

Environmental Impact Assessment

Blue Mountain Renewables 34 MW Wind Farm Project
Malvern, St. Elizabeth



February 2014



Environmental & Engineering Managers Ltd.

Unit #11, Barbican Business Centre, 88 Barbican Road, Kingston 8, Jamaica
Tel: (876) 622- 4193; Fax: (876) 622- 4745
Email: eem@environmanagers.com • www.environmanagers.com

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Executive Summary

BMR Jamaica Wind Limited (“BMR”) plans to construct a new Wind Farm adjacent to the existing Jamaica Public Service Company (“JPS”) Munro Wind Farm at Hermitage, St. Elizabeth. The company is seeking to install an additional 34 MW in the area around the existing 3MW wind farm developed and owned by local utility firm, the JPS. BMR is wholly owned by Blue Mountain Renewables LLC which was established in 2012 to develop renewable power generation projects throughout the Caribbean and Central American region. The proposed BMR Jamaica Wind Farm Project had been previously studied by JPS who agreed to sell such prior work products to BMR, for their use in developing the new Wind Farm. In exchange JPS received certain payments and the option for JPS to invest in up to 20% of the expansion project equity.

This Environmental Impact Assessment (EIA) report is being prepared and submitted in support of the permit and information requirements of the National Environment and Planning Agency (NEPA).

Project Location

The BMR Jamaica Wind Farm Project is to be located in the south-eastern section of the parish of St. Elizabeth; an estimated 12km south of parish’s main town of Santa Cruz. The project site is located approximately 100km west of the capital city of Kingston and 75km south-east of the city of Montego Bay.

The proposed project site for the BMR Jamaica Wind Farm is located on approximately 35.2 hectares (87 acres) of land adjacent the existing JPS Munro Wind Farm. The existing Munro Wind Farm site is the subject of a long-term lease arrangement between JPS and the Government of Jamaica. The proposed site spans several communities, which includes Malvern, Hermitage and Potsdam.

The proposed site is located in an area of high wind and is considered a Class I wind site. While part of the proposed site already has the existing wind farm, the rest of the area slated for the project is in agricultural use.

Project Objectives

The BMR Jamaica Wind Farm Project seeks to take advantage of Jamaica’s great wind resources by developing and optimising on the wind energy potential offered in one of only five of the most feasible areas on the island most suited for the development of large commercially viable wind farms. The project will see between US\$85 and \$90 million being invested in the development of the wind facility, which will contribute approximately 4.8% of energy generated by renewable sources to the renewable energy mix. Most importantly the project will help the country to reduce its overall dependence on oil, while helping the JPS to reduce system losses experienced through inefficient power plants. Key environmental benefits under the project include:

- Y Eliminates need to import and burn 250,000 barrels of foreign oil per year

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- Y 5.0 million barrels saved over 20 year life – save over \$500 million US of oil expense
- Y Zero emissions for power generation – significant reduction from current sources
 - o Nitrogen Oxides emissions will be reduced by 7,000 tonnes annually
 - o Sulphur Dioxide emissions will be reduced by 40,000 tonnes annually
 - o Carbon Dioxide emissions will be reduced by over 2 million tonnes annually

Project Design

To produce 34 MWs, eighteen (18) turbine locations (sites) will be selected, with a ***minimum*** of eleven (11) locations being utilised for the final installation of turbines. The final number of turbine locations and configuration of the wind farm will be determined based on:

- Y The type of wind technology selected
- Y The results of subsurface investigations and
- Y Environmental considerations and
- Y The final recommendations of a comprehensive transportation study on the movement of turbines from the Ports to the Project site.

Three (3) types of wind turbine technology are being considered for installation at the proposed wind farm location in Malvern. The turbines will be designed by Vestas and includes the following turbine types:

- Y V90-1.8MW
- Y V80-2.0MW
- Y V112-3.3MW

The turbines are pitch regulated upwind turbines with active yaw and three-blade rotor. The turbine utilises a microprocessor pitch control system called OptiTip[®] and the OptiSpeed[™] (variable speed) feature. With these features, the wind turbine is able to operate the rotor at variable speed (rpm), helping to maintain the output at or near rated power.

Legislative Policy

The national policies applicable to this project are the National Energy Policy and the National Renewable Energy Policy. The National Energy Policy was approved by Cabinet in October 2009. The National Renewable Energy Policy is still awaiting Cabinet approval.

The legislation applicable to this project include:

- Electric Lighting Act, 1890
- The Office of Utilities Regulation Act, 1995
- The Natural Resources Conservation Authority 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

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- Town and Country Planning Act, 1957
- The Parish Council Building Act, 1901
- The Wildlife Protection Act, 1945
- Flood Water Control Act, 1958

Impact Identification

The main activities to be undertaken for this project:

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

Potential Negative Impacts of Project

ASPECT		POTENTIAL NEGATIVE IMPACTS
Construction phase		
1.	Fugitive dust emissions	<ul style="list-style-type: none">• Air pollution• Respiratory problems
2.	Noise	<ul style="list-style-type: none">• Nuisance to persons• Habitat disturbance• Hearing impairment (temporary, permanent)
3.	Gaseous emissions	<ul style="list-style-type: none">• Air pollution• Respiratory problems

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	ASPECT	POTENTIAL NEGATIVE IMPACTS
4.	Land clearing and construction activities	<ul style="list-style-type: none"> • Vegetation loss/Disturbance of biological communities • Loss of Agricultural Crops and Displacement of Farmers and loss of revenue • Land slippages • Air pollution • Habitat destruction • Disruption of ecosystems • Soil erosion/sedimentation <ul style="list-style-type: none"> ○ 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
5.	Increased traffic movement	<ul style="list-style-type: none"> • Traffic congestion • Motor vehicle accidents
6.	Vibration from blasting	<ul style="list-style-type: none"> • Disruption of earthquake monitoring • Noise interference
7.	Solid waste (top soil, vegetation, construction debris, garbage)	<ul style="list-style-type: none"> • Land and water pollution
8.	Use of fuel	<ul style="list-style-type: none"> • Depletion of (oil) resources
9.	Use of water	<ul style="list-style-type: none"> • Depletion of water resources
10.	Human waste	<ul style="list-style-type: none"> • Land and water pollution
11.	Spills	<ul style="list-style-type: none"> • Land and water pollution
12.	Construction work	<ul style="list-style-type: none"> • Accidents causing death or injury
Operation Phase		
1.	Noise	<ul style="list-style-type: none"> • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
2.	Disruption in avifauna flight patterns	<ul style="list-style-type: none"> • Bird and bat deaths
3.	Vibration	<ul style="list-style-type: none"> • False earthquakes detected on seismograph monitoring equipment • Noise interference
4.	Disruption of air traffic	<ul style="list-style-type: none"> • Plane crashes
5.	Lightning strikes	<ul style="list-style-type: none"> • Fires

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	ASPECT	POTENTIAL NEGATIVE IMPACTS
		<ul style="list-style-type: none"> • Disruption in electricity supplies
6.	Flickering	<ul style="list-style-type: none"> • Health impacts – epilepsy in rare cases
7.	Diffraction/Shadowing, Reflection, Scattering	<ul style="list-style-type: none"> • Electromagnetic interference which can affect radar and radio communication
8.	Aesthetics	<ul style="list-style-type: none"> • Visually unattractive
9.	Land use	<ul style="list-style-type: none"> • Alteration of development and land use in the area • Depreciation of land value
10.	Oil spills/leaks	<ul style="list-style-type: none"> • Land and water pollution
Maintenance		
1.	Oil spills/leaks	<ul style="list-style-type: none"> • Land and water pollution
2.	Solid waste	<ul style="list-style-type: none"> • Land and water pollution
3.	Human waste	<ul style="list-style-type: none"> • Land and water pollution
4.	Maintenance work	<ul style="list-style-type: none"> • Accidents
Decommissioning		
1.	Solid waste	<ul style="list-style-type: none"> • Land and water pollution
2.	Noise	<ul style="list-style-type: none"> • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
3.	Oil spills/leaks	<ul style="list-style-type: none"> • Land and water pollution
4.	Human waste	<ul style="list-style-type: none"> • Land and water pollution

The table below provides a summary of the significant aspects for the construction, operation, maintenance and decommissioning phases of the project. Eleven (11) significant impacts have been identified, five (5) of which are associated with the construction phase of the project. The operations of the wind turbine have three (3) significant impacts: (i) susceptibility of turbines to lightning strikes (ii) disruption to avifauna species and (iii) increased noise nuisances. In all cases steps can be taken to mitigate against the negative impacts.

Summary of Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
Construction phase		
1.	Fugitive dust emissions & vehicular emissions <ul style="list-style-type: none"> • Air pollution • Respiratory problems 	NO
2.	Noise <ul style="list-style-type: none"> • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent) 	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
3.	Loss of Agricultural Crops and Temporary Displacement of Farmers	NO
4.	Loss of Vegetation and Disturbance of Biological Communities <ul style="list-style-type: none"> Habitat destruction Disruption of ecosystems Displacement of small farmers 	YES
5.	Soil erosion and sedimentation <ul style="list-style-type: none"> Off-site effect is the movement of sediment and agricultural pollutants into drainage channels On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil Slope failure 	YES
6.	Land and water pollution (solid waste) <ul style="list-style-type: none"> Top soil, vegetation, construction debris, garbage 	NO
7.	Traffic Disruption and Vehicle Conflicts <ul style="list-style-type: none"> Traffic congestion Motor vehicle accidents 	YES
8.	Vibration from blasting <ul style="list-style-type: none"> Noise interferences 	NO
9.	Use of fuel <ul style="list-style-type: none"> Depletion of (oil) resources 	NO
10.	Use of water <ul style="list-style-type: none"> Depletion of water resources 	NO
11.	Land and water pollution <ul style="list-style-type: none"> Human waste Fuel and oil spills 	NO
12.	Accidents from construction work causing death or injury	YES
Operation Phase		
1.	Noise <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance 	YES
2.	Disruption in avifauna flight patterns <ul style="list-style-type: none"> Bird and bat deaths 	YES
3.	Vibration and noise <ul style="list-style-type: none"> False earthquake signals 	NO
4.	Disruption in air traffic	NO
5.	Lightning strikes <ul style="list-style-type: none"> Fires Damage to wind turbines Disruption in electricity supplies Injury to workers 	YES
6.	Flickering (photosensitive epilepsy)	NO
7.	Shadow flicker	YES
8.	Diffraction/Shadowing, Reflection, Scattering	NO

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
	<ul style="list-style-type: none"> Electromagnetic interference which can affect radar and radiocommunication 	
9.	Aesthetics <ul style="list-style-type: none"> Visually unattractive 	NO
10.	Land use <ul style="list-style-type: none"> Alteration of development and land use in the area Depreciate land value 	NO
11.	Land and water pollution <ul style="list-style-type: none"> Fuel and oil spills 	NO
Maintenance		
1.	Land and water pollution <ul style="list-style-type: none"> Human waste Fuel and oil spills 	NO
2.	Land pollution <ul style="list-style-type: none"> Solid waste 	NO
3.	Accidents from maintenance work causing death or injury	NO
Decommissioning		
1.	Land pollution <ul style="list-style-type: none"> Solid waste 	YES
2.	Noise from equipment <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent) 	YES
3.	Land and water pollution <ul style="list-style-type: none"> Human waste Fuel and oil spills 	NO

Mitigation

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 table below.

Mitigation Measures for Negative Impacts

	Impacts	Mitigation Measures
Construction Phase		
1.	Noise <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent) 	<ul style="list-style-type: none"> Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn Sensitise residents in the area to the types of activities that will take place ahead of the works and assign a liaison person with whom the residents can relate Ensure project activities are scheduled during working hours of 7:00 a.m. to 7:00 p.m.

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	Impacts	Mitigation Measures
		<ul style="list-style-type: none"> • Operate well maintained vehicles and equipment • Blasting should be done in accordance with the requirements of Mines and Geology Department
2.	Emissions and Fugitive Dust <ul style="list-style-type: none"> • Health impacts e.g. respiratory problems • Air pollution 	<ul style="list-style-type: none"> • Cover haulage vehicles transporting aggregate, soil and cement • Cover and/or wet onsite stockpiles of aggregate, soil etc. • Ensure proper stock piling/storage and disposal of solid waste • Wet cleared land areas regularly • Use water sprays to minimise dust • Blasting should be done in accordance with the requirements of Mines and Geology Department • 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
3.	Vegetation Loss / Disturbance of Biological Communities <ul style="list-style-type: none"> • Air Pollution • Habitat destruction • Disruption of ecosystems 	<ul style="list-style-type: none"> • Only areas that are absolutely necessary for clearance should be cleared • In areas where vegetation has been removed and the lands have not been converted to permanent land uses (roadways and siting of turbines), re-vegetation exercises should be undertaken. • Replant trees in the same area of the project site or other areas • In cases where sensitive habitats will be disturbed, re-siting of turbines should be undertaken • Bring to the attention of the Jamaica National Heritage Trust and the NEPA immediately if any artefacts are found and safeguard same
4.	Displacement of Farmers <ul style="list-style-type: none"> • Loss of revenue • Disturbance of farming plots/ destruction of crops 	<ul style="list-style-type: none"> • A walk through of proposed lands to be used for the siting of turbines should be undertaken where farming plots are present. This should be done prior to the finalisation of the siting layout for the wind turbines • Make arrangements with farmers to compensate them for farm crops which may have to be removed
5.	Soil erosion and sedimentation due to land clearing and slope modification <ul style="list-style-type: none"> • Disruption of ecosystems • Land slippages • Blocked drainage channels • Loss of soil • Water pollution 	<ul style="list-style-type: none"> • Identify and avoid areas with very steep and unstable slopes and near to sinkholes • Minimise, where possible the clearance of vegetation and removal of top soil • Place or design access roads to follow natural topography and minimize hill side cuts. • Design runoff control features to minimise soil erosion • Re-vegetate areas not be used for the placement of permanent features • Place berms around stockpiles of top soil and aggregate (sand, gravel, marl) • Avoid steep cuts and where there are steep cuts they must be shored up • Utilise sediment traps to minimise sediment runoff
6.	Land pollution and displeasing aesthetics due to Solid Waste	<ul style="list-style-type: none"> • Contain garbage and construction debris onsite until disposal at the approved municipal disposal site at Myersville • Prohibit burning of solid waste on project sites
7.	Traffic Congestion/ <ul style="list-style-type: none"> • Immobility Vehicle-vehicle conflicts • Vehicle-pedestrian conflicts • Delayed traffic movements • Damage to road 	<ul style="list-style-type: none"> • Obtain permission from the owners of properties identified for alteration along transportation route. Compensation, if required, should be done at market prices • Erect traffic signs along main transportation route and in sensitive areas such as schools • Erect traffic assisting devices at the entrance/exit of construction sites and corners e.g. mirrors, flagmen, etc. • Transport heavy equipment and wind turbine parts during off-peak traffic

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	Impacts	Mitigation Measures
	infrastructure <ul style="list-style-type: none"> Alteration of private property 	hours (between 10:00p.m. to 4:00 a.m.) with police outriders and JPS to raise electrical wires <ul style="list-style-type: none"> 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 Advise schools and residents of the proposed project construction schedule and seek their buy-in and support
8.	Land and water pollution <ul style="list-style-type: none"> Human Waste Fuel and Chemical Spills 	<ul style="list-style-type: none"> Use a reputable company to provide portable toilets for workers on site The company should only dispose of sewage at an approved municipal treatment plant Store fuel and chemicals 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 Develop an Emergency Preparedness and Response Plan and train workers accordingly
9.	Depletion of water resources	<ul style="list-style-type: none"> Utilise low water consumption equipment Practice onsite water reuse and recycling where possible and practical
10.	Injury and/or death due to accidents during construction work	<ul style="list-style-type: none"> 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
Operational Phase		
1.	Noise <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent)	<ul style="list-style-type: none"> Situate wind turbines as far away as possible from residences and schools. Where possible turbines should be 2 km or more away from these receptors. Wind farm noise limits should be set relative to existing background noise levels and should not exceed 55 dB (daytime) and 50dBA (night time) at receptors such as schools, residences and commercial establishments. Establish barriers to deflect sound e.g. trees Wind turbines should contain no tonal component Monitor sound levels to ensure that they are within acceptable limits
2.	Disturbance/ destruction of avifauna species (bats and birds) Injury and/or death	<ul style="list-style-type: none"> Target hilltops or previously disturbed areas for the siting of turbines Install deterrents such as ultrasound blasters if applicable Locate turbines away from the flight path of birds Shut down turbines during high risk conditions such as hurricanes Perform post construction monitoring to evaluate what if any risks are posed by the turbines operation.
3.	Shadow Flicker	<ul style="list-style-type: none"> Turbines should be sited away from communities to prevent extended exposure to flickering. A distance of 10 times the rotor diameter (called the zone of influence for shadow flickering) is considered the minimum distance for the siting of turbines to mitigate against flickering. In the event shadow-flicker becomes an annoyance within an inhabited dwelling, some sort of screening should be considered. This could include strategically placed vegetation, window awnings, or window shades.

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	Impacts	Mitigation Measures
4.	Lightning <ul style="list-style-type: none"> Fires Destruction/ disturbance of vegetation 	<ul style="list-style-type: none"> A SCADA system to remotely monitor the turbines will be used and includes features to shut down the turbines in the event of a fire Ensure that fire extinguishers are available on the wind farm for emergency use
5.	Shadowing, Reflection, Scattering Electromagnetic Interference with RF signals	<ul style="list-style-type: none"> Install outdoor or higher antennae Relocate or realign antennae
6.	Disruption of Air Traffic	<ul style="list-style-type: none"> Final turbine designs and layout should be submitted to the Jamaica Civil Aviation Authority, allowing for a risk assessment to be done examining the potential risks of the proposed wind farm to air traffic movement The rotor blades, nacelle and upper two-thirds of the supporting mast of the wind turbines should be painted white. The nacelle must be lit by a medium density obstacle light of 2000 candelas per m² showing flashing red, unless otherwise directed by JCAA. The obstacle light should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any directions. The lights should operate at 20-60 flashes per minute and flash simultaneously with lights installed at other wind turbines to show the extent of the wind farm, unless otherwise directed by JCAA. The tower should be inspected regularly to detect any failure of these lights which must be replaced in minimum time.
7.	Vibration Disturbance of seismological equipment Noise interferences	<ul style="list-style-type: none"> The design of the wind farm must be such as to prevent or reduce noise interferences
8.	Land and water pollution <ul style="list-style-type: none"> Oil Spills/leaks 	<ul style="list-style-type: none"> Ensure that spill and oil cleaning kits and equipment are onsite Ensure that workers are trained in spill management
9.	Land use change <ul style="list-style-type: none"> Depreciation of land costs Loss of revenues Land use development change Loss of bauxite mining lands 	<ul style="list-style-type: none"> Turbines, where possible, should be sited away from farming lands In cases where farming lands will be used to site turbines, access roads or any other infrastructural feature associated with the wind farm, farmers of said lands should be compensated Turbines should not be sited on bauxite deposits, except in cases where formal approval has been granted by the Jamaica Bauxite Institute
Maintenance Phase		
10.	Land and water pollution <ul style="list-style-type: none"> Solid waste Oil spills/Leaks 	<ul style="list-style-type: none"> Properly contain garbage and construction debris for disposal at the approved dumpsite at Myersville Have spill containment and clean up equipment on site and dispose of waste in accordance with best practices
11.	Accidents due to maintenance work	<ul style="list-style-type: none"> Erect signs during maintenance activities Provide workers with the necessary Personal Protective Equipment (PPE) Train construction personnel in good safety practices and emergency preparedness and response measures

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	Impacts	Mitigation Measures
Decommissioning Phase		
12.	Land and water pollution <ul style="list-style-type: none"> • Solid waste 	<ul style="list-style-type: none"> • Properly contain garbage and construction debris for disposal at the approved dumpsite at Myersville • The disposal of large parts will need to be done with the approval of the National Solid Waste Management Authority (NSWMA)
13.	Noise <ul style="list-style-type: none"> • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent) 	<ul style="list-style-type: none"> • Advise community members of the times that decommissioning activities will take place • 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
14.	Land and water pollution <ul style="list-style-type: none"> • Human Waste • Fuel and Chemical Spills 	<ul style="list-style-type: none"> • Use a reputable company to provide portable toilets for workers • The company should only dispose of sewage at an approved municipal treatment plant • 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 • Develop an Emergency Preparedness and Response Plan and train workers accordingly
15.	Accidents/Injury due to Decommissioning work	<ul style="list-style-type: none"> • Erect signs during decommissioning activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures

Conclusion

The proposed project has many benefits to Jamaica's economy and environment while having a relatively small environmental footprint. The project also has a positive global environmental impact by reducing Jamaica's contribution to greenhouse gases which have been contributing to climate change. Once the mitigation measures for adverse environmental impacts which are mostly associated with the construction phase are implemented and managed, the net benefit to Jamaica will be positive.

Environmental Impact Assessment for the Proposed Blue Mountain Renewables 34MW Wind Farm Project

1.0 Introduction

BMR Jamaica Wind Limited (“BMR”) plans to construct a new Wind Farm adjacent to the existing Jamaica Public Service Company (“JPS”) Munro Wind Farm at Hermitage, St. Elizabeth. The company is seeking to install an additional 34 MW in the area around the existing 3MW wind farm developed and owned by local utility firm, the JPS. BMR is wholly owned by Blue Mountain Renewables LLC which was established in 2012 to develop renewable power generation projects throughout the Caribbean and Central American region. The proposed BMR Jamaica Wind Farm Project had been previously studied by JPS who agreed to sell such prior work products to BMR, for their use in developing the new Wind Farm. In exchange JPS received certain payments and the option for JPS to invest in up to 20% of the expansion project equity.

This Environmental Impact Assessment (EIA) report is being prepared and submitted in support of the permit and information requirements of the National Environment and Planning Agency (NEPA). Information on the Team that conducted the EIA is included at Appendix 1.

1.1 Energy Generation in Jamaica

The Jamaican electricity sector is comprised of a vertically integrated utility company, the JPS, which owns and operates the transmission and distribution grid and 634MW of power generation. Independent Power Producers (IPPs) generate an additional 289MW of power under contract to JPS.

JPS generation capacity consists of eighteen (18) heavy and diesel oil fired thermal power generating units located at four sites (Rockfort, Hunts Bay, Bogue and Old Harbour), eight (8) hydro power plants independently sited across the island and a wind plant (3MW) at Munro in the south central part of the island. The 289 MW of generation provided by IPPs include various slow and medium speed diesels (251 MW); oil fired boilers (11 MW) and wind energy farms (27 MW). JPS serves a population of over 575,000 residential, commercial and industrial consumers; residential customers accounting for close to 90% of the total customer base. Of the 634MW of capacity owned by JPS, 292MW of its base-load capacity is over thirty-five (35) years old and represents some of the most inefficient plants supplying the grid.

The national transmission system is comprised of approximately 400 km and 800 km of 138 kV lines and 69 kV lines respectively. The system is supported by twelve (12) 138/69 kV inter-bus transformers with a total capacity of 798 megavolt-amperes (MVA) and fifty-three (53) 69 kV transformers with a total capacity of 1026 MVA. The primary distribution system is constructed on a network of 24 kV, 13.8 kV and 12 kV power lines. System losses are now at 24%. An estimated 10% are of a technical nature and the other 14% are attributed to non-technical energy losses.

In 2011, the annual sales recorded by JPS were 3,176 GWh. Over the last five (5) years the energy sales by JPS has grown at an annual rate of 0.5%. To date the highest peak demand registered on the system was 644.4MW and the average system load factor is approximately

74%. Due to the primary dependence of this generation on heavy oil and diesel oil fuels, Jamaican retail electricity rates is approximately \$US\$0.40 per kWh¹ compared to U.S. consumers who pay approximately US\$0.10 per kWh².

1.2 Project Background and Rationale

In November 2012, the Office of Utilities Regulation (OUR) issued a Request For Proposals (RFP) for the supply of 115 MW of Electricity Generation Capacity from Renewable Energy Based Power Generation facilities on a Build, Own and Operate (BOO) Basis. The RFP put out by the OUR is in keeping with the Government of Jamaica's commitment to diversify Jamaica's energy supply by increasing the percentage of renewable sources in the energy mix to 30% by 2030.

The importance of energy diversification in Jamaica has become increasingly important as fuel costs have continued to account for a sizeable proportion of Gross Domestic Product (GDP). Jamaica has no fossil fuel resources and heavily depends on oil imports to support electricity generation. In fact 96% of electricity generation in 2009 was via petroleum imports. The cost of such imports has totalled in excess of US\$2.0 billion since 2008. In 2011, oil costs were US\$2.2 billion, representing 15% of GDP. Oil import costs peaked in 2008 at US\$2.7 billion, 19% of GDP.

With an oil market extremely vulnerable to external shocks, countries which do not have such resources are seeking ways to improve their energy efficiency and in the process promote sustainable energy development. The assessment and exploration of renewable energy potential has been one such strategy touted by experts to help Jamaica develop and adopt a sustainable approach towards energy efficiency. One of the primary goals of energy efficiency is its contribution to significant costs savings over a relatively short-time frame. In the case of Jamaica, this is particularly important, given the substantial amount of finances spent on oil imports, the inefficiency of power plants and the high transmission and distribution losses from the electricity grid.

The renewable energy potential in Jamaica is vast. According to the World Watch Institute, Jamaica has vast solar, wind, hydropower and waste to energy potential, from which the island can receive tremendous cost saving benefits. The assessment into the renewable energy potential of the island revealed the following:

- ✧ The entire island's electricity demand could be met with renewable resources.
- ✧ Distributed solar PV generation at the household and commercial level can play an important role in Jamaica's energy mix.
- ✧ Just ten (10) medium-sized wind farms could provide over half of the country's current power demand.
- ✧ Developing additional small hydropower capacity can provide cheap power to Jamaica's electricity grid and energy access for remote locations.

¹ Source: <http://www.worldwatch.org/system/files/Jamaica-Sustainable-Energy-Roadmap-112013.pdf>

² Shakuntala Makhijani, Alexander Ochs, et al., *Jamaica Sustainable Energy Roadmap: Pathways to an Affordable, Reliable, Low-Emission Electricity System* (Washington, DC: Worldwatch Institute, 2013).

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- Y Improving the efficiency of Jamaica's current biomass generation facilities and connecting them to the grid could provide nearly 10% of the country's electricity demand with agricultural waste alone.
- Y A coherent national waste management strategy is necessary in order to harness the significant public and private interest in waste-to-energy development.

In response to the OUR RFP BMR submitted a bid to generate 34-40MW of energy via the use of wind technology.

BMR seeks permission to build, construct, own and operate a wind generating facility in St. Elizabeth Parish, Jamaica ("the Project"). The Project will provide up to thirty-four (34) megawatts (MWs) of hourly electricity for the Jamaica Public Service Company ("JPS"). An electric transmission line, approximately eighteen (18) kilometres, will also be constructed to interconnect the Project with Jamaica Public Service ("JPS") grid. This line will span from the Project Site to the JPS Spur Tree substation and will have a rating no greater than sixty-nine (69), kilovolts (KV).

1.3 Project Objectives and Benefits

The BMR Jamaica Wind Farm Project seeks to take advantage of Jamaica's great wind resources by developing and optimising on the wind energy potential offered in one of only five of the most feasible areas on the island most suited for the development of large commercially viable wind farms. The project will see between US\$85 and \$90 million being invested in the development of the wind facility, which will contribute approximately 4.8% of energy generated by renewable sources to the renewable energy mix. Most importantly the project will help the country to reduce its overall dependence on oil, while helping the JPS to reduce system losses experienced through inefficient power plants. Key environmental benefits under the project include:

- Y Eliminates need to import and burn 250,000 barrels of foreign oil per year
- Y 5.0 million barrels saved over 20 year life – save over \$500 million US of oil expense
- Y Zero emissions for power generation – significant reduction from current sources
 - o Nitrogen Oxides emissions will be reduced by 7,000 tonnes
 - o Sulphur Dioxide emissions will be reduced by 40,000 tonnes
 - o Carbon Dioxide emissions will be reduced by over 2 million tonnes

The project additionally offers renewable technological advantages as lower cost wind power offers a more competitive edge when compared to other forms of renewable energy sources, e.g. solar power installations. Though initial capital costs are higher than solar, the output in the long-term is generally considered more favourable. Wind technologies when compared to solar technologies provide the following benefits:

- Y Wind turbines require less land space than solar panels
- Y Wind farms are more cost effective and efficient than solar panels for commercial scale production for the national grid
- Y Wind farms are less costly to maintain

2.0 Project Description

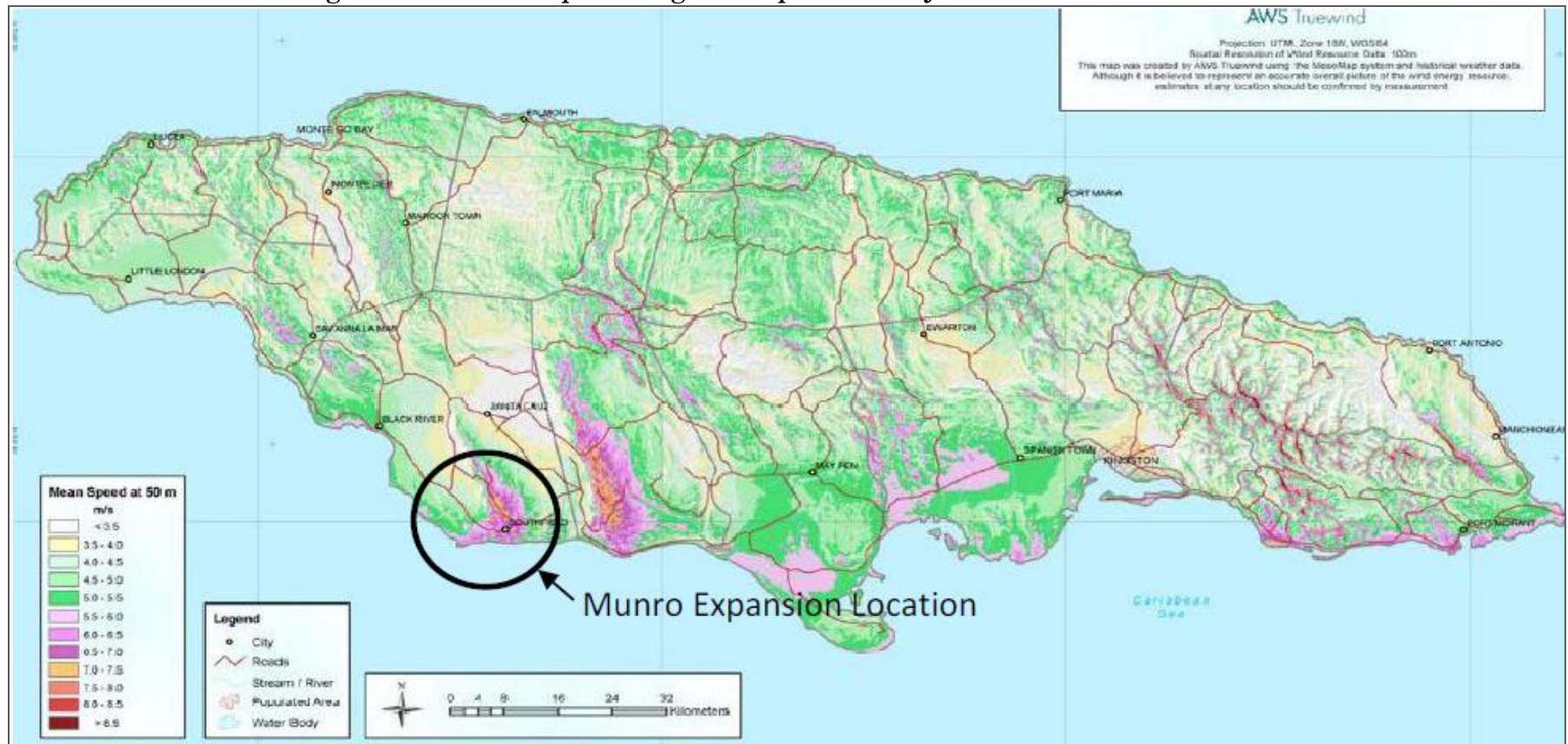
2.1 Project Location and Site

The BMR Jamaica Wind Farm Project is to be located in the south-eastern section of the parish of St. Elizabeth; an estimated 12km south of parish's main town of Santa Cruz (Figure 1). The project site is located approximately 100km west of the capital city of Kingston and 75km south-east of the city of Montego Bay.

The proposed project site for the BMR Jamaica Wind Farm is located on approximately 35.2 hectares (87 acres) of land adjacent the existing JPS Munro Wind Farm. The existing Munro Wind Farm site is the subject of a long-term lease arrangement between JPS and the Government of Jamaica. The proposed site spans several communities, which includes Malvern, Hermitage and Potsdam (Figure 2).

The proposed site is located in an area of high wind and is considered a Class I wind site. While part of the proposed site already has the existing wind farm, the rest of the area slated for the project is in agricultural use.

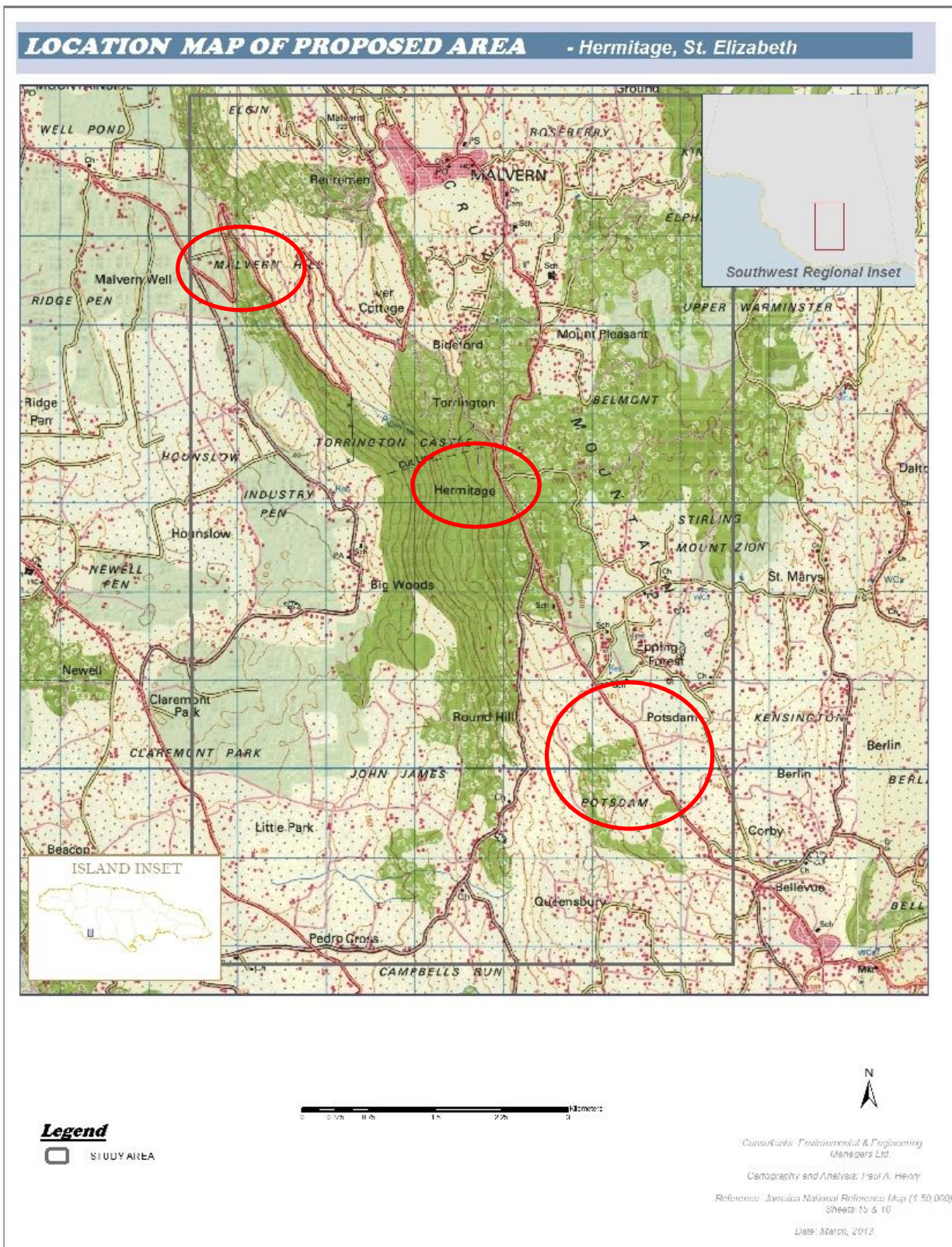
Figure 1: Location Map Showing the Proposed BMR Jamaica Wind Farm Site



Source: Blue Mountain Renewables LLC, 2013

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Figure 2: Location Map of Project Area



Source: EEM, 2013

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Table 1: Coordinates for BMR Jamaica Wind Turbine Locations

<i>Wind Turbine Locations - Blue Mountain Renewables</i>				
Turbine	Northings	Eastings	Latitude	Longitude
1	143201.586	175934.378	17°56'23.70"N	77°41'53.10"W
2	142999.790	176002.882	17°56'17.20"N	77°41'50.70"W
3	142875.357	175984.460	17°56'13.10"N	77°41'51.30"W
4	142744.413	175987.141	17°56'8.90"N	77°41'51.20"W
5	142494.738	176005.473	17°56'0.80"N	77°41'50.60"W
6	142436.625	176053.120	17°55'58.90"N	77°41'48.90"W
7	142191.594	176094.851	17°55'50.90"N	77°41'47.50"W
8	142046.279	176157.954	17°55'46.20"N	77°41'45.30"W
9	144539.450	175701.160	17°57'7.20"N	77°42'1.20"W
10	144336.554	175737.546	17°57'0.60"N	77°41'59.90"W
11	144140.587	175805.342	17°56'54.30"N	77°41'57.60"W
12	144080.913	176202.346	17°56'52.40"N	77°41'44.10"W
13	143758.601	176258.675	17°56'41.90"N	77°41'42.10"W
14	143646.279	176443.958	17°56'38.30"N	77°41'35.80"W
15	143443.191	176500.616	17°56'31.70"N	77°41'33.90"W
16	142565.673	176605.119	17°56'3.10"N	77°41'30.20"W
17	142343.840	176587.321	17°55'55.90"N	77°41'30.80"W
18	144704.774	175871.247	17°57'12.60"N	77°41'55.40"W
Note: Northing and Easting coordinates are in JAD69 Format				

Figure 3: Overlay of BMR Jamaica Wind Turbine Locations on Topographic Map

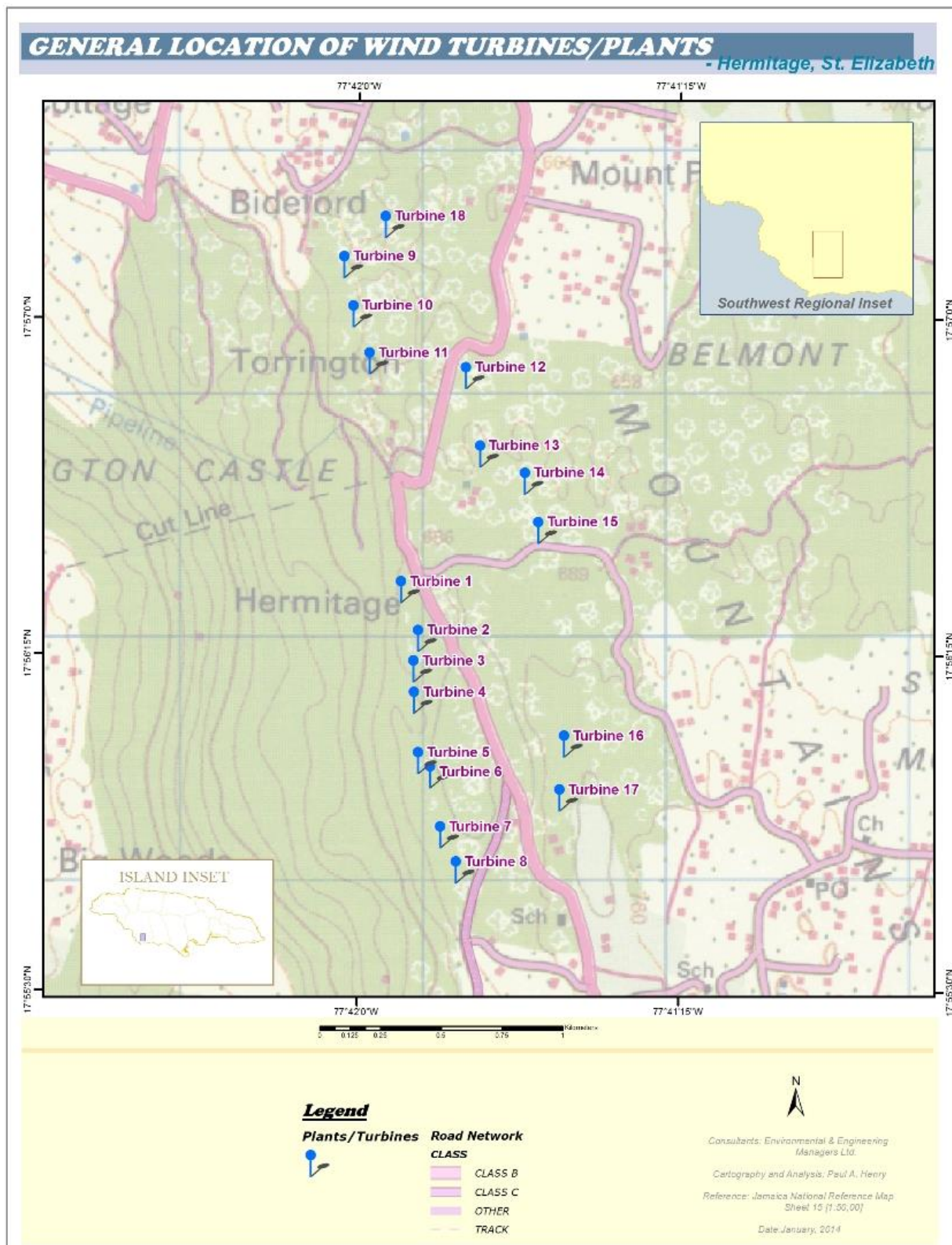
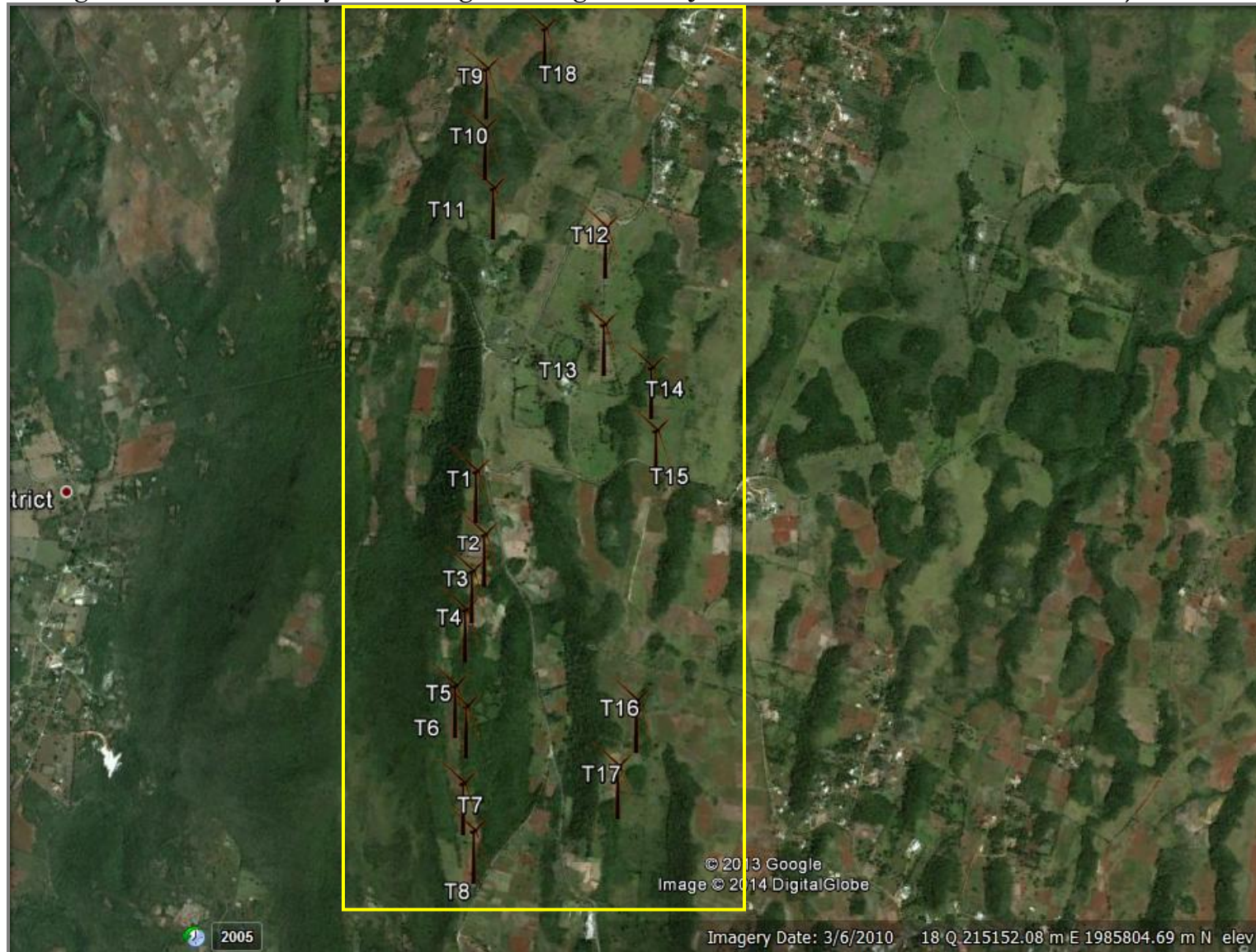
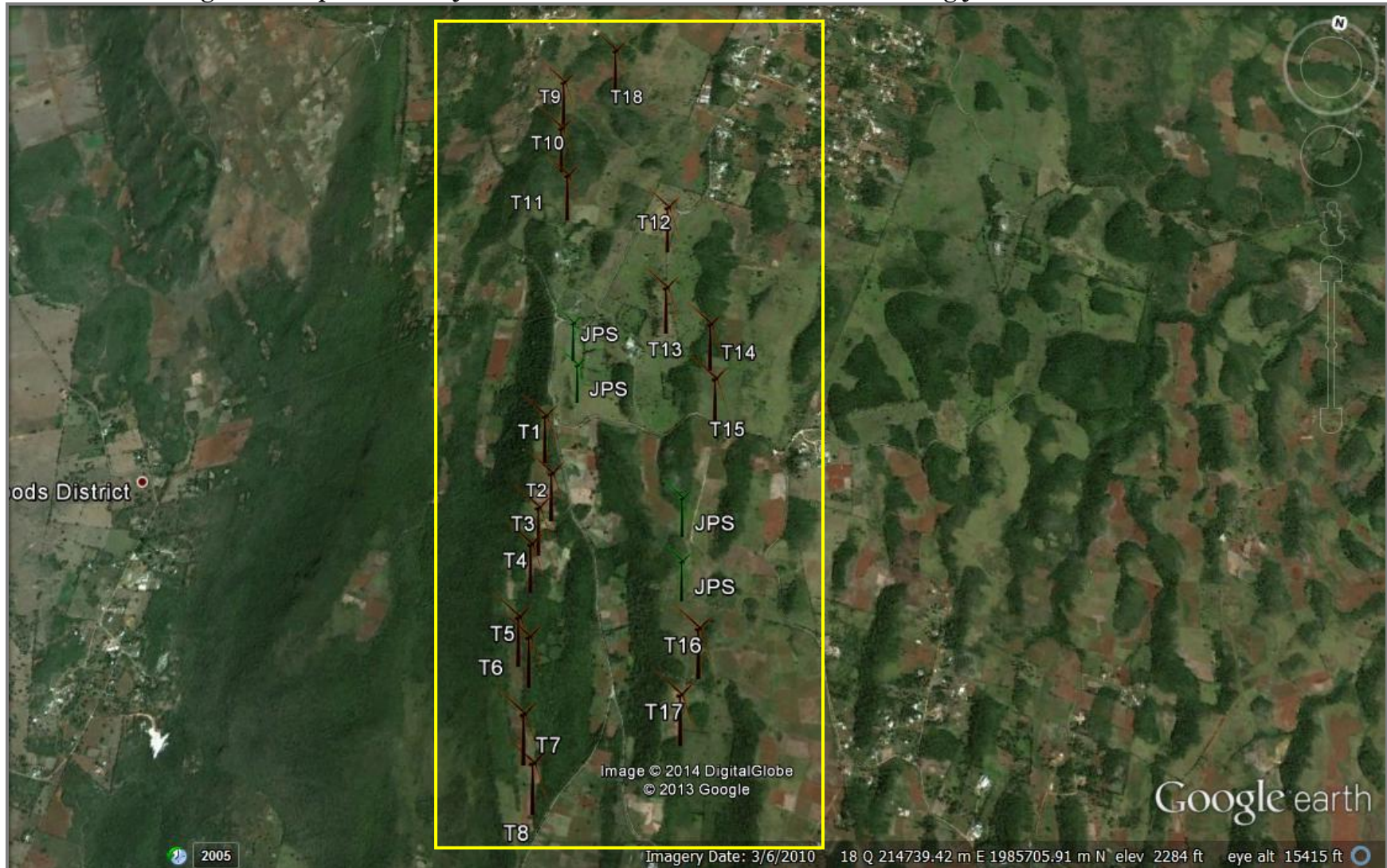


Figure 4: Preliminary Layout showing the Siting of BMR Jamaica Wind Turbines Within the Project Area



Source: Google Earth, with information from Blue Mountain Renewables LLC and modifications by EEM, 2014

Figure 5: Proposed BMR Jamaica Wind Turbine Locations and Existing JPS Turbine Locations



Source: Google Earth, with information from Blue Mountain Renewables LLC and modifications by EEM, 2014

Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm Project, Malvern St. Elizabeth, Jamaica

1.1 Project Design

To produce 34 MWs, eighteen (18) turbine locations (sites) will be selected, with a ***minimum*** of eleven (11) locations being utilised for the final installation of turbines (Table 1, Figure 3, Figure 4 and Figure 5). The final number of turbine locations and configuration of the wind farm will be determined based on:

- Y The type of wind technology selected
- Y The results of subsurface investigations and
- Y Environmental considerations and
- Y The final recommendations of a comprehensive transportation study on the movement of turbines from the Ports to the Project site.

Three (3) types of wind turbine technology are being considered for installation at the proposed wind farm location in Malvern. The turbines will be designed by Vestas and includes the following turbine types:

- Y V90-1.8MW
- Y V80-2.0MW
- Y V112-3.3MW

The turbines are pitch regulated upwind turbines with active yaw and three-blade rotor. The turbine utilises a microprocessor pitch control system called OptiTip® and the OptiSpeed™ (variable speed) feature. With these features, the wind turbine is able to operate the rotor at variable speed (rpm), helping to maintain the output at or near rated power.

The turbines consist of the following components:

- Y Rotor
- Y Blades
- Y Blade Bearing
- Y Pitch System
- Y Hub
- Y Main Bearing
- Y Gear Box
- Y Generator Bearings
- Y Yaw System
- Y Crane
- Y Towers
- Y Wind Sensors

1. Overview of Turbines

- Y **V90-1.8MW:** The Vestas V90-1.8 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V90-1.8 MW turbine has a rotor diameter of 90 m with a generator rated at 1.8 MW, depending on wind conditions. The turbine utilises a microprocessor pitch control system called OptiTip® and the OptiSpeed™ (variable speed) feature. With these features, the wind turbine is able to

Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm Project, Malvern St. Elizabeth, Jamaica

operate the rotor at variable speed (rpm), helping to maintain the output at or near rated power.

- Y **V80-2.0MW:** The Vestas V80-2.0 MW wind turbine is a pitch-regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V80-2.0 MW turbine has a rotor diameter of 80 m with a generator rated at 2.0 MW. The turbine utilises the OptiTip® and the OptiSpeed™ concepts. With these features, the wind turbine is able to operate the rotor at variable speed (rpm), helping to maintain the output at or near rated power.
- Y **V112-3.3MW:** The Vestas V112-3.3 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V112-3.3 MW turbine has a rotor diameter of 112m and a rated output power of 3.3 MW. The turbine utilises the OptiTip® concept and a power system based on a permanent magnet or induction generator and full-scale converter. With these features, the wind turbine is able to operate the rotor at variable speed and thereby maintain the power output at or near rated power even in high wind speed. At low wind speed, the OptiTip® concept and the power system work together to maximise the power output by operating at the optimal rotor speed and pitch angle.

2. Rotor

- Y The **V90-1.8 MW** is equipped with a 90-metre rotor consisting of three (3) blades and the hub. Based on the prevailing wind conditions, the blades are continuously positioned to help optimise the pitch angle (Table 2).

Table 2: Turbine Rotor Details

<i>Description</i>	<i>Turbine Technology</i>		
	Rotor V90-1.8 MW	V80-2.0MW	V112-3.3MW
Diameter	90m	80m	112m
Swept Area	6362 m ²	5027 m ²	9852 m ²
Rotational Speed Static, Rotor	14.9 rpm	16.7 rpm	13.6 rpm
Speed, Dynamic Operation Range	9.6-17.0 rpm	10.8-19.1 rpm	6.2-17.7 rpm
Rotational Direction	Clockwise (front view)	Clockwise (front view)	Clockwise (front view)
Orientation	Upwind	Upwind	Upwind
Tilt	6°	6°	6°
Hub Coning	2°	2°	4°
Number of Blades	3	3	3
Aerodynamic Brakes	Full feathering	Full feathering	Full feathering

- Y The **V80-2.0 MW** is equipped with an 80 metre rotor consisting of three blades and the hub. Based on the prevailing wind conditions, the blades are continuously positioned to help optimise the pitch angle (Table 2).

Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm Project, Malvern St. Elizabeth, Jamaica

- Y The **V112-3.3 MW** is equipped with a 112-meter rotor consisting of three blades and a hub. The blades are controlled by the microprocessor pitch control system OptiTip®. Based on the prevailing wind conditions, the blades are continuously positioned to optimise the pitch angle (Table 2).

3. Blades

- Y **V90-1.8MW:** The 44 m Prepreg (PP) blades are made of carbon and fibreglass. They consist of two airfoil shells bonded to a supporting beam (Table 3).

Table 3: PP Blades V90-1.8 MW

PP Blades V90 1.8 MW	
Type Description	Airfoil shells bonded to supporting beam
Blade length	44m
Material	Fiberglass reinforced epoxy and carbon fibres
Blade Connection	Steel roots inserts
Air Foils	RISØ P + FFA – W3
Maximum Chord	3.512m
Blade Tip (R44.5)	0.391m
Twist (blade root/blade tip)	27°
Approximate Weight	6750kg

- Y **V80-2.0MW:** The 39 m Prepreg (PP) blades are made of epoxy and fibreglass and consist of two airfoil shells bonded to a supporting beam (Table 4).

Table 4: PP Blades V80-2.0MW

PP Blades V80- 2.0 MW	
Type Description	Airfoil shells bonded to supporting beam
Blade length	39m
Material	Fiberglass reinforced epoxy
Blade Connection	Steel roots inserted
Air Foils	NACA63.xxx+FFA-W3
Largest Chord	3.372m
Weight	6600kg

- Y **V112-3.3 MW:** The 55m blades are made of carbon and fibreglass and consist of two airfoil shells bonded to a supporting beam (Table 5).

Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm Project, Malvern St. Elizabeth, Jamaica

Table 5: PP Blades V112-3.3MW

PP Blades V112 3.3 MW	
Type Description	Airfoil shells bonded to supporting beam
Blade length	54.65m
Material	Fiberglass reinforced epoxy and carbon fibres
Blade Connection	Steel roots inserts
Air Foils	Highlift profile
Maximum Chord	4.0m
Approximate Weight	14,500kg

4. Blade Bearings

The blade bearings described in Table 6 are double-row four-point contact ball bearings. They are applicable to all three (3) types of turbines.

Table 6: Blade Bearing of Wind Turbines

Blade Bearing	
Type	Double-row four point contact ball bearing
Lubrication	Grease Lubrication, manually re-greased

5. Pitch and Hydraulic System

The energy input from the wind to the turbine is adjusted by pitching the blades according to the control strategy. The pitch system also works as the primary brake system by pitching the blades out of the wind. This causes the rotor to idle (Table 7).

Double-row four-point contact ball bearings are used to connect the blades to the hub. The pitch system relies on hydraulics and uses a cylinder to pitch each blade. Hydraulic power is supplied to the cylinder from the hydraulic power unit in the nacelle through the main gearbox and the main shaft via a rotating transfer.

For the V-112s, each pitch system consists of a hydraulic cylinder mounted to the hub and a piston rod mounted to the blade via a torque arm shaft. Valves facilitating operation of the pitch cylinder are installed on a pitch block bolted directly onto the cylinder.

Table 7: Pitch System

Pitch System		
	V90-1.8 MW and V80-2.0MW	V112-3.3MW
Type	Hydraulic	Hydraulic
Cylinder	Ø 125/80-760	As described above
Number	1 piece/blade	1 piece/blade
Range	-5° to 90°	-9° to 90°

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Hydraulic accumulators inside the rotor hub ensure sufficient power to pitch the turbine in case of failure (Table 8).

For the V-112s, the Hydraulic System's main pump consists of two (2) redundant internal-gear oil pumps with a pressure of 260 bar. The filtration is 3µm (absolute). The Hydraulic System for the V90-1.8MW and V80-2.0MW is listed below in Table 8.

Table 8: Hydraulic System for 1.8 and 2.0MW Turbines

Hydraulic System	
V90-1.8MW and V80-2.0MW	
Pump Capacity	44 L/min
Working Pressure	180-200 bar
Oil Quantity	260 L
Motor	18.5 kW

6. Gear box

The main gearbox transmits rotational torque from the rotor to the generator and consists of a planetary stage combined with a two-stage parallel gearbox, torque arms and vibration dampers (Table 9 and Table 10). Torque is transmitted from the high-speed shaft to the generator via a flexible composite coupling, located behind the disc brake. The disc brake is mounted directly on the high-speed shaft.

Table 9: Gear Box components V90-1.8MW and V80-2.0MW

Gear Box	
Type	1 planetary stage +2 helical stages
Ratio	1:112.8 nominal (V90-1.8MW); 1:100.6 nominal (V80 2.0MW)
Cooling	Oil pump with oil cooler
Oil Heater	2 kW
Maximum gear Oil Temp	80°C (V90-1.8MW); 62°C (V90 3.0MW)
Oil Cleanliness	-/15/12 ISO 4406

Table 10: Gear Box Components V112-3.0MW

Gear Box	
Type	planetary stage + 1 helical stages
Gear House Material	Cast
Lubrication System	Pressure Oil lubrication
Back up Lubrication System	Oil sump filled from external gravity tank
Total Gear Oil Volume	1000-2000
Oil Cleanliness	ISO 4406-/15/12
Shaft Seals	Labyrinth
Mechanical power	3300 kW

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7. Yaw System

The yaw system is designed to keep the turbine upwind. The nacelle is mounted on the yaw plate, which is bolted to the turbine tower. The yaw bearing system is a plain bearing system with built-in friction. Asynchronous yaw motors with brakes enable the nacelle to rotate on top of the tower. The turbine controller receives information about the wind direction from the wind sensor. Automatic yawing is deactivated when the mean wind speed is below 3 m/s.

8. Tower Structure

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (i.e. in the gravitational direction) by mechanical connections.

The hub heights listed in Table 11 are calculated using the combined distance from the top of the turbine's foundation to ground level, which is approximately 0.2 m and the distance from the tower top flange to the centre of the hub, which is approximately 1.7 m.

Table 11: Tower Structure

<i>Tower Structure</i>			
	V90-1.8MW	V80-2.0MW	V112-3.3MW
Type description	Conical tubular	Conical tubular	Conical tubular
Hub height	80 m	IEC IA: 67 m	IEC 1A: 84 m
Material	S355 according to EN 10024 A709 according to ASTM	S355 according to EN 10024 A709 according to ASTM	S35 according to EN 10024 A709 according to ASTM
Weight	80 m IEC IIA, 117 metric tonnes*	67 m IEC IA: 116 metric tonnes*	84m, IEC IA/IIA 196 metric tonnes
Diameter	-	-	4.2 m
*Typical values. Dependent on wind class, and can vary with site/project			

9. Nacelle Bed Plate and Cover

The nacelle cover is made of fiberglass (Table 12). Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel.

The roof is equipped with wind sensors and skylights that can be opened from inside the nacelle to access the roof and from outside to access the nacelle. The nacelle cover is mounted on the girder structure. Access from the tower to the nacelle is through the yaw system.

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The nacelle bedplate (Table 12) is in two parts and consists of a cast-iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train and transmits forces from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw gears are bolted to the front nacelle bedplate.

The nacelle bedplate carries the crane girders through vertical beams positioned along the site of the nacelle. Lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as foundation for controller panels, the generator and transformer.

Table 12: Nacelle and Bed Plate Cover

<i>Nacelle Bed Plate and Cover</i>	
Type Description	Material
Nacelle Cover	GRP
Bedplate front	Cast Iron EN-GJS-400-18U-LT/EN 1560
Bedplate Rear	Welded grid structure

10. Cooling

The cooling of the main components (gearbox, hydraulic power pack and Vestas Converter System (VCS)) in the turbine is done by a water cooling system (Table 13). The generator is air cooled by nacelle air and the high-voltage (HV) transformer is cooled by mainly ambient air. All other heat generating systems are also equipped with fans and/or coolers but are considered as minor contributors to nacelle thermodynamics.

Table 13: Cooling

<i>Component</i>	<i>Cooling Type</i>	<i>Internal Heating at Low Temperature</i>
Nacelle	Forced air	Yes
Hub/Spinner	Natural air	No (yes for low-temperature (LT) turbine)
Gearbox	Water/oil	Yes
Generator	Forced air/air	No (heat source)
Slip rings	Forced air/air	Yes
Transformer	Forced air	No (heat source)
VCS	Forced water/air	Yes
VMP section	Forced air/air	Yes
Hydraulics	Water/oil	Yes

Y **Water Cooling:** The water cooling system is designed as a semi-closed system (closed system but not under pressure) with a free wind water cooler on the roof of the nacelle. This means that the heat loss from the systems (components) is transferred to the water system and the water system is cooled by ambient air.

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The water cooling system has three parallel cooling circuits that cool the gearbox, the hydraulic power unit and the VCS.

The water cooling system is equipped with a three-way thermostatic valve. The valve is closed (total water flow bypassing the water cooler) if the temperature of the cooling water is below 35°C and fully open (total water flow led to the water cooler) if the temperature is above 43°C.

Y **Gearbox Cooling:**

- For the V112s the gearbox and hydraulic cooling systems are coupled in parallel. A dynamic flow valve mounted in the gearbox cooling circuit divides the cooling flow. The cooling liquid removes heat from the gearbox and the hydraulic power unit through heat exchangers and a free-air flow radiator placed on the top of the nacelle. In addition to the heat exchangers and the radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.
- For the V90-1.8MW and the V80-2.0MW the gearbox cooling system (Table 14) consists of two oil circuits that remove the gearbox losses through two plate heat exchangers (oil coolers). The first circuit is equipped with a mechanically driven oil pump and a plate heat exchanger. The second circuit is equipped with an electrically driven oil pump and a plate heat exchanger. The water circuit of the two plate heat exchangers is coupled in series.

Table 14: Gear Box Cooling

Gearbox Cooling	
Gear Oil Plate Heat Exchanger 1 (Mechanically driven oil pump)	
Nominal Oil Flow	50 L/min (50% glycol) (1.8MW) ; 175L/min (50% glycol) (3.0MW)
Oil inlet Temperature	80°C
Number of Passes	2
Cooling Capacity	24.5kW
Gear Oil Plate Heat Exchanger 2 (electrically driven oil pump)	
Nominal oil flow	85 L/min
Oil Inlet Temperature	80°C
Number of passes	2
Cooling capacity	41.5 kW
Water Circuit	
Nominal Water Flow	Approximately 150 L/min (50% glycol)
Water inlet Temperature	Maximum 54°C
Number of Passes	1
Heat Load	66 kW

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Y **Generator Cooling V90-1.8MW and V80-2.0MW**

The generator cooling systems (Table 15) consists of an air-to-air cooler mounted on the top of the generator, two internal fans and one external fan. All the fans can run at low or high speed.

Table 15: Generator Cooling

Generator Cooling	
Air Inlet Temperature: External	50°C
Nominal Air Flow: Internal	8,000 m ³ /h
Nominal Air Flow: External	7,500 m ³ /h
Cooling Capacity	60 kW

Y **V112-3.3MW**

The thermal conditioning system consists of a few robust components:

- Y The Vestas CoolerTop® located on top of the rear end of the nacelle. The CoolerTop® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle.
- Y The Liquid Cooling System, which serves the gearbox, hydraulic systems, generator and converter is driven by an electrical pumping system.
- Y The transformer forced air cooling comprised of an electrical fan.

Generator and Converter Cooling: The generator and converter cooling systems operate in parallel. A dynamic flow valve mounted in the generator cooling circuit divides the cooling liquid flow. The cooling liquid removes heat from the generator and converter unit using a free-air flow radiator placed on the top of the nacelle. In addition to the generator, converter unit and radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

Transformer Cooling: The transformer is equipped with forced-air cooling. The ventilator system consists of a central fan, located below the service floor and an air duct leading the air to locations beneath and between the high voltage and low voltage windings of the transformer.

Nacelle Cooling: Hot air generated by mechanical and electrical equipment is removed from the nacelle by a fan system located in the nacelle.

11. Electrical Design and Equipment

- Y **Generator (V90-1.8MW and V80-2.0MW):** The generator is a three-phase asynchronous generator with wound rotor that is connected to the Vestas Converter System (VCS) via a slip ring system. The generator is an air-to-air cooled generator with

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an internal and external cooling circuit. The external circuit uses air from the nacelle and expels it as exhaust out the rear end of the nacelle.

The generator has four poles. The generator is wound with form windings in both rotor and stator. The stator is connected in Star at low power and Delta at high power. The rotor is connected in Star and is insulated from the shaft (Table 16).

Table 16: Generator Details V90-1.8MW and V80-2.0MW

<i>Generator</i>		
	V90-1.8MW	V80=2.0MW
Type Description	Asynchronous with wound rotor, slip rings and VCS	Asynchronous with wound rotor, slip rings and VCS
Rated Power (PN)	1.8MW	2.0MW
Rated Apparent Power	2.0 MVA ($\cos\varphi = 0.9$)	2.08MVA ($\cos\varphi = 0.96$)
Frequency	50 Hz	50 Hz
Voltage, Generator	690 Vac	690 Vac
Voltage, Converter	480 Vac	480 Vac
Number of Poles	4	4
Winding Type (Stator/Rotor)	Random/Form	Random/Form
Winding Connection, Stator	Star/Delta	Star/Delta
Rated Efficiency (Generator only)	>97%	>97%
Power Factor (cos)	0.90 ind-0.95 cap	0.96 ind-0.98 cap
Overspeed Limit According to IEC (2 minute)	2900 rpm	2,900 rpm
Vibration Level	≤ 1.8 mm/s	≤ 1.8 mm/s
Weight	Approximately 7,500 kg	Approximately 8,100 kg
Generator Bearing-Temperature	2 PT 100 Sensors	2 PT 100 Sensors
Generator Stator Windings-Temperature	3 PT 100 sensors placed at hot spots and 3 as backup	3 PT 100 sensors placed at hot spots and 3 as backup

- Y **Generator (V112-3.3 MW):** The generator is a three-phase synchronous generator with a permanent magnet rotor or a three phase asynchronous induction generator with cage rotor that is connected to the grid through a full scale converter. The generator housing is built with a cylindrical jacket and channels. The channels circulate cooling liquid around the generator internal stator housing.

Table 17: Generator Details V112-3.3MW

<i>Generator V112-3.3MW</i>		
	Alternative 1	Alternative 2
Type Description	Asynchronous with wound rotor, slip rings and VCS	Asynchronous with cage rotor
Rated Power (PN)	3.3 MW	3.3 MW
Rated Apparent Power	2.0 MVA ($\cos\varphi = 0.9$)	2.08MVA ($\cos\varphi = 0.96$)
Frequency	0-200 Hz	0-100 Hz

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Generator V112-3.3MW		
	Alternative 1	Alternative 2
Voltage , Stator (U_{NS})	3 X 710 V (at rated speed)	3 x 750 V (at rated speed)
Number of Poles	12	4/6
Winding Type	Form with VPI (Vacuum Pressurized Impregnation)	Form with VPI (Vacuum Pressurized Impregnation)
Winding Connection, Stator	Star	Star or Delta
Rated rpm	1450-1550 rpm	1450-1550 rpm
Rated Efficiency (Generator only)	>98%	>98%
Overspeed Limit According to IEC (2 minute)	2400 rpm	2,400 rpm
Generator Bearing	Hybrid/ceramic	Hybrid/ceramic
Generator Stator Windings-Temperature	3 PT 100 sensors placed at hot spots and 3 as backup	3 PT 100 sensors placed at hot spots and 3 as backup
Temperature sensors	1 per bearing	1 per bearing
Insulation Class	F or H	F or H
Enclosure	IP54	IP54
Vibration Level	≤ 1.8 mm/s	≤ 1.8 mm/s
Weight	Approximately 7,500 kg	Approximately 8,100 kg
Generator Bearing-Temperature	2 PT 100 Sensors	2 PT 100 Sensors

12. Transformer

The step-up transformer is located in a separate locked room in the back of the nacelle. The transformer is a three-phase, two-winding, dry-type transformer that is self- extinguishing. The windings are delta connected on the high-voltage side unless otherwise specified.

13. Wind Sensors

- ✧ **V90-1.8MW and V80-2.0MW:** The turbines are equipped with two ultrasonic wind sensors with built-in heaters as outlined in Table 18.

Table 18: Wind Sensor Details

Wind Sensors	
Type	FT702LT
Principle	Acoustic resonance
Built-in Heat	99 W

- ✧ **V112-3.3MW:** The turbine is either equipped with two ultrasonic wind sensors or one ultrasonic wind sensor and one mechanical wind vane and anemometer. The sensors have built-in heaters to minimise interference from ice and snow. The wind sensors are redundant, and the turbine is able to operate with one sensor only.

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14. Turbine Controller

Y **V90-1.8MW and V80-2.0MW:** The turbine is controlled and monitored by the System 3500 controller hardware and Vestas controller software. The turbine control system serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence in order to limit the inrush current.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.

Y **V112-3.3MW:** The turbine is controlled and monitored by the VMP6000 control system. The VMP6000 is a multiprocessor control system comprised of four main processors (ground, nacelle, hub and converter) interconnected by an optically based 2.5 Mbit ArcNet network. In addition to the four main processors, the VMP6000 consists of a number of distributed I/O modules interconnected by a 500 kbit CAN network.

I/O modules are connected to CAN interface modules by a serial digital bus, CTBus.

The VMP6000 controller serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Reactive power control and variable speed operation.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.
- Monitoring of the smoke detection system.

15. Multiple Voltage dips

The turbine is designed to handle re-closure events and multiple voltage dips within a short period of time due to the fact that voltage dips are not evenly distributed during the year. As an example, six voltage dips of duration of 200 ms down to 20% voltage within 30 minutes will normally not lead to a problem for the turbine.

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2.1.1 Protection and Monitoring Systems

1. Lightning Protection

The Lightning Protection System (LPS) consists of three main parts (Table 19).

- Lightning receptors.
- Down conducting system.
- Earthing system.

Table 19: Lightning Protection Design Parameters

Lightning Protection Design Parameters			Protection Level I
Current Peak Value	i_{max}	[kA]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/μs]	200

2. SCADA Interface Facilities

The project will be monitored using VestasOnline®. This Supervisory Control and Data Acquisition (“SCADA”) system comprises the following components:

- Y Wind power plant server - VestasOnline® server application for operating and managing wind power plants, including remote communication interface
- Y Business client - VestasOnline® client application with operator interface
- Y Communication network - fibre-optic cables and switches connecting the server to the turbines

VestasOnline® can monitor and control functions to help optimise the performance of the wind power plant and include:

- Y Online production view
- Y Plant layout view
- Y Event view
- Y Production reports
- Y Statistic reports
- Y Event notification

It is anticipated that the VestasOnline® Business SCADA system will be deployed at the project location. The system is for larger wind farms or for customers who want advanced reporting, higher redundancy or advanced control and monitoring functionality.

3. Telecommunication and Control Systems

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In addition to employing Vestas' SCADA system during operations, it is anticipated that a combination of cellular, digital and repeater communication services will be installed during construction and through the operational life of the facility. Vestas and their contractors have similarly installed reliable working communications at nearby wind farms.

2.1.2 Climate and Site Conditions Design Consideration

Wind turbine designs take into account climate and site conditions. Average and extreme design parameters are considered, which include temperature and wind speed. The extreme design parameters are outlined in Table 20.

The average design parameter for wind climate for the V112-3.3MW (IEC IA/IIA) has a design wind speed of 8.5 m/s. The average design parameter for wind climate for the V80-2.0MW has a design wind speed of 10.0 m/s and the V90-1.8MW has a wind speed of 8.5 m/s.

Table 20: Extreme Design Parameters Wind Turbines

<i>Wind Climate</i>	<i>IEC IA/IIA</i>		
	V90-1.8MW	V80-2.0MW	V112-3.3MW
Ambient temperature interval (standard temperature turbine)	-30° + 50°C	-30° + 50°C	-30° + 50°C
Extreme wind speed (10 minute average)	42.5 m/s	42.5 m/s	50 m/s
Survival wind speed (3 minute gust)	59.5 m/s	59.5 m/s	70 m/s

Source: Vestas

2.1.3 Wind Farm Meteorological Monitoring

Meteorological Monitoring Equipment

The VestasMetPanel 3000 meteorology station will be used to monitor meteorological data, particularly wind data at the proposed wind farm. The equipment is designed for remote monitoring of weather data such as wind speed, wind direction, temperature, etc. It is used typically for wind power plants where there are one or more meteorology stations connected to a common site computer by means of a communication network.

The VestasMetPanel 3000 will be equipped with sensors that measure:

- Y Wind speed (types selectable)
- Y Wind direction (types selectable)
- Y Ambient temperature
- Y Atmospheric pressure
- Y Relative humidity
- Y Rain detection

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- Y Panel temperature
- Y Precipitation
- Y Lightning strikes
- Y Electric field strength
- Y Optical visibility range
- Y Solar radiation

Monitoring Equipment

Each meteorology station will consist of a control panel installed at the base of the meteorology tower, several sensors and a communication cable between the controller and the sensors. A top box is also included for mounting of sensors at hub height on the meteorology tower. The control panel is supplied with a display and a keyboard for local display and configuration (Table 21).

Table 21: Monitoring Equipment for Vestas Wind Turbines

Unit	Manufacturer / Model	Position	No. of units
Wind speed anemometer	Vaisala WAA151	Hub height	1
Wind direction sensor	Vaisala WAV151	Hub height	1
Air pressure sensor	Vaisala Barometric Sensor PTB210	Ground level – inside meteorology panel	1
Rain detector	Vaisala Rain Detector DRD11A	Ground level – base of meteorology tower	1
Temperature sensor - with radiation shield*	Vaisala HMP155A	Hub height	1
Humidity sensor - with radiation shield*	Vaisala HMP155A	Hub height	1
Sensor Signal cables	Vestas	-	1 per unit
Top box	Vestas		1
Controller panel	Vestas	-	1

Source: Vestas

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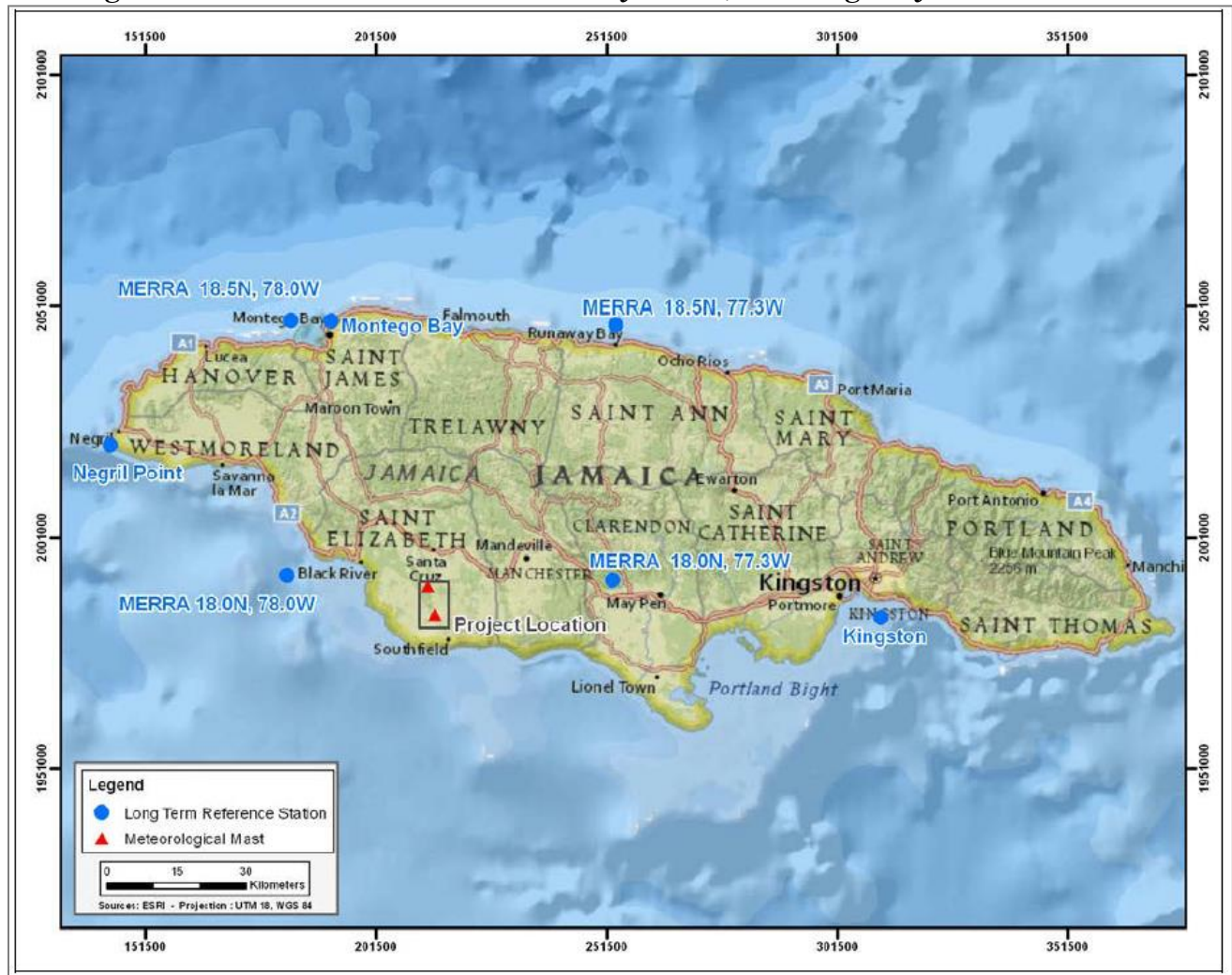
2.2 Wind Design Considerations

Figure 6 shows wind data collection stations in Jamaica including the JPS Met Masts.

2.2.1 Wind Potential and Assessment: Wind Data

In 2010, the Jamaica Public Service installed masts at the Munro Wind farm site. The met masts, named MM1 and MM2 have collected data series spanning across several years. For site specific wind conditions related to the BMR Jamaica Wind project, wind measurements were taken from mast MM1.

Figure 6: Wind Data Collection Stations in Jamaica, including the JPS Met Masts



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The measurements taken from the site mast is summarised in Table 22 below.

Table 22: Wind Measurements Mast 1

Mast/Device	Tower/Device Type	Installation Date	Measurement equipment IEC-compliance ¹
Mast 1	50 m triangular lattice	24 August 2010	Broadly Consistent

Note: 1. IEC 61400-12:2005 (E) [3]
Source: Garrad Hassan America Inc.

Wind data at the site mast were recorded using an NRG Symphonie Plus data logger, NRG #40C anemometers, and NRG #200P wind vanes. The data logger has been programmed to record, at 10-minute intervals, mean, standard deviation, maximum and minimum wind speed, wind direction and temperature.

Table 23 summarizes data recovery at the site mast at the upper measurement height.

Table 23: Data recovery Mast 1 (upper measurement height)

Mast/Device	Measurement Height (M)	Available years	Valid data (years)	Data recovery rate (%)
Mast 1	50 m	2.6	2.1	81

Source: Garrad Hassan America Inc.

2.2.2 Wind Data Analysis and Results

In the assessment of the wind regime at a potential wind farm site, data recorded at the site were correlated with data recorded at nearby long-term reference meteorological stations. This allowed the estimate of the long-term wind regime at the site to be representative of a longer historical period. When selecting an appropriate meteorological station for this purpose it is important that it should have good exposure and that data are consistent over the measurement period being considered.

An extensive review of the ground-based meteorological stations and other sources of long-term data surrounding the BMR Jamaica Wind site was undertaken in order to choose the most appropriate long-term reference for the energy assessment. Table 24 lists the appropriate data sets identified as potential sources of long-term reference data for the analysis and the location of each reference source.

Table 24: Reference Source Wind Data

Reference Station	Location relative to site	Begin date	End Date
Kingston	95km east	January 1996	April 2013
Montego Bay	65 km north	January 1996	April 2013
Negril	80km northwest	September 2001	June 2012
MERRA 18.0N 78.0W	35km west	January 2000	February 2013

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MERRA 18.5N 78.0W	70km northwest	January 2000	February 2013
MERRA 18.5N 77.3W	75km northeast	January 2000	February 2013
MERRA 18.0N 77.3W	40 km east	January 2000	February 2013
GL GH Virtual Met data	Mast location	March 2002	February 2013

Source: Garrad Hassan America Inc.

The summary results of the analysis on the BMR Jamaica Wind site are presented below:

1. Data recorded at MM 1 showed that the measured mean wind speed, representing 2.1 years of valid data, was found to be 7.6 m/s at 50 m height.
2. Valid data recorded at Mast 1 were correlated to the virtual met data (VMD) time series on a daily basis. This correlation was used to synthesize missing and historical wind speed data and to predict the long-term mean wind speed at Mast 1 at 50 m for the period from March 2002 to February 2013. By this method, the long-term annual mean wind speed at Mast 1 at 50 m is predicted to be 7.7 m/s. This value is noted to be 1.6% higher than the annual mean wind speed over the 2.1 years of records measured at the mast, indicating that the measured period was less windy than the period of data in the VMD.
3. Measured data recorded at Mast 1 were used to derive a boundary layer power law wind shear exponent. This shear estimate was used to extrapolate the long-term measurement height mean wind speed at the site mast to the proposed hub heights as shown in Table 25.

Table 25: Long-term Measurement at Mast 1

Mast/ Device	Measurement Height (m)	Long-term wind speed at measurement height (m/s)	Vertical shear exponent (α)	Long-term wind speed at 67m (m/s)	Long-term wind speed at 80m and 84m (m/s)
Mast 1	50	7.7	0.17	8.1	8.4/8.3

Source: Garrad Hassan America Inc.

The power law shear exponent for the site mast is considered to be reasonable given the site wind regime and ground cover. The uncertainty associated with assuming this value to be representative of the long term wind regime is considered in Section 2.2.3.

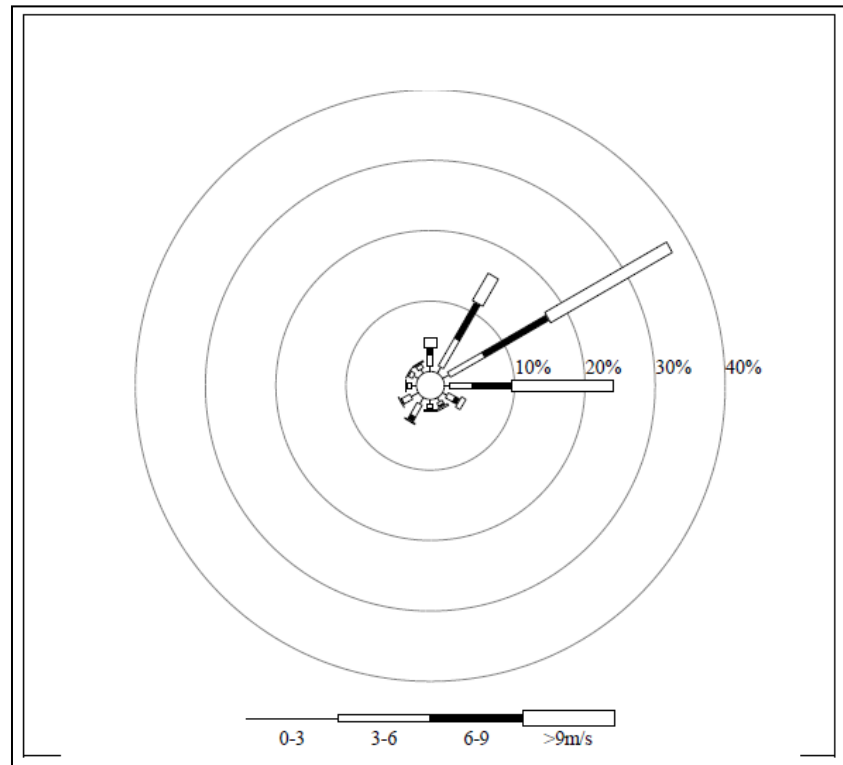
4. Hub height wind speed and direction frequency distributions at the site mast were derived by extrapolating the measured wind speed data on a ten-minute time series basis. The extrapolated wind speed data were combined with direction data recorded at the upper measurement height to create a wind speed and direction frequency distribution at each proposed hub height. The frequency

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distributions were then scaled to the predicted long-term wind speeds at the respective hub heights.

The Wind Farm computational model has been used to predict the effect of the existing Munro Wind Farm on the wind resource at Mast 1 on a directional basis. The overall wake effect was estimated to be 0.4%. Wake effects have been removed from the wind speed and direction frequency distributions at Mast 1 on a directional basis to predict the free-stream frequency distributions. The long-term unwaked wind speeds at Mast 1 were found to be 8.2 m/s at 67 m height, 8.4 m/s at 80 m height and 8.3 m/s at 84m height. The long-term free-stream wind speed and direction frequency distribution for Mast 1 at 80 m is shown as a wind rose in Figure 7.

Figure 7: Predicted long-term free stream annual wind rose at Mast 1 at 80m



Source: Garrad Hassan America Inc.

5. The variation in wind speed over the wind farm site has been initially predicted using the WAsP computational flow model. The wind flow model, initiated from Mast 1, has been used to predict the long-term wind regimes at the turbine locations. The predicted long-term wind speed for turbines with a hub height of 67m ranges between 7.9-8.1 m/s, while turbines with a hub height of 80-84m had long-term wind speeds ranging between 7.4-8.1 m/s and 8.2-8.5m/s respectively.

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The predicted long-term mean wind speeds averaged over all turbine locations for the proposed BMR Jamaica Wind project are noted to be 8.0 m/s for the 67 m hub height turbines, 7.7 m/s for the 80 m hub height turbines and 8.3 m/s for the 84m hub height turbines.

2.2.3 Uncertainty

The standard error associated with the predictions of the long-term mean wind speeds at the proposed hub heights are described in Table 26 below. It should be recognised that BMR may pursue additional wind studies, measurements, wind flow modelling and any other study necessary to further enhance the expected generation output of the site.

Table 26: Confidence Limits for Predictions

Probability of Exceedance (%)	Mean wind speed (m/s)	
	67m height	80m/84m height
99	7.3	7.5
95	7.6	7.8
90	7.7	7.9
75	7.9	8.1
50	8.2	8.3-8.4
Standard error (m/s)	0.37	0.40

Source: Garrad Hassan America Inc.

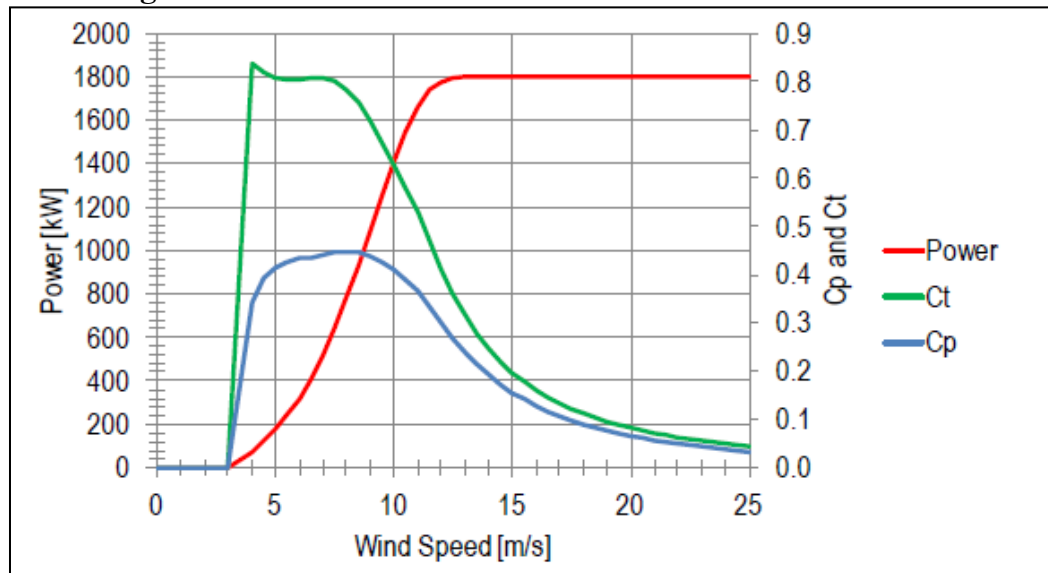
2.2.4 Performance and Wind Assessment of Turbines

1. Performance and Wind Assessment V90-1.8 MW

The wind performance data for the V90-1.8MW turbine is presented below in Figure 8.

Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm Project, Malvern St. Elizabeth, Jamaica

Figure 8: Performance data for the Vestas V90-1.8 MW turbine

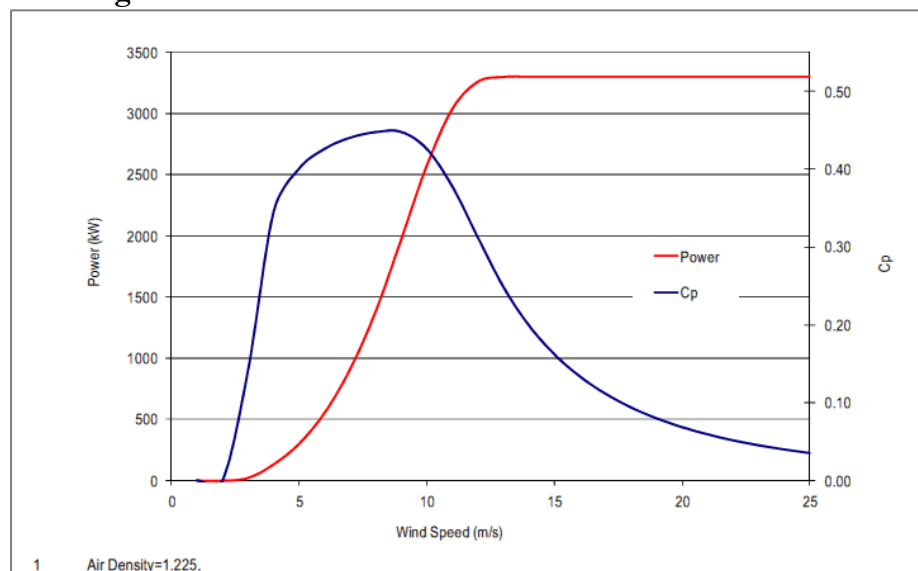


Source: Garrad Hassan America Inc.

2. Performance and Wind assessment V112-3.3MW

The forecasted capacity factor, an estimate by an independent wind study prepared by Garrad Hassan, for the V-112 layout, utilising eleven turbine positions is 34.2% at P50 probability. As with the eighteen (18) position layout, the capacity factor in both cases is determined by the variability of the wind resource. The turbines proposed in both cases have peak efficiency at wind speed of 8.0 m/s and above. The average wind speed at the site is 8.4 m/s. Figure 9 shows the performance data for the V112-3.3MW turbines.

Figure 9: Performance Data for the Vestas V112-3.3MW



Source: Garrad Hassan America Inc.

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2.3 Civil Works

Site preparation activities e.g. electrical works, construction of turbine foundations, erection of turbines etc., and the construction of access roads will be the main civil works executed at the site. Vestas has provided a site civil works guideline related to following:

- Y Road specification and design,
 - bearing capacity
 - subgrade,
 - pavement,
 - drainage system,
 - turning and lay-by areas
- Y Installation handstands
 - Blade unloading and preparation area
 - Nacelle lay down and preparation area
 - Main crane pad
- Y Lattice crane assembly/disassembly area
- Y Site compound

2.4 Transportation of turbines

Special arrangements will be made with the management of Port Esquivel for the offloading of wind turbines and associated equipment such as cranes. The equipment and turbines will be brought to the Port, where all components of the V80-2.0MW and V90-1.8MW will be offloaded and then transported to the project site. For the V112-3.0MW all components, except the turbine blades, will be brought into Port Esquivel and then transported to the project site. The blades for the V112s will be offloaded unto barges and transported to Port Kaiser then transported to the project site.

The transportation route from Port Esquivel to the project site is approximately 35km and extends across the parishes of Clarendon, Manchester and St. Elizabeth. The equipment and turbines will be transported on the Port Esquivel Road leading from Port Esquivel to the Highway (A2) connection at Freetown in the parish of Clarendon. The turbines will be transported through four roundabouts along the Highway in the parishes of Clarendon and Manchester, before being moved down Spur Tree Hill into the parish of St. Elizabeth. The equipment will be transported along the Sea Air Main Road, the Kinkead- Junction Main Road, the Bull Savannah Main Road and the Main Road Leading to Malvern.

The V112 blades will be transported a total distance of approximately 30km from Port Kaiser to the project site. The blades will be transported from the Port Kaiser access road to the New Forest Main Road then unto the Kinkead Junction Road, before being moved up the main road leading to Malvern.

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The routes to be used are the main routes used by public traffic. The transportation of wind turbines and associated components will take place primarily between 10:00 p.m. and 4:30 a.m. to prevent potential conflicts with other road users. The closure of roadways will be necessary in some instances during the transportation undertaking. The Police, JPS and members of the EPC contractor's team will accompany the trucks during the movement of the turbines from the Ports to the project site.

During the transportation of the turbines and associated components, several alterations will need to be made along the transportation route. This will include the construction of temporary roads (unpaved), road widening, lifting of electricity and cable wires, relocation and removal of electricity poles, limestone, vegetation and signage removal and possible alterations to private properties. No major buildings were observed along the route that will need to be demolished.

The detailed transportation plan for the movement of the turbines is in ***Annex 1*** to this report.

2.5 Project Schedule

The construction phase of the project is to be completed over 378 days. The construction phase is proposed to start in June 2014 and end in June 2015. Construction activities will be undertaken in phases and are outlined in Figure 10.

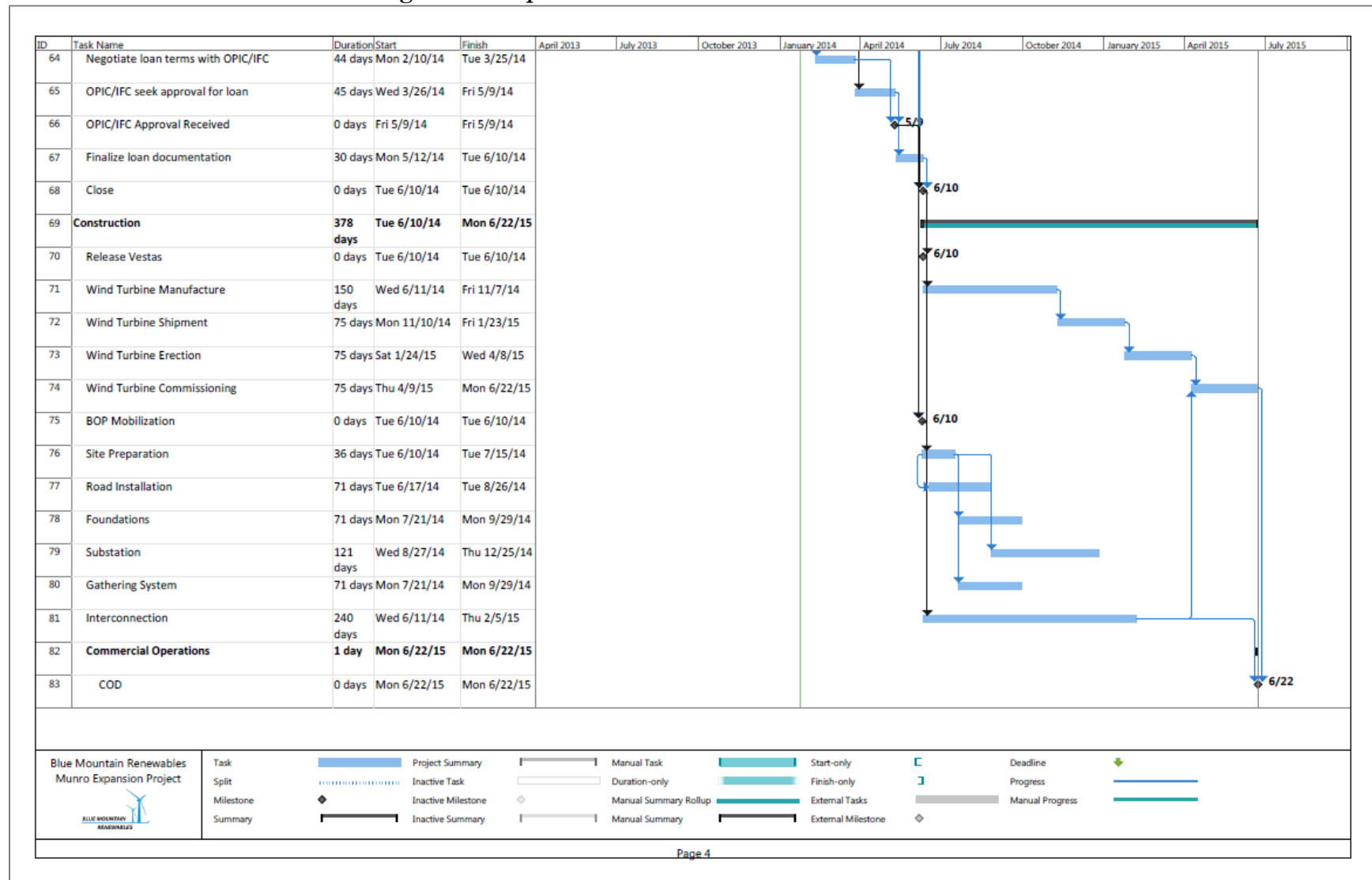
2.6 Decommissioning

The lifespan of the wind turbines is 25 years. At the end of their useful life, the existing turbines will be decommissioned and then re-commissioned using modern technology. During decommissioning the substation will not be taken out of service.

Skilled contractors will be used to dismantle the wind turbines and where necessary useful parts will be re-used for the newly commissioned turbines. Other parts may be returned to the manufacturer of the turbines, sold and/or given away as scrap where suitable. Any remaining components will be disposed of at an approved disposal site in accordance with environmental procedures and local legislation.

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Figure 10: Proposed Construction Schedule for Wind Farm



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3.0 Legal and Policy Framework

This section on the regulatory framework highlights the policies, legislation and standards that are applicable to renewable energy projects.

3.1 Applicable Policies

The national policies applicable to this project are the National Energy Policy and the National Renewable Energy Policy. The National Energy Policy was approved by Cabinet in October 2009. The National Renewable Energy Policy is still awaiting Cabinet approval.

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 two of which relate 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:

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

Another goal of the National Energy Policy relevant to the proposed project is Goal 4, which is outlined below.

Goal 4: Jamaica's energy supply is secure and sufficient to support long-term economic and social development and environmental sustainability".

Under this goal, Jamaica will seek to reduce the percentage of petroleum in the country's energy supply mix from the current 95% in order to protect the country from disruptions in oil supply and price volatility. The National Renewable Energy Policy will effectively contribute to fuel diversification to achieve this goal.

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

The National Renewable Energy Policy (2009-2030)

The policy seeks to provide affordable and accessible energy supplies with long-term energy security. The primary focus is the deployment of wind, the emerging potential and deployment of biomass and biofuels, the development of energy-from-waste initiatives, exploratory work on ocean energy and the deployment of other technologies such as solar and hydro-technologies.

There are five (5) goals of the National Renewable Energy Policy and these are as follows:

Goal 1: Support the economic, infrastructural and planning conditions conducive to the sustainable development of all of Jamaica's renewable energy resources

Goal 2: Create an enabling environment that facilitates the introduction of key policy instruments (financial and fiscal) for the promotion of renewable energy (by re-directing national resources and investments to Renewable Energy Technologies (RET)

Goal 3: Develop a dynamic legislative and regulatory environment, responsive to growth and development in the renewable energy sector

Goal 4: Enhance technical capacity and public awareness of renewable energy through effective support of training programmes, information dissemination strategies and ongoing government communication

Goal 5: Sustained Research and Development (R&D) and innovation in existing and emerging RETs

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The 2009-2030 National Renewable Energy Policy' primary objective is the achievement of Goal 3 of the National Energy Policy 2009-2030 which will be used to guide the development and introduction of specific measures to achieve the targets outlined for renewable energy (generation capacity) in the National Energy Policy (**Table 27**).

Table 27: Renewable Energy Targets

Indicator	2009	2012	2015	2030
Percentage of renewables in energy mix	9%	11%	12.5%	20%
Percentage of diversification of energy supply	9%	11%	33%	70%

The Ministry of Science, Technology, Energy & Mining has since reviewed the target for increasing the percentage of renewable sources in the energy supply mix from 20% in 2030 to 30% in 2030. Currently the percentage of renewable sources in the energy supply mix is 8% (which includes biomass); 3% lower than the target of 11% by 2012. The OUR issued RFP for the provision of 115MW of electricity generating capacity from renewable sources is intended to increase the existing renewable energy mix to 12.5% by 2015. Renewable energy as a percentage of Net Electricity Generation in 2013 was 5.8% and this figure only accounts for wind and hydropower renewable sources.

3.2 Applicable Legislation

The legislation applicable to this project include:

- Electric Lighting Act, 1890
- The Office of Utilities Regulation Act, 1995
- The Natural Resources Conservation Authority 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
- The Wildlife Protection Act, 1945
- Flood Water Control Act, 1958

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.

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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.

BMR Jamaica Wind Ltd. will have to apply to the OUR for a licence to operate the wind farm with generating capacity of 34 MW that they propose to construct in Malvern St. Elizabeth, Jamaica.

The Natural Resources Conservation Authority 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.

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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 will comprise a wind farm with a generation capacity of 34 MW in Malvern, St. Elizabeth, Jamaica, a permit will be required from NEPA. Several other permits will be required for other works associated with the wind farm construction such as:

1. Felling of trees and clearing of land of 10 hectares or more
2. Clearing cutting of forested areas and clearing of trees on land of 3 hectares and over on slopes greater than 25°
3. Pipelines and conveyors, including underground cables, gas lines and other such infrastructure with a diameter or more than 10 cm, for the transport of gas, oil or chemicals
4. Construction of new highways, construction of arterial roads, construction of new roads on slopes greater than 20°, major road improvements projects, including construction of a road of four or more lanes or realignment or widening of an existing road into four lanes where such road realignment or widening would be 10 km or more in continuous length

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 a wind farm, 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. This Act will also apply to solid waste generated from decommissioning activities.

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

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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.

The alteration of parochial roads and other road works will require approval from the Parish Council. Permission for the on-site sewage system will also be sought from the Parish Council.

The Wildlife Protection Act, 1945

The Wildlife Protection Act (1945) makes provision with respect to the management of wildlife, including fish, in Jamaica.

The Act makes provision for the protection of animals and birds and the protection of fish. Other provisions deal with the appointment of officers, regulations, power to enter lands, power of search, arrest without warrant, persons found offending, penalty for assaulting game warden, fishery inspector or constable, penalty for offences generally, jurisdiction over offences committed at sea, power to exempt from provisions of the Act, and forfeiture of things seized.

The Act specifies Game Sanctuaries and deals with hunting, etc. in a Game Sanctuary, prohibits the hunting of protected animals and protected birds, prohibits the hunting of animals and birds in and taking of eggs from the exclusive economic zone without a licence. Taking or killing of immature fish is declared an offence, and the use of explosives or other noxious materials in fishing is prohibited. It seeks to protect waters containing fish from trade effluents and industrial waste. Every person who knowingly buys sells or has in his possession fish taken, killed or injured in contravention of the provisions of this Act or of any associated regulations shall be guilty of an offence against this Act.

The Wildlife Protection Act and Regulations are administered by the National Environment and Planning Agency.

Flood Water Control Act, 1958

The Flood Water Control Act is administered by the National Works Agency. Any proponent of works being undertaken that could alter the drainage within the proposed

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location of the works will be required to prepare and submit a drainage plan for approval by the National Works Agency.

3.3 Recommended Standards

Noise levels

The Jamaica National Noise Standards in Table 28 (as extracted from the Recommendations for National Noise Standards for Jamaica, 1999) recommends zonal limits for noise. If any wind turbine was to be located near to a residential area or institution such as a school, these noise limits would apply. Based on the final design of the wind farm, it is not expected that the wind turbines will have an adverse impact on residences or schools.

Table 28: Time Based Zonal Noise Limits Zone

	7a.m. to 10:00p.m.	10:00p.m. to 7:00a.m.
Industrial	75dBA	70dBA
Commercial	65dBA	60dBA
Residential	55dBA	50dBA
Silence	45dBA	40dBA

4.0 Environmental Baseline

4.1 Climate

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 26.2°C (79.2°F), with an average maximum of 30.3°C (86.5°F) and an average minimum of 22.0°C (71.6°F). 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 11.0°C (20°F) in mountainous areas of the interior. Night-time values range from 18.9 to 25.6°C (66 to 78.1°F) in coastal areas. At elevations above 610 metres (2,000 feet), minimum temperatures of the order of 10°C (50°F) have been reported occasionally when active cold fronts reach the island.

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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-north-easterly wind and along the south coast, an east-south easterly 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 north westerly 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

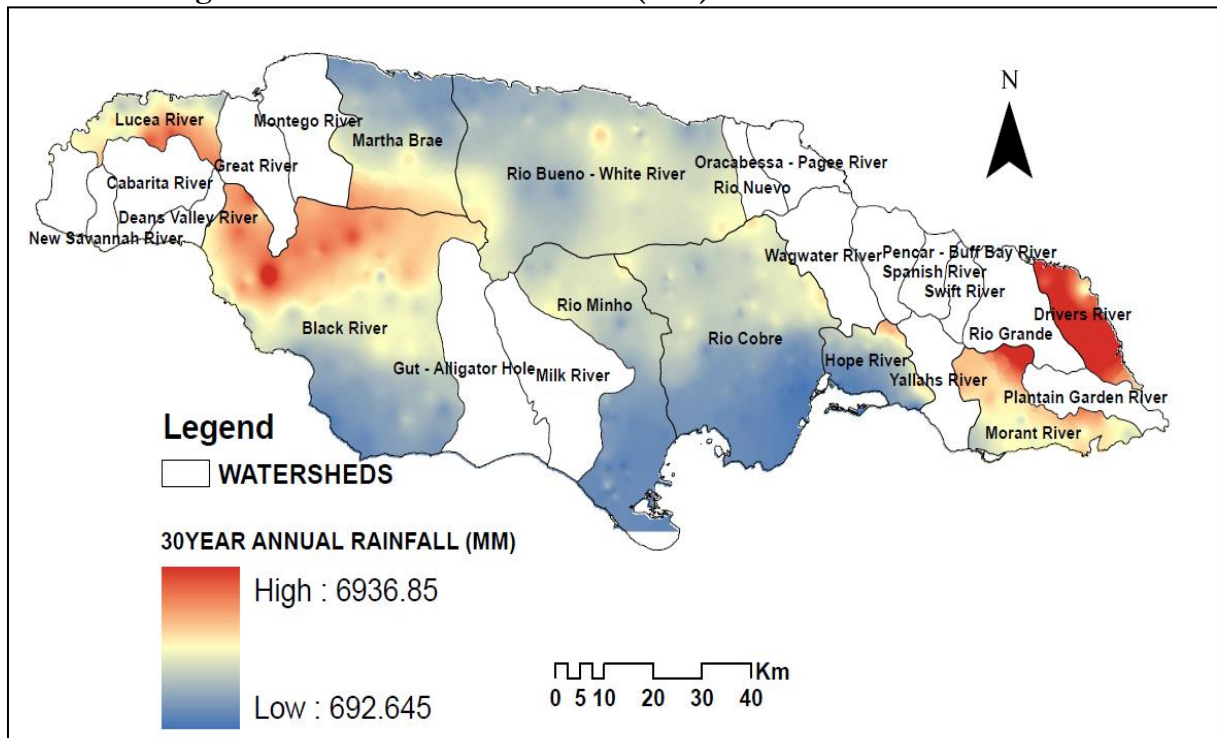
An examination of weather parameters for the island highlight that rainfall is the most variable. Rainy seasons are May to June and September to November. The rainfall is regionally very different in its intensity but show a likely annual distribution. Rainfall is comparatively higher from April to November 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.

The Tropical storm and hurricane season is from June to November.

Figure 11 shows that the parishes with the highest rainfall are eastern Portland and northern St. Elizabeth. The proposed project site is in an area of low rainfall.

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Figure 11: 30 Year Annual Rainfall (mm) Data for Watersheds



Source: Mona Geoinformatics Limited, UWI Mona 2012

4.2 Natural Hazards

Earthquakes

Earthquakes occur periodically in Jamaica and can be quite severe. Ninety-two (92) earthquakes have been recorded in Jamaica between January 1, 1973 and January 28, 2014 (Figure 12). In addition to the destruction of buildings, earthquakes can trigger landslides on steep slopes and cause hillside roads to fail. Dams and other protective flood barriers can also become destabilised following an earthquake event. The vast majority of Jamaica's earthquakes (source) have been confined to the eastern section of the island. St. Thomas, Portland and Kingston have experienced the most earthquake activity, with the Blue Mountains and John Crow mountains experiencing more frequent earthquake events. 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 is quite scarce.

Figure 12 shows that 92 earthquakes occurred as follows:

- After 1973-01-01 00:00:00
- Before 2014-01-28 00:00:00
- Magnitude \geq M1.0
- Magnitude \leq M8.0
- North of 17.600°N

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- South of 18.600°N
- East of 78.500°W
- West of 76.000°W
- Deeper than 0.0km
- Shallower than 800.0km

Seismicity

Jamaica is rated as Zone 3 in accordance with the Recommended Lateral Force Requirements of the Structural Engineering Association of California (SEAOC), having a horizontal seismic acceleration of 0.3 times gravity with a 10% probability of exceedance in 50 years.

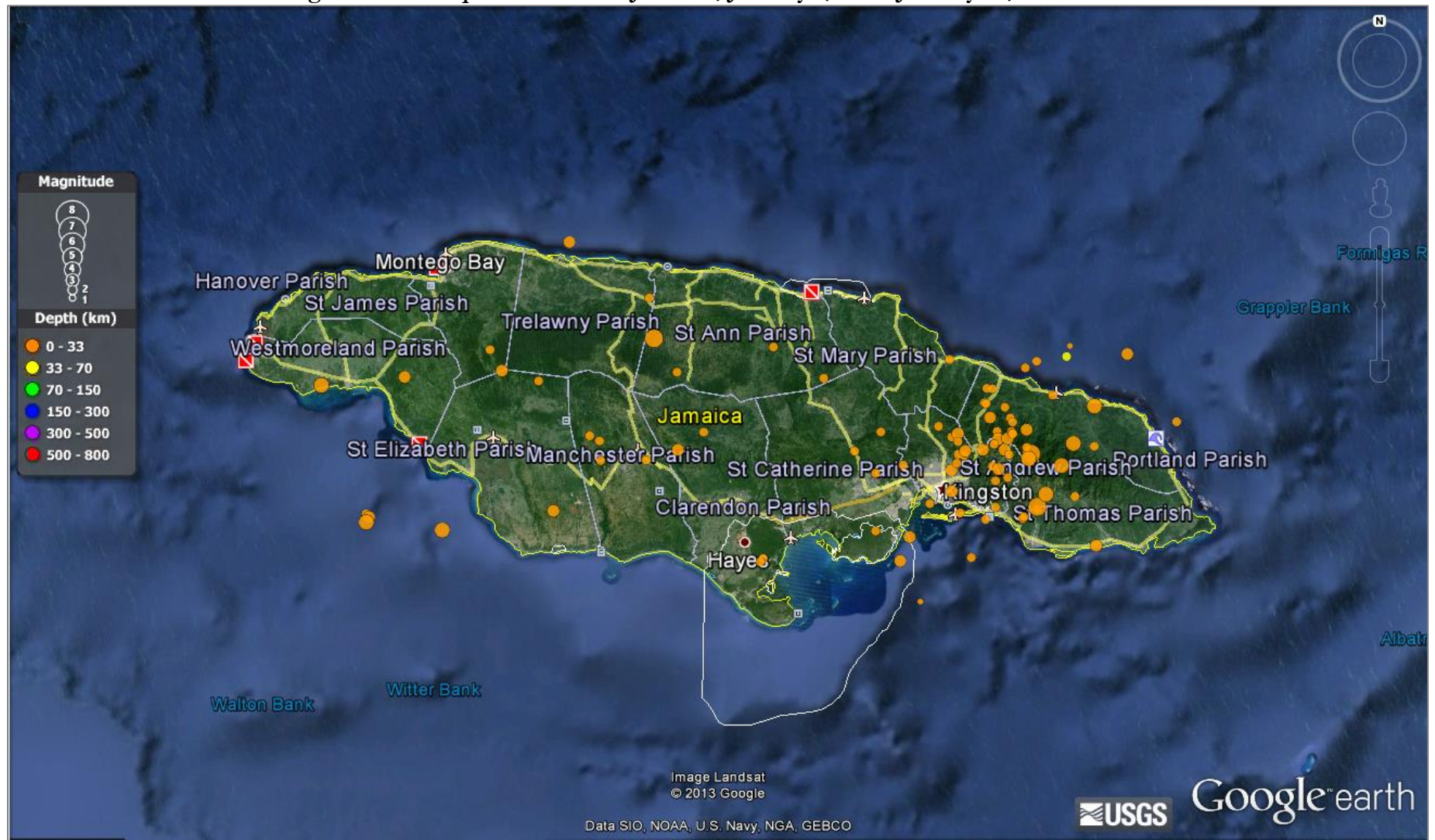
Hurricanes

Hurricanes are comparatively rare events that can have major impacts on the coastline. Their occurrence usually leads to widespread destruction of physical infrastructure, including roads, buildings and pipelines. Biological habitats are usually threatened by hurricane events, particularly in the coastal zone where storm surges rise up to 2-3 metres. Areas with dense vegetation cover are sometimes destroyed because of the impact of wind on plants. Hurricane Gilbert (1988), Hurricane Gustav (2008) and Hurricane Sandy (2012) have passed directly over the island. Ivan (2004), Iris (2001) and Dean (2007) passed just south of the island (Figure 13). The parishes of St. Elizabeth, Clarendon, Kingston and Manchester are the most susceptible to the impacts of hurricane events. Flooding (coastal), landslides, heavy rainfall are usually the main impacts felt in these parishes.

The principal hazards that could therefore affect the proposed wind farm include hurricanes and landslides.

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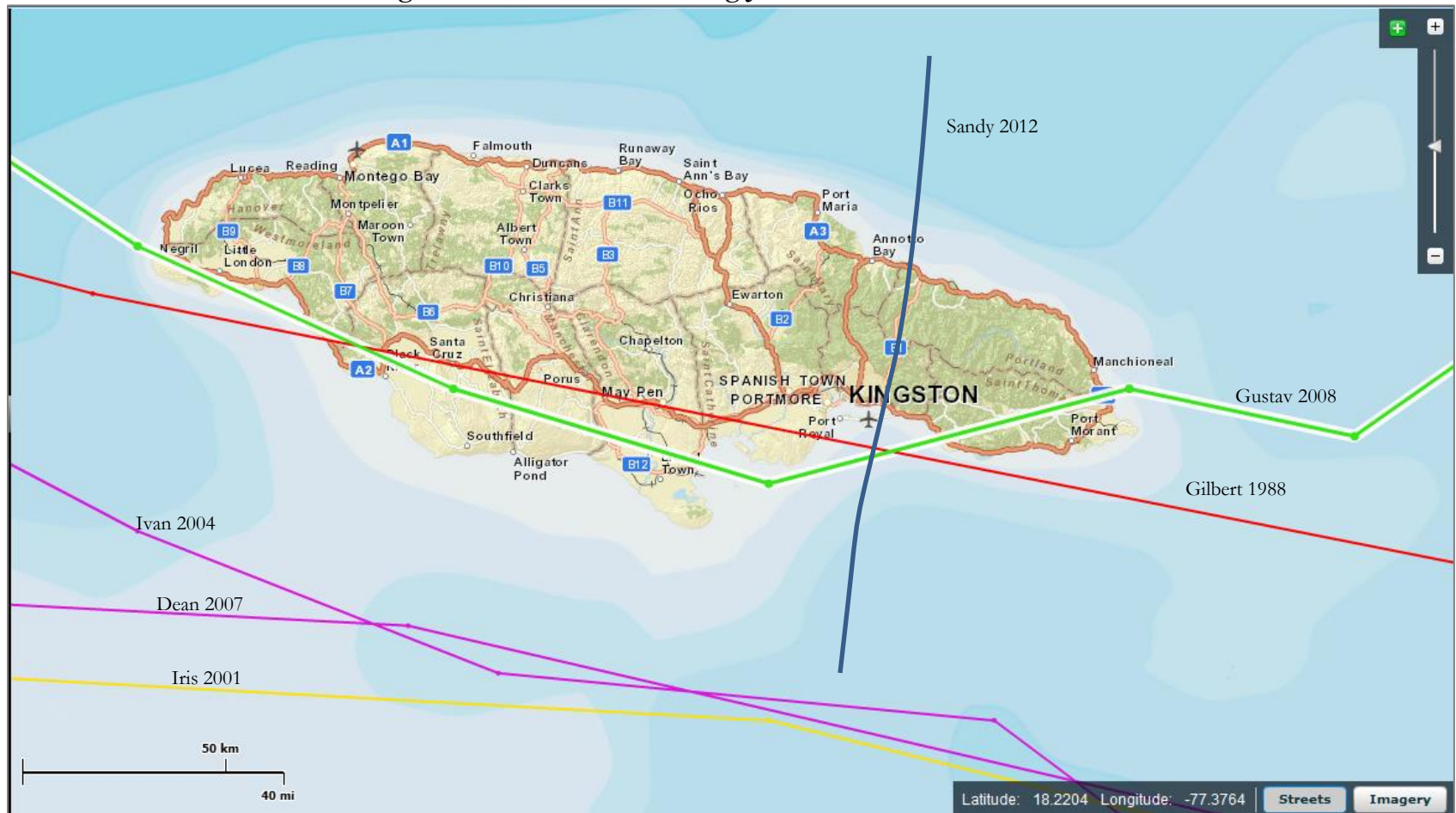
Figure 12: Earthquake Events in Jamaica, January 1, 1973- January 28, 2014



Source: <http://earthquake.usgs.gov/earthquakes/map/>

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Figure 13: Hurricanes Affecting Jamaica 1985-2013



Source: National Hurricane Center, 2013³

³ <http://maps.csc.noaa.gov/hurricanes/viewer.html>

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4.3 Physical Environment

4.3.1 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.

4.3.2 Geology

The Newport Formation (Mn) is extensive and generally accounts for much of the geological formations found in St. Elizabeth (Figure 14). 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 reflects the heterogeneity of formations found. The absence of the intersection of faults also indicates a greater general structural stability of the rocks in the area. It must however, be noted that where faulting exists, the rock fabric will tend to be micritic in nature and even recrystallized.

The Newport Limestone Formation is member of the White Limestone Group which accounts for much of Jamaica's renowned limestone coverage. The Group typically encompasses all limestones 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 1,400m and are deposited in a deep-water environment. Although some extents of the Newport Limestones are massive and dolomitized, none of those exist in the study area.

Alluvium (Qa) in the area exists as debris emanating from surface flow from the limestone scarps to the east of the morasses. These were laid in recent geological history and generally tend to range between the lowest unit of one metre (1m) to 25m thick.

Raised Morass (Qm) is largely peaty carboniferous fines periodically laid on the plains. These are also of recent Age and may be interspersed with alluvial sediments laid during a similar geological period.

The major fault indicated in Figure 14 attests to the presence of the Montpelier New Market Belt being separated from the Clarendon Block.

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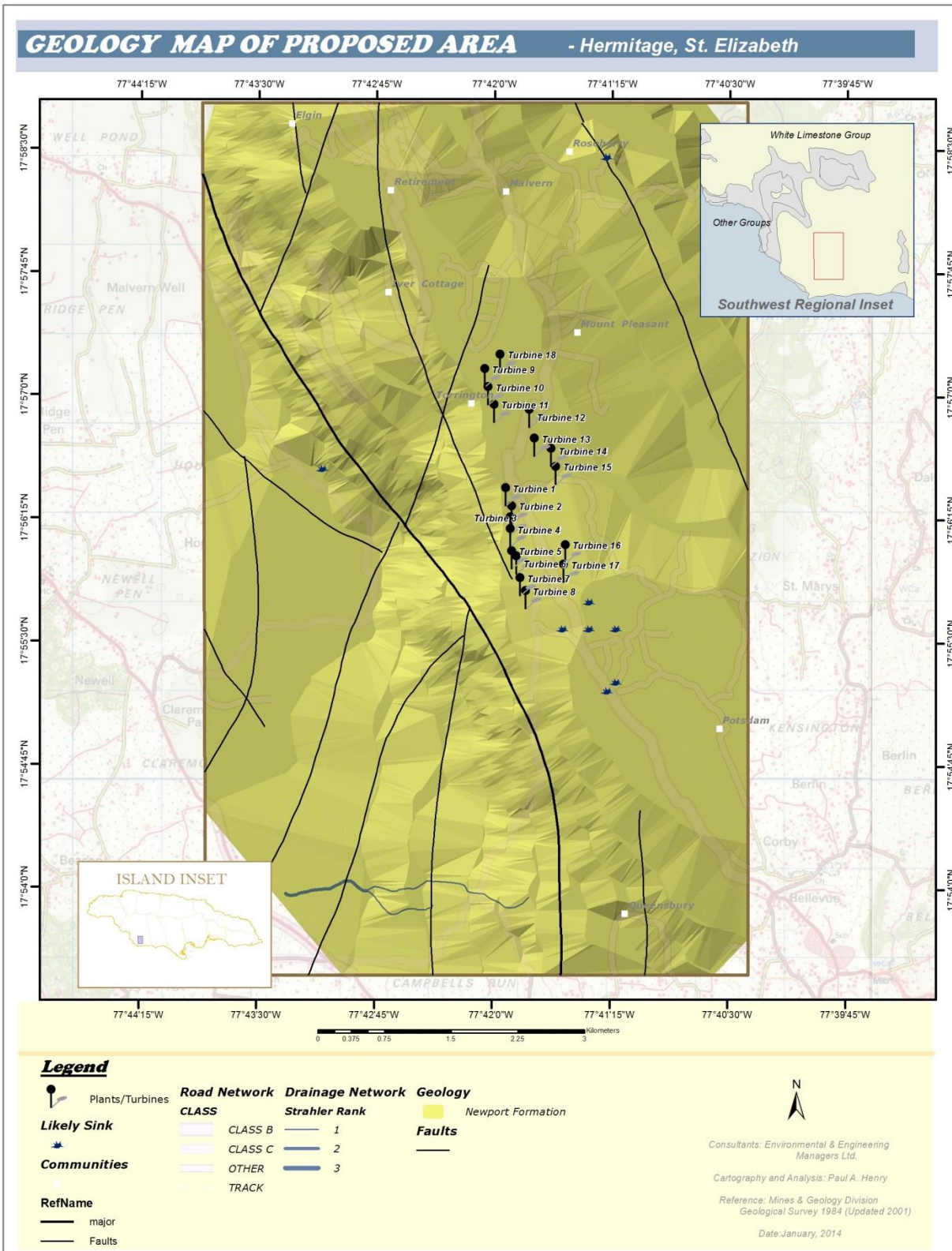
4.3.3 Pedology

The soil characteristics of the area are significantly influenced by the geology of the area and are primarily determined by the rate at which the rock will weather as well as the presence of biotic material. As a result there is much localised differentiation in soil types. Figure 15 shows the pedology of the proposed site for the wind farm.

Marked localisation is seen with loam textured soils being found exclusively on the planar lowlands. This could be as a result of a combination of the availability of surface water and biogenic factors. Additionally there is a small lens of unclassified soils found in a northwest-south east trending valley on the highland plateau. This notable spatial distribution again, could be as a result of soil infiltration rates being different in the valley reaches.

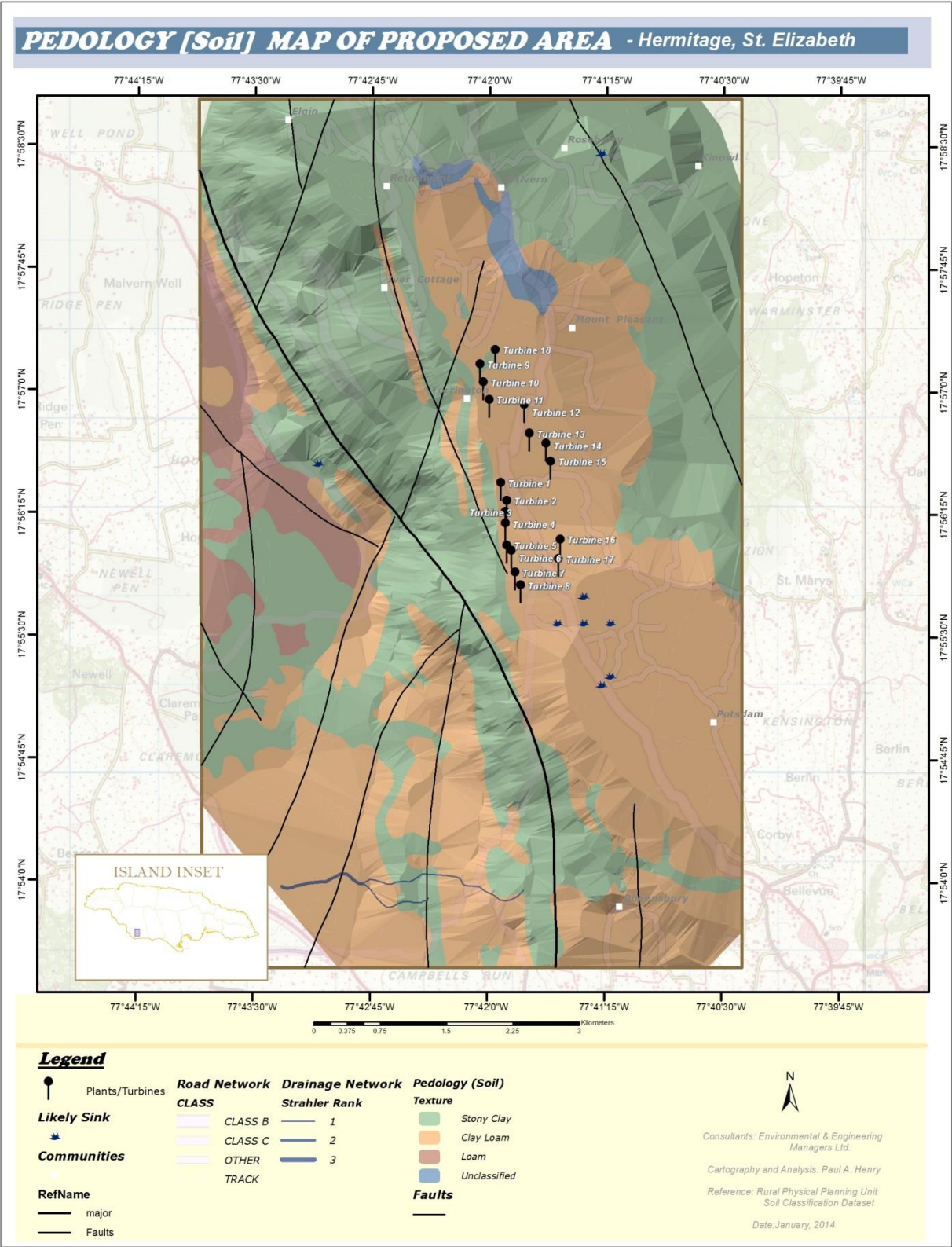
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Figure 14: Map showing Geology of Proposed Project Area



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Figure 15: Map Showing Pedology of Proposed Project Area



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4.3.4 Hydrology

A review of the hydrological profile of the study area is within the framework of the Black River Basin. This basin is found to receive approximately 1,850mm of precipitation annually which is distributed as overland flow and subsurface flow (ground water and soil water). Technical analyses of the spatial variables indicate that the basin spans a total extent of 1,640 km² with the stream network resulting in a total of 636km. This translates into a drainage density of approximately 0.4km of surface streams draining each 1km² of land surface.

These geomorphological parameters suggest that generally, this is a sparsely drained water basin given the low net-drainage density, when compared to the total volume of rainfall the basin would have intercepted during storm events. The low net drainage density indicates that water from the basin takes a longer time to reach surface water sources.

The area of interest as it relates to this watershed is effectively a catchment area forming a part of an unconfined limestone aquifer. This unconfined aquifer spans the Burnt Savannah lowlands/plains, through to the escarpment face immediately east of Mountainside and on to the plateau-like highlands forming Malvern, Hermitage and other areas such as Newport.

The Newport Formation facilitates transmissivity of groundwater (percolation) due to secondary permeability. This stems from its pervious nature created by bedding planes (though a massive rock fabric), cracks and joints despite being non-porous in some assemblages.

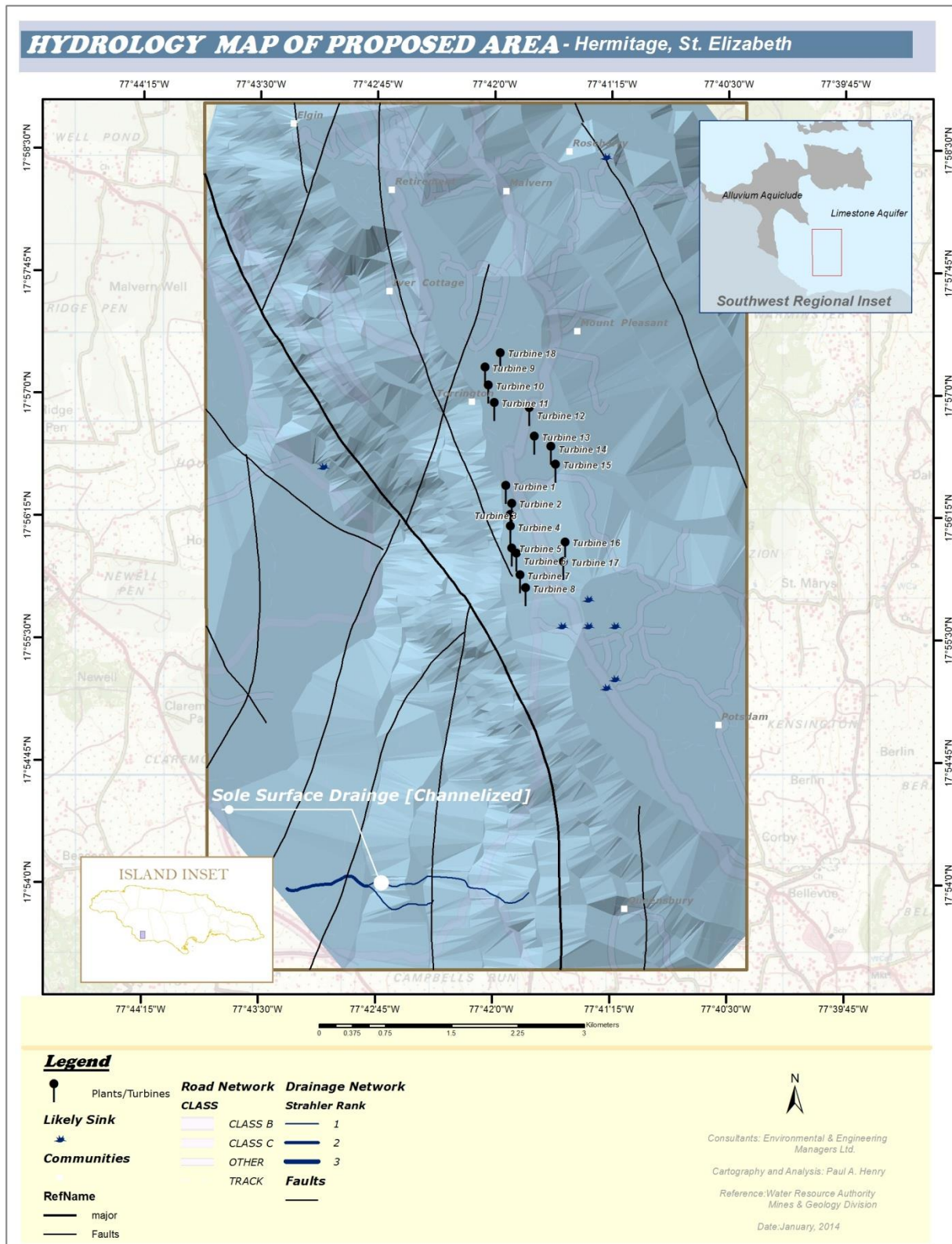
Precipitation from these highlands is initially transmitted via infiltration through the soil matrix and flows further downward under gravity through the intermediate zone where it reaches the permanent zone of saturation via percolation as ground water. This ultimately leads to the realisation of the specific yield of the aquifer in the lowland areas which can facilitate storage rather than transmission. This can be explained through:

- Y The general uniformity of the aquifer (Newport Formation) throughout the horizontal and vertical span of the aquifer
- Y The Darcy principle states [after Hubbert (1940), Chamberlin (1985) and King (1899)] that the flow will eventually become laminar when moving from areas of high topography to areas of low topography.
- Y The compaction of voids at the lowest depths of the aquifer due to the pressure of the rock mass above

The hydrology map (Figure 16) indicates the presence of wells to the west of the base escarpment. These are areas where the aquifer has realised specific yield (capacity to store water).

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Figure 16: Map Showing Hydrology of Proposed Project Area



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4.4 Noise Assessment

Baseline noise level readings were conducted on November 5th, 6th and 7th 2013 at several locations in the proposed project area.

Environmental Setting

The Malvern area is occupied mainly by residences, farm lands and schools. The noise levels in these areas are typically associated with existing wind turbines, vehicles for agricultural land use (e.g. tractors), school buses, animals and insects e.g. dogs, cows, birds, sprinklers on the farms, movement of the vegetation associated with the wind speed and direction. It is likely that during the day, noise levels are affected by the activities of the schools in the area.

Equipment

The readings were taken using a Quest Sound Level Meter 2100 model, a handheld meter with LCD display. The sound meter has two modes of operation. It measures sound pressure level (SPL) or maximum level (MAX), with a linear operating range of 32 to 140 dBA. The noise meter was calibrated using the Quest Model QC-10 acoustic calibrator. Both the handheld meter and its calibrator undergo annual calibration by the manufacturers, 3M. This was last completed in April 2013. Appendix 2 has the calibration certificate for the Sound Meter.

Methodology

Prior to commencing the exercise, reconnaissance of the area was done to try to identify the best access to the nearest location to the turbines. Sound level readings were done as close as possible to the proposed location of each turbine. Monitoring was done over a two (2) day period as follows.

- In the morning between 6:30 and 10:30 a.m.
- In the afternoon between 5:30 and 9:30 p.m.

Where possible, two readings were taken at each location and the average used as the baseline reading. Activities within the areas were noted while conducting the monitoring.

Results

Table 29 shows the proposed turbine locations and the associated actual locations where noise readings were taken.

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Table 29: Proposed Turbine Locations and their associated Noise Monitoring Sites

Turbine No.	Proposed Turbine Locations		Associated Noise Monitoring Sites	
	Longitude	Latitude	Longitude	Latitude
1	17°56'22.58"N	77°41'51.56"W	17°56'22.30"N	77°41'51.80"W
2	17°56'17.33"N	77°41'50.80"W	17°56'15.40"N	77°41'50.90"W
3	17°56'12.09"N	77°41'50.58"W	17°56'13.50"N	77°41'45.20"W
4	17°56'06.86"N	77°41'50.54"W		
5	17°56'01.51"N	77°41'49.47"W		
6	17°55'56.09"N	77°41'48.68"W	17°55'56.00"N	77°41'48.40"W
7	17°55'50.78"N	77°41'47.48"W	17°55'49.90"N	77°41'46.10"W
8	17°55'45.53"N	77°41'46.27"W	17°55'45.00"N	77°41'44.60"W
9	17°57'06.51"N	77°41'57.90"W	17°56'56.30"N	77°41'44.60"W
10	17°57'00.43"N	77°41'57.77"W	17°56'56.30"N	77°41'44.60"W
11	17°56'54.26"N	77°41'57.47"W	17°56'48.50"N	77°42'04.50"W
12	17°56'49.81"N	77°41'45.58"W	17°56'49.50"N	77°41'47.80"W
13	17°56'43.83"N	77°41'38.77"W	17°56'41.80"N	77°41'47.40"W
14	17°56'36.65"N	77°41'33.50"W	17°56'36.40"N	77°41'31.10"W
15	17°56'30.22"N	77°41'32.99"W	17°56'29.40"N	77°41'32.90"W
16	17°56'03.21"N	77°41'29.93"W	17°56'08.60"N	77°41'32.20"W
17	17°55'56.58"N	77°41'29.66"W	17°55'56.30"N	77°41'29.80"W
18	17°55'50.08"N	77°41'29.53"W	17°55'50.20"N	77°41'31.90"W

Figure 17 shows the Google Map image of these locations and highlights the proximity of the noise monitoring sites to the proposed turbine locations.

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Figure 17: Proposed Turbine Locations and Actual Noise Monitoring sites



Source: Google Map modified by EEM, 2013

Efforts were made to take two (2) sets of readings at each location one between the hours of 6:30 a.m. and 10:30 a.m. and another between the hours of 5:30 p.m. and 9:30 p.m. However, it rained on one of the afternoons reserved for taking noise level readings. The readings were therefore taken in the morning hours on the following day. Table 30 shows

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the average SPL and MAX readings for each of the two readings for each monitoring site. It also shows the overall SPL and MAX readings for each monitoring site.

The same monitoring site was used for Turbines #9 and #10 due to their close proximity to each other and lack of adequate access to these sites. There were no readings for Turbines #4 and #5 since these locations were not accessible. Based on the location of Turbine #4 midway between Turbines #3 and #6 and the similar land use for both sites, the average of the readings for both locations were taken and reported as average readings for Turbine #4. Based on the proximity of Turbine #5 to Turbine #6 and the similar land use, the average readings for Turbine #6 were also reported as the average readings for Turbine #5.

Table 30: Average Noise Level Readings for each Proposed Turbine Location

Turbine No.	First Reading			Second Reading			Average	
	Date & Time	SPL	MAX	Date & Time	SPL	MAX	SPL	MAX
1	6/11/13 8:41 AM	43.20	68.30	7/11/13 7:36 AM	30.80	39.80	37.0	54.1
2	6/11/13 8:51 AM	45.75	59.40	7/11/13 9:33 AM	31.40	32.90	38.6	46.2
3	7/11/13 9:29 AM	32.60	37.80	Not Applicable	-	-	32.6	37.8
4	Not Applicable	31.53	36.90	Not Applicable	33.15	37.90	32.3	37.4
5	Not Applicable	30.45	36.00	Not Applicable	33.15	37.90	31.8	37.0
6	7/11/13 6:51 AM	30.45	36.00	7/11/13 9:13 AM	33.15	37.90	31.8	37.0
7	7/11/13 6:44 AM	31.75	38.90	7/11/13 9:07 AM	33.95	38.80	32.9	38.9
8	7/11/13 6:38 AM	32.10	37.30	7/11/13 9:20 AM	33.85	37.90	33.0	37.6
9	5/11/13 5:54 PM	40.90	49.40	6/11/13 6:51 AM	36.55	49.30	38.7	49.4
10	5/11/13 5:54 PM	40.90	49.40	6/11/13 6:51 AM	36.55	49.30	38.7	49.4
11	6/11/13 7:18 AM	34.30	45.50	Not Applicable	-	-	34.3	45.5
12	7/11/13 8:21 AM	32.25	41.60	Not Applicable	-	-	32.3	41.6
13	5/11/13 6:03 PM	46.55	57.40	6/11/13 7:00 AM	38.90	41.30	42.7	49.4
14	6/11/13 7:43 AM	34.10	41.40	7/11/13 8:33 AM	35.10	49.60	34.6	45.5
15	5/11/13 6:15 PM	38.70	48.80	6/11/13 7:34 AM	37.15	47.00	37.9	47.9
16	5/11/13 6:22 PM	42.25	52.60	7/11/13 8:50 AM	33.85	45.70	38.1	49.2
17	6/11/13 9:25 AM	36.60	43.50	7/11/13 7:20 AM	31.40	34.20	34.0	38.9
18	6/11/13 9:31 AM	33.30	39.00	7/11/13 7:15 AM	31.55	43.20	32.4	41.1

There is only one set of readings for Turbine #11 as the location was not revisited due to the unsafe access to the best monitoring location. There is one set of readings each for Turbines #3 and #12. These locations were first identified on the final morning of sampling due to the inability to take measurements on the previous evening due to inclement weather.

All individual SPL readings were in the 30 – 47 dBA range while the overall average SPL readings were in the 31 – 43 dBA range. All individual MAX readings were in the 32 – 68 dBA range while the overall average MAX readings were in the 37 – 54 dBA range. The highest SPL readings were recorded at the proposed location for Turbine #13. The highest MAX readings were recorded at the proposed location for Turbine #1.

The monitoring site for Turbine #1 was almost in the exact location for the proposed location for Turbine #1 and is sandwiched by the nearby road and a farm. In addition, the

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location is in close proximity to the existing JPS/Munro Turbine #3. The higher MAX readings obtained at this location may have been due to the noise levels associated with the surrounding nearby activities (motor vehicles, turbines and farming activities).

The monitoring site for Turbine #13 was in an elevated section of a pasture which had a lot of trees and tall grass. It was very windy when measurements were being taken and despite the use of the windscreen to prevent measurement errors caused by wind blowing across the microphone, the noise levels were elevated due to the movement of the surrounding vegetation caused by the wind.

It should be noted that most MAX readings were taken without any of the existing intermittent disturbances in each area. These include vehicular traffic and animal sounds e.g. cows and dogs. For reference it should be noted that at monitoring sites #9 and #10, the MAX readings recorded was 62.1dBA with the passage of a car on the nearby road and was 85.2dBA with the passage of a tractor on the nearby road.

See Appendix 5 for typical levels of environmental noise.

4.5 Biological Environment

The biological baseline studies conducted as part of the EIA included a flora and avifauna survey and a chiropteran survey. The surveys were conducted to assess the likely impact of the turbines on the existing biological community.

4.5.1 Flora and Avifauna (Birds)

A comprehensive description of the area's flora and fauna was done, with recommendations aimed at minimising contact with turbine blades as well as, ensuring the preservation and restoration of the ecological balance with respect to avifaunal (bird) composition.

1. Aim

Three (3) objectives of the assessment were recognised:

1. To determine the species composition (of birds) within the study area
2. To assess the impact of the proposed turbine and access road construction on the bird composition and population
3. Suggest mitigation measures to reduce or eliminate negative effects.

2. Methodology

A. Avifaunal Census

Y 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

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point is selected and then all bird contacts (seen and/or 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:

- Greater concentration on the birds and habitats without having to watch where you walk (Bibby et. al. 1998).
- More time available to identify contacts (Bibby et. al. 1998)
- Greater opportunity to identify cryptic and skulking species (Bibby et. al. 1998)
- 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 factors which can affect both census techniques used.

- Time of Day – the best time for conducting a census is in the morning from sunrise until about 10am in the lowlands. It is recognised that as the day continues it gets hotter and the ability to detect birds decreases due to lack of movement. (Wunderle 1994). This survey was done between 6:30 a.m. and 11:00 a.m.
- 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 non-breeding season, when birds are less vocal. (Wunderle 1994).
- Weather – wind, rain, fog or if the day is too hot, affect a census (Wunderle 1994).
- Summer Counts versus Winter Counts – the counts conducted within the area were done within the middle of the winter period, therefore incorporating both residents and migrant birds, however such habitats are known to be utilised by summer migrants, and these winter counts may not incorporate these birds, as well as summer residents which may have left the location.

B. Other Faunal Surveys

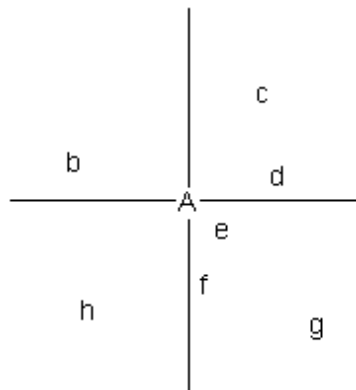
Other faunal surveys were done, through direct observation of species within a randomly selected area with a focus on insects (terrestrial), gastropods and any other mammals and/or rodents. The use of burrows, nests and tracks were also included to ensure a complete assessment of all the fauna.

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C. Vegetation Assessment

For tree assessment, a Point-Centred Quarter (P.C.Q.) Method was used.

The PCQ is perhaps the most popular of the plotless sampling techniques. Each sample is taken at a random location in the area to be sampled. This is frequently done by choosing random points along a transect but any randomisation technique may be used. The area near each random point (sample point) is divided into four imaginary quadrants as indicated below. Within each quadrant, the distance from the random point to centre of the nearest individual is measured. There are four quadrants, so a total of four trees will be measured at each sample point. In the diagram below, point A represents a random point (sample point) and the letters b through h represent trees. The distance from A to the centre of b, d, e, and h would be measured. For each individual (b, d, e, and h), the species name and its basal area or area of coverage are also recorded. The basal area is the area of a cross section of the stem. (Sampling Trees Using the Point-Centred Quartered Method, <http://faculty.clintoncc.suny.edu/faculty/michael.gregory/files/BIO%20206/206%20Laboratory/Point-Quarter%20Method/point-quarter%20instructions.htm>)



In addition vegetation descriptions were done from (randomly) selected points, including any forest or vegetation patch (Sampling Trees using the Point- Centred Quartered Method.

<http://faculty.clintoncc.suny.edu/faculty/michael.gregory/files/BIO%20206/206%20Laboratory/Point-Quarter%20Method/point-quarter%20instructions.htm>).

Lists of tree and plant species inclusive of plant life forms, endemics and native plants were generated.

3. Site Description

The area proposed for construction of all wind turbines can be characterised as follows:

Large areas dominated by grass and/or agricultural crops, with forest patches occurring in an enclosed fashion around the proposed turbine sites. Therefore an

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accurate description of all sites would be 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 cows) and cash crops generally but not limited to sweet potato and carrots.

For ease of description and the proposed alignment of the turbines, there were four (4) main groupings (Refer to **Figure 18**):

Group 1: consists of Turbines 1 – 8. (Figure 19 and Figure 20)

All proposed turbines would be bordered by forest patches to the north and south with the southern patch much larger and contiguous than the northern patch. The northern patch showed various levels of degradation. Significant secondary growth was observed. The ground cover in most places was 50%. Tree heights ranged from 5m – 7m and included species such as *Comocladia* sp., Logwood, Lead Tree and *Cocoloba* sp. Several shrubs were also observed including Rosemarie and Wild Sage.

The southern patch is much larger and heads downhill towards the Big Woods area. This forest/woodland site had similar tree species to those in the northern patch, however there were visibly larger trees and trunk diameters. There was a noticeable decrease in ambient temperature due to a more closed canopy. Ground cover was estimated at approximately 60%. Tree heights ranged from 5m – 9m.

The area between both patches was dominated by grass, several small farms with herbs and/or cash crops including carrots and sweet potato.

Group 2: consists of Turbines 9 – 11 (Figure 21 and Figure 22)

All proposed turbines would be bordered by a small forest patch to the south. The patch showed various levels of degradation. Significant secondary growth was observed. The ground cover in most places was 50%. Tree heights ranged from 5m – 9m and included species such as *Comocladia* sp., Logwood, Lead Tree and *Cocoloba* sp. Several shrubs were also observed including Rosemarie and Wild Sage. Also observed were small farm areas with cash crops such as carrots, sweet potatoes and ganja.

Group 3: consists of Turbines 12 – 15 (Figure 23)

The area is a composite of open area used primarily for grazing of cattle (i.e. pastureland) and secondary forest patch, which is large and contiguous in an east – west direction. It is noted that the proposed turbines would be evenly distributed on opposite sides of the patch. The patch showed levels of disturbance as coppiced trees were observed. Tree height ranged from 6m – 15m, with only a few emergent trees with height greater than 12m. Tree species observed included Fig, Sweetwood, Red Birch and Logwood. Other plant species included Wild Sage and Rosemarie. Ground cover within the patch was about 60%, while in the pastureland there was a

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mixture of grass and other herbs. Noted also was the practice of trees used as border planting between land parcels.

Group 4: consists of Turbines 16 – 18

All proposed turbines would be bordered by a fairly large and contiguous forest patch to the south. The patch showed some degradation with significant secondary growth observed. The ground cover in most places was 60%. Tree heights ranged from 5m – 10m and included species such as *Comocladia* sp., Logwood, Lead Tree and *Cocoloba* sp. Several shrubs were also observed including Rosemarie and Wild Sage. Also observed were small farm areas with cash crops such as carrots.

Table 31: Points where GPS readings were taken for assessment activity (faunal and/or floral monitoring)

<i>Type</i>	<i>ID #</i>	<i>Latitude</i>	<i>Longitude</i>	<i>Assessment</i>
WAYPOINT	316	17.94695816	-77.69899199	Fauna & Vegetation
WAYPOINT	317	17.94748941	-77.69988399	Fauna & Vegetation
WAYPOINT	318	17.94807857	-77.70063375	Fauna & Vegetation
WAYPOINT	319	17.94883026	-77.70024911	Fauna & Vegetation
WAYPOINT	320	17.94767657	-77.69509516	Fauna & Vegetation
WAYPOINT	321	17.94608946	-77.69463105	Fauna & Vegetation
WAYPOINT	322	17.94436555	-77.69436199	Fauna & Vegetation
WAYPOINT	323	17.94363532	-77.69198271	Fauna & Vegetation
WAYPOINT	324	17.94083225	-77.69383117	Fauna & Vegetation
WAYPOINT	310	17.93359657	-77.69720597	Fauna & Vegetation
WAYPOINT	311	17.93288008	-77.69727269	Fauna
WAYPOINT	312	17.93146932	-77.69659912	Fauna & Vegetation
WAYPOINT	313	17.92958373	-77.69609235	Fauna & Vegetation
WAYPOINT	314	17.93119323	-77.69423802	Fauna
WAYPOINT	315	17.93627283	-77.69559581	Fauna & Vegetation

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Figure 18: Showing Turbine Sites, Sites visited and Turbine Groupings for this report (Please note assessment points (in blue) overlaid at proposed turbine sites in Google Earth)



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Figure 19: Forest patch observed where Wind Turbines 1 – 8 are to be located



Figure 20: Forest patch observed where Wind Turbines 1 – 8 are to be located



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Figure 21: Edge of forest patch where Wind Turbines 9, 10 & 11 are proposed to be located



Figure 22: Edge of forest patch where Wind Turbines 9, 10 & 11 are proposed to be located



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Figure 23: Forest patch and open area where Wind Turbines 12, 13, 14 & 15 are proposed to be located



4.5.2 Results

The results of the flora and fauna survey are presented in the following Tables.

1. Faunal Assessment

Table 32: List of Observed Resident and Endemic Bird Species

No.	Common Name	Scientific Name	Status
1	Antillean Palm Swift	<i>Tachornis phoenicobia</i>	R
2	Jamaican Vireo	<i>Vireo modestus</i>	E
3	Jamaican Woodpecker	<i>Melanerpes radiolatus</i>	E
4	Jamaican Oriole	<i>Icterus leucopteryx</i>	ES
5	Red-Billed Streamertail	<i>Trochilus polytmus</i>	E
6	White Crowned Pigeon	<i>Patagioenas leucocephala</i>	R
7	Yellow-Faced Grassquit	<i>Tiaris olivacea</i>	R
8	White-Chinned Thrush	<i>Turdus aurantius</i>	E
9	Jamaican Euphonia	<i>Euphonia jamaica</i>	E
10	Red-Tailed Hawk	<i>Buteo jamaicensis</i>	R
11	Bananaquit	<i>Coereba flaveola</i>	ES
12	Vervain Hummingbird	<i>Mellisuga minima</i>	R
13	Orangequit	<i>Eunoernis campestris</i>	E
14	Yellow Shouldered Grassquit	<i>Loxipasser anoxanthus</i>	E
15	Greater Antillean Bullfinch	<i>Loxigilla violacea</i>	ES

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No.	Common Name	Scientific Name	Status
16	Olive Throated Parakeet	<i>Aratinga nana nana</i>	ES
17	Northern Potoo	<i>Nyctibius jamaicensis</i>	R
18	Loggerhead Kingbird	<i>Tyrannus caudifasciatus</i>	R
19	Sad Flycatcher	<i>Myiarchus barbirostris</i>	E
20	Mangrove Cuckoo	<i>Coccyzus minor</i>	R
21	Common Ground Dove	<i>Columbina passerina</i>	R
22	Northern Mockingbird	<i>Mimus polyglottos</i>	R
23	Smooth-Billed Ani	<i>Crotophaga ani</i>	R
24	Stolid Flycatcher	<i>Myiarchus stolidus</i>	R
25	Turkey Vulture	<i>Carthartes aura</i>	R
26	Black Faced Grassquit	<i>Tiaris bicolor</i>	R
27	Zenaida Dove	<i>Zenaida aurita</i>	R
28	Great Egret	<i>Ardea alba</i>	R
29	American Kestrel	<i>Falco sparverius</i>	R
30	Rufous Tailed Flycatcher	<i>Myiarchus validus</i>	E
31	Jamaican Tody	<i>Todus todus</i>	E
32	Common Yellowthroat	<i>Geothlypis trichas</i>	R

Key

Status: E – Endemic; ES – Endemic Sub-species; R – Resident; I – Introduced

Table 33: List of Observed Migratory Birds

No.	Common Name	Scientific Name	Summer/Winter
1	American Redstart	<i>Setophaga ruticilla</i>	Winter
2	Black-Throated Blue Warbler	<i>Dendroica caerulescens</i>	Winter
3	Prairie Warbler	<i>Dendroica discolor</i>	Winter
4	Palm Warbler	<i>Dendroica palmarum</i>	Winter
5	Ovenbird	<i>Seiurus aurocapillus</i>	Winter
6	Lincoln's Sparrow	<i>Melospiza lincolnii</i>	Winter
7	Northern Parula	<i>Parula Americana</i>	Winter

2. Vegetation Results

Table 34: Tree Species Observed

No.	Scientific Name	Common Name	Status	DAFOR Rating
1	<i>Allophylus cominia</i>	-	Native	R
2	-	Thatch Palm	Endemic	R
3	<i>Adeanthera pavonina</i>	Red Bead Tree	Native	O
4	<i>Guazuma ulmifolia</i>	Bastard Cedar	Native	F
5	<i>Cupania glabra</i>	Wild Ackee	Native	O
6	<i>Ficus Americana</i>	Jamaican Cherry Fig	Native	R
7	<i>Ficus membranacea</i>	Fig	Native	R

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No.	Scientific Name	Common Name	Status	DAFOR Rating
8	<i>Haematoxylum campechianum</i>	Logwood	Native	D
9	<i>Samanea saman</i>	Guango	Introduced	F
10	<i>Psidium guajava</i>	Guava	Native	A
11	<i>Magnifera indica</i>	Mango	Introduced	R
12	<i>Comocladia pinnatifolia</i>	Maiden Plum	Native	O
13	<i>Zanthoxylum martinicense</i>	Prickly Yellow	Native	O
14	<i>Bursera simarouba</i>	Red Birch	Native	R
15	<i>Coccoloba</i> sp.	Wild Grape	Native	R
16	<i>Cecropia peltata</i>	Trumpet Tree	Native	O
17	<i>Ceiba pentandra</i>	Cotton	Native	O
18	<i>Bauhinia divaricata</i>	Bull Hoof	Native	O
19	<i>Senna bicapsularis</i>	Yellow Candle Wood	Native	O
20	<i>Nectandra coriacea</i>	Small-leaved Sweetwood	Native	F
21	<i>Acacia</i> spp		Native	O
22	<i>Bambusa vulgaris</i>	Bamboo	Introduced	O
23	<i>Gliricidia sepium</i>	Quick Stick	Introduced	O
24	<i>Leucaena leucocephala</i>	Lead tree	Native	O
25	<i>Matayba apetala</i>	Cobywood	Native	O
26	<i>Clusia flava</i>	Tarpot	Native	O
27	<i>Crescentia cujete</i>	Calabash	Native	O
28	<i>Spathodea campanulata</i>	African Tulip Tree	Native	O

DAFOR: D – Dominant; A – Abundant; F – Frequent; O – Often; R – Rare

Table 35: Shrubs/Herbs Observed

No.	Scientific Name	Common Name	DAFOR Rating
1.	Black-eyed Susan	<i>Thunbergia alata</i>	A
2.	Blue Pea Vine	<i>Clitoria ternatum</i>	O
3.	Bougainvillea	<i>Bougainvillea</i> spp.	O
4.	Button Weed	<i>Borreria laevis</i>	A
5.	Chainy Root	<i>Smilax balbisiana</i>	O
6.	God Okra	<i>Hylocerus triangularis</i>	F
7.	Mistletoe	<i>Oryctanthus occidentalis</i>	R
8.	Jamaican Marigold	<i>Wedelia trilobata</i>	F
9.	Leaf of Life	<i>Bryophyllum pinnatum</i>	O
10.	Maiden Hair Fern	<i>Adiantum pedatum</i>	F
11.	Moses in the bulrushes	<i>Rheo spathacea</i>	F
12.	Pepper Elder	<i>Peperomia pellucid</i>	O
13.	Red Head	<i>Asclepias curassavica</i>	R
14.	Rosemarie	<i>Croton linearis</i>	R

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No.	Scientific Name	Common Name	DAFOR Rating
15.	Shame-o-lady	<i>Mimosa pudica</i>	O
16.	<i>Sida</i> sp.		O
17.	Spanish Needle	<i>Bidens pilosa</i>	F
18.	Sweet Potato	<i>Ipomoea batatas</i>	O
19.	Susumber/Gully Bean	<i>Solanum torvum</i>	R
20.	Tank Bromeliad	<i>Tillandsia</i> sp.	O
21.	Wild sage	<i>Lantana camara</i>	F

DAFOR: D – Dominant; A – Abundant; F – Frequent; O – Often; R – Rare

Table 36: Trees Utilised by Observed Species

No.	Tree Species	Bird Species	Purpose / Use
1.	<i>Bursera simarouba</i>	Jamaican Euphonia, Jamaican Oriole, Yellow-shouldered Grassquit, Jamaican Vireo	Feeding
2.	<i>Cecropia peltata</i>	Orangequit, Jamaican Euphonia,	Feeding
3.	<i>Comocladia pinnatifolia</i>	White-crowned Pigeon	Feeding
4.	<i>Magnifera indica</i>	Hummingbirds e.g. Red-billed Streamertail	Nesting
5.	<i>Clusia flava</i>	Jamaican Euphonia	Feeding

Table 37: Butterfly Species Observed

No.	Common Name	Scientific Name	Status
1.	Zebra	<i>Heliconius charitonius simulator</i>	R
2.	Cloudless Sulphur	<i>Phoebis sennae</i>	R
3.	Julia	<i>Dryas iulia delila</i>	R
4.	Small sulphur	<i>Eurema lisa euterpe</i>	R
5.	Buckeye	<i>Junonia genovera</i>	R
6.	White Peacock	<i>Anartia jatrophae</i>	ES
7.	Tropical Fritillary	<i>Euptoicta hegesia hegesia</i>	R
8.	Jamaican Goatweed Butterfly	<i>Eurema lisa euterpe</i>	R
9.	Josephina	<i>Ascia josephina paramaryllis</i>	R

Status: E – Endemic; ES – Endemic Sub-species; R – Resident

3. Other Animals

1. Snail – (Family: Pulmonata) shell evidence observed and live animals seen during surveys
2. Dragonfly (2 species observed – Anisoptera)
3. Honey Bee – *Apis* sp.
4. Anoles – *Anolis lineatopus*

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5. Grasshopper – *Orphullela punctata*
6. Wasp (1 species – possibly *Sceliphron assimile* DAHLBOM)

4.5.3 Discussion

From the conducted survey thirty two (32) bird species were observed. This included ten (10) endemic species, none of which are currently on the endangered species list for Jamaica. Also observed were four (4) endemic sub species and eighteen (18) residents. Both winter migrants and summer residents were observed indicating the timeline as being transitional for Jamaican bird species population. Seven (7) migratory species were observed.

Twenty eight (28) tree species were observed within the area. These species formed forest patches which showed various levels of degradation 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 proposed wind turbines.

Another twenty one (21) species of shrubs/herbs were observed of which there were two (2) endemic species observed, the cactus *Hylocereus triangularis* and Mistletoe. All other observed species were native.

A total of nine (9) butterfly species were observed of which there was one endemic sub-species observed.

1. Bird Distribution and Habitat Usage

Birds observed in all surveyed areas were within forest patches with only four species observed using the open areas and/or flying between patches. The species were American Kestrel, Red-tailed Hawk, Great Egret, Antillean Palm Swift.

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

It appears that bird shooting occurs in some sections of the study area as evidenced by the spent cartridges observed near the proposed area for Turbines 6 and 7. It is therefore likely that the proposed project will impact on these activities in the future.

2. Potential Impacts of Proposed Wind Turbine Generator

The number of turbines to be installed is eighteen (18) and the effect based on proposed positions should be minimal. Habitat loss from turbine installations should be minimal as the areas are denuded of vegetation and grass or cash crops dominate the areas.

Things to consider:

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- i. Height and direction of the turbines which may be orthogonal to movement of resident species as well nocturnal and migratory species. Height should not be above 150m as this can cause an increase in bird deaths (CWS, 2006).
- ii. Motion smear due to the movement of the blades; the danger may not be recognised by bird species and adaptation may not occur (CWS, 2006).

3. Issues, Recommendations and Mitigation Measures

	Issues/ Recommendations	Mitigation Measures
1.	Slight adjustments in positioning should be considered for Turbines 3, 4, 5, 10 and 11, based on the proximity to the forest patches and the potential need to remove habitat to accommodate the establishment of the turbines. They should be positioned to more open areas to reduce the removal of forest/woodland.	Suggestion addressed through micro-siting of the turbines.
2.	Based on observations at the proposed area for Turbines 12 and 13, a pair of Red-Tailed Hawks was observed. They seemed to utilise the forest patch in the proximity of the area. The turbines can be either re-aligned further south (100 to 200 m) in an open area or removed from the matrix of proposed turbines.	Suggestion addressed through micro-siting of the turbines. Focus is on using turbines 1 to 11.
3.	Antillean Palm Swifts were observed in the area where Turbines 14 and 15 are proposed. In this case the turbine locations could be maintained since they are a migratory species and are likely to relocate if obstructed by the turbine operations.	Will remain as viable options although focus is on using turbines 1 to 11.
4.	A follow up study is recommended to determine the impact that the turbines have on birds which may traverse the area (especially for Turbines 12, 13, 14 and 15. This can be done at the end of 1 year after turbine installation and operation.	Focus is on using turbines 1 to 11. If these turbines are used, they will be included in the post construction monitoring programme
5.	A monitoring mechanism should be developed to implement mitigation measures to minimise bird-wind turbine interaction where possible and if necessary, for example, if the blade is found to be the cause of unexpected mortality there can be	The avifauna –turbine interaction will be monitored post construction and mitigation measures implemented if necessary.

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	Issues/ Recommendations	Mitigation Measures
	timed shut downs to reduce the collision level with certain bird species.	

4. Conclusion

Based on habitat quality, the use of open areas by local avifauna where the wind turbines are to be placed is low so the development should have a low impact on birds. Impact on vegetation is also expected be low as the area is degraded, there are minimal trees present, and turbines are to be placed at locations which are not in the observed forest patches. To reduce the impact on birds and vegetation slight adjustments to the location of some turbines were made especially where the proposed sites were close to forest patches.

4.5.4 Chiropteran (Bat) Survey

The chiropteran survey was conducted over two seasons: rainy and dry season. The first phase of the survey was done during the rainy months of October to December 2013, while the survey conducted during the dry season was carried out between January and February 2014. The behaviour demonstrated by bats typically differs according to the seasons. Investigations were therefore conducted over the two seasons to ensure that differences in species concentration, foraging and feeding behaviour could be carefully observed. A summary of the wet and dry season findings are presented in this EIA report.

1. Caves

According to studies conducted by Finchman (1997)⁴ on the presence of caves in Jamaica, six (6) caves were identified as being within 2km of the proposed wind turbine site. These six caves are listed in Table 38.

Table 38: List of Caves Identified in Malvern/Munro Area

	Name of Cave	Location	General Description	Bat Presence
1.	Blair's Cave	Munro College area	Depth: 3m Type: Dry passage – “A narrow vertical slot about 2m deep leads to a small chamber about one metre high heading north.”	<i>Very low likelihood that any appreciable number of bats will be found in such a small cave</i>
2.	Campus Cave	Munro College area	Length: 6m Type: Dry passage – “A low cave noted by McGrath. May be the same site as	<i>Very low likelihood that any appreciable number of bats will be found in such a small cave.</i>

⁴ Finchman, Alan. G (1997). Jamaica Underground: The Caves, Sinkholes and Underground Rivers of the Island. University of the West Indies, Kingston, Jamaica.

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	<i>Name of Cave</i>	<i>Location</i>	<i>General Description</i>	<i>Bat Presence</i>
			Munro's Cave or Blair's Cave'	
3.	Chelsea Cave	Munro College area	Length: 16m Type: Shelter cave- "A cave located west of Munro College".	<i>This is a potential roost – needs investigation.</i>
4.	Kinowl Cave	Malvern area	Length: 37m Type: Stream passage "East of Malvern on the road from Bethlehem Training College. Passage is up 10m wide".	<i>This is a potential roost – needs investigation.</i>
5.	Munro Cave	Munro College area	Length: 12m Type: Chamber cave – "A complex chamber cave with low narrow passages in the grounds of Munro College. May be blocked".	<i>Potential bat roost if it is not currently blocked.</i>
6.	Palm Tree Cave	Chelsea House area	Length: 18m Type: Chamber cave – "A chamber up to 8m wide".	<i>Probable bat roost.</i>
7.	Pearmans Bush Cave	Munro College area	"Site noted by McGrath. May be confused with other caves noted in the Munro College area"	<i>The cave may not exist.</i>

Source: JCO, 2013

Investigations into the presence of the six (6) caves revealed that some of the named caves are likely the same, which have been assigned different names. The following was observed with the conclusion of the investigations:

- Six (6) caves are listed in the second edition of Jamaica Underground, by Alan G. Fincham, but a close reading of the information suggests that some of them are duplicate entries. During the course of the fieldwork, two (2) cave sites were located, Kinowl Cave and Blair's Cave. Kinowl Cave is located approximately 4-5km east of the community of Malvern, while Blair's cave is located on the campus of the Munro College.
- The field investigation revealed that Campus Cave as listed by Finchman as one of the six caves in the Munro/Malvern area is actually a duplicate of Blair's Cave. Information gathered from residents in the field suggested that two other caves may exist within the project area, but these were not found. No other cave roosts in, or near the project area were located.

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2. Surveying Equipment and Instruments

The surveys were undertaken using the following equipment and instruments:

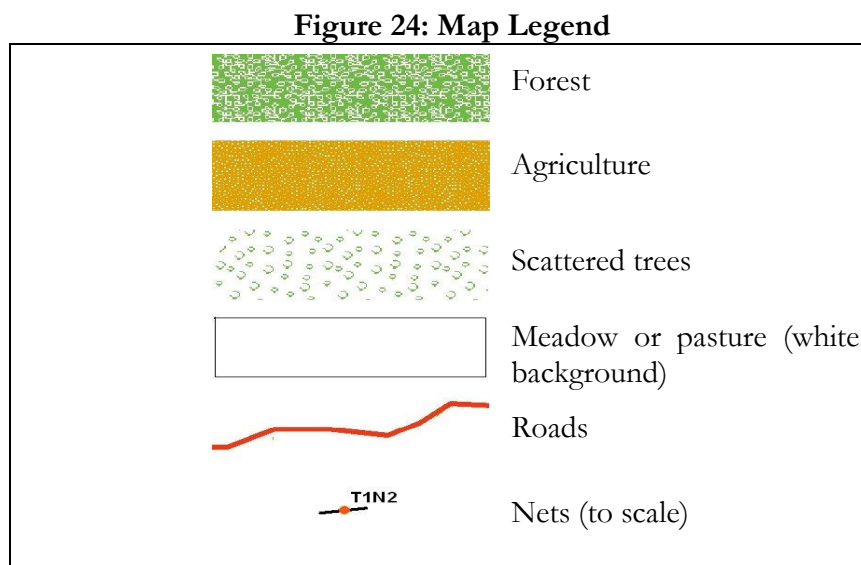
- Y Nets: Four nets in total were used, all with four tiers, and lengths of 4, 6, 6, and 9 metres.
- Y Acoustic detector: Pettersen D100.
- Y Lights: Surefire P2X Fury; Surefire 9P, led conversion; Petzl Ultra-wide; two DIY LED floods.
- Y Temperature and wind speed measuring equipment: Brunton Sherpa.
- Y GPS: Garmin GPSmap76CSx
- Y ArcGIS 9.3 with 3D Analyst software
- Y Caliper: SPL Dial 150mm
- Y Scale: Accu Weigh, model PL52500

3. Maps

The maps in this document were constructed with ArcGIS 9.3 using GPS data collected in the field, as well as inputs from the 1:50,000 digitized metric topographical maps, the Ikonos 6m DEM, and polygons for land-use created with Google Earth. Preliminary Garmin vector maps were created with GPS Map Edit to aid in site location and access.

Scale bars were not added, but the net lengths are accurate and were used instead. The orientation in all cases is true north up.

Figure 24 shows the map legend for all the maps presented in this section.



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4. Topographic Overview of Survey Locations

The proposed surveying sites were located within agricultural corridors surrounded by predominantly ruinate forest and meadow lands, with large trees across various sections of the landscape. A selected number of survey sites were located near the main road and cow pasture lands.

5. Methodology

Y Rainy Season

Three (3) nets were set up at each site (except for T7 where there was not enough room). Nets were opened beginning at sunset and remained opened for at least 4 hours (**Figure 25**). An acoustic detector was operated continuously (except for site T1), with varied frequency through the netting period. Visual observations were carried out intermittently with bright lights (up to 500 lumens), some beamed, and some wide-angled.

Lights used were not directly illuminated on the nets (Figure 26). This was done to prevent bats from likely seeing the nets, thereby preventing capture. This method was found to be particularly effective, as the lights attracted moths, which in turn resulted in increased bat activity around the nets. Only one of the bats captured was an insectivore, *Pteronotus parnellii*, but frugivores and nectivores will also feed on insects.

The nets were not opened during ‘true’ rain as tropical bats are prone to hypothermia if they are exposed to wet conditions for extended periods.

The maximum time between capture and release of bat species was thirty (30) minutes. In one instance, a small section of net was cut to release a badly entangled *Artibeus jamaicensis* that had reached the 30 minute point. Holding bags used in the capture of bats were cleansed between each netting session to prevent the spread of pathogens. No bag was reused during the course of any particular night.

Following several nights of observations, bats were seen flying close to the tree lines. They would make quick dashes into the open to catch a moth, and then return to the trees. To increase the likelihood of capture, nets were therefore located close to or perpendicular to forested areas.

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Figure 25: Mist Nets used to capture Bats



Figure 26: Lighting used at night



Y Dry Season

Three (3) mist nets were set up at each site. The nets which varied in lengths from 18 to 33 metres were opened at sunset and remained opened for at least four (4) hours. An acoustic detector was run continuously each night with the frequency varying throughout the netting period. Visual observations were carried out intermittently with bright lights (up to 500 lumens), some beamed and some wide-angled.

Lights used were not directly illuminated on the nets. This method was selected once again to prevent the bats from likely seeing the nets, thereby preventing capture. The method proved particularly effective, as the lights attracted moths, which in turn resulted in increased bat activity around the nets

Nets were erected perpendicular to and as close as possible to forested areas. The siting of the nets was based on observations made during the rainy season survey,

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where bats were observed staying close to the tree-line, whether flying through or foraging within those specific areas.

The maximum (average) time between capture and release of bat species was fifteen (15) minutes. Holding bags used in the capture of bats were cleansed between each netting session to prevent the spread of pathogens. No bag was reused during the course of any particular night.

6. Results (Wet Season)

Bats were found throughout the entire project area, but the rainy-season data suggest that distribution and foraging activities are not homogenous. A total of twenty-one (21) bats were captured and released during the survey, however the numbers observed visually and acoustically throughout the project site exceeded 100. The survey revealed that bat numbers, as well as foraging and fly-through activities were more concentrated at selected turbine locations. There were only two sites, T1 and T10, that no activities were observed.

Table 39: Wet Season Results of Bat Survey

<i>Turbine Location</i>	<i>Numbers detected acoustically</i>	<i>Numbers Observed Visually</i>	<i>Sighting Ratings</i>	<i>Numbers Captured</i>	<i>Behaviour</i>
T1	0	0	-	-	No Activity
T2	2	2	Low numbers	2	Foraging Flight path
T3	3	>2	Low numbers	3	Foraging
T4	4	>10	Frequent	0	Foraging (limited) Flight path (potential)
T5	4	>2	Low numbers	0	Foraging Fly through
T6	>3	>3	Frequent	3	Flight path Foraging
T7 (1 st)	>3	>3	Frequent	3	Flight path Foraging
T7 (2 nd)	>3	>3	Frequent	0	Foraging Fly through
T8	1	>8	Frequent	1	Foraging Flight path
T9	4	3	Low numbers	0	No foraging Fly throughs (occasional)
T10	0	0	-	-	No Activity
T11	2	2	Limited/low numbers	2	No foraging Fly throughs (occasional)

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<i>Turbine Location</i>	<i>Numbers detected aoustically</i>	<i>Numbers Observed Visually</i>	<i>Sighting Ratings</i>	<i>Numbers Captured</i>	<i>Behaviour</i>
T12	2	2	Limited/low numbers	3	No Foraging Fly throughs
T13	1	2	Limited	1	No foraging Fly-throughs
T14	3	1	Limited	0	Foraging (occasional) Fly throughs
T15 (1 st)	2	0	Limited	0	Fly throughs
T15 (2 nd)	2	1	Limited	1	Foraging (occasional) Fly throughs
T16	>10	>1	Frequent	0	Foraging Flight path
T17	1	3	Frequent	2	Foraging Fly throughs
T18	>10	>10	Very Frequent	0	

Source: Jamaica Caves Organisation, 2013

While five (5) bat species were identified, four (4) species were captured and released during the survey. These are identified in Figure 27.

The data presented in Figure 28 to Figure 30 shows the distribution of species and fly through and foraging activities by turbine location. The results showed specifically that total numbers, as well as foraging compared to fly-throughs are greater in the southwest. There is also a geographical variation in species make-up, with more *Artibeus* in the south, and more *Ariteus* in the central area.

Observations made across the project area revealed that there was a definite preference for forests and bushy fence-lines as flight paths and also as staging grounds for “hawking” attacks on flying moths by bat specie. The behaviour exhibited by the bats is likely due to predator avoidance. Additionally, three of the five species caught (*Artibeus jamaicensis*⁵, *Ariteus flavescens*⁶, and *Glossophaga soricina*⁷) are known to roost in tree hollows. The southwest side of the project area has more continuous forest and there was a correlation observed between the number of bat species and forest cover. In areas such as the southwest side, where forest cover was continuous and dense, a greater number of species were observed, compared to other areas where forest cover was predominantly sparse (Figure 31).

⁵ Jorge Ortega and Iva'n Castro-Arellano (2001) *Artibeus jamaicensis*. *Mammalian Species*, No. 662, pp. 1–9.

⁶ Richard E. Sherwin and William L Gannon (2005) *Ariteus flavescens*. *Mammalian Species*, No. 787, pp. 1–3.

⁷ Javier Alvarez, Michael R. Willig, J. Knox Jones, Jr., and Wm. David Webster (1991) *Glossophaga soricina*. *Mammalian Species*, No. 379: pp. 14.

Figure 27: Bat Species Captured and Released during Survey

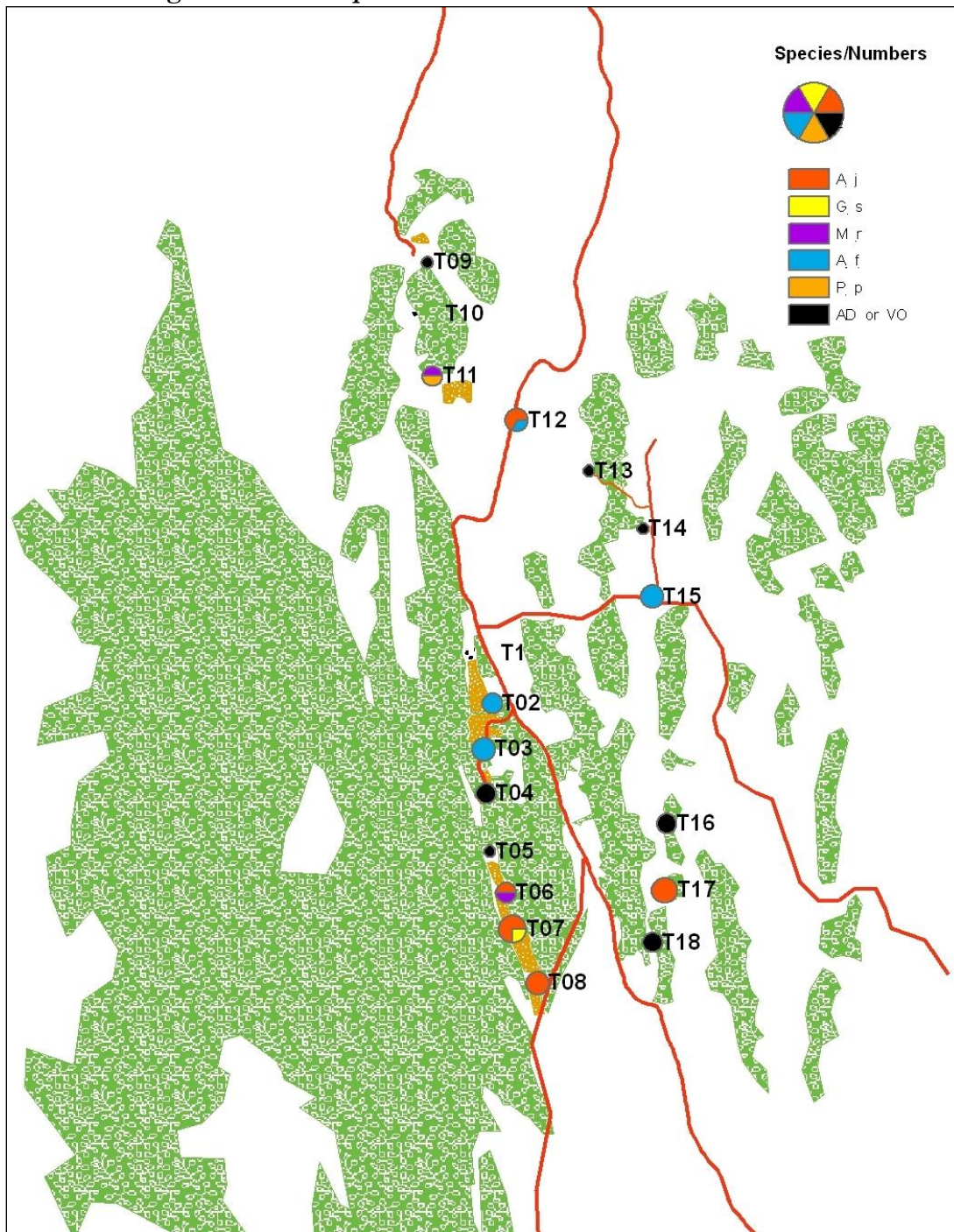


Source: Jamaica Caves organisation 2013

The behaviour of bats within forested areas was also reinforced by their foraging behaviour. Figure 30 shows that foraging activities were greatest within forested areas. Foraging information was recorded at each site, which included bat circling and the hawking of insects. The observed trends were plotted on a topographic map of the project area, which also highlighted a correlation between proximity to forest and foraging.

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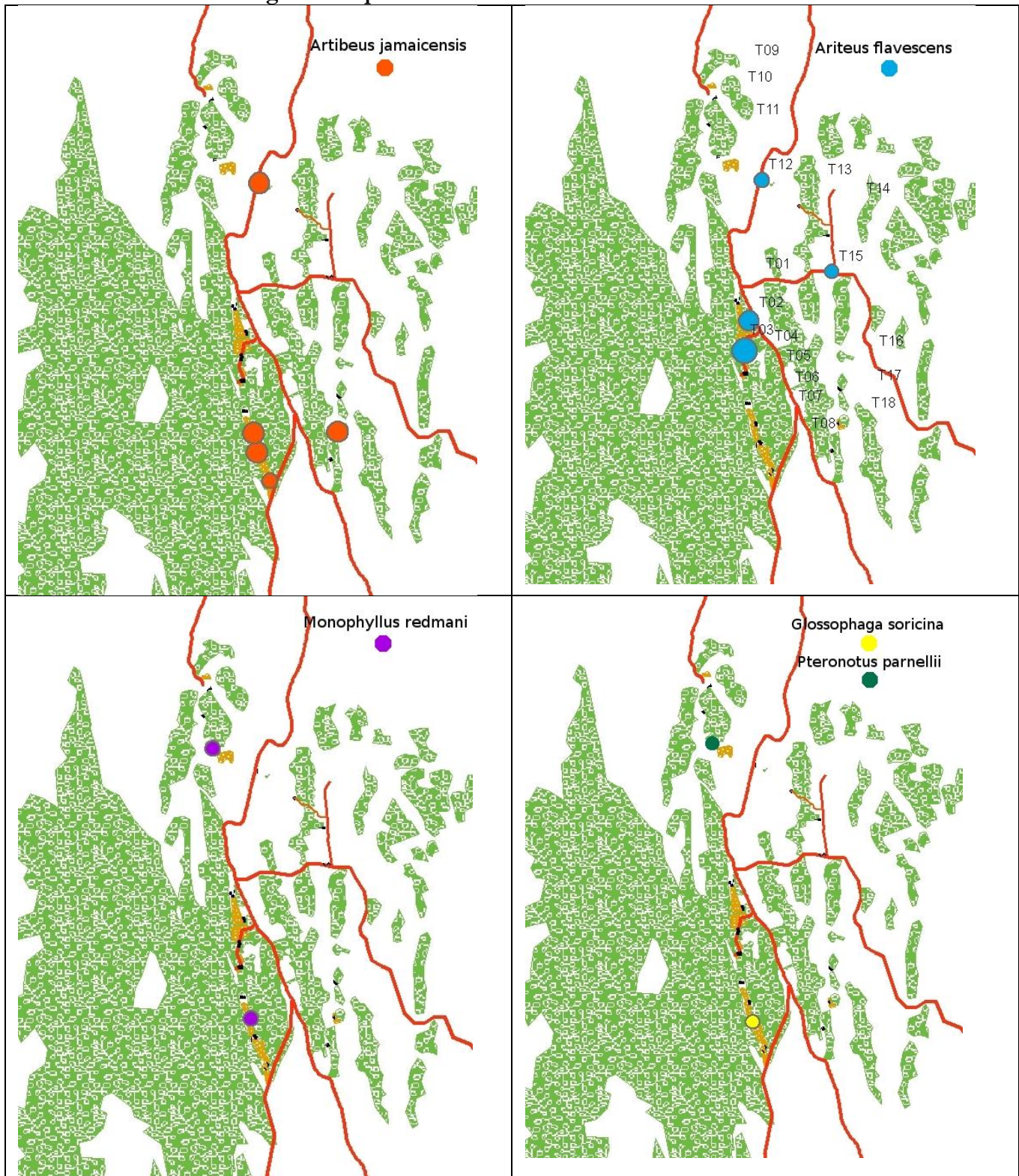
Figure 28: Total Specie Distribution at Turbine Locations



Source: Jamaica Caves Organisation, 2013

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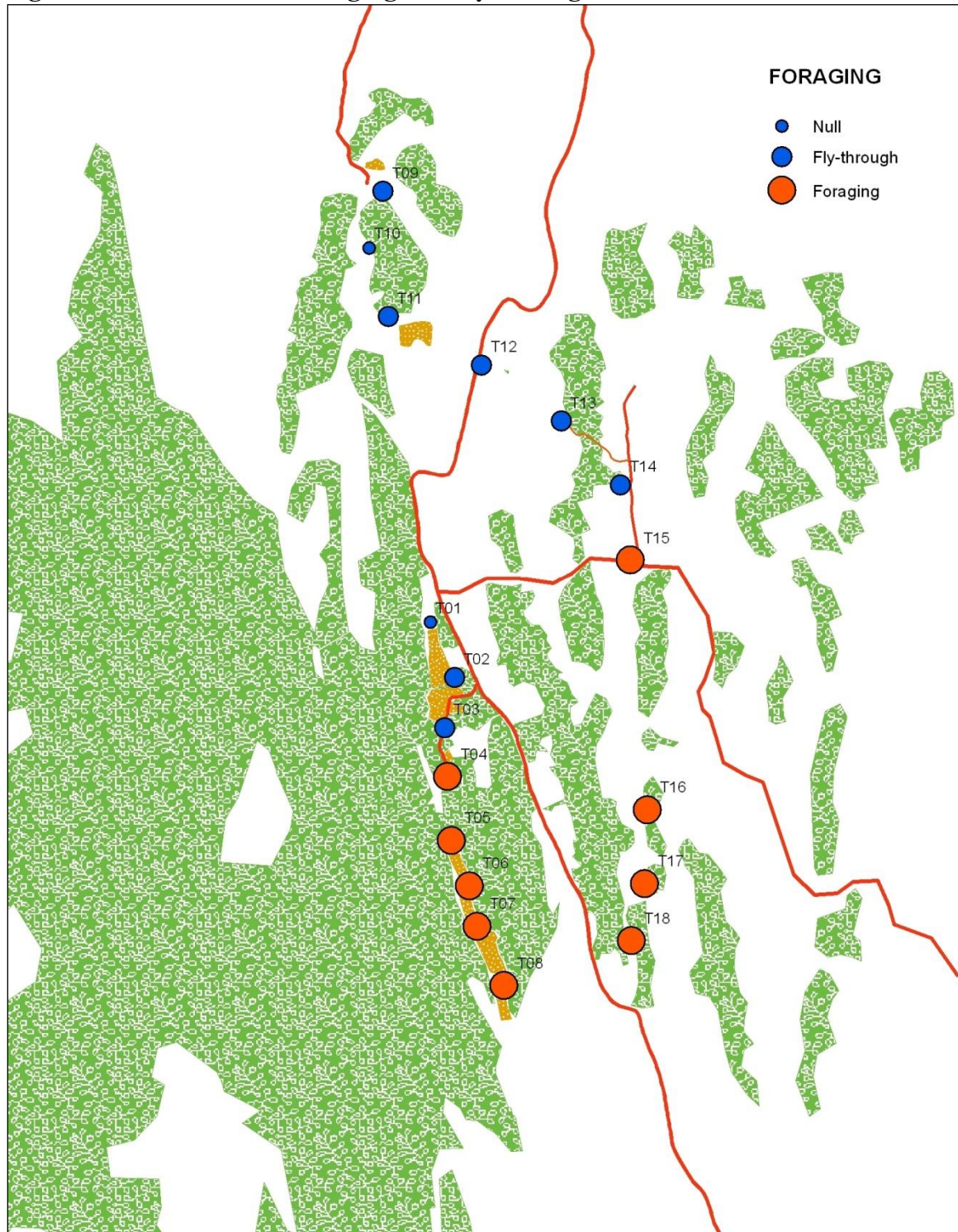
Figure 29: Species Distribution at Turbine Locations



Source: Jamaica Caves Organisation, 2013

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Figure 30: Distribution of Foraging and Fly-Through Activities at Turbine Locations



Source: Jamaica Caves Organisation, 2013

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Figure 31: View of Project Landscape and Forested Area



Source: Jamaica Caves Organisation, 2013

Predators:

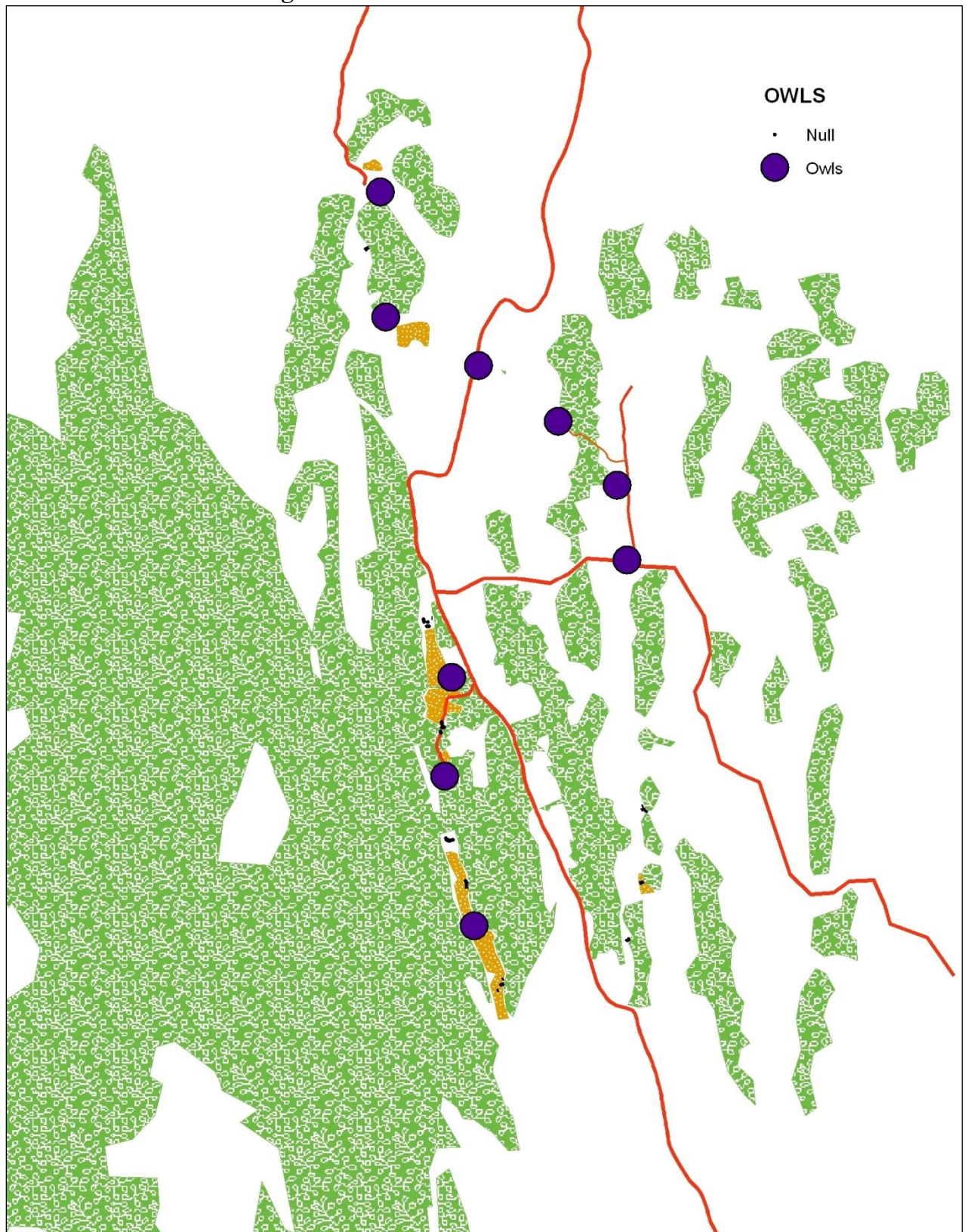
Barn Owls (*Tyto alba*) were widespread in the project area, but as with the bats, concentrated in certain sections. Every sighting was recorded while at the turbine sites, and as shown on Figure 32, there were fewer owls where there were more bats. Barn owls in the area are predating bats, having observed their behaviour at Site 11.

The large open meadows of the north-eastern sites allow easy foraging for owls, and little cover for bats to avoid it. Again, there is a strong correlation between bat numbers, foraging, and forest cover.

Micro-siting:

In some cases, it was noted during the wet season assessment that the proposed site locations were in existing forests adjacent to open areas. Minor changes in site locations that avoid the forested areas were made to turbine locations based on recommendations from the flora and fauna surveys done during the rainy season.

Figure 32: Presence of Owls



Source: Jamaica Caves Organisation, 2013

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7. Results (Dry Season)

The results provided for the dry season survey represents data collected from eleven sites. The sites T1 to T11 are representative of the minimum number of locations to be used for installation of the turbines. A total of twelve (12) bats were captured and released during the survey of the eleven (11) sites. Approximately seventy (70) bats were observed visually and acoustically detected at the sites. Foraging and fly through activities were noted throughout the turbine locations, but varied in intensity and occurrence. There were no foraging activities observed for sites T2, T6-T7, and T9-T11. Only at site T1 were no fly-through activities observed. However the site was used heavily for foraging.

All sites surveyed had at least one type of activity. During the rainy season survey, there were no recorded and/or observed activities at sites T1 and T10.

The dry season results are presented in Table 40.

Table 40: Dry Season Results of Bat Survey

<i>Turbine Location</i>	<i>Numbers detected acoustically</i>	<i>Numbers Observed Visually</i>	<i>Sighting Ratings</i>	<i>Numbers Captured</i>	<i>Behaviour</i>
T1	6	6	Frequent	0	Foraging (heavy)
T2	4	0	Low numbers	2	Fly-through
T3	6	1	Frequent	4	Foraging Flight path
T4	9	1	Frequent	1	Foraging Flight path
T5	5	1	Low numbers	0	Foraging (limited) Fly-through (occasional)
T6	2	0	Low numbers	0	Fly-through
T7	0	0	Frequent	3	Fly-through
T8	11	5	Frequent	1	Foraging Fly-through
T9	3	2	Low numbers	0	No foraging Fly through (occasional)
T10	1	2	Limited	0	Fly-through
T11	2	1	Limited/low numbers	1	No foraging Fly through (occasional)
T12	2	2	Limited/low numbers	1	No Foraging Fly through (occasional)
T13	n/a	n/a	n/a	n/a	n/a
T14	0	0	-	-	No activity

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<i>Turbine Location</i>	<i>Numbers detected acoustically</i>	<i>Numbers Observed Visually</i>	<i>Sighting Ratings</i>	<i>Numbers Captured</i>	<i>Behaviour</i>
T15	n/a	n/a	n/a	n/a	n/a
T16	2	1	Frequent	2	Foraging Fly-through
T17	3	0	Very frequent	8	Foraging Fly through
T18	n/a	n/a	n/a	n/a	n/a
n/a- No survey results					

During the dry season survey no new bat species were identified and/or captured. The data presented in Figure 33 shows the distribution of species by turbine location.

Figure 34 shows the combined species distribution for both dry and wet season.

Bats were found throughout the area of sites T1 to T11 in low numbers, but the distribution was not homogenous. The distribution data specifically showed that there were more bats, of more species, in the southern section. This pattern occurred in both the rainy-season and the dry-season (Figure 34).⁸

The concentration in the south, based on observations and data patterns, indicated that the main factor is the degree of forest cover. During both periods of fieldwork at sites 1 to 11, a preference for the use of forests and bushy fence-lines as flight paths and as staging grounds for ‘hawking’ attacks on flying moths was observed.

Three of the four species caught (*Artibeus jamaicensis*⁹, *Ariteus flavescens*¹⁰, and *Glossophaga soricina*¹¹) are known to roost in tree hollows. Evidently, the larger forests in the southwest of the project area are supporting a greater number of bats and species than are found in the relatively barren areas of the north.

Repeated visual observations over both surveying seasons have shown that bat species fly and forage at altitudes that are below the height of the turbine blades.

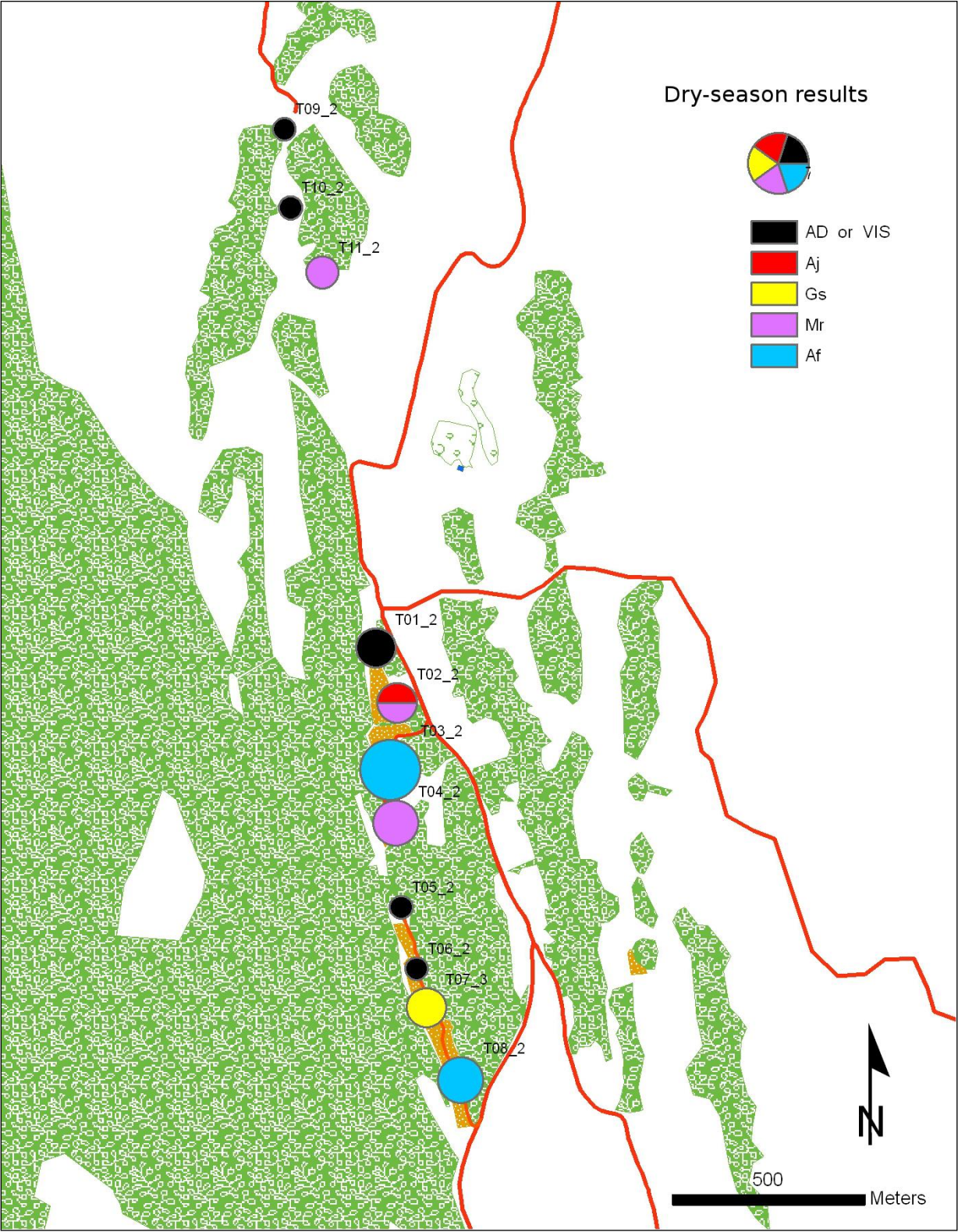
⁸ The values for symbol size include a component for sites where we had many acoustic detections and/or visual observations. The value is comprised of 1 for each bat caught, an additional 1 for sites with some acoustic detection and/or visual observations, and 3 for sites with many acoustic detections and/or visual observations.

⁹ Jorge Ortega and Iva'n Castro-Arellano (2001) *Artibeus jamaicensis*. *Mammalian Species*, No. 662, pp. 1–9.

¹⁰ Richard E. Sherwin and William L Gannon (2005) *Ariteus flavescens*. *Mammalian Species*, No. 787, pp. 1–3.

¹¹ Javier Alvarez, Michael R. Willig, J. Knox Jones, Jr., and Wm. David Webster (1991) *Glossophaga soricina*. *Mammalian Species*, No. 379: pp. 14.

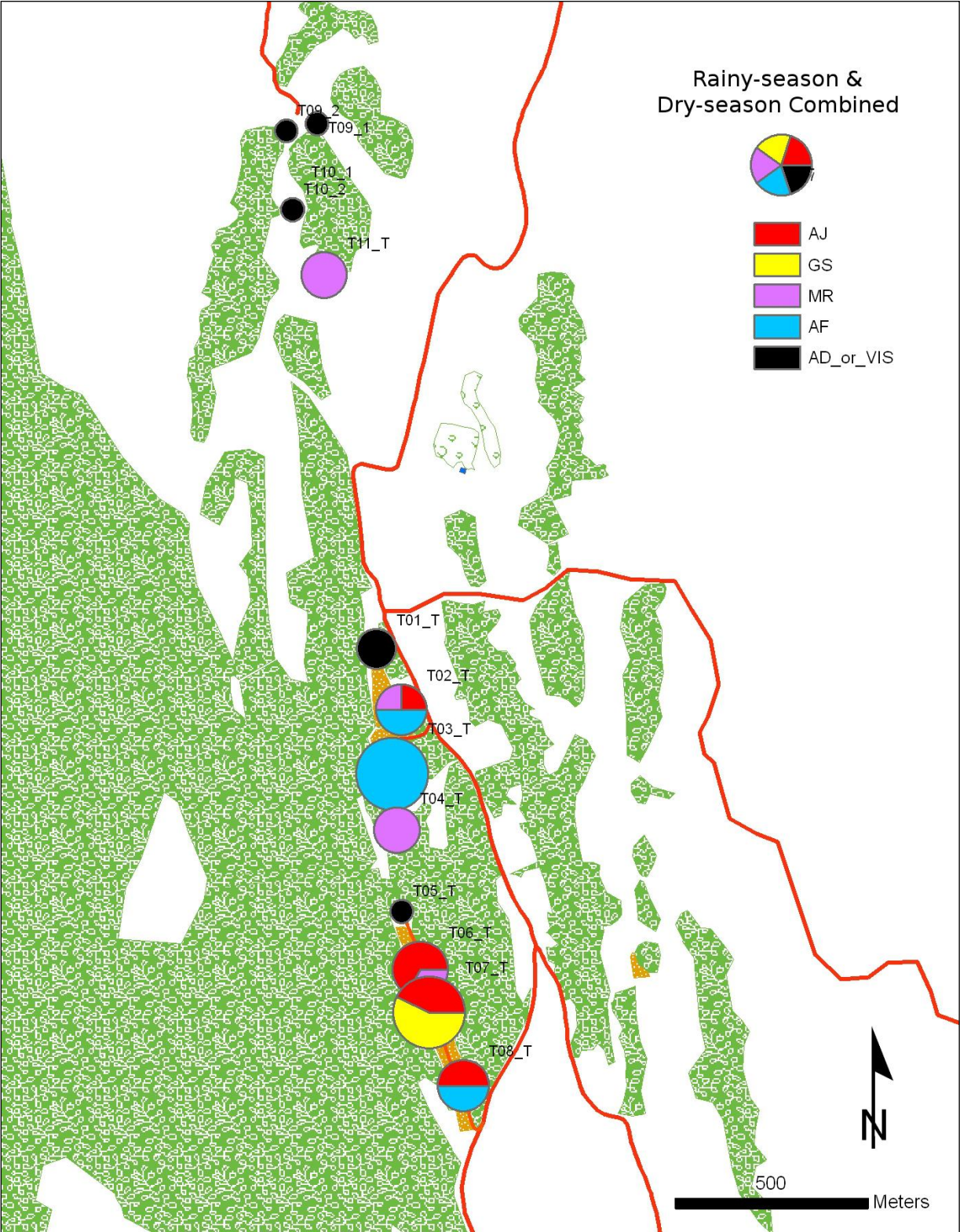
Figure 33: Species Distribution for Dry Season Surveys



Source: Jamaica Caves Organisation, 2014

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Figure 34: Species Distribution for Dry and Wet Seasons



Source: Jamaica Caves Organisation, 2014

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4.6 Social Environment

The social impact assessment (SIA) was prepared as part of the environmental impact assessment being undertaken for the proposed 34MW Wind Farm Project in Malvern, St. Elizabeth, Jamaica. The report outlines the existing socio-economic environment, by describing the demographic characteristics of the development area, which includes the impact zone, along with other quality of life indicators and provides a comprehensive overview of the perceptions held by various stakeholders about the proposed development.

The Development area (DA) is located in the south-eastern section of the parish of St. Elizabeth. The DA is defined as the area located within an 8-10km radius of the project site. The DA which consists of five (5) districts is designated as special areas¹² in the parish of St. Elizabeth. These include: Malvern, Junction, Southfield, Mountainside and Newell. Malvern and Newell are the only communities found within a 5km-radius of the project area. The DA districts and/or special areas combine for a total population of 14,515.

The social impact zone (herein referred to as the impact zone), in this report, is defined as the area located within a 3km radius of the project site and includes only the district of Malvern. The district is however popularly referred to as the Malvern-Munro district. A review of the demographic data for the social impact zone has shown that the Malvern-Munro district, which consists of approximately twenty (20) communities, has a total population of 5,815 and approximately 1,862 households.

For the perception survey 8-10% of the total households within the project area were targeted as part of the SIA study. This required the administration of 170-190 questionnaires. This figure presents approximately 3-4% of the total population of the communities. Households were the main target during perception surveys as it allowed for wider community participation.

4.6.1 Demographic Characteristics

A. Population, Gender and Age Distribution

According to the 2011 Population Census, the parish of St. Elizabeth has a total population of 150,205 (STATIN, 2013). This represents five point six percent (5.6%) of the total population of Jamaica. The parish grew at an annual rate of 0.27% between 2001 and 2011, a total population change of 2.60% over a 10 year period. Males accounted for fifty point nine percent (50.95%) of the total population, giving a male to female ratio of 1:1 in the parish. St. Elizabeth is considered a

¹² Any group of contiguous enumeration districts which make up either a rural or an urban area of special interest is called a Special Area. Three classes of special areas were identified for the country in the 2011 Census: (1). Class A special areas: These include all parish capitals and the Kingston Metropolitan Area (KMA) which covers Kingston and urban St Andrew; (2). Class B special areas: These include all other urban centres in Jamaica with a population of 2,000 or more persons; (3). Class C special areas: These are rural areas of special interest.

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predominantly rural parish, with eighty-five point six percent (85.6%) of the population living in rural areas (Table 41).

According to age distribution data for the parish, persons under the age of 15 years (children) accounted for the largest percentage of the parish's population at twenty-six point six percent (26.6%). The data shows that more than fifty percent (50%) of the parish's population is below the age of 30 years, while the group accounting for the least of the parish's population was the 65 and over age group at ten point one percent (10.1%).

Based on the age distribution data, the parish has a dependency rate of 58.05. This shows that for every 100 person working, there are 58 dependents. This ratio is lower than the national 2011 ratio of 57.07 (World Bank 2012).

Table 41: Parish Population by Age Group and Gender (St. Elizabeth)

St. Elizabeth Parish Population by Age Group				
Age Group	Gender		Total	Percentage of Total Population
	Male	Female		
Under 15	20,403	19,596	39,999	26.6
15-29	20,138	18,930	39,068	26.0
30-44	13,958	14,063	28,021	18.7
45-64	15,032	12,914	27,946	18.6
65+	6,999	8,172	15,169	10.1
Total	76,530	73,675	150,205	100.0

Source: STATIN, 2013, with modifications by EEM

B. Social Impact Zone

The social impact zone has a total population of 5,815 located in more than fifteen (15) communities and/or districts, situated across thirteen (13) enumeration districts (EDs) as shown in Table 42.

Table 42: Total Population for Social Impact Zone by Community and Enumeration District

Population of Impact Zone Communities		
Enumeration District	Total Population	Community Names
SE 1	389	Malvern (Hermitage, Iver Cottage, Torrington)
SE 2	456	Malvern
SE 19	255	Malvern
SE 20	243	Malvern
SE 21	421	Malvern (Roseberry)
SE 23	535	Malvern (Bideford)
SE 24	516	Malvern

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<i>Population of Impact Zone Communities</i>		
Enumeration District	Total Population	Community Names
SE 25	585	Mount Pleasant, Belmont
SE 27	360	St. Mary's
SE 52	677	Epping Forest, Kensington
SE 53	557	Potsdam, Berlin, Corby
SE 54	584	Munro
SE 55	237	Potsdam
	5,815	
Notes: SE- South East		

Source: STATIN, 2013, with modifications by EEM

The district of Malvern has the largest population size at 2,815 persons, while the community of St. Mary's has the smallest with approximately 360 persons. Males account for an estimated fifty-one percent (51%) of the total population within the impact zone, continuing the trend observed at the parish level. However examination of the data by community shows that for the communities of Malvern and Mount Pleasant, women account for a larger share of the population. In the case of Malvern, women account for fifty-four point three percent (54.3%) of the total population. Within the community of Munro, the dominance of the male gender is clear as shown by the demographic data which shows that males account for eighty-four percent (84%) of the total population within the community (Table 43).

Table 43: Population by Gender in Social Impact Zone

<i>Population by Enumeration District and Community</i>			
Enumeration Districts	Gender		
	<i>Males</i>	<i>Females</i>	Total
<i>Malvern</i>			
SE1	218	171	389
SE2	225	231	456
SE19	138	117	255
SE20	126	117	243
SE21	214	207	421
SE23	249	286	535
SE24	114	402	516
	<u>1284</u>	<u>1531</u>	<u>2,815</u>
<i>Mount Pleasant & Belmont</i>			
SE25	<u>279</u>	<u>306</u>	<u>585</u>
<i>St. Marys'</i>			

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<i>Population by Enumeration District and Community</i>			
<i>Enumeration Districts</i>	<i>Gender</i>		
SE27	<u>182</u>	<u>178</u>	<u>360</u>
<i>Epping Forest</i>			
SE52	<u>342</u>	<u>335</u>	<u>677</u>
<i>Munro</i>			
SE54	<u>491</u>	<u>93</u>	<u>584</u>
<i>Potsdam</i>			
SE53	297	260	557
SE55	119	118	237
	<u>416</u>	<u>378</u>	<u>794</u>
Total	2,994	2,821	5,815

Source: STATIN, 2013, with modifications by EEM

Similar age group distribution patterns observed at the parish level were also observed within the social impact zone, with one exception. The age group 45-64 accounted for a larger share of the total population than the 30-44 year age group. The under 15 age group, which accounted for approximately twenty-nine percent (29%) of the total population, is the largest age group within the impact zone. When combined with the 15-29 years age group, they account for approximately fifty-six percent (56%) of the total population found within the communities of the impact zone (Table 44).

The age dependency ratio within the social impact zone was 65.1, higher than the parish ratio of 58.05 and national ratio of 57.07. This shows that for every 100 person working, there are 65 dependents.

Table 44: Age Group Distribution by Community in Social Impact Zone

<i>Gender</i>	<i>Districts</i>	<i>Age Group</i>					<i>Total</i>
		Under 15	15-29	30-44	45-64	65+	
	Malvern						
Male		347	313	219	277	128	1284
Female		511	407	209	231	173	1531
	Munro						
Male		213	237	15	21	5	491
Female		30	19	18	15	11	93
	Potsdam						
Male		87	114	80	91	44	416

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<i>Gender</i>	<i>Districts</i>	<i>Age Group</i>					<i>Total</i>
		Under 15	15-29	30-44	45-64	65+	
Female		84	88	67	79	60	378
	Mount Pleasant						
Male		70	85	51	45	28	279
Female		83	71	58	49	45	306
	St Marys'						
Male		54	40	33	42	13	182
Female		51	39	29	33	26	178
	Epping Forest						
Male		80	96	51	77	37	341
Female		74	89	59	74	39	335
Total		1,684	1,598	889	1,034	609	5,814

Source: STATIN, 2013, with modifications by EEM

4.6.2 Housing

1. Housing Tenure

According to the 2011 census data, the parish of St. Elizabeth has 45,822 housing units, 48,071 dwelling units and 49,383 households (Table 45). The number of housing units in the parish account for six point four percent (6.4%) of the total number of housing units in Jamaica, while the parish has five point six percent (5.6%) of the total number of households in Jamaica. The total number of housing units within the parish of St. Elizabeth has increased fifteen percent (15%) over 2001 levels when the total number of housing units was 38,948.

Table 45: General Housing Data by Parish and Community

<i>Housing Data</i>			
Parish and Communities	Housing Units	Dwelling Units	Households
All Jamaica	711,331	853,668	881,089
St. Elizabeth	45,822	48,071	49,383
Malvern	764	788	821
Munro	205	-	227
Potsdam	377	-	400
Mount Pleasant	190	-	203
St. Mary's	73	-	85
Epping Forest	122	-	126

Source: STATIN, 2013, with modifications by EEM

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The communities within the social impact zone have a total of 1,731 housing units and 1,862 households (Table 46). The number of housing units and households within the social impact zone account for approximately three point seven percent (3.7%) respectively of the total number of housing units and households found within the parish.

Table 46: Housing Units and Household Size by Parish and Community

<i>Housing Units and Household Size</i>				
Parish and Communities	Housing Units	% of total housing units in parish	Households	% of total households in parish
St. Elizabeth	45,822	100.0	49,383	100.0
Malvern	764	1.66	821	1.66
Munro	205	0.44	227	0.46
Potsdam	377	0.82	400	0.80
Mount Pleasant	190	0.41	203	0.41
St. Mary's	73	0.16	85	0.17
Epping Forest	122	0.26	126	0.26
Total	1731	3.75	1862	3.76

Source: STATIN, 2013, with modifications by EEM

The vast majority of housing units within the parish and social impact zone communities are detached units. The data shows that in all cases in excess of ninety percent (90%) of the housing units are detached. The types of housing units in the communities are shown in Table 47.

Table 47: Housing Types by Parish and Community

<i>Types of Housing Units</i>			
Parish and Communities	Housing Units	Detached	Attached
St. Elizabeth	45,822	44,594	342
Malvern	764	740	9
Munro	205	204	0
Potsdam	377	368	1
Mount Pleasant	190	183	5
St. Mary's	73	68	1
Epping Forest	122	120	1

Source: STATIN, 2013, with modifications by EEM

According to the 2011 census, sixty-nine percent (69%) of all households owned the dwelling unit they occupied. Table 48 shows the breakdown in the housing tenure figures. In the community of Malvern, housing ownership is approximately sixty-seven percent (67%), two percentage points lower than at the parish level. There was no data available for the other communities within the social impact zone.

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Table 48: Housing Tenure Status by Parish and District

<i>Housing Tenure</i>								
	House-holds	Owned	Leased	Rent	Rent Free	Squatted	Other	Not Reported
St. Elizabeth	49,383	34,081	187	5,785	8,872	152	50	256
Malvern	821	548	0	95	166	0	0	12

Source: STATIN, 2013

4.6.3 Utility Services

1. Water

The National Water Commission (NWC) is the main provider of potable water in Jamaica. The NWC produces some 380 million gallons of water per month in the parish of St. Elizabeth through twenty (21) wells and six (6) surface sources. The average billed volume is only 54 million gallons per month which translates to an average non-revenue water (NRW) of 326 million gallons per month i.e. 86% of production.

This unacceptable level of NRW has had an adverse impact on the level of service provided to the people of the parish and on the financial performance of the NWC. The NWC now provides water to some fifty percent (50%) of the population in St. Elizabeth, which is a marginal improvement over that in 2001 when the level of coverage was 44%. The reliability of service to those who are served by NWC is estimated to average 16 hours per day.

The Malvern Munro Water Supply System is the system targeted to supply the Malvern Munro Demand Zone. This water supply system is supplied by water from the Park Lee Wells. There are a series of lift stations that convey water from these wells to the Malvern No. 1 Pump Station, where water is further lifted through to the Malvern No. 2 Pump Station. The Malvern No. 2 Pump Station pumps water to the Munro water storage tank.

The areas supplied by the Malvern/Munro Water Supply System include: Mountainside, Corby, Southfield, Manningsfield, Top Hill, Seaview, Flagaman, St. Mary's, Bellevue, Yardley Chase, Hampton, Bethlehem, Munro, Potsdam, Malvern, Brown Berry Lane, Round Hill, Parklee, Bantin, Epping Forest, Congo Hole, Red Bank, Port Sea, and Melksham.

Table 49 shows the current water supply situation in the parish and in the Malvern-Munro District.

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Table 49: Current Water Supply Situation By Parish and District

<i>Water Supply Situation</i>					
	Supply (gal/d)	Population	Base demand (gal/d)	Technical losses (gal/d)	Deficit (gal/d)
St Elizabeth	14, 102,000	119,671	5,502,124	7,163,156	(1,433,981)
Malvern/Munro	1,000,000	19,440	893,793	214,939	(108,732)

Source: National Water Commission, 2012

The NWC, as part of its Water Supply Improvement Plans, is undertaking improvement works on several water supply systems in the parish of St. Elizabeth. The improvement works are aimed at addressing supply deficiencies and improving overall operational efficiencies. Under the project the transmission main between the pump stations will be re-routed along the roadway to prevent farmers from continuing with the widespread illegal connections to air valves on the pipeline.

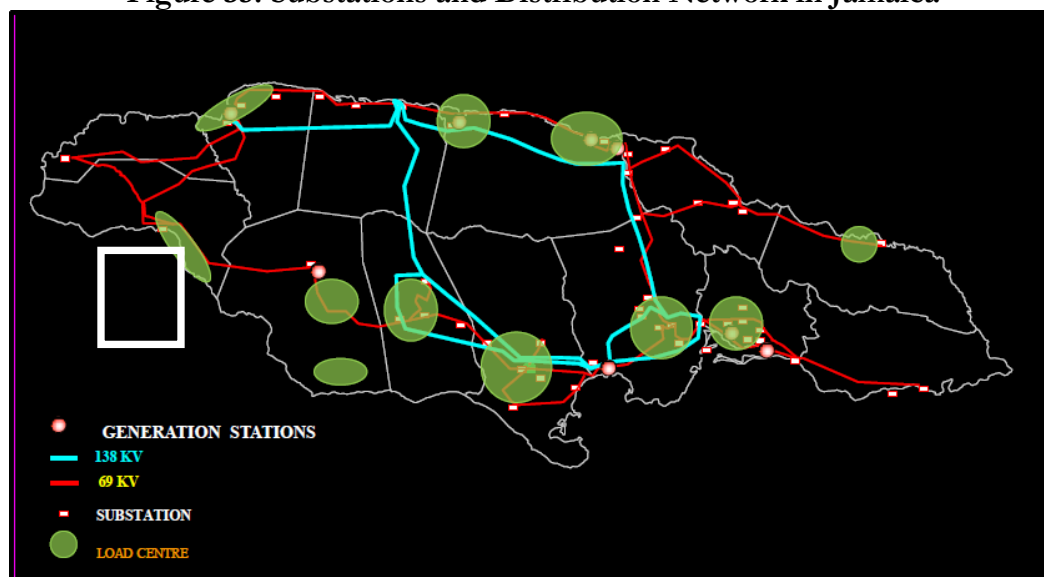
2. Electricity

Eighty-six percent (86%) of persons residing in the parish of St. Elizabeth use electricity as their main source of lighting.

The Maggotty substation (feeder name: 31/6 – 110) supplies the communities within the impact zone with electricity services. The substation is a 24 kV distribution system, which supplies electricity to the grid via a 69 kV sub-transmission line (Figure 35). The 24 kV distribution system is the most reliable primary distribution voltage on the JPS system. Outages on this system are generally due to load shedding.

Load shedding is the process of disconnecting customers 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 they are unable to continue supplying customers due to scheduled/planned maintenance.

Figure 35: Substations and Distribution Network in Jamaica



Source: Jamaica Public Service Company Limited, 2011

3. Sewage System

The National Water Commission (NWC) operates sixty-eight (68) sewage (wastewater) treatment plants island wide, collecting waste from approximately twenty-five (25%) of the Jamaican population.

Currently there are no NWC wastewater treatment plants in the parish of St. Elizabeth. However as part of its overall Sewerage Programme the NWC is seeking to construct wastewater treatment plants in the towns of Black River and Santa Cruz between 2019 and 2024. Soakaways are used as the main sewage treatment system within the impact zone.

4. Solid Waste

Solid waste management within the impact zone is the responsibility of Southern Parks and Market Limited (SPM); one of the four regional offices of the National Solid Waste Management Authority (NSWMA). The SPM is responsible for the management of the Martin's Hill and Myersville disposal sites in the parish of Manchester and St. Elizabeth respectively.

The nearest municipal disposal site to the proposed wind farm development site is at Myersville. The disposal site is located north east of the project site, approximately 8 km by road. Garbage is collected only on main roads within the social impact zone communities and this is done on a weekly basis.

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4.6.4 Municipal and Social Services

1. Health Facilities

The parish of St. Elizabeth is divided into six (6) health districts. There is one (1) hospital which serves the parish and twenty-four (24) health centres. The Black River Hospital is a Type C with a bed capacity of 60, bed complement of 97 and over one hundred percent (100%) occupancy.

The parish has six (6) Type 3 health centres, ten (10) Type 2, and eight (8) Type 1 facilities. Each health district has a Type 3 full service health centre with curative, maternal and child, dental, mental and environmental services.

The impact zone is served by the Junction Health District. The district has three health centres: Junction (Type 3), Malvern (Type 2) and Portsea (Type 2). The Malvern Health Centre was recently refurbished under the Jamaica Emergency Employment Programme (JEEP).

Type 2 and 3 facilities offer the following services: Family health (including antenatal, postnatal, child health, nutrition, family planning & immunization); curative, dental, environmental health, Sexually Transmitted Infections (STIs) treatment, counselling and contact investigation; child guidance, mental health and pharmacy. Type 2 facilities serve a population of approximately 12, 000 and is serviced by a visiting Doctor and Nurse practitioner. Type 3 facilities serve approximately 20,000 persons.

2. Educational Institutions

The parish of St. Elizabeth has eighty-seven (87) public education institutions, beginning at the early childhood/infant level through to the tertiary level. The parish has one of only two agricultural high (secondary) schools in Jamaica. There are six (6) education institutions within the impact zone, including the three largest education institutions in St. Elizabeth: Bethlehem Moravian College, Hampton School and Munro College. Five of the institutions are public, while the Munro Preparatory is a private institution. The Bethlehem All Age and Infant and the Munro Preparatory offer early childhood and primary level education, while Epping Forest Primary offers primary level education only. The two secondary level education institutions are Hampton School and Munro College, with Bethlehem Teacher's College being the lone tertiary institution within the impact zone. Table 50 outlines the educational data for schools within the impact zone for the year 2012/2013.

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Table 50: Educational Data for Schools within the Social Impact Zone, 2012-2013

Educational Institutions						
School Name	Class*	Percent attendance	Capacity	Enrolment	Number of Teachers	Pupil Teacher ratio
Epping Forest Primary	I	89	80	88	5	22:1
Bethlehem All Age and Infant	II	86	480	258	13	32:1
Munro Preparatory	n/a	n/a	n/a	n/a	n/a	n/a
Hampton School	IV	95	800	1,226	68	20:1
Munro College	III	95	800	1,060	55	22:1
Bethlehem Moravian Teacher's College	n/a	n/a	n/a	n/a	n/a	n/a
* See Appendix 4 for School Classification Code n/a- No data available						

Source: Ministry of Education, 2013

3. Protection and Emergency Services

The communities within the impact zone are served by the Malvern Police Station located in the Malvern town centre. The police station, which was destroyed by a hurricane in 2006, was re-built in 2012. The Santa Cruz Police Station also serves the communities within the impact zone.

Fire Services are provided by the Santa Cruz Fire Department or the Junction Fire Department. The Junction Fire Department is located within a 10km radius of the impact zone communities.

4. Communication Technology

LIME and Digicel are the major providers of telecommunication services across Jamaica. Both telecommunication companies provide cellular services to the communities within the social impact zone. Internet services are also provided to the communities via these two major communication companies. Cable services are provided within the communities by McKoys Cable Television Company. Internet and cable services are not however widespread throughout the communities.

4.6.5 Community Organisations

1. St. Elizabeth Women (SEW) Limited

St. Elizabeth Women (SEW) Limited is a social action organisation formed in 2008. The organisation aims to empower women in dealing with economic and social stress and is supported by several international agencies, including the Canadian International Development Agency (CIDA) and the United Nations Population

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Fund (UNFPA). The founder of the organisation is Dr. Glenda Simms, former Director of the Bureau of Women's affairs.¹³

The organisation has a group in the community of Malvern. However it is unclear whether the group is still active.

2. Malvern Science Resource Centre

The Malvern Science Resource Centre (MSRC) is an educational facility which focuses on environmental management. Its mission is to provide an information centre for science teachers, students and aspiring environmentalists. The Centre was opened in June 1992 in the district of Malvern, in Southeast St. Elizabeth. It is a non-profit and non-governmental institution, with the main purpose of supporting science departments and libraries of schools within the southeast community of St. Elizabeth.

The MSRC is housed in an old estate house opposite the Hampton Girls School and was established with funding by the Masthead Foundation with some support from local donors like Alcan Jamaica. The MSRC has various exhibits and showcases, including exhibits in the Sun, Sea and Sand rooms, which cleverly relate the world of science to the physical resources and economy of the island. A small Hall of Fame section is also on display at the centre and includes local celebrities like Dr. Thomas Lecky, who against official disapproval pursued cross-breeding experiments to produce the Jamaica Hope, an acclimatized dairy cow; and Mrs. Beth Jacobs, a family planning pioneer. The MSRC also distributes How-to literature and advice on environmentally friendly options like Solar Ovens and Banana Circles.¹⁴

4.6.6 Economy

Agriculture is the major economic activity in the parish of St. Elizabeth. Tourism, though an industry said to have vast potential, is still in its infancy stage. There has been a shift within the economy focusing on manufacturing which has increased with local and foreign investments but it is agriculture that continues to dominate the economy. Bauxite was previously a major economic contributor within the parish, however since the global recession of 2008, bauxite mining has ceased within the parish.

1. Agriculture

The parish of St. Elizabeth is known as the 'bread basket' and/or 'food basket' of the island of Jamaica, because of its vibrant agricultural sector in the parish. The parish in 2007 accounted for nine point five percent (9.5%) of the total area of land designated as farm areas in Jamaica with an estimated 29,483 hectares of farm area. The parish though having the fifth largest proportion of farm area by parish in the

¹³http://www.jamaicaobserver.com/westernnews/-Sew--ing-seeds-for-self-help-and-growth_10080187#ixzz2mzcwJless

¹⁴http://discoverjamaica.com/gleaner/discover/tour_ja/tour6.htm /
<http://www.treasurebeach.net/guide/gs/main.cfm>

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island in 2007 experienced a decline of twenty-three point one percent (23.1%) between 1996 and 2007 in its total percentage of farm area. The parish does however have the most number of farms in Jamaica. The parish has approximately 34,437 farms, which account for fifteen percent (15.1%) of the total number of farms in Jamaica. The number of farms in the parish grew by thirty-four point six percent (34.6%) over 1996 base level figures, even though the total farm area declined.

The parish produces a large quantity of ground provisions, root crops, fruits, vegetables, tree crops, peas, corn, sugar, rum, pimento, coffee and ginger. Agricultural crops are produced for the export and local markets. The lowlands of St. Elizabeth include properties such as Gilnoc, Fonthill, Pepper, Longhill, Goshen, Friendship, and Warminster among others, which are all famous for the quality of their cattle, horses and mules.

The parish has two (2) active food processing companies, Southern Fruits and Food Processors Ltd., at Bull Savannah for the processing of tomatoes, carrots and pineapples under the brand name Village Pride and Southside Distributors Limited in Comma Pen established in 2006. Southside Distributors Limited also processes tomatoes, carrots, pineapples and ackees. Additionally they have a line of jerk and barbeque sauces and juice products.

A cassava factory was established at Goshen in the parish in the 1970s but it was closed in the early 1980s. There are also pimento leaf factories at Giddy Hall, Bogue and Braes River.

The sugar industry, which is still very active in the parish, is considered one of the oldest and most important industries in the parish. The Appleton Sugar Estate in Siloah comprises the only remaining active sugar factory and distillery in the parish. The Estate which is owned by Campari under its local subsidiary, J. Wray and Nephew Limited, produces sugar and the world famous 'Appleton Rum.'

The agricultural industry grew by two point six percent (2.6%) in 2012 relative to 2011, when the industry grew by nine point eight percent (9.8%). The improvements in the industry have been steady, since the industry recorded a decline of fourteen point three percent (14.3%) between 2007 and 2008. The industry accounted for six point eight percent (6.8%) of the overall GDP of Jamaica, an increase over 2011 baseline figure of six point six percent (6.6%). The contribution made to GDP from the industry has recorded steady increases between six to six point six percent (6-6.6%) annually from 2009-2012, since 2008 when contribution was recorded at five percent (5.0%).

In 2012 the industry earned J\$74,571.2 million, an increase of six percent (6%) over 2011 baseline figures, while food export earnings also increased, moving from US\$232.2 million in 2011, to US\$274.0 million in 2012 (Table 51 and Table 52).

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Table 51: Agricultural Contribution to GDP (value added by industry) 2012

<i>Value added by industry at current prices (J\$ Million)</i>					
Category	2008	2009	2010	2011	2012
Agriculture, Forestry and Fishing	\$48,938.4	\$59,812.6	\$62,329.4	\$70,012.2	\$74,571.2

Source: ESSJ, 2013

Table 52: Agricultural Imports and Exports 2012

<i>Imports and exports (US\$ million)</i>				
		2011	2012	
Food	Imports	\$938.7	\$959.2	
	Exports	\$232.3	\$274.0	
<i>Non-traditional exports (US\$ '000)</i>				
Non-traditional	Exports	\$135,613.0	\$144,799.0	

Source: ESSJ, 2013

2. Bauxite

Bauxite mining began in the early 1950s in St. Elizabeth. The Kaiser Bauxite Company was the first to undertake mining in the parish. Alumina Partners of Jamaica (ALPART), previously one of the largest employers within the bauxite industry began mining operations in 1969 in the parish. The company which was one of the largest single earners of foreign exchange for the Government of Jamaica closed down in late 2008 primarily due to the global recession.

3. Tourism

There has been noticeable growth in the tourism industry in the parish of St. Elizabeth. The parish has emerged as one of fastest growing tourist destinations on the island. St Elizabeth has significantly increased its room capacity for tourists and is strongly pushing a tourism package with a difference - community tourism which would include eco-tourism. The Appleton Rum Distillery and the Black River are two of the popular tourist sites within the parish. Other notable tourist destinations include: Lover's Leap, Apple Valley Park, Y.S. Falls, and the Accompong Maroon Village. In recent years the Great Morass has been developed to attract tourists, while popular sea food restaurants, such as *Little Ochie* have attracted local and international tourists.

Between January and October 2012, the tourism industry nationally earned approximately US\$1.7 billion, an increase of 3.2% over the same period in 2011. According to the Economic and Social Survey of Jamaica (ESSJ) the **Hotels and Restaurant Industry**, which captures most of the tourism activity, grew by one point eight percent (1.8%) in 2012 and contributed five point five percent (5.5%) of GDP. This was an increase compared to 2011 levels when contribution to GDP was five point four percent (5.4%). Total tourist expenditure earnings (tourist revenues)

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in 2012, was US\$2,046.5 million, an increase of one point nine percent (1.9%) over 2011 levels.

4.6.7 Economic Indicators

According to the 2011 census, approximately fifty-seven percent (57%) of Jamaica's population 14 years and over were economically active. Males had a higher participation rate of sixty-six percent (66%), compared to women at forty-seven (47%). The employment rate nationally was eighty-five point nine percent (85.97%). Unemployment rate for males was thirteen point nine percent (13.94%) and fourteen point two percent (14.2%) for females.

The distribution of the employed by employment status nationally showed approximately forty-five percent (45%) of persons being employed within the private sector, twenty-eight percent (28%) self-employed without paid employees and approximately fifteen percent (15%) being employed by the government. Wholesale and Retail, inclusive of motor vehicle repairs and household goods and the agricultural and mining industry employed more than a third of Jamaica's employed labour force. Wholesale and Retail employed approximately twenty-percent (20%), while agriculture, which includes fishing and forestry and mining and quarrying employed fifteen percent (15%).

The data shows that the parish of St. Elizabeth has a labour participation rate of fifty-two percent (52%), the second lowest participation rate on the island. However the parish has one of the lowest unemployment rates, which at the time of census taking was 12.84%. This figure is approximately one percentage (1%) point lower than the national unemployment rate. The occupational group distribution for St. Elizabeth showed that forty percent (40%) of employed persons within the parish were skilled personnel employed in the agricultural, forestry and fisheries industry, nineteen percent (19%) in Service and Sales and seven point seven percent (7.7%) employed as Managers and Professionals (Table 53).

Table 53: Select Occupational Group by Parish

<i>Occupational Group (St. Elizabeth)</i>			
	Male	Female	Total
Skilled (agricultural, forestry and fisheries)	17,213	3,407	20,620
Managers and Professionals	1,318	2,656	3,974
Service and Sales	3,072	6,777	9,849
Elementary Occupations	3,216	2,793	6,009
Other	8,618	2,314	10,932
Total	33,437	17,947	51,384

Source: STATIN, 2013 with modifications by EEM

Males account for eighty-three percent (83%) of workers in the '***Skilled (agricultural, forestry and fisheries group)***'. Females however accounted for the larger proportion of workers in the Managers and Professionals and Services and Sales groups. They accounted for sixty-six percent (66%) of workers in the Managers

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and Professional group and sixty-eight percent (68%) of workers in the Service and Sales group.

Table 54: Select Employment Status by Parish

Employment Status (St. Elizabeth)			
	Male	Female	Total
Paid Government Employee	1,666	3,259	4,925
Paid employee in private enterprise	9,309	4,941	14,250
Self-employed without paid employee	18,342	6,381	24,723
Self-employed with paid employee	2,114	772	2,886
Other	2006	2594	4,600
Total	33,437	17,947	51,384

Source: STATIN, 2013 with modifications by EEM

As shown in Table 54, the employment status distribution shows that the vast majority of persons employed within the parish are self-employed workers. Approximately fifty-three percent (53%) of the total number of persons employed are self-employed, forty-eight percent (48%) falling in the category of '*self-employed without paid employee*.' Twenty seven percent (27%) of persons fell in the category of '*paid employee in private enterprise*' and nine point five percent (9.5%) were '*Paid Government Employee*.'

4.6.8 Cultural and Historical Background

The parish of St. Elizabeth has several well-known heritage sites, including the Black River Court House, Lover's Leap, the Appleton Railway Station and the St. Elizabeth Parish Church. There are two (2) heritage sites located within close proximity to the proposed location of the BMR Jamaica Wind Project. These are (i) Munro College, a boarding school for boys and (ii) Hampton High School, a boarding school for girls.

1. Munro College

Munro College had its origins in the Munro and Dickenson Trust. Robert Hugh Munro in his will dated January 21, 1797, bequeathed a part of his estate to his nephew Caleb Dickenson and the Churchwardens of St. Elizabeth to set up a school in the parish for the education of as many poor children as the funds was able to provide for and maintain. Dickenson improved the property at Munro, so that when he died in 1821, he was far wealthier than his uncle had been. In his will, Dickenson desired that his Trustees carry out the wishes of his uncle to educate the poor.

On the 30th, October, 1834, an Act for the sale of the real estate of Robert Hugh Munro and Caleb Dickenson was read and passed on November 6. By this Act, the Trustees were given power of sale for both real estate and slaves belonging to Robert Hugh Munro and Caleb Dickenson for the purpose of investing the funds and applying the same to the purposes of their wills and for no other purpose.

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The Trustees were appointed to select a convenient and healthy site or sites within the former limits of St. Elizabeth for erection of a school or several schools for poor boys and a school or several schools for poor girls and for an Alms House. In 1856, a Free School for boys was opened near Black River and early in 1857, the premises of Potsdam in the Santa Cruz Mountains was purchased and the school moved there.

2. Hampton

In 1858, a school for girls was started at Potsdam, on the same property as the Boys' School. The school, which relocated to Torrington and Mount Zion between the period 1858 and 1883, closed its doors in 1884 because of poor student attendance. It later reopened in 1885 at a new location, the Malvern house, before relocating to its current location, Hampton in 1891. The school, which later became known as Hampton also had its origins in the Munro and Dickenson Trust.

The information on the heritage sites of Munro College and Hampton was sourced from the website of the Jamaica National Heritage Trust.

4.7 Community Perception: Perceived Benefits and Challenges

As a means of gathering detailed information on the perspective of key stakeholders on the potential impacts associated with the proposed 34MW BMR Jamaica Wind Project in Malvern, St. Elizabeth, Jamaica questionnaires were administered throughout the district and communities which fall within a 3km radius of the project site.

A review of the demographic data for the social impact zone has shown that the Malvern-Munro areas (the social impact zone) has a total population of 5,815 and approximately 1,862 households.

For the perception survey nine percent (9%) of the total households within the project area were targeted to be surveyed as part of the SIA study. This resulted in the administering of 170 questionnaires; a figure which represented approximately three (3%) of the total population of the communities.

Households are part of the central focus of the study as the use of households allows for greater levels of stakeholder participation from a wider cross section of residents. It also provides the opportunity for greater dissemination of information when more households are involved, rather than individuals.

4.7.1 Community Profile

Survey participants were represented from the following communities:

- Y Potsdam
- Y Munro
- Y Malvern (Proper)

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- Y Smithfield
- Y Iver Cottage
- Y Roseberry
- Y Fairmount
- Y Braemer

The communities of Munro, Potsdam and St. Mary's accounted for close to forty-six percent (46%), while the remaining respondents were from the larger district of Malvern, which includes several communities such as Smithfield, Fairmount and Iver Cottage.

The data showed that approximately eighty percent (80%) of all survey respondents had lived in their community for ten (10) years or more. The average number of years for length of residency was 30.73, with the lowest number of years of residency being 1 year and the highest 88 years. A standard deviation¹⁵ of 18.981 was recorded, indicating a varied distribution as it relates to the average number of years persons have resided in their communities.

4.7.2 General Profile of Respondents

The gender breakdown of survey participants showed that males had a higher participation rate, accounting for approximately fifty-nine percent (59%) of the total number of persons interviewed. The dominance of male participants in the survey was expected, as males account for a larger proportion of the total population within the area surveyed.

Approximately twenty-nine percent (29%), nearly a third (1/3) of survey participants belonged to the 18-29 age group. The 60 and over age group had the least number of participants, accounting for an estimated ten percent (10%) of the total number of persons participating in the survey. The age group categories 40-49 and 50-59 each accounted for approximately twenty-one percent (21%) of survey participants, while the 30-39 age group accounted for eighteen percent (18%) of the total respondents.

Table 55 shows the age group distribution for survey participants.

¹⁵ The standard deviation shows how much variation or [dispersion](#) from the average exists. A low standard deviation indicates that the data points tend to be very close to the [mean](#) (also called expected value); a high standard deviation indicates that the data points are spread out over a large range of values.

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Table 55: Age Group Distribution of Respondents

<i>Age Group Categories of Respondents</i>			
	Frequency	Percent	Cumulative Percent
18-29	48	28.9	28.9
30-39	30	18.1	47.0
40-49	35	21.1	68.1
50-59	36	21.7	89.8
60 and over	17	10.2	100.0
Total	166	100.0	

Source: EEM, 2013

The survey revealed that the basic literacy rate amongst respondents was 100%. An estimated ninety-nine percent (99%) of respondents had received at a minimum primary level education. Secondary level education was identified by close to forty-six percent (46%) of respondents as the highest educational level they had attained. This educational level accounted for the largest proportion of respondents from the total number of persons surveyed (Table 56 and Figure 36).

The number of respondents who had completed tertiary level education and undertaken additional training also reflected a significant proportion of the total respondents, with seventeen point five (17.5%) of the group attaining tertiary education and a similar percentage furthering their education at training/skills institutions.

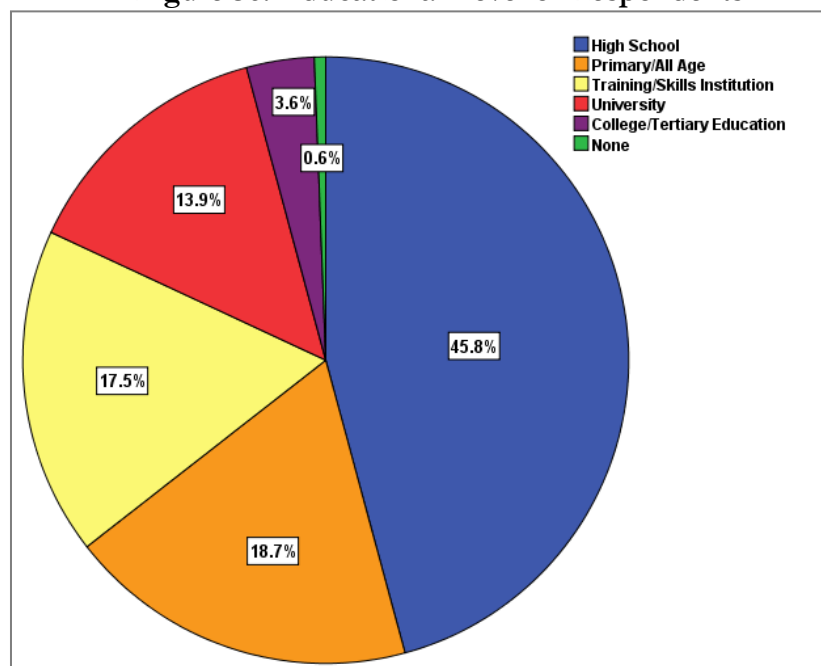
The analytical results of the education data are reflective generally of a changing educational pattern within farming communities. The educational pattern within farming communities in Jamaica typically show that the largest proportion of the population has only attained primary level education, with the numbers achieving secondary and tertiary level education being minimal.

Table 56: Educational Level of Respondents

<i>Educational Level of Respondents</i>				
	Frequency	Percent	Valid Percent	Cumulative Percent
None	1	0.6	0.6	0.6
Primary/All Age	31	18.7	18.7	19.3
High School	76	45.8	45.8	65.1
College/Tertiary Education*	6	3.6	3.6	68.7
Training/Skills Institution	29	17.5	17.5	86.1
University	23	13.9	13.9	100.0
Total	166	100.0	100.0	
*- College/Tertiary education represents institutions that do not have degree and/or graduate programmes				

Source: EEM, 2013

Figure 36: Educational Level of Respondents



Source: EEM, 2013

4.7.3 Economic Baseline

Farming, as supported by the information presented in Section 4.6.6 on the economy, is the main profession within the communities surveyed. Thirty-five point five percent (35.5%) of all persons surveyed indicated that they were farmers; representing more than a third of the total number of respondents participating in the survey. Teaching, which was selected by nine percent (9%) of respondents as their profession, was the only other profession in which more than five percent (5%) of respondents were engaged. Other areas of profession mentioned by respondents included: carpentry, welding, construction, administration and business and retail sale and management.

Table 57 shows, overall, the majority of survey participants were involved in low and semi-skilled type professions. The data showed that only an estimated eleven percent (11%) of respondents fell in the occupational category of '*professional/large business owner/manager*,' while nine percent (9%) combined belonged to the categories of '*small business owner/manager/administrator*' and '*medium business owner/manager/semi-professional/large farmer*.'

Persons falling within the '*Skilled/Trade/Technical/Clerical/Sales*' accounted for approximately fourteen percent (14%) of the total number of persons surveyed.

In the case of farmers, of the fifty-nine (59) respondents who acknowledged being farmers, only one (1) was a medium sized farmer, cultivating on land in excess of five (5) hectares. All other participants within this category cultivated on land two (2) hectares or less. A comparative analysis of occupational and age group categories,

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showed that approximately fifty-four percent (54%) of persons currently engaged in farming were between the age of 40-59, with the age group category 50-59 accounting for thirty-two percent (32%) of the total number of persons who indicated their profession as that of farming (Table 58). This age group trend is similar to patterns observed nationally, where older persons are the ones more involved in farming.

The 2007 Agricultural Census shows that less than six percent (6%) of farmers across the island are 25 years and under, compared to an estimated thirty-six percent (36%) of farmers who are between 45 and 64 years (STATIN, 2010). Though the survey has revealed that close to seventeen percent (17%) of farmers within the impact zone were between 18-29 years, the data did not allow for a comparison with the national age group category of *25 years and under*, because of limitations with the data collection instrument, which does not allow for participants to reveal their actual age. However in terms of comparing overall participation, it is shown that persons belonging to younger age categories are less involved in farming than their older counterparts.

Table 57: Occupational Level of Survey Participants

<i>Occupational level of Respondents</i>			
Occupational Categories	Frequency	Percent	Cumulative Percent
Unemployed/Housewife/Student	24	14.5	14.5
Unskilled/Labourer/Domestic	8	4.8	19.3
Semi-skilled/Machine operators	17	10.2	29.5
Skilled/Trade/Technical/Clerical/sales	23	13.9	43.4
Small farmer/micro-business owner	57	34.3	77.7
Small business owner /Manager/ Administrator	13	7.8	85.5
Medium business owner/Manager/Semi-professional/ Large Farmer	2	1.2	86.7
Professional/ Large business owner/Manager	18	10.8	97.6
Other	4	2.4	100.0
Total	166	100.0	

Source: EEM, 2013

Table 58: Age Group Distribution of Farmers

<i>Age Group Categories of Farmers</i>		
	Frequency	Percent
18-29	10	16.9
30-39	11	18.6
40-49	13	22.0
50-59	19	32.2
60 and over	6	10.2
Total	59	100.0

Source: EEM, 2013

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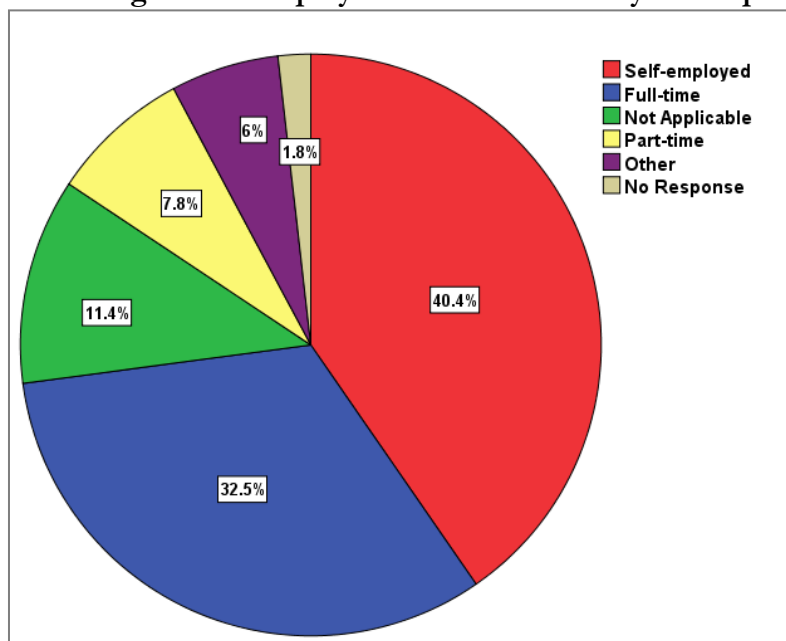
4.7.4 Employment and Income

The employment level amongst respondents was high, with only three point six percent (3.6%) of the total number of persons surveyed indicating they were unemployed. In addition to those unemployed, seven point eight percent (7.8%) of respondents were students, three percent (3%) were housewives and an estimated two percent (2%) were retired. The data showed that an estimated eighty-three point seven percent (83.7%) of respondents were employed.

Self-employment emerged as the employment status category which accounted for the majority of respondents. An estimated forty percent (40%) of all respondents were self-employed, followed by thirty-two point five percent (32.5%) of respondents who were employed on a full-time basis. Approximately eight percent (8%) of participants were employed part-time (Figure 37). The large proportion of self-employed and part-time workers was consistent with normal labour trends and patterns typical of groups involved in low skilled and skilled occupations. The trends observed in terms of employment status and occupational grouping were consistent with the parish trends presented in Section 4.6.7.

Though the surveying data shows that unemployment levels are below five percent (5%) within the social impact zone, a figure approximately eight percent (8%) below the parish level of twelve point eight percent (12.84%), it is important to note that many of the occupational tasks carried out by respondents are seasonal. Farmers, carpenters, welders and domestic workers noted that their occupational activities were not steady and therefore there were times during the year they received no income.

Figure 37: Employment Status of Survey Participants



Source: EEM, 2013

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4.7.5 Earnings

Seventy four percent (74%) of the total number of participants interviewed responded to the question on income (Table 59). The number of persons responding represented approximately eighty-eight percent (88%) of the one hundred and thirty-nine persons who were currently employed.

Table 59: Monthly Income Status of the Total Number of Respondents

<i>Monthly Income in Jamaican dollars</i>			
	Frequency	Percent	Cumulative Percent
<\$10,000	2	1.2	1.2
\$10,000-\$30,000	67	40.4	41.6
\$31,000-\$60,000	29	17.5	59.0
\$61,000-\$90,000	14	8.4	67.5
\$91,000-\$120,000	4	2.4	69.9
>\$120,000	7	4.2	74.1
No Response	20	12.0	86.1
Not Applicable	23	13.9	100.0
Total	166	100.0	

Source: EEM, 2013

The data in Table 60 presents the total number of persons employed. An analysis of income figures shows close to half of all respondents employed earned a monthly income of between \$10,000 and \$30,000, while an estimated twenty-one percent (21%) earned between \$31,000 and \$60,000. Both these income categories accounted for the largest proportion of respondents. Less than one point five percent (1.5%) of respondents earned less than \$10,000 monthly, while five percent (5%) earned in excess of \$120,000 monthly.

Table 60: Monthly Income Status of Employed Respondents

<i>Monthly Income in Jamaican dollars</i>			
	Frequency	Percent	Cumulative Percent
<\$10,000	2	1.4	1.4
\$10,000-\$30,000	67	48.2	49.6
\$31,000-\$60,000	29	20.9	70.5
\$61,000-\$90,000	14	10.1	80.6
\$91,000-\$120,000	4	2.9	83.5
>\$120,000	7	5.0	88.5
No Response	16	11.5	100.0
Total	139	100.0	

Source: EEM, 2013

An assessment of the income data by occupational level showed that the majority of persons earning in excess of \$91,000 monthly belonged in the Professional/Large Business Owner occupational group. For respondents who indicated 'teaching' as their

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profession, they accounted for an estimated fifty-four percent (54%) of the total number of persons earning in excess of \$91,000 monthly. Other persons earning in excess of \$91,000 included business owners and large scale farmers.

When the data was further disaggregated and comparisons made with national income statistics, such as the national minimum wage, several other potential scenarios were seen. For example, with approximately fifty percent (50%) of income respondents earning less than \$30,000 monthly, the probability exists that some respondents are earning less than the national minimum wage of \$5000 weekly. If the seasonality of the employment status of respondents is taken into consideration, then the number of persons earning below minimum wage is likely to become larger.

With such a large number of respondents employed in what they termed as seasonal occupations, it was not surprising that approximately forty-seven percent (47%) of all respondents had additional sources of income. A cross tabulation of the data showed that from the total number of persons employed, approximately fifty-two percent (52%) (i.e. 72 out of the 139 persons currently employed) had additional sources of income. Financial investments and remittances were the main sources of additional income.

4.7.6 Community Housing, Infrastructure and Utilities

Housing ownership within the surveyed area was higher than the national figure of sixty percent (60%) and lower than the parish figure of sixty-nine percent (69%). An estimated sixty-seven point five percent (67.5%) of the total number of persons interviewed owned the dwelling they occupied. The housing tenure pattern within the social impact zone is consistent with housing tenure patterns observed within rural areas. It is typical in rural areas to have housing ownership being the most common form of housing tenure when compared to urban areas, where 'rent' is generally the most common and preferred form of tenure.

Table 61 and Figure 38 shows the housing tenure status breakdown based on responses provided by participants during the survey.

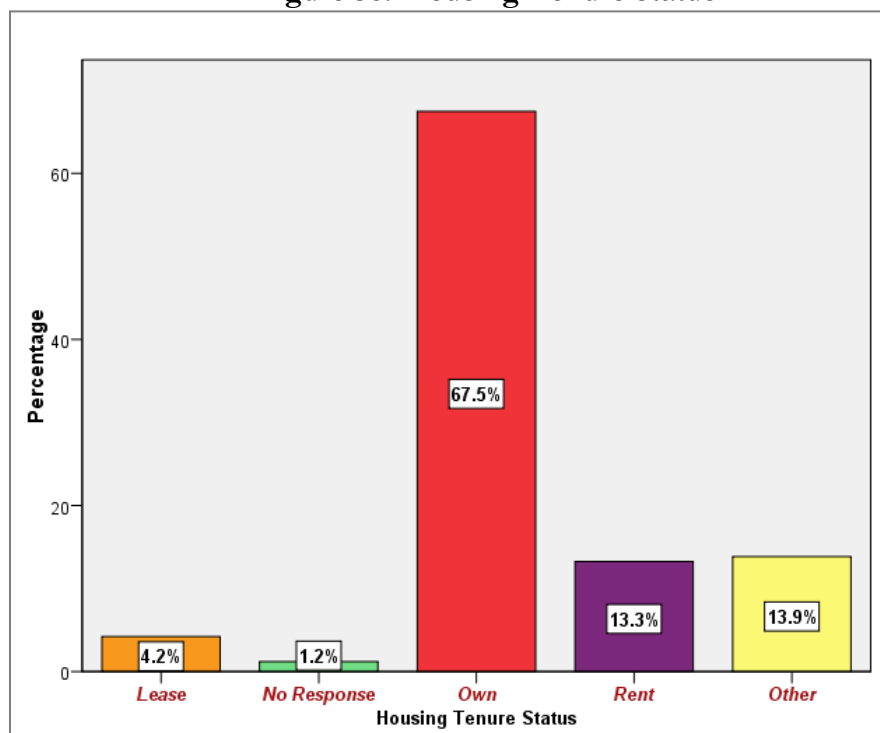
Table 61: Housing Tenure Status of Respondents

<i>Housing Tenure Status</i>			
	Frequency	Percent	Cumulative Percent
Lease	7	4.2	4.2
No Response	2	1.2	5.4
Own	112	67.5	72.9
Rent	22	13.3	86.1
Other	23	13.9	100.0
Total	166	100.0	

Source: EEM, 2013

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Figure 38: Housing Tenure Status



Source: EEM, 2013

A breakdown of the data focusing on housing tenure by community showed a level of consistency in the housing tenure status across all three major communities when compared to overall trends observed for the total group surveyed (Table 62). Ownership was the highest form of tenure in all three communities, with Malvern recording the lowest overall level of ownership at sixty-two percent (62%). The percentage of persons owning their homes, particularly in Malvern, were similar to tenure status figures published in the 2011 census on housing.

Table 62: Housing Tenure Status by Community

<i>Community and Housing Tenure Status</i>						
Community Name	Housing Tenure Status					Total
	Lease	No Response	Own	Rent	Other	
Malvern	1	1	56	10	21	89
Munro	5	0	22	4	0	31
Potsdam	1	1	34	8	2	46
Total	7	2	112	22	23	166

Source: EEM, 2013

The general housing stocks observed within the communities were constructed predominantly of concrete and/or wood. Housing conditions ranked from fair to very good within the communities surveyed. A vast majority of the housing stock

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observed were single storey dwelling units. There were a few exceptions in the community of Munro, where larger two storey dwellings were observed.

The average household size within the impact zone was 3.75, with the minimum number of person per household being 1 and the maximum being 15. The standard deviation recorded was 2.067 showing that the average size was closer to being the norm within the communities.

The average number of children per household was 1.05, with the minimum number of children per household being 0 and maximum 8. The average number of adults per household was 2.75, with the minimum number being 1 and the maximum 7. The standard deviation of 1.383 for children per household and 1.264 for number of adults per household shows the average sizes are in line with what is normal across the community for general household composition.

4.7.7 Land

The data on land tenure status was consistent with the trends emanating from the housing tenure data analysis, where currently the majority of respondents acknowledged owning the lands they occupied. Approximately sixty-three percent (63%) of survey participants claimed ownership of the land they occupied (Table 63). This figure on land ownership was approximately four percentage (4%) points less than the proportion of persons owning their house. A primary factor which contributed to this notable difference in the tenure status for land when compared to housing, as revealed by survey participants, is the number of persons occupying 'family lands.' An estimated nineteen (19%) of survey participants acknowledged that the lands they occupied were family land.

Interviews conducted with the residents within the social impact zone revealed that while persons in most cases may own the dwelling unit they occupy, lands are often-time family lands shared amongst several people for multiple and varied uses. This type of land tenure pattern assists in explaining why there is often-time a disparity between housing and land tenure ownership status in rural communities.

Table 63: Land Tenure Status

<i>Land Tenure Status</i>			
	Frequency	Percent	Cumulative Percent
Lease	6	3.6	3.6
No Response	2	1.2	4.8
Own	105	63.3	68.1
Rent	21	12.7	80.7
Other	32	19.3	100.0
Total	166	100.0	

Source: EEM, 2013

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4.7.8 Water

Large storage tanks atop houses were a common feature within the communities surveyed. Rain water harvesting and water distribution from private trucks to household tanks were the principal ways in which respondents access water for domestic uses. According to data collected and analysed on domestic water sources, only an estimated twenty-six percent (26%) of the total number of persons participating in the survey had a public connection, which was piped into their dwelling. This compares to sixty percent (60%) of respondents who depended on rain water and/or water delivered via private trucks to supply their households with water. Community members acknowledged that in some cases it was necessary to have access to several sources of water for reliability purposes and this was reflected in the survey. Approximately eight percent (8%) of respondents noted they had both water tanks and public water connections.

The absence of public connections across the community is the main contributing factor for the widespread presence of water storage tanks within the surveyed area. The National Water Commission (NWC) currently runs connections on the main road only leading into the main town centre of Malvern. Houses located along the main therefore have access to public water provided by the NWC. Recently the NWC has begun running connections along secondary roadways leading off the main. The connections are being installed as a response to growing number of housing sub-divisions that are being undertaken within the community of Munro and Malvern.

Seventy-five percent (75%) of all respondents considered their water supply to be reliable and/or very reliable. A comparison of data related to water sources and reliability did not show any major disparities based on type of source and overall reliability of the source currently being used (Table 64). For respondents who had public connection, close to twenty-eight percent (28%) considered this supply source unreliable and/or very unreliable, while an estimated nineteen percent relying on rainwater and/or private distribution trucks considered their source unreliable and/or very unreliable.

Table 64: Reliability of Various Sources of Water

Source of Domestic Water and Reliability of Water Supply Sources Cross tabulation						
Source of Domestic Water	Reliability of Water Supply Sources					Total
	No Response	Reliable	Unreliable	Very Reliable	Very Unreliable	
Both	0	8	3	2	1	14
No Response	0	0	0	0	1	1
Other	0	6	2	1	0	9
Private Connection Into Dwelling	2	58	14	21	4	99
Public Piped in Dwelling	1	21	12	8	1	43
Total	3	93	31	32	7	166

Source: EEM, 2013

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4.7.9 Lighting

Electricity was the main source of lighting for households within the communities. Ninety-five percent (95%) of respondents used electricity as their main lighting source. The Jamaica Public Service Company Limited (JPS) is the major provider of electricity services to the communities surveyed. Other sources of light included candles and kerosene lamps.

The Hampton School for Girls, in addition to receiving electricity service from JPS, also has small wind turbines which provide electricity to various buildings on the school's compound, inclusive of the staff cottages. The Munro College previously used a wind turbine to generate electricity for its facilities; however the turbine is no longer in operation.

Only twelve percent (12%) of survey participants considered their electricity supply unreliable and/ or very unreliable. Persons acknowledging the unreliability of their service used electricity as the main lighting source for their household.

Survey participants (149 out of 166) who utilised electricity as their main lighting source spent on average \$6,600 monthly for electricity services. The minimum spent to cover electricity costs was \$1,500 and the maximum \$28,000 (Table 65). Only four percent (4%) of respondents spent in excess of \$15,000 to cover electricity costs. Approximately eighty-eight percent (88%) spent between \$1,500 and \$10,000 monthly to cover electricity costs. There was no distinct correlation or clear identifiable pattern between household size and the costs associated with electricity services.

Table 65: Descriptive of the Cost of Electricity

<i>Costs of Electricity</i>			
Minimum	Maximum	Mean	Standard Deviation
\$1,500	\$28,000	\$6,693.29	\$3,866.412

Source: EEM, 2013

4.7.10 Solid Waste

Open air burning of garbage is still widely practiced in rural communities in Jamaica. The practice continues due to (i) cultural norms and traditions which are ingrained in society, (ii) the inadequacy of solid waste infrastructure and facilities to meet the current demand and (iii) lack of adequate road infrastructure (poor road conditions) which makes it difficult to access some rural communities.

Amongst the group surveyed, an estimated sixty-nine percent (69%) revealed that they utilised the services of the public garbage collection agency, while approximately twenty percent (20%) acknowledged burning their garbage. Eight percent (8%) of respondents burnt and utilised public garbage collection services. Less than three percent (3%) of respondents utilised private garbage collection services.

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Persons who burnt their garbage explained that the public garbage truck does not service all sections of the various communities and mostly provide collection services for persons located on the main road ways. As a means of protecting themselves against vermin and rodent infestations, the general practice is to dig deep holes in the back yards of the residential land occupied by households, where garbage is then thrown in and burnt. In some cases residents may have their garbage transported to the main road on days scheduled as garbage collection days within their communities. Residents have said this practice has however waned as the infrequency of garbage collection often-times results in the ‘piling up’ of garbage, in which case burning becomes the default option for residents.

The collection and burning of garbage is generally undertaken weekly. Table 66 shows the primary methods of garbage disposal used in the communities surveyed.

Table 66: Methods of Garbage Disposal

<i>Method of Garbage Disposal</i>			
	Frequency	Percent	Cumulative Percent
Burn Only	33	19.9	19.9
Other	1	0.6	20.5
Public Garbage Truck and Burn	14	8.4	28.9
Private Collection Only	3	1.8	30.7
Public Garbage Truck Only	114	68.7	99.4
Public Garbage Truck and Private Collection	1	0.6	100.0
Total	166	100.0	

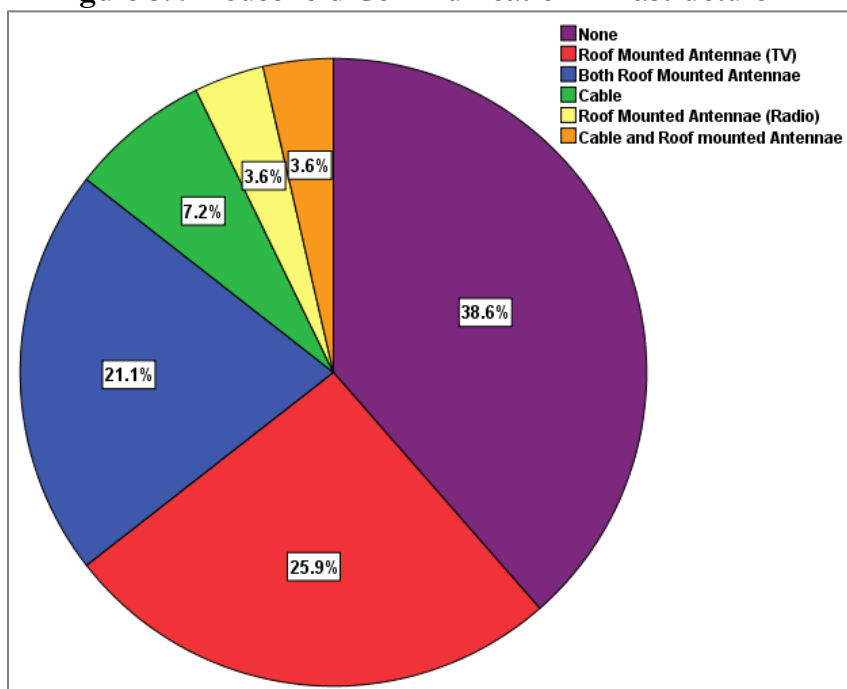
Source: EEM, 2013

4.7.11 Communication Infrastructure

Roof mounted communication features/infrastructure were used widely throughout the communities. Sixty-one percent (61%) of survey participants had one or more types of roof mounted antennae. These included roof mounted antennae for television and radio. Roof mounted antennae for television were the most utilised type of communication infrastructure, with forty-seven percent (47%) of all respondents or seventy-six percent (76%) of the total number of persons having roof mounted infrastructure utilising the feature (Figure 39).

Several satellite dishes were observed atop houses within the communities. Discussions with residents revealed that the presence of satellite dishes had significantly decreased as more persons now have access to cable services which are provided by private cable companies.

Figure 39: Household Communication Infrastructure



Source: EEM, 2013

4.7.12 Community Organisation and Structure

Interaction and dialogue with community members, is arguably one the most critical aspects of the SIA report. The community structure is an important component, which ultimately creates the platform for which community members can share their concerns and outline their expectations as it relates to the introduction of developments within their community. This section of the survey provides an overview of the existing community structure and provides a look at the leadership structure and social capital which exists within the community.

1. Community Appreciation and Development

Peaceful, safe and a wonderful climate is how the majority of respondents described the community in which they reside. Respondents were appreciative of the lack of major crimes being committed in their communities. The survey data showed that more than fifty percent (50%) of respondents valued their community because they considered it safe (Table 67). An examination of the data on criminal occurrence revealed that approximately seventy-two percent (72%) of the total number of persons surveyed had no concerns about major crimes as their community was not being affected by such activities. For those indicating the occurrence of criminal activities within their community, eighty percent (80%) identified praedial larceny as the criminal activity which posed the greatest threat to themselves and other community members.

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This type of criminal activity, though not widespread, was of concern given the heavy reliance on farming within the communities to support economic livelihoods.

Other factors noted by respondents as being of value to them were the physical environment and climate. Forty percent (40%) of respondents accounted for the total number of persons who were appreciative of (a) the physical environment and (b) climate. The climate in the Malvern-Munro area is considered one of the best in the world. Farmers in particular noted that the land resources and climate were well suited for farming.

Table 67: Respondents Reasons for Valuing Community

<i>Community Value</i>		
	Frequency	Percent
Community Activities	2	1.2
Climate	33	19.8
Everything	7	4.2
Educational Facilities	1	.6
Employment	1	.6
Nothing	1	.6
No Response	5	3.0
Peaceful/Quiet/Safe	94	56.6
Physical Environment	34	20.5
People	17	10.2

Source: EEM, 2013

While survey participants were quite appreciative of the social and environmental benefits of living in their communities, many bemoaned the lack of economic opportunities available to residents, particularly young boys. More than one third of the group surveyed (36.7%) identified the creation of job opportunities and the development of businesses and industries as being critical for the social and economic development of their community. In discussions held with several residents it was pointed out that their communities were extensively affected by youth migration as there were no job opportunities for the young men and women leaving high school. They also noted for those who matriculated to universities to further their studies, there were no incentives for them to return to their communities.

Infrastructural development, specifically the lack thereof, was also highlighted as an area where the community has the potential to benefit. Approximately fifty-two percent (52%) of respondents noted that poor road conditions, the absence of water infrastructure, limited telecommunications (internet) and banking infrastructure such as automated machines, were hampering the development of their community (Table 68).

For close to eleven percent (11%) of respondents social development facilities and training/skills centres were the most critical requirements for their community.

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Community members expressed that there was a lack of social programmes and training facilities within the communities, which often resulted in many young people remaining idle or otherwise engaged in ‘questionable’ activities. Participants noted that for young people who were not interested in farming and/or teaching and wanted to acquire other practical skills, there were no facilities/centres within their communities to satisfy these desires. Community members often travelled to the main town of Santa Cruz to access such facilities.

Sporting activities, as supported by the data which showed that an estimated seventy-eight percent (78%) relied on the activity for recreational purposes, remains the single most popular activity which all community members participate in at some level. Football is the top sporting activity within the communities located within the social impact zone. During football events, whether formally or informally organised, it is normal to see community members gathering at the event. Respondents were quick to note that football and other sporting activities were the only form of ‘engaged activities’ young people had within their community.

Table 68: Respondents Views on Types of Community Improvements Needed

<i>Types of Community Improvements</i>		
	Frequency	Percent
Community and Municipal Facilities	3	1.8
Housing	15	9.0
Infrastructural Development	86	51.8
Social Development Facilities Training/Skills Centres	18	10.8
Business Development and Job Opportunities	61	36.7
More People	1	.6
None	4	2.4
No Response	7	4.2
Improvement of Air Quality	1	.6

Source: EEM, 2013

2. Community Structure and Social Capital

One of the recurring themes during the survey was the slow pace at which the communities within the Malvern area were developing and the general decline of organised community groups. Voluntary community groups focusing on various aspects of the social, economic and environmental development of the community were said to be on the decline, with many young people disinterested in carrying on the work of these organisations. Based on the results of the survey, forty-seven percent (47%) of the total group surveyed were aware that a community citizen’s association existed in their community, with even a smaller amount, only eight percent (8%) of the total number of persons surveyed (18% of those aware of the associations) being members of these associations (Table 69 and Figure 40).

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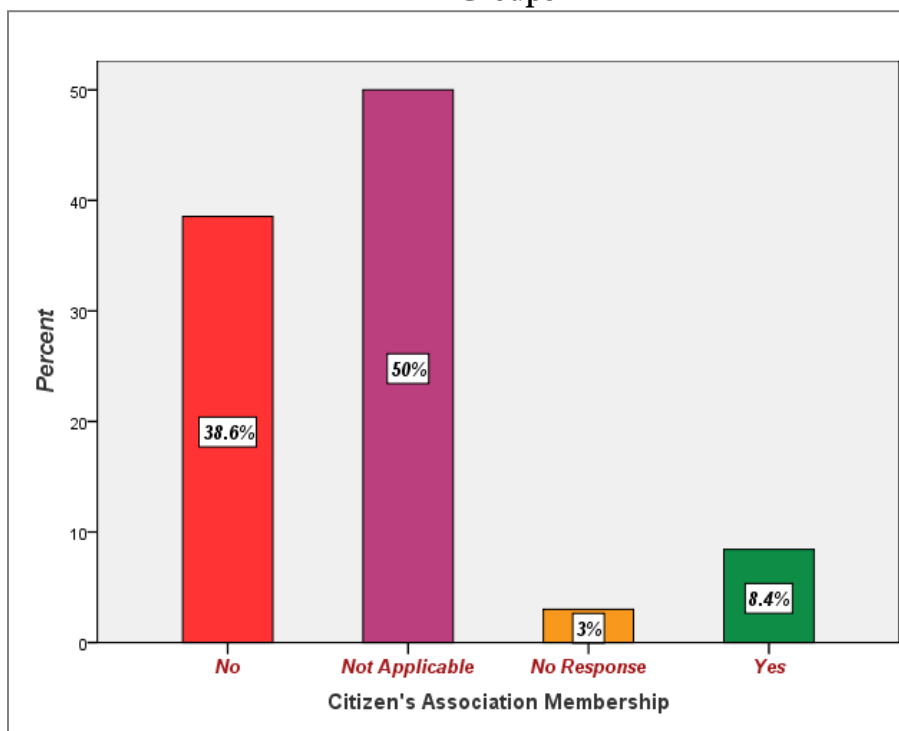
Table 69: Level of Community Awareness on Existence of Citizen's Association

<i>Community Citizen's Association Awareness</i>			
	Frequency	Percent	Cumulative Percent
No	84	50.6	50.6
Yes	78	47.0	97.6
No Response	4	2.4	100.0
Total	166	100.0	

Source: EEM, 2013

Citizen's association meetings are normally held at the community centres located in each major district. The Munro and Potsdam communities are served by the Potsdam and Munro Community Centres, respectively while the community of Malvern has several Community Centres serving various communities within the district. An estimated sixty-four percent (64%) of respondents were aware of the existence of a community centre in their community. Of the total indicating they were aware of the community centre, close to forty percent (40%) used the community centre.

Figure 40: Proportion Respondents who are Members of Citizen's Association Groups



Source: EEM, 2013

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The number of persons aware of the presence of voluntary groups within their community was even less. Only twenty four percent (24%) of respondents were aware of the existence of such groups and the work they were doing in their and other surrounding communities. Work carried out by such groups involved community beautification projects, welfare programmes targeting vulnerable groups such as children, the elderly and the disabled and educational initiatives and programmes. The groups undertaking such work include: Red Cross, Police Youth Club and the Church through its various outreach groups.

Informal discourse with several community members revealed that the community of Malvern previously had a Cancer Society and A Women's Citizen's Group. However an ageing population and increased youth migration had resulted in the decline and eventual disbandment of these organisations.

On matters related to the community's development, community members and members of the political directorate e.g. Councillors and Members of Parliament were identified as the primary decision makers. One-third of all respondents recognised community members as the main decision makers for matters related to their community. A similar number of respondents identified Councillors as the primary decision makers within their communities. Twenty percent (20%) of survey participants were not aware or were unsure how decisions about their community's development were made.

4.7.13 Natural Disasters

Lightning storms, hurricanes, drought, fire and earthquakes were recognised as the various types of natural disaster events affecting the communities within the social impact zone. Lightning storms and hurricanes were identified as the two major disaster events affecting the community as shown in Table 70. Lightning storm events are generally associated with rainfall events, but in some instances lightning events are associated with no precipitation at all. Lightning strikes have been known to damage buildings and split trees within the social impact zone and in rare cases people have been hurt or killed.

Table 70: Types of Disasters Affecting Communities

<i>Types of Natural Disasters</i>		
	Frequency	Percent
Drought	39	23
Fire	39	23
Hurricane	166	100
Earthquake	39	23
Lightning storms	166	100

Source: EEM, 2013

Though hurricane events do not happen frequently, their occurrence usually results in widespread flooding, the destruction of property and the displacement of people in Jamaica. While flooding has not affected communities within the impact zone, the

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destruction of property and displacement of people have been associated impacts of hurricanes. In the event of hurricane events, community members generally seek shelter at churches or schools. The churches and schools designated as disaster shelters in the community are:

- Y Bethlehem All-Age
- Y Bethlehem Moravian Church

The community centre in Potsdam is also used as a place for shelter.

4.7.14 Natural Resource Usage and Management

Land resources were recognised by respondents as being the most critical resource within their community. An estimated ninety-six percent (96%) of respondents deemed the resource important, with seventy percent (70%) noting that they utilised land resources within their communities for domestic and commercial purposes. The vast utilisation of land resources and the high importance given to such resources was not unexpected given the community's current dependence on farming to support economic livelihoods.

Survey participants were questioned about particular threats or sources of pollution affecting the resources they utilised however only eleven percent (11%) of respondents indicated that their resources were being affected by pollution. Indiscriminate dumping of garbage was identified as the major pollution threat to land resources.

4.7.15 Wild Life

Eighty-two percent (82%) of survey participants highlighted that various types of wildlife species were present in their community, with approximately seventy seven percent (77%) of the group identifying these resources as important. Though not a popular community activity, bird shooting is carried out as a recreational activity within the periods designated as bird shooting season.

1. Migrant Birds

Migrant bird species are common across the landscape of Jamaica and have been identified in the social impact zone. However residents interviewed as part of the survey were not aware of the differences between migrant and local bird species. In fact only thirty-six percent (36%) of respondents indicated that they had noticed migrant birds within their communities during late summer to early September, with many observed over several months extending into early December. The survey revealed that farmers were more aware of the various types of bird species which interacted with the landscape and were able to some extent differentiate between local and migrant species.

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2. Bats

There are several small caves within the social impact zone, however many of them have not yet been the target of major exploration. With several caves littered across the landscape, the presence of bats does not go unnoticed within the communities. While the survey data showed that only sixty-five percent (65%) of respondents had observed bats within their communities, residents were quick to point out that the number of bats usually observed within the community had declined substantially with the destruction of the old wattle and daub¹⁶ buildings within the communities. Older survey participants noted that bats generally lived in the roof tops of these older buildings and came out at nights to forage and feed. Table 71 shows the frequency of bat sightings from community members.

Bat sightings are common at the older type buildings located on the campuses of the Bethlehem Teachers College and the Hampton School.

Table 71: Frequency of Bat Sightings in Community

<i>Frequency of Bat Sightings</i>		
	Frequency	Percent
Daily/Nightly	51	46.8
No Response	13	11.9
Occasionally	40	36.7
Weekly	5	4.6
Total	109	100.0

Source: EEM, 2013

For persons noting the presence of bats, approximately forty-seven percent (47%) saw the species on a daily basis (nights), while an estimated forty-one percent (41%) saw them less frequently.

4.7.16 Community Social Impacts

This section gives an overview of the perspective of stakeholders on the potential negative and positive impacts that may arise with the implementation of the proposed project.

1. Project Awareness and Support

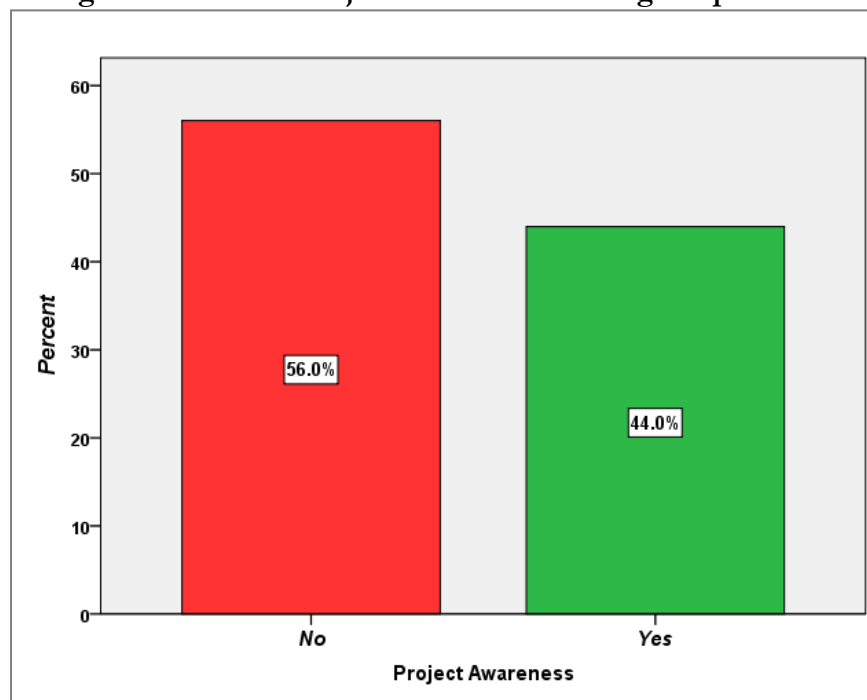
Forty-four percent (44%) of all respondents were aware of proposed plans to expand the existing wind farm at Munro (Figure 41). Respondents who had gained some knowledge of the proposed project had heard through multiple sources. These included: community members (word of mouth), daily newspapers and radio. For those who had heard about the project, the vast majority were unsure if the project

¹⁶ Wattle and daub is a composite building material used for making walls, in which a woven lattice of wooden strips called wattle is daubed with a sticky material usually made of some combination of wet soil, clay, sand, animal dung and straw.

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was being done by a private entity or in collaboration with the Jamaica Public Service Company Limited. The enquiry about the developer of the proposed wind farm is likely linked to the public's general distrust of and discontent with the JPS surrounding ongoing issues related to the increasing cost of electricity services.

Figure 41 Level of Project Awareness Among Respondents



Source: EEM, 2013

Community members were highly supportive of the project, with several respondents noting that their support was predicated on the basis that JPS was not the developer. Approximately eighty-six percent (86%) of the group surveyed supported the project, while an estimated thirteen percent (13%) were totally against the project. The remainder of respondents either provided no response to the question or were unsure. On the basis of importance, overall eighty-two point five percent (82.5%) of community members surveyed felt the project was important both for their community and in the national interest (Table 72).

Table 72: Respondents Perspective on the Importance of the Project

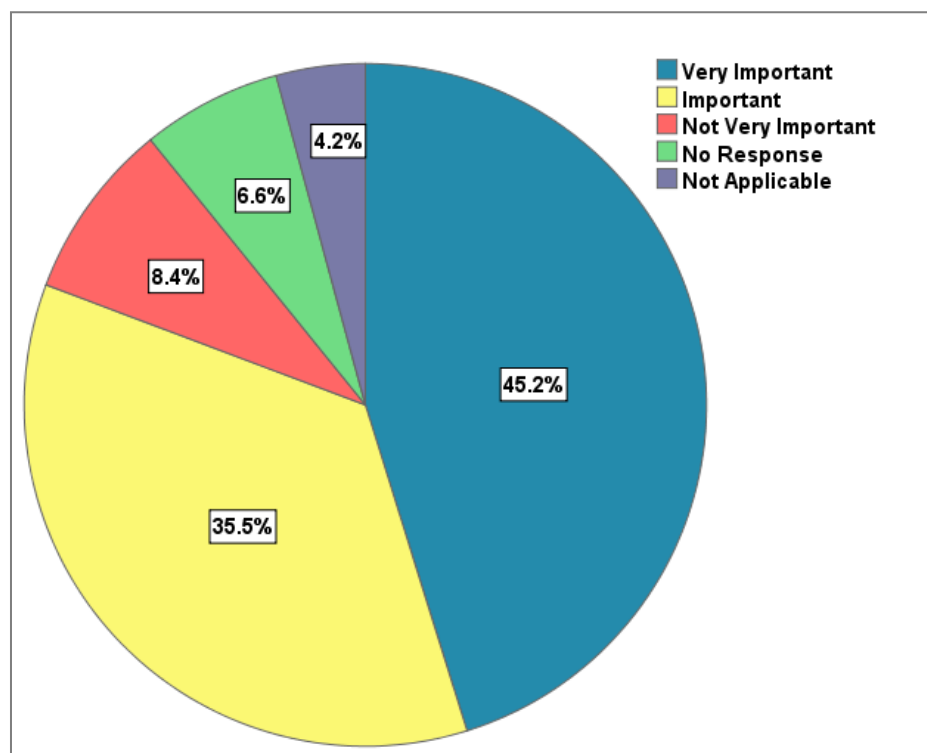
<i>Importance of Proposed Project</i>			
	Frequency	Percent	Cumulative Percent
No	20	12.0	12.0
No Response	8	4.8	16.9
Unsure	1	.6	17.5
Yes	137	82.5	100.0
Total	166	100.0	

Source: EEM, 2013

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Forty-five percent (45%) of the total number of persons surveyed ranked the project as being '*very important*,' with an additional thirty-five percent (35%) gave an overall ranking of '*important*.' A breakdown of the figures shows that the number of persons ranking the project as '*very important*' represented close to fifty-five percent (55%) of the total number of persons supporting the project, while those who assigned the project a ranking of '*important*' represented forty-three percent (43%) of the total number of respondents who supported the project (Figure 42).

Figure 42: Overall Level of Importance as Ranked by Respondents



Source: EEM, 2013

An expected reduction in the cost of electricity, an improvement in the supply of electricity and reduced dependence on oil/fuel imports were a few of the reasons behind the support given by respondents towards the project. Fifty-three percent (53%) of respondents indicated that their reason for supporting the project was the expected reduction in electricity costs and an improvement in the electricity service provision. It was important to note that respondents believed that the reduction in electricity costs should also filter down to the consumer. Other key reasons given for community support included:

- Y Opportunity for job creation
- Y Reduction in oil/fuel imports
- Y Promotion and use of renewable and alternative sources of energy
- Y Environmental protection and conservation

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- Y Opportunity for community investment and development
- Y Promotion of new and emerging technologies
- Y Stimulation of local and national economy through spin off and multiplier effects

For the estimated thirteen percent (13%) of respondents who were not in support of the project, the following were identified as the primary reasons:

- Y The project only benefits the developers. Revenues earned from the project are not used to support community programmes or initiatives or establish community programmes which help with long-term outputs. All revenues earned go back to the developer.
- Y The project will lead to the destruction of farm lands, which will affect the livelihoods of a significant number of persons who depend on farming to support themselves and their families.
- Y Community resources were being utilised and there are no direct benefits to the community or its members, particularly in the operational phase. Respondents against the project noted that while a few community members were able to receive job opportunities during the construction phase of projects, residents do not see any reduction in their overall electricity bills with the introduction of wind turbines in their communities. Those opposing the project, and to some extent some supporting, felt the community should receive direct benefits as the resources within their community were being utilised and residents were being inconvenienced to support these developments.

4.7.17 Project Impacts – Community Perspective

The data examined showed that the respondents interviewed as part of the representative sample were supportive of the proposed project. However while there was overwhelming support for the project, respondents identified several concerns as it related to the construction and operation of the wind farm within their community. While highlighting their concerns, respondents also noted the potential positive impacts that they associated with the undertaking of this project. The impacts identified by respondents are presented below.

4.7.18 Project Impacts (Negative)

1. Temporary and/or Permanent Displacement of Farmers

Approximately nineteen percent (19%) of survey participants felt the project would have a negative impact on agricultural lands, while twelve percent (12%) felt farmers would be placed at a disadvantage as a result of the project. The destruction of farming plots, crops, limited compensation for farming products lost and the potential loss of access to agricultural lands were some of the concerns raised by respondents.

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It is important to note that while the majority of persons interviewed did not think the project would have a permanent negative impact on farmers, they felt during the period of construction, farmers were the most likely group to be affected given their dependence on the land to support their livelihoods and that of the communities.

Threats included:

- Y Air pollution from construction related activities affecting farmers and their crops
- Y Land excavation and clearance resulting in destruction of lands and crops
- Y Noise pollution, resulting in disturbance of farmers and animals

Respondents highlighted that proper compensation/redress mechanisms were required to address concerns/issues likely to arise due to the proposed project.

2. Noise Nuisance

The majority of respondents surveyed noted that the existing turbines installed by the Jamaica Public Service Company Limited had not resulted in an increase in nuisance noise levels within their communities. Many noted over time that residents had become acclimatised to the sound emitted by the turbines. In fact many noted the distance of their homes from the turbines contributed to the limited disturbance residents experienced. Farmers indicated that it was while working on their farms that they were likely to hear the sounds of the turbines given the close proximity of the turbines to farming lands.

The survey data showed that approximately nineteen percent (19%) of respondents expected an increase in nuisance noise levels with the implementation of the new wind turbines.

3. Lightning Strikes

Respondents were increasingly aware of the impacts lightning strikes have had in their community and the frequency with which these events occurred. There were therefore concerns surrounding the construction of the turbines and the ability of the structures to 'attract' lightning. Respondents felt the structures placed them at additional risks during lightning storms as parts of the turbines could become dislodged hitting someone.

4. Limited Community and Personal Benefits

It was clear from the responses provided via the questionnaires and community walk through that survey participants were highly sceptical about the benefits to be derived by community members. More than a third of respondents did not anticipate receiving any personal benefits from the project, whether in the form of employment

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or a reduction in their electricity bills. An estimated fifty five (55%) percent of respondents did not expect to see a reduction in their electricity bills, even though many felt community members should at least benefit directly from these projects. It was interesting to note that approximately forty-six percent (46%) of respondents felt that community members would receive some form of benefit, but this was likely to be short-term employment.

Community members were quick to highlight that they had received no benefits from the establishment of the JPS wind farm project constructed in 2009, beyond a few community members getting work as part of the construction team. Seventy-seven percent (77%) of respondents felt their community had the necessary skill sets required during the construction phase of the project. There was a general consensus that skill sets required for the operational phase of the project were lacking within the community. However a number of respondents felt this was an area where the project could benefit the community, as this was an opportunity for training to be offered to capable locals to assist in the operation and maintenance of the turbines after construction of the wind farm.

5. Other negative impacts

Other negative impacts identified by community respondents included:

- Y Migration of workers into the communities
- Y Increased competition for limited/scarc water resources during construction of the wind farm
- Y Increased potential for accidents on roadways related to children

4.7.19 Project Impacts (Positive)

1. Employment and Stimulation of Local Economy

Seventy four percent (74%) of respondents expected the project to have an overall positive impact on job creation, both for community members and the general public. While twenty one percent (21%) of respondents felt there would be no likely changes to the employment status in their community, it was generally believed that jobs created would be given to persons outside of the community. The data showed that an estimated fifty five (55%) percent of respondents were hopeful about themselves or other community members receiving a job as a result of the project.

2. Enhancement of Landscape Aesthetics (Community Appearance)

Approximately forty percent (40%) of survey participants held the view that the presence of the turbines would help to improve the overall appearance of their community. The turbines were called 'beautiful' by some participants, while others thought their appearance gave the community a distinct look.

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3. Reduction in Electricity Costs

While there was widespread scepticism about community members seeing a likely reduction in their electricity bills, respondents anticipated that a likely reduction in electrical costs would be the end result of such a project being implemented, though they were not the likely recipients. Sixty-eight percent (68%) of respondents indicated that a reduction in electricity costs was expected, which should yield tremendous direct benefits for JPS and indirect benefits for community members. Respondents were of the general view that financial resources saved from a reduction in the number of barrels of oil/fuel imported can be used in other critical areas such as education and health. It is through this medium that respondents saw the opportunity for direct personal benefits.

4. Stimulation of Macro-economy

Fifty-nine percent (59%) of the total number of persons surveyed felt the project would have a positive impact on the economy overall. Job creation, reduction in fuel imports, introduction of new technologies, development of local capacity through skills development training and development of a potential tourist product, were some of the areas in which community members felt the project would help to stimulate the economy.

5. Environmental Conservation and Promotion of Renewable Energy Sources

A reduction in fuel/oil imports and the use of natural renewable resources was identified by an estimated one third of community members as an opportunity to promote environmental conservation within their community. The use of pollution free methods to generate energy were highlighted as potential educational and health benefits for the communities in which the project is being proposed for implementation.

6. Educational Awareness and Training

Several community members interviewed felt the project being proposed could be used as an educational opportunity for young people within the community and across Jamaica. Respondents proposed that under the project, school children are given the opportunity to visit the wind farm and learn about the functions of the turbines. The persons supporting this venture believed community members could be identified and trained to execute these educational programmes.

7. Other positive impacts

Other positive impacts identified by respondents included:

- Y Increase in land value
- Y Improvement in the supply of electricity

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4.7.20 Community Benefits: Desired Outcomes and Partnerships

Community members surveyed, while able to identify potential benefits to be derived from the project, were quick to point out that these benefits are mostly short-term. Employment opportunities offered during the project were seen as the most direct and tangible community benefits. However these benefits were mostly linked to the construction phase of the project. Throughout the survey respondents referenced the wind farm established by the JPS, which many indicated had provided no other benefit to the community beyond short-term employment during construction. Residents highlighted that much of the benefits associated with the establishment of the Munro Wind Farm had not filtered down to the community. The preference for community members were to see more direct community benefits from the project, given the trade-offs necessary between the developers and community members for the project to be a success. The following were proposed as possible avenues for the project proponents to make more valid and tangible long-term contributions within the Malvern-Munro District:

1. Provide training opportunities for locals in the maintenance of the turbines, thereby giving them an opportunity to secure employment during the operational phase of the project
2. Provide financing for the construction of a community training facility, offering various types of programmes for young people, including a training programme on the management of turbines
3. Partner with the Bethlehem Teacher's College in developing a programme focusing on environmental conservation and renewable energy and provide a scholarship grant for one student at the institution wishing to further their studies in environmental management and energy conservation.
4. Provide funding, equipment and/or technical support for the restoration of the Munro Wind turbine
5. Establish scholarship grants for two (2) students from either the Munro College and/or Hampton School for Girls wishing to pursue tertiary studies in the field of civil and/or environmental engineering
6. Partner with the Malvern Science Resource Centre to restore the centre and open a section focusing on wind turbines and their functions

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Table 73: Respondents Perspective on the Potential Impacts Associated with Project

	Positively		Negatively		No Effect		No Response		Not Sure	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Agricultural Lands	15	9.0	31	18.7	112	67.5	4	2.4	4	2.4
Bauxite Lands	7	4.2	11	6.6	139	83.7	6	3.6	3	1.8
Land Values	46	27.7	12	7.2	96	57.8	8	4.8	4	2.4
Noise levels	3	1.8	32	19.3	122	73.5	7	4.2	2	1.2
Job Creation	124	74.7	2	1.2	35	21.1	4	2.4	1	.6
Economy	98	59.0	6	3.6	52	31.3	6	3.6	4	2.4
Cost of Electricity	113	68.1	3	1.8	40	24.1	7	4.2	3	1.8
Community members	76	45.8	3	1.8	77	46.4	6	3.6	4	2.4
Community Appearance	66	39.8	2	1.2	89	53.6	6	3.6	3	1.8

Source: EEM, 2013

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5.0 Analysis of Alternatives

5.1 Do Nothing (Status Quo)

The Government of Jamaica (GOJ) is seeking to increase the percentage of renewable sources in the energy supply mix. The GOJ has established a revised target of 30% by 2030, 10% higher than the previous target identified in the 2009-2030 National Renewable Energy Policy. In 2009, the GOJ had a target percentage of 10% by 2010 and 11% by 2012. According to information from the Renewable Energy Division within the Ministry of Science, Technology, Energy & Mining (January 2014) at the end of 2013, 10% of the energy supply mix in Jamaica was via renewable sources. This figure has remained unchanged since 2011.

The proposed project will add approximately 3-4% of renewable energy to the existing supply mix with the installation of the 34 MW wind farm. Under the proposed project schedule, the wind farm would be fully operational by 2015, thereby increasing the energy supply mix from renewable sources to 14%. This percentage would keep Jamaica on track to meet its target of 30% by 2030 and surpass the intended target of 12.5% for 2015.

A reduction in fuel imports is also one of the intended sustainable development targets for the GOJ. With more than US\$2 billion spent annually on the importation of oil, the GOJ is seeking to reduce overall dependence on oil imports, which accounts on average for more than 12% of GDP. The proposed project will eliminate the need for the importation and burning of approximately 250,000 barrels of foreign oil annually. Within the lifespan of the project over 5 million barrels of oil would not need to be imported, resulting in a likely saving of over US\$500 million.

Jamaica is currently lagging behind in terms of meeting its desired targets for renewable energy generation. The slow pace of energy generation via renewable sources prompted the GOJ to issue a request for proposal for the supply of 115MW of renewable energy in 2013. The RFP was in keeping with the GOJ's commitment to diversify the energy sector. Under the 'Do nothing' scenario the GOJ would lose the opportunity to meet and surpass its 2015 target of 12.5% contribution of renewable energy to the energy mix. Additionally the opportunity for a significant reduction in the number of barrels of oils imported annually would be lost.

5.2 Alternative Energy Generation Technology

The proposed site, based on studies done on the renewable energy potential of Jamaica, has both wind and solar energy potential. The irradiance potential of the site is in excess of 5 kWh/m²/day; making the site ideally suited for solar energy generation. However solar farms are land intensive projects and require expansive land areas to make them commercially viable. To generate 1MW of solar energy, approximately 2.4 hectares (6 acres) of land is required. Therefore to generate 34MW of solar energy would require at least 81.6 hectares of land area, approximately 45% more land area than what is required to support the proposed 34 MW wind farm, along with supporting infrastructure e.g. roads, office/maintenance

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complex etc. It should be noted that the 2.4 hectares of land area required to generate 1MW of energy, does not include the space required for supporting infrastructure.

A comparison of the technologies has shown that the power output per footprint from wind is generally greater than solar. Wind farms are more cost effective and efficient than solar panels for commercial scale production for the national grid and are also considered less costly to maintain.

5.3 Alternative Land Use

Bauxite mining and agricultural expansion are alternative land uses which could be accommodated at the proposed location for the wind farm. Currently agricultural activities are wide spread within the proposed project area as farming is the main source of economic livelihood for persons living within the Malvern area. An increase in the land area farmed can support agricultural expansion and help to improve local economic conditions through the provision of jobs.

Bauxite mining, also a viable alternative, was once a dominant economic activity within the parish. The Alpart bauxite company provided employment to many residents within parish, including the project area, creating and supporting socio-economic opportunities and benefits. The project area is rich in bauxite deposits and is therefore a suitable mining site.

While both alternative land uses can co-exist with the proposed land use, there are external issues which currently do not make these alternatives viable.

1. Land tenure issues, along with the rapid conversion of land for housing within the project area have placed some restrictions on the land area available to farmers for use.
2. The closure of the Alpart Company recently has resulted in the cessation of bauxite mining within the parish of St. Elizabeth; though only likely to be an extended temporary closure.

5.4 Alternative Site

Jamaica's wind energy potential is vast, but only a selected number of sites are ideally suited for large viable commercial wind farms. These sites are found in the parishes of St. Mary, St. Thomas, Manchester and St. Elizabeth. The parishes of Manchester and St. Elizabeth have been identified as two of the most ideally suited locations for large commercial wind farms because of the wind speeds generated in such areas. Sites such as Wigton in Manchester and Retrieve (Malvern) in St. Elizabeth have wind speeds in excess of 10 m/s and are able to generate considerable energy via the use of wind turbines.

The proposed project is located within one of the highly suited sites for wind energy generation in Jamaica. The site is located in the district of Malvern, <1 km from the community of Retrieve and generates wind speeds in excess of 10 m/s. This site offers tremendous opportunities for development, not only because of its wind energy potential,

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but due to its overall accessibility. One of the challenges in developing commercial wind farms in areas suited for energy generation by wind is the issue of access to these areas. There is no suitable road infrastructure in some of these areas and the topography consists of very steep angled slopes which makes construction related activities difficult.

The proposed area for the development of the 34MW wind farm has an advantage in that the area has already seen the development of one commercial wind farm. The area has therefore undergone developmental changes, which facilitate construction activities related to the proposed project.

6.0 Impact Identification and Assessment

The purpose of this task is to identify the major environmental and socio-economic impacts of the construction and operation associated with the proposed Wind Farm. 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.

6.1 Environmental Considerations for Wind Farm Design and Layout

BMR Jamaica Wind Ltd. will ensure that in the siting of each wind turbine all physical, biological and social environmental conditions identified in the environmental baseline are considered and properly assessed to ensure limited to no negative impact with the construction and operation of the wind farm. In cases where negative impacts are likely, mitigation measures will be implemented to ensure the protection of the environment and all sensitive receptors.

The main activities to be undertaken for this project:

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

The main negative environmental impacts for all the above project phases are outlined in Table 74.

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Table 74: Potential Negative Impacts

ASPECT		POTENTIAL NEGATIVE IMPACTS
Construction phase		
13.	Fugitive dust emissions	<ul style="list-style-type: none"> • Air pollution • Respiratory problems
14.	Noise	<ul style="list-style-type: none"> • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
15.	Gaseous emissions	<ul style="list-style-type: none"> • Air pollution • Respiratory problems
16.	Land clearing and construction activities	<ul style="list-style-type: none"> • Vegetation loss/Disturbance of biological communities • Loss of Agricultural Crops and Displacement of Farmers and loss of revenue • Land slippages • Air pollution • Habitat destruction • Disruption of ecosystems • Soil erosion/sedimentation <ul style="list-style-type: none"> ○ 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
17.	Increased traffic movement	<ul style="list-style-type: none"> • Traffic congestion • Motor vehicle accidents
18.	Vibration from blasting	<ul style="list-style-type: none"> • Disruption of earthquake monitoring • Noise interference
19.	Solid waste (top soil, vegetation, construction debris, garbage)	<ul style="list-style-type: none"> • Land and water pollution
20.	Use of fuel	<ul style="list-style-type: none"> • Depletion of (oil) resources
21.	Use of water	<ul style="list-style-type: none"> • Depletion of water resources
22.	Human waste	<ul style="list-style-type: none"> • Land and water pollution
23.	Spills	<ul style="list-style-type: none"> • Land and water pollution
24.	Construction work	<ul style="list-style-type: none"> • Accidents causing death or injury

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ASPECT		POTENTIAL NEGATIVE IMPACTS
Operation Phase		
11.	Noise	<ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent)
12.	Disruption in avifauna flight patterns	<ul style="list-style-type: none"> Bird and bat deaths
13.	Vibration	<ul style="list-style-type: none"> False earthquakes detected on seismograph monitoring equipment Noise interference
14.	Disruption of air traffic	<ul style="list-style-type: none"> Plane crashes
15.	Lightning strikes	<ul style="list-style-type: none"> Fires Disruption in electricity supplies
16.	Flickering	<ul style="list-style-type: none"> Health impacts – epilepsy in rare cases
17.	Diffraction/Shadowing, Reflection, Scattering	<ul style="list-style-type: none"> Electromagnetic interference which can affect radar and radio communication
18.	Aesthetics	<ul style="list-style-type: none"> Visually unattractive
19.	Land use	<ul style="list-style-type: none"> Alteration of development and land use in the area Depreciation of land value
20.	Oil spills/leaks	<ul style="list-style-type: none"> Land and water pollution
Maintenance		
5.	Oil spills/leaks	<ul style="list-style-type: none"> Land and water pollution
6.	Solid waste	<ul style="list-style-type: none"> Land and water pollution
7.	Human waste	<ul style="list-style-type: none"> Land and water pollution
8.	Maintenance work	<ul style="list-style-type: none"> Accidents
Decommissioning		
5.	Solid waste	<ul style="list-style-type: none"> Land and water pollution
6.	Noise	<ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent)
7.	Oil spills/leaks	<ul style="list-style-type: none"> Land and water pollution
8.	Human waste	<ul style="list-style-type: none"> Land and water pollution

6.2 Potential Negative Impacts

6.2.1 Construction Phase

1. Air Pollution

Site preparation and other construction related activities are expected to adversely affect air quality during the construction phase. The clearance of vegetation, slope

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excavation and levelling, blasting for excavation of turbine foundations, construction of access roads, road widening and the movement of heavy vehicles and equipment are some of the activities which are expected to increase the volume of fugitive dust within the boundaries of the project area and the local surrounding areas. The change in air quality can lead to health impacts such as respiratory problems and reduction in general visibility in some areas.

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 is considered short term and can be mitigated.

2. Noise Pollution

An increase in ambient noise levels is expected throughout the construction phase as site preparation and construction related activities are undertaken. Blasting, slope re-grading and levelling and the use of heavy equipment are likely to be the main sources of noise emissions. A baseline noise survey conducted throughout the project area showed sound pressure level readings for individual turbine sites were in the 30-47 dBA range. Average SPL readings for each location were 31-43 dBA. MAX readings for the sites were in 32-68 dBA range while the overall average MAX readings were in the 37 – 54 dBA range. All readings recorded were less than 60 dBA, which is the typical noise level for speech at one metre (conversational noise). The National Noise Standards are presented in Table 75.

The use of heavy equipment and blasting activities are likely to increase noise levels beyond 100 dBA, particularly during periods when several construction and site preparation activities are being undertaken simultaneously. Persons working on the site are likely to be the most impacted by the noise from construction related activities given their direct involvement with the activities. Current users of the site, which include farmers, will also be affected by changes in ambient noise levels.

The project site's proximity to educational institutions will also result in sensitive receptors being exposed to temporary noise nuisances. These institutions include: Munro College, Munro Preparatory, Hampton School and Bethlehem Teachers' College.

This impact is considered temporary as heightened noise nuisances are expected to last only for the duration of the construction period. Noise emissions will be intermittent and will be confined to approved work hour periods. The presence of forested areas and uneven slopes are also likely to act as sound barriers, helping to

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deflect noise emissions in some areas, thereby lessening potential impacts on sensitive receptors.

Mitigation measures can be implemented to reduce the impact on the nearby schools from construction related activities.

Table 75: 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. Loss of Vegetation and Disturbance of Biological Communities

The project area for the turbines covers an estimated 44.4 hectares of land area. The area includes agricultural, pasture and forested lands. It is estimated that a total of 24.90 hectares of vegetation will be removed from the wind farm site. Approximately 8.71 hectares of forest or trees will be cleared and 16.19 hectares of meadow/pasture or grass areas. Vegetation will be cleared to allow for the construction of site access roads, turbine foundations, substation, and maintenance facilities.

Additional vegetation will be removed outside the boundaries of the wind farm to facilitate the construction of the transmission line from the JPS Spur Tree substation to the wind farm substation. Approximately twenty-six (26) hectares of forest vegetation will be removed to facilitate the construction of the transmission line along the designated 18km route.

Clearing of vegetation for construction activities may affect ecosystems by increasing the potential for soil erosion and generating noise. These changes can lead to habitat loss and fragmentation for forest-dependent species. In the operation phase of the project, replanting exercises will be undertaken to re-establish some areas with vegetation. Approximately twelve (12) hectares of vegetation will be re-planted within the boundaries of the wind farm.

4. Loss of Agricultural crops and temporary Displacement of Farmers

The loss of agricultural crops and the temporary displacement of farmers are potential impacts associated with the construction phase of the proposed project. The construction of access roads, clearance of vegetation and the movement of equipment, trucks and turbine components are expected to result in the temporary

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disturbance of farming activities. Restrictions are expected to be placed on the movement of farmers within the boundaries of the project area. Some farmers may not be able to access their plots during the construction period, while some farmers will be permanently relocated due to the loss of land for use under the project.

The destruction of farm lands and the loss of agricultural crops are likely to result in significant losses to some farmers given their heavy reliance on agricultural activities to support socio-economic livelihoods. Farmers who are involved in animal rearing are expected to suffer no adverse impacts, as cows and goats being herded will be relocated to adjacent lands.

The total number of farmers to be affected by the project is unknown. However it is expected that dialogue and negotiations between the developers and farmers will take place in order to minimise all potential risks and also offer suitable/appropriate compensation, where appropriate.

5. Slope Modifications and Soil Erosion

Changes to the general topography of the project site are expected with the undertaking of several construction related activities. Terrain modification will take place with the removal of vegetation, blasting and excavation, and grading and levelling of slopes. Blasting, grading and levelling will have to be undertaken in a manner to reduce the risks of slope failures, which are a likely potential given the steepness of slopes within the project area.

Topographic changes will lead to the loss of topsoil. Soil erosion and sedimentation are also potential impacts as the clearance of vegetation and other earthworks will result in the exposure and loosening of the soil.

Soil erosion is a naturally occurring process, where soil particles become dislodged due to rain and wind. However construction activities related to the installation of wind turbines generally exacerbate these conditions. The following activities are likely to contribute to soil erosion:

- Y Vegetation removal
- Y Blasting,
- Y Excavation,
- Y Grading and levelling
- Y Construction of turbine foundations and
- Y Installation of turbine components
- Y Construction of substations and underground cables

Sedimentation is likely during periods of heavy rainfall due to storm water run-off. Similarly where soil is not properly contained or stockpiled, loose soil will be subjected to mobilisation in storm water run-off during periods of heavy rainfall and can cause sedimentation in drainage and storm-water channels.

6. Traffic Disruptions and Vehicle Conflicts

Wind turbines consist of heavy and bulky components which require detailed planning and logistics to transport them from the manufacturers to their eventual project site using different modes of transport. In transporting turbines on land there are greater safety considerations because of the presence of multiple road users, and various types of permanent and temporary structures, including road infrastructure e.g. overhead bridges and above ground lighting infrastructure e.g. electricity distribution line and poles.

The proposed route from Port Esquivel for the transportation of the turbines is not a new route and was previously used by the JPS. However the size of the turbines being transported by BMR is larger than those transported by the JPS for their wind farm. The Port Kaiser route is however a new route.

Significant alterations will have to be undertaken along the routes being used to transport the turbines. Construction of temporary roads, road widening, vegetation, limestone and signage removal, relocation and removal of electricity poles and the lifting of electricity and cable wires are some of the proposed alterations which will have to be undertaken along the transportation routes for the turbines. It will be necessary for permission to be obtained from the owners of land which will require alterations. Storage spaces for signage and poles removed will also be necessary.

During the transportation of the various turbine components traffic disruptions are expected. The movement of heavy trucks and equipment will require other road users to maintain safe distances and in some way yield (or provide the right of way) to oncoming transportation vehicles. During the transportation of turbine components, it is not anticipated that traffic disruptions and vehicle and pedestrian conflicts will be significant, as this activity will take place during late night and early morning periods between 10:00p.m.-4:00a.m. The risks however remain. The trucks transporting the turbine equipment will require assistance from the Police, the JPS and members of the EPC contractor's team to safely traverse the designated routes.

Throughout the construction period, the movement of trucks and other construction equipment will increase on the Malvern main road. The roadway provides the only access route to the site and is also the only access route to four educational institutions located along the road. Pedestrians, taxis, school buses and private vehicles are currently the primary users of the roadway, with pedestrians being a visible and dominant part of the landscape. The potential risks for vehicular and pedestrian accidents will be significant due to:

- The dimension/layout of the road- the road is narrow and winding, with deep corners and steep slopes in some areas along the route
- The number of pedestrians, inclusive of school children utilising the roadways, particularly during the week at select hours

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- The absence of public transportation infrastructure along the roadway e.g. bus stops and taxi-stands. Since there are no dedicated facilities for taxis and buses plying the Malvern main road public passenger vehicles utilise the main road and/or gateways to stop to pick up or let off passengers.

The potential risks and impacts can be mitigated.

7. Vibration

Blasting exercises are expected to result in surface vibrations. The vibrations are likely to be detected by seismological monitoring equipment located at Munro College Station, which is expected to result in noise interferences. The impact will however be short-term. A blasting schedule should be prepared and submitted to the Earthquake Unit at the University of the West Indies.

8. Land and Water Pollution

The following aspects could cause land pollution:

- 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
- Spills - fuel storage and dispensing during the construction period can result in the pollution of land resources in the event of a spill.

All the aspects listed above can be managed and mitigation measures can be established to prevent the potential for land pollution.

It is unlikely that there will be any pollution of water resources as there are no surface water sources in the area.

9. Use of Fuel

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

10. 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 will be negligible.

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11. Accidents

Where construction work is being done, the potential exists for accidents. Occupational health and safety measures can be instituted to eliminate or minimise these potential impacts.

6.2.2 Operation

1. Noise Emissions

The noise generated from wind turbines is very directional which exposes receptors located away from the immediate vicinity of wind farms to noise generated at the site. Noise is caused when turbulent air flows over the sharp edge of the blade. This causes the sound to radiate, resulting in noise emissions being heard from some distance away from the site of the turbines.

Newer, larger turbines, as is the case for this project, are far less noisy than the smaller, older ones. This is as a result of modern technological changes to the shape of the rotor blades which has helped to control the disruptive pattern of turbulence. Larger models are being designed to facilitate greater conversion of acoustic noise generated from the wind into rotational torque. Proper siting and the use of insulating materials also help to reduce noise impacts.

The BMR Jamaica Wind Farm is surrounded by agricultural, residential and institutional land uses. It is expected that farmers and students and teachers of the Munro Preparatory are likely to be the most affected by noises emitted by the turbines because of their close proximity to several of the turbine locations. Residential dwellings within close proximity to the turbines such as Smithfield, Fairmount, Munro, Torrington, Hermitage and Bideford, will also be impacted. The effect of noise on residents is likely to fall within one or more of the following categories:

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

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:

- Y The level of intensity, frequency, frequency distribution and patterns of the noise source;
- Y Background sound levels;
- Y The terrain between the emitter and receptor
- Y The nature of the receptor; and
- Y The attitude of the receptor about the emitter

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In the case of the selected wind farm site the topography consists of steep and gently sloping hills, with interspersed pockets of flat land in valley areas. This type of terrain contributes to uneven noise patterns as emissions are deflected. As such it is difficult to determine the level of impact on receptors. A noise assessment was undertaken and will be used in the siting of the turbines to identify the best locations relative to potential receptors.

The noise from the proposed wind turbines at different speeds is provided in Table 76 to Table 78. The information presented shows the low and high decibel levels on the “A” scale.

Table 76: Sound Power Data for Vestas V112-3.3 MW Wind Turbine

Wind Speed	Sound power (10 m above ground, hub height 84 m, standard air density 1,225 kg/m ³)
4 m/s	97.2 dB(A)
5 m/s	100.8 dB(A)
6 m/s	104.4 dB(A)
7 m/s	106.5 dB(A)
8 m/s	106.5 dB(A)
9 m/s	106.5 dB(A)

Table 77: Sound Power Data for Vestas V80- 2.0MW Wind Turbine

Wind Speed	Sound power (10 m above ground, hub height 67 m, standard air density 1,225 kg/m ³)
4 m/s	93.2 dB(A)
5 m/s	98.6 dB(A)
6 m/s	102.7 dB(A)
7 m/s	104.3 dB(A)
8 m/s	105.0 dB(A)
9 m/s	105.0 dB(A)

Table 78: Sound Power Data for Vestas V90- 1.8 MW Wind Turbine

Wind Speed	Sound power (10 m above ground, hub height 80 m, standard air density 1,225 kg/m ³)
4 m/s	94.6 dB(A)
5 m/s	98.8 dB(A)
6 m/s	101.8 dB(A)
7 m/s	103.5 dB(A)
8 m/s	104.0 dB(A)
9 m/s	104.0 dB(A)

Studies indicate however that noise levels drop off significantly at a distance of 300 m to between 40 and 50 decibels, somewhere between an air conditioner and a

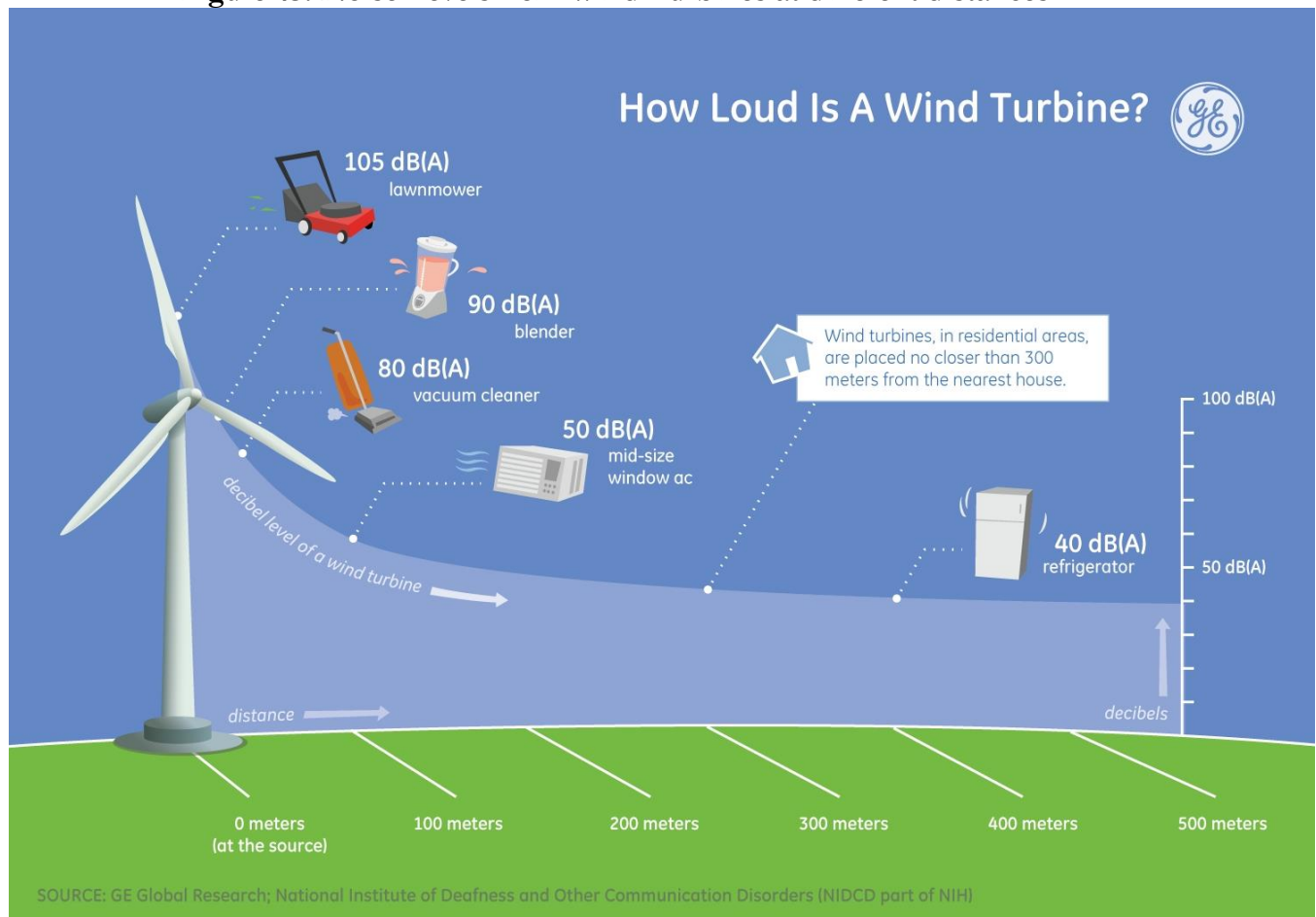
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refrigerator. At about 500 meters, the levels drop to about 38 decibels, which is well below the typical 40-45 decibels of background noise in a populated area, meaning that a turbine's noise would be lost amongst it. (Figure 43)

While this is the case, some persons are still affected by the rotational sound from the turbines as far as 1.6 m from the turbines which causes them annoyance and in some cases distress. The issues of noise pollution from wind turbines is very subjective so it is very important to site the wind turbines as far away from residences and schools as possible and to communicate with the stakeholders on the likely impacts associated with the development. It is usually unmet expectations from stakeholders based on ineffective communication by the developer that leads to discord.

The final design of the wind farm by the supplier Vestas has determined the locations for the wind turbines to eliminate or minimise the potential noise impact on receptors.

Figure 43: Noise Levels from Wind Turbines at different distances



Source: <http://www.gereports.com/how-loud-is-a-wind-turbine/>

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2. Reduction in Ecological Species and Habitat Displacement

Bird and bat mortality at wind farms is one of the most significant environmental impacts associated with wind turbine developments. In North America and Europe, thousands of birds and bats die each year due to collision with the blades of the turbines. According to a 2013 study of bat and bird mortality in the United States, approximately 573,000 birds were killed by wind turbines in 2012, while an estimated 888,000 bats were killed. The number of birds and bats killed were estimated at 51,630 megawatt (MW) of installed wind-energy capacity in the United States in 2012. This showed average mortality rates of 11 birds per MW and 17 bats per MW of generating capacity. The data on mortality has shown an estimated 30% increase in mortality rates for avifauna species since 2009 based on a study done by the US Fish and Wildlife Service. It is important to note that the study only estimated bird and bat kills from the actual turbines and not those caused by meteorological towers and power transmission lines.

Bird Mortality

There are generally two types of impacts to birds at wind farms: (i) Direct mortality from collisions and (ii) indirect impacts from avoidance of an area, habitat disruption and/or abandonment, reduced nesting/breeding density, loss of refugia and behavioural effects.

The risk of collision with wind turbines is one of the major potential threats faced by birds. Birds are generally killed in collisions with turbine blades, meteorological towers and power transmission lines at wind facilities. With modern wind technology birds face the most risk from turbine blades, due to the speeds at the tips of the blades. While the revolution speed of the turbine rotors have decreased with improvements in wind technology, the speed at the tips of the turbine blades have remained mostly the same. Older wind turbines have smaller blades that rotate frequently over the period of a minute. These design features resulted in extremely high risk of collision for birds as most are clipped while attempting to fly across wind farms. With modern changes to wind turbine designs, blades are being built larger and rotate less frequently; lessening potential collision risks.

Poorly sited turbines have also been recognised as a major contributing factor affecting bird mortality rates. In areas that have large bird communities and are also used frequently by migratory birds there is a higher rate of bird kills when turbines are sited within flight paths.

During the faunal assessment thirty-two (32) resident and endemic species were observed, while seven (7) migrant species were observed across the project area. Based on the assessment, all of the birds surveyed utilised the forested areas and some of the open areas within the project site. While bird species are likely to be negatively impacted by the proposed development over the long-term, it is anticipated that overall the impact will be minor for this proposed development.

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Habitat loss from turbine installations will be minimal and will not pose significant threats to the habitats of birds. Similarly the re-siting of turbines within open spaces areas based on the results of the flora and fauna surveys for the original turbine locations, away from forest patches will minimise the likely collision risks between birds and the wind turbines.

Migrant bird species over-time will identify new flight paths to avoid collisions with turbines. Post-construction observation of the site will be necessary to document and assess implementing suitable mitigation measures.

Bats

Two (2) caves were found within a 10km radius of the project site. The Blair cave is located within a 1km radius of the project site. Neither of the caves was used by bats as roosting nests.

Bat mortality rates are in most cases higher than that of birds at wind farm facilities. This has been supported by several studies, including the recent study by Smallwood (2013), which shows a thirty-five percentage (35%) difference in the number of bats killed each year compared to the number of birds killed in North America. Bats for unknown reasons are found to be attracted to turbines (National Wind Coordinating Collaborative, 2010)¹⁷. Studies have indicated that the sound of the turbines is one possible reason for the attraction. With wider and longer blades which produce greater vortices and turbulence in their wake as they rotate, this poses a potential problem for bats.

Bats use their echolocation to avoid collisions with man-made objects. However there is no evidence that the echolocation calls work with non-stationary structures such as the spinning blades of the turbine. Spinning blades cause a drop in the localised air pressure around the blades and this is reported to make them undetectable to the bats, causing a serious hazard. The drop in air pressure is also said to result in an expansion of the lungs of the bats which causes internal haemorrhaging resulting eventually in their death.

The impacts wind farms have on bat species vary and are determined by a host of factors (size of wind farm, size and types of turbines, siting of turbines, vegetation covering of site etc.). While some wind farms pose negligible to minor threats, there are others which pose significant threats to bat species. Major impacts have included:

1. Mortality through collision with rotary blades – typically at or near the tips of blades where circumferential velocities are high;
2. Barotrauma – mortality when bats' lungs are damaged when they enter or are sucked into the low pressure area over the rotating blade;

¹⁷ http://www1.eere.energy.gov/wind/pdfs/birds_and_bats_fact_sheet.pdf

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3. Loss of foraging habitat – either due to wind farm construction or because bats avoid the wind farm area;
4. Loss of roosting habitat – either loss of vegetation for tree-roosting species or the wind farm is constructed too close to a roosting/maternity cave;
5. Barrier effect on commuting and migration routes – either due to the physical presence of the wind farm or the open space created in a previously-forested location in which “cluttered space” forest-dependent species travel.

The results of the bat survey have shown that the impacts of the proposed BMR Jamaica Wind Farm are likely to be minor on bat species based on several factors:

1. There were no threatened and/or endangered species identified during the survey.
2. Turbines are being sited and positioned away from foraging areas and flights paths. Bat species foraged within forested areas and close to the tree lines of open space areas. In siting the turbines away from these areas and into open space areas the likelihood of collision risks are reduced.
3. There were no roosting sites identified within the boundaries of the project site.

The wind farm is being commissioned for 25 years and therefore post construction monitoring of bat activities will be required at the project site to determine the most suitable mitigation measures to be adopted in ensuring the protection of these species. Monitoring of bat kills will also be critical in assessing the degree and scale of impact the turbines are having on the species.

3. 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 (P2P) Radiocommunication systems
- Point-to-Multipoint Radiocommunication systems
- Satellite Uplinks and receive systems (e.g. VSATs)

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- 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:

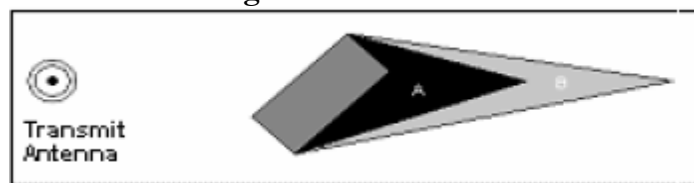
- a. Impact on broadcast type systems which include radio, TV and cellular type networks, and
- b. Impact on Point-to-Point systems such as microwave links connecting cellular sites, radio links referred to as Studio-to-Transmitter Link (STL) and Transmitter-to-Transmitter Link (TTL); as well as Point-To-Multipoint 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 (P2P) 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 44) would appear in the section of the path between the wind turbine and the receiver, i.e. away from the transmitter.

Figure 44: Diffraction



Source: RABC-CanWEA Guideline¹⁸

Mirror-Type reflections

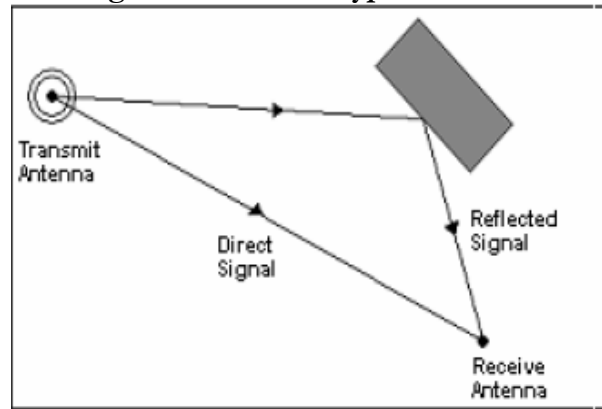
It is possible for an obstacle such as a wind turbine, although not in the direct path of a radio link (i.e. line of sight from transmitter to receiver) to affect the quality of the signal at the receiver. This may occur if the transmitted signal bounces off (i.e. is

¹⁸ 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

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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 45).

Figure 45 - Mirror Type Reflection



Source: RABC-CanWEA Guideline¹⁹

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 Effect²⁰ 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; 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.”

¹⁹ 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

²⁰ The Doppler Effect is the change in frequency of a wave for an observer moving relative to the source of the wave.

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Impact on 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 is essentially 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 Broadcast transmitters and Point-to-Point) that may be impacted by the operation of wind turbines, then for proximity reasons:

- The radius of the Consultation Zones is 1.0 km around:
 - Fixed Land Mobile Radios (LMR) stations,
 - Point-to-Point (P2P) stations below 890 MHz,
 - Cellular and other wireless mobile service provider stations.
- The consultation zones specifically for Broadcast transmitters are:
 - AM station – 5.0 km (single tower), 15 km (multiple towers)
 - FM station – 2.0 km
 - TV station – 2.0 km
- The consultation zones specifically for Over-the-Air reception are:
 - Analog TV station – 15 km
 - Digital TV station – 10 km

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

- Weather radars: A minimum of 50 km
- Air Traffic Control radars: A minimum of 60 km for military or civilian airfield

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For air defence and vessel traffic radars, it is important that the project proponent consults with the relevant local authority to determine if the turbines will have any impact on radars providing such services.

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/authorised 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/authorised 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 is presented in Table 79 and Figure 46.

The SMA provided information to indicate that the following RF signal sites are within 5 km of the proposed wind farm site.

Table 79: RF Signals within 5 km of Project Site Boundary

Customer Name	Site Name	Site Location	Distance from Project site (km)	Frequency Band	Type of Service
1. Cable & Wireless Jamaica Limited (C&WJL)	Malvern	17°58'24.89"N 77°42'11.90"W	2.29 km	2.1 Ghz, 850/1900 MHz	Fixed Link/Cellular
2. Digicel Jamaica Limited (Digicel)	Malvern	17°58'23.24"N 77°42'3.27"W	2.21 km	11 GHz, 850/1900 MHz	Fixed Link/Cellular
3. Jakes Holdings Limited (Jakes) & Restaurants of Jamaica Limited (RJL)	Munro	17°52'59"N 77°43'59"W	6.46 km	150, 155, 169, 174, 481 MHz	Land Mobile
4. Treasure Beach Foundation (TBF)	Malvern	17°58'3"N 77°42'1"W	1.59 km	156 MHz	Land Mobile
5. University of the West Indies (UWI) –	Munro College	17°55'30"N 77°41'6"W	1.10 km	452 MHz	Land Mobile

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Customer Name	Site Name	Site Location	Distance from Project site (km)	Frequency Band	Type of Service
Earthquake Unit					
6. Digicel Jamaica Limited (Digicel)	Bellevue Hill	17°53'48.479"N 77°39'27.932"W	5.31 km	15 GHz	Fixed Link/Cellular
7. Cable & Wireless Jamaica Limited (C&WJL)	Treasure Beach	17°53'16.29"N 77°43'52.08"W	5.91 km	2, 13, 18, 19 GHz	Fixed Link/Cellular
8. Cable & Wireless Jamaica Limited (C&WJL)	Leeds	18°00'7.11"N 77°41'12.69"W	5.52 km	13 GHz	Fixed Link/Cellular

Source: Spectrum Management Authority, Jamaica, February 2014

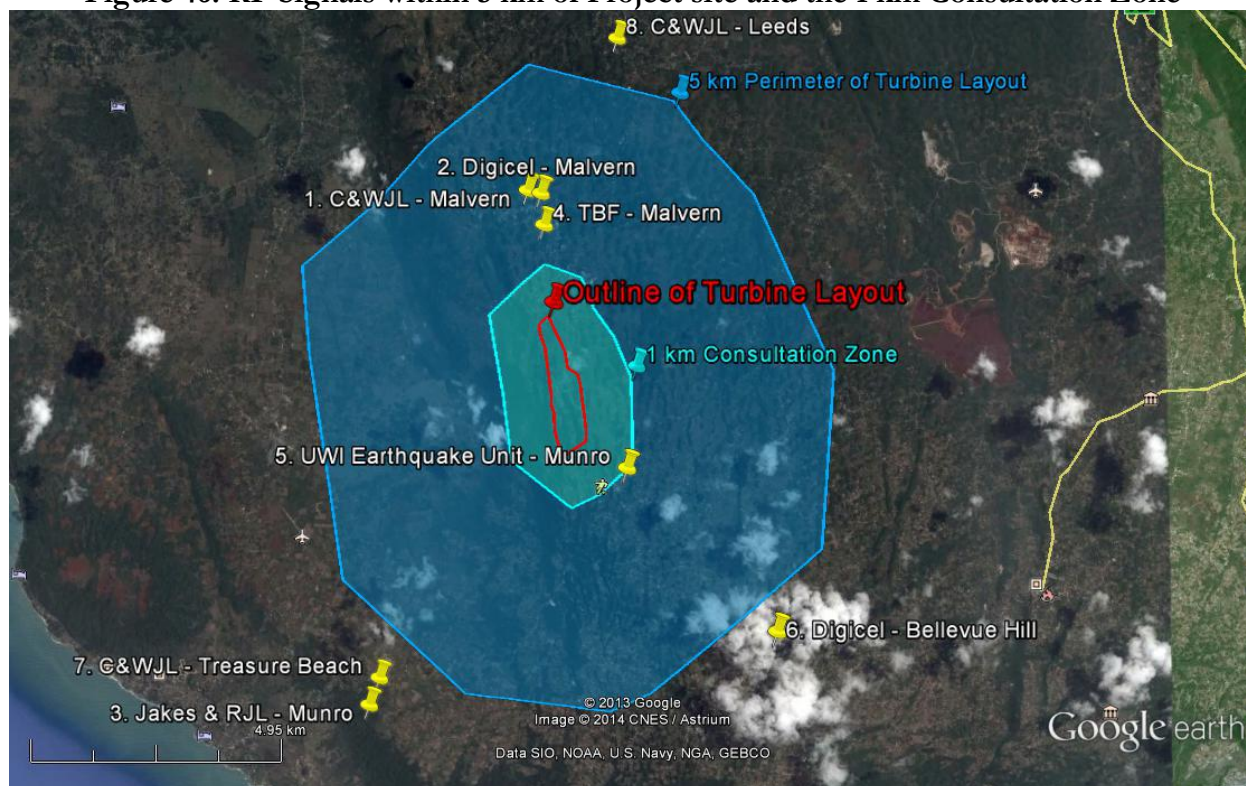
Google Earth was used to measure the distances from each location identified by SMA to the closest turbine. These locations and their distances from the project area are highlighted in Table 79. This analysis shows that only four of the eight sites identified by SMA are actually within 5 km of the project site. These four locations are: Cable & Wireless Jamaica Limited (C&WJL) – Malvern, Digicel (Jamaica) Limited (Digicel) – Malvern, Treasure Beach Foundation (TBF) – Malvern and University of the West Indies (UWI) Earthquake Unit – Munro College. This can also be seen in Figure 46.

The types of radio frequency service at these sites are classified as either 'fixed link/cellular' or 'land mobile'. Research conducted globally and the experience of existing wind farms in countries such as Australia, indicate that interference to fixed link services caused by wind turbines would be negligible²¹. 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.

²¹ Woodlawn Wind Farm EIS: http://www.woodlawnwind.com.au/_PDF/_Sections/15.pdf

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Figure 46: RF Signals within 5 km of Project site and the 1 km Consultation Zone



For land mobile services (2-way radio services using VHF²² or UHF²³), 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 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.

In both cases (fixed link and land mobile), the applicable consultation zone is 1.0 km. Table 79 and Figure 46 show that none of the relevant RF signals fall within the 1.0 km zone. The closest RF signal to the project area is the UWI Earthquake Unit at 1.1 km. If interference is experienced, the user may be able to change their position and eliminate the interference. However, if the station is fixed, an assessment should be done after the Turbines are in operation to determine if there is any impact.

Mobile Cellular Service

Mobile Cellular Networks comprise of cellular base stations (which link with mobile phones) as well as fixed link (P2P) sites for carrying traffic between cellular base stations. From Table 79 it can be surmised that:

²² VHF: Very High Frequencies

²³ UHF: Ultra High Frequencies

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- a. There are no point-to-point stations below 890 MHz which would fall within the 1.0 km consultation zone.
- b. There are no cellular mobile service provider stations (base stations) within the 1.0 km consultation zone.

Therefore the wind farm should not have any impact on mobile cellular service within the environs of the proposed project 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 turbine²⁴. Furthermore, the fibre 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. 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 receivers are within the 15 km for analog TV stations (Jamaica does not have digital free-to-air TV signal at this time).

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

²⁴ 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

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Based on the socio-economic survey conducted for this EIA within 2 km of the project area, of the one hundred and sixty six (166) respondents:

- 25.9% have roof mounted antennae for TV stations,
- 3.6% surveyed have roof mounted antennae for radio stations
- 38.6% have no antennae.

These percentages indicate that some of the members of the surrounding communities have already implemented the mitigation measure of installing an outdoor antenna. If these members are impacted, the other mitigation measures would apply.

Subscriber Television Service (Cable TV)

The Broadcasting Commission responded to the request for information indicating that all information is detailed on their website. Based on their website, the Operators licensed to provide cable services closest to the project area

- a. McKoy's Cable Television Company Limited, serving the Southfield and Junction zones
- b. Unique Vision Cable Company, serving the Southfield and Nain zones

Checks with the above companies confirmed that the cable services are provided through wired installations only. There is therefore no wireless transmission of cable service within 5 km of the proposed wind farm project area.

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

4. 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 89.5 km from the proposed site which is outside of the recommended consultation zone of 50 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 will not have a negative impact on the weather radar operated by the Meteorological Service.

BMRJW, the Project Proponent made direct contact with the Jamaica Civil Aviation Authority (JCAA) and provided them with the required information. The JCAA advised in their response that the nearest Government Aerodrome is the Norman Manley International Airport, Palisadoes, Kingston (97 km from project site) and the nearest private aerodrome is in Nain, St. Elizabeth (11 km from project site). The JCAA therefore approved the project stating that the wind turbine is located beyond the Outer Horizontal surface limits of the Norman Manley International Airport and Nain aerodrome.

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The closest air traffic monitoring and control radar to the wind turbine site operated by the JCAA is located at Pike in Manchester which is approximately 37 km from the proposed project site. Based on the JCAA approval the operation of the wind farm will not have an impact on this radar.

5. Shadow Flicker

For the purpose of this analysis, shadow flicker shall be defined as:

*Rotating blades of wind turbines will result in shadows moving across nearby structures and the surrounding landscape. When the repeating change of light intensity falls across a narrow opening, such as a window, it can cause a flicker effect within the structure (hereafter referred to as “receptors”), as the shadow appears to flick on and off. This effect is known as shadow-flicker and only occurs within a structure.*²⁵

Shadow flicker may cause a disturbance within structures when the repeating pattern of light intensity change falls across the windows or doors of buildings. This effect is most conspicuous when windows face a rotating wind turbine and when the sun is low in the sky (e.g. shortly after sunrise or shortly before sunset). Shadow flicker only occurs under certain specific conditions and its intensity varies depending on factors such as:

- Shadow flicker does not occur at night;
- Shadow flicker will not occur on foggy or overcast days when daylight is not sufficiently bright to cast shadows;
- 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 in the sky;
- Unshaded windows face a turbine; and
- No flicker will occur when the turbine is not in operation.

A primary factor which determines the intensity of shadow flicker at a potential location (e.g. the facility where the shadow falls) is the distance of the wind turbine from that particular point (i.e. inhabited dwelling). 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 flicker 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 130° either side of North will be so impacted. The distance of 10 times the rotor diameter is called the study area for shadow flickering. In this case the potential shadow flicker was evaluated within 1,120m. Although seven (7) of the eighteen (18) turbines will have

²⁵ Onshore Wind Energy Planning Conditions Guidance Note – A Report for the Renewables Advisory Board and BERR (October 2007).

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slightly smaller rotor diameters (90m), to be conservative the study area was determined at a consistent distance of 1,120m.

Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance. In general, the largest number of shadow flicker hours, along with greatest shadow flicker intensity, occurs nearest the wind turbines.

The Study Area

An analysis was conducted of specific locations within 1,120m around each proposed wind turbine location. The locations (or receptors) are either a point within a community (e.g. Hermitage) or a specific structure (e.g. Munro Preparatory School).

The information presented in Table 82 was developed using *WindPRO Basis* software (WindPro) and associated shadow module. This is a widely accepted modelling software package developed specifically for the design and evaluation of wind power projects.

Data Input and Assumptions

Variables and assumptions used in calculating the potential shadow flicker include:

- ✎ Terrain – Publicly available terrain information was used to create a digital elevation model (DEM).
- ✎ Latitude and Longitude – WindPro considers the azimuth and altitude of the sun in relation to the proposed turbine. For this analysis, the Project coordinates were specified by using Universal Transverse Mercator coordinate system (UTM) North American Datum (NAD) 83 Zone 18 (reflecting the appropriate zone for this region).
- ✎ Turbine Dimensions and Blade Rotation Speed – For the purpose of this analysis, turbines 1-11 were modeled using the dimensions of a Vestas V112 with a hub height of 84m and rotor diameter of 112m, and turbines 12-18 were modeled using the dimensions of a Vestas V90 with a hub height of 80m and rotor diameter of 90m.
- ✎ Sun Coverage – Shadow-flicker will occur when more than 20 percent of the sun is blocked by the turbine blade. Less than 20 percent will not result in a noticeable shadow.
- ✎ Sun Angle – The angle of the sun over the horizon will be at least three degrees. A lower angle will result in the light passing through atmosphere becoming too diffused to form a coherent shadow.²⁶
- ✎ Receptor Locations – Locations of communities/structures, within the study area were derived from interpretation of Google images.
- ✎ Receptor Windows – It was conservatively assumed that every receptor had windows (one meter by one meter) one meter above ground, in all directions. WindPro refers to this as the “Green house” mode.

²⁶ WindPro (EMD International A/S).

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- Y Sunshine probabilities (average sunlight hours per day) – The WindPro model calculated shadow frequency based on average hours of sunshine per month. Since this is based on an average amount, it should be expected that there may be a possibility of more or less sunshine per day and month. The following hours of sunlight were used based on publicly available information for Kingston.

Table 80: Average number of hours of sunshine monthly in Kingston

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hours: Mins	8:30	8:38	8:48	8:54	8:11	7:54	8:25	8:11	7:24	7:29	8:06	8:05

- Y Screening from Vegetation and Structures – Results from WindPro assumes that the area lacks vegetation and other structures that would block the receptor. This assumption is considered conservative, as shadows should not occur in areas where the turbine is substantially screened by vegetation and/or structures.²⁷

As part of this analysis, the effect of vegetation is accounted for by using GIS to overlay the WindPro results onto data that has identified areas which would not have visibility of the proposed turbines (based on vegetated stands of 12.19m in height). For the purpose of this analysis, it was assumed that shadows will not occur in areas where turbines are not visible due to the screening effects of vegetation.

- Y Operational Time/Rotor Orientation – The WindPro model was given the number of hours per year that the turbine might be operating for every wind direction identified below. The total hours in Table 81 below are 8,760 hours/year, or 100% of the hours in one calendar year. Moreover, the orientation of the rotor (determined by wind direction) affects the size of a shadow cast area. To more accurately calculate the amount of time a shadow will be over a specific location (based on rotor orientation), the WindPro model considers typical wind direction. These hours are used to determine average annual shadow hours for the year.

Table 81: Number of Turbine Operating Hours per Year for Operating Wind Directions

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
650	1,737	2,656	1,454	286	149	138	127	275	299	186	106	120	100	129	348

Using the variables identified above, WindPro calculated the number of hours per year the shadow of a rotor would theoretically fall at any given location within the 1,120m radius of each turbine. Each of the nine receptors identified were evaluated to determine potential shadow-flicker impact (see Table 82).²⁸

²⁷ It is important to note that the closer the vegetation is to the receptor the higher probability it will screen potential shadow flicker.

²⁸ Hours for each receptor do not take into account activities within the receptor (i.e. rooms of primary use or enjoyment versus less frequently occupied rooms) or account for the direction/location of windows.

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Table 82: Shadow-Flicker Summary

Community/ Receptor²⁹	Maximum (worst case) Potential Shadow Hours per Year	Maximum (worst case) Potential Shadow Hours per Day	Expected Potential Shadow Hours per Year³⁰	Receptor Screened by Intervening Vegetation?³¹	Turbine(s) Causing Potential and General Timeframe of Potential Shadow³²
Hermitage	106:36	1:04	50:02	Yes	<u>Turbine 1:</u> January – 3:38 pm to 4:37 pm November – 3:34 pm to 4:12 pm December – 3:28 pm to 4:37 pm <u>Turbine 15:</u> April – 7:19 am to 8:13 am May – 7:19 am to 8:12 am July – 7:35 am to 8:17 am August – 7:27 am to 8:21 am September 7:40 am to 8:01 am
Torrington	301:40	1:58	87:24	Yes	<u>Turbine 11:</u> February – 8:04 am to 9:47 am March – 7:55 am to 10:47 am April – 8:38 am to 10:32 am May – 8:40 am to 10:08 am July – 9:15 am to 10:08 am August – 8:39 am to 10:23 am September – 8:28 am to 10:26 am October – 8:29 am to 10:25 am
Round Hill	0:00	0:00	0:00	No	Not Applicable

²⁹ Location of receptors provided in Figures 1 and 2.

³⁰ Hours based on maximum potential shadow hours excluding the screening value of existing vegetation.

³² Shadow flicker will not occur every day of the month identified.

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Community/ Receptor²⁹	Maximum (worst case) Potential Shadow Hours per Year	Maximum (worst case) Potential Shadow Hours per Day	Expected Potential Shadow Hours per Year³⁰	Receptor Screened by Intervening Vegetation?³¹	Turbine(s) Causing Potential and General Timeframe of Potential Shadow³²
Munro Preparatory School	149:18	1:03	44:04	Yes	<u>Turbine 7:</u> May – 6:52 pm to 7:23 pm June – 6:40 pm to 7:31 pm July – 6:40 pm to 7:32 pm August – 6:46 pm to 7:27 pm <u>Turbine 8:</u> March – 6:07 pm to 7:06 pm April – 6:03 pm to 7:07 pm August – 6:02 pm to 7:03 pm September – 6:02 pm to 7:04 pm
St. Mary's	0:00	0:00	0:00	No	Not Applicable
Munro College	0:00	0:00	0:00	No	Not Applicable
Mount Pleasant	44:52	0:30	23:00	Yes	<u>Turbine 9:</u> January – 4:58 pm to 5:30 pm November – 4:45 pm to 5:11 pm December – 4:45 pm to 5:26 pm <u>Turbine 18:</u> January – 5:08 pm to 5:38 pm February – 5:08 pm to 5:38 pm October – 5:47 pm to 6:01 pm November – 4:39 pm to 5:09 pm
Bideford	0:00	0:00	0:00	No	Not Applicable

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Community/ Receptor²⁹	Maximum (worst case) Potential Shadow Hours per Year	Maximum (worst case) Potential Shadow Hours per Day	Expected Potential Shadow Hours per Year³⁰	Receptor Screened by Intervening Vegetation?³¹	Turbine(s) Causing Potential and General Timeframe of Potential Shadow³²
Belmont	49:44	0:26	21:50	Yes	<u>Turbine 9:</u> March – 5:48 pm to 7:05 pm September – 6:21 pm to 6:45 pm October – 6:21 pm to 6:43 pm <u>Turbine 10:</u> February – 5:30 pm to 5:55 pm October – 6:00 pm to 6:25 pm November – 5:00 pm to 5:21 pm <u>Turbine 11:</u> January – 5:02 pm to 5:29 pm November – 4:50 pm to 7:10 pm December – 4:50 pm to 5:26 pm

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The analysis indicates that there are several buildings within 1,120m of the turbines. Generally, these buildings are located in the communities of Mount Pleasant, Belmont, Bideford, Torrington, Hermitage, Munro College, St Mary's and Round Hill. Although these communities are represented as receptors, it is important to note that it does not represent the potential shadow flicker at each individual dwelling within the community.

It should also be noted that the four (4) existing turbines (not evaluated in this analysis) are located within the outline of the turbine layout for the proposed project. These existing turbines have a rotor diameter of 50m and therefore their zone of influence is 500m. Therefore the study area for the existing turbines falls within the study area (1,120m) for the proposed turbines. Due to the smaller study area for the existing turbines, none of the receptors identified within the study area for the proposed turbines are likely to be affected by shadow flicker due to the operation of the existing turbines.

Although it is anticipated that all communities and the Munro Preparatory School will not be significantly protected by vegetation, it is still anticipated that localized vegetation not contained in this analysis may provide some beneficial screening in select locations. For the purpose of this analysis, further evaluation of screening caused by existing vegetation will not be addressed.

Northern Hemisphere of the Study Area

Most of these communities and hence most of the buildings in the study area for each turbine are located in the northern hemisphere of the overall combined project area. Of the communities within this area, Ivor Cottage and Hampton School are closer to the perimeter of the 1,120m boundary and were therefore not assessed further. The location of structures will determine the amount of potential shadow-flicker they receive. Those closer to the turbines will potentially experience more shadow versus those located further away as shadow flicker will diminish with increasing distance from the turbines. The communities of Torrington and Hermitage are very close to the project area, thus resulting in 87:24 hours from turbine 11 for Torrington and 50:02 hours from turbines 1 and 15 for Hermitage. They are both sparsely populated and hence a minimal amount of buildings are present.

The communities of Belmont and Mount Pleasant are likely to experience shadow flicker for 21:50 hours and 23:00 hours respectively. These expected annual potential shadow hours are below the threshold of 30:00 hours per year. Additionally, the maximum shadow hours per day for each location do not exceed the 30 min/day threshold.

Potential mitigation measures which could be applied, on a case-by-case basis, in these communities include:

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- Adjust the location of a specific turbine or turbines in the attempt to provide additional distance between the turbines and community.
- In the event shadow-flicker becomes an annoyance within an inhabited dwelling, some sort of screening should be considered. This could include strategically placed vegetation, window awnings, or window shades.

Southern Hemisphere of the Study Area

Of the communities in the southern hemisphere of the zone of influence, Round Hill, St Mary's and Munro College are closer to the perimeter of the 1,120m zone of influence than to the turbines. The buildings in these communities are therefore expected to have a reduced impact of the shadow flicker effect since that effect diminishes with increasing distance from the turbines.

Munro Preparatory School is closer to the project area than to the perimeter of the zone of influence and is therefore likely to be impacted by shadow-flicker. The analysis shows that the school will have a potential to receive a combined 44:04 hours of shadow flicker from turbines 7 and 8. This is due to the proximity of these turbines (0.45 – 1.0 km) to the cluster of buildings at the Munro Preparatory School. It is unlikely that the Munro Preparatory School will be affected from the other turbines in the southern hemispheres (i.e. Turbines 16 and 17). The analysis has indicated that shadow flicker at the school will occur during evening hours, at which time classes will not be in session. Therefore, it is not expected that the potential shadow flicker will be an annoyance to the building occupants.

If shadow-flicker should become an annoyance at the Munro Preparatory School or any of the other locations within the study area, mitigation measures can be suggested. These would include one or more of the following:

- Planting vegetation at the appropriate height which would serve as vegetative buffers which would shield the buildings from the effect of the shadow flicker
- Installing blinds at all relevant windows and doors to shield the building occupants from the impact of the shadow flicker effect

Recommended Mitigation Measures

Given the fact that the shadow flicker effect diminishes with increasing distance from the turbines, it is likely that most of the inhabitable dwellings within the overall zone of influence will experience reduced levels of shadow flicker impact due to their proximity to the perimeter of the zone of influence. The communities of Hermitage, Torrington, Mount Pleasant, Belmont and the Munro Preparatory School are the locations that likely will experience some level of impact from shadow flicker effect. The expected hours per year are outlined in Table 82 for each location. However, these hours do not take into account how each dwelling is used and specific direction of window and door openings. These are two considerations that will be a factor in whether shadow flicker may become an annoyance by the resident.

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As identified in Table 82, should the project only use turbines 1-11, the potential for shadow flicker would be further reduced in many of these identified locations. For instance, if turbine locations 12 to 18 are not used, the communities of Hermitage and Mount Pleasant would be exposed to less shadow flicker.

The project proponent BMRJ will take these potential impacts into consideration and will determine the optimum location for the wind turbines and relevant mitigation measures to eliminate or minimise the impact of shadow flicker on nearby buildings.

6. Vibration

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 potential earthquake, also known as a 'false' earthquake signal.

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 Table 83. The stations operate on a 24 hour basis. All vibrations detected by the monitors are recorded and stored.

Table 83: 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 proposed wind farm will be located less than 1km from the seismograph station found at Munro College in St. Elizabeth and is therefore within the consultation of 10km. It is anticipated that vibration from the

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wind farm will be noticeable and are likely to be received by the seismological station at Munro College. However the readings will not be recorded as an earthquake event as earthquakes are declared and recorded only when three signals go high and stay high simultaneously, i.e. three monitoring stations in a triangulation pattern must pick up the vibration.

The vibration from the turbines does however have the potential to affect the detection of smaller earthquakes by the Earthquake Unit. Vibration readings are translated into various sounds by the monitoring equipment. These sounds come in at various frequencies and helps seismic experts in determining the type of event which is taking place, the likely source and the scale of the event.

The vibrations from the turbines are expected to be consistent and are therefore likely to result in noise interferences, given 24 hour operation of the equipment. Depending on the level of interference generated as a result of the vibration of the turbines, it may prove difficult for smaller earthquakes to be detected as the signals received from the turbines may potentially '*drown out*' the signals from smaller earthquakes.

The Earthquake Unit will be upgrading its instruments to broad band and will be able to cover a wider frequency range, possibly up to 10 Hz. The equipment is being upgraded to improve the reception of earthquake signals.

Improvements in modern wind technology have helped to reduce the overall impact of vibration associated with turbines. Additionally vibration monitoring has also increased and is undertaken mostly through the SCADA system developed for monitoring the operation of turbines. During the first three (3) months after the wind turbines have been commissioned the operators of BMR wind farm should work closely with the Earthquake Unit at the University of the West Indies in monitoring the impacts the turbines are having on seismological monitoring within the area. Vibration monitoring will also help to provide information on changes in vibration patterns associated with the wind farm and the conditions which are influencing the patterns observed. The results of vibration monitoring can help to mitigate potential negative impacts or minimise overall negative impacts.

7. 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 is small and insufficient to cause any significant impact. The potential for land pollution exists however if spills and leaks are not managed.

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8. Lightning Strikes

Studies on the effect of lightning storm events on wind farms has become more frequent as more wind farms are being constructed in lightning prone regions. Similarly the height of wind turbines has increased, prompting renewed interest in the impacts of lightning on tall objects. Lightning strikes on wind farms generally result in significant blade repair costs.³³

Lightning studies have shown that the possibility of objects being struck by lightning increases for objects over 100m in height on flat terrain. Additionally, the probability of upward initiated lightning increases when the object resides on locally elevated terrain. As wind turbines have increased in height

The proposed wind farm will be located in a lightning prone area. Though the maximum height of the turbines is 84m, the location is within an elevated terrain and therefore the turbines are exposed to potential lightning strikes. Wind turbines are said to have larger attractive radius (striking distance) for lightning strikes than stationary towers of the same height, because of the presence of the moving blades.

The turbines to be installed for the project are designed with lightning protection sensors. The turbines themselves are also constructed using materials that act as electrical insulators, helping to limit likely damage by lightning strikes. Monitoring and possible shut down of wind turbines during lightning and thunderstorm events will be necessary to minimise and mitigate against potential adverse impacts.

9. 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.

10. 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

³³ Nicholas Wilson, Jackson Myers, Dr. Kenneth Cummins, Matt Hutchinson, and Dr. Amitabh Nag (2013). Lightning Attachment To Wind Turbines In Central Kansas: Video Observations, Correlation With The NLDN And In-Situ Peak Current Measurements. <http://www.vaisala.com/Vaisala%20Documents/Brochures%20and%20Datasheets/WEA-ERG-EMEA-EWEA%202013-Lightning%20Attachment%20to%20Wind%20Turbines%20in%20Central%20Kansas-PO.145.pdf> . Accessed January 2013

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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 Norman Manley International Airport and Nain Aerodrome and would therefore not pose obstructions to air traffic.

11. Land Use Changes and Land Value Depreciation

The proposed development is classified as an industrial land use. According to the St. Elizabeth Parish spatial development (land use) plan, agriculture and low density residential are the land use types designated for the area of Malvern/Munro. While industrial land uses are not identified for the area, there are certain light industrial land uses which are deemed acceptable by the Parish Council for the area.

The proposed land use will represent a moderate change from present baseline conditions. The erection of a 34MW wind farm, while compatible with agricultural land uses, is not compatible with residential land uses, more specifically medium and high density residential land uses. Noise generated from the turbines is the major deterrent affecting the co-existence of the land uses within a shared space or within close proximity to each other.

Due to the incompatibility of these land uses, it is likely that open lands within close proximity to the turbines, which have been identified for conversion to residential developments will have a lower sale value. It is also likely that these lands may not attract residential buyers and instead can only be used for agricultural use.

6.3 Significant Environmental and Social 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 84. The significance of the impacts is presented in Table 85.

Table 84: 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/inter national 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

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CRITERIA	Minor	Moderate	Severe
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
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	No risk to public health. Modification of	Conflict with policies or land-use plans Loss of populations of	Large scale loss of productive capacity of renewable resources

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CRITERIA	Minor	Moderate	Severe
stakeholders to make trade-offs, given the potential benefits of the project, limited environmental changes or the ability to mitigate adverse impacts	landscape without down grading special social, economic and aesthetic values Within legal thresholds and allowable limits Some loss of biological populations and habitats	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	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 85: Significance of Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
Construction phase			
1.	Fugitive dust emissions & Vehicular emissions <ul style="list-style-type: none"> Air pollution Respiratory problems 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> The highest concentration of fugitive dust and vehicular emissions is expected to occur at the project sites. Road construction activities will affect the local area Fugitive dust from trucks transporting (uncovered) aggregate Some fugitive dust will be generated as a result of blasting for turbine foundations High wind speeds are expected to rapidly disperse fugitive dust and diesel emissions <p>DURATION – Minor to Moderate</p> <ul style="list-style-type: none"> Short-term - This is expected to last for the duration of the construction phase (12 months) of the project <p>INTENSITY (BASELINE CHANGE) - Minor to Moderate</p> <ul style="list-style-type: none"> Change from present baseline conditions given the extensive construction works to be undertaken at the project site. Workers on the site will be affected the most The concentration of activities within the anticipated construction period is likely to impact receptors within close proximity to the project site. With extensive farming activities being undertaken in the project area, there is expected to be major disturbances to farmers. Temporary disturbance to ecological species is anticipated. The smothering of flora species by dust is an expected impact. Fauna 	NO

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		<p>species will be less impacted are expected to temporarily migrate</p> <ul style="list-style-type: none"> It is not anticipated that there will be any adverse changes to the baseline status of social, economic and environmental receptors in the long-term. However within the short-term, there are likely to be minor to moderate impacts. <p>AFFECTED NUMBERS - Moderate to Severe</p> <ul style="list-style-type: none"> An estimated 20-30% of the population stand to be affected given the proximity of the proposed site to the community of Malvern. The community has five (5) educational institutions and it is anticipated that the pupils and staff will be affected as the schools are located within 1-1.5km of the project boundary. The Munro Preparatory School and Munro College are located south-east of the project site. The Munro Preparatory is located less than 0.5km from the project boundary. The school is approximately 400-500m from turbines 6, 7 & 17. Munro College is located approximately 1km from the nearest turbine, #7. The biological community within the project boundary will be affected, particularly during vegetation removal exercises. Biological community outside of immediate boundary are also likely to face some stress during this phase. Access paths construction, clearance of vegetation and the release of noxious emissions associated with the movement of heavy vehicles and equipment will result in disturbance to the existing biological species. It is not anticipated that the impact will be significant as the biological community on site has been exposed to external stresses associated with farming and land clearance activities. <p>SECONDARY IMPACTS - Minor</p> <ul style="list-style-type: none"> Increase in greenhouse gas emissions from motor vehicles that contribute to global warming and climate change <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Completely reversible: dust will eventually settle or clear out of the atmosphere as a result of wind and rainfall and emissions will be dispersed. <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Fugitive dust, not acceptable; must be mitigated and kept at a minimum Stakeholders will be willing to make trade-offs in respect of the temporary nuisances provided that appropriate mitigation measures are implemented. There is however expected to be considerable concerns as it relates to dust management and the impact on school children. 	
2.	Noise	SCALE – Moderate to Severe	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
	<ul style="list-style-type: none"> • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent) 	<ul style="list-style-type: none"> • Beyond site boundary, with likely disturbances beyond a 2km radius from the project site. • Noise will affect the schools located within the project area. Munro Preparatory is likely to be the most affected given its proximity to several turbine locations. • With blasting noise levels are likely to exceed 100 dBA. <p>DURATION - Minor</p> <ul style="list-style-type: none"> • Short term (during work hours), quickly reversible. • This impact is expected to last for the duration of the construction period (12 months) <p>INTENSITY - Moderate</p> <ul style="list-style-type: none"> • Disturbance of community's social fabric • Nuisance noise during construction is expected to be a noticeable change in the immediate area of construction. • Where construction activities are being undertaken simultaneously, noise levels are expected to be above acceptable levels. <p>AFFECTED NUMBERS - Moderate</p> <ul style="list-style-type: none"> • While the total number of social receptors to be likely affected remains unknown, it is anticipated that between 10-15% of the population will be directly exposed, given the location of residences, educational and religious institutions to the project site • Workers at the site will be the most affected by construction related noises • Students and staff at the Munro Preparatory School are expected to experience increased noise nuisance during work hours for the duration of the construction period (12 months) • Increased truck traffic passing through communities en route to the site can cause an increase in noise nuisance intermittently throughout the construction period <p>SECONDARY IMPACTS – Moderate to severe</p> <ul style="list-style-type: none"> • Temporary or long term hearing impairment for persons on the construction site without hearing protection <p>REVERSIBILITY</p> <ul style="list-style-type: none"> • The effects of the temporary nuisance are completely reversible with cessation of the construction activities. • Permanent hearing loss is irreversible <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> • In general, stakeholders are willing to make trade-offs in respect 	

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		of temporary nuisances provided that available and appropriate mitigation measures are implemented.	
3.	Loss of Productive Farm Lands and Temporary Displacement of Farmers	<p>SCALE - Minor Onsite</p> <p>DURATION - Minor Farming activities will be temporarily affected by construction activities. The impact is expected to last for the duration of the construction period (12 months). However it is not expected that each farmer will be affected to the same degree and for the same duration for the entire construction period.</p> <p>INTENSITY – Minor to Moderate</p> <ul style="list-style-type: none"> • The clearance of open pastures for access roads and wind turbines will see the destruction of some farms, with the removal of agricultural crops. • The expected changes will vary and are dependent on several factors: <ul style="list-style-type: none"> ○ The number of farmers to be affected ○ The percentage of farm lands/crops destroyed ○ The types and value of crops destroyed <p>AFFECTED NUMBERS Farmers stand to be affected by the destruction of farmlands. While actual numbers will only be known during the negotiation process between farmers and the developers, it is not anticipated that the numbers will be significant as temporary relocation to other areas and compensation for losses will help in off-setting significant impacts.</p> <p>SECONDARY IMPACTS - Moderate</p> <ul style="list-style-type: none"> • Temporary unemployment • Loss of income • Loss of potential socio-economic opportunities <p>REVERSIBILITY The overall impact is reversible as farmers can be relocated either temporarily and/or permanently. Compensation for losses will also help to alleviate potentially adverse impacts.</p> <p>ACCEPTABILITY If disturbances are temporary and if adequate compensation is provided for losses, then it is expected that affected social receptors will be accepting of proposed baseline changes.</p>	NO
4.	Removal of vegetation <ul style="list-style-type: none"> • Habitat destruction • Disruption of ecosystems 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> • Onsite, within project site boundaries; specific areas identified for access roads and wind turbine towers. • Offsite /Regional: removal of forested vegetation to facilitate of 	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		<p>the wind farm substation and along transportation routes for the wind turbine components</p> <ul style="list-style-type: none"> • Total of 24.9 hectares of vegetation will be cleared on site and the amount along the transportation route for the wind turbine components is unknown <p>DURATION – Minor to Severe</p> <ul style="list-style-type: none"> • Long term and likely to be permanent: roadways (4.11 ha); wind turbines and components (24.9 ha) • Short -term, for duration of project: (i) temporary gravel to be reclaimed (11.27 ha), (ii) crane pads and construction lay-down area (iii) areas along transportation routes which will re-vegetate naturally over time <p>INTENSITY - Moderate</p> <ul style="list-style-type: none"> • There will moderate losses of flora due to various construction activities. The clearance of approximately 8.7 ha of forested areas will be the most notable vegetation loss • Disruption and loss of ecological habitats is an expected impact. Fauna to be impacted include all observed species of butterflies, snails and other insects as well as impact to bats and native (including resident and endemic) and migratory bird species which were observed utilising these marginal habitats for feeding and foraging. • Forested areas and vegetation are however classified as being degraded and of low quality. Therefore overall impact on fauna species is not expected to be significant. <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> • Less than 5% of the fauna species utilising the project site are expected to be impacted, given the presence of additional expanses of forested areas, which species are likely to migrate to during the construction period. • Changes in species abundance (occurrence) and variety will not change with the removal of vegetation under the project. Human activities e.g. farming and the felling of trees for wood have resulted in the degradation of forested areas. Clearance activities are therefore not expected to result in the further degradation of the vegetation of the area. <p>SECONDARY IMPACTS - Minor</p> <ul style="list-style-type: none"> • Modification of topography/ landscape <p>REVERSIBILITY – Minor to Moderate</p> <ul style="list-style-type: none"> • Areas temporarily cleared will be naturally restored over time, at no cost, that is, grass will fill in those areas cleared where no structure has been erected. Alternatively, these areas can be restored by planting grass/shrubs at a low cost 	

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		<p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Modification of landscape without down grading special social, economic and aesthetic values Social receptors will be generally accepting of the project if there are tangible direct and indirect benefits associated with the project. While there are tremendous benefits associated with the use of alternative energy sources over the long-term, it is not possible to assess whether social receptors will be accepting of changes over the short to medium term. 	
5.	<ul style="list-style-type: none"> Soil erosion Slope failure Sedimentation <p>From land clearing and construction activities</p> <ul style="list-style-type: none"> Off-site effect is the movement of sediment and agricultural pollutants into drainage channels On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> Onsite (within project site boundaries) land pollution can occur and it may extend beyond the site boundary to the community Sediments may be transported by storm water beyond the site boundary but impacts are expected to be more significant on site and within the community/local area around the project site (2 km) <p>DURATION – Moderate to severe</p> <ul style="list-style-type: none"> Long term impacts once slopes are modified and soil is lost through erosion <p>INTENSITY– Moderate to severe</p> <ul style="list-style-type: none"> Slope failure would lead to a major change in baseline conditions. The loss of ecosystems, destruction of farms lands and the blockage of drainage channels are likely impacts associated with topographic modification. Soil excavation and filling will be a major component of the project. During access road construction and installation of the wind turbine foundations, it is likely that large volumes of top soil will be removed and rocks excavated to ensure proper levelling of the road surfaces and foundation sites. This activity will represent a major change from present baseline conditions and is likely to result in the destruction of biological habitats and disruption of ecosystems. There are no surface or ground water resources within the project boundary; therefore there are no likely threats of water pollution. Increased run-off may however increase sediment loadings into the nearby drainage channels/networks. Disturbance of community's environmental and social fabric <p>AFFECTED NUMBERS – Moderate to severe</p> <ul style="list-style-type: none"> It is anticipated that less than 10% of social receptors will be directly exposed to threats from topographic and slope modification. Farmers face the most likely threats due to the location of their farms. It is difficult to estimate the percentage of ecological receptors 	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		<p>which are likely to be affected by topographic changes. However it is anticipated that the likely impacts will be similar to those associated with vegetation removal and excavation activities which would be <5%</p> <ul style="list-style-type: none"> • An estimated 50% of the project site will be cleared of vegetation, blasted, excavated and/or graded. These activities are expected to affect between 50-75% of flora and fauna species on site due to the high volume of soil and stone debris to be dislodged and the widespread potential for run-off. • Sedimentation and soil erosion will pose significant threats to farm lands located within the general vicinity of the project site. Farm lands at lower slope elevations may face the greatest threat in the event of run-off from the top of steep slopes. <p>SECONDARY IMPACTS - Moderate</p> <ul style="list-style-type: none"> • Loss of income for farmers whose lands maybe affected • Loss of biological habitats and disruption of ecosystems • Blockage of drainage channels/networks <p>REVERSIBILITY – Moderate to severe</p> <ul style="list-style-type: none"> • Not reversible <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> • Not acceptable; appropriate measures must be put in place to prevent slope failure and soil erosion which could lead to significant impacts on social and ecological receptors. 	
6.	Land and water pollution and displeasing aesthetics from solid waste (top soil, vegetation, construction debris, garbage)	<p>SCALE - Minor</p> <ul style="list-style-type: none"> • Onsite (within project site boundaries) land pollution can occur <p>DURATION - Minor</p> <ul style="list-style-type: none"> • Short term, for the duration of the project <p>INTENSITY</p> <ul style="list-style-type: none"> • Moderate disturbance to areas that have conservation value • Limited disturbance of secondary growth areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric • No threat to water resources as there are no surface or ground water resources at the project site or within the surrounding communities <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> • <1% of the population or habitat will be directly exposed <p>SECONDARY IMPACTS - Minor</p> <ul style="list-style-type: none"> • Garbage may attract rodents and flies 	NO

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		<ul style="list-style-type: none"> Uncontained garbage can affect aesthetics Uncontained top soil can be washed away during rainfall events Foul odours <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Completely reversible at minimal cost <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable; appropriate facilities must be provided for collection, treatment and disposal 	
7.	Traffic disruptions and vehicle conflicts due to increased traffic movement <ul style="list-style-type: none"> Traffic congestion Motor vehicle accidents 	<p>SCALE – Moderate to severe</p> <ul style="list-style-type: none"> Traffic and transportation impacts will extend beyond the boundaries of the project site. Potential impacts are anticipated along the designated transportation routes for the turbines and within the local area around the project site. <p>DURATION - Minor</p> <ul style="list-style-type: none"> Short term for the duration of the project <p>INTENSITY – Moderate to severe</p> <ul style="list-style-type: none"> Significant alterations will be made to the designated transportation routes for turbine components. Significant increase in truck traffic due to delivery of construction materials Disturbance of community's environmental, social and economic receptors <p>AFFECTED NUMBERS - Severe</p> <ul style="list-style-type: none"> Road users along the designated routes for the transportation of the turbines will face potential traffic and transportation threats. While the number of persons to be impacted cannot be accurately estimated, it is anticipated that a large number of road users will be affected, particularly along the highway (A2) which is used by persons travelling along the south coast of the island. Land owners whose properties will require alterations will also be affected. A significant number of properties will need to be altered along both routes and will require dialogue with the owners to ensure that satisfactory compensations are awarded, if required. It is anticipated that more than a third (33%) of the population within the Malvern community will be affected by changes in traffic patterns. The Malvern main road is the sole major access route to the project site and is used frequently by residents within the surrounding communities. Taxis and private vehicles frequently use the roadway. Pedestrian traffic is also a notable feature of the roadway and the general project area. It is expected that all road users in the area will be affected. The 	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		<p>degree and scale of impact will likely vary from user to user.</p> <ul style="list-style-type: none"> Residential, commercial and institutional establishments allocated along the main road are likely to be the most impacted given the proximity of these communities to the main road and site. All five (5) schools located along the Malvern main road are likely to face the most direct disruptions due to anticipated movement of vehicles along this section of the travel route. The location of key commercial establishments in the town centre e.g. restaurants, supermarkets, etc. will likely attract workers, which can result in the movement of trucks and other vehicles along other access routes beyond the project site <p>SECONDARY IMPACTS - Moderate to severe</p> <ul style="list-style-type: none"> Increased fuel consumption as a result of traffic congestion Death and injury as a result of accidents Increased fugitive emissions Increased vehicular emissions Increased wear and tear of road surfaces Increased travelling and waiting times <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Road and property alterations are reversible, but will take time and in some cases maybe costly. The removal and/or relocation of infrastructure (electricity poles, cable wires, phone wires etc.) will be temporary and is therefore reversible. Traffic congestion reversible after construction ends The effects of motor vehicle accidents are not reversible <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> While some changes will be accepted by stakeholders, it is anticipated that some changes will be met with resistance. However it is expected that dialogue and adequate compensation should help to alleviate such issues, particularly those related to land acquisition/ temporary land occupation. Some level of tolerance is expected by the residents in the communities surrounding the project sites 	
8.	Vibration and noise from Blasting <ul style="list-style-type: none"> False earthquake readings Noise interference reduce detect-ability of small earthquakes 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> The site falls within the 10km consultation zone for seismological monitoring. <p>DURATION - Minor</p> <ul style="list-style-type: none"> Short term for the duration of blasting exercises within construction phase. <p>INTENSITY - Minor</p>	NO

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		<ul style="list-style-type: none"> It is expected that there will be negligible changes to the existing baseline conditions. Blasting vibrations are likely to be received by seismological monitoring equipment at the Munro College Station likely resulting in noise interferences. However since blasting exercises will be for a short period, noise interferences will not be ongoing. <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> The vibration of the turbines is not likely to affect social and biological receptors within the project site or surrounding communities falling within the 10km consultation zone. <p>SECONDARY IMPACTS</p> <p>-</p> <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Reversible once blasting exercises are completed <p>ACCEPTABILITY</p> <p>Blasting vibrations while likely to result in noise interference are not anticipated to affect the detection of earthquakes. Seismologists are able to differentiate between sudden vibrations caused by external activities such as blasting and therefore will be accepting of this short-term interference.</p>	
9.	Use of fuel <ul style="list-style-type: none"> Depletion of (oil) resources 	<p>SCALE - Minor</p> <ul style="list-style-type: none"> National/international scale as an imported non-renewable energy source is being used but quantities are relatively small <p>DURATION - Minor</p> <ul style="list-style-type: none"> Short term, for the duration of the project <p>INTENSITY – Minor</p> <ul style="list-style-type: none"> Contribution to global depletion of resources is negligible <p>AFFECTED NUMBERS</p> <ul style="list-style-type: none"> Contribution to national and global demand is low <p>SECONDARY IMPACTS – Minor</p> <ul style="list-style-type: none"> Contributes to greenhouse gas emissions Contributes to air pollution Contributes to high fuel bill and foreign exchange demand <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Permanent 	NO

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		ACCEPTABILITY <ul style="list-style-type: none"> Acceptable given the type of project; no alternatives available 	
10.	Land and water pollution from effluent/spills <ul style="list-style-type: none"> Human waste Oil and fuel 	SCALE - Minor <ul style="list-style-type: none"> Onsite within project site boundaries land pollution can occur DURATION– Minor <ul style="list-style-type: none"> Short term, for the duration of the project INTENSITY– Minor <ul style="list-style-type: none"> No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS – Minor <ul style="list-style-type: none"> <1% of the population or habitat will be directly exposed SECONDARY IMPACTS - Minor <ul style="list-style-type: none"> Foul odours May attract rodents and flies Unightly 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 <ul style="list-style-type: none"> Quantities small, land pollution reversible naturally over time ACCEPTABILITY <ul style="list-style-type: none"> Not acceptable; appropriate facilities must be provided for collection, treatment and disposal 	NO
11.	Accidents from Construction work causing death or injury	SCALE – Moderate to severe <ul style="list-style-type: none"> Onsite within project boundaries Off-site regional if traffic-traffic and traffic-pedestrian conflict occur DURATION – Minor to severe <ul style="list-style-type: none"> Impacts may be short term, long term or permanent INTENSITY <ul style="list-style-type: none"> Has the possibility to disturb the baseline social and economic receptors AFFECTED NUMBERS <ul style="list-style-type: none"> <5% of the population or habitat will be directly exposed 	YES

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		<p>SECONDARY IMPACTS</p> <p>-</p> <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Death and serious injury not reversible <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable, mitigation measures must be implemented 	
12.	<p>Use of water</p> <ul style="list-style-type: none"> Depletion of water resources 	<p>SCALE - Minor</p> <ul style="list-style-type: none"> Beyond site boundary but within community/local area around project site (2 km) but qualities will be relatively small <p>DURATION- Minor</p> <ul style="list-style-type: none"> Short term for the duration of the project <p>INTENSITY- Minor</p> <ul style="list-style-type: none"> Limited or no adverse change to the baseline status of social, economic and environmental receptors <p>AFFECTED NUMBERS</p> <p>-</p> <p>SECONDARY IMPACTS</p> <p>-</p> <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Permanent <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> No alternative, water needed for construction 	NO
Operation Phase			
1.	<p>Noise</p> <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent) 	<p>SCALE – Moderate to severe</p> <ul style="list-style-type: none"> The noise emitted from the wind turbine will vary considerably within and around wind farms. Wind turbines create more sound as the wind speed increases, with the sound emitted decreasing as the distance from its source increases. The sound from turbines will therefore extend beyond the boundary. <p>DURATION - Severe</p> <ul style="list-style-type: none"> Long term, permanent; for as long as the wind turbines are in operation. <p>INTENSITY – Moderate to severe</p> <ul style="list-style-type: none"> The Munro Preparatory School is likely to be the most affected by the sounds emitted by the wind farm as it will be located approximately 400-500 m from turbines number 6, 7 & 17. The 	YES

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		<p>turbines are likely to generate noise in excess of the acceptable level of 55 dBA daytime. The Munro College is also likely to be affected by the noise emitted from the turbines. However the distance of the school (1km) and the presence of natural sound barriers across the landscape will assist in deflecting sounds.</p> <ul style="list-style-type: none"> Residents living less than 1 km from any of the turbines will be impacted by the noise from the turbines which is likely to exceed 55dBA (daytime) and 50 dBA (night-time) Though the increase in noise level is considered a moderate increase in baseline levels, ecological species are not expected to be adversely affected. <p>AFFECTED NUMBERS - Moderate to severe</p> <ul style="list-style-type: none"> It is anticipated that the entire student and staff population will be impacted, including other users of the schools, including parents and auxiliary workers. Students and staff will be the most impacted. Farmers are likely to be the most affected given the proximity of farms to the turbines. It is likely that some farmers will be located less than 500m from the turbines and therefore will face the greatest exposure to noise nuisances. The exact number of residences located within 1 km of any of the turbines is not known but based on the publicly available Google Earth Image for February 2014, some residences in Smithfield, Hermitage, Torrington, Fairmount, Munro and Bideford could be impacted adversely. <p>SECONDARY IMPACTS - Moderate to severe</p> <ul style="list-style-type: none"> Discontent amongst community members <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Only reversible if the turbines are not in operation or decommissioned <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Residents, particularly those located within close proximity to the site may not willingly accept the increased noise level associated with the operation of the turbines. There will be concerns from parents, as well as staff members at the schools that will be affected based on their proximity to the wind farm. Appropriate measures will need to be put in place to mitigate the noise impacts and respond to complaints associated with increased noise levels from the turbines. If these measures are effective, then residents will generally be accepting of the moderate change in noise levels. 	
2.	<p>Disruption in avifauna flight patterns</p> <ul style="list-style-type: none"> Bird and bat deaths 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> Beyond site boundary but within community/local area around project site 	YES

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		<p>DURATION- Moderate</p> <ul style="list-style-type: none"> Long term, permanent. For as long as the wind turbines are installed and in operation. <p>INTENSITY – Minor to Moderate</p> <ul style="list-style-type: none"> The degree of intensity cannot be accurately assessed based on existing baseline information. Long-term monitoring activities at the site during the operational phase will help to provide a better assessment of the overall impacts on avifauna species. It is anticipated that there will be likely negative minor to moderate impacts based on current interaction patterns between avifauna species, the project site and the forested areas adjacent the proposed site. <p>AFFECTED NUMBERS – Minor to Moderate</p> <ul style="list-style-type: none"> Birds – the site is actively used by several bird species, but the interaction of birds with turbines has shown that the overall impact is very limited. It is therefore not anticipated that more than 1% of the bird species utilising the site will be impacted. The greatest impact may be for migrant bird species. This impact is expected to be a short-term impact, as over time migrant species will be more aware of the change in the environment. Bats – the impact is expected to be adverse, given the species attraction to turbines. However there are no endangered species in the area as the bats observed are commonly found in other parts of the country. <p>SECONDARY IMPACTS</p> <p>-</p> <p>REVERSIBILITY – Minor to Moderate</p> <ul style="list-style-type: none"> There is likely potential for minor long-term impacts on species abundance within the area but not nationally. The projected operation timeline of twenty (25) years can result in large volumes of bat and bird species being killed. With proper mitigating measures, the impacts could be reduced and over-time be considered likely reversible. <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Acceptability will depend on the effectiveness of mitigation measures. Mitigation measures can help to reduce the likely impacts on avifauna; however these methods may not immediately reduce the anticipated changes in baseline conditions. Long-term monitoring of the behaviour of avifauna will be required. 	
3.	<p>Vibration and noise</p> <ul style="list-style-type: none"> False earthquake 	<p>SCALE - Minor to Moderate</p> <ul style="list-style-type: none"> The site falls within the consultation zone of 10km. 	NO

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
	<p>readings</p> <ul style="list-style-type: none"> • noise interference • reduce detect-ability of small earthquakes 	<p>DURATION – Moderate to severe</p> <ul style="list-style-type: none"> • Long term, permanent. For as long as the wind turbines are installed and in operation. <p>INTENSITY – Minor to moderate</p> <ul style="list-style-type: none"> • It is expected that there will be minor changes to the existing baseline conditions. The vibration produced by turbines is likely to be received by seismological monitoring equipment at the Munro College Station, which is likely to result in noise interferences at the Earthquake Unit at UWI which receives vibration/earthquake signals. <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> • The vibration of the turbines is not likely to affect social and biological receptors within the project site or surrounding communities falling within the 10km consultation zone. <p>SECONDARY IMPACTS - Minor</p> <ul style="list-style-type: none"> • Noise interference from the turbines can interfere with the detection of smaller earthquakes. <p>REVERSIBILITY</p> <ul style="list-style-type: none"> • Reversible once the turbines are no longer in operation <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> • If vibrations and noises generated from the turbines are significantly affecting the detection of small earthquakes and producing repeated noise nuisances, this may not be acceptable. 	
4.	Disruption in air traffic	<p>SCALE - Minor</p> <ul style="list-style-type: none"> • Beyond site boundary outside of community and local area around project site but not likely to occur <p>DURATION - Minor</p> <ul style="list-style-type: none"> • The Jamaica Civil Aviation Authority has indicated there are no risks posed to the aircraft based on current flight paths • So no disruption to air traffic is expected as long as the turbines exist and the flight paths remain the same. <p>INTENSITY - Minor</p> <ul style="list-style-type: none"> • Based on the existing flight paths of aircrafts from the Norman Manley International Airport, it is not likely that there will be any adverse impacts or changes to the existing baseline status of social, economic and environmental receptors 	NO

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		<p>AFFECTED NUMBERS With the existing flight paths no persons or habitats will be affected</p> <p>SECONDARY IMPACTS -</p> <p>REVERSIBILITY -</p> <p>ACCEPTABILITY <ul style="list-style-type: none"> Acceptable given the current 'no risk' assessment and mitigation measures to reduce and/or eliminate potential threats and/or disruptions </p>	
5.	<p>Lightning strikes</p> <ul style="list-style-type: none"> Fires Damage to wind turbines Disruption in electricity supplies injury to wind farm workers 	<p>SCALE – Minor to moderate</p> <ul style="list-style-type: none"> On site or within project site boundaries - fires Widespread or at a regional/national scale – potential for the disruption of electricity supplies <p>DURATION - Moderate</p> <ul style="list-style-type: none"> Repair or replacement of wind turbines damaged is costly and may take some time <p>INTENSITY- Moderate</p> <ul style="list-style-type: none"> The degree of change to social receptors will be negligible as JPS will still remain the major supplier of electricity. Disruptions to the turbines are likely to affect BMRJW only. Significant economic impact if BMRJW has to repair or replace turbine Air pollution from emissions associated with fires Potential injury to social receptors as turbine parts may become damaged and dislodged during lightning events. Only workers with permitted access to the site are expected to be affected. <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> Less than <1% 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 <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> Land pollution from fires and disposal of damaged equipment <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Reversible but likely to be costly <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable, measures should be taken to minimise or eliminate the impact of lightning strikes 	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
6.	Diffraction/Shadowing, Reflection, Scattering <ul style="list-style-type: none"> Electromagnetic interference which can affect radar and radio communication 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> Beyond site boundary but within community/local area around project site <p>DURATION - Minor</p> <ul style="list-style-type: none"> Long term, permanent. For as long as the wind turbines are installed and in operation but not likely to occur <p>INTENSITY - Minor</p> <ul style="list-style-type: none"> Limited or no adverse change to the baseline status of social, economic and environmental receptors <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> 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 the neighbouring communities. However, the results of the socio-economic survey indicate that the majority of the occupants have externally mounted roof antennae which already mitigates against the impact on the TV reception caused by the operation of the wind turbine. <p>SECONDARY IMPACTS</p> <p>-</p> <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Reversible once the turbines are no longer in operation <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Acceptable based on the benefits to be derived and the fact that the potential impact can be mitigated 	NO
7.	Flickering <ul style="list-style-type: none"> Photosensitive epilepsy 	<p>Health impacts such as photosensitive epilepsy occur in extremely rare cases. The analysis of the frequency of wind turbines indicate that this impact is not expected to occur.</p>	NO
	<ul style="list-style-type: none"> Shadow Flicker 	<p>SCALE – Moderate</p> <ul style="list-style-type: none"> Within the 1.12 km boundary around the wind farm <p>DURATION– Moderate</p> <ul style="list-style-type: none"> Long term, for as long as the turbines are in operation <p>INTENSITY</p> <ul style="list-style-type: none"> Disturbance of community’s environmental and social fabric <p>AFFECTED NUMBERS – Moderate</p> <ul style="list-style-type: none"> 5 – 10 % of the population may be directly exposed <p>SECONDARY IMPACTS – Moderate</p>	YES

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		<ul style="list-style-type: none"> Social discontent amongst affected community members <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Reversible once the turbines no longer operate <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable; measures to mitigate incidence of shadow flicker should be implemented 	
8.	Aesthetics <ul style="list-style-type: none"> Visually unattractive 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> Due to the location of the wind farm, the turbines will be visible beyond site the boundary and the community. <p>DURATION - Severe</p> <ul style="list-style-type: none"> Long term, permanent. For as long as the wind turbines are installed and in operation. <p>INTENSITY – Minor to moderate</p> <ul style="list-style-type: none"> This is classified as a minor change from present baseline conditions. There is an existing wind farm in the community; however the wind farm is small. The proposed wind farm will be larger and more expansive across the landscape. Limited or no adverse change to the baseline status of social, economic and environmental receptors <p>AFFECTED NUMBERS - Severe</p> <ul style="list-style-type: none"> >30% of population is affected as the wind turbines can be seen from far away <p>SECONDARY IMPACTS</p> <p>-</p> <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Only reversible if the turbines are removed <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Acceptable based on the benefits to be derived 	NO
9.	Land use <ul style="list-style-type: none"> Alteration of development and land use in the area Depreciate land value 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> Beyond site boundary but within community/local area around project site <p>DURATION - Severe</p> <ul style="list-style-type: none"> Long term, permanent. For as long as the wind turbines are installed and in operation. <p>INTENSITY- Moderate</p> <ul style="list-style-type: none"> Disturbance to the community's social, economic and 	NO

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		<p>environmental fabric</p> <ul style="list-style-type: none"> No change in existing land ownership rights expected <p>AFFECTED NUMBERS- Moderate</p> <ul style="list-style-type: none"> Less than 10% of population will be affected regarding value of land as much of the land is owned by the Commissioner of Lands and is not earmarked for immediate use. Small farming activities can coexist with the wind turbines <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> Restricts the expansion of certain types of land uses e.g. residential, recreational and commercial, due to apparent conflicts. <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Only reversible if the turbines are decommissioned In the event that occupation rights are revoked, removal of the wind turbines will prove costly. <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Acceptable use of land based on the benefits to be derived 	
10.	<p>Land and water pollution from effluent and spills</p> <ul style="list-style-type: none"> Oil spills/leaks 	<p>SCALE - Minor</p> <ul style="list-style-type: none"> Quantities are likely to be small Onsite within project site boundaries land pollution can occur <p>DURATION</p> <ul style="list-style-type: none"> Short term, if an incident occurs <p>INTENSITY</p> <ul style="list-style-type: none"> Disturbance and pollution of farming plots Limited or no adverse change to the baseline status of social, economic and environmental receptors No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> <1% of the population or habitat will be directly exposed <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> Unightly 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 <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Quantities are likely to be small; can be cleaned up; land 	NO

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		<p>pollution reversible naturally over time</p> <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable; appropriate facilities must be provided for collection, treatment and disposal 	
Maintenance			
1.	Land and water pollution from effluent and spills <ul style="list-style-type: none"> Oil spills/leaks 	<p>SCALE - Minor</p> <ul style="list-style-type: none"> Quantities are likely to be small Onsite within project site boundaries land pollution can occur <p>DURATION</p> <ul style="list-style-type: none"> Short term, if an incident occurs <p>INTENSITY</p> <ul style="list-style-type: none"> Disturbance and pollution of farming plots Limited or no adverse change to the baseline status of social, economic and environmental receptors No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> <1% of the population or habitat will be directly exposed <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> 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 <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable; appropriate facilities must be provided for collection, treatment and disposal 	NO
2.	Land pollution from solid waste	<p>SCALE - Minor</p> <ul style="list-style-type: none"> Onsite within site boundaries land pollution can occur <p>DURATION - Minor</p> <ul style="list-style-type: none"> Short term, for the duration of the maintenance activity. <p>INTENSITY</p>	NO

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		<ul style="list-style-type: none"> Disturbance of secondary vegetated areas and farming plots Limited or no adverse change to the baseline status of social, economic and environmental receptors No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> <1% of the population or habitat will be directly exposed <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> Garbage may attract rodents Uncontained garbage can affect aesthetics Foul odours May attract rodents and flies <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Quantities are relatively small; completely reversible at minimal cost <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable; appropriate facilities must be provided for collection, treatment and disposal 	
3.	Accidents from Maintenance work causing death or injury	<p>SCALE - Minor</p> <ul style="list-style-type: none"> Onsite within site boundaries <p>DURATION – Minor to severe</p> <ul style="list-style-type: none"> Impact of accidents can be short term long term or permanent <p>INTENSITY – Minor to severe</p> <ul style="list-style-type: none"> Has the possibility to disturb the baseline social and economic receptors <p>AFFECTED NUMBERS</p> <ul style="list-style-type: none"> <1% of the population or habitat will be directly exposed <p>SECONDARY IMPACTS</p> <p>-</p> <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Death and serious injury not reversible <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable, mitigation measures must be implemented 	NO
Decommissioning			
1.	Land pollution from solid	SCALE - Minor	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
	waste	<ul style="list-style-type: none"> Onsite within site boundaries land pollution can occur <p>DURATION - Minor</p> <ul style="list-style-type: none"> Short term, for the duration of the decommissioning <p>INTENSITY - Minor</p> <ul style="list-style-type: none"> Limited or no adverse change to the baseline status of social, economic and environmental receptors No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities <p>AFFECTED NUMBERS - Minor</p> <ul style="list-style-type: none"> <1% of the population or habitat will be directly exposed <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> Garbage may attract rodents and flies Uncontained garbage can affect aesthetics Large quantities of material will be removed, some will be reused, some sold and the remainder discarded <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Completely reversible at minimal cost <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Not acceptable; appropriate facilities must be provided for collection, treatment and disposal 	
2.	Noise from equipment <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent) 	<p>SCALE - Moderate</p> <ul style="list-style-type: none"> Beyond site boundary but within community/ local area around project site (2 km) Noise may affect the schools (Munro Preparatory School) <p>DURATION - Minor</p> <ul style="list-style-type: none"> Short term (during work hours), quickly reversible This effect is expected to last for the duration of the decommissioning exercise <p>INTENSITY - Moderate</p> <ul style="list-style-type: none"> Disturbance of community's social fabric Nuisance noise during decommissioning is expected to be a noticeable change in the immediate area <p>AFFECTED NUMBERS – Moderate to severe</p> <ul style="list-style-type: none"> Between 10-20% of the population will be directly exposed, given the proximity of the site to residential areas. Farmers are the likely receptors to be most affected given the proximity of their farms to the decommissioning site. 	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		<ul style="list-style-type: none"> Workers at the site could be affected by noise related to the decommissioning exercise Students and staff at the Munro Preparatory School (less than 500m from Turbines 6, 7 & 17) may experience increased noise nuisance during work hours for the duration of the decommissioning exercise Increased truck traffic passing through communities en route to the site can cause an increase in noise nuisance intermittently over the decommissioning exercise <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> Temporary or long term hearing impairment for persons on the construction site without hearing protection <p>REVERSIBILITY</p> <ul style="list-style-type: none"> The effects of the temporary nuisance are completely reversible with cessation of the decommissioning activities. Hearing loss and other permanent impacts are not reversible. <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> In general, stakeholders are willing to make trade-offs in respect of temporary nuisances provided that available and appropriate mitigation measures are implemented. 	
3.	Land and water pollution from effluent/spills <ul style="list-style-type: none"> Human waste Oil and fuel 	<p>SCALE - Minor</p> <ul style="list-style-type: none"> Onsite within project site boundaries land pollution can occur <p>DURATION– Minor</p> <ul style="list-style-type: none"> Short term, for the duration of the project <p>INTENSITY– Minor</p> <ul style="list-style-type: none"> No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities Limited or no adverse change to the baseline status of social, economic and environmental receptors <p>AFFECTED NUMBERS – Minor</p> <ul style="list-style-type: none"> <1% of the population or habitat will be directly exposed <p>SECONDARY IMPACTS - Minor</p> <ul style="list-style-type: none"> Foul odours May attract rodents and flies Unightly 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 	NO

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI- CANT
		REVERSIBILITY <ul style="list-style-type: none"> Quantities small, land pollution reversible naturally over time ACCEPTABILITY <ul style="list-style-type: none"> Not acceptable; appropriate facilities must be provided for collection, treatment and disposal 	

6.4 Cumulative Impacts – Operational Phase

Local

There are no major developments planned for the area (communities) in the vicinity of the proposed project based on the development plans of the Parish Council. Therefore the only local cumulative impacts for consideration are impacts on avifauna, noise and shadow flicker based on the existence of the JPS 3 MW Wind Farm.

As it relates to avifauna, the Project has incorporated into its layout, recommendations made by bird, bat and fauna consultants to avoid potential areas where undue clearing and turbine placement could be experienced. In order to minimise impacts on the population of birds and bats within the direct vicinity, the project's revised layout has sought to minimise any additional clearing that would cause undue or increased loss of habitat to resident bird or bats within the direct vicinity and region, thereby avoiding potential displacement of native species and foraging habitat. The project has sought to maximise, where practicable, existing disturbed areas so as not to materially impact the local environment. The project substation, laydown yard, and operations facility are examples utilising previously disturbed areas. Further, BMRJ has performed a detailed road design analysis using specialty hauling vehicles to reduce the project's overall proposed disturbance and clearing requirements necessary for installation, further minimising direct impacts at the project site.

The four (4) JPS operational wind turbines which lie within BMRJ's project footprint, as documented through field investigations performed by BMRJ's consultants, have not revealed any undue displacement of species or a notable level of mortality.

The shadow flicker assessment revealed that based on the location of the JPS 3 MW Wind farm that the effects were well within the proposed 34 MW Wind Farm study area. So the overriding impacts are from the proposed project.

Based on the location of the JPS 3 MW wind farm, in the middle of the north-south alignment for the 34 MW wind farm and not near any residential or institutional facilities, the cumulative noise level impacts would not adversely affect any social receptors.

Regional

Presently there are two additional wind farms being contemplated for development in the neighbouring parish of Manchester and two wind farms are operational, one in Manchester

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(Wigton Wind Farm). It is unclear whether the two new wind farm projects will employ measures adopted by BMRJ but given the available wind resource, it is not expected that the total capacity of these facilities will exceed 50MWs. By their nature, the two new projects are limited in size and scope compared to larger installations found in the United States. There is no other planned material infrastructure development in the region to note.

National/Global

Finally, the cumulative effects of the proposed project should be considered in the overall context of the contribution to climate change. As the understanding of atmospheric climate change continues to evolve, the release of atmospheric greenhouse gases caused by human activities has the potential to cause irreversible changes to the atmosphere including local wildlife and habitat. In this context, the project stands to help stem this change as it has the ability to displace the burning of fuels linked to climate change as a result of generating additional carbon dioxide, and other heat trapping gases within the atmosphere. This overall beneficial cumulative impact is of significant importance and should outweigh the other cumulative impacts which are minor and can be mitigated.

6.5 Potential Positive Impacts

The positive impacts associated with the project are presented below and in Table 86.

6.5.1 Construction Phase

1. Stimulation of Local Economy and Employment Opportunities

Approximately two hundred and fifty-four (254) direct, indirect and induced jobs will be created with the proposed BMR Jamaica Wind Farm project. During the construction phase of the project, two hundred and fifteen (215) persons are expected to attain employment either through direct, indirect or induced means, while fifteen (15) persons are expected to gain employment during the operational phase. Approximately one hundred and nineteen (119) local jobs are to be created from the project (pre-construction to operation).

Non-managerial jobs for locals are expected to total approximately ninety-five (95), while twenty-four (24) managerial jobs for locals are expected to be created.

For the construction phase of the project engineers, architects, construction workers, port workers, truck drivers, equipment operators, security guards, surveyors, building contractors and unskilled labour will all benefit from the project. During the operational phase engineers and maintenance personnel will be needed. 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.

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

2. Infrastructural Improvement

Road construction and widening activities along several major roadways will lead to infrastructural improvements along the designated travel route for the turbines. Access roads leading to the site will help to improve the current road infrastructure in certain sections of the project area, providing improved access for farmers and other road users.

Additional improvements will be made to utility infrastructure. Electricity (power) infrastructure will be constructed onsite and offsite to support the distribution of electricity from the wind farm to the national grid. During the construction of the transmission lines and substation it is anticipated that any existing power infrastructure which is required for the project will be improved.

It is expected that pipes for supplying water to the site will also be constructed. The NWC only has piping infrastructure on the Malvern main road. The proposed project site has no access to formal water supply and will need to establish a connection from the main road to supply the wind farm. If any residential development falls along possible access routes to the site, then there are likely benefits related to the improvements to be undertaken with water infrastructure.

6.5.2 Operational Phase

1. Stimulation of Local Economy

During the operational phase of the project fifteen (15) persons will be employed as maintenance workers and engineers to undertake operation and maintenance (O&M) activities related to the wind turbines. It is expected that local personnel will be involved in this aspect of the project given their close proximity to the turbines and ability to respond immediately (or faster) in the event of an emergency.

Maintenance personnel are expected to receive formal training in the maintenance and operation of the turbines, including the use of monitoring equipment, such as noise meters. The training received by operation and maintenance personnel will be a long-term benefit.

2. 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. Emissions associated with wind technology are as a result of pre-construction and

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construction activities, which are offset during the operational phase of the project as the wind turbines emit zero emissions for power generation.

The BMR Jamaica Wind farm is projected to contribute annually the following:

- Y Nitrogen Oxides emissions will be reduced by 7,000 tonnes
- Y Sulphur Dioxide emissions will be reduced by 40,000 tonnes
- Y Carbon Dioxide emissions will be reduced by over 2 million tonnes

3. Reduction in Fuel Consumption and Costs

The constant fluctuation and significant increases in fuel costs has made it increasingly important for developing and non-producing oil nations to explore and utilise alternative and cleaner energy sources. The largest fuel cost associated with the 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.

Overall the cost of the actual wind turbine is the single largest cost component, and can make up seventy percent (70%) or more of the entire cost of a land-based wind project. The cost of installation, such as construction, makes up the remaining capital costs. Recent reductions in capital costs have been primarily driven by significant reductions in wind turbine costs. The United States Department of Energy found that in 2012 the average installed cost for wind farms stood at nearly \$1,940/kW, down almost \$200/kW from the reported average cost in 2011 and down almost \$300/kW from the reported average cost in both 2009 and 2010. This reduction in capital costs has also made wind farm development costs more comparable to gas and coal.³⁴

According to data from Renewable UK (2010)³⁵ the capital cost of turbines i.e. construction of turbine, foundation, electrical equipment and grid connection is a capital intensive-technology. In 2009 the installed cost for turbines was approximately US\$2,000-2,500 per kW in Europe. This cost when compared to gas and coal which had an average installed costs of US\$1,014 and US\$2,574 respectively, showed the gaps between wind development and other energy forms e.g. coal.

Today as the data has shown, with reducing capital costs, wind energy has become increasingly competitive as the power of choice. Proper siting, improved technology and with more affordable operation and maintenance costs, wind energy has emerged as one of the most affordable and preferred forms of electricity today. Fluctuating cost of fuel for conventional technologies has made operation and

³⁴ American Wind Energy Association <http://www.awea.org/Resources/Content.aspx?ItemNumber=5547>

³⁵ <http://www.bwea.com/pdf/briefings/Wind-Energy-Generation-Costs.pdf>

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maintenance of these facilities sometimes costly, however O & M activities for wind turbine technology is very inexpensive requiring negligible amounts of fuel.

The BMRJ project is estimated to eliminate the need to import and burn 250,000 barrels of oil and in the process save approximately US\$500 million in oil expenses annually.

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 and Educational Centre

Large wind farms across the globe have become increasingly popular as tourist attractions. While public opinion has been split on the overall aesthetic appeal of wind farms, they have become popular field trip sites, particularly for schools and wind farm enthusiasts. The BMR Jamaica Wind farm is likely to attract visitors to the area, with school children likely being the most frequent visitors.

The wind farm also has the potential to be used as a renewable energy educational centre. The wind farm is being developed using the latest wind technology. Operators of the facility in receiving visitors to the facility can develop an information centre where visitors can learn more about the wind turbines and see demonstration videos on how they work.

Overtime it is anticipated that the wider Malvern community could receive spin-off benefits from the wind farm. Visitors to the area will require basic social amenities, such as retail food shops etc., thereby increasing commercial activity within the town.

Table 86: Significant Impact Assessment - Positive

	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
Construction phase		
1.	Employment Opportunities	SCALE <ul style="list-style-type: none">Regional DURATION

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	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		<ul style="list-style-type: none"> Short-term for contracted workers - This is expected to last for the duration of the construction phase (9-12 months) of the project <p>INTENSITY (BASELINE CHANGE)</p> <ul style="list-style-type: none"> 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 <p>AFFECTED NUMBERS</p> <ul style="list-style-type: none"> It is anticipated that 100 persons will benefit from employment on the proposed project; some likely to be from neighbouring communities <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> 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 <p>REVERSIBILITY</p> <ul style="list-style-type: none"> Short term employment ends after project is completed <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Acceptable, persons are in need of employment
Operational Phase		
1.	Reduction in greenhouse gas emissions	<p>SCALE</p> <ul style="list-style-type: none"> Regional/National/International <p>DURATION</p> <ul style="list-style-type: none"> Long-term <p>INTENSITY/BASELINE</p> <ul style="list-style-type: none"> 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 <p>AFFECTED NUMBERS</p> <ul style="list-style-type: none"> Unknown how many persons or ecological species could benefit, but the impact is expected to be global <p>SECONDARY EFFECTS</p> <ul style="list-style-type: none"> Reduced global temperatures (negligible impact)

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	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		<ul style="list-style-type: none"> Improved local conditions (temperature) Improved air quality
2.	Reduction in fuel costs and demand for foreign exchange for the importation of oil	<p>SCALE</p> <ul style="list-style-type: none"> National <p>DURATION</p> <ul style="list-style-type: none"> Long-term <p>INTENSITY/BASELINE</p> <ul style="list-style-type: none"> The reduction in fuel costs and consumption will take place incrementally and will therefore be seen as a minor change from existing baseline conditions. <p>AFFECTED NUMBERS</p> <ul style="list-style-type: none"> All members of the population will be impacted either directly or indirectly. <p>SECONDARY EFFECTS</p> <ul style="list-style-type: none"> Increased potential to reduce dependency on oil (long-term) Increased financial resources for other renewable energy projects
3.	Promotion of use of alternative energy	<p>SCALE</p> <ul style="list-style-type: none"> Regional/National/International <p>DURATION</p> <ul style="list-style-type: none"> Long-term <p>INTENSITY/BASELINE</p> <ul style="list-style-type: none"> This will represent a major change from existing baseline conditions, particularly in developing countries <p>AFFECTED NUMBERS</p> <ul style="list-style-type: none"> The entire population stands to benefit from such an initiative <p>SECONDARY EFFECTS</p> <ul style="list-style-type: none"> 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	<p>SCALE</p> <ul style="list-style-type: none"> Local <p>DURATION</p> <ul style="list-style-type: none"> Long-term

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	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		<p>INTENSITY/BASELINE</p> <ul style="list-style-type: none"> Moderate to significant change in social and economic fabric of the communities <p>AFFECTED NUMBERS</p> <ul style="list-style-type: none"> The entire population stands to benefit from such an initiative <p>SECONDARY EFFECTS</p> <ul style="list-style-type: none"> Increased commercial activity May encourage more alternative energy projects
Maintenance		
1.	Maintenance activities	<p>SCALE</p> <ul style="list-style-type: none"> Regional <p>DURATION</p> <ul style="list-style-type: none"> Long-term – for as long as the wind turbines are in operation <p>INTENSITY (BASELINE CHANGE)</p> <ul style="list-style-type: none"> Small increase in commercial activity when maintenance work is being done in the area <p>AFFECTED NUMBERS</p> <p>-</p> <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> Increased income earning potential for workers Increased standard of living Reduction in unemployment <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Acceptable, persons are in need of employment
Decommissioning		
1.	Decommissioning and removal of wind turbines Employment Opportunities	<p>SCALE</p> <ul style="list-style-type: none"> Regional <p>DURATION</p> <ul style="list-style-type: none"> Short-term for contracted workers - This is expected to last for the duration of the decommissioning exercise <p>INTENSITY (BASELINE CHANGE)</p> <ul style="list-style-type: none"> 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

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POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
	<p>exercise</p> <p>AFFECTED NUMBERS</p> <ul style="list-style-type: none"> Some local residents will benefit from short term employment <p>SECONDARY IMPACTS</p> <ul style="list-style-type: none"> Increased income earning potential for workers Increased standard of living Increased commerce in neighbouring communities Reduction in unemployment <p>ACCEPTABILITY</p> <ul style="list-style-type: none"> Acceptable, persons are in need of employment

6.6 Summary of Significant Impacts

Table 87 presents a summary of the significant aspects for the construction, operation, maintenance and decommissioning phases of the project. Eleven (11) significant impacts have been identified, five (5) of which are associated with the construction phase of the project. The operations of the wind turbine have three (3) significant impacts: (i) susceptibility of turbines to lightning strikes (ii) disruption to avifauna species and (iii) increased noise nuisances. In all cases steps can be taken to mitigate against the negative impacts.

Table 87: Summary of Significant Impacts

ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
Construction phase	
13. Fugitive dust emissions & vehicular emissions <ul style="list-style-type: none"> Air pollution Respiratory problems 	NO
14. Noise <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent) 	YES
15. Loss of Agricultural Crops and Temporary Displacement of Farmers	NO
16. Loss of Vegetation and Disturbance of Biological Communities <ul style="list-style-type: none"> Habitat destruction Disruption of ecosystems Displacement of small farmers 	YES

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
17.	Soil erosion and sedimentation <ul style="list-style-type: none"> Off-site effect is the movement of sediment and agricultural pollutants into drainage channels On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil Slope failure 	YES
18.	Land and water pollution (solid waste) <ul style="list-style-type: none"> Top soil, vegetation, construction debris, garbage 	NO
19.	Traffic Disruption and Vehicle Conflicts <ul style="list-style-type: none"> Traffic congestion Motor vehicle accidents 	YES
20.	Vibration from blasting <ul style="list-style-type: none"> Noise interferences 	NO
21.	Use of fuel <ul style="list-style-type: none"> Depletion of (oil) resources 	NO
22.	Use of water <ul style="list-style-type: none"> Depletion of water resources 	NO
23.	Land and water pollution <ul style="list-style-type: none"> Human waste Fuel and oil spills 	NO
24.	Accidents from construction work causing death or injury	YES
Operation Phase		
12.	Noise <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance 	YES
13.	Disruption in avifauna flight patterns <ul style="list-style-type: none"> Bird and bat deaths 	YES
14.	Vibration and noise <ul style="list-style-type: none"> False earthquake signals 	NO
15.	Disruption in air traffic	NO
16.	Lightning strikes <ul style="list-style-type: none"> Fires Damage to wind turbines Disruption in electricity supplies Injury to workers 	YES
17.	Flickering (photosensitive epilepsy)	NO
18.	Shadow flicker	YES
19.	Diffraction/Shadowing, Reflection, Scattering <ul style="list-style-type: none"> Electromagnetic interference which can affect radar and radiocommunication 	NO
20.	Aesthetics <ul style="list-style-type: none"> Visually unattractive 	NO
21.	Land use	NO

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	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
	<ul style="list-style-type: none"> Alteration of development and land use in the area Depreciate land value 	
22.	Land and water pollution <ul style="list-style-type: none"> Fuel and oil spills 	NO
Maintenance		
4.	Land and water pollution <ul style="list-style-type: none"> Human waste Fuel and oil spills 	NO
5.	Land pollution <ul style="list-style-type: none"> Solid waste 	NO
6.	Accidents from maintenance work causing death or injury	NO
Decommissioning		
4.	Land pollution <ul style="list-style-type: none"> Solid waste 	YES
5.	Noise from equipment <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent) 	YES
6.	Land and water pollution <ul style="list-style-type: none"> Human waste Fuel and oil spills 	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 88.

Table 88: Mitigation Measures

	Impacts	Mitigation Measures
Construction Phase		
11.	Noise Nuisance to persons <ul style="list-style-type: none"> Habitat disturbance Hearing impairment (temporary, permanent) 	<ul style="list-style-type: none"> Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn Sensitise residents in the area to the types of activities that will take place ahead of the works and assign a liaison person with whom the residents can relate Ensure project activities are scheduled during working hours of 7:00 a.m. to 7:00 p.m. Operate well maintained vehicles and equipment Blasting should be done in accordance with the requirements of Mines and Geology Department

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	Impacts	Mitigation Measures
12.	Emissions and Fugitive Dust <ul style="list-style-type: none"> Health impacts e.g. respiratory problems Air pollution 	<ul style="list-style-type: none"> Cover haulage vehicles transporting aggregate, soil and cement Cover and/or wet onsite stockpiles of aggregate, soil etc. Ensure proper stock piling/storage and disposal of solid waste Wet cleared land areas regularly Use water sprays to minimise dust Blasting should be done in accordance with the requirements of Mines and Geology Department 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
13.	Vegetation Loss / Disturbance of Biological Communities <ul style="list-style-type: none"> Air Pollution Habitat destruction Disruption of ecosystems 	<ul style="list-style-type: none"> Only areas that are absolutely necessary for clearance should be cleared In areas where vegetation has been removed and the lands have not been converted to permanent land uses (roadways and siting of turbines), re-vegetation exercises should be undertaken. Replant trees in the same area of the project site or other areas In cases where sensitive habitats will be disturbed, re-siting of turbines should be undertaken Bring to the attention of the Jamaica National Heritage Trust and the NEPA immediately if any artefacts are found and safeguard same
14.	Displacement of Farmers <ul style="list-style-type: none"> Loss of revenue Disturbance of farming plots/ destruction of crops 	<ul style="list-style-type: none"> A walk through of proposed lands to be used for the siting of turbines should be undertaken where farming plots are present. This should be done prior to the finalisation of the siting layout for the wind turbines Make arrangements with farmers to compensate them for farm crops which may have to be removed
15.	Soil erosion and sedimentation due to land clearing and slope modification <ul style="list-style-type: none"> Disruption of ecosystems Land slippages Blocked drainage channels Loss of soil Water pollution 	<ul style="list-style-type: none"> Identify and avoid areas with very steep and unstable slopes and near to sinkholes Minimise, where possible the clearance of vegetation and removal of top soil Place or design access roads to follow natural topography and minimize hill side cuts. Design runoff control features to minimise soil erosion Re-vegetate areas not be used for the placement of permanent features Place berms around stockpiles of top soil and aggregate (sand, gravel, marl) Avoid steep cuts and where there are steep cuts they must be shored up Utilise sediment traps to minimise sediment runoff
16.	Land pollution and displeasing aesthetics due to Solid Waste	<ul style="list-style-type: none"> Contain garbage and construction debris onsite until disposal at the approved municipal disposal site at Myersville Prohibit burning of solid waste on project sites
17.	Traffic Congestion/ <ul style="list-style-type: none"> Immobility Vehicle-vehicle conflicts Vehicle-pedestrian conflicts Delayed traffic movements Damage to road infrastructure Alteration of private 	<ul style="list-style-type: none"> Obtain permission from the owners of properties identified for alteration along transportation route. Compensation, if required, should be done at market prices Erect traffic signs along main transportation route and in sensitive areas such as schools Erect traffic assisting devices at the entrance/exit of construction sites and corners e.g. mirrors, flagmen, etc. Transport heavy equipment and wind turbine parts during off-peak traffic hours (between (10:00p.m. to 4:00 a.m.) with police outriders and JPS to raise electrical wires

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	Impacts	Mitigation Measures
	property	<ul style="list-style-type: none"> 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 Advise schools and residents of the proposed project construction schedule and seek their buy-in and support
18.	Land and water pollution <ul style="list-style-type: none"> Human Waste Fuel and Chemical Spills 	<ul style="list-style-type: none"> Use a reputable company to provide portable toilets for workers on site The company should only dispose of sewage at an approved municipal treatment plant Store fuel and chemicals 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 Develop an Emergency Preparedness and Response Plan and train workers accordingly
19.	Depletion of water resources	<ul style="list-style-type: none"> Utilise low water consumption equipment Practice onsite water reuse and recycling where possible and practical
20.	Injury and/or death due to accidents during construction work	<ul style="list-style-type: none"> 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
Operational Phase		
16.	Noise <ul style="list-style-type: none"> Nuisance to persons Habitat disturbance Hearing impairment (temporary, permanent) 	<ul style="list-style-type: none"> Situate wind turbines as far away as possible from residences and schools. Where possible turbines should be 2 km or more away from these receptors. Wind farm noise limits should be set relative to existing background noise levels and should not exceed 55 dB (daytime) and 50dBA (night time) at receptors such as schools, residences and commercial establishments. Establish barriers to deflect sound e.g. trees Wind turbines should contain no tonal component Monitor sound levels to ensure that they are within acceptable limits
17.	Disturbance/ destruction of avifauna species (bats and birds) Injury and/or death	<ul style="list-style-type: none"> Target hilltops or previously disturbed areas for the siting of turbines Install deterrents such as ultrasound blasters if applicable Locate turbines away from the flight path of birds Shut down turbines during high risk conditions such as hurricanes Perform post construction monitoring to evaluate what if any risks are posed by the turbines operation.
18.	Shadow Flicker	<ul style="list-style-type: none"> Turbines should be sited away from communities to prevent extended exposure to flickering. A distance of 10 times the rotor diameter (called the zone of influence for shadow flickering) is considered the minimum distance for the siting of turbines to mitigate against flickering. In the event shadow-flicker becomes an annoyance within an inhabited dwelling, some sort of screening should be considered. This could include strategically placed vegetation, window awnings, or window shades.

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	Impacts	Mitigation Measures
19.	Lightning <ul style="list-style-type: none"> Fires Destruction/ disturbance of vegetation 	<ul style="list-style-type: none"> A SCADA system to remotely monitor the turbines will be used and includes features to shut down the turbines in the event of a fire Ensure that fire extinguishers are available on the wind farm for emergency use
20.	Shadowing, Reflection, Scattering Electromagnetic Interference with RF signals	<ul style="list-style-type: none"> Install outdoor or higher antennae Relocate or realign antennae
21.	Disruption of Air Traffic	<ul style="list-style-type: none"> Final turbine designs and layout should be submitted to the Jamaica Civil Aviation Authority, allowing for a risk assessment to be done examining the potential risks of the proposed wind farm to air traffic movement The rotor blades, nacelle and upper two-thirds of the supporting mast of the wind turbines should be painted white. The nacelle must be lit by a medium density obstacle light of 2000 candelas per m² showing flashing red, unless otherwise directed by JCAA. The obstacle light should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any directions. The lights should operate at 20-60 flashes per minute and flash simultaneously with lights installed at other wind turbines to show the extent of the wind farm, unless otherwise directed by JCAA. The tower should be inspected regularly to detect any failure of these lights which must be replaced in minimum time.
22.	Vibration Disturbance of seismological equipment Noise interferences	<ul style="list-style-type: none"> The design of the wind farm must be such as to prevent or reduce noise interferences
23.	Land and water pollution <ul style="list-style-type: none"> Oil Spills/leaks 	<ul style="list-style-type: none"> Ensure that spill and oil cleaning kits and equipment are onsite Ensure that workers are trained in spill management
24.	Land use change <ul style="list-style-type: none"> Depreciation of land costs Loss of revenues Land use development change Loss of bauxite mining lands 	<ul style="list-style-type: none"> Turbines, where possible, should be sited away from farming lands In cases where farming lands will be used to site turbines, access roads or any other infrastructural feature associated with the wind farm, farmers of said lands should be compensated Turbines should not be sited on bauxite deposits, except in cases where formal approval has been granted by the Jamaica Bauxite Institute
Maintenance Phase		
25.	Land and water pollution <ul style="list-style-type: none"> Solid waste Oil spills/Leaks 	<ul style="list-style-type: none"> Properly contain garbage and construction debris for disposal at the approved dumpsite at Myersville Have spill containment and clean up equipment on site and dispose of waste in accordance with best practices
26.	Accidents due to maintenance work	<ul style="list-style-type: none"> Erect signs during maintenance activities Provide workers with the necessary Personal Protective Equipment (PPE) Train construction personnel in good safety practices and emergency preparedness and response measures
Decommissioning Phase		

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	Impacts	Mitigation Measures
27.	Land and water pollution <ul style="list-style-type: none"> • Solid waste 	<ul style="list-style-type: none"> • Properly contain garbage and construction debris for disposal at the approved dumpsite at Myersville • The disposal of large parts will need to be done with the approval of the National Solid Waste Management Authority (NSWMA)
28.	Noise <ul style="list-style-type: none"> • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent) 	<ul style="list-style-type: none"> • Advise community members of the times that decommissioning activities will take place • 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
29.	Land and water pollution <ul style="list-style-type: none"> • Human Waste • Fuel and Chemical Spills 	<ul style="list-style-type: none"> • Use a reputable company to provide portable toilets for workers • The company should only dispose of sewage at an approved municipal treatment plant • 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 • Develop an Emergency Preparedness and Response Plan and train workers accordingly
30.	Accidents/Injury due to Decommissioning work	<ul style="list-style-type: none"> • Erect signs during decommissioning activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures

8.0 Emergency Preparedness and Response

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

Wind turbines have been designed to withstand aerodynamic forces however more attention is now being paid to the impact of earthquakes on wind turbines. Wind turbines are now being designed based on the results of seismic loading tests that are undertaken during the design phase of the turbines. Turbines are being designed with an emergency stop and additional research is being undertaken to assess the structural resistance of wind turbines to earthquakes.

In the parish of St. Elizabeth, earthquakes have originated in the northern and southern sections of the parish. Earthquake events have occurred in the vicinity of the project site.

The entire island of Jamaica is susceptible to hurricanes and tropical storms. The parishes of St. Elizabeth, Clarendon, Kingston and Manchester have been the most susceptible to the impacts of hurricane events based on information provided by the National Oceanic and Atmospheric Administration (NOAA).

The Wigton Wind Farm situated in Manchester and located less than 20 km from the proposed BMR Jamaica Wind Farm 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

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- 2008: Tropical Storm Gustav – No repair cost

In the event of a hurricane, the following procedures will be followed:

- All turbine blades will be shut down
- The hurricane will be monitored for direction and wind speed
- Ratchet straps may be placed on nacelle covers
- The turbines may be manually yawed 90° clockwise out of the wind 12 hours after a hurricane warning is issued
- Liaise with System control
- The site will be secured
- Additional mitigation measures may be employed by BMRJ's Operational Personnel in order to secure the safety of the Project and Project Personnel.

9.0 Environmental Health and Safety Management and Monitoring Plan

This Environmental Management Plan (EMP) has been prepared to ensure that all activities undertaken during the construction and operations of the proposed development are done in a manner that will reduce and/or eliminate the identified adverse impacts associated with the proposed project. The EMP serves to outline the prevention methods and procedures that should be adopted by the developers and operators of this development to ensure that the physical, biological and social environments are protected. This plan will therefore cover the following:

- i. Management Objectives during Construction and Operational Phases
- ii. Management and Monitoring Actions to be implemented
- iii. Persons responsible for the implementation and management of monitoring actions
- iv. Performance targets and specifications
- v. Implementation Schedule

9.1 Environmental Management Objectives

1. Construction Phase

- a. Establish controls for contractors to ensure that the proposed mitigation measures are implemented in a timely and effective manner. This includes provisions for worker safety, road safety, waste and materials management.
- b. Effectively minimise risks and negative environmental effects of natural disasters and hazards (hurricanes, fires, earthquakes, oil spills and accidental leaks).
- c. Reduce and manage predicted waste-streams.
- d. Minimise construction nuisances to other land users, including adjoining land users throughout the development phase of the project.

2. Operational Phase

- a. Develop and implement comprehensive environmental management plans, which clearly identify targets for environmental performance.
- b. Develop and implement safety procedures and operation and maintenance training that must be undertaken by all staff members and visitors to the site.
- c. Ensure that staff is trained in environmental management and monitoring procedures.

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- d. Conduct maintenance operations in a way that is compliant with environmental and turbine manufacturer regulations.
- e. Properly maintain the project area to ensure that the adjacent ecosystems and their aesthetic appearance are not negatively impacted.

9.2 Safety Requirements

1. Construction & Decommissioning Phases

The contractor shall comply with safety rules and regulations that are enforced at the site in accordance with local and 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 these requirements 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 the Project Manager 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 the Project Manager 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.

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2. Operational Phase

- a. Signs, notices and directions must be erected in clear view of visitors, outlining all safety rules and regulations governing the use of the wind farm and its facilities.
- b. Fire extinguishers, fire alarms, smoke detectors and other safety equipment should be placed in strategic locations across the property. Operation and Maintenance Staff should be trained in the use of all safety equipment. Visitors to the site should also be briefed on the safety requirements at the wind farm, prior to touring the turbines.
- c. Emergency assembly sites should be clearly labelled and communicated to visitors to the BMR Jamaica Wind Farm Site.

9.3 Post Permit Documentation Requirements

1. Emergency Preparedness Response Plan

An Emergency Preparedness and Response Plan (EMP) will be prepared under separate cover.

The goal of this plan is to prevent where possible and minimise the effects of emergencies, disasters and accidents on the operations of the facility. Emergency preparedness will help to reduce human suffering and economic losses that could arise. The specific objectives of the plan are to:

- a. Identify risks
- b. Implement measures to minimise the likelihood of emergencies that can adversely impact humans and the environment.
- c. Provide an immediate and effective response to incidents that represent a risk to human safety, public health and the environment.
- d. Ensure that the Wind Farm can be operational as quickly as possible after the occurrence of an emergency and/or disaster situation.

The approach taken to emergency response planning is four-fold:

- a. Prevention: actions to reduce exposure to or eliminate the hazard. Reducing the degree, extent and magnitude of hazards can be achieved through the proper scaling, designing and redesigning of elements of the project.
- b. Preparedness: actions to plan, equip and train for the event, which includes the education of both visitors and staff utilising the premises through drill and other information dissemination methods.
- c. Response: action to save lives and property during the event. This includes safety procedures, methods and equipment required.
- d. Recovery: actions taken to resume pre-event conditions.

2. Closure Plan

This project is expected to have a life of 25 years. As such a Closure Plan will be developed under separate cover to govern the decommissioning activities with the objective of minimising adverse environmental impacts.

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9.4 Mitigation and Monitoring Programme

Table 89 presents the Environmental Management and Monitoring Plan for the construction and operation of the Wind Farm facility to be operated by BMR Jamaica Wind Limited.

Table 89: Management and Monitoring Plan

	Management Plan	Monitoring Programme
Construction phase		
1.	Fugitive dust emissions & vehicular emissions <ul style="list-style-type: none"> • Cover haulage vehicles transporting aggregate, soil and cement • Cover and/or wet onsite stockpiles of aggregate, soil etc. • Ensure proper stock piling/storage and disposal of solid waste • Wet cleared land areas regularly • Use water sprays to minimise dust • Blasting should be done in accordance with the requirements of Mines and Geology Department • 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 	<ul style="list-style-type: none"> • BMR 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 <ul style="list-style-type: none"> • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn • Sensitise residents in the area to the types of activities that will take place ahead of the works and assign a liaison person with whom the residents can relate • Ensure project activities are scheduled during working hours of 7:00 a.m. to 7:00 p.m., with the exception of blade lifts where deemed necessary³⁶ • Operate well maintained vehicles and equipment • Blasting should be done in accordance with the requirements of Mines and Geology Department 	<ul style="list-style-type: none"> • BMR is to check periodically with the schools and residents to find out if they have any complaints • BMR 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.	Loss of Productive Farms and Temporary Displacement of Farmers <ul style="list-style-type: none"> • Minimise clearance of the areas that are being used for farming • Advise farmers in advance of construction schedule to prevent loss of crops • Compensate farmers for loss of crops where necessary 	<ul style="list-style-type: none"> • BMR is to ensure that farmers are relocated to areas that are suitable for farming • BMR is to ensure that during construction, operation and decommissioning phases there are no adverse threats posed to farmers
4.	Loss of Vegetation and Disturbance of Biological Communities	<ul style="list-style-type: none"> • BMR is to ensure that contractors only clear vegetation that has been identified

³⁶ Blade lifts may have to be done at night if daytime conditions are too windy. Stakeholders will be advised accordingly if this becomes necessary.

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	Management Plan	Monitoring Programme
	<ul style="list-style-type: none"> Only areas that are absolutely necessary for clearance should be cleared In areas where vegetation has been removed and the lands have not been converted to permanent land uses (roadways and siting of turbines), re-vegetation exercises should be undertaken. Replant trees in the same area of the project site or other areas In cases where sensitive habitats will be disturbed, re-siting of turbines should be undertaken Bring to the attention of the Jamaica National Heritage Trust and the NEPA immediately if any artefacts are found and safeguard same 	<p>for removal during the construction phase of the project</p> <ul style="list-style-type: none"> BMR is to ensure that replanting exercises are undertaken following the completion of road works
5.	<p>Land pollution due to solid waste (top soil, vegetation, construction debris, garbage)</p> <ul style="list-style-type: none"> Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville Landscape project sites with top soil excavated 	<ul style="list-style-type: none"> BMR 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
6.	<p>Land and water pollution due to human waste</p> <ul style="list-style-type: none"> Contract a reputable company to provide portable toilets for workers 	<ul style="list-style-type: none"> BMR is to verify that waste is being taken to an approved wastewater treatment facility
7.	<p>Soil erosion and sedimentation</p> <ul style="list-style-type: none"> Only clear top soil from areas to be used Place berms around stockpiles of top soil and aggregate Shore up unstable soils 	<ul style="list-style-type: none"> BMR is to conduct periodic audits of contractor operations The Contractor's monthly report to provide details of the mitigation measures implemented
8.	<p>Increased traffic movement</p> <ul style="list-style-type: none"> Erect signs along main transportation route and in sensitive areas such as schools Advise contractor of the need for their drivers to obey speed limits Transport heavy equipment and wind turbine parts during off-peak traffic hours (between 10:00 p.m. 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 	<ul style="list-style-type: none"> The Contractor's monthly report to provide details of the mitigation measures implemented
9.	<p>Construction work</p> <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Conduct periodic audits of contractor operations The Contractor's monthly report to provide details of the mitigation measures implemented

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	Management Plan	Monitoring Programme
10.	Fuel and oil spills <ul style="list-style-type: none"> • Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and clean up equipment on site • Train personnel in spill management procedures 	<ul style="list-style-type: none"> • BMR is to conduct periodic audits of contractor operations • The Contractor/BMR is to respond and clean up spills in accordance with emergency preparedness and response plans • The Contractor is to report to BMR on emergencies • BMR 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.	<ul style="list-style-type: none"> • Noise 	<ul style="list-style-type: none"> • BMR is to maintain turbines in accordance with manufacturer's requirements • During commissioning of wind turbine BMR is to assess noise levels at Munro Preparatory School to have a record of noise levels during operations • BMR is to check with Munro Preparatory School within the first month of operation of the turbines to determine if they have any concerns • BMR is to assess noise levels within a 2 km zone around the wind farm and check with residents to determine if there are any adverse impacts
2.	Disruption to avifauna	<ul style="list-style-type: none"> • BMR is to implement a pre-construction, construction and operation monitoring programme to assess how the bats and birds will be affected by the turbine operations
3.	Disruption in air traffic	<ul style="list-style-type: none"> • BMR is to ensure that all lights are operating in accordance with guidelines provided by the Jamaica Civil Aviation Authority • BMR is to ensure that the lights on towers are inspected quarterly to inspect lights to detect any failure
Maintenance Phase		
1.	Solid waste <ul style="list-style-type: none"> • Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville 	<ul style="list-style-type: none"> • BMR is to obtain verification that solid waste is disposed of at an approved municipal disposal site

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	Management Plan	Monitoring Programme
2.	Maintenance work <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> BMR is to maintain preventive and unscheduled/emergency maintenance records BMR is to maintain records of near misses and accidents
Decommissioning phase		
1.	Land pollution from solid waste <ul style="list-style-type: none"> Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville 	<ul style="list-style-type: none"> BMR is to obtain verification that contractor has disposed of solid waste at an approved municipal disposal site
2.	Noise from equipment <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> BMR is to check periodically with the schools to find out if they have any complaints
3.	Land and water pollution from human waste and oil spills/leaks <ul style="list-style-type: none"> Contract a reputable company to provide portable toilets for workers Store fuel with secondary spill containment infrastructure Utilise proper dispensing equipment Have spill containment and cleanup equipment on site 	<ul style="list-style-type: none"> BMR is to obtain verification that waste is being taken to an approved wastewater treatment facility BMR is to conduct periodic audits of contractor operations The Contractor/BMR is to respond and clean up in accordance with emergency preparedness and response plans The Contractor is to report to BMR on emergencies BMR is to report to NEPA in accordance with permit requirements

9.5 Reporting

During the construction phase:

- The contractor will submit monthly reports to BMR Jamaica Wind Ltd. outlining work progress including environmental mitigation measures that are implemented, accidents, incidents requiring activation of the emergency response plans and breaches in environmental requirements, if any.
- BMR Jamaica Wind Ltd 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 phases BMR Jamaica Wind Ltd will submit the following reports to NEPA

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

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10.0 References

1. Adams, C.D. 1972. *Flowering Plants of Jamaica*. University of the West Indies, Mona, Jamaica
2. Batash, M. (2011). Summary of International Wind Turbine Noise Regulations. http://rnp.org/sites/default/files/pdfs/Bastash%20RNP_Criteria2.pdf accessed November 2013.
3. Bibby C.J.; Jones, M.J. and S.J. Marsden. 1998. *Expedition Field Techniques: Bird Surveys*. Expedition Advisory Centre, Royal Geographical Society, London.
4. Ellenbogen, J. et al, (2012). Wind Turbine Health Impact Study. Massachusetts, Michigan, USA.
5. Garrad Hassan America Inc.; Document No.: 702181-USSD-R-01 Munro Expansion Wind
6. Farm; May 7, 2013
7. Garraway, E. & A. Bailey 2005. *Butterflies of Jamaica*. Macmillan Publishers Limited
8. Genoways, H. et al, (*undated*). *Bats of Jamaica*. Museum of Texas Tech University. Texas, USA.
9. Global Environment Facility (2009): ROtI Handbook: Towards Enhancing the Impacts of Environmental Projects.
10. Government of Alberta (2013). Wildlife Management- Bat Mitigation Framework for Wind Power Development. Alberta, Canada.
11. Iremonger, S. 2002. *A Guide to Plants in the Blue Mountains of Jamaica*. The University of the West Indies Press.
12. Marzaouca, D. (2014). Blue Mountain Wind Farm route Survey for Vestas V112 wind Turbines. Kingston, Jamaica
13. Massa, A. and A. Sutton (1998). Environmental Policy Framework St. Elizabeth. Kingston, Jamaica.
14. Ministry of Education (2013). Jamaica School Profiles 2012-2013. Kingston, Jamaica
15. National Water Commission (2011). Draft St. Elizabeth Water Supply Plans. Kingston, Jamaica
16. Parker, Tracey 2003. *Manual of Dendrology Jamaica*. Forestry Department, Ministry of Agriculture. Government of Jamaica
17. Planning Institute of Jamaica (2013). Economic and Social Survey of Jamaica 2012. Kingston, Jamaica
18. Planning Institute of Jamaica (2012). Economic and Social Survey of Jamaica 2011. Kingston, Jamaica
19. Shakuntala Makhijani, Alexander Ochs, et al., (2013). Jamaica Sustainable Energy Roadmap: Pathways to an Affordable, Reliable, Low-Emission Electricity System. Washington, DC: Worldwatch Institute.
20. Statistical Institute of Jamaica (2013). Population and housing Census: Jamaica Economic Activity, Volume 8. Kingston, Jamaica
21. Statistical Institute of Jamaica (2013). Population and housing Census: Jamaica Education, Volume 4. Kingston, Jamaica
22. Statistical Institute of Jamaica (2013). Population and housing Census: Jamaica Housing, Volume 10 Part B. Kingston, Jamaica
23. Statistical Institute of Jamaica (2013). Population and housing Census: Jamaica Housing, Volume 10 Part A. Kingston, Jamaica
24. Statistical Institute of Jamaica (2012). The Labour Force Report 2011. Kingston, Jamaica
25. Tetra Tech EC et al. (2008). American Wind Energy Association Wind Energy Siting Handbook. Washington D.C.
26. VestasMetPanel 3000, Meteorology Station, Document no.: 0001-4151 V05; 2012-10-11 (Public)

Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm Project, Malvern St. Elizabeth, Jamaica

27. Vestas - Class 1, General Specification, V90–1.8/2.0 MW, 50 Hz VCS; Document no.: 0004-6207 V11; 2012-05-28 (Restricted - Propitiatory)
28. Vestas - General Specification, V80-2.0 MW 50 Hz VCS; Document no.: 0004-7878 V11; 2012-12-12 (Restricted - Propitiatory)
29. Vestas - Class I; Requirements for Access and Site Roads, Lay-By Areas and Crane Pads;21/04/2010
30. Vestas - General Conditions and Site Facilities Requirements (undated)
31. Vestas - Class 1 VestasOnline® Business Server Hardware Description; Document no.: 958855V11; 2012-07-20
32. Wunderle Jr, J.M. 1994. *Census methods for Caribbean land birds*. Gen. Tech. Rep. SO-98. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station
33. *Wind Turbines and Birds: A Guidance Document for Environmental Assessment*. Environment Canada Canadian Wildlife Service March 2006

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Appendix 1: EIA Team

1. Project Leader & Environmental Engineer

Ianthe Smith, P.E., is an environmental engineer, environmental consultant and a trained and experienced ISO 14000 Lead Auditor. Mrs. Smith has an undergraduate degree in Civil Engineering from the University of the West Indies (1986) and a Master of Engineering Degree in Environmental Engineering from the University of Toronto (1994). Based on her experience, Mrs. Ianthe Smith, Principal Environmental Engineer/Team Leader along with Director Ernest W. Smith and other associates, will provide consultancy services in accordance with the Terms of Reference provided.

2. Radio frequency Specialist

Ernest W. Smith, P.E., is an Electrical Engineer with over 15 years professional experience as a Power Systems Engineer working for the Jamaica Public Service Company. His knowledge of power generating systems will prove invaluable in interpreting the implications of any technical issue related to the construction and operation of the proposed wind farm and its likely impact on the environment.

3. Environmental Engineer

Kimballe Campbell, P.E. is an Engineering Consultant at Environmental and Engineering Managers Ltd. She obtained a Bachelor of Science degree in Chemical Engineering in May 2005 from Yale University from which she received a full academic scholarship. In May 2010, she graduated from Cornell University with a Master of Engineering degree in Engineering Management and a concentration in Sustainable Energy Systems. During this programme she completed courses which include: Project Management, Analysis of Sustainable Energy Systems and Urban Transportation, Energy & Environmental Systems for Sustainable Development. She worked with the West Indies Alumina Company (WINDALCO) for approximately six (6) years as a Process Engineer and most recently as Senior Environmental and Industrial Hygiene Engineer prior to joining Environmental and Engineering Managers Ltd.

4. Urban Planner and Social Impact Assessment Specialist

Kamille Dwyer, M.Sc. is an Urban and Regional Planner, Environmental Consultant and Geographer with six (6) years experience in the field of land use planning, social research and environmental management. She holds a Master's of Science degree in Urban and Regional Planning and a Bachelors of Arts degree in Geography (University of the West Indies). Ms. Dwyer has worked as a project manager, land use and social scientist consultant on more than thirty-five (35) environmental, land-use and social based projects, including environmental and social impact assessments, socio-economic surveys and community participatory forums. She has undertaken work across the Caribbean region in countries such as Anguilla, Belize, St. Kitts and Nevis, Montserrat, Antigua and Barbuda, Jamaica and Trinidad and Tobago.

Ms. Dwyer has extensive knowledge and experience in social surveying, research and data entry and analysis. Having served in the capacity of project manager for various environmental and

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land use related projects, she also has widespread knowledge and understanding of the regulatory planning and environmental system in Jamaica and the Caribbean.

5. Terrestrial Ecologist/Ornithologist

Marlon Beale is a Terrestrial Ecologist/Ornithologist who holds a B.S. in Zoology from the University of the West Indies (Mona Campus) and is currently a candidate for a PhD in Terrestrial Ecology at the University of the West Indies (Mona Campus). Over the past four (4) years he has worked with the Jamaica Conservation and Development Trust for which he currently serves as the Executive Director. He has been associated with Bird Life Jamaica for over 10 years and was once a Field Worker there. He is a member of the Jamaica Institution of Engineers (JIE) and has been trained in Arc View 9.x and other GIS applications, Protected Areas Management Techniques and Participatory Forest Management Techniques.

6. Geographical Information Systems and Earth Science Consultant

Paul Henry is a Geographical Information Systems and Earth Science Consultant and holds a B.A. in Geography (University of the West Indies-Mona Campus), a M. Sc. in Geographic Information Systems (Lund University –Sweden) and is currently a candidate for a M.Sc. in Occupational Environmental Health and Safety. He has worked in several capacities which include Research Analyst at the Office of Disaster, Preparedness and Emergency Management (ODPEM), Part-time Lecturer at the College of Agricultural Sciences and Education (CASE) and Inspector of Mines at the Mines and Geology Division of the Government of Jamaica. Currently, he is the Manager of Securities and Standards in the Protective Security Unit at the Ministry of National Security and Justice. He is a member of the Jamaica Association of Explosives Engineering Professionals (JAEPP) and Jamaica Geographical Society (JGS).

7. Speleologist

Ronald Stewart is an Electrical Technician, with college training in Electrical Technology from George Brown College in Toronto Canada and a certified Speleologist with extensive field training in cave exploration, bat surveying, guano sampling and geomorphology mapping. Mr. Stewart has received training in geomorphology from the Keck Science Center and Carleton University, cave exploration and archaeology from the University of the West Indies, Mona, Jamaica, Queens University, Windsor Research Centre, Jamaica, and Western University. He has undertaken over 300 cave explorations in Jamaica and is recognised by the National Environment and Planning Agency as the authority on speleological sites in Jamaica.

Ronald is the founder of the Jamaica Caves Organisation (JCO) and was the lead author of the Jamaica Cave Protection Guidelines, adopted by the Jamaica Tourism Development Company. He has served as the principal investigator for several cave assessments in Jamaica.

8. Speleologist

Johannes Pael is a Business Administrator who holds a degree in Business Administration from Baylor University, Texas, USA. He is a certified speleologist with specific training from University of Ontario in netting and species identification, correct bat handling and netting

***Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm
Project, Malvern St. Elizabeth, Jamaica***

methods and recording bat calls with electronic recorders. Additional training in bat surveying techniques has also been undertaken with the National Environment and Planning Agency, Windsor Research Centre and the Royal Ontario Museum.

Mr. Pael has served as an associate investigator conducting explorations and research into over 100 caves and sinkholes in Jamaica. He has undertaken several field investigations related to hydrology, bats, reptiles and geology. He is currently the Director of the Jamaica Caves Organisation.

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Project, Malvern St. Elizabeth, Jamaica**

Appendix 2: Calibration Certificates for Sound Level Meter and Calibrator

3M Oconomowoc
Personal Safety Division

3M Detection Solutions
1060 Corporate Center Drive
Oconomowoc, WI 53066-4828
www.3M.com/detection
262 567 9157 800 245 0779
262 567 4047 Fax

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Certificate of Calibration

Certificate No: 1102759QIJ080067

Submitted By: ENVIRONMENTAL AND ENG. MGR LTI
UNIT #11 BARBICAN BUS. CENTER
KINGSTON 8, JAMAICA

Serial Number: QIJ080067 Date Received: 4/18/2013
Customer ID: Date Issued: 4/26/2013
Model: QC-10 CALIBRATOR Valid Until: 4/26/2014

Test Conditions: Model Conditions:
Temperature: 18°C to 29°C As Found: IN TOLERANCE
Humidity: 20% to 80% As Left: IN TOLERANCE
Barometric Pressure: 890 mbar to 1050 mbar

SubAssemblies:
Description: Serial Number:

Calibration Procedure: 56V981

Reference Standard(s):

I.D. Number	Device	Last Calibration Date	Calibration Due
ET0000556	B&K ENSEMBLE	6/24/2012	6/24/2013
T00230	FLUKE 45 MULTIMETER	2/2/2012	2/2/2014

Measurement Uncertainty:

+/- 1.1% ACOUSTIC (0.1dB) +/- 1.4% VAC +/- 0.012% HZ
Estimated at 95% Confidence Level (k=2)

Calibrated By:  4/26/2013
BETHANY JOHNSON Service Technician

Reviewed/Approved By:  4/26/2013
Technical Manager/Deputy

This report certifies that all calibration equipment used in the test is traceable to NIST or other NMI, and applies only to the unit identified under equipment above. This report must not be reproduced except in its entirety without the written approval of 3M Detection Solutions.

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Project, Malvern St. Elizabeth, Jamaica**

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Certificate of Calibration

Certificate No: 1102759DAJ080015

(A) indicates out of tolerance condition

<u>Test Type</u>	<u>Nominal</u>	<u>Tolerance-</u>	<u>Tolerance+</u>	<u>As Found</u>	<u>As Left</u>	<u>Unit</u>
Calibration	114.0	113.5	114.5	114.5	114.0	dB
A Weighting/125Hz	97.9	96.4	99.4	99.2	98.8	dB
A Weighting/250Hz	105.4	103.9	106.9	106.4	106.0	dB
A Weighting/500Hz	110.8	109.3	112.3	111.6	111.2	dB
A Weighting/1kHz	114.0	113.5	114.5	114.5	114.0	dB
A Weighting/2kHz	115.2	113.7	116.7	115.8	115.4	dB
C Weighting/125Hz	113.8	112.3	115.3	114.9	114.5	dB
C Weighting/250Hz	114.0	112.5	115.5	114.9	114.5	dB
C Weighting/500Hz	114.0	112.5	115.5	114.8	114.4	dB
C Weighting/1kHz	114.0	113.5	114.5	114.4	114.0	dB
C Weighting/2kHz	113.8	112.3	115.3	114.5	114.0	dB
Linearity/120dB	120.0	119.3	120.7	120.6	120.2	dB
Linearity/110dB	110.0	109.3	110.7	110.4	110.0	dB
Linearity/100dB	100.0	99.3	100.7	100.4	100.0	dB
Linearity/90dB	90.0	89.3	90.7	90.4	90.0	dB
Linearity/80dB	80.0	79.3	80.7	80.4	80.0	dB
Linearity/70dB	70.0	69.3	70.7	70.5	70.1	dB
AC Out	0.116	0.073	0.184	0.107	0.107	VAC
DC Out	1.187	0.687	1.607	1.156	1.156	VDC

* indicates non accredited

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Certificate of Calibration

Certificate No: 1102759DAJ080015

Submitted By: ENVIRONMENTAL AND ENG. MGR LTI
UNIT #11 BARBICAN BUS. CENTER
KINGSTON 8, JAMAICA

Serial Number:	DAJ080015	Date Received:	4/18/2013
Customer ID:		Date Issued:	4/26/2013
Model:	2100 SLM	Valid Until:	4/26/2014
Test Conditions:		Model Conditions:	
Temperature:	18°C to 29°C	As Found:	IN TOLERANCE
Humidity:	20% to 80%	As Left:	IN TOLERANCE
Barometric Pressure:	890 mbar to 1050 mbar		

SubAssemblies:

Description:	Serial Number:
MICROPHONE QE 7052 1/2 IN. ELECTRET	36228

Calibration Procedure: 53V903

Reference Standard(s):

I.D. Number	Device	Last Calibration	Date Calibration Due
ET0000452	FLUKE 45 MULTIMETER	2/18/2013	2/18/2015
ET0000556	B&K ENSEMBLE	6/24/2012	6/24/2013

Measurement Uncertainty:

+/- 2.2% ACOUSTIC (0.19dB) +/- 1.4% VAC +/- 0.1% VDC
Estimated at 95% Confidence Level (k=2)

Calibrated By:  4/26/2013
BETHANY JOHNSON Service Technician

Reviewed/Approved By:  4/26/2013
Technical Manager/Deputy

This report certifies that all calibration equipment used in the test is traceable to NIST or other NMI, and applies only to the unit identified under equipment above. This report must not be reproduced except in its entirety without the written approval of 3M Detection Solutions.

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Project, Malvern St. Elizabeth, Jamaica***

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Certificate of Calibration

Certificate No: 1102759QIJ080067

(A) indicates out of tolerance condition

<u>Test Type</u>	<u>Nominal</u>	<u>Tolerance-</u>	<u>Tolerance+</u>	<u>As Found</u>	<u>As Left</u>	<u>Unit</u>
AC OUT/1kHz	1.000	0.950	1.050	1.003	1.003	VAC
Calibration	114.0	113.7	114.3	114.2	114.0	dB
Frequency	1000	980	1020	1000	1000	Hz

* indicates non accredited

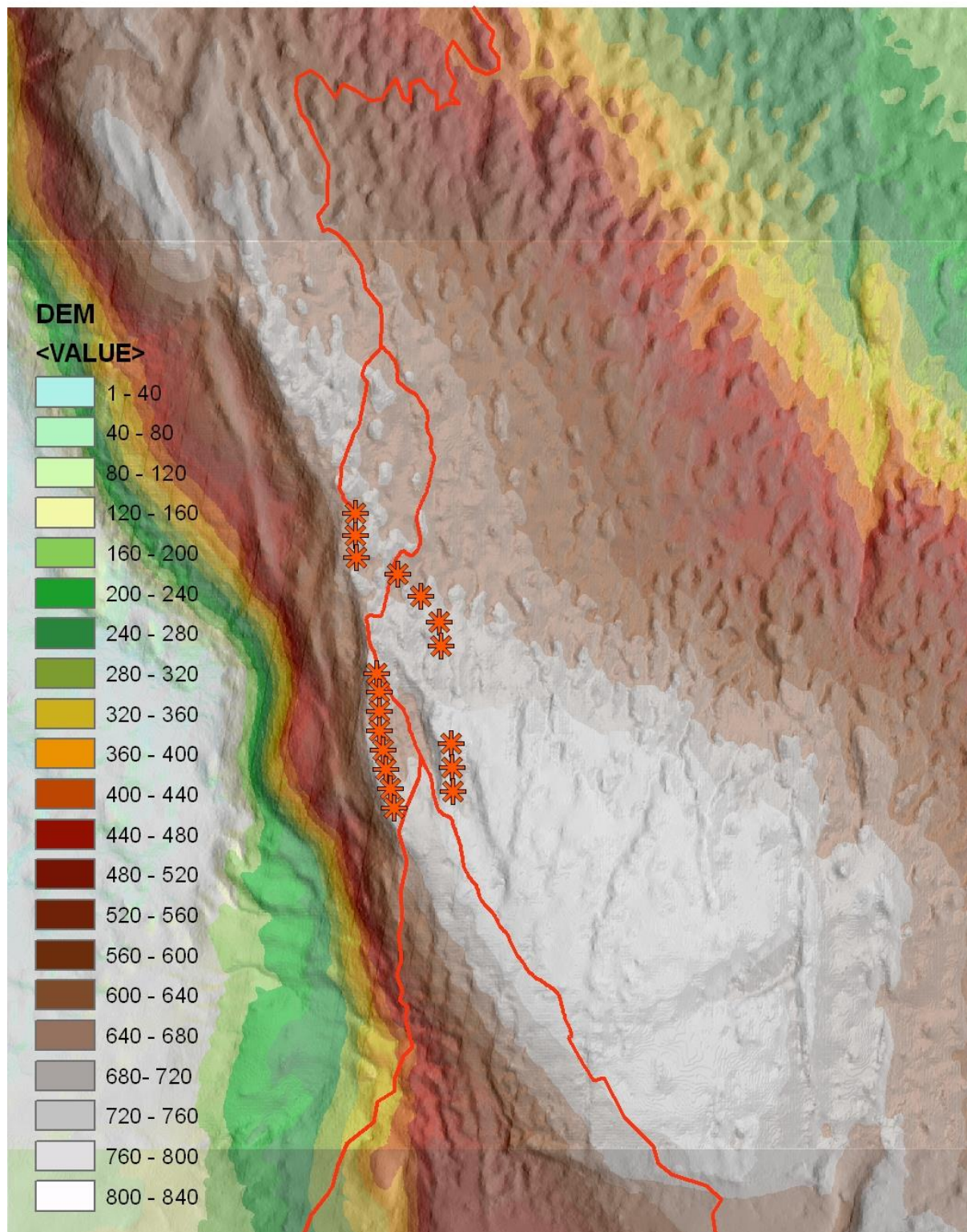
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Project, Malvern St. Elizabeth, Jamaica*

Appendix 3: Map: Digital Elevation Model (Ikonos 6m)



Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm Project, Malvern St. Elizabeth, Jamaica

Appendix 4: School Classification Code

SCHOOL CLASSIFICATION CODE

School Type	Classification	Range
Infant	Class V	> 1200 pupils
Primary	Class V	> 1200 pupils
All - Age	Class IV	851 - 1200 pupils
Primary & Junior High	Class III	501 - 850 pupils
	Class II	251 - 500 pupils
	Class I	≤ 250 pupils
* Secondary	Class IV	≥ 5501 points
	Class III	3451 - 5500 points
	Class II	2201 - 3450 points
	Class I	≤ 2200 points

NOTES :

* Secondary Schools are classified on a point system depending on the course duration.

3 Year course - 3 points per student

5 Year course - 4 points per student

7 Year course - 5 points per student

Technical High Schools are allotted 5 points per full time student.

Environmental Impact Assessment for the Blue Mountain Renewables 34 MW Wind Farm Project, Malvern St. Elizabeth, Jamaica

Appendix 5: 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
<i>Level at which sustained exposure may result in hearing loss</i>	<i>90 - 95dB</i>
Power mower at 3'	107dB
Snowmobile, Motorcycle	100dB
Power saw at 3'	110dB
Sandblasting, Loud Rock Concert	115dB
<i>Pain begins</i>	<i>125dB</i>
Pneumatic riveter at 4'	125dB
<i>Even short term exposure can cause permanent damage - Loudest recommended exposure WITH hearing protection</i>	<i>140dB</i>
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