few small farmers will be affected for the duration of the construction • Loss of aesthetic value of area REVERSIBILITY • Areas temporarily cleared will be naturally restored over time, at no cost, that is, grass will fill in those areas cleared where no structure will be erected. Alternatively, these areas can be restored by planting grass at a low cost ACCEPTABILITY • Modification of landscape without down grading special social, economic and aesthetic values • Given the tremendous benefits to be had from the use of alternative energy sources, persons will be willing to accept land use changes	
7.	**Soil erosion** • Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil	SCALE • Sediments may be transported by storm water beyond the site boundary but within the community/local area around the project site (2 km) DURATION • Short term, for duration of project INTENSITY • No habitat destruction or disruption of ecosystems; negligible loss of biological populations • Disturbance of degraded areas, with little conservation value • Minor change in species occurrence or variety • Limited or no adverse change to the baseline status of social, economic and environmental receptors	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		AFFECTED NUMBERS • <5% of the population or habitat will be directly exposed as there are no residences in Hermitage SECONDARY IMPACTS - REVERSIBILITY • Permanent ACCEPTABILITY • Not acceptable; mitigation required	
8.	**Construction work** • Accidents causing death or injury	SCALE • Onsite within project boundaries DURATION • Short term for the duration of the project INTENSITY • Has the possibility to disturb the baseline social receptors AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS - REVERSIBILITY • Death and serious injury not reversible ACCEPTABILITY • Not acceptable, mitigation measures must be implemented	**YES**
9.	**Increased traffic movement** • Traffic congestion • Motor vehicle accidents	SCALE • Beyond site boundary but within community/local area around project site (2 km) DURATION • Short term for the duration of the project INTENSITY • Disturbance of community's environmental, social and economic receptors AFFECTED NUMBERS • >10% of the population will be directly exposed; all road users in the area will be affected • Even though there are no residences in Hermitage, two schools	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		are within 1.5 km of the project sites, and trucks will pass through surrounding communities en route to the project sites. • The main road that provides access to the project sites is the main parochial road linking Munro to Malvern and is traversed by a number of route taxis SECONDARY IMPACTS • Increased fuel consumption as a result of traffic congestion • Death and injury as a result of accidents • Increased vehicular emissions • Increased wear and tear of road surfaces • Increased travelling and waiting times REVERSIBILITY • Traffic congestion reversible after construction ends • The effects of motor vehicle accidents are not reversible ACCEPTABILITY • Some level of tolerance is expected by the residents in the communities surrounding the project sites	
10.	**Use of water** • Depletion of water resources	SCALE • Beyond site boundary but within community/local area around project site (2 km) DURATION • Short term for the duration of the project INTENSITY • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS - SECONDARY IMPACTS - REVERSIBILITY • Permanent ACCEPTABILITY • No alternative, water needed for construction	**NO**
11.	**Fuel and oil spills** • Land and water pollution	SCALE • Onsite (within project site boundaries) land pollution can occur • No threat to water resources as there are no ground or surface	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		water resources at the project sites or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Unsightly appearance of areas where spills occur • Quantities are likely to be small but they may be transported to other locations via storm water • Land and water pollution associated with waste disposal REVERSIBILITY • Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
Operation Phase			
1.	**Disruption in air traffic** • Plane crashes	The Jamaica Civil Aviation Authority has indicated that the wind turbines pose no risk to aircraft as they are not along a flight path	**NO**
2.	**Lightning strikes** • Fires • Damage to wind turbines • Disruption in electricity supplies	SCALE • On site or within project site boundaries - fires • Widespread or at a regional//national scale – potential for the disruption of electricity supplies DURATION • Repair or replacement of wind turbines damaged is costly and may take some time • Restoration of electricity is short term as JPS can take measures to compensate for shortfall INTENSITY • Some social impact as a result of loss of power supply • Significant economic impact if JPS has to repair or replace turbine	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		• Air pollution from emissions associated with fires AFFECTED NUMBERS • 5-10% of the population or habitat is directly exposed; persons within the community and/or regionally may be affected by the short term loss of power SECONDARY IMPACTS • Land pollution from disposal of damaged equipment • Increase in cost of electricity generation due to use of fossil fuel during period of shortfall REVERSIBILITY • Reversible but likely to be costly ACCEPTABILITY • Not acceptable, measures should be taken to minimise or eliminate the impact of lightning strikes	
3.	**Noise** • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	SCALE • Onsite within boundary of project site DURATION • Long term, permanent; for as long as the wind turbines are in operation. INTENSITY • There are no residents in Hermitage and based on the design of the turbine the noise levels will be less than 50 dB at 200 m • Minor increase in baseline noise level at the site should not adversely impact on ecological species AFFECTED NUMBERS - SECONDARY IMPACTS - REVERSIBILITY • Only reversible if the turbines are not in operation or decommissioned ACCEPTABILITY • Generally acceptable since there is no impact on residents	**NO**
4.	**Oil spills/leaks** • Land and water pollution	SCALE • Quantities are likely to be small • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		water resources at the project sites or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Unsightly appearance of areas where spills occur • Quantities are likely to be small but they may be transported to other locations via storm water • Land and water pollution associated with waste disposal REVERSIBILITY • Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
5.	**Disruption in avifauna flight patterns** • Bird and bat deaths	SCALE • Beyond site boundary but within community/local area around project site DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation. INTENSITY • Limited or no adverse change to the baseline status of environmental receptors AFFECTED NUMBERS • Birds - Expected to be extremely low since that location of the turbines are not in a flight path • Bats – None known to exist in the area SECONDARY IMPACTS -	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		REVERSIBILITY • Only reversible if the turbines are not in operation or decommissioned ACCEPTABILITY • Acceptable based on siting of turbines	
6.	**Land use** • Alteration of development and land use in the area • Depreciate land value	SCALE • Beyond site boundary but within community/local area around project site DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation. INTENSITY • Disturbance of degraded areas, with little conservation value • Minor change in species occurrence or variety • Disturbance to the community's social, economic and environmental fabric • No change in existing land ownership rights expected AFFECTED NUMBERS • >10% of population is affected regarding value of land • Small farming activities can coexist with the wind turbines SECONDARY IMPACTS • Restricts housing development within the area as this would pose a conflict REVERSIBILITY • Only reversible if the turbines are decommissioned • In the event that occupation rights are revoked, removal of the wind turbines will prove costly. ACCEPTABILITY • Acceptable use of land based on the benefits to be derived • Acceptable to Parish Council in principle; formal approval pending	**NO**
7.	**Aesthetics** • Visually unattractive	SCALE • Beyond site boundary but within community/local area around project site DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation.	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		INTENSITY • Disturbance of degraded areas, with little conservation value • Minor change in species occurrence or variety • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS • >10% of population is affected as the wind turbines can be seen from far away SECONDARY IMPACTS - REVERSIBILITY • Only reversible if the turbines are removed ACCEPTABILITY • Acceptable based on the benefits to be derived	
8.	**Flickering** • Health impacts – photosensitive epilepsy in extremely rare cases	Research conducted and the design specifications of the wind turbines indicate that the wind turbines will not cause adverse health effects.	**NO**
9.	**Diffraction/Shadowing, Reflection, Scattering** • Electromagnetic interference which can affect radar and radiocommunication	SCALE • Beyond site boundary but within community/local area around project site DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation. INTENSITY • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS • Consultations and information received indicate that the wind turbines will pose no interference to radio frequency signals in the area except for the potential impact on TV reception at two (2) locations, Munro Preparatory School and Munro College that fall within the consultation zone of 2.2 km for TV reception SECONDARY IMPACTS -	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		REVERSIBILITY • TV reception can be improved by using externally mounted antennae ACCEPTABILITY • Acceptable based on the benefits to be derived and the fact that the potential impact can be mitigated	
10.	**Vibration and noise** • False earthquake signals received by seismological equipment	Consultations and information received indicated that the wind turbines will pose no interference to seismological monitoring equipment at Munro College	**NO**
	Maintenance		
1.	**Oil spills/leaks** • Land and water pollution	SCALE • Quantities are small • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Unsightly appearance of areas where spills occur • Quantities are likely to be small but they may be transported to other locations via storm water • Land and water pollution associated with waste disposal REVERSIBILITY • Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
2.	**Solid waste** • Land pollution	SCALE • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Garbage may attract rodents • Uncontained garbage can affect aesthetics • Uncontained top soil can be washed away during rainfall events REVERSIBILITY • Completely reversible at minimal cost ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**NO**
3.	**Human waste** • Land and water pollution	SCALE • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		SECONDARY IMPACTS • Foul odours • May attract rodents and flies REVERSIBILITY • Quantity of sewage small, land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
4.	**Maintenance work** • Accidents causing death or injury	SCALE • Onsite within project boundaries DURATION • Short term for the duration of the maintenance activities INTENSITY • Has the possibility to disturb the baseline social receptors AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS - REVERSIBILITY • Death and serious injury not reversible ACCEPTABILITY • Not acceptable, mitigation measures must be implemented	**NO**
Decommissioning			
1.	**Solid waste** • Land and water pollution	SCALE • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities DURATION • Short term, for the duration of the decommissioning INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Garbage may attract rodents and flies • Uncontained garbage can affect aesthetics • Un-vegetated soil can be washed away during rainfall events REVERSIBILITY • Completely reversible at minimal cost ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
2.	**Noise from equipment** • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	SCALE • Beyond site boundary but within community/ local area around project site (2 km) • Noise may affect the schools (Munro Prep and College) DURATION • Short term (during work hours), quickly reversible • This effect is expected to last for the duration of the decommissioning period INTENSITY • Disturbance of community's social fabric • Nuisance noise during decommissioning is expected to be a noticeable change in the immediate area AFFECTED NUMBERS • Less than 1% of the population is directly exposed; there are no residents in Hermitage • Workers at the site could be affected by decommissioning related noise • Students and staff at the Munro Preparatory School, the closest building to WTG#1 & #2 (approx. 1km), may experience increased noise nuisance during the work hours and for the duration of the decommissioning period (9-12 months) • Increased truck traffic passing through communities en route to the site can cause an increase in noise nuisance intermittently over the decommissioning period SECONDARY IMPACTS • Temporary or long term hearing impairment for persons on the construction site without hearing projection (Appendix 7)	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		REVERSIBILITY • The effects of the temporary nuisance are completely reversible with cessation of the decommissioning activities. ACCEPTABILITY • In general, stakeholders are willing to make trade offs in respect of temporary nuisances provided that available and appropriate mitigation measures are implemented.	
3.	**Oil spills/leaks** • Land and water pollution	SCALE • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the site or within the surrounding communities DURATION • Short term, for the duration of the decommissioning INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Unsightly appearance of areas where spills occur • Quantities are likely to be small but they may be transported to other locations via storm water • Land and water pollution associated with waste disposal REVERSIBILITY • Quantities are likely to be small; can be cleaned up; land pollution reversible over time naturally • Avoidable with good maintenance practices ACCEPTABILITY Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**NO**
4.	**Human waste** • Land and water pollution	SCALE • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		DURATION • Short term, for the duration of the decommissioning INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Foul odours • May attract rodents and flies REVERSIBILITY • Quantity of sewage small, land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	

6.1 Positive Impacts

Table 28 presents the positive impacts of the project for both the construction and operations phases.

Construction Phase

1. Employment Opportunities

The Jamaica Public Service Company plans to employ 60 workers during the construction phase of the project. It is anticipated that during the construction phase engineers, architects, construction workers, truck drivers, equipment operators, security guards, surveyors, building contractors and unskilled labour, will all benefit from the project.

During the operation phase maintenance workers and engineers will be required for the operation and maintenance (O&M) of the wind turbines.

Local contractors and workers will be utilised as much as possible. However if the required number of workers or level of expertise cannot be found within nearby communities, then contractors and workers will be sourced regionally, nationally and internationally, in that order of priority.

The increased income for local residents will likely cause an increase in commercial activity in the nearby towns.

Operational Phase

1. Reduction in greenhouse gas emissions

One of the benefits of electricity production from wind turbines is that it does not lead to the emission of greenhouse gases or other noxious emissions as is the case with fossil fuels. Wind energy is a clean renewable form of energy that requires significantly less consumption of natural resources, such as land and water.

2. Reduction in Fuel Consumption and Costs

The constant fluctuation and drastic increases in fuel costs has made it increasingly important for developing and non-producing oil nations to discover and utilise alternative and cleaner energy sources. The largest fuel cost associated with production of electricity from wind sources is in the construction phase of the project for the transportation of equipment and wind turbine parts and the use of heavy duty equipment. These fuel costs are relatively low and short term in duration. Since no fuel is used to generate electricity from wind turbines there is a net reduction in fuel consumption per kW of electricity generated by JPS.

The installation of the wind turbines will reduce overall fuel cost by US$1.7 million annually.

3. Reduction in Electricity costs to Consumers

The United States Environmental Protection Agency, estimated in 2007 that the installed costs for turbines ranged between US $1000 and US $5000 per kW capacity. Based on a study conducted by the USEPA, a wind turbine with a generation capacity of 10kW located at a site, with average wind speeds of 12 mph can produce approximately 10,000 kWh annually, which is enough to power a small building. Calculating the average price for conventional electricity in the USA of US 9c per kWh, the wind turbine would reduce annual grid-based electricity costs by approximately US$900. This would provide savings which could result in the payback period for construction and installation being greatly reduced.

The Jamaica Public Service estimates that 10,512,000 kWh will be produced annually from the four (4) 750kWh wind turbines. This would result in an overall savings of US$1.7 million in fuel costs annually. Currently the average cost of electricity production

is $0.28 US cents (J$24.98) per kWh. The cost reduction in overall energy production is likely to increase savings for JPSCo. and also for the consumers. It is projected that following the immediate implementation of the turbines consumers will see a 0.27% savings on their electricity bills.

4. Promotion of Alternative Sources of Energy

Non-producing oil nations have led the charge in developing cleaner and more affordable alternative energy sources to reduce (a) their dependence on foreign oil, (b) the percentage of Gross Domestic Product spent on crude oil (c) reduce greenhouse gas emissions (d) reduce the threats of global warming and (e) develop more sustainable approaches towards conserving limited natural resources.

Climate change is the most serious environmental threat facing the world today and clean renewable energy sources like wind power are a significant part of the solution. Wind power is plentiful in many parts of the world and can be harnessed safely to generate electricity, without producing any dangerous waste or unwanted by-products

5. Potential Tourist attraction

The installation of the wind farm at Hermitage may lead to an increase in visitors to the area. There will likely be school trips as well as visits by persons who are interested in viewing the installation. This may lead to increased commercial activity in the nearby towns.

Table 28 - Positive Impacts of Project

	POTENTIAL BENEFITS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**
Construction phase		
1.	Employment Opportunities	SCALE • Regional DURATION • Short-term for contracted workers - This is expected to last for the duration of the construction phase (9-12 months) of the project • Long-term - in cases where direct responsibility for the operation of wind turbines is vested in a new department or division, this can lead to long-term benefits INTENSITY (BASELINE CHANGE) • Opportunities that provide employment to members of the public are viewed as a welcome change to present baseline conditions • Increased commerce in neighbouring communities will result in changes to economic baseline AFFECTED NUMBERS • It is anticipated that 60 persons will benefit from employment on the

	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		proposed project; some likely to be from neighbouring communities SECONDARY IMPACTS • Increased income earning potential for workers • Increased standard of living • Increased commercial activities for the duration of the project in neighbouring communities • Reduction in unemployment REVERSIBILITY • Short term employment ends after project is completed ACCEPTABILITY • Acceptable, persons are in need of employment
Operational Phase		
1.	Reduction in greenhouse gas emissions	SCALE • Regional/National/International DURATION • Long-term INTENSITY/BASELINE • This is a minor change from current baseline conditions. Jamaica, (as part of the entire Caribbean Region) accounts for 1% of total greenhouse gas emissions globally. The reduction in greenhouse gas emissions locally can however make a small, but meaningful contribution in helping to solve the world's growing climate change problem . AFFECTED NUMBERS • Unknown how many persons or ecological species could benefit, but the impact is expected to be global SECONDARY EFFECTS • Reduced global temperatures (negligible impact) • Improved local conditions (temperature) • Improved air quality
2.	Reduction in fuel costs and demand for foreign exchange for the importation of oil	SCALE • National DURATION • Long-term INTENSITY/BASELINE • The reduction in fuel costs and consumption will take place incrementally and will therefore be seen as a minor change from existing baseline conditions.

	POTENTIAL BENEFITS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**
		AFFECTED NUMBERS • All members of the population will be impacted either directly or indirectly. SECONDARY EFFECTS • Increased potential to reduce dependency on oil (long-term) • Increased financial resources for other renewable energy projects
3.	Promotion of use of alternative energy	SCALE • Regional/National/International DURATION • Long-term INTENSITY/BASELINE • This will represent a major change from existing baseline conditions, particularly in developing countries AFFECTED NUMBERS • The entire population stands to benefit from such an initiative SECONDARY EFFECTS • Reduces the percentage of GDP spent on oil imports • Reduces the severity of climate change impacts • Creates employment opportunities • Reduces greenhouse gas emissions
4.	Potential tourist attraction	SCALE • Local DURATION • Long-term INTENSITY/BASELINE • Moderate to significant change in social and economic fabric of the communities AFFECTED NUMBERS • The entire population stands to benefit from such an initiative SECONDARY EFFECTS • Increased commercial activity • May encourage more alternative energy projects

	POTENTIAL BENEFITS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**
		Maintenance
1.	Maintenance activities	SCALE • Regional DURATION • Long-term - in cases where direct responsibility for the operation of wind turbines is vested in a new department or division, this can lead to long-term benefits INTENSITY (BASELINE CHANGE) • Small increase in commercial activity when maintenance work is being done in the area AFFECTED NUMBERS - SECONDARY IMPACTS • Increased income earning potential for workers • Increased standard of living • Reduction in unemployment REVERSIBILITY • Short term employment ends after project is completed ACCEPTABILITY • Acceptable, persons are in need of employment
		Decommissioning
1.	Decommissioning and removal of wind turbines Employment Opportunities	SCALE • Regional DURATION • Short-term for contracted workers - This is expected to last for the duration of the decommissioning phase (9-12 months) INTENSITY (BASELINE CHANGE) • Opportunities that provide employment to members of the public are viewed as a welcome change to present baseline conditions • Increased commercial activities for the duration of the decommissioning phase AFFECTED NUMBERS • Some local residents will benefit from short term employment SECONDARY IMPACTS • Increased income earning potential for workers • Increased standard of living

	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		• Increased commerce in neighbouring communities • Reduction in unemployment REVERSIBILITY • Short term employment ends after project is completed ACCEPTABILITY • Acceptable, persons are in need of employment

6.2 Summary of Significant Impacts

Table 29 presents a summary of the significant aspects for the construction, operation, maintenance and decommissioning phases of the project. Most of the significant impacts identified are associated with the construction and decommissioning phases. The operations of the wind turbine have only one significant impact which is its susceptibility to lightning strikes. In all cases the significant impacts can be mitigated.

Table 29 - Summary of Significant Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
	Construction phase	
1.	Fugitive dust emissions & vehicular emissions • Air pollution • Respiratory problems	**NO**
2.	Noise • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	**YES**
3.	Solid waste (top soil, vegetation, construction debris, garbage) • Land and water pollution	**NO**
4.	Use of fuel • Depletion of (oil) resources	**NO**
5.	Human waste • Land and water pollution	**NO**
6.	Removal of vegetation • Habitat destruction • Disruption of ecosystems • Displacement of small farmers	**NO**
7.	Soil erosion • Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
8.	Construction work • Accidents causing death or injury	**YES**
9.	Increased traffic movement • Traffic congestion • Motor vehicle accidents	**YES**
10.	Use of water • Depletion of water resources	**NO**
11.	Fuel and oil spills • Land and water pollution	**NO**
	Operation Phase	
1.	Disruption in air traffic • Plane crashes	**NO**
2.	Lightning strikes • Fires • Damage to wind turbines • Disruption in electricity supplies	**YES**
3.	Noise • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	**NO**
4.	Oil spills/leaks • Land and water pollution	**NO**
5.	Disruption in avifauna flight patterns • Bird and bat deaths	**NO**
6.	Land use • Alteration of development and land use in the area • Depreciate land value	**NO**
7.	Aesthetics • Visually unattractive	**NO**
8.	Flickering • Health impacts	**NO**
9.	Diffraction/Shadowing, Reflection, Scattering • Electromagnetic interference which can affect radar and radiocommunication	**NO**
10.	Vibration and noise • False earthquake signals	**NO**
	Maintenance	
1.	Oil spills/leaks • Land and water pollution	**NO**
2.	Solid waste • Land pollution	**NO**
3.	Human waste • Land and water pollution	**NO**
4.	Maintenance work • Accidents causing death or injury	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
	Decommissioning	
1.	Solid waste • Land and water pollution	**YES**
2.	Noise from equipment • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	**YES**
3.	Oil spills/leaks • Land and water pollution	**NO**
4.	Human waste • Land and water pollution	**NO**

7.0 Mitigation Measures

Negative environmental impacts can be mitigated by implementing measures during the construction, operating, maintenance and decommissioning phases to eliminate or significantly reduce them.

Mitigation measures to address the potential negative impacts, significant or not, associated with this project are presented in Table 30.

Table 30 - Mitigation Measures for Negative Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
	Construction phase	
1.	Fugitive dust emissions & Vehicular emissions • Air pollution • Respiratory problems	• Cover haulage vehicles transporting aggregate, soil and cement • Cover onsite stockpiles of aggregate, cement, soil etc. • Ensure proper stock piling/storage and disposal of solid waste • Wet cleared land areas regularly • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. dust masks and ensure that they are worn • Operate well maintained vehicles and equipment
2.	Noise • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	• Advise schools and residents in the surrounding communities of construction dates and times • Ensure that construction activities are undertaken within the stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn
3.	Solid waste (top soil, vegetation, construction debris, garbage) • Land and water pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville • Landscape project sites with top soil excavated
4.	Human waste • Land pollution	• Use a reputable company to provide portable toilets for workers
5.	Soil erosion • Sediments in storm water runoff	• Only clear top soil from areas to be used • Place berms around stockpiles of top soil
6.	Construction work • Accidents causing death or injury	• Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
7.	Increased traffic movement • Traffic congestion • Motor vehicle accidents	• Erect signs along main transportation route and in sensitive areas such as schools • Transport heavy equipment and wind turbine parts during off-peak traffic hours (between (2:00 to 4:00 a.m.) with police outriders • Trucks transporting construction material should be advised to comply with the speed limits • Use traffic signals or flagmen to manage traffic flows where road improvement works are being undertaken
8.	Fuel and oil spills • Land and water pollution	• Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site and dispose of waste in accordance with best practices
	Operation Phase	
1.	Lightning strikes • Fires • Damage to wind turbines • Disruption in electricity supplies	• Lightning arrestors and lightning masts are an integral part of the wind turbine installations
	Maintenance	
1.	Solid waste • Land pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville
2.	Human Waste • Land and water pollution	• Use a reputable company to provide portable toilets for workers
3.	Maintenance work • Accidents causing death or injury	• Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures
	Decommissioning	
1.	Solid waste • Land pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville
2.	Noise from maintenance equipment • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	• Advise schools and residents in the surrounding communities of decommissioning dates and times • Ensure that decommissioning activities are undertaken within the stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn
3.	Oil spills/leaks • Land pollution	• Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site and dispose of waste in accordance with best practices
4.	Human Waste • Land and water pollution	• Use a reputable company to provide portable toilets for workers

8.0 Analysis of Alternatives

There are two potential alternatives to the proposed wind project; 'do nothing' and hydropower. There are also a number of siting options and turbine designs that were examined.

8.1 Alternative Projects

'Do Nothing'

The 'do nothing' alternative means that JPS will continue to use fossil fuel as the energy source for electricity generation. With fuel prices continuing to increase, it is becoming increasingly difficult for developing nations to withstand the rising cost of oil. Most importantly, the increases in global oil prices have also affected other areas such as food prices. The 'do nothing' alternative does not seem plausible given the proposed rationale of the project and the benefits to be derived.

Hydropower Energy Development

This is a suitable alternative to the proposed project and the JPS proposes to expand its generating capacity by using a mix of renewable energy resources. They have received approval from the OUR for a 6.3MW hydropower plant expansion at Maggotty, St. Elizabeth. Rather than being an alternative in this case, it is complementary.

8.2 Siting Options

While wind is the primary criterion for determining potential sites for wind turbines, other key factors, such as accessibility (to the site), human population, housing density, ecological community and the extent of works required to make such sites fully functional must also be considered. Potential sites examined for wind turbines were at Malvern/Munro, St Elizabeth; Hellshire, St. Catherine and Palisadoes, Kingston in a Rapid Environmental Assessment conducted by Environmental & Engineering Managers Ltd. in June 2008.

That assessment identified twelve negative impacts associated with the construction and operational phases of the project ranging from negligible to significant (Table 31 - Summary of Negative Impacts). All four (4) of the impacts associated with the operational phase of the project were classified as minor or negligible. Four (4) significant impacts were identified, two (2) for the Malvern/Munro sites and three (3) for the Hellshire site, all of which were associated with the construction phase.

Table 31 - Summary of Negative Impacts

	IMPACT	EFFECT LEVEL
Construction Phase		
1.	Changes in Air Quality	Minor
2.	Nuisance Noise	Minor (Palisadoes)
		Moderate (Hellshire and Malvern/Munro)
3.	Resource Consumption	Moderate
4.	Construction of Roads and Blasting of Slopes	Significant (Hellshire and Malvern/Munro)
5.	Disturbance of Ecosystems	Negligible (Palisadoes)
		Moderate (Malvern/Munro)
		Significant (Hellshire)
6.	Modification of Protected Land Areas	Negligible (Palisadoes)
		Significant (Hellshire)
7.	Land Ownership rights and Potential Land-Use Conflicts	Minor
8.	Increase in Vehicular Traffic	Negligible (Palisadoes)
		Moderate (Hellshire)
		Significant (Malvern/Munro)
Operational Phase		
1.	Nuisance Noise	Minor
2.	Leaking of Lubricating Oil	Minor
3.	Reduction in Ecological Species (birds and bats)	Minor
4.	Reduction in Aesthetic Value of the Physical Landscape	Negligible

Based on the number and type of negative impacts associated with the Hellshire site and its rich biodiversity and sensitive ecology, it was recommended that it should not be considered as a wind turbine site. Sites at Malvern/Munro and Palisadoes were found to be suitable for further development in this regard and OUR has in fact given JPS approval for these developments to take place. NEPA has already approved wind turbines for Palisadoes and the sites in St. Elizabeth are the subject of this EIA.

8.3 Wind Turbine Design

Alternative wind turbine designs were examined by Wind Energy Consulting and Contracting Inc. From this work, optimal design specifications for the wind turbines were determined and used by JPS as the basis to request proposals for their supply and installation.

The Munro project area was used as the pilot to determine the most suitable wind turbine to be used at the proposed project sites. Six (6) potential sites were identified (Table 32), located approximately 10 km north of the southern coastline, in a mountainous area with average elevation of approximately 700 m. M0 and M1 were adjacent to the Munro College campus while sites M2 to M5 were selected based on the wind resource map. Table 32 provides the estimated wind speed at each of the six (6) locations.

There are two columns for estimated wind speed:

a. Normal roughness refers to roughness obtained from Modis satellite images with a resolution of 1 km x 1 km;
b. Areas around the site are modelled as roughness = 3, which corresponds to a forest; this is a high value for roughness.

The normal roughness model was used as an optimistic case and shows a significant increase in wind speeds between M0 to M1 and M2 to M5. The roughness of 3 was used for the purpose of computing a lower bound of wind speed and represents the pessimistic case.

Table 32 - Wind Turbine Micro sites, Their Elevation and Wind Speed

Name	**Latitude**	**Longitude**	**Elevation in meters**	**Estimated Wind Speed at 50m**	
				Normal roughness	Roughness = 3 for M2 to M5
M0	17.926338 N	77.682531 W	790.0	7.7 m/s	
M1	17.925500 N	77.680499 W	785.0	7.7 m/s	
M2	17.931661 N	77.697913 W	678.1	9.5 m/s	8.7 m/s
M3	17.938769 N	77.697818 W	679.7	9.6 m/s	8.8 m/s
M4	17.943988 N	77.698102 W	673.6	9.1 m/s	8.3 m/s
M5	17.948037 N	77.699993 W	670.0	9.2 m/s	8.4 m/s

Source: Wind Energy Consulting and Contracting Inc., 2008

The (6) six potential sites identified in the Munro area were, on average, at an elevation of 670 m. Based on estimated wind speeds at an elevation of 50 m above ground, four (4) wind turbine models were identified by the JPS for use at their proposed project locations (Table 33 - Proposed Wind Turbine Models).

Table 33 - Proposed Wind Turbine Models

Turbine Name	Turbine specification
T1	Vensys 77-1500. 77m rotor, 85m hub height, 1.5MW rated power
T2	Vestas V52-850. 52m rotor, 55m hub height, 850KW rated power
T3	Gamesa G52-850. 52m rotor, 55m hub height, 850KW rated power
T4	Norwin 46-750. 46m rotor, 45m hub height, 750KW rated power

Source: Wind Energy Consulting and Contracting Inc., 2008

The most suitable turbine was determined based on the estimated wind speed at each of the six (6) micro sites. The wind modelling method used is outlined in Appendix 8.

Based on the wind data analysis the M1 site had the lowest energy production, while the remaining sites M2 to M5 demonstrated similar expected energy production. The differences were attributed primarily to changes in elevation, elevation profiles and to production curves of the turbines.

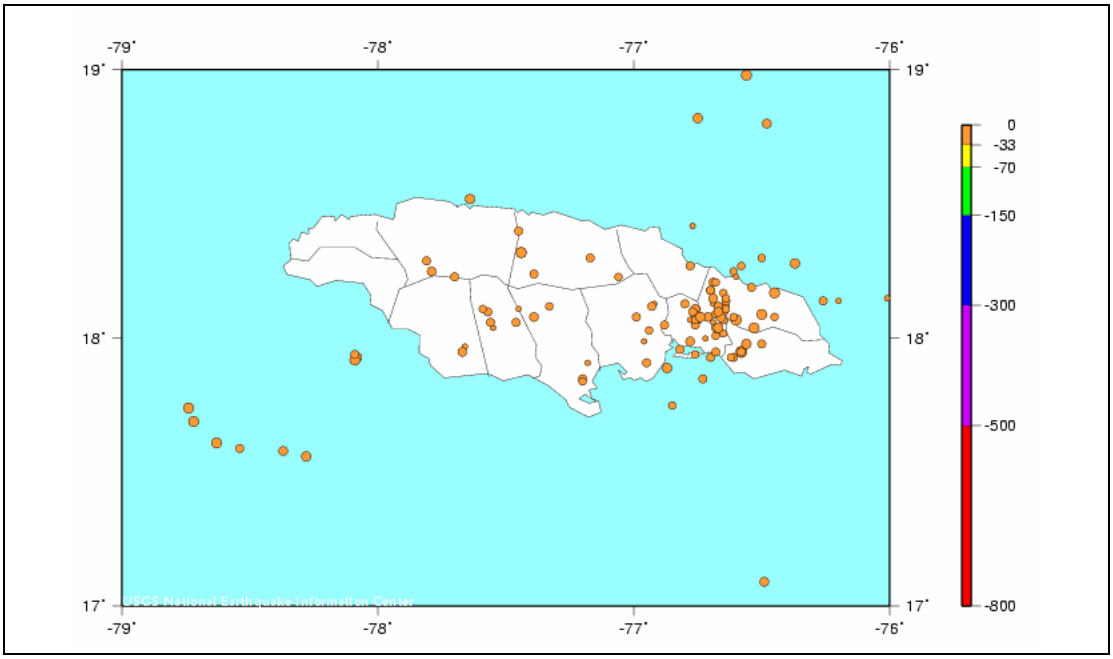
The data analysis indicated that Vensys 77-1500 had the highest capacity factor followed by Gamesa 52-850, Vestas 52-850 and Norwin 46-750. The region containing sites M2 to M5 were found to be suited for a wind farm. Preliminary analysis indicated that the region can accommodate twelve 850KW turbines with total installed capacity of 10MW.

9.0 Emergency Preparedness and Response

The wind turbines have been designed to withstand hurricanes and earthquakes.

There are no recorded earthquake events, which have originated in the parishes of Westmoreland or Hanover, and their origination in the parishes of St. James, St. Elizabeth and St. Mary in the east is quite scarce.

Figure 56 - Earthquake events affecting Jamaica 1975-2008



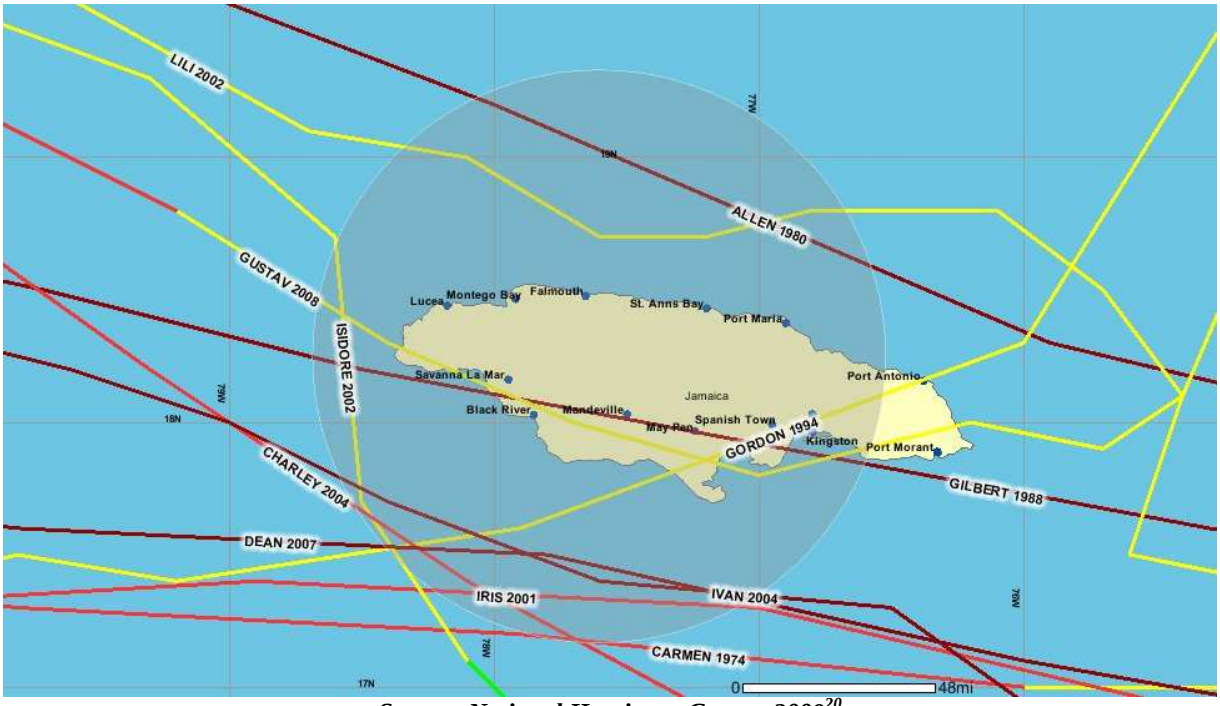
Source: NEIC (rectangular grid search): http://neic.usgs.gov/cgi-bin/epic/epic.cgi

The parishes of St. Elizabeth, Clarendon, Kingston and Manchester are the most susceptible to the impacts of hurricane events. The Wigton Wind Farm situated in Manchester (near to the border with St. Elizabeth) has experienced at least two hurricanes and one tropical storm wind conditions as follows

- 2004: Hurricane Ivan (Category 5) – Repair cost approx US$640K
- 2007: Hurricane Dean (Category 4) – Repair cost approx US$106K
- 2008: Tropical Storm Gustav – No repair cost

In the event of a hurricane, the blades of the wind turbines at Hermitage will be parked in the direction of the wind. This will prevent the turbines from getting damaged.

Figure 57 – Hurricanes and Tropical Storms Affecting Jamaica, 1957-2007



Source: National Hurricane Center, 2009[20]

Since St. Elizabeth is in a known lightning zone, lightning arrestors are on all the wind turbines. This should significantly reduce the likelihood of a fire as a result of lightning. In the event of a fire within the perimeter of the facility, the local fire services would be contacted to extinguish it.

As the facility will be un-manned, two options are being considered in order for an alarm to be raised and the fire services alerted:

- Use locals (residents) to do fire watch on JPS's behalf or
- Install remote monitoring of the facility with the aid of cameras.

[20] http://maps.csc.noaa.gov/hurricanes/viewer.html

10.0 Environmental Health and Safety (EHS) Management and Monitoring Plan

Safety

In accordance with JPS's health and safety plan, the Contractor executing the installation of the wind turbines must provide JPS with a detailed Safety Programme for the project. JPS's acceptance of the Safety Programme will not in any way relieve the Contractor of full and complete responsibility for the safety of its operations.

The Contractor's written Health & Safety Plan must, as a minimum, address the JPS's safety requirements.

JPS Safety Rules

The contractor shall comply with safety rules and regulations that are enforced at the site in accordance with international safety standards such as Occupational Health and Safety Administration (OHSA) and the provisions of the draft Jamaica Occupational Safety and Health Act (JOSHA).

a. The contractor shall be solely responsible for the safety of his subcontractor's employees. It is mandatory that all personnel required to perform work at the site be fitted with approved PPE such as safety helmet, glasses and boots at minimum while on site. Additional PPE must be worn based on the hazards identified. Failure to comply with this request will result in the expulsion of the offending individual(s) from the site. A pre-start site conference meeting on safety will be held by JPS to advise the contractor of the safety standards and requirements expected.
b. The contractor shall promptly correct any unsafe conditions brought to his attention.
c. In the event of an accident, the contractor shall provide JPS with a written report of all pertinent details of the accident within twenty-four (24) hours of its occurrence. This report shall include recommended actions to prevent future occurrence.
d. The contractor shall provide protection and storage for his equipment, general property, vehicles and personnel during all phases of the work.
e. The contractor shall be responsible for his sub-contractors' compliance with safety regulations.
f. The contractor shall provide a first-aid station and people who can administer first aid on site.
g. The contractor shall ensure that his on-site work force is fully equipped with the required safety gears, e.g. hats, boots, gloves, overalls, goggles, equipment for working at high elevations etc.

The Contractor's Health and Safety Plan in included at Appendix 9.

Environmental Monitoring and Management Plan

The Environmental Monitoring and Management Plan (EMMP) will guide JPS on the contractual obligations that it must have in place with the EPC contractor who is working on their behalf. JPS is still ultimately responsible for the project and to prevent and minimise adverse environmental and social impacts associated with the project.

JPS will have to monitor the contractor to ensure that contractual requirements related to environmental management and monitoring are implemented. There will be some aspects of the project that JPS will have to monitor and manage themselves. Many of the contents of the EMMP will likely be conditions of the permit from NEPA for this project.

The EMMP is presented at Table 34.

Table 34 - Environmental Monitoring and Management Plan

	Management Plan	Monitoring Programme
	Construction phase	
1.	Fugitive dust emissions & vehicular emissions • Cover haulage vehicles transporting aggregate, soil and cement • Cover onsite stockpiles of aggregate, cement, soil etc. • Ensure proper stock piling and disposal of solid waste • Wet cleared land areas regularly to control fugitive dust • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. dust masks and ensure that they are worn • Operate well maintained vehicles and equipment	• JPS is to ensure that the contractor implements the required mitigation measures by conducting periodic audits • The Contractor's monthly report to provide details of the mitigation measures implemented
2.	Noise • Advise schools and residents in the surrounding communities of construction dates and times • Ensure that construction activities are undertaken within the stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn	• JPS is to check periodically with the schools to find out if they have any complaints • JPS is to respond promptly to correct confirmed complaints related to the project • The Contractor's monthly report to provide details of the mitigation measures implemented
3.	Solid waste (top soil, vegetation, construction debris, garbage) • Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville • Landscape project sites with top soil excavated	• JPS is to obtain verification that the contractor has disposed of solid waste at an approved municipal disposal site • The Contractor's monthly report to provide details of the mitigation measures implemented
4.	Human waste • Contract a reputable company to provide portable toilets for workers	• JPS is to verify that waste is being taken to an approved wastewater treatment facility

	Management Plan	Monitoring Programme
5.	Soil erosion • Only clear top soil from areas to be used • Place berms around stockpiles of top soil and aggregate	• JPS is to conduct periodic audits of contractor operations • The Contractor's monthly report to provide details of the mitigation measures implemented
6.	Construction work • Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures	• Conduct periodic audits of contractor operations • The Contractor's monthly report to provide details of the mitigation measures implemented
7.	Increased traffic movement • Erect signs along main transportation route and in sensitive areas such as schools • Advise contractor of the need to their drivers are to obey speed limits • Transport heavy equipment and wind turbine parts during off-peak traffic hours (between 2:00 to 4:00 a.m.) with police outriders • Notify relevant communities of the transportation of heavy equipment through their communities • Use traffic signals or flagmen to manage traffic flows where road improvement works are being undertaken	• The Contractor's monthly report to provide details of the mitigation measures implemented
8.	Fuel and oil spills • Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site	• JPS is to conduct periodic audits of contractor operations • The Contractor/JPS is to respond and clean up spills in accordance with emergency preparedness and response plans • The Contractor is to report to JPS on emergencies • JPS is to report to NEPA in accordance with permit requirements • The Contractor's monthly report to provide details of the mitigation measures implemented
	Operation Phase	
1.	• Maintain turbines in accordance with manufacturer's requirements	• During commissioning of wind turbine JPS is to assess noise levels at the hub, 500 m, at Munro Preparatory School which is approximately 1 km and at Munro College which is about 1.5 km from the project sites to have a record of noise levels during operations • JPS is to monitor the area around wind turbines weekly to determine during the first 2 months and

	Management Plan	Monitoring Programme
		thereafter quarterly to observe if there are any bird or bat fatalities • JPS is to check with Munro Preparatory School within the first month of operation of the turbines to determine if they have any concerns
	Maintenance Phase	
1.	Solid waste • Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville	• JPS is to obtain verification that solid waste is disposed of at an approved municipal disposal site
2.	Human waste • Contract a reputable company to provide portable toilets for workers	• JPS is to obtain verification that waste is being taken to an approved wastewater treatment facility
3.	Maintenance work • Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures	• JPS is to maintain preventive and unscheduled/emergency maintenance records
	Decommissioning phase	
1.	Solid waste • Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville	• JPS is to obtain verification that contractor has disposed of solid waste at an approved municipal disposal site
2.	Noise from equipment • Advise schools and residents in the surrounding communities of decommissioning dates and times • Ensure that decommissioning activities are undertaken within the stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn	• JPS is to check periodically with the schools to find out if they have any complaints
3.	Oil spills/leaks • Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site	• JPS is to conduct periodic audits of contractor operations • The Contractor/JPS is to respond and clean up in accordance with emergency preparedness and response plans • The Contractor is to report to JPS on emergencies • JPS is to report to NEPA in accordance with permit requirements

Reporting

During the construction phase:

1. The contractor will submit monthly reports to JPS outlining work progress including environmental mitigation measures that must be implemented, accidents, incidents requiring activation of the emergency response plans and breaches in environmental requirements, if any.
2. JPS will submit monthly reports to NEPA outlining work progress including environmental mitigation measures that must be implemented, accidents, incidents requiring activation of the emergency response plans and breaches in environmental requirements.

During the operating and maintenance phase JPS will submit the following reports to NEPA

1. An annual report outlining the monthly generating capacity of the wind turbines and indicating any anomalies that occurred.
2. Reports on accidents and incidents requiring activation of emergency response plans within 48 hours of occurrence.

Consultations:

1. Mr. Peter Baker – National Land Agency
2. Mr. Ricardo Clarke - Meteorological Service, Jamaica
3. Mr. Lynvol Stephens and Mr. Derrick Grant – JCAA/Aerotel
4. Mr. Paul Williams, Network Engineer - UWI Earthquake Unit
5. Mrs. Michelle Dunn – EHS Department, JPS
6. Miss. Azalee Lawson – EHS Department JPS
7. Ms. Marlene Forbes – Manager, EHS Department JPS
8. Mr. David Cook – Project Manager, JPS
9. Mr. Val Fagan – V.P. Generation Expansion, JPS
10. Mr. Andreas Haiduk – Chief Hydrologist, Water Resources Authority
11. Mr. Devo Mullings - Climate Branch, Meteorological Service, Jamaica
12. Mr. Cordel Green – Executive Director, Broadcasting Commission
13. Mr. Danville Davidson – Managing Director, Spectrum Management Authority
14. Mr. Bradford Gayle – Principal, Munro College
15. Ms. Janice Simpson – Principal, Munro Preparatory School

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12. Terrence O'Rourke document: http://www.windyhillscaledon.org/files/West_Wight_-_Flicker_and_Communications.pdf

Appendix 1: Terms of Reference for EIA

TERMS OF REFERENCE

ENVIRONMENTAL IMPACT ASSESSMENT FOR

3 MW WIND TURBINE PROJECT

1. INTRODUCTION

The Jamaica Public Service Company Limited (JPS) is the electric utility for the island of Jamaica. (JPS) will be developing a 3 MW wind project in the Munro environs.

These terms of reference are to guide the environmental impact assessment (EIA) that is necessary for the requisite permits in accordance with the national environmental regulations.

2. PROJECT BRIEF

The project will include construction and installation of four (4) 750 kWh wind turbines in Munro.

SITE LOCATION

The general site is in the Hermitage area in St. Elizabeth.

TERMS OF REFERENCE

The Terms of Reference (TOR) for conducting the EIA are based on the General Guidelines for Conducting EIAs (NEPA revised 2007) for prescribed categories under the NRCA Act.

The Environmental Impact Assessment will include but not necessarily be limited to:

1) Project Objectives
2) Complete description of the existing site proposed for development.
3) Significant environmental issues of concern through the presentation of baseline data, which should include social, cultural and heritage considerations. Assess public perception of the proposed development.
4) Policies, Legislation and Regulations relevant to the project.
5) Likely impacts of the development on the described environment, including direct, indirect and cumulative impacts, and their relative importance to the design of the development's facilities.
6) Mitigation action to be taken to minimise predicted adverse impacts if necessary and quantify associated costs.
7) Monitoring Plan that should ensure that the mitigation plan is adhered to.
8) Alternatives to the project that could be considered at that site or at any other location including no action alternative.
9) Conclusions

To ensure that a thorough environmental impact assessment is carried out, it is expected that the following tasks be undertaken:

Task # 1 - Description of the Project

Provide a comprehensive description of the project and the surrounding environment specifying any information necessary to identify and assess the environmental effects of the project. This should include project objectives and information on, rationale for the project and background, the nature, location/existing setting, timing, duration, frequency, general layout including construction of any additional power lines and their impacts on the surroundings communities, as well as the impact of the turbines on the power supply and carbon footprint of the energy sector are to also be discussed, pre-construction activities, construction methods, works and duration, and post construction plans. A description of raw material inputs, technology and processes to be used as well as products and by-products generated, should be provided. Note areas to be reserved for construction and areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment.

Task # 2 - Description of the Environment/Baseline Studies Data Collection and Interpretation

Baseline data will be generated in order to give an overall evaluation of the existing environmental conditions, including a historical meteorological evaluation to include but not be limited to wind characteristics and analysis, values and functions of the area, as follows:

i.) physical environment
ii.) biological environment
iii.) socio-economic and cultural constraints

It is expected that methodologies employed to obtain baseline and other data be clearly detailed. Baseline data will include:

Physical

i.) A description of the existing soil and geology, landscape, aesthetic values and hydrology. Special emphasis should be placed on storm water run-off, drainage patterns, and aquifer characteristics. Any slope stability issues that could arise should be thoroughly explored.

ii.) Water quality of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of the development.

iii.) Coastal and Marine ecosystem, including but not limited to any wetlands including mangroves, seagrass and coral community with indication of its function and value in the project area.

iv.) Noise levels of undeveloped site and the ambient noise in the area of influence

v.) Obvious sources of existing pollution and extent of contamination

vi.) Availability of solid waste management facilities

Biological

Present a detailed description of the flora and fauna (terrestrial and aquatic if applicable) of the area, with special emphasis on rare, threatened, endemic, protected and endangered species. Migratory species, wild food crop plants and presence of invasive alien species should also be considered. There may be the need to incorporate micro-organisms to obtain an accurate baseline assessment. Generally species dependence, habitats/niche specificity, community structure and diversity ought to be considered.

Socio-economic & cultural

Present and proposed land use; transportation of heavy equipment, road widening and associated traffic considerations particularly in the construction phase of the project, planned development activities; issues relating to squatting and relocation; public health and safety. The historical importance (heritage, archaeological sites and feature) and other material assets of the area should also be examined. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development be conducted. This assessment may vary with community structure and may take multiple forms such as public meetings and/or questionnaires/surveys.

Task #3 - Policy, Legislative and Regulatory Considerations

Outline the pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The examination of the legislation should include at minimum, legislation such as the

NRCA Act, the Public Health Act, the Town and Country Planning Act and the appropriate international convention/protocol/treaty where applicable.

Task # 4 - Identification and Assessment/Analysis of Potential Impacts

Examine and identify the major potential environmental and public health issues of concern and indicate their relative importance to the development project. These should include the occupational exposure, health and safety measures and population exposure in the appropriate study area(s) and changes and or enhancement in emergency response plan. Identify potential impacts as they relate to, (but are not restricted by) the following:

- change in drainage patterns
- flooding potential if necessary
- landscape impacts of excavation and construction
- loss of and damage to geological and palaeontological features
- loss of species and natural features
- habitat loss and/or fragmentation
- biodiversity/ecosystem functions including impacts of bird and bat mortality
- pollution of potable, surface or ground water
- air pollution
- socio-economic and cultural impacts
- impact of flooding, loss of natural features, excavation and construction on the historic landscape, architecture and archaeology of the site
- risk assessment
- noise and vibration, EMF
- solid waste disposal
- soil
- change in land use
- visual impacts – aesthetics
- impact on traffic associated with road widening and the transportation of heavy equipment to the site

Distinguish between significant positive and negative impacts, direct and indirect, long term and immediate impacts to include discussion on site restoration and residual impacts and the proposed mitigation measures. Identify avoidable as well as irreversible impacts. Cumulative impacts of this and other proposed and/or existing developments will be explored.

Characterize the extent and quality of the available data, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of

mitigation strategies, which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts will be represented in matrix form.

Task #5 - Drainage Assessment

An assessment of Storm Water Drainage should be conducted. The EIA Report will cover but not be limited to where necessary:

i.) Drainage for the site during construction to include mitigation for sedimentation to the aquatic environment

ii.) Drainage for the site during operation, to include mitigation for sedimentation to the aquatic environment

iii.) Drainage control for crossings of rivers and/or gullies, to include impacts that drainage control features could have on aesthetics, water quality and sedimentation of rivers and/or gullies.

Task # 6 Mitigation & Emergency Preparedness and Response

Prepare guidelines for avoiding or reducing (e.g. restoration and rehabilitation), as far as possible, any adverse impacts due to proposed usage of the site and utilising of existing environmental attributes for optimum development. The potential impacts on aircrafts in the area should be addressed. Quantify and assign financial and economic values to mitigating methods.

Indicate the emergency preparedness and response plans for dealing with risks and hazards identified at Task 4.

Task # 7 - EHS Management and Monitoring Plan

Design a plan for the management of the natural, historical and archaeological environments of the project to monitor implementation of mitigatory or compensatory measures and project impacts during construction and occupation/operation of the units/facility. An EHS Management Plan and Historic Preservation Plan (if necessary) for the long-term operations of the site should also be prepared.

An outline of a monitoring programme (if necessary) should be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development. At the minimum the monitoring programme and report should include:

- An introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit and/or licence(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- Project maintenance and decommissioning
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
- Frequency of reporting to NEPA

Task # 8 - Project Alternatives

Examine alternatives to the project including an assessment of the impacts of all the alternatives examined and the no-action alternative. This examination of project alternatives should incorporate the use history of the overall area in which the site is located and previous uses of the site itself.

Task #9 - Public Participation/Consultation Programme

Conduct public presentation(s) on the findings of the EIA to inform, solicit and discuss comments from the public on the proposed development if necessary.

- Document the public participation programme for the project.
- Describe the public participation methods, timing, type of information to be provided to the public, and stakeholder target groups.
- Summarise the issues identified during the public participation process
- Discuss public input that has been incorporated into the proposed project design; and environmental management systems

Task #10 – Energy Statement

Examine the Government National Energy Policy and renewable projects. Discuss briefly the Munro Wind Project in relation to the National Energy Policy.

THE EIA REPORT

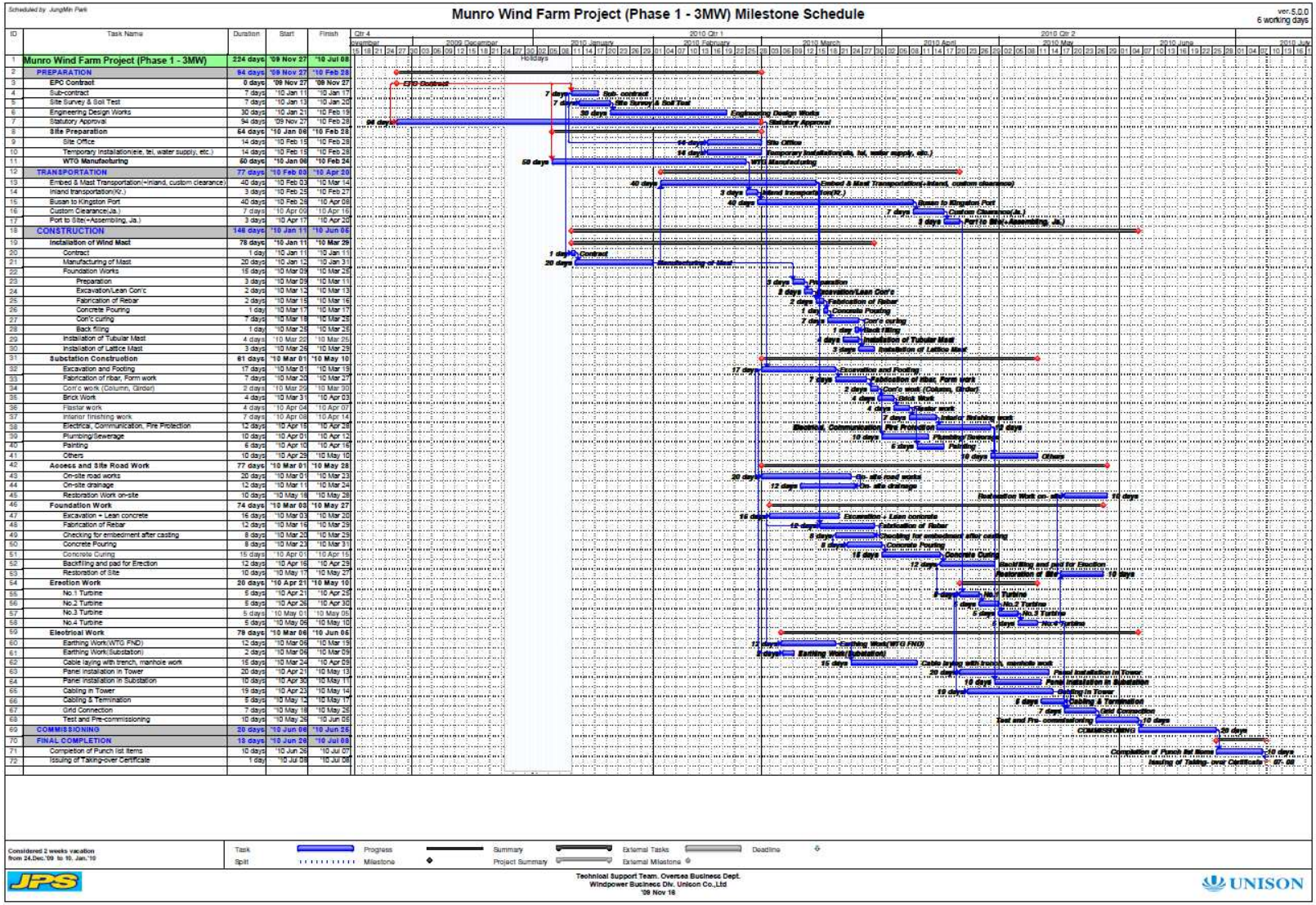
All Findings will be presented in the EIA report. The report will contain an introduction explaining the need for, and context of the project. The report should, at a minimum, cover the following basic aspects:

- Executive Summary
- Policy, Legal and Administrative Framework
- The EIA Methodology
- Description of the Existing Environment
- Description of the Proposed Project in detail
- Identification and Assessment of Potential Direct, Indirect, Cumulative, Positive and Negative Environmental Impacts
- Physical
- Natural Hazard Risk
- Biological
- Heritage - Cultural and Historic Heritage Sites
- Human/Social
- Public Involvement
- Recommended Mitigation Measures
- Identification and Analysis of Alternatives
- Management of the Environmental and Heritage aspects of the Project
- Environmental Management of the Project
- Environmental Quality Objectives
- Training
- Draft Outline Monitoring Programme

- List of References
- Appendices including:
  - Reference documents
  - Photographs/ maps/ site plans
  - Data Tables
  - The study team including Technical Team – name, qualifications and roles
  - TOR
  - Notes from Public Consultation
- Glossary of Technical Terms used

Fourteen hard copies and an electronic copy of the report will be required for submission to the National Environment and Planning Agency.

Appendix 2: Gantt Cart showing Project Schedule



ID	Task Name	Duration	Start	Finish
1	Munro Wind Farm Project (Phase 1 - 3MW)	224 days	'09 Nov 27	'10 Jul 08
2	PREPARATION	94 days	'09 Nov 27	'10 Feb 28
3	EPC Contract	0 days	'09 Nov 27	'09 Nov 27
4	Sub-contract	7 days	'10 Jan 11	'10 Jan 19
5	Site Survey & Soil Test	7 days	'10 Jan 13	'10 Jan 20
6	Engineering Design Works	30 days	'10 Jan 21	'10 Feb 19
7	Statutory Approval	94 days	'09 Nov 27	'10 Feb 28
8	Site Preparation	54 days	'10 Jan 06	'10 Feb 28
9	Site Office	14 days	'10 Feb 15	'10 Feb 28
10	Temporary Installation(ele, tel, water supply, etc.)	14 days	'10 Feb 15	'10 Feb 28
11	WTG Manufacturing	60 days	'10 Jan 06	'10 Feb 24
12	TRANSPORTATION	77 days	'10 Feb 03	'10 Apr 28
13	Embed & Mast Transportation(+Inland, custom clearance)	40 days	'10 Feb 03	'10 Mar 14
14	Inland transportation(Kr.)	3 days	'10 Feb 25	'10 Feb 27
15	Busan to Kingston Port	40 days	'10 Feb 28	'10 Apr 08
16	Custom Clearance(Ja.)	7 days	'10 Apr 09	'10 Apr 16
17	Port to Site(+Assembling, Ja.)	3 days	'10 Apr 17	'10 Apr 20
18	CONSTRUCTION	148 days	'10 Jan 11	'10 Jun 08
19	Installation of Wind Mast	78 days	'10 Jan 11	'10 Mar 29
20	Contract	1 day	'10 Jan 11	'10 Jan 11
21	Manufacturing of Mast	20 days	'10 Jan 12	'10 Jan 31
22	Foundation Works	15 days	'10 Mar 09	'10 Mar 29
23	Preparation	3 days	'10 Mar 09	'10 Mar 11
24	Excavation/Lean Con'c	2 days	'10 Mar 12	'10 Mar 13
25	Fabrication of Rebar	2 days	'10 Mar 15	'10 Mar 16
26	Concrete Pouring	1 day	'10 Mar 17	'10 Mar 17
27	Con'c curing	7 days	'10 Mar 18	'10 Mar 26
28	Back filling	1 day	'10 Mar 25	'10 Mar 25
29	Installation of Tubular Mast	4 days	'10 Mar 22	'10 Mar 25
30	Installation of Lattice Mast	3 days	'10 Mar 26	'10 Mar 29
31	Substation Construction	61 days	'10 Mar 01	'10 May 10
32	Excavation and Footing	17 days	'10 Mar 01	'10 Mar 19
33	Fabrication of ribar, Form work	7 days	'10 Mar 20	'10 Mar 27
34	Con'c work (Column, Girdor)	2 days	'10 Mar 29	'10 Mar 30
35	Brick Work	4 days	'10 Mar 31	'10 Apr 03
36	Plastar work	4 days	'10 Apr 04	'10 Apr 07
37	Interior finishing work	7 days	'10 Apr 08	'10 Apr 14
38	Electrical, Communication, Fire Protection	12 days	'10 Apr 15	'10 Apr 28
39	Plumbing/Sewerage	10 days	'10 Apr 01	'10 Apr 12
40	Painting	6 days	'10 Apr 15	'10 Apr 19
41	Others	10 days	'10 Apr 29	'10 May 10
42	Access and Site Road Work	77 days	'10 Mar 01	'10 May 28
43	On-site road works	20 days	'10 Mar 01	'10 Mar 23
44	On-site drainage	12 days	'10 Mar 11	'10 Mar 24
45	Restoration Work on-site	10 days	'10 May 18	'10 May 28
46	Foundation Work	74 days	'10 Mar 08	'10 May 27
47	Excavation + Lean concrete	16 days	'10 Mar 03	'10 Mar 26
48	Fabrication of Rebar	12 days	'10 Mar 15	'10 Mar 29
49	Checking for embedment after casting	8 days	'10 Mar 25	'10 Mar 29
50	Concrete Pouring	8 days	'10 Mar 23	'10 Mar 31
51	Concrete Curing	15 days	'10 Apr 01	'10 Apr 15
52	Backfilling and pad for Erection	12 days	'10 Apr 16	'10 Apr 29
53	Restoration of Site	10 days	'10 May 17	'10 May 27
54	Erection Work	20 days	'10 Apr 21	'10 May 18
55	No.1 Turbine	5 days	'10 Apr 21	'10 Apr 29
56	No.2 Turbine	5 days	'10 Apr 26	'10 Apr 30
57	No.3 Turbine	5 days	'10 May 01	'10 May 05
58	No.4 Turbine	5 days	'10 May 06	'10 May 10
59	Electrical Work	78 days	'10 Mar 06	'10 Jun 06
60	Earthing Work(WTG FND)	12 days	'10 Mar 06	'10 Mar 19
61	Earthing Work(Substation)	2 days	'10 Mar 08	'10 Mar 09
62	Cable laying with trench, manhole work	15 days	'10 Mar 24	'10 Apr 09
63	Panel installation in Tower	20 days	'10 Apr 21	'10 May 13
64	Panel installation in Substation	10 days	'10 Apr 30	'10 May 11
65	Cabling in Tower	15 days	'10 Apr 23	'10 May 14
66	Cabling & Termination	5 days	'10 May 12	'10 May 17
67	Grid Connection	7 days	'10 May 18	'10 May 26
68	Test and Pre-commissioning	10 days	'10 May 28	'10 Jun 08
69	COMMISSIONING	20 days	'10 Jun 09	'10 Jun 26
70	FINAL COMPLETION	13 days	'10 Jun 29	'10 Jul 09
71	Completion of Punch list items	10 days	'10 Jun 29	'10 Jul 07
72	Issuing of Taking-over Certificate	1 day	'10 Jul 08	'10 Jul 08

Appendix 3: Avifauna Assessment Methodology

Fixed Radius Point Count Census Method

This Point Count method is based on the principle of counting birds at a defined point or spot and determining the distance of each bird censured. A point is selected and then all bird contacts (seen and heard) are recorded, with a determination of distance given (< 25m or >25m) for each contact. This is done for a predetermined time, usually 10 minutes, before moving to another point at a specified distance away (Bibby et al. 1998). Points for this survey were 60m – 100m apart.

Advantages of this method include:

1. Greater concentration on the birds and habitats without having to watch where you walk (Bibby et. al. 1998).
2. More time available to identify contacts (Bibby et. al. 1998)
3. Greater opportunity to identify cryptic and skulking species (Bibby et. al. 1998)
4. Easier to relate bird occurrence to habitat features (Bibby et. al.1998).

Technique Weaknesses

As with all survey techniques, there are weaknesses, which influence overall results. Below are given factors which affect both census techniques used.

1. Time of Day – the best time for conducting a census is in the morning from sunrise until about 10am in the lowlands. It is recognized that as the day continues it gets hotter and the ability to detect birds decreases due to lack of movement. (Wunderle 1994).
2. Time of Year – the change in behaviour of birds during the breeding and non-breeding seasons affect detection. However for this report, the assessment was done in the breeding season, when birds are more vocal. (Wunderle 1994).
3. Weather – things such as wind, rain, fog or if the day is too hot, affect conducting a census (Wunderle 1994).
4. Summer Counts versus Winter Counts – the counts conducted within the area were done within the early winter period, therefore incorporating both residents and early arriving migrant birds, however such habitats are known to be utilized by summer migrants, and these winter counts tend not incorporate these birds.

Appendix 4: Social Impact Assessment Survey Instrument

SOCIO-ECONOMIC SURVEY (October 2009)
Proposed Wind Energy Project, Hermitage, St. Elizabeth, Jamaica

PERSONAL/CONFIDENTIAL

Personal Interview Schedule (Target: Household Head)

Interviewer: _____ **Respondent ID:** _____
Date: _____ **Location:** _____

In order to determine the social and economic characteristics of the area, and garner your views, perspectives and acceptance of the proposed development I would like to ask you some questions.

Demographic Profile

1. Sex: Male ☐ Female ☐

2. To what age group do you belong?
   <18 ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 and over ☐

3. How long have you lived there (here)? _____

4. Where are you originally from (Town and Parish)? _____

Quality of Life Indicators

Education

5. What is the highest level of education you have attained? (last school you attended)
   None ☐ Primary/All Age ☐ Training/Skills Institution ☐
   High School ☐ College ☐ University ☐
   Other, specify _____

6. Are you presently attending school? Yes ☐ No ☐

Employment and Income

7. Are you employed? Yes ☐ No ☐

   Please tick the box which best describes your type of employment

Full-time ☐ Part-time☐ Self-employed☐ Other, specify _____

8. What is your present means of livelihood (occupation)? _____

9. What is your main means of travel? (work, shopping etc.)?
Private vehicle ☐ Bus☐ Taxi☐ Other, specify _____

10. What is your weekly/monthly income in Jamaican Dollars (JMD)? (optional)

Less than $10,000 ☐ $10,001-$30,000 ☐ $30,001-$60,000 ☐

$60,001-$90,000 ☐ $90,001-$120,000☐ $120,001 – $150,000 ☐

Above $150,000 ☐

Housing (including Tenure), Health and Social Services

11. Do you _____ your house?
Own ☐ Lease☐ Rent ☐ Other, specify _____

12. Do you _____ the land on which your house is located?
Own☐ Lease☐ Rent ☐ Other, specify _____

13. Including yourself, how many people live in your household? _____
(a) Number of adults _____
(b) Number of children less than 18 years _____
(c) Which School(s) do they attend_____ (include community location)

14. How many of the following rooms does your residence have?
Bedrooms __ Bathrooms __

15. What type of sanitary conveniences (toilet facility) does your household use?
Water Closet/Flush toilet☐ None☐ Pit Latrine ☐ Other,specify _____

16a. What is the main source of lighting for your home? (What is the average cost of electricity bill)
Electricity☐ Kerosene☐ Candles☐ Other, specify _____

16b. How reliable is your electricity supply?
_____

17. What type of fuel is used mostly by the household for cooking?

Gas☐ Electricity☐ Wood☐ Kerosene ☐ Other, specify _____

18. What is the main source of domestic water supply for the household?

Public piped water into dwelling☐ Private Tank☐ Public piped water into yard☐
Community Tank ☐ Government Water Trucks (free) ☐ Public Standpipe☐
Private Water Trucks (paid)☐ Spring or River☐ Other, specify _____

19a. What is the main method of garbage disposal for your household?

Public Garbage Truck☐ Private Collection☐ Burn☐ Other, specify _____

19b. If public garbage truck, how often do trucks pick up garbage? _____

20. Do you have access to a residential telephone? Do you have access to a cellular phone?
Yes☐ No☐

21. Do you have access to the following services?

Type of Service	**Location**	**Distance Travelled (km)/miles**
Health Care		
Police Station		
Fire Station		
Post Office/Agency		

Community Development

22. (a) What does the average person do for fun within the community?

Parties ☐ Youth Clubs☐
Sports Clubs☐ Charity☐
Church groups/activities☐ Other, specify☐

(b) Do you belong to any social groups? _____

23. What do you value most about your community?

_____
_____
_____

24. What types of improvement are needed in the community?

_____
_____
_____

25a. Is the community usually affected by Hurricanes/natural disasters (flooding, fire, earthquake etc.,)
How did you fare in the last Hurricane/tropical storm/natural disaster?

_____
_____
_____

25b. How long was it before water, power and telephone were restored?

_____

26. Is your community affected by lightning? Yes ☐ No ☐ If yes, How often and in what ways?

_____

Perception of the Proposed Development

27. Do you know what a wind turbine is? Yes☐ No ☐ (If yes, please explain its use)

_____
_____
_____

28. Are you aware of the planned wind turbine energy development at Hermittage?
Yes☐ No ☐ If yes, through what medium?

_____

29. What kind of impact do you think this development will have on the community?

_____
_____
_____
_____
_____

30. What do you think of the JPS Co. building wind turbines to satisfy electrical demand by the country?

_____
_____

_____
_____
_____
_____
_____

31. What do you think will be the benefits of renewable energy such as wind turbines to your community and Jamaica?

_____
_____
_____
_____
_____
_____

Thank you for your cooperation and participation in this survey☺

Interviewer Comments and Observations

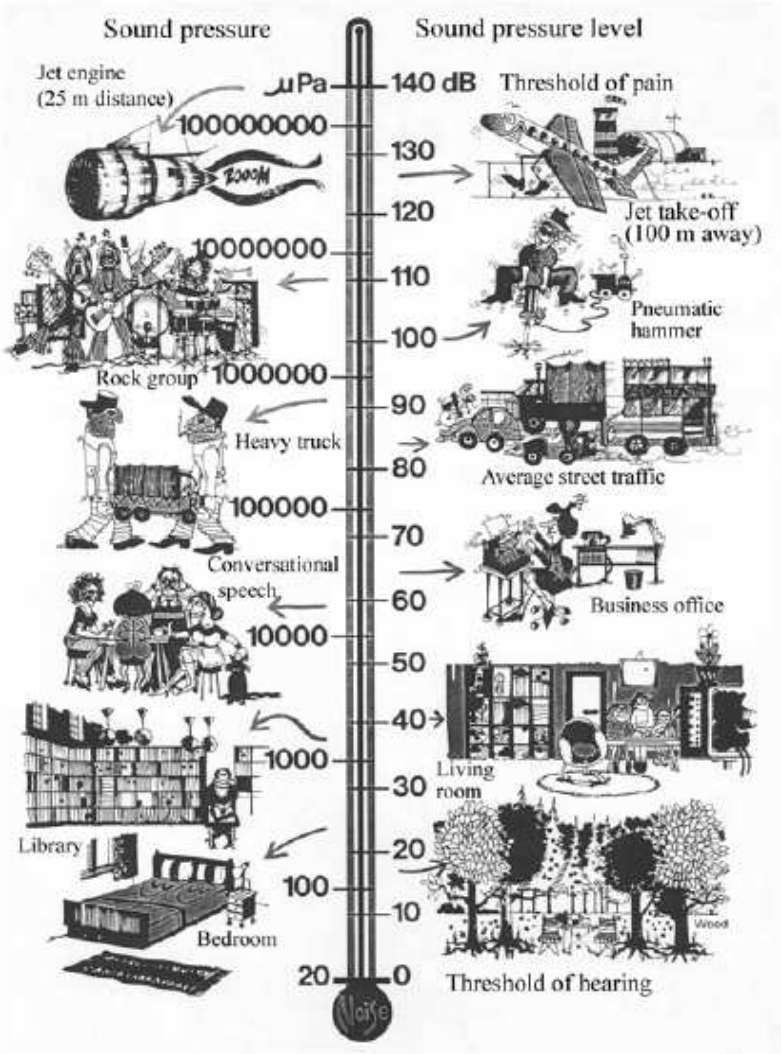
_____
_____
_____
_____

Appendix 5: Measuring Noise Level

The human response to sounds measured in decibels has the following characteristics:

- Except under laboratory conditions, a change in sound level of 1 dB cannot be perceived.
- Doubling the energy of a sound source corresponds to a 3 dB increase
- Outside of the laboratory, a 3 dB change in sound level is considered a barely discernible difference.
- A change in sound level of 5 dB will typically result in a noticeable community response.
- A 6 dB increase is equivalent to moving half the distance towards a sound source
- A 10 dB increase is subjectively heard as an approximate doubling in loudness
- The threshold of pain is an SPL of 140 dB

The figure below illustrates the relative magnitude of common sounds on the dB scale. For example, the threshold of pain for the human ear is about 200 Pa, which has an SPL value of 140 dB.



Appendix 6: Jamaica Civil Aviation Authority Obstacle Evaluation Results

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Form

4 Winchester Road
Kingston 10
Mailing Address
P.O. Box 8998
CSO. KINGSTON

Site Identification No JPS08001 M2.1	Operating Company JAMAICA PUBLIC SERVICE CO. LTD.	Site Location MUNRO	Parish ST. ELIZABETH
WGS-84 Coordinates of Site N 17:55:56.05 W 77:41:51.80	Clark 1880 Coordinates of Site	Nearest Govt. Aerodrome (A) SANGSTER INTERNATIONAL	Nearest Private. Aerodrome (B) NAIN
Threshold Coordinates of Runway of nearest Aerodrome (A) WGS-84 N18:30:13.20 W77:54:48.20		Direction from nearest Runway (A) 160°T	Distance from nearest Runway (A) 67236m
Affected Annex 14 Surface Outer Horizontal ☐ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Intermediate ☐ Inner Transitional ☐ En-route ☐		Base of Lowest Surface	Base Elevation 684m MSL
		Height of Structure Tower = 56.5m Blade radius = 23.5m Total = 80m AGL	Elevation of Apex 764m MSL
Penetration : NONE			
Effect of Penetration			
Recommendation: **APPROVED** The wind turbine is beyond the Outer Horizontal surface limits of Sangster International Airport and Nain Aerodrome. The generator housing of the wind turbine must be lit by a medium intensity obstacle light of 2000 candelas per metre square showing flashing red. This light should operate at 20 – 60 flashes per minute. Additionally, there should be low intensity obstacle lights mounted on the tower at 40 metres above ground showing steady red. The tower should be inspected regularly to detect any failure of these lights which must be replaced in minimum time.			

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding	Recommendation	Specialist: Dwight Dietrich Signature Date 9th July 2008

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Form

4 Winchester Road
Kingston 10
Mailing Address
P.O. Box 8998
CSO. KINGSTON

Site Identification No JPS08002 M2.2	Operating Company JAMAICA PUBLIC SERVICE CO. LTD.	Site Location MUNRO	Parish ST. ELIZABETH
WGS-84 Coordinates of Site N17:56:04.15 W77:41:53.62	Clark 1880 Coordinates of Site	Nearest Govt. Aerodrome (A) SANGSTER INTERNATIONAL	Nearest Private. Aerodrome (B) NAIN
Threshold Coordinates of Runway of nearest Aerodrome (A) WGS-84 N18:30:13.20 W77:54:48.20		Direction from nearest Runway (A) 160^{0}T	Distance from nearest Runway (A) 66983m
Affected Annex 14 Surface		Base of Lowest Surface	Base Elevation 676m MSL
Outer Horizontal ☐ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Intermediate ☐ Inner Transitional ☐ En-route ☐		Height of Structure Tower = 56.5m Blade radius = 23.5m Total = 80m AGL	Elevation of Apex 756m MSL
Penetration NONE			
Effect of Penetration			
Recommendation **APPROVED** The wind turbine is beyond the Outer Horizontal surface limits of Sangster International Airport and Nain aerodrome. The generator housing of the wind turbine must be lit by a medium intensity obstacle light of 2000 candelas per metre square showing flashing red. This light should operate at 20 – 60 flashes per minute. Additionally, there should be low intensity obstacle lights mounted on the tower at 40 metres above ground showing steady red. The tower should be inspected regularly to detect any failure of these lights which must be replaced in minimum time.			

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding	Recommendation	Specialist: Dwight Dietrich Signature Date 4th July 2008

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Form

4 Winchester Road
Kingston 10
Mailing Address
P.O. Box 8998
CSO. KINGSTON

Site Identification No JPS08003 M2.3	Operating Company JAMAICA PUBLIC SERVICE CO. LTD.	Site Location MUNRO	Parish ST. ELIZABETH
WGS-84 Coordinates of Site N17:56:12.27 W77:41:53.74	Clark 1880 Coordinates of Site	Nearest Govt. Aerodrome (A) SANGSTER INTERNATIONAL	Nearest Private. Aerodrome (B) NAIN
Threshold Coordinates of Runway of nearest Aerodrome (A) WGS-84 N18:30:13.2 W77:54:48.2		Direction from nearest Runway (A) 160^{0}T	Distance from nearest Runway (A) 66747 m
Affected Annex 14 Surface Outer Horizontal ☐ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Intermediate ☐ Inner Transitional ☐ En-route ☐		Base of Lowest Surface Height of Structure Tower = 56.5m Blade radius = 23.5m Total = 80m AGL	Base Elevation 668m MSL Elevation of Apex 748m MSL
Penetration			
Effect of Penetration			

Recommendation **APPROVED** The wind turbine is beyond the Outer Horizontal surface limits of Sangster International Airport and Nain aerodrome. The generator housing of the wind turbine must be lit by a medium intensity obstacle light of 2000 candelas per metre square showing flashing red. This light should operate at 20 – 60 flashes per minute. Additionally, there should be low intensity obstacle lights mounted on the tower at 40 metres above ground showing steady red. The tower should be inspected regularly to detect any failure of these lights which must be replaced in minimum time.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding	Recommendation	Specialist: Dwight Dietrich Signature Date 4th July 2008

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Form

4 Winchester Road
Kingston 10
Mailing Address
P.O. Box 8998
CSO. KINGSTON

Site Identification No JPS08004 M2.4	Operating Company JAMAICA PUBLIC SERVICE CO. LTD.	Site Location MUNRO	Parish ST. ELIZABETH
WGS-84 Coordinates of Site N17:55:51.20 W77:41:50.03	Clark 1880 Coordinates of Site	Nearest Govt. Aerodrome (A) SANGSTER INTERNATIONAL	Nearest Private. Aerodrome (B) NAIN
Threshold Coordinates of Runway of nearest Aerodrome (A) WGS-84 N18:30:13.2 W77:54:48.2		Direction from nearest Runway (A) 160°T	Distance from nearest Runway (A) 67394m
Affected Annex 14 Surface Outer Horizontal ☐ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Intermediate ☐ Inner Transitional ☐ En-route ☐		Base of Lowest Surface	Base Elevation 689m MSL
		Height of Structure Tower = 56.5m Blade radius = 23.5m Total = 80m AGL	Elevation of Apex 769m MSL
Penetration NONE			
Effect of Penetration			
Recommendation **APPROVED** The wind turbine is beyond the Outer Horizontal surface limits of Sangster International Airport and Nain aerodrome. The generator housing of the wind turbine must be lit by a medium intensity obstacle light of 2000 candelas per metre square showing flashing red. This light should operate at 20 – 60 flashes per minute. Additionally, there should be low intensity obstacle lights mounted on the tower at 40 metres above ground showing steady red. The tower should be inspected regularly to detect any failure of these lights which must be replaced in minimum time.			

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding	Recommendation	Specialist: Dwight Dietrich Signature Date 4th July 2008

Appendix 7: Environmental Noise

Environmental Noise	
Weakest sound heard	0dB
Whisper Quiet Library	30dB
Normal conversation (3-5')	60-70dB
Telephone dial tone	80dB
City Traffic (inside car)	85dB
Train whistle at 500', Truck Traffic	90dB
Subway train at 200'	95dB
Level at which sustained exposure may result in hearing loss	*90 - 95dB*
Power mower at 3'	107dB
Snowmobile, Motorcycle	100dB
Power saw at 3'	110dB
Sandblasting, Loud Rock Concert	115dB
Pain begins	*125dB*
Pneumatic riveter at 4'	125dB
Even short term exposure can cause permanent damage - Loudest recommended exposure WITH hearing protection	*140dB*
Jet engine at 100', Gun Blast	140dB
Death of hearing tissue	180dB
Loudest sound possible	194dB

OSHA Daily Permissible Noise Level Exposure	
Hours per day	Sound level
8	90dB
6	92dB
4	95dB
3	97dB
2	100dB
1.5	102dB
1	105dB
.5	110dB
.25 or less	115dB

Appendix 8: WindPRO Modelling Specifics

GIS modelling of Munro College was done using elevation data with 5m contours, and manually created roughness model. On land the background roughness was set to 2.

The annual energy production in above Table assumes 10% loss due to the uncertainty and/or losses, as described below:

1. Uncertainties include: Wind statistics, terrain description, power curve, and the calculation method.

2. Losses include**:** Grid/transformer, unavailability of WTG due to maintenance, blade degradation and icing, high-wind hysteresis and operation mode losses.

Wind speeds are very specific to the exact location. Therefore before a utility scale project is undertaken, wind data should be collected at the proposed site for at least one year. Since wind data is being collected at Kingston airport, a shortcut may be adopted. This involves measurement of wind speed and direction at using a mobile SODAR wind measurement device. Wind measurements may be made for 2 week durations at each site in succession. This should be done in each of the four seasons. This will provide a cost effective method to correlate wind measurements at the existing met-tower at Kingston with wind measurements at the proposed sites (using SODAR). If the correlations are consistent during the measured periods, then the statistical process may be reliably used to derive wind speed and direction at the proposed sites. A SODAR device allows wind speeds to be measured at several heights between 10 to 80m above the surface, every 10 minutes. This equipment may be mounted in an enclosed trailer that may be pulled by a car or pickup truck. So it may be transported from one site to another with minimal effort. This is in contrast with a traditional met-tower which requires significant assembly and disassembly to move from one site to another.

Appendix 9: Contractor's Health and Safety Plan

Jamaica Wind Energy Project
Munro,Saint Elizabeth,Jamaica

Health and Safety Plan

Document No.	JPS-UNI-P-C-02		
	Name	Date	Revision
Created by	DongHun,Yang	24- July-2009	0
Checked by	SeungChul,Jang	25- July-2009	0
Approved by	YoungSeo,Ko	27- July-2009	0

UNISON Co., Ltd.

UNISON	Health and Safety Plan	Doc.No.:	JPS-UNI-P-C-02
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Site Specific

Health- and Safety Plan.

The purpose of this document is to outline any possible and known safety hazards during the preparation and installation of the UNISON wind turbines and to outline the preventive measures to minimize the risk of dangerous situations and accidents.

By signing this document EPC Contractor, Erection, Electrical Contractor and supervisors acknowledges, have understood and should follow.

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EPC Contractor

I, (PRINT FULL NAME) _____
acknowledge that I have read and fully understand these rules and agree that my team shall comply with them at all times while on this site. I also understand that disregard for these rules should result in disciplinary action.

_____ _____
SIGNATURE: DATE:

Erection Contractor

I, (PRINT FULL NAME) _____
acknowledge that I have read and fully understand these rules and agree that my team shall comply with them at all times while on this site. I also understand that disregard for these rules should result in disciplinary action.

_____ _____
SIGNATURE: DATE:

Electrical Contractor

I, (PRINT FULL NAME) _____
acknowledge that I have read and fully understand these rules and agree that my team shall comply with them at all times while on this site. I also understand that disregard for these rules should result in disciplinary action.

_____ _____
SIGNATURE: DATE:

Supervisors

I, (PRINT FULL NAME) _____
acknowledge that I have read and fully understand these rules and agree that my team shall comply with them at all times while on this site. I also understand that disregard for these rules should result in disciplinary action.

_____ _____
SIGNATURE: DATE:

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SITE SAFETY RULES – FIELD AND SERVICE PERSONNEL

PLEASE NOTE: - The following rules are mandatory. Any person choosing to disregard them may be removed from the site and prohibited from working on this site again.

1. All site employees shall be familiar with emergency contact numbers, emergency exits of the job site. Such lists and maps shall be posted in each crew trailer as well as each vehicle.
2. All site employees shall be familiar with known and recognized safety hazards and the emergency response plan.
3. Dress code: long or short sleeved shirts, and trousers (no shorts) without holes, and suitable weather protective wear. Avoid clothing made from polyester, nylon etc.
4. Hard hats and safety footwear must be worn at all times, except in the immediate vicinity of buildings or while riding in vehicles.
5. Other protective safety equipment must be worn where hazards exist or as the job task or conditions require; (e.g.: high visibility vests or the like, gloves, dust masks, ear plugs, fall protection, etc.)
6. All climbing and lifting equipment must be inspected daily and defective equipment removed from service immediately.
7. Climbing gear (harness) must be used to prevent falling down. Any disregard of using climbing gear / harness shall be prosecuted with removal of the person from the job site immediately.
8. Each working- and or erection team shall have separate radio channel communication. Make sure that radio's are fully charged each morning.
9. All site personnel shall use extreme caution (park upwind and follow procedures) during freezing conditions when turbines are operating.
10. No controlled substances, alcohol, or firearms are permitted on the site.
11. All plant operators (crane operators etc.) must be properly trained. Employers must provide training, or verify current and valid records of training, before operation of machinery is assigned.
12. Wind turbine tower doors must NEVER be locked from the inside or otherwise inhibit emergency entry.
13. All underground cables must be identified, and turned off if possible, prior to any excavation.
14. High visibility barriers and signals must be erected around all open excavations and trenches.
15. Where necessary, high visibility traffic control measures must be used when working on or close to the site roads especially when using cranes and excavators, digging trenches, or blocking part of the road for rotor assembly etc.
16. All incidents, including near misses, must be reported to your supervisor so that corrective measures can be taken to prevent recurrence.
17. All personnel must attend regularly scheduled site safety meetings with their employers.
18. Know your company site safety supervisor and the correct procedures to follow in emergency situations.

BE SAFETY CONSCIOUS AT ALL TIMES.

DO NOT DO ANYTHING, WHICH COULD POTENTIALLY JEOPARDIZE YOUR SAFETY,

OR THE SAFETY OF OTHERS WHILE ON THIS SITE.

Safety Hazards and Preventive Actions:

1. Due to limited space and hazard, no more than 3 - maximum 4 persons including the site supervisor shall be working in the top (rotor) during installation.

2. During installation of the rotor it is necessary to remove the cover of the high-speed shaft in the nacelle. This poses a safety hazard when turning the rotor. Therefore, each person working around or close to the high shaft / break disk must remove his harness and other loose items/clothes which could potentially be caught by rotating parts.

3. During any cable work and final completion of the turbine, the crew working in the rotor must set the disk brake manually before attempting any type of work. Before leaving the rotor the crew shall release the brake again to allow the wind turbine to freewheel.

4. Misunderstanding and lack of communication poses a safety hazard. Before any lift or any major work task is initiated the foremen of the crew(s) shall go over the installation sequence with the crew and dictate who shall give signals etc. Also radio communication shall be checked. If any incidents should occur the foremen of the crew shall immediately contact the site safety officer for emergency. Furthermore, the contractor shall employ sufficient number of English speaking staff in order to secure a clear communication between supervisors and the working crew.

5. The site Safety Officer shall take local weather forecast in the morning and inform the crews. Anyone employed or present at the job site has the responsibility to watch out for incoming severe weather such as high winds, thunder and lightning and immediately inform the site Safety Officer. In such case the site Safety Officer shall call all working teams, suspend the work in progress and call down the crews.

6. The crew working in the top shall warn the ground crew before entering to the hub, then the ground crew shall move away from the area below the rotor immediately. Working with tools outside nacelle and hub in the height poses a risk of falling items.

7. Before loosing any tagline or turning the rotor for the first time the top crew shall warn the ground crew.

8. Do not work in more than one level inside the tower.

9. Dropping the cables from the top of the tower poses a safety hazard. Persons dropping the cables should take extreme caution not to get caught in a cable loop laying on the platform which could pull the person down.

10. Be cautious with sharp knives etc. when skinning/stripping cables during the cable installation work – have first aid kit available in the tower.

11. Watch out for snakes. The job site may have poisonous snakes. Watch out and use long sleeve boots, do not approach – see also Emergency Response Plan.

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Emergency Response Plan:

The Site Manager for the job site is Mr. – **cell:** **office:**

The Safety Manager is Mr. **- cell:** **office:**

See also Emergency Contact List posted in offices.

The Emergency Response Plan is made to minimize the personal injury and property damage caused by accidents on the job site and shall serve as a guidance of a) what to do – and b) how to do when an accident happen.

1. A site map showing emergency exits has been prepared and is posted in each crew and office trailer. This site map has named exits with numbers which are crucial for any emergency call (ambulance or fire dept.)

2. The Safety Manager shall submit the site map of emergency exits to the Emergency Call Center (ambulance and fire) and ensure that the Emergency Call Center understands how to use the map and the correct entrance (exits) in an emergency situation.

3. The Site Manager shall every morning post an updated plan of which roads could be blocked due to e.g. civil works, equipment transports, rotor assembly or turbine erection.

4. A site office area map has been prepared showing the Site Emergency Room, fire extinguisher placement etc. The Site Emergency Room is open at all time during site working hours and be equipped with all necessary first aid equipment.

5. In case of an accident (all other than electrical):

    a. The crew foreman shall immediately call the site Safety Officer or the next on the list (see Emergency Contact list)
    b. Describe what has happen and where.
    c. Site Safety Officer or other person receiving the call shall immediately call the Emergency Call Center for ambulance and rescue team.
    d. While performing step a, b & c other crew members shall get hold of first aid kit and start immediately to provide first aid support to the injured person.
    e. Send one person to the designated emergency entrance/exit to guide the rescue team / ambulance to the site.
    f. When rescue team / ambulance arrive on the site they shall take over and the Safety Manager shall designate needed assistance to the rescue team, other crew members on the site shall immediately remove from the area.
    g. The contractor has provided min.2 set of the harness tower rescue equipment which shall be located in the emergency room. It should be the discretion of the rescue team

whether to use the harness equipment and in such case the site supervisor could guide how to use.

h. No work shall be resumed before an investigation has been conducted with a report of corrective actions and working procedures as well as equipment has been inspected for any damages.

6. In the event or if there is a suspicion of an accident occurred from electrical chock:

a. Do **not** touch injured person before **all power** is switched off and lock out the switch in order to prevent other personnel to switch on power incidentally.
b. The crew foreman shall immediately call the site Safety Officer or the next on the list (see Emergency Contact list).
c. Describe what has happen and where.
d. Site Safety Officer or other person receiving the call shall immediately call the Emergency Call Center for ambulance and rescue team.
e. While performing step a, b & c other crew members shall get hold of first aid kit and start immediately to provide first aid support to the injured person.
f. Send one person to the designated emergency entrance/exit to guide the rescue team / ambulance to the site.
g. When rescue team / ambulance arrive on the site they shall take over and the Safety Manager shall designate needed assistance to the rescue team, other crew members on the site shall immediately remove from the area.
h. The Contractor has provided min. 2 set of the harness tower rescue equipment which shall be located in the emergency room. It should be the discretion of the rescue team whether to use the harness equipment and in such case the site supervisor could guide how to use.
i. No work shall be resumed before an investigation has been conducted with a report of corrective actions and working procedures as well as equipment has been inspected for any damages.

7. In case of snake bit:

a. Inform your crew foreman of possible snake bit.
b. The crew foreman shall immediately call the site Safety Officer or the next on the list (see Emergency Contact list).
c. If possible, notice the specie of snake.
d. Bring injured person to site safety room and call hospital.
e. Follow instructions from hospital and see separate folder for instructions in case of snake bit (poisonous or not poisonous)

Exhibits:

- Map / plan of Emergency Exits.
- Emergency Contact list.
- Site Office Map
- Folder with description of dangerous snakes etc.