ENVIRONMENTAL IMPACT ASSESSMENT
THE BARBADOS LIGHT & POWER COMPANY LIMITED
LAMBERTS EAST WIND FARM
GENERATING STATION

FINAL REPORT WITH ADDENDUM TO ADDRESS COMMENTS RECEIVED

Submitted to:

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EXECUTIVE SUMMARY

Project Proposal

The Barbados Light and Power Company Limited is applying to the Town and Country Development Planning Office (TCDPO) for planning permission to construct a 10 MW wind farm comprised of 11 wind turbines, associated control building, and access tracks on land at Lambert's East in the parish of St. Lucy, Barbados. Each turbine will have a tubular tower of approximately 55 m height, and three rotor blades with a rotor diameter of approximately 56 m. A new transmission line will connect the site to a new substation to be developed at Trents.

Project Schedule

Barbados Light and Power Company Limited originally planned to commence development of the project during 2007 with completion early in 2009. However the schedule has since been delayed. Additional site studies such as geotechnical testing will also be required to complete the design. It is estimated that the construction period will take approximately 6 months.

Approach

The proposed Terms of Reference (TOR) for the Environmental Impact Assessment were provided in an Outline Planning Application to TCDPO dated June 11, 2004. These TOR were subsequently approved with comments on October 3, 2005.

The assessment was completed as a phased approach involving a Phase I to define the project components and include collection of baseline data and information on the defined Project area, and a Phase II that involved an effects assessment of the construction and operation of the proposed wind farm. An emphasis on the use of Valued Ecosystem Components as the focal points for impact assessment and the evaluation of potential interactions between project components and activities was incorporated.

In April 2007, AMEC completed the report "Environmental Impact Assessment – Lamberts East Windfarm" to meet the requirements of the TOR.

Following public and regulatory review, a series of comments were provided to BLPC for further clarification and response. The current report responds to the additional information requested. The responses to these comments are provided in Appendix H as "Addendum to Final Report".

Assessment of Environmental Effects

An assessment of the environmental effects has been completed for the construction phase and the operational phase of the proposed wind farm. A final section deals with potential effects to the environment from accidents and malfunctions. Recommended mitigation methods and significance of the environmental effects are discussed for each potentially impacted valued ecosystem component. The EIA has considered the following impacts from construction and operations:

Aesthetics

Photomontages have been prepared to simulate the windfarm on the landscape from key vantage points at Risk Road, Pie Corner and the existing wind turbine. In addition, a map of the zone of visual influence shows areas from which the windfarm can be seen.

The nature of the landscape of this part of Barbados is such that there are few viewpoints from which the whole of the wind farm can be seen. This partial visibility of the turbines allows the structures to elegantly blend in with the scenery. From these simulations, it can be stated that the project will not impose a significant visual impairment of the scenery of the area.

Ecological Effects

There are no environmentally sensitive areas in the proximity to the site and hence the study focussed on the effects on birds and bats.

It is known that birds breed in and migrate close to, or through the project area as Barbados is a temporary stop en-route to South America. The preferred habitats for these species are coastal beaches and mudflats, as well as freshwater and saltwater marshes. In the Lamberts study area, there is no preferred habitat for these shorebirds in proximity to the site. As a result, migratory shorebirds and waders do not utilize the study area. Therefore, collisions are not likely and significant adverse effects on shore birds are not expected.

Similar to the transitory migratory species, overwintering species rely on habitats that provide foraging and refuge. The Lamberts study area does not provide the appropriate habitat for these over wintering residents.

Based on studies done on similar wind farms and the data collected on migratory and resident birds at the proposed wind farm site, the significance of effects on avian populations due to operation of the windfarm is considered to be minor.

There are no maintained records of bat distribution in Barbados. Field surveys of the study area, both during the day and during the evening hours did not record any sightings of bats. The proposed location of the turbines is not in proximity to any significant stands of trees that would provide roosting areas. The gully areas near the study area were surveyed and no bats or significant areas for bat hibernacula were observed. As a result, it is unlikely that the area supports a large resident population of bats. Based on previous studies done on similar wind farms and lack of observed usage of the site by bat species, the significance of effects on bat populations due to operation of the wind farm is considered to be minor.

Air Quality

During construction the potential impacts on air quality are predominantly dust emissions from excavations. These will be localized short duration and can be mitigated by a dust control program and by good housekeeping. The Environmental Management Plan for construction provides mitigation measures for dust control. The impacts from construction on air quality are therefore considered minimal.

There will be no air emissions from the windfarm during operations. The facility will have a beneficial effect on air quality as it will reduce BLPC's overall emissions by displacing the use of fossil fuelled generation.

Noise

Noise levels during construction will be localized, of short duration and restricted to working hours, and the impacts are considered to be minor.

Sound contours were developed for the wind farm operating at different wind speeds using a software noise model. Based on maximum power output at a wind speed of 8m/s, the predicted noise level at the Lambert's Plantation house which is the closest receptor is 45 dBA. This sound level is consistent with the recommended outdoor noise standards of the World Health Organization and the World Bank for sleeping. At higher wind speeds the background sound levels increase at a greater rate than the turbine noise.

Residents to the east of the site have expressed concerns over low frequency sound, based on published experience at some European facilities. Several studies have been done in other jurisdictions in response to community concerns over low frequency sound which was problematic of early wind turbines from the 1980s. Advances in turbine design have addressed the problems of low frequency sound. Research conducted on modern wind turbines has shown that the levels of low frequency noise have been below accepted thresholds, and are no longer a problem. Wind turbines have an amplitude modulation at low frequency producing the characteristic "swoosh", which should not be confused with low frequency sound or infrasound.

Traffic

Moving the turbine blades and towers from the port to the site will result in abnormal loads travelling along country lanes. The main section of each turbine blade is approximately 25 m long and weighs about 4 tonnes. The tower is a tapered steel tube with a maximum diameter of 3.5 m which is supplied in 2 or 3 sections of length and has a total weight of about 60 tonnes. The weight of the nacelle is 20-25 tonnes. An assessment will be done of the routing for major equipment transfers from the port in advance, to identify any constraints. It is recommended that the Ministry of Public Works and Transport be provided with the schedule and routing for equipment transport, to coordinate the overnight transport of oversize loads. In addition, the public will be provided with advance information on temporary road closures through announcements in the newspapers and through radio and television.

There will be no significant effect on traffic during the operations phase as the site will be unmanned except for maintenance checks.

Groundwater

The site is located in a Zone 4 water zone which is not a sensitive area for groundwater protection. The operation of wind generators produces no discharges and, other than lubricants contained within the nacelle, uses no liquid products. The Environmental Management Plan describes measures to be taken to protect groundwater. Consequently, no effects/impacts to groundwater are expected from the construction or operation of the windfarm.

Electromagnetic Interference

Contact was made with the telecommunications companies, the CBC and the airport to determine the probability of effects of the turbines on transmissions. It was determined that the wind farm will not affect cellular telephone, communications transmissions, satellite television receptions or airport radar.

The effect of the wind farm on households using a conventional antenna is difficult to predict due to the directional nature of the transmissions, and the type of individual antenna being used. A study completed by the BBC recommends that wind turbines be at least 500 m from any viewer to avoid interference. Very few residences are within this separation distance and hence the potential for interference will be limited. Indications from the public open house were that the area to the east of the proposed wind farm has a poor reception using conventional antennae due to the higher ground along the ridge blocking direct line of sight to the transmitter. It is recommended that BLPC take preliminary measurements of signal strength in the area close to the site, to allow confirmation of effects on signal quality following development of the project.

Corrective measures can be used after the construction of the wind turbines to minimize the impact of any resulting degradation to the TV signal. These measures include providing improved antennae or repeaters. No significant adverse environmental effects related to electromagnetic interference are likely with implementation of the recommended mitigation measures.

Shadow Flicker

A wind turbine, like other tall structures, can cast a shadow on the neighbouring area when the sun is low in the sky. The movement of the rotor blades can chop the sunlight, causing a flickering (blinking) effect referred to as “shadow flicker”.

The potential flicker was modeled and the results plotted on maps which show the maximum number of hours per year of shadow flicker on a 1 m x 1 m (vertical) house window situated 2 m above the ground and facing north, east, south or west. For those dwellings closest to the wind farm the theoretical maximum amount of shadow flicker could be as much as 80 hours per year, an average of less than 15 minutes per day. The effects diminish with distance. The modeling is very conservative and assumes full sunshine throughout the year (ie no cloudy periods). It does not take into account the following:

- Periods when the sun is obscured by cloud – no shadow
- Wind direction – shadow flicker is not an issue when the rotor is pointing in a direction perpendicular to the direction of the sun from the window
- Turbine operating hours – there is no shadow flicker when a wind turbine is shutdown, as would be the case for low or very high wind, maintenance or repair
- Shading due to terrain, vegetation, or buildings – these will block the shadow
- Hours when the property is actually used by people (who are awake) and they are situated at a spot where flicker could be an irritant – at other times there is no one to be annoyed by the flicker

Taking into account all of the factors will reduce the period that shadow flicker might be an irritant to at most a few minutes per day. Should shadow flicker be an issue, it can be mitigated by planting trees in specified locations or by pre-programming the turbine to shut down at times when shadow flicker would cause a nuisance.

The effects of shadow flicker are considered to be minor and no significant environmental effects are anticipated.

Waste Disposal

There are few sources of waste from a wind farm, these are incidental to the generation of power and related to maintenance activities. Typical wastes generated would include failed equipment, packaging materials, and other materials associated with maintenance of equipment such as spent lubricating oils. The Environmental Management Plan recommends procedures for the management of these wastes. It is concluded that there will be no significant effects/impacts from waste disposal during the operational phase of the proposed wind farm.

Accidents and Malfunctions

The wind industry has an excellent safety record. With more than 70,000 turbines in service across the world, and over 25 years of operation, the industry has recorded only one accidental death of a member of public (a German skydiver).

To prevent fires, the wind turbine generators have built-in thermal sensors to shut them down if an overheating condition arises. The wind farm will not store bulk oils or chemicals or have any activities that have the potential for a serious spill. The Environmental Management Plan includes contingency measures to address potential accidents or malfunctions.

With the implementation of mitigation measures, significant adverse residual effects due to accidents and/or malfunctions are unlikely to occur.

Conclusions

With the assistance of input from the general public and regulatory agencies, and following detailed analysis by the Project Team, the environmental effects (both biophysical and socio-economic) associated with the construction and operation of the proposed wind farm Project have been assessed. This assessment has concluded that the Project is not likely to cause significant adverse environmental effects given implementation of the recommended mitigation measures.

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LIST OF ACRONYMS

BEI	British Electricity International
BLPC	The Barbados Light and Power Company Limited
BWEA	British Wind Energy Association
CEA	Cumulative effects assessment
CITES	Convention on International Trade in Endangered Species of Wild Fauna & Flora
CO_2	Carbon dioxide
CEE	Cumulative environmental effect
EA	Environmental Assessment
ECCs	Environmental components of concern
EIA	Environmental impact assessment
ESAs	Environmentally sensitive areas
FCCC	Framework Convention on Climate Change
GS	Generation station
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature and Natural Resources
kWh	Kilowatt hour
MW	Megawatt
NO_x	Nitrogen oxide
NCC	National Conservation Commission
RES	Renewable Energy Systems
SO_2	Sulphur dioxide
TCDPO	Town and Country Development Planning Office
TCPA	Town and Country Planning Act
TOR	Terms of reference
UN	United Nations
VECs	Valued ecosystem components
VSCs	Valued socio-economic components
WHO	World Health Organization
ZVI	Zone of visual influence

1.0 INTRODUCTION

The Barbados Light and Power Company Limited (BLPC) is the primary supplier of electrical energy in Barbados. BLPC has a developed infrastructure comprising generation stations, transmission and distribution systems, maintenance facilities and offices. Presently, BLPC operates three generating stations:

- The Garrison Hill Generating Station provides peak-load power via a single gas turbine generator;
- The Seawell Generating Station provides peak-load power via multiple gas turbine generators; and
- The Spring Garden Generating Station, which is the main base-load plant, has recently undergone expansion so that the site is now developed to its full capacity.

To provide for future power demands and system reliability, BLPC is embarking on the development of two additional generation sites:

- Trent's Generating Station (Trents GS) will be located on lands that are part of the Trent's Plantation in St. Lucy and located approximately 3 km inland of the Arawak Cement Plant situated along the Barbados western seacoast. BLPC intends to develop that site for additional thermal generation, initially using distillate fuel with the potential for future expansions utilizing natural gas, as there is a possibility that natural gas from Trinidad could be made available to Barbados in commercial quantities within the next few years. The EIA has been completed for that project and BLPC is awaiting planning approvals; and
- A 10 MW wind farm proposed on land at Lambert's Plantation in the parish of St Lucy. The Lamberts East Wind Farm is the subject of this EIA.

1.1 Project Proposal

BLPC is applying to the Town and Country Development Planning Office (TCDPO) for planning permission to construct a 10 MW wind farm comprised of 11 wind turbines, associated control building, and access tracks on land at Lambert's East in the parish of St. Lucy (Figure 1-1). Each turbine will have a tubular tower of approximately 55 m height, and three rotor blades with a rotor diameter of approximately 56 m. The rated output of each turbine will be approximately 900 kilowatts (kW) at optimum wind speeds. A small transformer enclosure will be located at the base of the turbines, and there will be a small building on the site to house the control and metering equipment. A wind monitoring mast with instrumentation will complete the site installation.

Underground power cables will link the turbines to the control building and there will be an overhead transmission line from the control building to connect the plant to the grid at the Trent's GS. This line will be at 24 kilovolts and consist of 4 wires carried on wooden poles.

The wind farm will feed approximately 28 million kWh annually into the local grid system, producing over 2% of the island's electricity and equivalent to meeting the electricity needs of 11,000 homes.

1.1.1 Proposed Location

1.1.1.1 Island of Barbados

Barbados as the most easterly island in the Caribbean chain of islands situated south of St. Lucia, east of St Vincent, and north of Trinidad. The island is 23 kilometres (14 miles) at the widest point, 34 kilometres (21 miles) long, and is 432 square kilometres (166 square miles) in area. Most of the island is made up of soft marine deposits of coral limestone that give way in the north-eastern part of the island to a terrain of clays and sandstones. Although the island has been described as flat and low lying, it in fact rises from west to east in a series of gentle terraces to its highest point of about 1100 ft at Mount Hillaby in St. Andrew. The terrain dips in St. George to form the St. George Valley, separating the main limestone terraces from a lower limestone ridge in the Christ Church area. Additional information about the island of Barbados is provided in Section 5.0.

1.1.1.2 Proposed Project Area

The wind farm site is located in the parish of St. Lucy, at the northern end of the island, about 7 km north east of Speightstown and approximately 1.5 km from the east coast (Figure 1-1). Land use in the vicinity is agricultural with the area being a plateau of gently rolling hills about 150 m above the sea.

The site itself is approximately 1.5 km in length. The proposed development consists of eleven wind turbines situated on the top of the eastern escarpment of the plateau on uncultivated land (Figure 1-2). Related works include tower base transformers, associated underground cabling, access tracks, control building, anemometry mast, and a temporary compound for storage during construction. The layout of the proposed development has been designed effectively to capture the wind's energy and minimize the local environmental impacts, wherever possible. The site also allows for flexibility to move the location of each turbine to accommodate any local construction issues that may be found during detailed site surveying.

Access to the site will be from the Class 11 road from Alexandra to Boscobelle.

1.1.2 Land Use

Actual land use that will be utilized by the turbines will be only 1-2% of the site area, as the turbines are limited to the area of the towers themselves, transformers pads and the access tracks leading to them. Apart from the land actually used, farming activities in the surrounding fields can continue undisturbed by the wind farm.

1.1.3 Application and Approval Process

BLPC has made application (No. 3262/11/04C) for planning approvals to the TCDPO. The TCDPO has the mandate to regulate and approve new and expanded developments. The Government of Barbados has introduced guidelines for the types of developments requiring an environmental impact assessment (EIA) and the related studies that are required in the EIA for planning approval. The new generating station is included in the list of projects that trigger an EIA.

As part of the planning approvals process for projects requiring an EIA, the TCDPO establishes a committee of relevant agencies to provide review and comment on the project. In advance of the EIA, the proponent submits a Terms of Reference (TOR) document to TCDPO for approval of the work scope to be completed. TOR for the Lamberts East Wind Farm were submitted to TCDPO, dated June 11, 2004, and are included in Appendix A.

Upon completion of the EIA, the proponent is required to submit the report to TCDPO. The report is circulated to the various government agencies for comment. The EIA process also requires that the applicant conduct a public information session to present the project to the public and the results of the EIA.

1.2 Project Justification

There is growing evidence that the world's climate is changing as a result of human activities, primarily as a result of burning fossil fuels. The concentration of carbon dioxide (CO_2) in the atmosphere is already 30% higher than in pre-industrial times and if emissions continue to grow at the present rate, concentrations are expected to double by the end of the next century (WHO/UNEP, 1995).

> *"Human activities are directly increasing the atmospheric concentrations of several greenhouse gases, especially CO_2."* (IPCC, 1998).

Studies undertaken by an international team of scientists and presented at the Buenos Aires Conference were co-ordinated by the Hadley Centre. Compared with increases in temperatures of just 0.6^{o}C over the past 140 years, the Centre's climate model now predicts that global temperatures would rise by a further 3^{o}C over the next 100 years. These increases would threaten habitats such as tropical forest and grassland, create further pressure on global water resources, and lead to increased flooding events (Wind Directions, 1999).

As most renewable energy sources such as wind, solar and hydro power produce no gaseous emissions there is no contribution to climate change (global warming) or acid rain. Subsequently, these types of initiatives can reduce global emissions of pollutants, helping to meet international and national targets that have been set to combat climate change.

Every kilowatt hour (kWh) of electricity generated by wind will displace a kWh of conventionally generated electricity. The annual output of the wind farm is estimated at 30.03 gigawatt hours per year (32.76 GWh/year for 12 turbines per the RES feasibility study prorated to 11 turbines being proposed). BLPC currently generates all power using fossil fuels. Base load power is predominantly supplied by low speed diesel engines and steam generators operating on heavy fuel oil. This is supplemented by gas turbine generators operating on distillate fuels. As the gas turbines are more expensive to operate, they are the last units to be dispatched and operate to meet peak demand.

The following table shows the anticipated annual reduction in emissions from the displacement of fossil fuelled generation. The most conservative estimate is that the wind farm will displace the energy generated from the gas turbine generators operating on distillate fuel. During off peak periods there will be displacement of generation using heavy fuel oil and which has higher emissions levels of most pollutants (SO_2, NO_X and Particulate Matter).

Table 1-1: Atmospheric Pollutants Avoided

Engine type	Fuel	Units	Savings in Emissions		
			CO_2	SO_2	NO_x
Gas turbines	Distillate	g/kWhr	736	1	3.9
		tonnes/year	22,097	28	117
Low speed diesels	Heavy fuel oil	g/kWhr	581	6.6	13.3
		tonnes/year	17,455	198	398

Reserves of fossil fuels are finite and as the scarcity increases these fuels are becoming more expensive. The price per unit of electricity generated from renewable energy, particularly wind energy, is falling as renewable technologies become more advanced. The economics of renewable energy generation is therefore improving over time. The benefits are even greater when compared to conventional forms of energy generation if external environmental costs are taken into account.

Renewable energies can only be used where they occur and it therefore depends on the region as to what renewable energy source can be utilised. Barbados has the benefit of a steady easterly trade wind which blows most of the year and makes this site particularly suitable for the generation of electricity from wind.

1.2.1 International Policy on Renewable Energy

The United Nations (UN) Conference on the Environment and Development (the Earth Summit) was held in Rio de Janeiro in June 1992 to address global environmental concerns and particularly climate change. One of the outcomes was the establishment of an action plan, known as Agenda 21 (UN, 1994), to guide and encourage the achievement of sustainable development, particularly at the local level. Agenda 21 calls for a switch to environmentally sound energy sources, particularly renewable energy, in order to achieve sustainable development:

> *"The need to control atmospheric emissions of greenhouse and other gases and substances would increasingly need to be based on efficiency in energy production, transmission, distribution and consumption, and on growing reliance on environmentally sound energy systems, particularly new and renewable sources of energy."* (UN, 1994).

Barbados is a signatory to the United Nations Framework Convention on Climate Change (FCCC), which commits all developed country parties to take measures to return emissions of CO_2 to 1990 levels by the year 2000. In December 1997 the Third Conference of the Parties was held in Kyoto, Japan. At Kyoto legally binding targets for reducing emissions of greenhouse gases were set for industrialised countries. The target set for the European Union is for an 8% cut in emissions by 2010. Parties to the protocol are to be encouraged to achieve these emissions reductions through a series of policies and measures, such as improving energy efficiency, reforming energy and transport sectors, protecting forests and other carbon sinks, promoting renewable energy and phasing out inappropriate fiscal measures. Barbados, as a non-annex 1 country, has no legally binding stabilization or reduction targets for greenhouse gas emissions, though it is required to submit a national communication on its implementation of the FCCC.

The National Strategic Plan of Barbados 2005-2025 (Goal 4) recognizes the need for environmentally sustainable use of natural resources. Objective 1.1, strategy 1.10 states:

> *"Ensure that appropriate development standards are used to build resilience against the increasing intensity of natural hazards associated with the effects of climate change, as well as eliminating those practices which lead to global warming and sea-level rise."*

1.3 Alternative Sites for Development

In the mid nineteen eighties, a major wind energy study was undertaken by British Electricity International (BEI) for the Government of Barbados. Phase 1 involved wind studies to identify a site for a pilot wind turbine generator, and Phase 2 initiative involved monitoring and evaluation of the performance of the pilot plant (RES, 2003). The results of both phases were used to make recommendations on the viability of undertaking large scale wind farming activity for generating electricity in Barbados.

Studies included wind speed measurements at various locations on the island to provide an indication of the potential for wind energy developments. These were presented on maps of average wind speed (Figure 1-3). An anemometer was installed at Lamberts East to collect wind data over approximately four years at typical hub heights for wind turbines.

The conclusion was that the wind regimes in Barbados were appropriate for this technology and that there were a number of sites that would be suitable for the establishment of wind farms (RES, 2003). At that time, the system was felt to be capable of absorbing 10 MW of wind farm capacity, eventually increasing to 20 MW.

Additional feasibility studies, completed by BLPC in partnership with Renewable Energy Systems (RES), involved a series of internal studies consisting of both desk research and various site visits to further determine potential sites for wind farm development in Barbados. The process considered a variety of site selection criteria based on environmental, technical and financial constraints, and used wind data already available. Significant use was made of data from the aforementioned BEI study. Parameters considered in identifying potential areas for wind farm development are shown in Table 1-2.

Table 1-2: Criteria used in screening potential sites for wind farm developments

Criteria	Value/Comment
Wind speed	Not lower than 7m/s at 50m hub height for likely viability at current energy costs
Minimum land area	1 sq km for 5 or more wind turbines including their separation from residences
Max distance to grid	Within 10 km from connection point to transmission line
Separation to property	Prefer minimum 350 m to residential property and count of properties within 0.5 km to determine potential impacts stage
Average gradients	Not to exceed 1 in 10
Site access	Sufficient access for 0.9 MW turbine, considering public roads from docks and potential site tracks
National and Local Designations	Apply discretionary consideration depending on other site criteria and environmental issues
Ground Conditions	Some consideration is given to the likelihood that the ground conditions are suitable for foundation construction, though detailed consideration is anticipated at a later stage

The study evaluated the following four sites recognized, identified and protected as potential sites for wind energy development under the Draft Barbados National Physical Development Plan – Amended (2003):

- **Lamberts –** The original Howden turbine site is relatively close to dwellings and does not have adequate space for erection of more than one wind turbine to replace the existing turbine, without significant impact on local residences. It has probably the best wind regime of all the designated sites.

- **Lamberts East –** This site is to the east of Lamberts Plantation house, on the edge of the escarpment facing the sea. A planning application was submitted in 1998 for this site which incorporated a 9 MW wind farm, utilizing all the available land without unreasonable encroachment on neighbouring dwellings. Soil conditions appear to be favourable for the turbine foundations and the initial wind speed estimates are a reasonable 7.7 m/sec, a little lower than Lamberts.

- **Upper Salmons –** Although not exactly indicated on the Plan‘s map, this is assumed to be the coastal plain to the east of Upper Salmons. This will have a wind speed of about 0.5 m/sec lower than Lamberts East and has the problem of dwellings within 300 m distance. As there will be a high background noise level from the waves breaking on the rocks, a development there may well be acceptable. The coastal plateau seems to be of rock which should provide suitable conditions for turbine foundations, though the turbine reliability may be marginally reduced due to exposure of the machinery to salt spray from the coastal environment.

- **Bissex Hill/Melvin Hill –** this is in the National Park area, and it is not immediately obvious where wind turbines could be sited to avoid close proximity to housing whilst maintaining good exposure to the Easterly Trade Winds. Soil conditions are suspected to be poor resulting in difficulty/cost in construction of foundations.

Additional sites with potential for wind developments were identified based on a desk study and consultation with BLPC and the Barbados Government. None of the additional sites was ideal.

This process ultimately led to the selection of Lambert's East as the preferred potential wind farm site. The following factors are considered favourable:

- For the majority of the time, the wind speed is predicted to be in the range 4 to 11 m/s (average 7.7 m/s) and blowing from the east or east south east. Turbulence is relatively low, and is actually at its highest at the lower wind speeds when it will have minimal effect on wind turbine performance. A low wind regime turbine could be specified for this site based upon the measured wind regime.

- The site meets the desired 350 m separation from residences. This is to ensure that noise levels at nearby houses will be sufficiently low, and that dwellings are not overshadowed. There is good road access to the site for the construction phase. The site is remote from the airport and will not affect aviation.

- The site is reasonably close to the transmission line from the North substation to the new substation at Trents.

- This site is one of the sites recognized, identified and protected as a potential site for wind energy development under the recently approved revision to the Barbados Physical Development Plan Amended (2003) (Figure 1-4).

- The Site is about 2 kilometres away from the Natural Heritage Conservation Area and to the east of a National Park Village. It thus has adequate separation from these areas.

1.4 Report Organization

This report consists of the following sections:

Section 1 - Introduction. Provides a brief Project overview and purpose and explains the context under which the EIA is being submitted.

Section 2 - Regulatory and Legislation Overview. This section provides an overview of all policies and legislation that exist in Barbados that may be applicable to this proposed Project.

Section 3 - Approach and Environmental Assessment Methodology. Describes how the assessment has been conducted, including social impacts and public consultation.

Section 4 - Project Description. Provides a more detailed summary of the facilities and activities that are encompassed in the Project to help identify possible interactions with the environment.

Section 5 - Project Environmental Setting. Describes the current environmental baseline conditions of the Project Area.

Section 6 - Valued Ecosystem Components. Valued Ecosystem Components (VECs) are those environmental issues which have been identified through issues scoping and pathway analysis. This section details the list of VECs considered for the Project.

Section 7 - Environmental Effects Assessment. Specifies the potential effects and significance of these effects during the construction and operational phases.

Section 8 - Cumulative Effects Assessment - Specifies the effects of this project with other projects in the same area.

Section 9 – Social Impact Assessment. Describes the effects of the project on the socio-economic environment and the program of public and agency consultation to obtain input to the study.

Section 10 – Summary of Mitigation and Recommendations. Summary of mitigative methods to be implemented into the Project activities and design, and recommendations.

Section 11 - Conclusions. Summary of conclusions.

Section 12 - References. Lists references used in the preparation of the report.

From:http://www.lib.utexas.edu/maps/americas/barbados.gif

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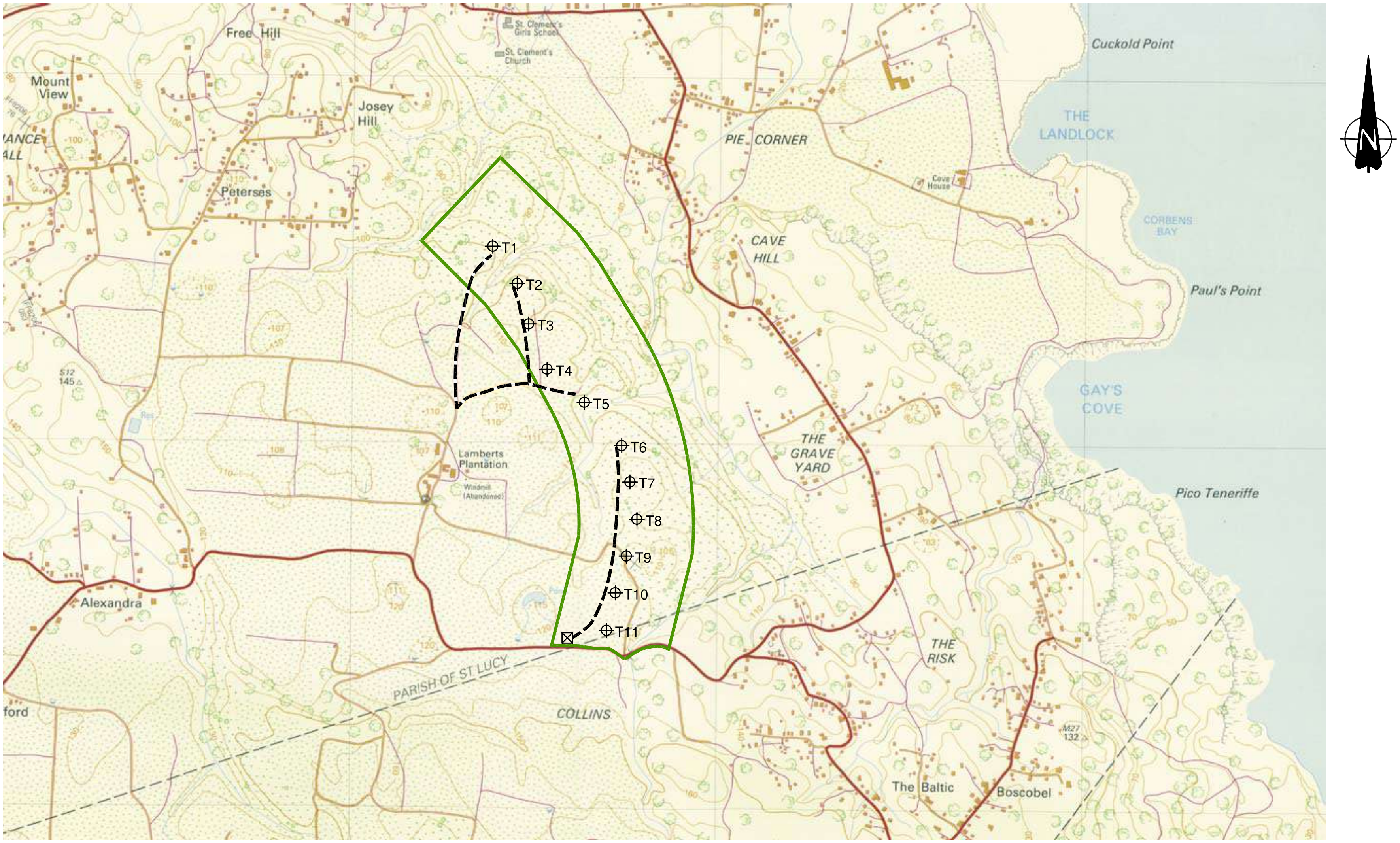
LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

LAMBERTS EAST WIND FARM SITE LOCATION

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 1-1**

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 1-1.cdr



LEGEND

⌖T1	TURBINE
— — —	PROPOSED SITE ACCESS ROADS
⊠	CONTROL ROOM
———	PROPOSED SITE BOUNDARY

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LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT

SITE PLAN

SCALE	DATE NOVEMBER 2006
PROJECT NO. TV61036	FIGURE NO. FIGURE 1-2

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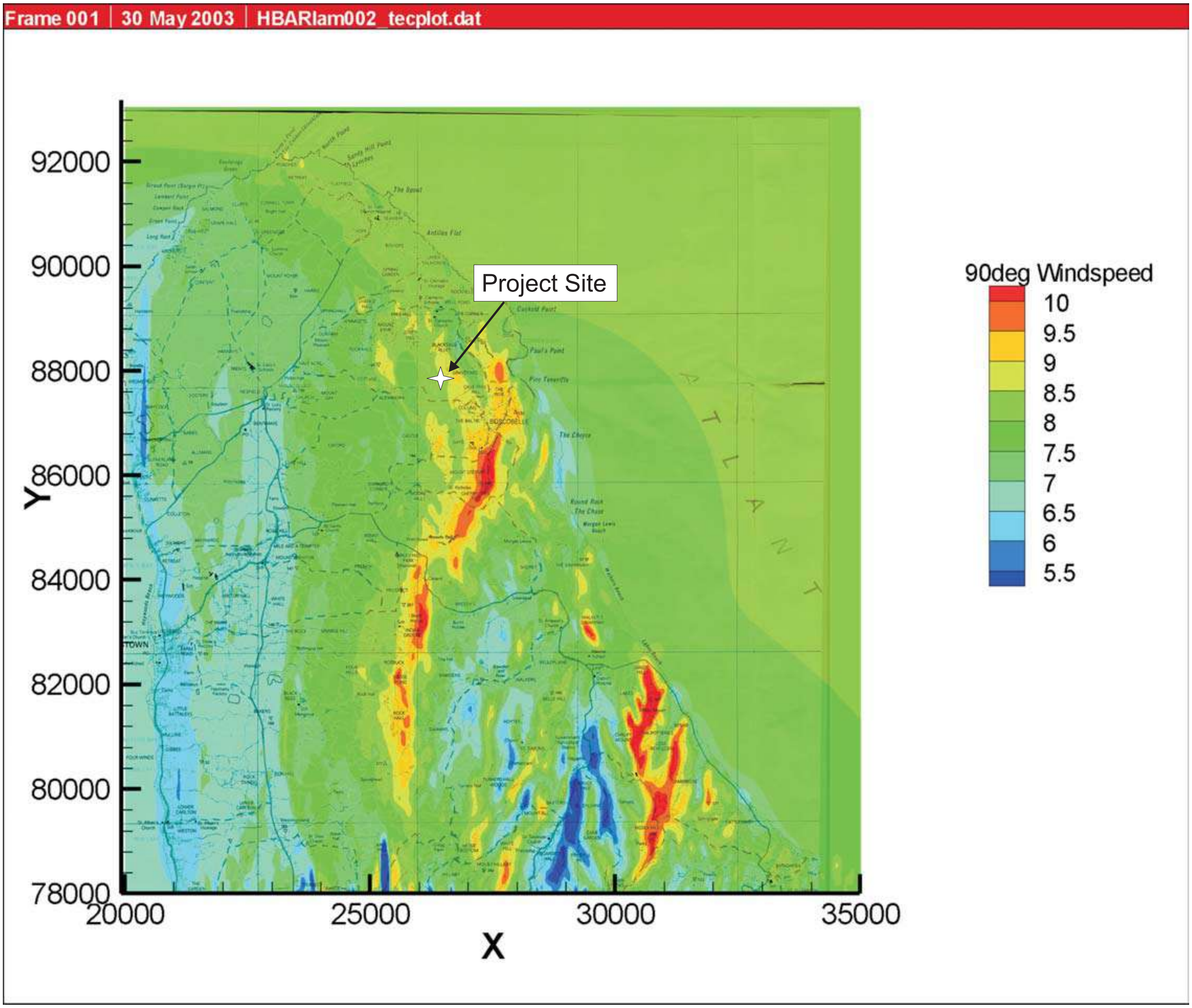

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LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

90 DEGREE WIND SPEED MAP

PROJECT NUMBER TV 61036	DATE NOVEMBER 2006
VENDOR DWG No / CLIENT DWG No	**FIGURE 1-3**

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 1-3.cdr

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LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

LAND USE PLAN

PROJECT NUMBER TV 61036		DATE DECEMBER 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 1-4**

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2.0 REGULATORY AND LEGISLATION OVERVIEW

2.1 Review of Relevant Legislation and Policies

No legislative guidelines exist specifically for wind farms in Barbados. However, other *Acts* and guidelines to mitigate the effects of the operations and construction on the environment and adjacent land uses are applicable. The wind farm facility will not result in any air emissions or wastewater discharges, nor will it include any fuel storage. The following legislation is therefore considered relevant:

- *Town and Country Planning Act;*
- *Barbados National Trust Act*;
- *Wild Bird Protection Act;*
- *National Conservation Commission Act;*
- *Protection of New Plant Varieties Act;*
- *Trees (Preservation) Act;*
- *Occupational Health and Safety at Work Act;* and
- *Civil Aviation Act*.

These Acts are discussed in greater detail in the following sections along with applicable regulations and standards, and associated planning documents.

2.1.1 Town and Country Planning Act

The legislation relating to environmental protection for new and expanded developments includes a number of acts in addition to the provisions under the *Town and Country Planning Act* (*TCPA*) that control and mitigate adverse effects on coastal and heritage resources and in sites of natural scenic beauty. Specific criteria relating to air emissions, warm water discharge and water quality changes allowed by new developments are determined under the *TCPA*, which allows the Chief Town Planner to request information to assist in assessing an application for a new development.

The planning objectives and policies of the Government of Barbados are described within the National Physical Development Plan (Draft) - Amended 2003. The National Physical Development Plan (Draft) provides:

> *"a vision for the future growth and development of the Nation by setting out policies to guide relationships among land uses, community facilities and physical infrastructure. It is also intended to coordinate public and private development initiatives in Barbados to the year 2010, within a framework of sustainable development".*

The National Physical Development Plan (Draft) provides the following guiding principals for planning policies and the approval of new developments:

- the efficient use of land, resources and finances of the nation;
- the promotion of social equity, health and safety for all residents;
- the conservation, protection and enhancement of environmental and man-made resources;
- a settlement structure that maintains and creates vibrant and safe places for people to live, work and play; and
- the management of growth so that it occurs in an orderly fashion while ensuring that environmental features and agricultural lands are maintained.

The National Physical Development Plan (Draft) aims to manage the natural environment and resources to ensure the best use of their aesthetic, educational, ecological, recreational, and economic benefits. It protects the physical environment by establishing:

- general environmental planning policies which apply to all land use designations throughout the island;
- policies respecting development in the Coastal Zone Management Plan Areas; and
- policies to control development in natural hazard lands including gullies, escarpments, coastal and other erosion areas and flood prone lands.

2.1.1.1 Special Industry

The National Physical Development Plan (Draft) recognizes the importance of industries that require controlled siting to prevent incompatible development within built-up areas. Specific industry types are listed and designated as “Special Industry” with the intent to:

- recognize and protect existing special industrial areas;
- direct uses which are incompatible with special industry (such as residential, recreation, tourism, etc.) to locations which are well removed from existing special industry sites; and
- ensure that new special industrial development will not produce negative impacts on natural areas or sensitive urban land uses.

The National Physical Development Plan (Draft) lists wind power projects as Special Industry.

The planning controls for Special Industry include:

- A detailed review of proposals for residential, tourism or community developments within 500 m of a Special Industry. The proposals will only be accepted if they will not be negatively affected by the Special Industry.

- Applicants requesting planning permission for a new special industry development, or an expansion of an existing facility are required to complete an Environmental Impact Assessment (EIA).
- New special industry sites will be encouraged to locate where:
  - the existing infrastructure can support the development, otherwise the proponent must pay the full costs of upgrading;
  - the site is not in the proximity of a Zone 1 Water Protection Area;
  - there will be no negative impact on sensitive land uses (residences, tourist areas, community facilities);
  - there will be no negative impact to environmentally sensitive areas, coastal environment or National Heritage Conservation Areas; and
  - the site will not be adjacent to existing industrial sites.

New developments not meeting the site location objectives will be required to do the following:

- demonstrate how the negative impacts will be mitigated;
- ensure that developments adhere to the Water Protection Zone Policies that protect groundwater resources; and
- ensure that outside materials storage is screened from public view.

In addition to the planning policies for "Special Industry" the amended National Physical Development Plan (Draft) recognizes four designated areas that have the potential for wind energy development. (See Section 1.3 above for a brief site review). These sites have been chosen by the Government of Barbados based on their suitability according to criteria such as size of the site, distance from residential uses, proximity to the electrical grid, road access, and the ability of the soil to support turbine foundations (Government of Barbados 2003). The purpose of this type of designation is twofold, to:

- Recognize existing wind energy facilities; and
- Identify and protect potential sites for future wind energy development projects.

2.1.1.2 Impact Assessments

To complete the review of the application, the Chief Town Planner may request a report constituting an EIA for any development that has the potential for a significant environmental effect. In addition, the National Physical Development Plan (Draft) defines a series of "Special Industries" that are designated as requiring an EIA where the applicants are requesting planning permission for a change in use to or to an expansion of the facility.

The new Lambert's East Wind Farm is designated as a Special Industries project requiring an EIA.

The Government of Barbados, Ministry of Health and the Environment, has prepared the document Environmental Impact Assessment Guidelines and Procedures for Barbados (1998) which outlines the EIA process and requirements.

In the case of a simple application with minor impacts, the assessment may be an EIA of limited scope. Where the project involves the potential for more significant impacts, the EIA required will be more comprehensive. Generally, the process is an interactive one, involving meetings and discussions between the TCDPO and others, including the relevant governmental agencies and departments, as determined by the Chief Town Planner.

The EIA is initiated after the Terms of Reference for the project are agreed upon with the TCDPO. The contents of the EIA Terms of Reference are required to include the following broad categories:

- an outline of the environmental issues and the disciplines required for studying the issues;
- a list of the government and other agencies that appear to have an interest in the application. A consultation program is also included; and
- a proposed program for consultation with the local public.

The steps involved in completing the EIA following the approval of the Terms of Reference for the scope of the study include, gathering of data, consulting with the public and interested agencies, and completion of the EIA document for circulation. Although the environmental effects of projects are site specific, potential releases to the environment, noise, waste management and other details are typically required for an EIA. Upon completion, the EIA is submitted to the TCDPO for review by the Environmental Impact Assessment Review Panel, which receives comments from interested agencies and the public.

When the panel is satisfied that the EIA addresses the environmental impacts, approval is provided which may or may not include specific conditions. The Chief Town Planner allows no development of the site without prior approval of the EIA.

2.1.2 Barbados National Trust Act

The *Barbados National Trust Act* allows for a listing of places of natural beauty with their animal and plant life, and the pursuance of a policy of preservation. As a result, the Barbados National Trust has a vested interest in the proposed project to ensure that not only is it consistent with the future landscape but also that the industrial outputs from the facility will not compromise its aim of preserving areas of natural beauty.

2.1.3 Wild Birds Protection Act

The *Wild Birds Protection Act* provides for the protection of some forty-six (46) species of wild birds specified in the schedule. Any person who knowingly kills or wounds or attempts such an act is liable to a fine, one-half of which is payable to the informant. Possession or export of the skin or features of any wild birds are also an offence, which is punishable by a fine. The only exception is the killing of wild birds for the purpose of obtaining specimens for natural history, provided a licence has been obtained by the Minister (not defined) to do so.

2.1.4 National Conservation Commission Act

The *National Conservation Commission Act* establishes the National Conservation Commission (NCC) which has as one of its main functions to conserve the natural beauty of Barbados; to control and develop public parks, public gardens, beaches and caves; to provide advice on the removal of coral from the ocean bed; and to regulate commercial activities in public parks, gardens, caves, and on beaches.

2.1.5 Protection of New Plant Varieties Act

The *Protection of New Plant Varieties Act* was formulated because of legal obligations imposed by the World Trade Organization and addresses, amongst other issues, the qualification of rights of plant breeders, their entitlement to protection, licenses and criminal liability in respect of variety denomination. This act seeks to protect property rights with respect to flora, and therefore can be used as a tool to regulate and control biodiversity access.

2.1.6 Trees (Preservation) Act

The *Trees (Preservation) Act* provides that the killing of any tree one metre or more in circumference is an offence unless a permit has been obtained from the Chief Town Planner. The Act also empowers the Chief Town Planner to require the owner of vacant land or land adjoining or near a public road to plant or replant trees and to clear land of weeds or overgrown grass.

2.1.7 Occupational Health and Safety at Work Act

The new *Occupational Health and Safety at Work Act* provides prescriptive standards of safety and health in the workplace that are consistent with those of other jurisdictions. The owner is responsible for providing a safe workplace and worker protection for hazardous tasks. Workers are expected to report any unsafe procedures to their supervisor and conduct their duties in a safe manner. BLPC has safety procedures and policies that are aligned with this new *Act.*

2.1.8 Civil Aviation Act

The *Civil Aviation Act* dated 1983 and the Civil (Air Navigation) Regulations dated 1984 deal mainly with aircraft equipment, aircraft crew, air traffic control, and fatigue of the crew and the registration of aircraft. The *Act* also defines the airport traffic zone as having 3 km boundaries to a height of 600 meters. The proposed wind farm site does not fall within this airport traffic zone. The *Act* provides the airport with the authority to control activities within the airport zone that interfere with airport operations. Major projects proposed within the airport zone should be reviewed with the airport management to ensure that there are no impacts on the airport operations.

In general, the *Civil Aviation Act* does not have major environmental requirements associated with the proposed project nor does it change the scope of this EIA. As part of the planning approval the airport authority will require that at least one turbine tower be lit with warning lights due to the tower height.

2.2 Selected Project Standards and Guidelines

Wind turbines do not use water, release air emissions, discharge wastewater or produce waste as part of the generation process. The regulatory environmental standards that are applicable to the Project are therefore focussed on noise.

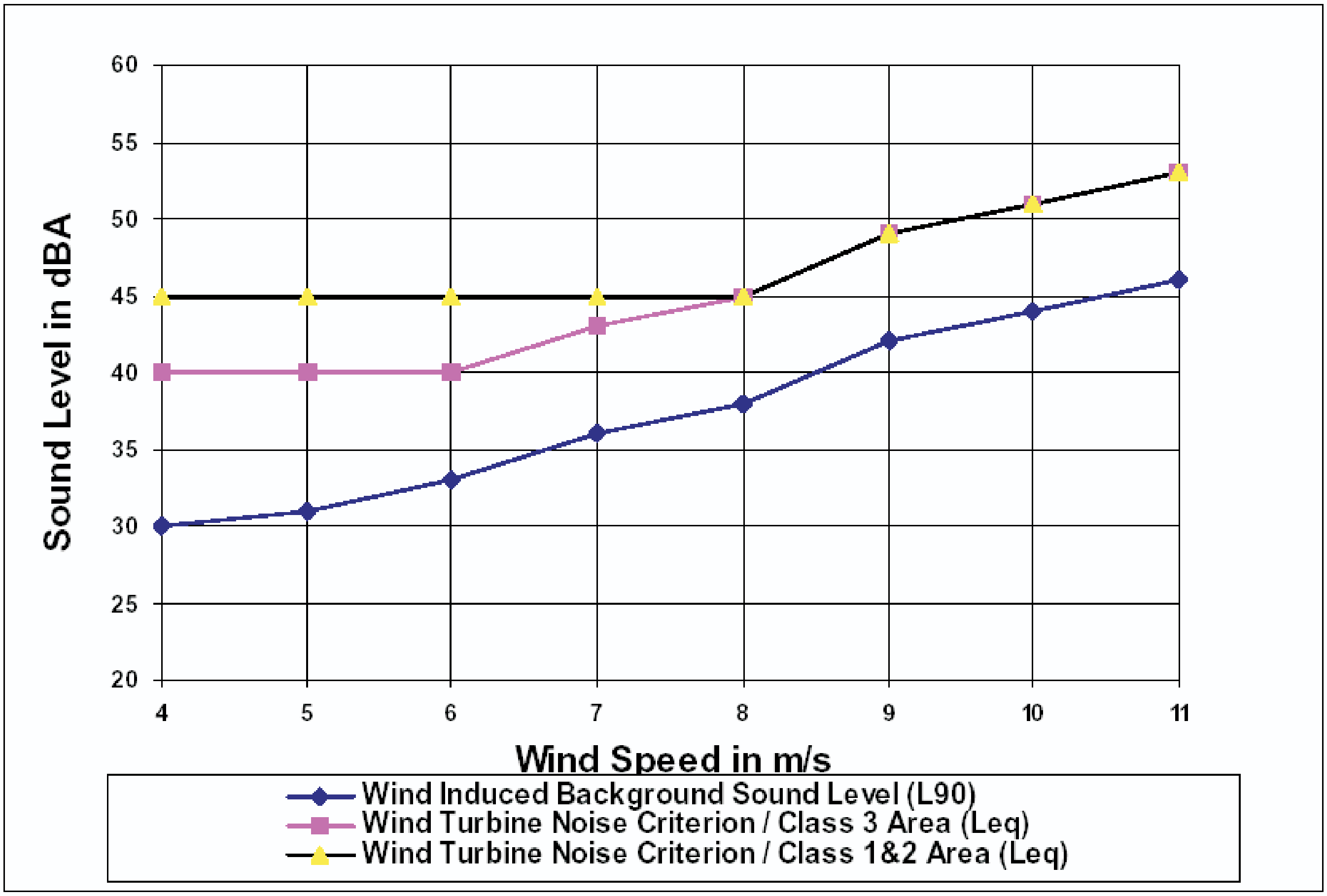
The Environmental Protection Department of the Ministry of Energy and the Environment does not have legislated standards for noise levels but does include conditions for noise abatement in new projects. The Department also investigates noise complaints.

In considering relevant standards for noise, wind farms are unique. Noise standards for industrial equipment are based on levels predicted at nearby receptors (such as homes) and are typically set at the higher of 45dB or at baseline levels. For most applications, this assumes a steady noise output which has the greatest effect on receptors during periods of low baseline noise typically at night and during periods of low wind. Both the World Bank and World Heath Organization recommend daytime noise levels of up to 55dBA and night-time levels of 45dBA. The World Bank also allows a 3dBA increase over background noise. For this project the night-time levels of 45dBA would be the limiting levels due to the 24 hour operating status.

For wind farms, turbine noise increases with wind speed but wind-induced background noise also increases. To compensate for this, the Province of Ontario in Canada has developed a noise guideline specific for use on wind farm projects titled Interpretation for Applying MOE NPC Technical Publications to Wind Turbine Generators (Appendix B). The guideline recognizes that baseline noise levels at nearby sensitive receptors also increase with wind speed. The allowable levels, expressed as hourly L_{eq}, are based on whether the receptor is an urban or rural area. Class 1 refers to receptors in an urban environment, Class 3 a rural environment and Class 2 being in between.

It is proposed to use 45dBA as the acceptable noise level for wind speeds of 8m/s or less in accordance with World Bank and World Health Organization guidelines and use the above guideline for assessing acceptable noise levels from the project for higher wind speeds. The allowable hourly L_{eq}[1] are shown in Figure 2-1.

[1] L_{eq}: the equivalent continuous noise level is a notional steady noise level, which over a given time, would provide the same energy as the intermittent noise. Noise standards often specify the length of time over which noise should be measured.



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LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

HOURLY ALLOWANCE NOISE LEVELS FOR WIND FARMS

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 2-1**

3.0 APPROACH AND ENVIRONMENTAL ASSESSMENT METHODOLOGY

The EIA will be completed to meet the requirements as set out in the Environmental Impact Assessment Guidelines and Procedures for Barbados (1998).

The Government of Canada has a specific guideline for preparing environmental impact statements for wind farm developments titled; Environmental Impact Statement Guidelines for Screenings of Inland Wind Farms Under the Canadian Environmental Assessment Act. In addition, the International Finance Corporation (IFC) has developed the Environmental Health and Safety Guidelines for Wind Energy (IFC 2006). The guidance documents have been reviewed and the EIA for the Lamberts East Wind Farm has been developed in the context of these guidelines.

An Environmental Assessment (EA) is a complete process, which should begin at the earliest stages of planning and remain in force throughout the life of a project, moving through a series of stages:

- Describing the project and establishing environmental baseline conditions;
- Scoping the issues and establishing the boundaries of the assessment;
- Assessing the potential environmental effects of the project, including residual and cumulative effects;
- Identifying potential mitigative measures to eliminate or minimize potential adverse effects; and
- Environmental effects monitoring and follow-up programs.

This approach emphasizes the use of Valued Ecosystem Components (VECs) as the focal points for impact assessment. Generally, VECs are defined as those aspects of the ecosystem or associated socio-economic systems that are important to humans (Beanlands and Duinker, 1983).

The EA focused on the evaluation of potential interactions between project components and activities on the one side, and VECs that were identified through an issues scoping process on the other side.

3.1 Phased Approach to Conducting the EIA

The work to complete the EIA was done in a number of phases. Phase I involved the definition of the project components, collection of baseline data and information on the defined Project area. Phase II involved an effects assessment of the construction and operation of the proposed wind farm.

The EIA is based on scientific, engineering, environmental and economic parameters, professional judgment, and consultation with the public, applicable government agencies, communities, interest groups and other stakeholders directly affected by the Project. The approach includes the following steps:

Step 1 - Assembling Project Baseline Information

- developing the Project description, including construction and operation activities; and
- preparing a description of existing environmental conditions to assess the potential effects of the various Project activities on the environment and the potential effects of the environment on the Project.

Step 2 - Issue Scoping

- identifying environmental and socio-economic issues during development of the study;
- ensuring that the concerns of the regulatory agencies involved in the Project review are identified;
- taking into consideration public concerns;
- identifying environmental issues or features that may be affected by the Project, by professionals in the field;
- ensuring that elements of the environment that could be affected by the Project and are protected by legislation or regulation are included as Valued Ecosystem Components (VECs);
- identifying pathways between the environment and Project activities. Where pathways cannot be identified, the environment is deemed not to be affected by the Project and, therefore, is no longer considered as part of the analysis; and
- ensuring that alternatives that were identified are evaluated in the context of the proposed Project.

Step 3 - Identification of Valued Ecosystem Components

Valued Ecosystem Components (VECs) are those environmental issues that have been identified through issues scoping and pathway analysis. The result of Step 2 of the assessment is to develop a list of VECs for which the effect assessment will focus through:

- developing a definition of each VEC, including scope (spatial and temporal boundaries), and description of linkages (or pathways) with the Project and with other components of the environment; and
- identifying issues relative to the identified VECs.

Step 4 – Effects Assessment

The effects assessment considers the environmental effects of the project with the proposed abatement technologies as applied (such as noise level controls), and inclusive of the mitigation measures as provided in the report. In order to be considered a significant adverse environmental effect, the assessment of these potential effects must determine that the effect is adverse **and** significant **and** likely.

The term cumulative environmental effect (CEE) means the effect on the environment, which results from the effects of a project when combined with those of other past, existing and imminent projects and activities. These may occur over a certain period of time and distance. The following points provide an indication of what should be considered:

- there must be an environmental effect of the project being assessed;
- the environmental effect must also be likely;
- that environmental effect must be demonstrated to operate cumulatively with the environmental effects from other projects or activities; and
- it must be known that the other projects or activities have been, or will be, carried out and are not hypothetical.

Step 5 - Environmental Protection Measures

The next step is to define or describe the details of the environmental protection measures that would be applied to the project for construction and operations of the facilities.

3.2 Baseline Data Collection

To provide accurate and scientific analysis of the potential environmental effects of the proposed Project on the environment, it is critical to have data that represents the state of the environment prior to developing the Project. This baseline data can then be used, in conjunction with the predicted Project outputs, to complete the environmental assessment for the Project. For certain specific environmental components, it was necessary to collect more detailed and site-specific information. Section 5.0 of this report outlines the results of baseline programs that were conducted for this EIA.

3.3 Spatial and Temporal Boundaries

The effect of a specific project activity on a VEC may differ in both space and time from the effect of any other activity. Certain project activities may have long-term consequences; others will be of short duration. Therefore, an important aspect of the EIA process is the determination of study boundaries. Temporal and spatial study boundaries have been considered for the construction and operation phases of the Project.

The spatial boundaries for wind tower construction include the actual footprint of each individual turbine, the entire Project site, as well as the spatial distribution of those VEC's which the assessment has determined are potentially affected. The operation phase includes spatial bounds similar to those for the construction phase.

For the operational phase, the temporal bounds extend for at least 20 years subsequent to completion of construction. The study has also considered longer durations for environmental effects on the VECs that could persist for all Project phases.

3.4 Methodology to Predict Environmental Effects

Methodologies used in the identification and assessment of effects may be specific to each discipline and can be grouped in the following categories:

- Review of published literature;
- Acquisition and review of unpublished reports and data from government agencies and departments, universities and research institutions, and other relevant projects;
- Interviews with resource persons and knowledgeable individuals;
- Use of models and extrapolation from datasets and trends;
- Compilation of relevant statistical datasets;
- Site visits and evaluations; and
- Formulation of effect hypotheses and linkages for each VEC determined to be vulnerable to effect from Project activities.

VECs are identified through determining the pathways or linkages between the issues and the Project. Predictions are based on a combination of objective (measurable) and subjective (deduced) experience based on professional judgment, experience, and evaluation.

3.5 Mitigation

When significant adverse effects are likely, mitigation measures are required. Mitigation is defined as the “elimination, reduction or control of adverse environmental effects, including restitution through replacement, restoration, compensation, or any other means for any damage to the environment caused by such effects” (Natural Resources Canada, 2003).

Mitigation will be consistent with the requirements of all relevant legislation, regulations, guidelines and policies, as well as management plans, specifications, and best management practices, where practical. Mitigation will be considered in a hierarchical manner with impact avoidance measures identified first, reduction measures second and compensation last.

Mitigation measures will be outlined for all VECs within the bio-physical and socio-economic environment. All proposed mitigation measures will be described in detail, including methods, timing and duration

3.6 Cumulative Effects

The environmental effects of the Project in conjunction with other activities and other projects that have or will be carried out in the Project Area are examined. For the purpose of identifying and assessing cumulative effects, the spatial dimensions of the bounded areas for each VEC remain the same. The temporal boundaries, however, are extended to include activities in the past, those that are under way in the area, and known projects planned outside of the time boundaries established for the Project. A review of other similar projects that have been operational for long durations (20 - 25 years) also provides insight into the potential cumulative effects of this Project.

3.7 Determination of Significance

A common scale of reference for determining significance is required in order that the relative importance of various environmental effects can be compared.

A definition of significance that is often applied for the assessment of environmental effects is:

> *"any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance".*

A significant adverse environmental effect is defined as an effect that is adverse **and** significant **and** likely.

Significance has been based on scientific determinations, social values, public concerns, and economic judgments. The significance of Project-induced changes on VECs is considered for all issues and is as determined based on the criteria set out in Table 3-1.

Table 3-1: Criteria to Determine Level of Significance when Determining Environmental Effects

Key Terms	Criteria
Adverse	Loss of rare or endangered species; Reductions in species diversity; Loss of critical/productive habitat; Transformation of natural landscapes; Toxic effects on human health; Reductions in the capacity of renewable resources to meet the needs of present and future generations; Loss of current use of lands and resources for traditional purposes; and Foreclosure of future resource use or production.
Significant	Magnitude; Geographic extent; Duration and frequency; Irreversibility; and

Key Terms	Criteria
	Ecological context.
Likely	Probability of occurrence; and Scientific uncertainty.

The scoping exercise used to describe the VECs (including definition of spatial and temporal bounds) included an element of likelihood of interaction between the VEC and Project activities, including both construction and operation. The significance of potential effects on VECs is determined as outlined in Table 3-1.

The effect predictions are made in the following context:

- It is highly likely or unlikely that the interaction between the proposed activity and the VEC will result in a significant adverse effect within the bounded area due to a sustained suppression of fitness to maintain the population, or a decrease in density of the population below naturally occurring levels; and/or,
- Any interaction between the proposed activity and the VEC that will result in contaminant concentrations exceeding regulatory criteria.

3.8 Consultation Process

As part of the EIA process and the social impact assessment, consultations are completed with the public and government agencies to ensure that all of the relevant issues are addressed within the report. The following sections outline the components of the consultation process that have been undertaken as part of the Project development.

3.8.1 Community Consultation (Open Houses)

The Project was introduced and public input solicited through public Open House events held by BLPC near the Lamberts East site on November 4 and 5, 2006. The Open Houses featured poster boards providing information about the project and the environmental assessment program, and a video and slide presentation general information about wind power.

The goal of the open houses was to:

- Identify issues and concerns of those potentially affected by the project;
- Address concerns through discussions or potentially through project design adjustments;
- Obtain environmental and socioeconomic information from those most familiar with the area to enable the identification of constraints which may affect site selection (besides the information gathered from local residents during the field surveys);

- Provide sufficient information about the project in a timely manner to enable the public to respond effectively to the EIS document when it is presented during the public participation period in the EIA process; and,
- Inform the public about the EIA process and the opportunity for public comments.

As a follow-up to the Open House sessions, a Public Meeting was also held on the evening of February 24, 2007. Summaries of the results of these Open House sessions and the Public Meeting are provided in Section 8.3.

3.8.2 Regulatory Consultation

A critical component of the EIA process involves the consultation with the Barbados regulatory authorities. The consultation for this Project was initiated by the submission of a TOR Report for the EIA to the Barbados Town and Country Planning Department. Subsequent consultations were held with members of this committee, as well as other regulators, to review the proposed scope of work and responses to the comments, to describe the specific work plan for the baseline data collection program, and to obtain specific Project related information. These consultations were arranged with the following agencies:

- Town and Country Development Planning Office to confirm EIA scope;
- Barbados Water Authority to discuss water resources;
- Ministry of Energy and Public Utilities regarding EIA scope and expectations;
- Environmental Protection Department regarding EIA scope and expectations;
- Department of Transportation for traffic information during construction and operations;
- Grantley Adams Airport to confirm any airport requirements;
- Barbados Museum on known historical resources;
- Ministry of Agriculture and Rural Development on rural development issues;
- Barbados National Trust on significant heritage features;
- Ministry of Tourism regarding tourism developments in area;
- Graeme Hall Swamp regarding migratory birds;
- Caribbean Broadcasting Company to consider any interference with radio or TV signals;
- Starcom Network to consider any interference with signals;
- Digicel to consider any interference with signals; and
- Cable and Wireless to consider any interference with signals.

The TOR have been reviewed, and approved by the TCDPO (Appendix A).

4.0 PROJECT DESCRIPTION

4.1 Turbine Type and Location

A three bladed turbine of approximately 900 kW capacity (similar to the Vestas V-52 850 kW model described in Appendix D) with a tubular tower is the favored option for this site, with a hub height of approximately 55 m and a rotor diameter of approximately 56 m. All assessments within the EIA have been based on this specification. Final selection of the actual supplier and model of wind turbine will be made shortly before construction starts.

The turbines begin generating automatically at a wind speed of about 3 m/s and have a shut down wind speed of 25 m/s. They will generate their full rated power output when the wind speed reaches about 14 m/s, and thereafter perform close to this level up to shut down. A diagram of a typical 900 kW wind turbine is illustrated in Figure 4-1. A transformer unit is also required and will be located at the base of each turbine (see Figure 4-2).

BLPC is considering the use of turbines that have operated successfully throughout the world today in the 850/900 kW capacity, 50 m plus rotor diameter range. Enercon, Gamesa, Mitsubishi, Suzlon, and Vestas all produce machines that are suitable for this Project. The most cost effective and suitable design for the proposed site is likely to be chosen from one of these manufacturers. The colour and finish of the wind turbines will be agreed upon with the TCDPO and is normally the subject of a planning condition of approval. A significant amount of research has been undertaken into turbine colour and finish, to minimize visual impact, with off-white or pale grey generally being the most appropriate. The tower base transformer units would normally be a dark green or gray.

At each wind turbine location, the foundation is overburdened with soil approximately 1 m deep, leaving only the concrete or steel plug to which the steel tower is attached exposed. The plug is approximately 4 m in diameter (area = 12.5 m^2). Movement is then unrestricted around the tower.

During the erection period, a hardcore pad will be provided alongside each turbine on which the crane will stand while lifting components into place. These can be removed once assembly is completed.

4.2 Project Site Description and Infrastructure

4.2.1 Access Road

The access tracks would be a maximum of 4.5 m wide with a total length of approximately 1.5 km. This translates to an estimated land take of the access roads of 6750 m^2 (less than 1 hectare).

4.2.2 Control Building

The control building would take up an area of approximately 30 m x 15 m. The main construction compound would temporarily require an area of approximately 60 m x 40 m, however; this area would be fully reinstated after construction.

4.2.3 Transformer

A small transformer, approximately 2 x 2 x 2 meters in size is sited adjacent to each tower, using approximately 4 m^2 of land per turbine (see Figure 4-2).

4.2.4 Transmission Lines

The grid connection was also examined for the Project as this can be a limiting factor in the development of wind farms either due to the distance to a suitable connection point or whether the grid line is capable of accepting new capacity. A single overhead 24 kV transmission line presently serves this part of the island. However, BLPC is embarking on an upgrade of the transmission line capacity in the northern section of the island where much of the new tourist and residential development is taking place. This expansion will involve the installation of underground high voltage (132 kV) transmission cables that will ultimately connect BLPC's transmission network in the central part of the island to the north of the island. The route follows the corridor of the main road (Highway 2A) that runs from Warrens Substation in the Parish of St. Michael to the North Substation in St. Peter (see Figure 4-3). A new substation will ultimately be built at the proposed Trents Generating Station site, which will be connected to North Substation.

The cables will be buried directly in a trench and protected by a plastic barrier board and backfilled. Warning tape will be placed in the trench and markers placed along the transmission line route. The cables will be placed in ducts at several road crossings. There are also sections of the route where cables will be routed next to or under bridges that traverse deep gullies. The project will be executed in phases to the existing infrastructure, as follows:

- Phase 1: St. Thomas to Carlton Substation, a distance of approximately 4.9 km.
- Phase 2: Carlton to North Substation, a distance of approximately 5.8 km.
- Phase 3: Warrens to St. Thomas Substation, a distance of approximately 6.0 km.
- Phase 4: Connection of the North substation to a new substation to be located at the proposed Trent's Generating Station, a distance of approximately 5 km.

BLPC has completed detailed surveys for Phase 1 and Phase 2 of the project and permission has been obtained from the government authority to construct. Once approvals are completed for the balance of the routing BLPC expects to schedule contracts for completing Phases 3 and 4 of the transmission line upgrading.

The wind farm will have an underground 24 kV collector system connecting the high voltage terminals of the wind turbine transformers. An overhead 24 kV transmission line will connect the wind farm to an existing 24 kV circuit serving the northeastern part of the island.

The 24 kV transmission line from the Lamberts East Wind Farm could connect to the underground 132 kV transmission line linking the North and Trents substations (to be constructed under Phase 4 above), which initially would operate at 24 kV. Once the 132 kV line is switched over from 24 kV to 132 kV operation, the wind farm would be connected directly to Trents substation, either by an underground 24 kV line following the routing of the 132 kV line or by an overhead 24 kV line taking a more direct route, as shown in Figure 4-3.

4.3 Project Schedule

BLPC plans to commence development of the project during 2007 with completion early in 2009. Additional site studies such as geotechnical testing are required to complete the detailed design. Commencement of construction will be dependent on the overall planning approvals and the delivery of turbines. It is estimated that the construction period will take approximately 6 months. A detailed schedule will be prepared upon completion of the project design.

4.4 Project Activities

4.4.1 Construction

The construction phase of the wind farm lasts approximately 6 months. This period is somewhat weather dependant and can be affected by ground conditions found at the site. Key equipment and buildings that will be constructed or erected on site will include:

- towers;
- turbine generators;
- rotors;
- transformers;
- control building;
- anemometry mast; and
- transmission lines.

The normal sequence of events for the construction program would be as follows:

- Complete any necessary improvements to the track network which is to be used as the access route to the site;
- If required, upgrade the site entrance and existing farm track to the site and install the site accommodation and temporary compound;
- Construct the site access tracks with field gates and temporary fencing (if required);

- Excavate the foundations;
- Construct the wind turbine foundations;
- Install the transformers and install the grid connection;
- Lay power and instrumentation cables;
- Construct the control building;
- Erect and connect the towers and turbines;
- Raise the anemometry mast;
- Commission the turbines; and
- Carry out land reinstatement, remove temporary compounds and clear the site.

The construction will normally be completed during daytime hours; however there will be requirements for extended hours during major concrete pours or other installations that cannot be interrupted. The construction will provide approximately 40 temporary employment positions.

The following sections provide a description of the construction activities that will occur during the development of the proposed wind farm and are typical for this type of project.

4.4.1.1 Site Access Tracks

Site access tracks would permit access by construction vehicles and would be required throughout the life of the project for maintenance purposes. The route of the site access tracks has been chosen in order to minimize environmental disturbance while working within technical constraints. The tracks would be constructed using local hard-core/marl, with a maximum overall width of 4.5 m, with some local widening on bends and at passing bays. The design will allow drainage of rainwater using lateral drains where appropriate and ditches with culvert. Any new openings across existing fences would be fitted with suitable gates and/or stock grids in consultation with the landowner.

4.4.1.2 Foundations

The foundation for each tower would comprise approximately 100 m^3 of concrete reinforced by 8.5 tonnes of steel bar, in a tapered cylindrical block of 11 m diameter and 2.25 m deep, as illustrated in Figure 4-2. The foundation surface lies up to 2 m below the normal ground surface and is back filled with soil and reinstated. Approximately 200 m^3 of spoil would be excavated per turbine base. All rock and most spoil that is excavated are put back on top of the foundations. Any excess spoil would be spread in areas agreed with the landowner.

An alternative foundation design may be considered if the rock formation is found to be suitable. This is an annular concrete cylinder approximately 4 m diameter set about 5 m deep into the rock, and on to which the tower is bolted. Thus it is a deeper but smaller diameter foundation, which relies on the strength of the surrounding rock for its stability.

4.4.1.3 Site Cabling and Transformer

All cabling between the turbines and their transformers would be underground. All power and control cabling on site from the transformer and between the turbines would be laid in trenches approximately 0.5 m wide by 0.75 m deep located adjacent to the access tracks (see Figure 4-4). These trenches would be partially backfilled with adjacent topsoil that has been sieved/graded to remove stones where applicable. Clay plugs would be placed in the trenches at intervals to prevent water flow through into the cable trenches. The top 100 mm of soil would be stripped and laid beside the trench, and used to reinstate to original ground level immediately after installation of the cables.

Between the turbines, a 24 kV underground cable will be used to connect together the individual turbine transformers at the tower bases. The SCADA system cabling would be laid in the same trenches and the underground cabling between turbines would follow the routes of the access tracks wherever possible. All cables would be buried according to current best practice, and well below cultivation depth.

4.4.1.4 Control Building

A new control building would be required to house the main wind farm switchgear, metering and associated equipment. This control building would be constructed with local materials and house switchgear, computer control equipment and small spares. The position of the control building is indicated on the site layout (Figure 1-2).

4.4.1.5 Civil Site Work

After initial site preparation, construction of foundations for turbines and installation of underground cables will be performed. This involves trenching, burying underground cables and backfilling.

4.4.1.6 Anemometry Mast

The anemometry mast will be a free standing or guyed tower approximately 50 m tall fabricated of galvanized steel tube. It will be located centrally in the wind farm, and will carry instrumentation both at the top and an intermediate height.

4.4.1.7 Grid Connection Line

A 24 kV overhead line to connect from the control building to the existing distribution grid will also be constructed. It will be approximately 5 km long and consist of 4 wires mounted on wooden poles. Typical 24 kV line construction used in Barbados is shown in Figure 4-4.

4.4.1.8 Equipment Delivery and Installation

Major equipment will be off-loaded at the Port of Bridgetown and moved to site via road transport. As the blades are approximately 25 m in length, these will require coordination of shipments to minimize disruption of traffic. (See Figure 4-5 for shipment of 40m length blades), The towers and wind turbines will be erected using mobile cranes (see Figure 4-6).

4.4.1.9 Commissioning and Testing

Prior to plant start-up, all systems will be commissioned to ensure correct operation and to adjust the operating parameters to optimize performance. Acceptance testing will be completed on equipment to ensure that it meets the engineering specifications. Operating staff will be trained on equipment control and operation.

This phase normally takes approximately one to two months to complete and is conducted in the presence of engineers and technical specialists representing the owner, contractor and major equipment suppliers.

4.4.1.10 Clean-Up and Landscaping

The clean-up of the construction site is the final construction activity to be conducted. The clean-up crew will pick up debris, remove surplus materials and equipment, and clean or repair any soiled areas. Temporary buildings will be removed from site, and laydown areas restored. Landscaping will be installed in accordance with the landscape plan.

4.4.2 Operations and Maintenance

The Project will be designed to operate continuously (24 hours per day, 7 days per week) to supplement base load power. The wind farm will be unattended and remotely operated from BLPC's central control room at Spring Garden, using a sophisticated supervisory control system which continually interrogates each of the turbines and the high voltage (HV) connection. In normal operation this system operates the wind farm. If a fault were to develop requiring an operator to intervene, the supervisory control system would alert the permanently manned operational centre via one of two telephone lines. The operators would then take the appropriate action depending upon the nature of the fault and would be able to remotely shutdown one or all of the wind turbines or disconnect the wind farm from the grid.

Signs would be permanently located around the site to provide contact details in the event of an emergency. This information would also be made available to the local police station.

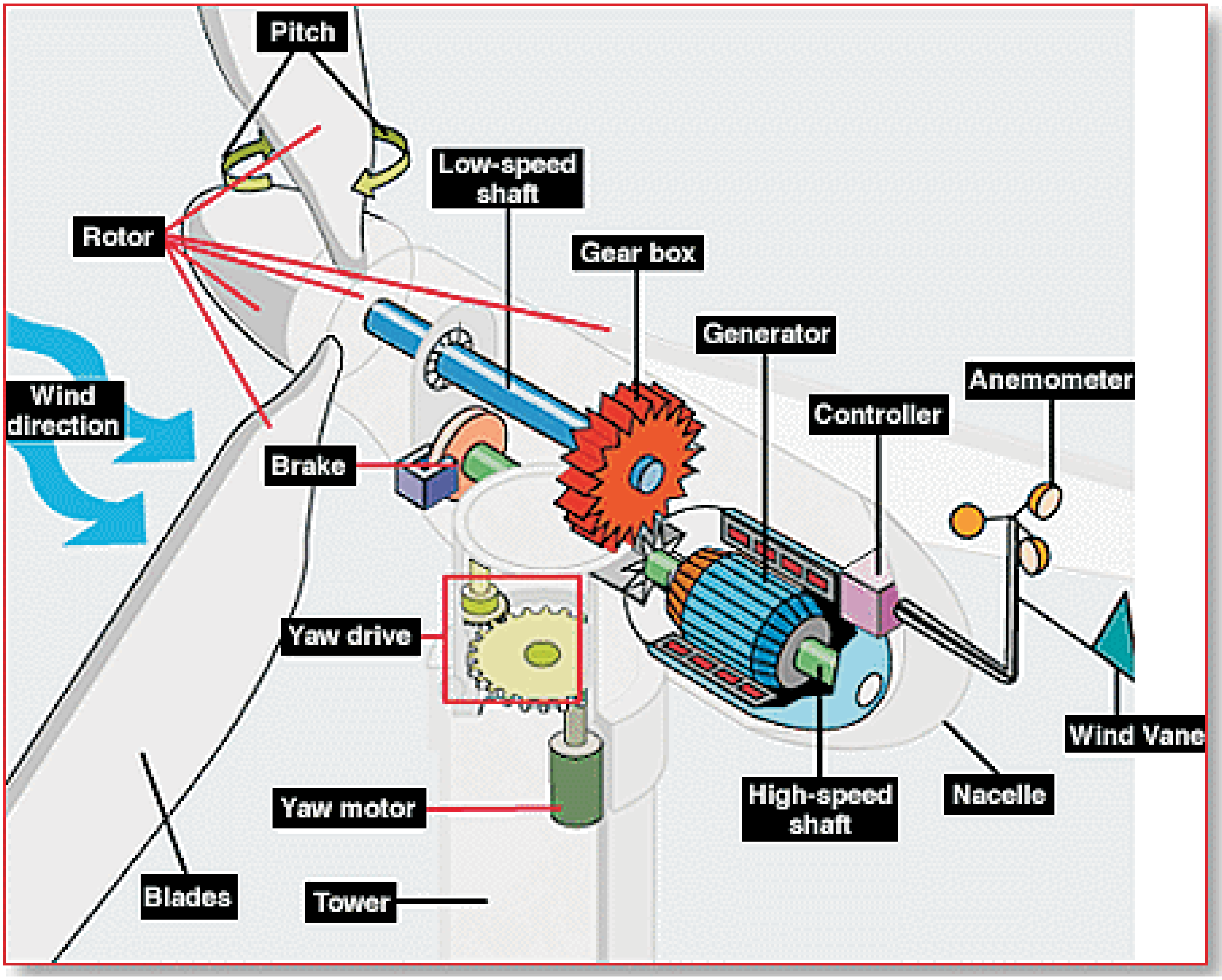
4.4.3 Decommissioning

The expected operational life of the wind farm is in excess of twenty years from the date of commissioning. At the end of this period a decision would be made as to whether to refurbish, remove, or replace the turbines. If a decision were to be taken to remove the turbines this would entail the removal of all the turbine components, transformers, substation, roads and associated buildings. The site will be restored to an acceptable condition for its intended use.

Prior to decommissioning, BLPC will review the work plan with the appropriate government agencies to ensure that it meets the regulatory requirements in effect at that time.

Major pieces of equipment are recyclable or reusable, except the turbine blades. The steel towers can be sold for scrap. Electrical equipment can either be salvaged for reuse or sold for recycling. Some parts such as the generators and cabling will have a high resale value. The exposed concrete foundation would be removed to approximately one metre below grade and the remaining foundation buried. Local labour is readily available to complete the decommissioning and this phase will provide economic benefits to the community. The cost of decommissioning a wind farm can usually be balanced against its scrap value.

As there is no industrial processing or fuel or chemical handling during the operations phase, the potential for site contamination is very low. The wind farm project will not, therefore, result in any residual long term decommissioning issues that would be detrimental to future site uses.



LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

DIAGRAM OF A TYPICAL WIND TURBINE

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 4-1**

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 4-1.cdr

TOWER FOUNDATION

TOWER BASE AND TRANSFORMER

amec

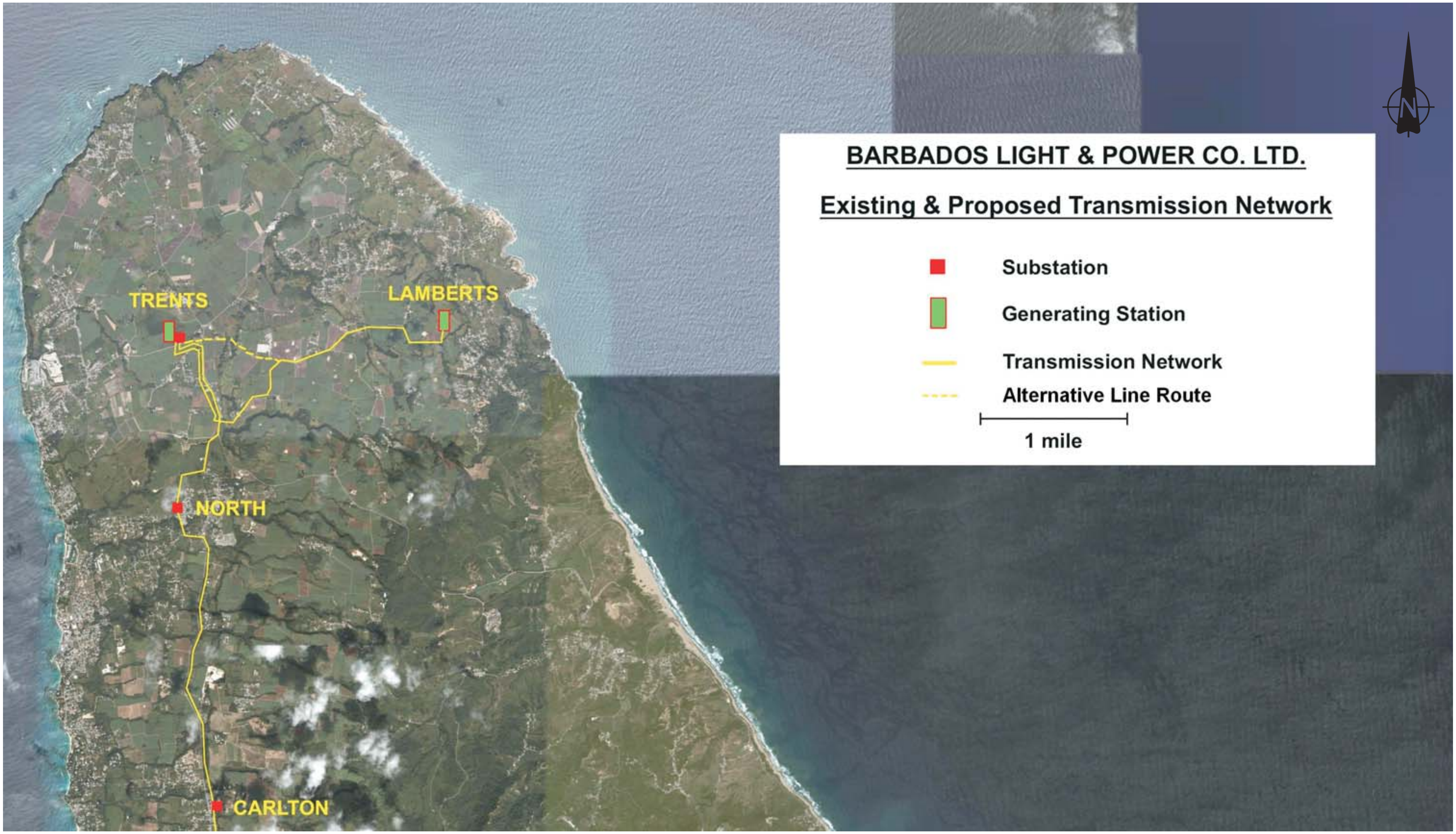
LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

TOWER FOUNDATION AND TRANSFORMER

PROJECT NUMBER TV 61036	DATE JANUARY 2007
VENDOR DWG No	CLIENT DWG No

FIGURE 4-2

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 4-2.cdr



amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

TRANSMISSION LINE NETWORK

PROJECT NUMBER TV 61036	DATE JANUARY 2007
VENDOR DWG No	CLIENT DWG No

FIGURE 4-3

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 4-3.cdr

LAYING UNDERGROUND POWER CABLE

OVERHEAD 24KV POWER LINE

amec		
LAMBERTS EAST WIND FARM ENVIRONMENTAL IMPACT ASSESSMENT BARBADOS		
POWER LINE INSTALLATION		
PROJECT NUMBER TV 61036		DATE JANUARY 2007
VENDOR DWG No	CLIENT DWG No	**FIGURE 4-4**

amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

TRANSPORTING WIND TURBINE BLADES

PROJECT NUMBER TV 61036		DATE JANUARY 2007
VENDOR DWG No	CLIENT DWG No	**FIGURE 4-5**

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 4-5.cdr



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LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

ERECTING TOWER AND TURBINE

PROJECT NUMBER TV 61036		DATE JANUARY 2007
VENDOR DWG No	CLIENT DWG No	**FIGURE 4-6**

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 4-6.cdr

5.0 PROJECT ENVIRONMENTAL SETTING

This section provides a description of the environmental setting for the proposed wind farm and includes those components of the environment potentially affected by the proposed Project. The description has been prepared from available information, discussions with government representatives and resource managers, relevant mapping, and information collected during field investigations, and provides information on environmental components that may potentially be affected by the Project, or which may influence or place constraints on the execution of Project-related activities.

5.1 Climate and Atmospheric Conditions2

Barbados' climate may be described as mild subtropical characterized by moderate temperatures in the 21 to 30°C range, clear skies and gentle easterly winds. There is a dry season from January to May and a wet season from June to December when seasonal cooling north-east trade winds blow steadily. The island is on the southern edge of the West Indian hurricane zone, but apart from coastal damage experienced in 1998 due to ocean swells, it has not been affected by any major hurricane conditions since Hurricane Allen in 1980 (Government of Barbados, 2002).

Temperatures show very little variation throughout the year, with day to night variations of approximately 8°C. Annual rainfall averages 1,367 mm and the island has about 3,028 hours of sunshine per year, which represent 69.1% of the annual daylight hours. Winds are generally gentle to moderate, exceeding 5.7 m/s about 41% of the time, whereas the periods of calm or light variable winds amount to approximately 2%, on an annual basis. Wind direction and frequency data are summarized below in Table 5-1. The hourly wind directions are grouped into 16 classes, each corresponding to a 22.5-degree sector. One additional class corresponds to calm conditions when the wind speed was less than 0.5 m/s.

[2] Climatic data was available from the Caribbean Meteorological Institute (Husbands, St. James station, latitude 13° 09'N, longitude 59° 37'W). Wind data was also obtained from the Grantley Adams Airport in Bridgetown.

Table 5-1: Frequency Distribution (Counts) for 1999 Meteorological Data from Grantley Adams Airport

Direction		Wind Class (m/s)						Subtotal	Percent of Direction
(Compass)	(Degrees)	0.5-2.1	2.1-3.6	3.6-5.7	5.7-8.8	8.8-11.1	>=11.1		
N	**0**	83	53	27	5	0	0	168	1.9%
NNE	**22.5**	85	85	59	28	5	0	262	3.0%
NE	**45**	104	300	367	217	16	0	1004	11.5%
ENE	**67.5**	53	331	1193	1163	248	2	2990	34.1%
E	**90**	22	165	1101	1145	235	5	2673	30.5%
ESE	**112.5**	14	79	288	183	28	2	594	6.8%
SE	**135**	11	45	105	73	5	2	241	2.8%
SSE	**157.5**	6	35	36	30	1	0	108	1.2%
S	**180**	6	24	53	50	21	2	156	1.8%
SSW	**202.5**	4	18	24	35	10	0	91	1.0%
SW	**225**	3	12	13	22	4	1	55	0.6%
WSW	**247.5**	12	9	10	5	1	0	37	0.4%
W	**270**	17	9	22	21	5	0	74	0.8%
WNW	**292.5**	13	6	10	7	0	0	36	0.4%
NW	**315**	18	3	2	0	0	0	23	0.3%
NNW	**337.5**	43	26	5	0	0	0	74	0.8%
Subtotal		494	1200	3315	2984	579	14	8586	
Percent of Class		5.6%	13.7%	37.8%	34.1%	6.6%	0.2%		98%
Calms									174 (2%)
Missing Data									0
Total Counts									8760

The data clearly show the dominance of easterly winds. If the direction 45 to 112.5 degrees (NE to ESE) are grouped, then the winds corresponding to this sector account for 82.9% of all wind directions. In other words, approximately 83% of the time the wind blows towards the west, plus or minus 22.5 degrees.

Figure 5-1, is a "wind rose" that was formed from the hourly data observations for the Grantley Adams Airport reported in Table 5-1. The wind rose supplements the results from Table 5-1 by demonstrating the predominance of westerly winds (i.e., winds blowing from the east towards the west).

5.2 Noise

A separation distance of 350m has been observed for this project, to ensure that noise levels at houses nearest to the wind farm are sufficiently low. Population density is relatively low in this part of the island. The majority of local dwellings straddle the coast road which is to the east of the site and at a lower elevation. These dwellings are also to the windward of the machines, the direction in which there is least propagation of any noise and there is a separation distance of at least 350 m from any dwelling to the nearest proposed wind turbine. An additional separation distance of 50 m is required, and achieved, from roads and public footpaths.

Ambient noise levels were measured to provide an indication of the local environment. These were established by conducting 24 hour acoustical measurements in the vicinity of the site, between May 18 and 26, 2006. Noise investigations were carried out using a noise logging dosimeter to determine the daytime and night-time noise environments. Measurements were taken at a series of locations surrounding the selected sites where potential receptors such as housing are present. These locations were determined in the context of the nearest sensitive receptors (dwellings). Four representative noise-sensitive receptor locations around the site were identified, and unattended automated measurements were conducted to monitor daytime and night-time conditions.

5.2.1 Identification of Receptors

During an initial tour of the site, the surrounding area was investigated to identify representative receptors around the site. Measurements were performed at four locations (Figure 5-2), described as follows:

Lamberts Plantation (L1)

This site was selected as being the closest residence to the turbines. Measurements were taken from an area directly to the southeast and within 50m of the plantation house over approximately 24 hours from May 18 (14:00 hours) to May 19 (13:15 hours). Readings were in the range of 50dBA during daytime hours with the lowest hourly L_{eq} being in the range of 37dBA and occurring in the early morning hours.

Residence in area of Date Tree (L2)

This site was selected as being one of the closest houses to the turbines and representative of the residential area to the east. Measurements were taken from a house under construction over approximately 23 hours from May 21 (14:15 hours) to May 22 (12:40 hours). Readings were in excess of 60dBA during daytime and evening hours with the lowest hourly L_{eq} being in the range of 55dBA and occurring overnight.

Residence behind Seventh Day Adventist Church at Cave Hill (L3)

This site was selected as representative of the area around Cave Hill and broadside to the line of turbines. Measurements were taken from a house behind the Church over approximately 22 hours from May 23 (14:45 hours) to May 24 (13:00 hours). Readings were in the range of 50dBA during daytime and evening hours with the lowest hourly L_{eq} being in the range of 45dBA and occurring overnight.

Residence at Josey Hill (L4)

This site was selected as representative of the area immediately to the north of the line of turbines. Measurements were taken from a house at Peterses Road over approximately 21 hours from May 25 (13:00 hours) to May 26 (09:40 hours). Readings were in the range of 45dBA during daytime and evening hours with the lowest hourly L_{eq} being in the range of 36dBA overnight.

5.2.2 Applicable Noise Criteria

The World Bank and World Health Organization guidelines for noise recommend that night-time sound levels at sensitive receptors such as houses not exceed 45dBA. However, these guidelines do not account for the increase in ambient sound levels with increase in wind speed, although the World Bank allows a 3dBA increase over background sound levels. This is particularly evident where there is substantial vegetation that results in rustling sounds that dominate the local acoustic environment.

The Province of Ontario, Canada has established noise guidelines for wind turbines. The guideline (Appendix B) recognizes that the background sound level increases with wind speed and makes an allowance for wind induced effects. Using the Ontario guideline for noise for wind turbines, the applicable noise criteria would be that of a Class 2 area. Under conditions of wind speeds under 8m/s the sound level limit at receptors is 45dBA or the minimum hourly background sound level, whichever is higher (refer to Figure 2-1).

The applicable noise criteria should therefore be 45dBA at wind speeds under 8 m/s, 49dBA at 9 m/s, 51dBA at 10 m/s and 53dBA at 11 m/s.

5.3 Topography

Barbados is a comparatively flat island, rising in a series of terraced tablelands to Mount Hillaby at 336 m (1,104 ft) in the Parish of St. Andrew (Government of Barbados 2002). The north-east of the island is known as the Scotland District area (approximately 14% of the island) and is described as eroded and rocky, while the rest of the island (approximately 86%) is coral limestone, crossed with deep river-bed gullies that accommodate the movement of water during heavy rain (Government of Barbados 2002). There are no permanent rivers in Barbados. On the East coast of the island, much of the shoreline is rocky, pounded by strong surf and on the

West and South coasts, natural coral reefs develop in calmer sea conditions and protect beaches of white sand, making these coasts highly valuable for tourism development (Government of Barbados 2002).

The proposed wind farm site is characterized by rolling agricultural landscape without any special designations.

5.4 Geology and Surficial Soils

Barbados is the top of a seamount that rises 300 m above sea level from the Barbados Ridge and was formed as an accreted wedge created by the movement eastwards of the Eastern Caribbean plate over the South American plate (RES 2003). The process continues with the leading edge now probably located 20 to 30 km west of Barbados (RES 2003).

Most of Barbados is covered by a layer of limestone called the coral cap that varies in thickness from approximately 10 to 100 m and consists of coral and coralline limestone bedrock with sporadic occurrences of sand deposits (RES 2004c). Beneath the coral cap are oceanic beds consisting of marl and ash covering the “Wedge Cover Unit” comprised of mudstones, sandstones and marls that weather to form silty clay to sandy clay soils (RE.S 2004c). The most frequent soil type is fertile clay or clayey loam (RES 2003).

Longitudinal “reefs” occur parallel to the coastline and are seen as a series of terraces extending inland; the oldest and highest terraces being about 700,000 years, while the youngest adjacent to the coast are in the process of formation (Machel 1999). The average rate of tectonic uplift is about 0.4 m per 1,000 years, providing a rough measure for the ages of the various terraces and the amount of cementation of the coral that has occurred (RES 2003).

Gullies are formed from the erosion of the limestone cap or the collapsed roofs of sinkholes, caverns and underground streams. These may follow cracks of tectonic origin within or below the coral cap (Machel 1999).

The proposed wind farm site is covered with a shallow veneer of clay soil derived from coralline limestone typical of the soils on Barbados. Limestone outcrops occur at several locations on the site.

5.5 Hydrogeology and Groundwater Quality

In 1964, Barbados introduced groundwater protection zones (Klohn-Crippen, 1996). Five zones were defined on the basis of the travel time for bacteria, and restrictions were placed on development, in-ground sewage disposal systems, soakaway pits and quarrying. The highest level of protection is represented by Zone 1, which restricts new residential and industrial development, prohibits soakaway pits and quarrying. Zone 5 represents the lowest priority and provides no constraints to development. The proposed Lamberts windfarm Project is located within Zone 4 and close to Zone 3.

The closest Zone 1 recharge (stream water) zone is approximately five kilometres to the southwest of the site, near the boundary of the parishes of St. Lucy and St. Peter, in the vicinity of Alleynedale (Klohn-Crippen, 1996 – Drawing IX). Figure 5-3 shows the location of the proposed Project with respect to these water zones.

The chemical quality of groundwater in Barbados is typical of water found in limestone formations. The major ions present in the water are calcium, magnesium, sodium, potassium, bicarbonate, chloride and sulphate. Total dissolved solids are generally in the range of 400 to 700 mg/L. In some areas, the impact of in-ground disposal of sewage and agricultural runoff has resulted in elevated concentrations of nitrate.

5.6 Ecological Components

Barbados is a small island with relatively limited terrestrial fauna and floral populations for a tropical island. This is due in part to intense development, low forest cover, and few pristine habitats and food sources (many foods sources and habitats are currently of anthropogenic origin). The following sections provide a brief overview of the floral and faunal species within the Project study boundaries.

5.6.1 Flora

There are about 700 species of flowering plants in Barbados with only two endemic species identified so far, neither of which are rare or endangered: *Phyllanthus andersonii* - a gully shrub, and *Metastelma barbadense* - a slender climber (Government of Barbados 2002). The natural vegetation over most of the island originally comprised drought-tolerant forest and shrubs, developing into tropical forest in the moister, sheltered regions. However, native vegetation is now more or less confined to a few small patches in the hills, and along the exposed east coast, which has remained relatively undeveloped (Government of Barbados 2002). Over the past 300 years sugarcane was and continues to be the primary crop planted on the island; however, there has been a steady decline in the area under sugarcane cultivation and an increase in the area under natural vegetation such as secondary forest, particularly in the Scotland District (Government of Barbados 2002).

The vegetative habitats on Barbados can be split into two categories: man-made and natural. Table 5-2 lists the different classes of vegetation in these categories.

Table 5-2: Vegetation Classes

Man-Made	Natural
Plantation forests	Beaches, sand dunes, and sandy bushlands
Sugarcane plantations	Sea cliffs and sea rocks
Pastures	Rocky land and inland cliffs
Cane-field roads	Gullies
Roadsides	Forests
Ponds and streams	Coastal wetlands
Miscellaneous waste sites	

The project site is located on agricultural land, at Lamberts East in the northern parish of St. Lucy. The site occupies a ridge at the periphery of an area of relatively flat land, which forms part of the Castle Plantation. Vegetation on the site consists mainly of coarse grass. Sugar cane is grown to the west of the site on the Castle plantation. The seaward (eastward) slope of the site is covered by grass and scrub.

5.6.2 Fauna

The only remaining extant indigenous mammals of Barbados are six species of bats, about which very little is known (Horrocks 1997). Instead, the mammalian fauna of Barbados is dominated by exotic or introduced species including mongoose (*Herpestes javanicus*), European hares (*Lepus europaeus*), mice (*Rodentia* sp.) and rats (*Rodentia* sp.) (RES 2003). The island's ubiquitous green or vervet monkey (*Cercopithecus aethiops sabaeus*) was introduced originally as a pet from West Africa some 350 years ago (UNEP, 1995). Found only on Barbados is the non-poisonous and rarely seen grass snake (*Natrix natrix*) (RES 2003). The island also has a small harmless blind snake (*Leptotyphlops humilis*), whistling frogs (*Eleutherodactylus johnstonei*), lizards (*Reptilia* sp.), and red-footed tortoises (*Geochelone carbonaria*) (Government of Barbados 2002; RES 2003).. Hawksbill turtles (*Eretmochelys imbricata*) come ashore to lay their eggs on the island's sandy beaches on a regular basis, and the leatherback turtle (*Dermochelys coriacea*) is an occasional nester (RES 2003). More than 180 species of birds have been sighted on Barbados. Most are migrating shorebirds and waders that breed in North America and stop over on the island en route to winter feeding grounds in South America. Only a fraction actually nest on Barbados, including wood doves (*Turtur* sp.), blackbirds (*Icteridae* sp.), bananaquits (*Coereba flaveola newtoni*), guinea fowl (*Numida meleagris*), cattle egrets (*Bubulcus ibis*), herons (*Ardeidae* sp.), finches (*Fringillidae* sp.) and three kinds of hummingbirds (*Trochilidae* sp) (Government of Barbados 2002; RES 2003).

5.6.2.1 Avifauna

The bird fauna of Barbados is much more diverse than the island’s mammalian fauna; however, much of the diversity is attributable to seasonal migrants passing through the island on the way to South America towards the end of the year. The resident bird species are relatively few by comparison, the numbers of species having declined primarily due to habitat loss following the island's colonization in the 1600s and through predation by introduced mammals such as the mongoose and the green monkey (Government of Barbados 2002).

Resident avifauna

Reports estimate at least 36 species of birds are resident and confirmed as nesting in the wild in Barbados including at least sixteen exotics, eight of which occur naturally due to expanded range (although some may have been unintentionally human-assisted), and eight of which have been deliberately introduced (Government of Barbados 2002). Although most of the resident species adapt well to human-altered habitats, and are considered to be common, a few species with more specialized habitat requirements (e.g. Audubon's shearwater and the yellow warbler) are rare. Many of the island's resident avian species are protected under the *Wild Birds Protection Act* (1985).

Migratory birds

Since Barbados lies on a major migratory flyway for the eastern North American populations of many shorebird species, over 150 species of migratory birds have been recorded in Barbados, including seabirds (e.g. gulls and terns) and shorebirds (e.g. plovers and sandpipers). Furthermore, bad weather events cause migratory birds to fly low over Barbados, and the presence of suitable aquatic habitat attracts the birds to land.

There are four natural areas with critical habitat for migratory birds – Graeme Hall swamp, Chancery Lane swamp, Green Pond and Long Pond, and twelve artificially maintained shooting swamps, including one that is currently maintained as a private bird sanctuary, where birds alight and feed (Government of Barbados 2002). Although providing preferred habitat for species such as gallinules and gaulins, the manmade freshwater swamps are not the preferred habitat of most migratory species, which generally prefer shore or tidal marsh areas (Government of Barbados 2002). Figure 5-4 shows the locations of these natural areas in relation to the proposed Project site.

Studies have found that during autumn migration in the West Indies, blackpoll warblers (*Dendroica striata*) have sufficient energy reserves to fly overhead without stopping, and that grounding of these warblers is sporadic. A monitoring program initiated at Harrison Point (HP), St. Lucy, Barbados from late September to early November, and supplemented with sight observation data from HP from autumn 1993 to 2000, supports the hypothesis, and thus the prevailing view, that blackpoll warblers undertake a long transoceanic migration during autumn (primarily in October) over the western North Atlantic Ocean to South America. (McNair et. al., 2002). Studies have also been conducted on the chestnut-sided warbler, a long-distant migrant that breeds in central-eastern North America and migrates along the gulf coast of the United States or flies across the Gulf of Mexico to the Yucatan Peninsula (Brown and Collier, 2003). The species is exceedingly rare in Barbados and other islands of the Lesser Antilles, and population trends indicate a steady decline in abundance on the breeding grounds (Curson *et al*

1994). Studies performed at over-wintering grounds in Central America show that the chestnut-sided warbler prefers second-growth forest and often second-growth habitat margins, within shrubs or cleared areas. Within the West Indies, the species is usually found in well-forested areas (Brown and Collier, 2003).

Studies of bird movements over the windward Caribbean Islands using radar techniques showed that autumnal migration over Antigua occurred as early as late August, with peaks in early September and again in October with the heaviest migrations occurring in mid-October (Williams, 1984). Observation of the departure of migrants from North American and ground observations in the Caribbean suggest that a division exists among migrating species, such that early peak migrations are shorebird species and later peak migrations are wood warblers (Williams, 1984).

Winter residents

A substantial number of bird species are regular winter visitors to Barbados (e.g. osprey (*Pandion haliaetus*), purple gallinule (*Porhyrula martinica*), great blue heron (*Ardea herodias*) and little blue heron (*Florida caerula*). Graeme Hall swamp, Chancery Lane swamp, Long Pond and Green Pond all provide important foraging and refuge habitat for these over-wintering species (Government of Barbados 2002). Winter residents have habitat needs overlapping with those of resident and migratory birds and although critical habitats are in place at Turner's Hall woods, woodlands in the upper reaches of less accessible gullies, and the wetland areas of Graeme Hall swamp, Long Pond, Green Pond and Chancery Lane, as well as remnant swamps along the west coast of the island, there is no formal monitoring of winter residents and no management infrastructure is in place (Government of Barbados 2002).

5.6.2.2 Bats

Of the six species of bats present in Barbados, one species, *Monophyllus plethodon plethodon,* is an endemic sub-species, and another is likely an endemic subspecies of *Myotis nigricans* (Government of Barbados, 2002). There is no available information on the distribution and abundance of bats in Barbados, except that the house bat *Molossus molossus molossus* is apparently common (Government of Barbados, 2002).

A general lack of knowledge about the ecology of the bats of Barbados makes it difficult to assess additional threats to populations or habitats. As one or possibly two of the bats of Barbados are endemic sub-species, they are therefore unique to Barbados and of significant scientific, educational and intrinsic value (Government of Barbados, 2002).

5.6.3 Endangered Species

Barbados has no legislation for the general protection of wild fauna and flora. Some species of wild plants are worthy of protection in respect of which no legislation pertains (Government of Barbados, 2002). However, under the *Convention on International Trade in Endangered*

Species of Wild Fauna and Flora (CITES), to which Barbados is signatory, the Government of Barbados has included in the Biodiversity Strategy and Action Plan for Barbados an objective to protect critical habitats of rare and endangered species in terrestrial, coastal, marine and freshwater environments (Government of Barbados, 2002).

Flora

The Biodiversity Strategy for Barbados (Government of Barbados, 2002) referenced a study that indicated that there were 23 (non-flowering) plants in Barbados that require protection, although all are found elsewhere in the Lesser Antilles. Fifteen of these species are known from only one site and eight species were considered rare or endangered in Barbados (Government of Barbados, 2002).

Fauna

None of Barbados' mammals are endangered, with the exception of the raccoon (*Procyon gloveralleni*) should it be proved still extant. There is no published information on the habitat use of the Barbados raccoon but in the unlikely event that a viable population of raccoons still exists. The rarity of this species would make them extremely valuable for scientific, educational and intrinsic values, and for the direct economic value if the animal were exploited as an eco-tourism attraction (Government of Barbados, 2002).

The hare (*Lepus capensis*) is rare, presumably partly as a result of a historically growing mongoose population and partly because of hunting by local people (Government of Barbados 2002). Recent rises in numbers are likely due to favoured crops that are being grown, increased availability to grassland that was formerly under sugar cane, and decreased use of herbicides (Horrocks, 1997)

There is no protective legislation for mammals in Barbados, either for the species themselves or their habitats (Government of Barbados, 2002).

The endemic grass snake (*Liophis perfuscus*) has not been sighted since 1961, likely affected by human, rat and mongoose predation, land clearance, pesticide use, and spread of field fires (Horrocks, 1997). This species could be considered one of the world's rarest and there is therefore an urgent need to assess its status and initiate a conservation program (Government of Barbados, 2002).

Both species of marine turtles nesting in Barbados are considered endangered at some level by the International Union for the Conservation of Nature and Natural Resources (IUCN, 1996). The hawksbill turtle (*Eretmochelys imbricate*) is characterized as Critically Endangered and the leatherback turtle (*Dermochelys coriacea)* is designated as Endangered.

5.7 Environmentally Sensitive Areas

Environmentally sensitive areas (ESA) are areas that are recognized, either by legislation, the scientific community or the general public, as being a particular component of the ecosystem that is especially sensitive to disturbance by anthropogenic events. The National Physical Development Plan (1998) also lists a number of Significant Natural Features and Hazard Lands. A number of areas of inland Barbados would be categorized as environmentally sensitive areas, including:

- Gullies;
- Escarpments;
- Chancery Lane Swamp;
- Harrison Caves;
- Public Parks and Open Spaces;
- Nationally Protected Landscapes;
- Natural Heritage Conservation Areas;
- National Forest Candidate Sites; and
- Coastal Management Zones.

The project site does not encounter any of these ESAs, with the exception of being in proximity to escarpments and gullies which are characteristic of the type of bluff where the Project is located. These areas that occur within the Project area will be avoided with the siting of turbines and access roads.

5.8 Land Use

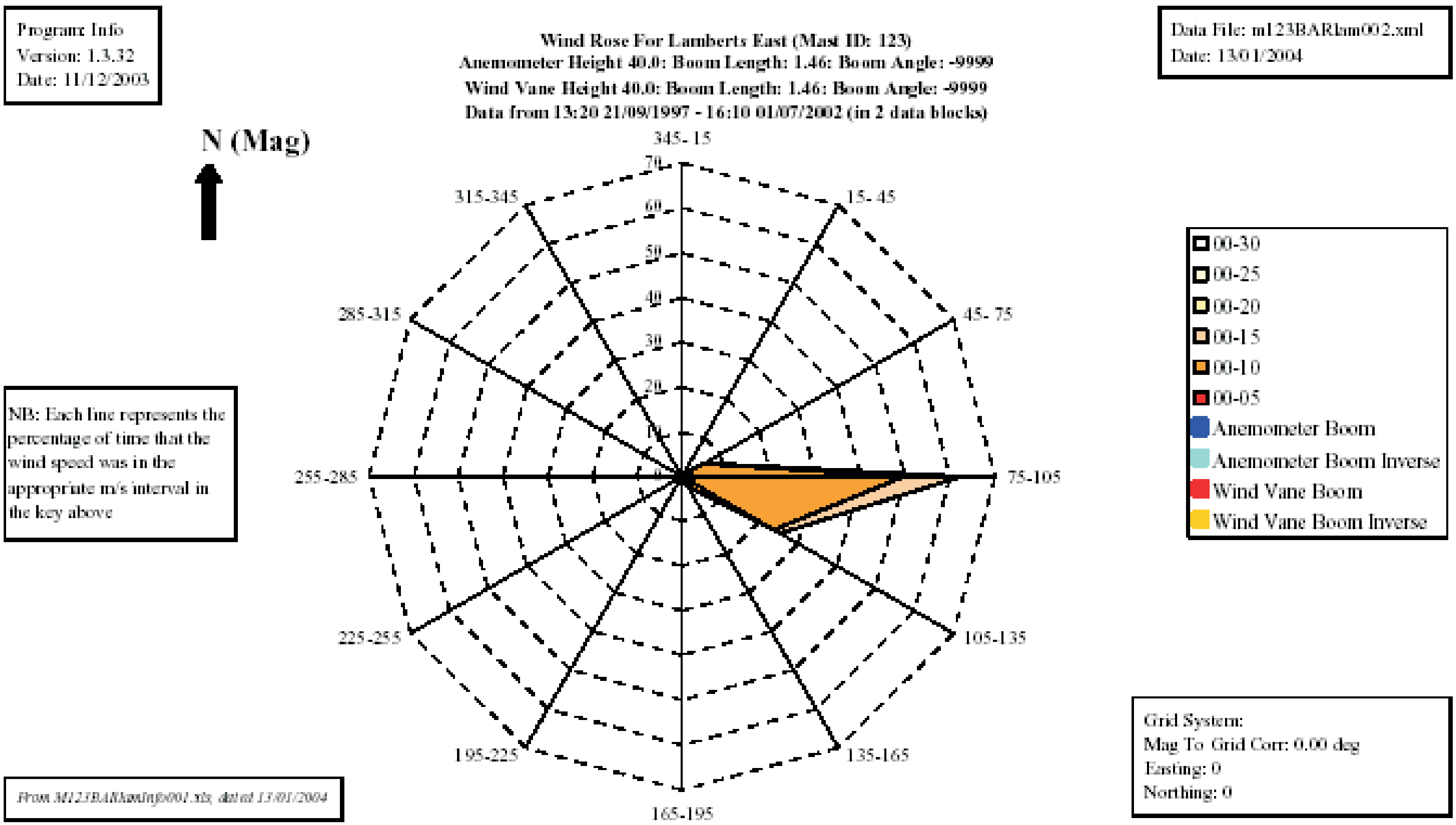
The following sections provide an overview of the types of existing land use that occur in the Project area. The main types of land use that exist in the general study area include:

- Agricultural: Areas of land that are used primarily for agricultural purposes;
- Residential: Areas where the use of the land is primarily for residential dwellings and homes;
- Commercial: Areas that have predominantly commercial operations such as shops, restaurants, bars, gas stations, etc.;
- Industrial: Areas that are used primarily for industrial purposes including airports, generating stations, cement/asphalt plants, warehouses, factories and storage;
- Institutional: Areas that are used primarily for institutions such as government, churches, schools, libraries, etc.;
- Employment: Areas that are intended to accommodate General Industrial and Light Industrial uses; and

- Transmission Line Routes: The grid connection can be a limiting factor in the development of wind farms, either due to the distance to a suitable connection point or whether the grid line is capable of accepting new capacity.

5.9 Traffic

Traffic in Barbados has become increasingly congested in the last few years by the proliferation of privately owned automobiles. This is further impacted by the large number of development and construction projects on the Island, as well as ongoing maintenance of roads and municipal services.



amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

HOURLY WIND DATA OBSERVATIONS FOR THE GRANTLEY ADAMS AIRPORT

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 5-1**

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 5-1.cdr

1 APPROXIMATE NOISE MONITORING LOCATIONS

0 250 500 1000

METERS

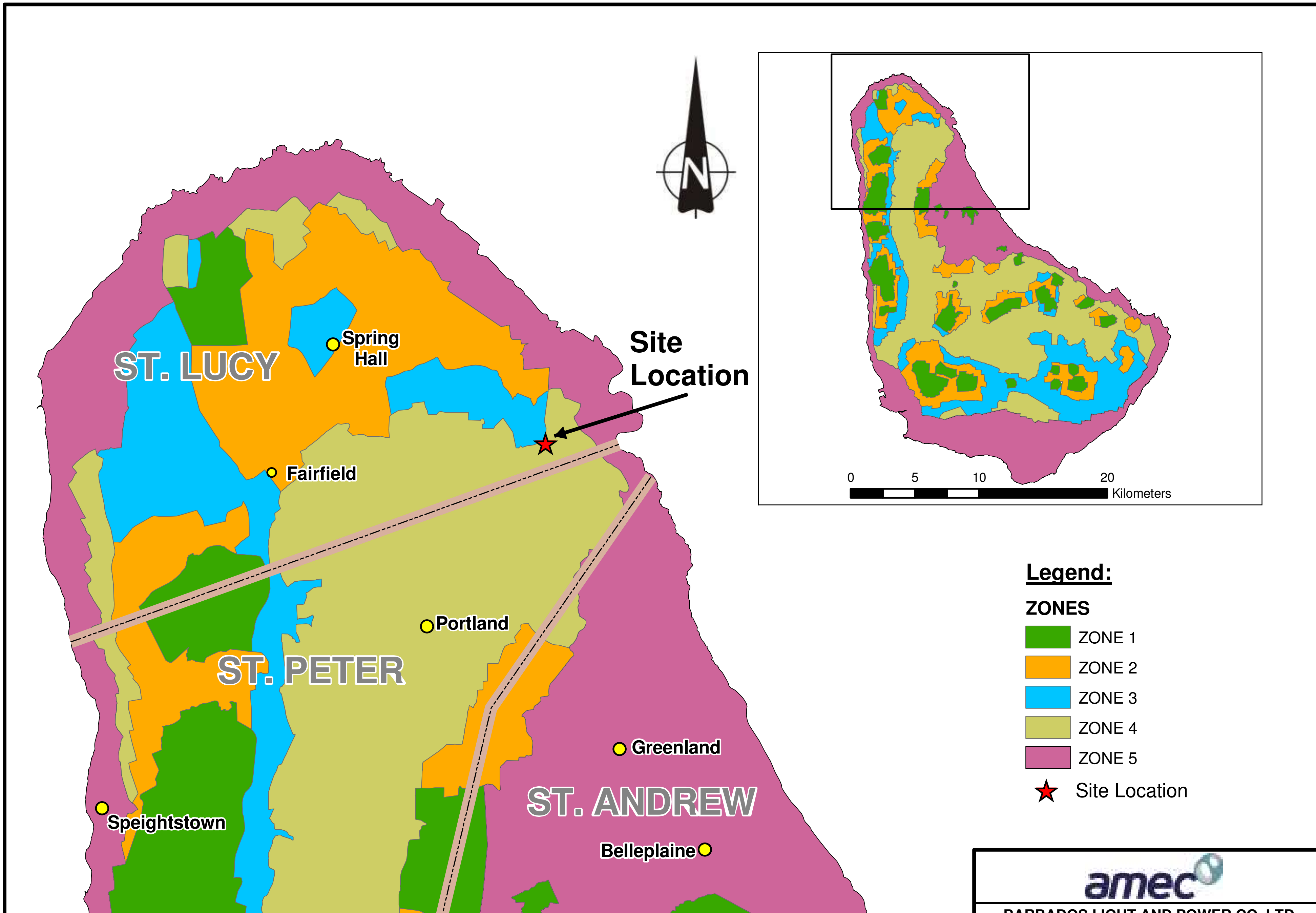
amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

LOCATIONS OF NOISE MONITORING SITES

PROJECT NUMBER: TV61036	DATE: JANUARY 2007
VENDOR DWG. No.	CLIENT DWG. No. FIGURE 5-2

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 5-2.dwg Feb 1/2007 11:27:43 AM EST



amec

BARBADOS LIGHT AND POWER CO. LTD.
ENVIRONMENTAL IMPACT ASSESSMENT
LAMBERTS WIND FARM

WATER ZONES

PROJECT NUMBER: TV61036	DATE: November 2006
VENDOR DWG No	CLIENT DWG No **FIGURE 5-3**

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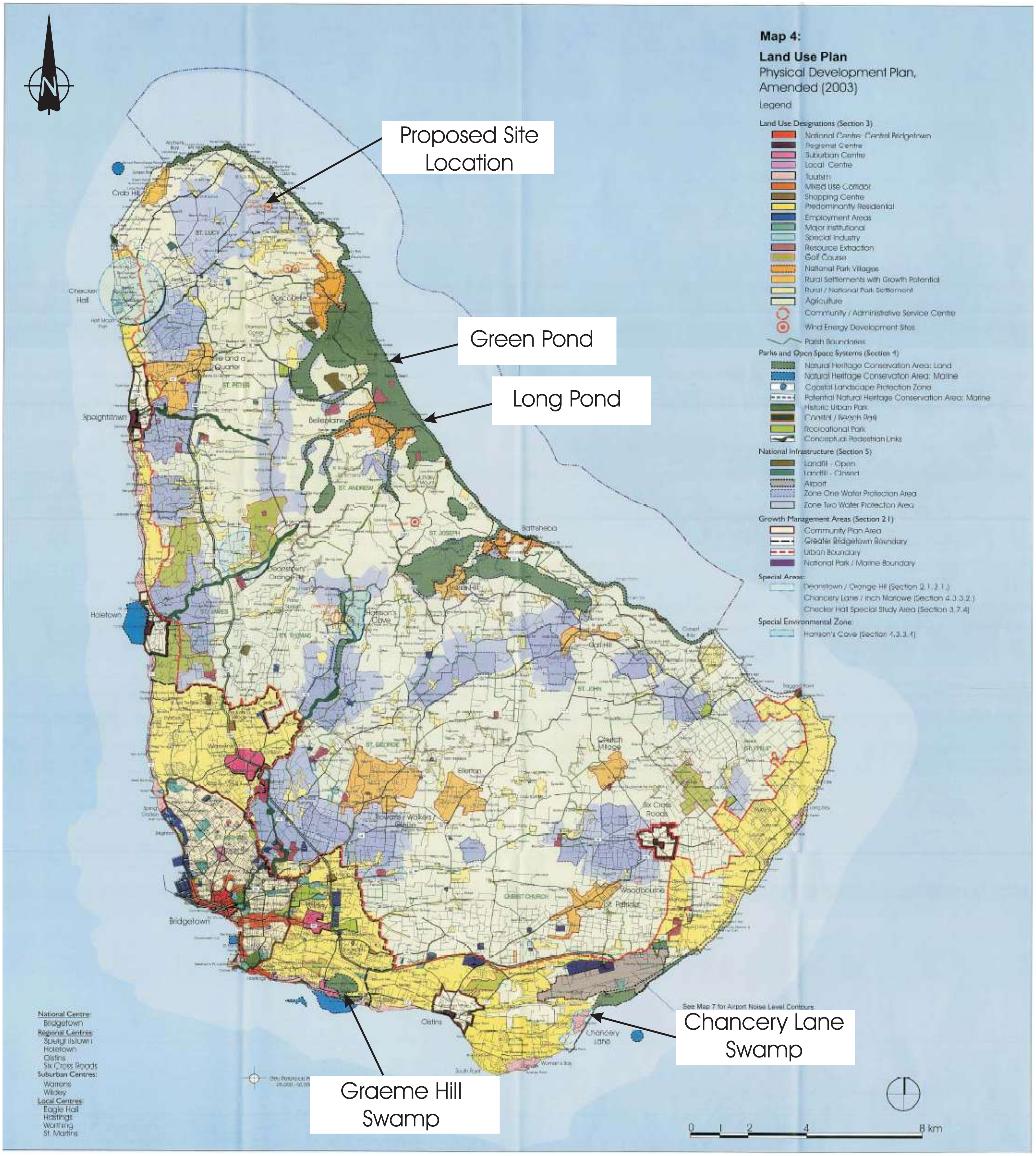

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LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

NATURAL FEATURES AND HABITATS

PROJECT NUMBER TV 61036		DATE DECEMBER 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 5-4**

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2006\TV61036 Figure 5-4.cdr

6.0 VALUED ECOSYSTEM COMPONENTS

6.1 Issues Scoping and VEC Selection

This part of the environmental assessment serves to identify those environmental components that are likely to be affected by the project.

The potential interactions between project components or project activities and environmental components of concern (ECC), specifically VECs, are identified during an issues scoping process. Environmental components include the biological, physical and socio-economic environment. As a result of this process, the actual assessment will focus (only) on issues/components of concern.

Consultations with stakeholders (e.g. regulators and the public) as well as the scientific community, are part of the issues scoping process and help in the identification of VECs. The other approach to VEC selection is based on experience gained during other comparable environmental assessments, available information on the environment surrounding the proposed project, and the technical and professional expertise of AMEC.

The evaluation of the environmental issues resulted in the following Project VECs:

- Air quality
- Noise
- Aesthetics
- Traffic
- Waste Disposal
- Accidents and Malfunctions
- Electromagnetic Interference
- Shadow Flicker
- Groundwater
- Ecological Effects
  - Birds (breeding, migratory birds etc)
  - Other Fauna
  - Flora
  - Endangered species

6.2 Temporal and Spatial Assessment Boundaries

The traditional approach to project bounding involves assessing changes to the environment within the physical boundaries of development. Beanlands and Duinker (1983) determined that in order to properly evaluate impacts, physical and biological properties must be determined temporally and spatially. This approach has been taken for the determination of bounds for the assessment of the proposed project. The effects of a specific project activity on a VEC may differ in both space and time from the effect of any other activity. Some project activities may have long-term consequences, while others will be of short duration.

Temporal project bounding for the proposed Project includes the short-term construction activities as well as the long-term operation of the wind energy facility (turbine design lifetime 20 years) and its decommissioning, including site remediation. There is some temporal variability, since a refurbishment of the turbines at the end of their regular lifetime is likely. This refurbishment will likely double the lifetime of the wind generator facility. Also, the duration of the effects is likely to vary with the VEC and the project activity. Therefore, different temporal boundaries may be used to reflect:

- the nature and duration of the effect;
- the characteristics of the indicator; and
- the types of actions and projects that will need to be considered within the cumulative effects assessment.

The spatial boundaries for assessing potential effects will typically be established by determining the spatial extent of an effect of a project component or a project activity. The physical boundaries of the site are as shown on Figure 1-2.

The physical (spatial) boundaries of the project may vary depending on the individual VEC. For example, for endangered plant species, the project boundaries will be restricted to the lay-down areas, access roads and ancillary structures. However, for socio-economic impacts, the boundary extends the project footprint to include local communities/towns at a minimum.

Scientific and technical knowledge, input from the public, professional experience and traditional knowledge will be used to develop the temporal and spatial boundaries.

7.0 ENVIRONMENTAL EFFECTS ASSESSMENT

7.1 Construction

The following sections describe the potential effects on the environment from the construction activities associated with the Project

7.1.1 Aesthetics

During the construction phase concerns with aesthetics are associated with the increased number of vehicles required to transport the turbine blades and towers, as well as other vehicles associated with this phase.

Recommended Mitigation

The route of the access track to the site will be chosen to minimize the disturbance of aesthetics.

Significance of Environmental Effects

Since the construction phase is estimated to be short (i.e. 6 months), no significant adverse environmental effects are likely to occur.

7.1.2 Ecological Effects

The only potential ecological effect that is predicted from the construction of the Project involves the clearing of vegetation for access roads and each of the turbine sites. Access roads will likely involve the upgrading of existing cart and tractor roads and therefore will only require minimal clearing. Also the Project site is an active agricultural operation and only terrestrial ecosystems are present, inclusive of shrub land and a sugar cane plantation. However, only the shrub land will be cleared for project implementation and this type of vegetation does not fall in any of the categories of rare, endangered, or endemic. As well, this area does not represent any critical breeding or foraging habitat for any protected species of fauna. As a result there will be no potential adverse environmental effects on ecological components from the construction activities.

7.1.3 Air Quality

The potential effects on air quality and the related Project interactions during construction are overburden disturbance and construction equipment operation. These are described in the following subsections.

7.1.3.1 Overburden Disturbance

The primary air quality concern during construction is the impact of particulate matter on the surrounding environment. Particulate emissions during the Project construction are associated with land clearing, blasting, excavation, and backfilling operations.
The potential effect of particulate matter is influenced by site and weather conditions (rain and wind direction) and by preventative measures implemented during construction to minimize emissions. Emissions of particulates that exceed air quality guidelines may result in problems on the construction site and under special circumstances (such as strong winds) in off-site areas as well. The generation of particulates at construction sites depends on the silt content of the soils being disturbed, the proportion of dry days, operator habits, construction vehicle type and speeds, vehicle weights, and the number of vehicles.

Particulate emissions will be generated during overburden disturbance as part of the Project construction.

<u>Recommended Mitigation</u>

Specific mitigation required is outlined in the Construction Environmental Management Plan in Appendix C and includes:

- The application of dust suppressants such as water, calcium chloride, or tree lignin based dust suppressant on the work sites as required (calcium chloride will not be used on agricultural fields);
- Use of rock drills equipped with dust collectors in good working order; and
- Adequate control of dust at work sites that are in proximity to nearby residences.

<u>Significance of Environmental Effects</u>

The significance of effects on air quality due to overburden disturbance is considered to be minor, as they will be localized, of small magnitude and short duration. No significant adverse environmental effects are likely to occur.

7.1.3.2 Construction Equipment Operation

Construction equipment produces emissions typical of gas or diesel fuelled vehicles. Generally, emissions may cause occasional nuisance problems on construction sites; however, they do not present significant problems outside the construction site due to their transitory nature. The level of gaseous emissions during construction and the potential effect of these emissions relates to the duration and intensity of the emissions.

The management of spills or leaks from equipment is addressed in Sections 7.1.6 and 7.3.

Recommended Mitigation

It is recommended that all construction equipment operate with the standard emissions controls that each piece of equipment was originally equipped with. All vehicles shall be maintained in a proper fashion in order to minimize vehicle emissions to the extent possible.

Significance of Environmental Effects

Potential effects due to gaseous emissions during construction are expected to be localized, of limited volume, and of short duration. No significant adverse environmental effects are expected.

7.1.4 Noise

Construction activities will contribute to an increase in noise levels at the project site. For the most part this is unavoidable but will be relatively short lived. The construction activities will occur during the daytime hours and should not affect night-time noise levels.

Recommended Mitigation

The major sources of noise will be the excavation equipment and trucks. To prevent excessive noise levels, all contractors will be required to provide working machinery and equipment with noise suppression devices equivalent to original equipment.

Significance of Environmental Effects

No significant adverse environmental effects from construction related noise are likely with proper implementation of the recommended mitigation measures.

7.1.5 Traffic

Due to the generally rural nature of the wind farm site, the road network may not always be suitable for construction traffic and for moving large pieces of equipment without some upgrading. Consultation with the Department of Transportation is therefore necessary in order to ascertain a suitable access route and to discuss whether any road improvement is necessary.

7.1.5.1 Public Highway Access

The expected access route for abnormal loads will be from the docks along to Gordon Cummins Highway, and then along Highway 2A to All Saints Church but avoiding Rose Hill and taking the bypass at St. Lucy Church. This will need to be confirmed with the contractor in consultation with the Department of Transportation

7.1.5.2 Site Access

Access to the site will then be along the Class 11 road from Alexandra to Boscobelle. Separate entrances will be required for the tracks to both the north and south of this road.

7.1.5.3 Vehicle Numbers

The abnormal loads which need transporting are the turbine blades and towers. The main section of each blade is approximately 25 m long and weighs about 4 tonnes. The tower is a tapered steel tube with a maximum diameter of 3.5 m. It is supplied in 2 or 3 sections of length and has a total weight of about 60 tonnes. The weight of the nacelle is 20-25 tonnes. During the 6-month construction phase, there would be an increase in vehicle movements. The nature and quantity of the traffic is estimated below. A journey includes trips to and from the site.

Table 7-1: Traffic Movements during Construction

Activity And Duration	Approx. Journeys Per Turbine	Total Journeys	Approx. Journeys Per Day
Turbine Delivery (6 weeks)	6	72	2
Turbine Electric's (6 weeks)	2	24	1
Turbine Foundations (11 weeks)	25	300	5
Access Track Construction (3 to 4 weeks)	10	120	10
Other e.g. tracked plant, 2 cranes, fencing, site huts (over 26 weeks)	N/A	Approximately 50	<1

The second half of the access track construction period would be the busiest for traffic movements when stone trucks and foundation trucks could be making journeys at the same time. It should be noted that there would be days when there would be no traffic in one or all of the categories.

It is likely that at any one time approximately 10 cars/vans would be on site being used by site engineers and other construction staff. In addition, one journey would be made by a 250/300 tonne capacity mobile crane (travelling weight of approximately 90 tons on 8 axles, with an approximate axle load of 11.5t) which would be required to erect the turbines. A journey would also be made by a second smaller crane, which would also be required for general work and the erection of turbines. This would be a 70/100 tonne capacity mobile crane.

Traffic movements would generally be confined to normal working hours (7am to 7pm), though exceptions might be required for the movement of abnormally long wind turbine components. No increase in the night-time background noise level is anticipated.

Recommended Mitigation

The Department of Transportation will be provided with the schedule for equipment transport, to coordinate for overnight transport of oversize loads and the requirement for road closures at least one month in advance so that there will be no conflicts with other road work. In addition, the public will be provided with advance information on road closures through announcements in the newspapers and through radio and television. Road closures will be posted with detour signs and the detour routes will be fully sign posted throughout to ensure traffic follows the correct routing and an assessment will be done of the routing for major equipment transfers from the port in advance to identify any constraints.

Significance of Environmental Effects

As noticeably increased traffic levels would only be experienced during the 6 months of construction and any necessary road improvements to the local highway network would be implemented in consultation with the Department of Transportation, it is considered that the local transport network would be able to absorb the additional traffic movements associated with the construction of the wind farm.

When considered over the life of the project, the short term impact of increased traffic levels is considered to be minimal. Any necessary road upgrading would also improve the condition of the local road network. The overall effect of the wind farm on the highways and traffic is therefore considered to be minor.

7.1.6 Waste Disposal

General construction waste is anticipated during the construction stages of the project.

Recommended Mitigation

All contractors will be required to implement a solid/hazardous waste management plan during construction to minimize the waste generated and to re-use non-hazardous waste on-site if possible (i.e. grubbing and excavation materials). In addition, those materials that cannot be re-used will be removed from the site and disposed of properly.

Maintenance of vehicles and heavy machinery will be performed offsite whenever possible, thus not resulting in hazardous waste on-site. If an oil change onsite cannot be avoided, the waste oil will be carefully collected and removed from the site. Oil spill kits will be onsite to remediate any accidental spills of oil during the operation of heavy equipment, such as hydraulic oil.

Significance of Effects

No significant adverse environmental effects from waste disposal are likely with proper implementation of the recommended mitigation measures.

7.2 Operations

7.2.1 Aesthetics

The major impacts of a wind farm are generally its visual impact.

7.2.1.1 Visual Assessment

The process of landscape and visual assessment has enabled a clearer picture to be gleaned as to the anticipated nature of impacts upon both the landscape resource and the visual environment arising from the proposed introduction of the Lambert's East Wind Farm. This section of the EIA provides a Zone of Visual Influence (ZVI) map (Figure 7-1) and photomontages (Figures 7-2 to 7-5) from separate viewpoints to allow the effects upon the receiving environment to be assessed.

7.2.1.1.1 Zone of Visual Influence (ZVI)

The ZVI map (Figure 7-1) shows the areas from which the turbine or parts of the turbine will be seen. It should be noted that the map indicates the areas from which a part (or several parts) of a wind turbine are visible, rather than complete turbines. Due to the undulating nature of the terrain, visibility of the wind farm is relatively limited and there are few points from which all of the turbines can be seen. It is noted that the colours in Figure 7-1 respond to the number of nacelles that are visible from any spot within 6km of the site accounting for terrain, and that the mapping does not account for the screening due to vegetation.

7.2.1.1.2 Photomontages

The view points indicated on Figure 7-2 and listed below in Table 7-2 were chosen for the photomontages (Figures 7-3 to 7-5). To produce the photomontages, photographs were taken from the view points using a digital camera mounted on a tripod. Multiple shots were "stitched" together using Canon® camera software to form a panoramic view. The grid coordinates of various reference points in the photographs were obtained using a portable GPS. A digitized map of the area is used to generate a wireline projection of the site from each viewpoint with the turbines incorporated.

The nature of the landscape of this part of Barbados is such that there are few viewpoints from which the whole of the wind farm can be seen. This partial visibility of the turbines allows the structures to elegantly blend in with the scenery. From these simulations, it can be stated that the project will not impose a significant visual impairment of the scenery of the area.

Table 7-2: Locations of Photomontage Viewpoints

Location of Viewpoint		BN Grid Reference	Distance from site
View Point	**Description**		
Viewpoint 1	From the Pie Corner Mission	E25255 N88150	1.5 km.
Viewpoint 2	From Risk Road	E26310 N87895	.4 km.
Viewpoint 3	From the existing turbine	E27660 N87780	1 km.

Recommended Mitigation

Specific mitigative options have been discussed and included in the plans for the site as follows:

- The route of the access track to the site will be chosen to reduce the visibility for the dwellings to the east of the site;
- The tower height of the turbines has been kept to a minimum reasonable dimension to allow for decreased/minimized visual impact; and
- The number of turbines has been reduced from earlier studies while still retaining the same total energy output via use of larger output turbines.

Significance of Environmental Effects

The significance of effects on aesthetics due to operation of the wind farm is considered to be minor. No significant adverse environmental effects are likely to occur.

7.2.2 Ecological Effects

7.2.2.1 Avifauna

There is a general concern regarding birds in relation to wind turbine generators, particularly due to the potential for collisions with the turbines. The impact best known to the public is the potential for direct bird mortality due to collisions with turbines, and with overhead powerlines. The risk will be different depending on the species, due to differences in avoidance behaviour, flight patterns, food source, etc. Birds may also be attracted to lights on turbines (if required), potentially leading to increases in collisions. Effects are generally considered to be small (Kingsley and Whittam, 2003).

Direct Bird Mortality or Injury

Wind farm developments have been associated with three major risks for direct bird injury and deaths: bird strikes (collisions), electrocution, and increased predation. Of these, the deaths due to collisions with the turbines are of major interest to the public. Bird mortality from collisions is perceived by the public as the most significant adverse effect of wind farms on wildlife (NWCC, 1999; in Sea Breeze, 2004). Deaths resulting from collisions with ancillary facilities, such as power lines, guy wires, and wind towers, are also documented and potentially significant, but are rarely “noticed” by the public.

The risk of bird deaths from collisions with wind turbines and ancillary structures has received intense scrutiny, reflected in a large and ever increasing number of scientific studies carried out or commissioned by a variety of people and organizations, ranging from independent university scientists to wind industry associations. Most wind power projects now have intensive environmental effects monitoring programs, which will add more data to help in the design of modern developments to incorporate more environmental considerations focusing on birds.

These studies highlight that the bird mortality from wind turbines varies, but is generally very low. Certain taxonomic groups and species are at greater risk than others. Other factors influencing the risk include the location of the turbine (landscape), the size of turbine, size of the wind farm, other technical details, the number of birds present, the behaviour of the birds, the food source, weather conditions, etc. Therefore, the risk for birds can vary considerably from one wind farm project to another.

The attention to bird strikes was initiated by the high numbers of bird fatalities incurred at one of the first major wind farm projects in California. At the Altamont Pass in California, a large number of birds are killed each year - more than half of them raptors, including the protected golden eagle (Orloff and Flannery, 1992, in: CWS, 2003; Erickson et al., 2002; in Kingsley and Whittam, 2003). However, outside of California, only about 2.7 % of birds killed at wind farms are raptors (Erickson et al., 2001, in Kingsley and Whittam, 2003).

In general, the number of deaths at modern wind farms is much lower, and some wind farms do not find any dead birds. Erickson et al. (2001) reviewed the available data on wind farms in the US. He estimated that on average, 2.19 birds per turbine each year are killed across the US - without considering the variation between the wind farms. Across the US, an average of 0.033 raptors per turbine are killed each year. If wind developments in California are excluded, the average number drops to 1.83 birds per turbine per year (corrected for searcher efficiency and scavenging). The average for raptors drops to 0.006 raptors per turbine each year. Based on 15,000 turbines in the US and 2.19 birds per turbine, this equates to a total of 33,000 birds per year, of which 26,600 of these are killed in California. While this number may seem high, it is very small considering the millions of birds passing through these areas. It is also very small when considering the high number of birds killed due to other human activities (see below).

Erickson et al. (2001) also find that the number of victims per turbine is highly variable, ranging from 0 to a high of 4.45 birds per turbine per year (summary in BLM, 2004). The latter high number, which was found at Buffalo Ridge Phase III in Minnesota, included an unparalleled incident where 14 passerines were killed at 2 turbines. The estimated fatality rates reported are conservative estimates because they include fatalities that are unrelated to collisions with turbines, such as predation or collisions with vehicles (BLM, 2004).

Kerlinger (2001, in Kingsley and Whittam, 2003) reviewed studies from the US and Europe. He confirms that in general, the number of birds killed is low, and that there are no wind farms on either continent where ecologically significant mortality was caused, except potentially the Altamont pass wind farm in California. Kingsley and Whittam (2003) state that they consider mortality rates above the average of 2.19 birds per turbine to be high, and those below this level to be low.

Several factors influence the risk of collisions of birds with turbines:

- Bird density is one of the seemingly most obvious factors. In areas with a large number of birds, the probability of collisions is increased. However, only one study (EVEAERT, 2003 - in Kingsley and Whittam, 2003) has found a direct relationship, while generally, a high bird density does not necessarily result in high mortality.
- The number of turbines/scale of the wind farm: large wind farms kill more birds than small wind farms. In fact, all four reviewed wind farms with 11 or less turbines reported no bird fatalities (BLM, 2004). However, there is no correlation between the turbine number and the mortality rate per turbine for larger wind farms (i.e., large wind farms do not kill disproportionately more birds per turbine than smaller farms (Kingsley and Whittam, 2003).
- Differences in turbine technology may contribute to higher risks. Generally, it is assumed that older turbines, which rotate faster (up to over 60 rpm), present a higher risk, but there is no conclusive data for this notion. New turbines with a larger rotor diameter and a capacity of 600 kW to 1.5 MW appear to have a similar per turbine raptor mortality rate as smaller turbines. However, on the basis of rotor-swept area (RSA) or per wattage, the mortality rate is about 3 - 7 times lower (Kingsley and Whittam, 2003; BLM, 2004). Since one large turbine may replace several small turbines in terms of capacity, it can be expected than modern wind farms have a lower overall mortality rate. Birds including raptors may be able to see rotors that move less rapidly better than fast moving rotors (motion smear) (BLM, 2004). Larger turbines generally move slower (15-30 rpm), though the tip speed is still high (Kingsley and Whittam, 2003).
- Turbines with lattice towers appear to pose a greater risk for raptors (Orloff and Flannery 1992, in Kingsley and Whittam, 2003), potentially due to the attraction of the lattices for perching. Modern turbines usually have tubular steel towers, thus eliminating this risk. However, Anderson et al. (2000, in Kingsley and Whittam, 2003) could not show significant differences between different turbine types.

- Taller towers have a larger distance between the rotor and the ground, thus birds are less likely to fly through the rotor swept area (BLM, 2004). If turbines are too tall, however, there may be collision issues with long-distance migrants (Kingsley and Whittam, 2003).
- Lighting at or near the turbines: Aviation markers on turbines, required by aviation authorities, were found to potentially attract birds, with steady red lights being the most attractive. Blinking red marker lights in poor visibility can potentially disorient birds. Birds may fly around turbines until exhausted, or they may be attracted to the turbines and collide with the lit turbines and nearby unlit turbines. Quickly flashing white strobe lights seem to be un-attractive (BLM, 2004). In one study, quickly flashing red strobe lights also did not attract birds. Also, bright sodium vapour lights at a substation were fingered in the death of a number of birds at the neighbouring, unlit turbine, within a single night. When the light was turned off, no more collisions occurred (Kingsley and Whittam, 2003).
- Reduced visibility due to fog, rain, low clouds or darkness, contribute to collisions, with 93 % of fatalities correlated to inclement weather in one study (BLM, 2004).
- Wires: birds often die of collisions with wires, such as guy wires or overhead powerlines (see below).
- Location/position of the turbines within the wind farm: End-row turbines and turbines within 500 m of a canyon appear to pose more risk to raptors than other turbines at the Altamont pass (Orloff and Flannery, 1992 in Kingsley and Whittam, 2003).
- Long-range migrants are less likely to collide with turbines, unless bad weather forces them to fly low, or during takeoff and landing. The risk to resident birds may be higher, because they fly lower and spend more time in the area (BLM, 2004).
- Spatial arrangement of the turbines, including spacing (BLM, 2004).

Another factor contributing to collision may be that birds likely do not hear turbines as well as humans, especially in windy (noisy) conditions (BLM, 2004).

Generally, there also is a high risk from collisions with ancillary structures such is powerlines, windtower, guy wires, that may even be higher than the risk for collisions with turbines. At the Altamont Pass, 55 % of dead raptors were killed by collisions with turbines, 8 % by electrocution, 11 % by collisions with wires, and for 26 % the cause of death is undetermined (Orloff and Flannery, 1992, in: Kingsley and Whittam, 2003). At Foot Creek Rim, each meteorological tower killed about 8.1 birds per year, while each turbine was estimated to kill 1.5 birds (Young et al., 2003 in BLM, 2004).

It should be noted that the relative abundance of a species does not correlate to the relative frequency of fatalities (Thelander and Rugge, 2000 in BLM, 2004). However, common, year-long residents including sparrows, rock doves and starlings are often the most common victims (Erickson et al., 2001, 2003a in BLM, 2004).

The avian victims at wind farms come from different taxonomic groups, including raptors, passerines, waterfowl and shorebirds (Erickson et al., 2001). Relatively few species were found as victims. Vulnerability to wind turbine collisions is species-specific, since only few species in a bird group were found as collision victims in a study comparing data from five studies. For example, only one of 37 to 44 waterfowl species was found to collide with turbines, while about one third of all raptor species present were among the victims at the Altamont Pass (BLM, 2004).

Bird Mortality from Wind Turbines in Perspective

A comparison of mortality rates from wind turbines with bird mortality from other sources related to human activities shows that the estimated number of bird deaths from wind turbines is much less than the estimated number of deaths from other sources, which can be hundreds of millions of birds across the USA (Erickson et al., 2001).

While these numbers are not meant as a justification for ignoring bird deaths caused by turbines, they put the numbers into perspective. The impact of these bird deaths on a species that is threatened or endangered can be significant, while in large secure populations, these deaths can be suffered without any significant long term effects. Wind farms should still be located and designed in ways that minimize threats to birds, and the best available techniques and management methods (e.g. type of lighting) should be used for the same purpose.

Lamberts Study Area

Based on background data search and observations during site visits, it is known that birds breed in and migrate close to, or through, the project area. Although estimates vary, information from the nearby five shooting swamps in St. Lucy reveals that between 12,000 - 15,000 birds are shot between July and October each year. The target species include golden and black-bellied plovers, greater and lesser yellowlegs, and pectoral sandpipers. Non-target species include least, white-rumped and semipalmated sandpipers, and semipalmated plovers (Burke, Pers. comm., 2006). It is reported that Barbados is a temporary stop over for these species on their route to South America, or are forced to land due to meteorological conditions. Anecdotal evidence suggests that birds arrive from due north and depart on a southerly course which would put them clear of the proposed wind farm. The preferred habitats for these species are coastal beaches and mudflats, as well as freshwater and saltwater marshes.

In addition, although total numbers are unknown, peregrine falcons (subspecies *tundrius*) en route to South America use the updrafts along the escarpment on the east coast (Burke, Pers. comm., 2006). The proposed wind farm area can therefore have the potential to be close to some migratory bird routes.

Studies of shorebirds at coastal wind farms in Europe found that shorebirds are at a very low risk of collisions with turbines, even if high numbers of birds are present. This includes areas

Recommended Mitigation

The following mitigation measures were implemented during project design:

- Field studies were carried out to identify use of the study area by particular species, particularly by migrating birds and raptors (e.g. migration corridors, flight paths, raptor nest sites and other areas of high raptor activity).
- Migrating bird landfall sites and breeding habitat were avoided.
- Guy wires have been avoided for turbine towers.

Mitigation measures which could be used during project implementation:

- Minimum amount of aviation lighting required by transportation authorities should be used, and the aviation authorities should be consulted to see if white strobe lights with a minimum number of flashes per minute can be used.
- Strong lights, such as sodium vapour lights which are often used for security at substation buildings, should be avoided or shielded.

Specific monitoring options will be discussed with regulatory agencies and could involve routine monitoring of the sites for evidence of bird mortality or potentially a study on site to confirm the proximity of southbound migrating birds to the proposed turbines, particularly in the months of late July to late October.

Significance of Environmental Effects

Based on previous studies done on similar wind farms and based on data already collected on migratory and resident birds at the proposed wind farm site, the significance of effects on avian populations due to operation of the wind farm is considered to be minor. No significant adverse environmental effects are likely to occur.

7.2.2.2 Bats

Bat mortality at wind farms is generally low, but in some locations can be high for reasons that are not well known. Most dead bats were solitary, tree-roosting species, with hoary bats being the most frequent victim across the US, followed by Red Bat and Silver-haired bat (Erickson et al., 2002; 2004 Environment Canada, 2004; BLM, 2004). In total, only 9 of the at least 39 species of bats in the USA have been found as victims of turbine collisions (BLM, 2004). In a study of four wind farms, 86 % of bat deaths occurred in late August to early October, indicating that migrating bats account for most of the collisions (Keeley et al., 2001). Environment Canada (2004), includes the dispersal period with the fall migration period.

It has been noticed that most collisions occur during migration and inclement weather conditions (Van Gelder 1956 in Erickson et al., 2002). The reason for this is unknown, but it has been speculated that migrating bats turn off their "sonar" (Curry and Kerlinger, 2005) or at least reduce the number of echolocation calls while traveling through open areas (Van Gelder, 1956 in Keeley et al., 2001).

Another reason may be the type of area bats use for migration. Most *Lasiurus* species migrate long distances. Hoary bats, for example, can fly long distances and potentially migrate from Alaska to Central America. Therefore, they may be more likely to fly through open areas or at rotor blade height (Keeley, et al., 2001). Most of the other common bat species, e.g. the genus *Myotis*, may be less likely to fly through open areas or at heights where wind turbine blades are located, as they are not known to travel such long distances as *Lasiurus* sp. (Keeley et al., 2001).

As bats generally do not forage above 25 m, which is the lowest height of the blades on modern wind turbines (Erickson et al., 2002), it can be expected that the rate of bat mortality at modern wind farms is lower than at older facilities. Depending on the species, bats generally forage from 1m above ground to tree top level, or up to 5 m, 6 m or 10 m (Erickson et al., 2002). However, some species have been observed to occasionally fly as high as 30 m and 200 m (Erickson). Many migrating bats, however, regularly fly much higher than 100 m or between 46 m and 100 m (Altringham, 1996; Allen, 1939; both in Erickson et al., 2002).

Curry and Kerlinger (2005) drew several conclusions from the available data for more than a dozen wind farms across the US, including the following. Apparently, the number of bats killed is generally low, except in Minnesota and Wisconsin, where there may be "moderate" numbers. Many cases involved migrating bats, suggesting that migrating bats turn off their "sonar", resulting in collisions with towers. Generally, members of only about seven species are involved, most of them common, tree-dwelling species, with widespread geographic distribution. Endangered and threatened species were not involved, and impacts on populations seem unlikely (Curry and Kerlinger, 2005).

The main trends regarding bat mortality according to BLM (2004) are: firstly, the majority of bat mortalities tends to be tree-dwelling vesper bats; secondly, most mortality involves migrant or dispersing bats rather than resident breeding bats (Keeley et al., 2001; Johnson et al, 2003 and Johnson and Strickland, 2004, both in BLM, 2004).

Lamberts Study Area

As previously described, there are no maintained records of bat distribution in Barbados. Field surveys of the study area, both during the day and during the evening hours did not record any sightings of bats. The proposed location of the turbines is not in proximity to any significant stands of trees that would provide roosting areas. The gully areas near the study area were surveyed and no bats or significant areas for bat hibernacula were observed. As a result, it is unlikely that the area supports a large resident population of bats.

with large numbers of wintering birds, staging areas and wind farms that are crossed by migrating shorebirds. Shorebirds readily avoid turbines. Also, they fly at high altitude when migrating or commuting, and climb and land rapidly. However, turbines should not be placed near staging areas, as shorebirds are easily disturbed and may collide with turbines when fleeing a threat (Kingsley and Whittam, 2003).

In the Lamberts study area, there is no preferred habitat for these shorebirds in proximity to the site. As a result, migratory shorebirds and waders do not utilize the study area. Also, flight movements and feeding activities were generally along the coastline, near marsh areas or flight was high above the turbine height. In addition, shorebirds are known to readily avoid turbines. Therefore, collisions are not likely and significant adverse effects on shore birds are not expected.

Similar to the transitory migratory species, overwintering species such as the osprey (*Pandion haliaetus*), purple gallinule (*Porhyrula martinica*), great blue heron (*Ardea herodias*) and little blue heron (*Florida caerula*) rely on critical habitats in places such as Turner's Hall woods, woodlands in the upper reaches of less accessible gullies, and the wetland areas of Graeme Hall swamp, Long Pond, Green Pond and Chancery Lane, as well as remnant swamps along the west coast of the island, Graeme Hall swamp, Chancery Lane swamp, Long Pond and Green Pond all provide important foraging and refuge habitat for these over-wintering species (Government of Barbados 2002). The Lamberts study area does not provide the appropriate habitat for these overwintering residents.

The incidences of collisions for raptor species increases when the turbines are installed in areas where raptors spend a lot of time (Hoover 2002, in BLM, 2004). However, the relative abundance of a species and the relative frequency of collisions are not correlated (BLM, 2004). Also, the correlation between overall raptor nest density and fatalities is very low. Few species surveyed during nest surveys were found as victims at newer wind farms (Johnson et al., 2003, in BLM, 2004).

While a large number of raptors are killed at the Altamont Pass, California, raptors in general are known to be able to avoid turbines easily when simply flying or soaring, even when they are close to the blades and at the same height (e.g. Osborn et al., 1998; W.K. Brown, 2003, both in: Kingsley and Whittam, 2003; Young et al., 2003 b, in BLM, 2004). Few raptors were killed at a wind farm in Alberta despite a large number of birds being present (Kingsley and Whittam, 2003). Interestingly, deadly collisions at Tarifa, Spain, occurred on days with good visibility (Kingsley and Whittam, 2003).

No raptors or raptor nests were observed at the Lamberts study area during numerous field investigations. As previously indicated, while peregrine falcons may be incidentally observed in Barbados, there are no records of their regular occurrence in the vicinity of the proposed wind farm.

Recommended Mitigation

No additional mitigation is required to minimize bat mortality from the proposed Project.

Significance of Environmental Effects

Based on previous studies done on similar wind farms and lack of observed usage of the site by bat species, the significance of effects on bat populations due to operation of the wind farm is considered to be minor. No significant adverse environmental effects are likely to occur.

7.2.2.3 Flora and Fauna

There will be no effects/impacts to flora and/or fauna during the operational phase of the proposed wind farm.

7.2.3 Air Quality

There will be no effects/impacts to air quality during the operational phase of the proposed wind farm.

7.2.4 Noise

Mechanical and electrical noise from a wind turbine can be contained in the main by the wind turbine nacelle structure. However, the noise created by the rotor cannot be confined and is broadcast to the surroundings. As wind speeds increase, so too does the background noise, such that at the higher wind speeds the background noise levels increase at a greater rate than the wind turbine noise.

As the Government of Barbados does not have specific noise levels standards for wind farm developments, the suggested criteria is based on the guidelines used in Ontario Canada. Under those guidelines, the maximum noise levels at the closest residence would be 45dBA at up to 8m/s wind speed and would be allowed to increase at higher wind speeds due to the wind-induced increased background sound levels. This also compares with the guidelines for the World Health Organization and World Bank which each recommend 45dBA at sensitive receptors such as houses during the night time.

Noise data was obtained for the Vestas V-52 850 kW turbine which is of the size proposed for this project (Appendix D). The sound levels are based on worst-case noise levels at maximum power output. Reduced noise levels can be achieved for the same wind speeds but with lower power outputs. Figure 7-6 displays a graph indicating that the increase in sound pressure from the turbine with wind speed is 1.1 dB per m/s versus the background noise increase of 2.2 dB per m/s. This demonstrates that the background noise increases faster than the turbine noise, as the wind speed increases. Hence the predicted 45dBA at 8m/s is a reasonable criterion as higher wind speeds will elevate background noise above that of the turbines.

Sound contours were developed for the wind farm at different wind speeds using the ReSoft WindFarm software noise module. This is based on the "Description of Noise Propagation Model Specified by Danish Statutory Order on Noise from Windmills (Nr. 304, Dated 14 May 1991)" as produced by the Danish Ministry of the Environment National Agency for Environmental Protection. The DSO 304 model attenuation coefficient has been adjusted to match the 40, 43 and 45 dBA noise level predicted by an ISO 9613-2 model as referenced by the Ontario noise guideline. The ISO 9613-2 model was used to check the results from the DSO 304 model with the adjusted attenuation coefficient. Figures 7-7 to 7-9 show sound level contours in the vicinity of the closest receptors for given wind speeds of 6m/s (40 dBA contour), 7m/s (43 dBA contour) and 8m/s (45 dBA contour), respectively.

Based on maximum power output, the predicted noise level at the Lambert's Plantation house which is the closest receptor meets the WHO guideline of 45 dBA at a wind speed of 8m/s (Figure 7-9). At higher wind speeds the background sound levels will increase at a greater rate than the turbine noise. The WHO guidelines are acceptable levels of sound for sleeping but do not require inaudibility. Wind turbines have an amplitude modulation at low frequency producing the characteristic "swoosh", which should not be confused with low frequency sound or infrasound as discussed below.

Low Frequency Sound

Some area residents have expressed concerns over the output of low frequency sound from wind turbines. These concerns are based on information available over the internet where neighbours of wind farms had complained about noise and the potential for low frequency sound (less than 200Hz) and infrasound (less than 20Hz).

Surveys completed independently in the UK by Dr. Amanda Harry and Dr. Bridget Osborne documented a range of symptoms among residents in the vicinity of large wind farms, which they attributed to low frequency sound. Dr. Nina Pierpoint, a US physician, has posted numerous articles linking low frequency sound from wind farms with health concerns, in opposition to a proposed wind energy development in close proximity to her community.

In response to concerns over low frequency sound and infrasound from 3 wind farms cited in the survey by Dr. Amanda Harry, the Department of Trade & Industry of the UK conducted a study at dwellings where there had been complaints (DIT 2006). The study concluded that:

- *"infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour;*
- *low frequency noise as measurable on a few occasions, but below the existing permitted Night Time Criterion. Wind turbine noise may result in internal noise levels within a dwelling that is just above the threshold of audibility, however at all sites it was lower than that of local road traffic noise;*

- *that the common cause of complaint was not associated with the low frequency noise, but the occasional audible modulation of aerodynamic noise especially at night. Data collected showed that the internal noise levels were insufficient to wake up residents at these three sites. However once awoken, this noise can result in difficulties in returning to sleep."*

The British Wind Energy Association also commissioned a study (BWEA 2005) of low frequency sound from turbines. The study concluded that the early wind turbines from the 1980s were designed with the blades located downwind of the turbine tower such that the wind had to travel past the tower before it struck the blades. This caused the sound output from this type of turbine to generate a strong low frequency pulse. Advances in turbine design have the blades on modern turbines located upwind of the tower. The stand-off distance between the blades and the tower has also increased in order to minimise the possibility that the blades may interact with disturbed air flow upwind of the tower. The consequence of these developments has been to dramatically reduce tower interaction effects, and the generation of high levels of low frequency noise by wind turbines. Research conducted in low frequency noise on modern wind turbines has shown that the levels of low frequency noise have been below accepted thresholds, and is therefore not considered to be a problem.

A study conducted by HGC Engineering for the Government of Canada (NRCan, 2006) addressed sound, including low frequency (infrasonic) sound, at the Pubnico Point Wind Farm in Nova Scotia. The wind farm consists of seventeen Vestas 1.8MW turbines with hub heights of 80m. (The turbines proposed for Lamberts East are in 1MW range with hub height of approximately 50m.) Acoustic measurements were taken within the wind farm and at two homes nearest to the site, the nearest (the d'Entremont residence) being 330 metres from the closest turbine. The study concluded that: *"Sound at infrasonic frequencies is not present at perceptible levels near the wind turbine generators nor at the d'Entremont residence and it is concluded that infrasound is not an issue".*

In summary, low frequency sound is prevalent in the environment from many natural (wind, waves) and anthropogenic sources (traffic, appliances). Although there have been suggestions that low frequency sound from wind turbines is problematic, scientific studies have found that modern turbines do not produce significant levels. Recent design improvements resulting in upwind turbines, slower rotor speeds and an increased distance between tower and rotor have been incorporated to dramatically reduce the low frequency sound associated with earlier downwind turbines.

Recommended Mitigation

The wind farm will meet the recommended WHO criteria for noise. Sound reduction measures are incorporated into the design and structure of modern wind turbines and therefore no additional mitigation measures are required.

Specific monitoring options will be discussed with regulatory agencies and could involve monitoring at the closest residences following installation of the turbines.

Significance of Environmental Effects

The wind farm will meet WHO and other international criteria for noise. There will be no significant effects/impacts on nearby residences during the operational phase of the proposed wind farm.

7.2.5 Traffic

Once the wind farm is completed the associated vehicle movements would be very limited. The site would require vehicular access for maintenance and control purposes consisting of a visit utilizing a 'pick up truck' once or twice per week.

Each machine will require two services per year, each requiring one man-day of effort. Thus there will be two periods of two weeks each year when staff will be on site on a full time basis. Unplanned maintenance may require additional attendance for limited periods throughout the lifetime of the wind farm.

In addition to the specific traffic associated with the maintenance and operation of these turbines, it is anticipated that there may be some interest in the facilities from an educational or public interest perspective. As a result, there may be some visitors, or academic tours of the facilities, which may generate some limited and sporadic traffic around the study area.

Recommended Mitigation

Employees will be encouraged to utilize car pools and/or public transport when required to access the wind farm site. In addition, a pull off and parking area will be provided at the site to accommodate the potential vehicular traffic that may be associated with academic tours or visitors to the site.

Significance of Environmental Effects

The overall effect of the wind farm on the highways and traffic is considered to be minor and no significant environmental effects are expected.

7.2.6 Groundwater

The siting of the sub-station could represent a risk to groundwater pollution in the event of the unlikely accidental release of cooling oils and other chemicals from the transformer element. Contractors would be required to take precautions against spillages of chemicals during the construction and operational period. The site is in a Zone 4 water zone which is not a sensitive area of groundwater protection.

The operation of wind generators produces no discharges and, other than lubricants contained within the nacelle, uses no chemicals. Provided that reasonable care is taken during their routine maintenance and that vehicles using the access roads are well maintained, the effect of the operation of the wind turbines on surface and ground waters would be negligible.

Recommended Mitigation

Appropriate site management measures as described in the Environmental Management Plan should be taken to ensure that surface runoff is not contaminated by fuel and lubricant spillages.

Significance of Environmental Effects

There will be no effects/impacts to groundwater during the operational phase of the proposed wind farm.

7.2.7 Electromagnetic Interference

Wind farms can interfere with communication systems which use electromagnetic waves such as television, radio or microwave. Interference can be caused by a "shadow" effect or by "reflection". Wind farms can also interfere with the 'line of sight' microwave communication paths of mobile/cellular phone networks. The BBC has prepared a fact sheet covering the effects of wind farms on television reception, which recommends that the wind turbine be at least 500 m from any viewer to avoid interference (BBC 2006).

Contact was made with the various agencies as follows to determine the probability of effects of the turbines on transmissions:

- Grantley Adams Airport: The wind turbines will not affect airport radar. BLPC should contact Airport Authority at the time of design to confirm warning light requirements (Beckles 2006).
- Caribbean Broadcasting Company: CBC are unable to determine if there will be an effect on television reception due to the complex number of factors involved (Husbands 2006).
- Starcom Network: The wind turbines should not affect satellite TV reception as provided by Starcom Network (Rollins 2006).
- Digicel (Ryan Thomas); No response provided
- Cable and Wireless: The wind turbines will not affect transmissions from Cable and Wireless (Thorpe 2006).

The wind farm will not affect cellular telephone, communications transmissions, satellite television receptions or airport radar. The effect of the wind farm on households using a conventional antenna is difficult to predict due to the directional nature of the transmissions, and the type of individual antenna being used. Indications from the public open house were that the area to the east of the proposed wind farm has a poor reception using conventional antennae due to the higher ground along the ridge blocking direct line of sight to the transmitter. The CBC is planning on installing additional infrastructure to improve pay–TV reception in the vicinity of the wind farm (personal communication, Glynne Husbands, 2006).

Very few residences are within the 500 metre separation distance as recommended by the BBC and hence the potential for interference will be limited.

Recommended Mitigation

The effects of wind farm developments on signal strength at individual homes are difficult to predict. In most instances corrective measures are used after the construction of the wind turbines to minimize the impact of any resulting degradation to the TV signal.

It is recommended that BLPC take preliminary measurements of signal strength in the area close to the site and particularly on the low lands to the east. This will allow confirmation of effects on signal quality after development of the project. The following are some examples of mitigation methods that can be used either individually or in combination to reduce or even eliminate the degradation of the TV signal (CBC 2006):

- Improve the directivity of the receiving antenna;
- Relocate the receiving antenna; or,
- Addition of a repeater station.

Significance of Effects

No significant adverse environmental effects related to electromagnetic interference are likely with proper implementation of the recommended mitigation measures.

7.2.8 Shadow Flicker

A wind turbine, like other tall structures, will cast a shadow on the neighbouring area when the sun is visible. It may be annoying to a person if the rotor blades chop the sunlight, causing a flickering (blinking) effect while the rotor is in motion. This moving and repetitive casting of shadows is referred to as shadow flicker, which can occur when the sun is low in the sky and the shadows are cast over windows of nearby buildings.

Shadow flicker frequency is related to the rotor speed and the number of blades on the rotor. For the wind turbines being considered for Barbados, the frequency is around 1.0 to 1.5 Hz. If there are obstacles between the wind turbine and the particular receptor, such as terrain, trees or buildings, shadow flicker is either significantly reduced or eliminated at the receptor.

The potential flicker for the wind farm was modeled. The results are given on the maps of Figures 7-10 to 7-13, which show shadow flicker contours.

The maps show the possible maximum number of hours per year of shadow flicker on a 1 m x 1 m (vertical) house window situated 2 m above the ground and facing north, east, south or west. For dwellings closest to the wind farm the theoretical maximum amount of shadow flicker could be as much as 80 hours per year, or an average of less than 15 minutes per day. The effects of shadow flicker diminish with distance.

The modeling is very conservative and assumes full sunshine throughout the year (ie no cloudy periods). It does not take into account the following:

- Periods when the sun is obscured by cloud – no shadow
- Wind direction – shadow flicker is not an issue when the rotor is pointing in a direction perpendicular to the direction of the sun from the window
- Turbine operating hours – there is no shadow flicker when a wind turbine is shutdown, as would be the case for low or very high wind, maintenance or repair
- Shading due to terrain, vegetation, or buildings – these will block the shadow
- Hours when the property is actually used by people (who are awake) and they are situated at a spot where flicker could be an irritant – at other times there is no one to be annoyed by the flicker

Taking into account all of the factors will reduce the period that shadow flicker might be an irritant to at most a few minutes per day.

Mitigation Measures and Significance of Effects

Should shadow flicker be an issue, it can be mitigated by planting trees in specified locations. It can also be mitigated by pre-programming the turbine with dates and times when shadow flicker would cause a nuisance. The turbine would then be shut down, when sunlight, wind speed and the angle and position of the sun combine to cause a flicker nuisance.

The effects of shadow flicker are considered to be minor and no significant environmental effects are anticipated.

7.2.9 Waste Disposal

The project does not produce waste as a function of generating power. There are few sources of waste from a wind farm, these are incidental to the generation of power and related to maintenance activities. Typical wastes generated would include failed equipment, packaging materials, and other materials associated with maintenance of equipment such as spent lubricating oils.

Due to the nature of the operations, the generation of quantities of hazardous wastes is unlikely. Any such wastes will be in small quantities and associated with maintenance.

Waste oils can be removed from site and incinerated at the future Trents Generating Station or reused as fuel for the steam boilers at Spring Garden. Other domestic type wastes can be disposed in local landfill.

Recommended Mitigation

The recommended procedure for management of wastes is covered in the Environmental Management Plan for the Operation of the Lamberts East Wind Farm included as Appendix E.

Significance of Effects

There will be no significant effects/impacts from waste disposal during the operational phase of the proposed wind farm.

7.3 Accidents and Malfunctions

The wind industry has an excellent safety record. With more than 70,000 turbines in service across the world and over 25 years of operation the industry has recorded only one accidental death of a member of the public (a German skydiver). Many wind farms in Europe are situated on public lands, often with public footpaths passing through them.

Nevertheless, during all phases of the Project there is potential for accidents to occur. Some accidents may have significant consequences. Such events may include fires, and uncontrolled releases of materials such as petroleum, oils, lubricants, solvents and epoxy resins.

While wind turbines have caught fire, this is an extremely rare occurrence. Causes of fire are typically overheating of components in the nacelle, such as generators, gearboxes, braking systems, electrical enclosures or hydraulic systems, or lightning strikes. To prevent overheating, the turbine generators include built-in thermal monitors which automatically shut down the unit before the temperatures reach a high enough point to cause a fire. Fire suppression systems can also be installed in the nacelle. Grounding systems are fitted to suppress lightning strikes, thereby reducing the chance for lightning to cause a fire.

Spills can potentially occur from the following:

- Petroleum product spills during site clearing and construction due to equipment malfunctions and refuelling activities;
- Spills of transmission oil or transformer liquids during maintenance of the turbines and transformers, spills for fuel or oil from the vehicles used for turbine and road maintenance, and leaks of transformer and transmission liquids from turbines and transformers during normal operation;

- Spills of paint or solvents used for turbine paint touch-ups are also possible; and
- Herbicide spills, although only to be used on rare occasions, are also possible.

Spills and leaks of any of these substances may have adverse effects on the VECs named above. Depending on the size of the spill, the impact may be significant.

Recommended Mitigation

The fundamental approach to accidents is one of prevention through training and being prepared to respond to any emergency. The CSA publication "Emergency Planning for Industry" (CAN/CSA-Z731-03) recommends the following spill prevention and contingency planning measures:

- Reducing the need for hazardous substances by substituting for less harmful ones.
- Incorporating appropriate preventative and response measures and construction practices.
- Providing environmental awareness training to contractors and workers involved in the Project. Training will include the handling, clean-up, reporting and disposal of contaminated material.
- Maintaining appropriate spill response equipment in a readily accessible location.
- Reporting all spills to applicable authorities.
- Ensuring vehicles with obvious fuel or oil leaks do not enter the project area.
- Use of approved herbicides.

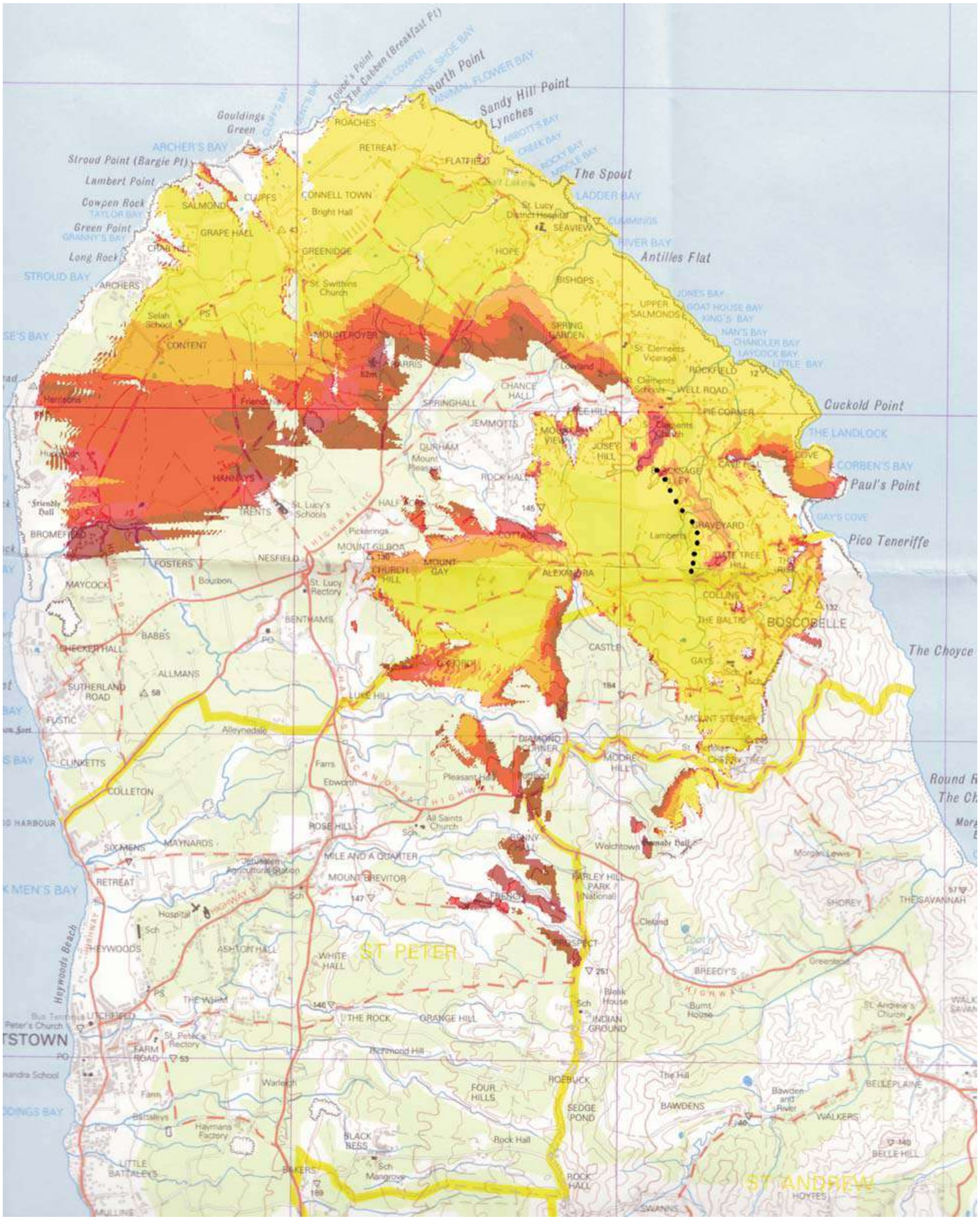
Frequent inspection of the turbines and transformers will ensure that any leaks are discovered promptly. Leaks will be repaired, and spills will be cleaned up immediately.

Inclusion of heat sensors in the nacelle, to automatically shut down the turbine should an overheating condition occur, will prevent fires.

The Environmental Management Plan includes contingency measures to address potential accidents or malfunctions. BLPC has developed the document *"Spill Contingency Plan for the Operation of the Spring Garden Generating Station"* that provides response procedures for potential spills.

Significance of Effects

With the implementation of mitigation measures, significant adverse residual effects due to accidents and/or malfunctions are unlikely to occur.



Visibility	
1 to 2	
3 to 5	
6 to 8	
9 to 11	

amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

ZONE OF VISUAL INFLUENCE MAP FOR LAMBERT'S EAST WIND FARM

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 7-1**

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2004\TV61036 Figure 7-1.cdr

3 Approximate viewpoint location

amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

LOCATION OF PHOTOMONTAGE VIEWPOINTS

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 7-2**

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amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

VIEW OF THE LAMBERT'S EAST WIND FARM FROM THE PIE CORNER MISSION

PROJECT NUMBER TV 61036	DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No

FIGURE 7-3

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LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

VIEW OF THE LAMBERT'S EAST WIND FARM FROM RISK ROAD

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 7-4**

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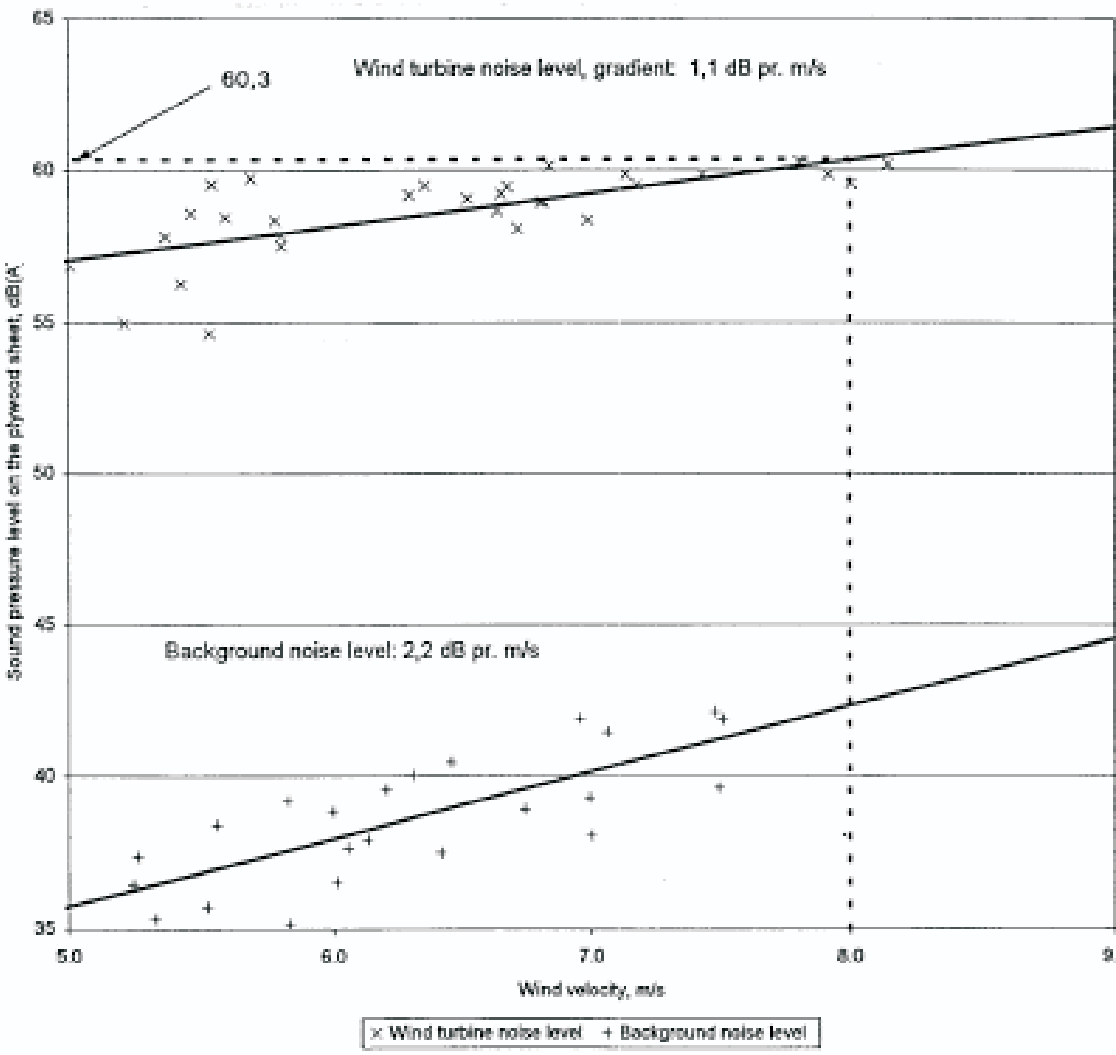
LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

VIEW OF THE LAMBERT'S EAST WIND FARM FROM THE EXISTING WIND TURBINE

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 7-5**



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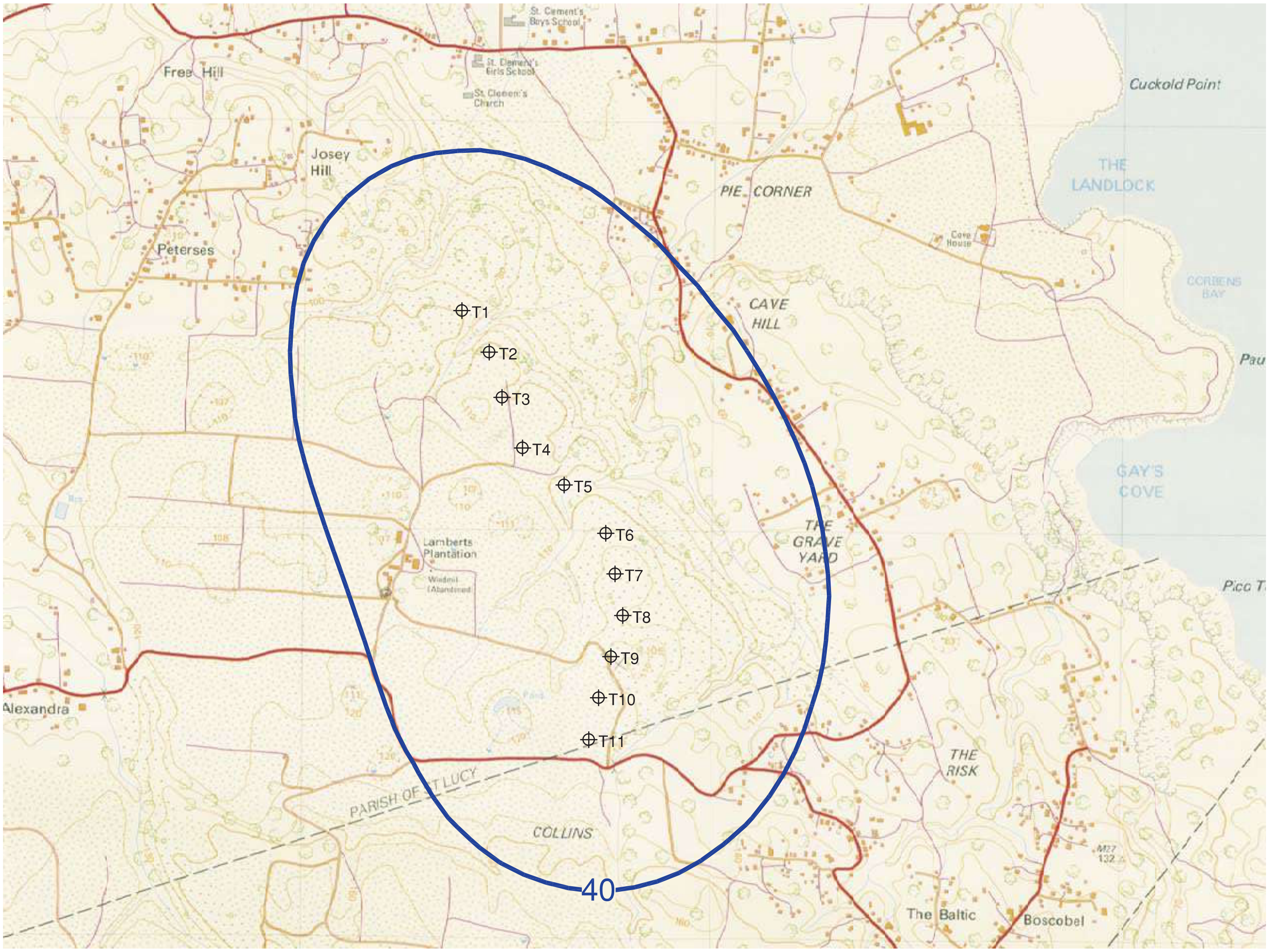
LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

WIND TURBINE NOISE LEVELS FOR VESTAS TURBINE

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 7-6**



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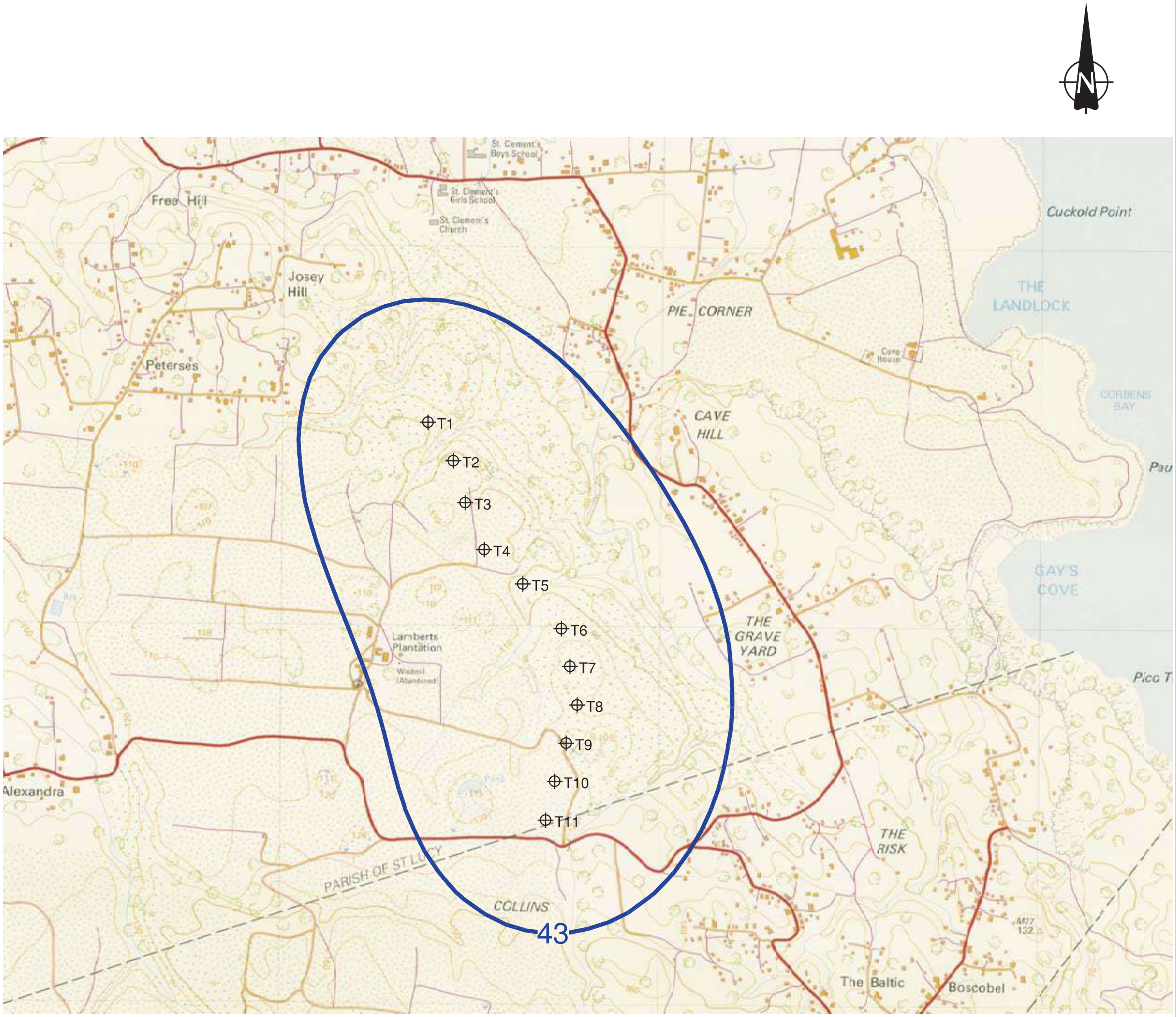
LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

SOUND LEVEL CONTOURS FOR 6M/S WIND SPEED

PROJECT NUMBER TV 61036	DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No

FIGURE 7-7

P:\DECOM\Projects\TV61036 Barbados windfarm\Figures\November 23, 2004\TV61036 Figure 7-7.cdr



amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

SOUND LEVEL CONTOURS FOR 7M/S WIND SPEED

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 7-8**

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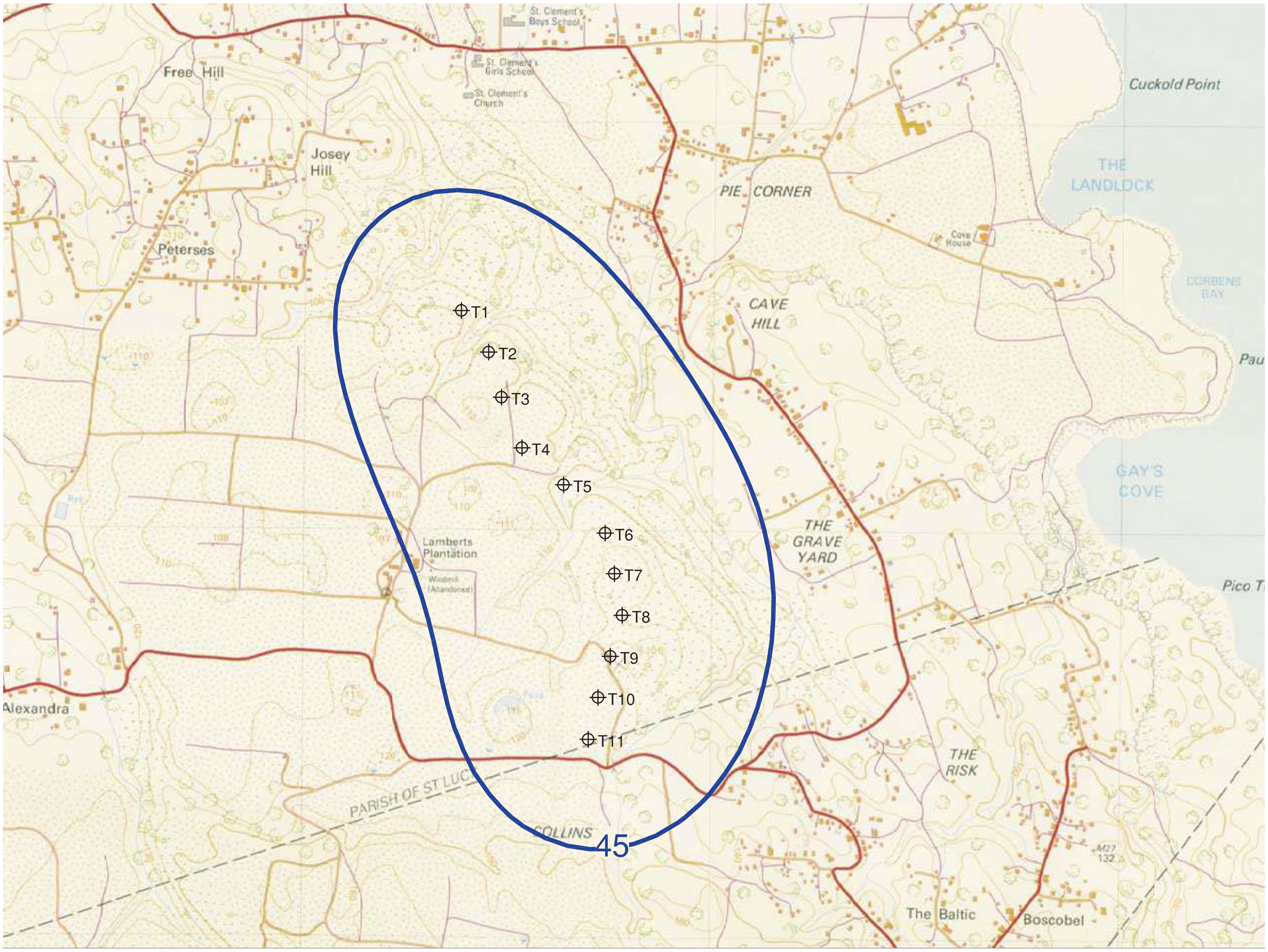

amec

LAMBERTS EAST WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT
BARBADOS

SOUND LEVEL CONTOURS FOR 8M/S WIND SPEED

PROJECT NUMBER TV 61036		DATE AUGUST 2006
VENDOR DWG No	CLIENT DWG No	**FIGURE 7-9**

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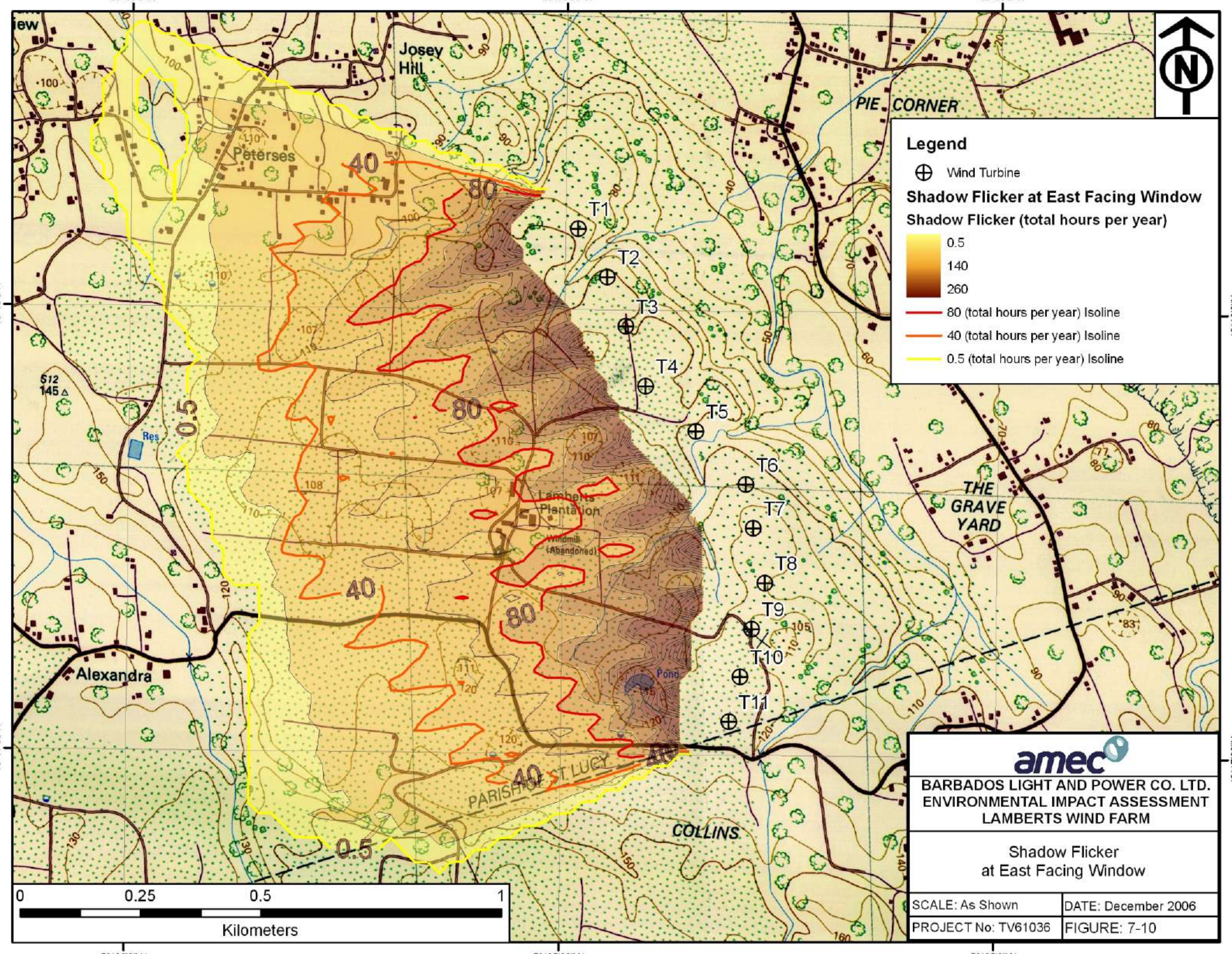

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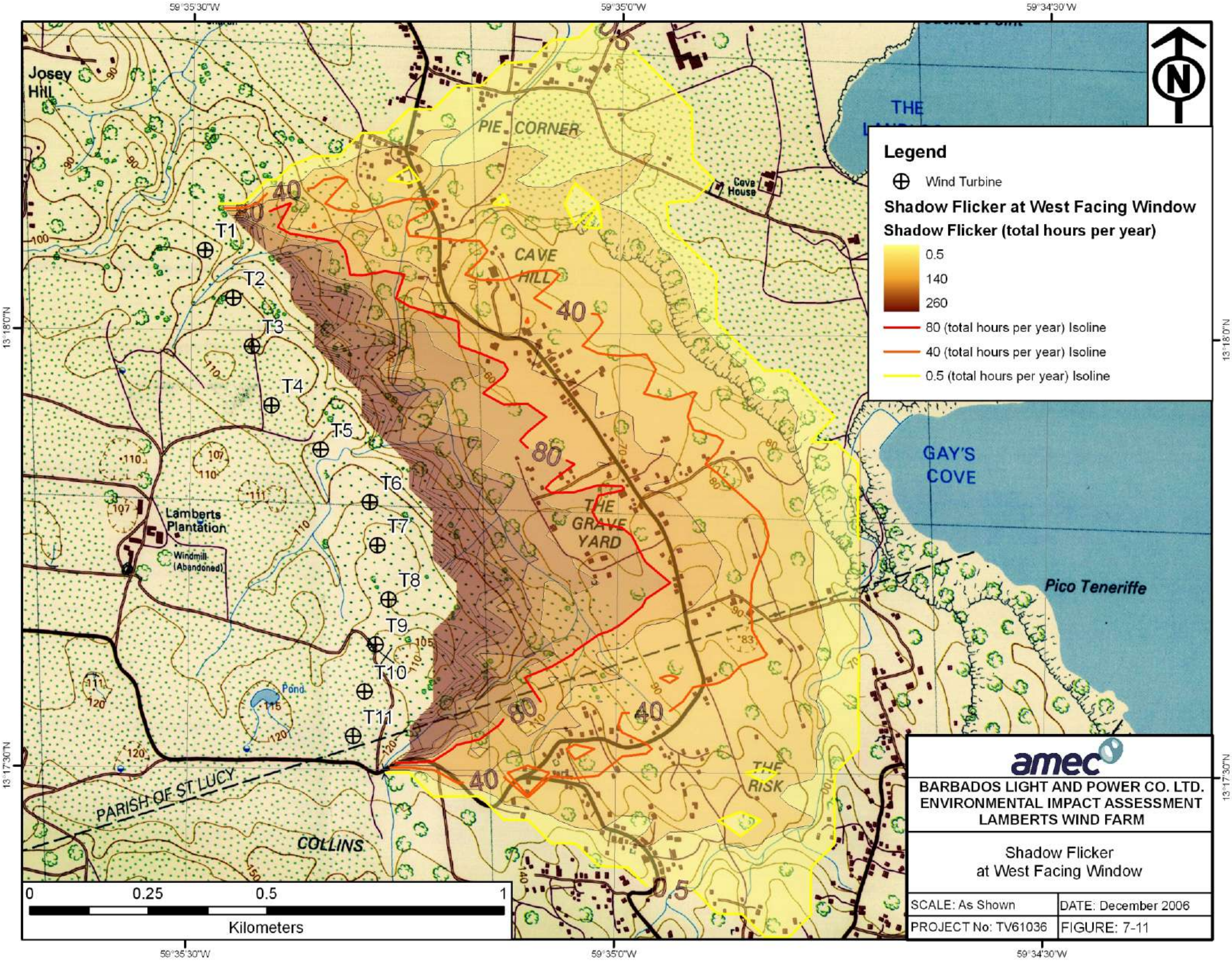
BARBADOS LIGHT AND POWER CO. LTD.
ENVIRONMENTAL IMPACT ASSESSMENT
LAMBERTS WIND FARM

Shadow Flicker at East Facing Window

SCALE: As Shown	DATE: December 2006
PROJECT No: TV61036	FIGURE: 7-10



59°35'30"W
59°35'0"W
59°34'30"W
13°18'0"N
13°17'30"N
Josey Hill
PIE CORNER
CAVE HILL
THE GRAVE YARD
THE RISK
COLLINS
PARISH OF ST LUCY
Lamberts Plantation
Windmill (Abandoned)
Pond
Cove House
THE
GAY'S COVE
Pico Teneriffe
T1
T2
T3
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Shadow Flicker (total hours per year)
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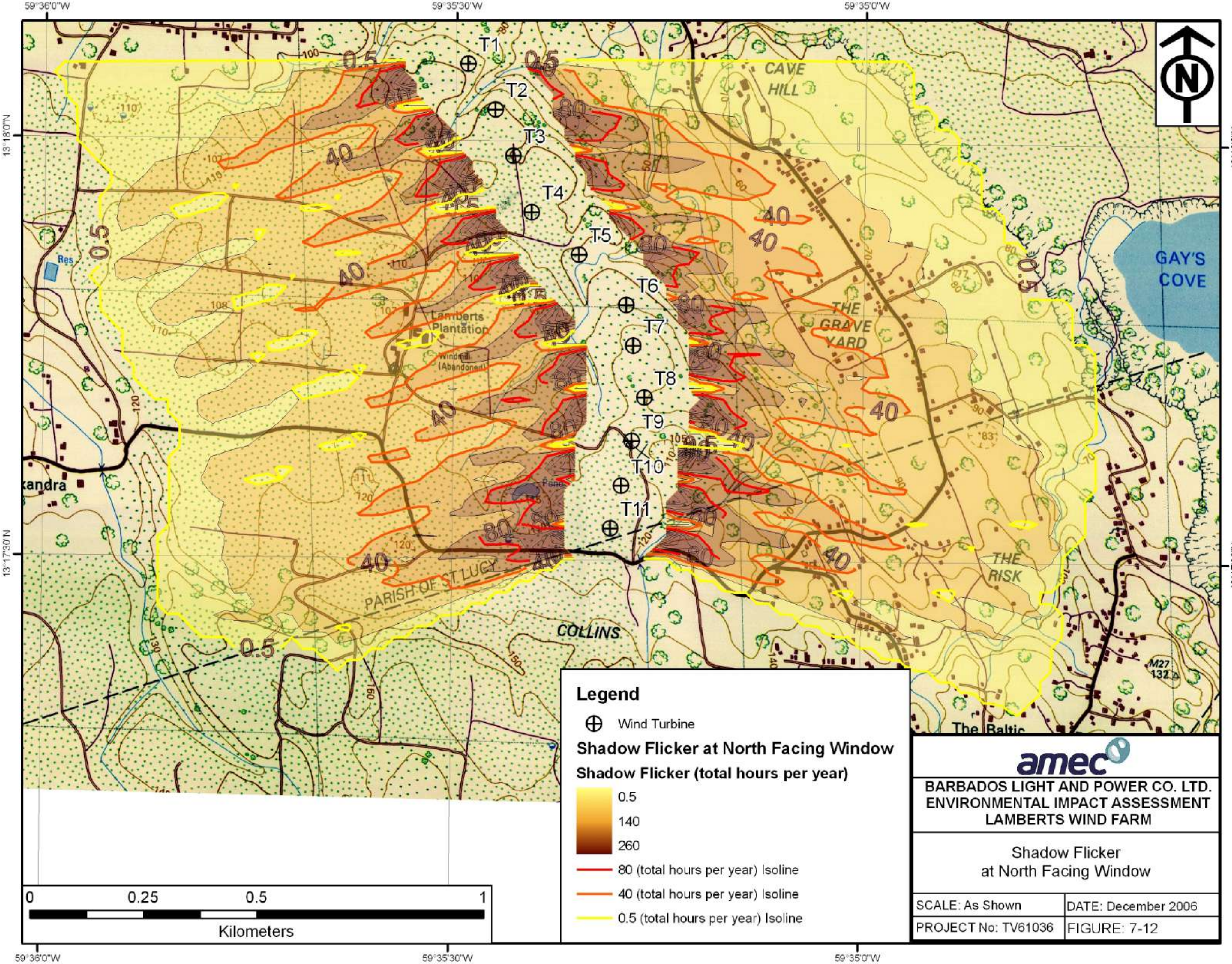
Kilometers
amec
BARBADOS LIGHT AND POWER CO. LTD.
ENVIRONMENTAL IMPACT ASSESSMENT
LAMBERTS WIND FARM
Shadow Flicker
at West Facing Window
SCALE: As Shown
DATE: December 2006
PROJECT No: TV61036
FIGURE: 7-11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59°35'0"W
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13°17'30"N
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CAVE HILL
GAY'S COVE
THE GRAVE YARD
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Wind Turbine
Shadow Flicker at North Facing Window
Shadow Flicker (total hours per year)
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80 (total hours per year) Isoline
40 (total hours per year) Isoline
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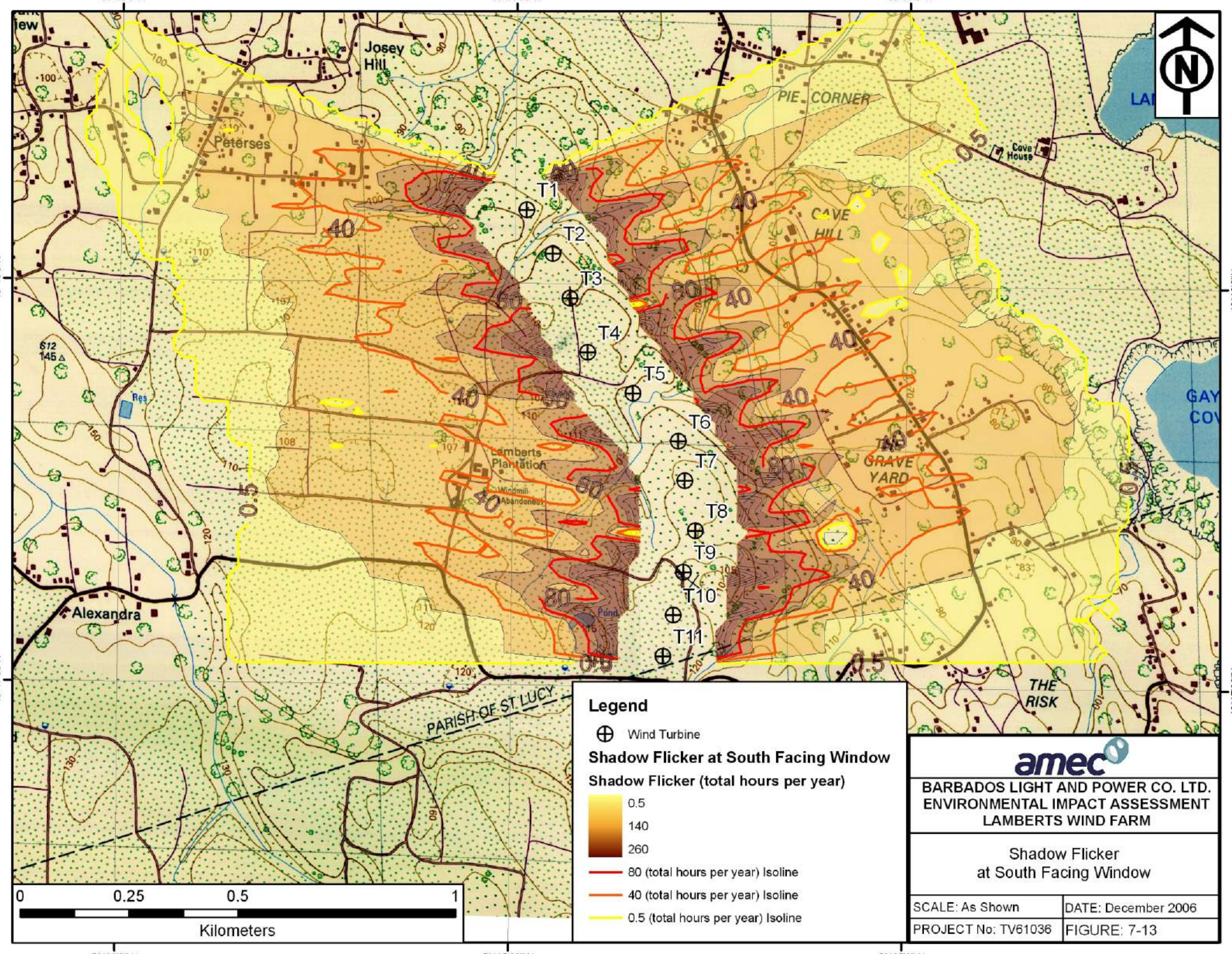
Kilometers
amec
BARBADOS LIGHT AND POWER CO. LTD.
ENVIRONMENTAL IMPACT ASSESSMENT
LAMBERTS WIND FARM
Shadow Flicker at North Facing Window
SCALE: As Shown
DATE: December 2006
PROJECT No: TV61036
FIGURE: 7-12



Legend
Wind Turbine
Shadow Flicker at South Facing Window
Shadow Flicker (total hours per year)
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260
80 (total hours per year) Isoline
40 (total hours per year) Isoline
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Kilometers
amec
BARBADOS LIGHT AND POWER CO. LTD.
ENVIRONMENTAL IMPACT ASSESSMENT
LAMBERTS WIND FARM
Shadow Flicker
at South Facing Window
SCALE: As Shown
DATE: December 2006
PROJECT No: TV61036
FIGURE: 7-13
59°36'0"W
59°35'30"W
59°35'0"W
13°18'0"N
13°17'30"N
Josey Hill
PIE CORNER
Peterses
CAVE HILL
THE GRAVE YARD
Lamberts Plantation
Alexandra
PARISH OF ST LUCY
THE RISK
Cove House
T1
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8.0 SOCIAL IMPACT ASSESSMENT

8.1 Socio-Economic Conditions

Education, particularly higher education, is believed to be the main vehicle of social mobility in Barbados. The enrolment ratio in primary and secondary education is 100 per cent. Tertiary education is not mandatory, but is free. Barbados boasts one of the highest levels of educational attainment among the Caribbean territories. The literacy rate in Barbados, which is estimated at 95%, is also believed to be one of the highest in the Caribbean.

A fundamental social indicator of level of development is that of public health care. The Government of Barbados has supported the principal of universal access to health care through "free delivery" of services to all sectors of the population. Several polyclinics have been established throughout the island providing free or subsidised medical, dental and ophthalmic care to the general population.

Barbados has an open economy with a very narrow range of exports, a heavy dependence on imported goods and a fragile and limited natural resource base. Although there has been an increase in the size of the offshore sector, the expansion of the tourism sector was the primary engine of economic growth in Barbados during the 1990s.

8.2 Economic Effects of the Lamberts East Wind Farm

Wherever reasonably possible, local contractors and employees will be used for all aspects of the wind farm development. Employment would be created during the construction phase when local firms would be invited to bid for a significant portion of the construction work, on roads, foundations and the building. Construction materials, if available, will be sourced locally and local transport and plant hire companies used wherever possible. Up to 40 jobs could be created during the 6 month construction stage and 2 equivalent full-time jobs during operation. It is anticipated that over 80% of the construction jobs would be sourced locally. Should there be a requirement for major maintenance; BLPC staff will be supplemented by off-shore specialists.

The wind farm will cost over $20 million Barbados dollars to construct of which around a quarter should be invested locally through local contractors for civil engineering works, purchase of local materials, electrical installation and the grid connection. Wind farm developments are an ideal form of farm diversification. Rent should be paid to the landowners at a time when the economics of farming is becoming less favourable. Economic benefit accrues to the local area both directly and indirectly and the effect of the wind farm on the local economy is considered to be a positive benefit.

8.3 Public Consultation

BLPC conducted a program of public consultation as part of the EIA process. This program consisted of a 2-day public open house session on November 4th and 5th 2006 followed by a public meeting on February 24th 2007.

This two phased approach allowed the community the opportunity to obtain an understanding of the scope of the project at the open house and to follow up later with informed questions at the public meeting.

The objectives of the consultation program were to:

- Provide an opportunity for the public to have meaningful input into key decisions with respect to project development;
- Provide information about the project to the public to enable them to respond effectively to the development option being presented to them;
- Obtain additional environmental and socio-economic information from those most familiar with the area to enable the identification of constraints which may affect site selection;
- Identify issues and concerns of those potentially affected by the Project to ensure that they are addressed in the EIA;
- Provide responses to questions about the project and its effects; and
- Enhance communication between BLPC and the community.

8.3.1 Public Open House - November 4th and 5th 2006

On November 4th and 5th 2006, BLPC conducted open house sessions at the Ignatius Byer Primary School in Lowlands, St Lucy. The sessions were provided to introduce the proposed windfarm to the community and to solicit comments. BLPC placed an advertisement in local newspapers notifying the public about the upcoming open house sessions. A copy of this notice is provided in Appendix F. Table 8-1 lists the dates the advertisement appeared in respective newspapers.

Table 8-1: Newspaper Advertisement Schedule

Newspaper	Dates of Advertisement
The Nation	• Sunday, October 29th • Tuesday, October 31st • Wednesday, November 1st • Friday, November 3rd • Saturday, November 4th • Sunday, November 5th
The Barbados Advocate	• Sunday, October 29th • Monday, October 31st • Thursday, November 2nd • Friday, November 3rd • Saturday, November 4th • Sunday, November 5th

Notices were also broadcast on the local radio stations, informing listeners about the time and location of the open house events. One notice was broadcast on Wednesday November 1, 2006 between 6:30 and 8:00 am. Three more notices were broadcast on Thursday, November 2, 2006 and Friday, November 3, 2006. On each of these days, the notice was broadcast twice between 6:30 and 8:00 am and once between 4:30 and 6:00 pm. These notices were broadcast on the following stations:

- VOB;
- Love FM;
- Gospel 790; and
- CBC 900.

In addition, approximately 2,600 invitations were mailed out to the local residents, and businesses informing them of the open house sessions, and asking them to attend. The distribution of these invitations covered properties in an approximate area from North Point to Mount Gay to Boscobelle. A copy of this mail-out is provided in Appendix F.

The open house sessions were conducted from 3 pm to 6 pm each day, at the Ignatius Byer Primary School in Lowlands, St Lucy. At each session, representatives from BLPC and the environmental consultants (AMEC Earth & Environmental) were on hand to speak to members of the public to provide an overview of the Project, to answer questions, and to document concerns or issues that members of the public had.

The information available at the open houses included:

- Posters displaying Project and Environmental information, including:
  - The purpose and description of the Project;
  - Site location plan of the proposed facilities;
  - An outline of the Environmental Assessment process;
  - What the EIA report will contain, and the types of environmental studies that have been conducted;
  - Visual landscape of the wind farm using photomontage photographs and a map showing the zone of visual influence.
  - Information on noise effects;
  - Estimates of greenhouse gas and emissions avoidance; and
  - The projected schedule.
- A pamphlet handout that summarized the Project and EIA process.
- A copy of the Draft EIA report.
- A copy of the feasibility report.
- A visual slide presentation describing the project and the phases of construction.
- Excerpts of the film “Out of the Blue” which describes the operation of modern windfarms.

Copies of the posters, slide presentation and the handout pamphlet are provided in Appendix F.

A booklet was maintained at the open houses which attendees were asked to sign. During the November 4 open house, 31 members of the public signed the booklet and during the November 5 open house, 23 members of the public signed the booklet. It is also conservatively estimated that an additional 10 people may have attended on Saturday and another 10 on Sunday who did not sign the booklet (for example only one member of a group signed the book, or people did not wait to sign, etc.).

Members of the public who signed the booklet were also asked to document any comments, potential concerns or issues they may have with the Project. The attendees were provided with take away copies of the following:

- The pamphlet handout that summarized the Project and EIA process.
- A copy of the executive summary from the Preliminary Draft EIA report.

The following table summarizes the issues that were identified by the attendees. A response to the issue or a reference to the appropriate section of the EIA which addresses the issue is also provided in the table. Where there were multiple questions or comments about the same issue (i.e., noise), it is only summarized once in the table. Overall, the Project was considered positive by the majority of the members of the public who attended. Copies of the sign-in and comment sheets from the open houses are provided in Appendix F.

Table 8-2: Comments Received / Addressed Through Open House Session

Comments / Questions	Response
Project is a good idea.	No response required.
Open House was informative and well planned/ organized.	No response required.
Effects on property value due to visual impacts of the turbines	Visual effects are covered in Section 7.2.1 of the EIA report. The site has been identified in the draft “Barbados National Physical Plan” as one of four areas zoned for wind developments, which takes into account locations of population centres.
Uncertain about the project	Additional information was provided as a takeaway (pamphlet and executive summary of the EIA). The draft EIA was also posted on the internet. A BLPC contact number was provided for any follow-up information.
Too near to houses, suggest 2km separation.	Section 7.2.4 of the EIA covers the noise effects that show acceptable levels at the closest receptors. The site has been identified in the draft “Barbados National Physical Plan” as one of four areas zoned for wind developments, which takes into account setbacks from population centres.
Concern over health effects.	There are no air emissions or wastewater discharges from the project that could affect health. Section 7.2.4 of the EIA covers the noise effects that show acceptable levels at the closest receptors.
Concerns that turbines will eventually be abandoned at end of useful life as per the existing nearby wind turbine.	Section 4.4.3 of the EIA covers decommissioning of the turbines.
Effects on emerging small business.	The EIA considers the effects and benefits of the project on the community as a whole.
Would prefer a presentation meeting.	The format allows public consultation where the EIA team can be available to provide information to each attendee and solicit additional information useful the EIA process. This is not always achieved through a presentation style meeting. Several respondents indicated that the session was well presented and informative.
Recommend additional open houses in Alexandra and Mount Gay as these communities do not have direct public transport to this venue.	The selected location was considered to be closest to the most affected communities.
Not convinced that there will be no affects on vegetation.	Ecological effects are considered in Section 7.2.2 of the EIA.
Questions regarding noise generated by the station and the potential effect on the surrounding residents	This issue is addressed in the EIA (Sections 5.2 and 7.2.4).
Plant should be constructed and operational as soon as possible	No response required.
Project is good for the environment.	Sections 1.2 of the EIA and the poster boards provide

Comments / Questions	Response
	information on the displacement of emissions.

8.3.2 Public Meeting - February 24th 2007

On February 24th 2007, BLPC conducted a public meeting to provide additional project information and to respond to questions from the community. BLPC placed advertisements in newspapers notifying the public about the upcoming meeting. A copy of the notice is provided in Appendix G. The following table lists the dates the advertisement appeared in respective newspapers.

Table 8-3: Newspaper Advertisement Schedule

Newspaper	Dates of Advertisement
The Nation	• Sunday, February 18th • Tuesday, February 20th • Wednesday, February 21st • Friday, February 23rd • Saturday, February 24th
The Barbados Advocate	• Sunday, February 18th • Monday, February 19th • Thursday, February 22nd • Friday, February 23rd • Saturday, February 24th

Notices were also broadcast on the local radio stations, informing listeners about the time and location of the meeting. One notice was broadcast on Wednesday February 21st, 2007 between 6:30 and 8:00 am. Three more notices were broadcast on Thursday, February 22nd and Friday, February 23rd, 2007. On each of these days, the notice was broadcast twice between 6:30 and 8:00 am, once between noon and 1:00 pm and once again between 4:30 and 6:00 pm. These notices were broadcast on the following stations:

- VOB;
- Love FM;
- Gospel 790; and
- CBC 900.

The public meeting was held on February 24th 2007 at the Phillipi Episcopal Church in Josey Hill, St Lucy, commencing at 6:30pm. The meeting was attended by approximately 100 people, and 30 persons signed the register. Member of Parliament the Honourable Dennis Kellman was present to represent the constituency and Dr. Carlos Chase represented the medical association. The forum consisted of presentations from the panel followed by questions from the audience. A copy of the slide presentation and handout materials is provided in Appendix G. The panel was chaired by Dr. Basil Springer and presentations were provided as follows:

- Mr. Roger Blackman, representing BLPC, provided an overview of the project, the rationale of selecting wind over other renewable energy sources and the reasons for selecting the Lamberts East site.
- Mr. William Hinds represented the Ministry of Energy and the Environment. He provided the Government's perspective on the role of the windfarm in the Government's Renewable Energy Policy.
- Mr. Peter Rostern of AMEC summarized the EIA process and the key findings of the study. These included noise, shadow flicker, birds, and electromagnetic interference. Reference was also made to the setback selected for the wind farm in comparison to local setback requirements of some US bylaws.
- Mr. Ingram Cumberbatch represented the Josey Hill community. He outlined the resident's concerns primarily related to noise, appearance and the selected setback.

The following table categorizes the issues that were identified by the attendees. A response to the issue or a reference to the appropriate section of the EIA which addresses the issue is also provided in the table. Where there were multiple questions or comments about the same issue (i.e., noise), it is only summarized once in the table.

Table 8-4: Comments Received / Addressed at the Public Meeting

Comments / Questions	Response
Setbacks o The 350 m setback selected was inadequate. Some jurisdictions were requiring 1km or more.	o There is no universal standard for setbacks. o Some US municipalities have ordnances based on a multiple of the turbine height. Other countries have adopted much greater distances. o The World Health Organization guideline for night-time noise outside of a dwelling is 45dBA. The setback meets the 45dBA noise contour at the closest residence.
Geology o There are many caves in the area which could affect the foundations of the wind turbines.	o A geotechnical study has not been completed of the site. This will be completed if the project is approved. o Should caves be found under the site, the placement of the turbines may need to be adjusted to provide acceptable conditions for foundations.
Noise o Vehicle noise, particularly buses climbing Cave Hill, can be heard over long distances. o Concerns expressed over low frequency sound. o Old turbine could be heard at St. Lucy's Church	o Modelling was completed of all eleven turbines operating simultaneously that shows the 45dBA noise contour can be met at wind speeds up to 8m/s. At higher wind speeds the background noise becomes dominant and increases at a higher rate than turbine noise. o Low frequency sound was problematic of the older turbines. New turbines emit very low levels of low

Comments / Questions	Response
	frequency sound that is below accepted standards. o The existing turbine was an early design and was noisy. New turbines have very low levels of noise associated with them.
Health o Objections made to progress being made at the expense of health. o Questions of who takes responsibility for health risks.	o Project will meet regulatory standards in terms of noise. o Wind energy projects are being promoted world-wide as a clean alternative to power generation from fossil fuels.
Location o Why not alternative sites? o Why not develop sites offshore? o Isn't the land better suited to housing development?	o Lamberts East is one of 4 sites designated by the government in the National Physical Development Plan (Draft) for wind energy development. BLPC investigated all 4 sites and concluded that Lamberts East was the most suitable site for the project. o Off-shore wind projects are expensive to construct but have been built in shallow waters off some European countries. The seabed off Barbados drops rapidly into very deep waters and development of an off-shore wind farm would not be feasible. o The National Physical Development Plan (Draft) has designated the site for wind energy projects and not housing.
Cost o Will energy costs go down if the project is built?	o The wind-farm will provide the power equivalent to displace approximately BDS$5.6million per year of fuel oil. This reduced cost will be factored into the overall operating costs of the utility.
Alternative Energy Resources o Why not use solar energy? o Why not wave energy? o Why not incineration?	o Charts were provided showing comparative costs of various technologies (refer to presentation Appendix G). Solar power from photovoltaic cells is very expensive in terms of capital and total energy costs per kilowatt hour. It is much higher than current forms of generation and wind. o BLPC has a small component of solar energy operating at Seawell. o Wave energy is also expensive and not proven over the long term. o Approximately 15MW of power is to be included in the proposed cane project. o Incineration has been considered by government but the costs will be high.
Medical Opinion o It had been expected that the panel would include representation from the medical profession. o Doctors should comment on the health issues. o Recommended that reference be made to articles written by Dr. Nina Pierpoint.	o Dr. Chase was in the audience but could not comment on the health issues at that time. o A response from the medical community will be provided.
Aesthetics o The old wind turbine is an eyesore and should be demolished. o Possible to turn the old windmill into a look-out tower as a tourist attraction.	o Old wind turbine is not owned by BLPC. o BLPC will consider removing the old wind turbine or retrofitting it as a tourist attraction as part of the new project.

Comments / Questions	Response
New Condominium Development in St Lucy o Is there a link between the new wind farm and the new condominium development in St. Lucy?	o There is no link between these priojects. o Power from the wind farm will go into the main power grid from which it is distributed to all customers.
Governance o There is conflict of interest in Ministry of Energy and Environment under the same Minister. o AMEC linked to other wind farm developments. o Should the government be doing the EIA?	o Comments noted on dual role of Ministry of Energy and Environment. o AMEC was selected based on its experience in all forms of power generation and its 30 years of history working with BLPC. AMEC is not involved as a developer in the wind farm. o Government requires the proponent of a project complete the EIA for review and approval by government agencies. The government can impose monitoring requirements on the project to verify the predicted effects.
Equipment o Will old equipment be used?	o The equipment will be new. o Specifications for tender have not been completed to date. These will be finalised pending planning approval..
Lightning o What protection will there be against lightning strikes? o Will there be power surges?	o The turbines will include lightning protection. o The control systems will be designed to prevent lightning strikes from causing surges to the grid.
Proposals o A representative from the community should be allowed to visit a similar wind farm and discuss the effects with local residents.	o BLPC will consider this suggestion.

9.0 SUMMARY OF MITIGATON AND RECOMMENDATIONS

Recommended mitigation measures for specific VEC's during construction and operations are summarized in Tables 9-1 and 9-2, respectively. These recommendations and mitigation measures are intended to ensure that the conclusions of the assessment are achieved.

Table 9-1: Summary of Recommended Mitigation during Construction

Valued Ecosystem Component (VEC)	Recommended Mitigation during Construction
Aesthetics	• The route of the access track to the site will be chosen to minimize the disturbance of aesthetics.
Air Quality	Overburden Disturbance • The application of dust suppressants such as water, calcium chloride, or tree lignin based dust suppressant on the work sites as required (calcium chloride will not be used on agricultural fields). • All rock drills are equipped with dust collectors in good working order. • There will be adequate control of dust at work sites that are in proximity to nearby residences. Construction Equipment Operation • All construction equipment will operate with the standard emissions controls. • All vehicles shall be maintained in a proper fashion in order to minimize vehicle emissions to the extent possible.
Noise	• To prevent excessive noise levels, all contractors will be required to provide working machinery and equipment with noise suppression devices equivalent to original equipment.
Traffic	• Provide the Department of Transportation with the schedule for equipment transport, to coordinate for overnight transport of oversize loads and the requirement for road closures at least one month in advance so that there will be no conflicts with other road work. • The public will be provided with advance information on road closures through announcements in the newspapers and through radio and television. • Road closures will be posted with detour signs and the detour routes will be fully sign posted throughout to ensure traffic follows the correct routing. • Complete an assessment of the routing for major equipment transfers from the port in advance to identify any constraints.
Waste Disposal	• All contractors will be required to implement a solid/hazardous waste management plan during construction to minimize the waste generated and to re-use non-hazardous waste on-site if possible (i.e. grubbing and excavation materials). • Those materials that cannot be re-used will be removed from the site and disposed of properly. • Maintenance of vehicles and heavy machinery will be performed offsite whenever possible. If an oil change onsite cannot be avoided, the waste oil will be carefully collected and removed from the site. • Oil spill kits will be onsite to remediate any accidental spills of oil during the operation of heavy equipment, such as hydraulic oil.

Table 9-2: Summary of Recommended Mitigation during Operations

Valued Ecosystem Component (VEC)	Recommended Mitigation during Operations
Aesthetics	• Positioning of the turbines will be done so as to reduce the visual impact of the wind farm from the surrounding populated areas; • The route of the access track to the site will be chosen to reduce the visibility for the dwellings to the east of the site; • The tower height of the turbines has been kept to a minimum reasonable dimension to allow for decreased/minimized visual impact; and • The number of turbines has been reduced while still retained the same energy output via larger output.
Ecological Effects	Avifauna • Use minimum amount of aviation lighting required by transportation authorities, and the aviation authorities should be consulted to see if white strobe lights with a minimum number of flashes per minute can be used. • Strong lights, such as sodium vapour lights which are often used for security at substation buildings, should be avoided or shielded.
Noise	• Specific mitigative options to reduce noise have been incorporated into the design and structure of the wind turbines and therefore the wind farm will meet the recommended criteria for noise. No additional mitigative measures are required.
Traffic	• Encourage car pools, use of public transport for employees
Groundwater	• Appropriate site management measures as described in the Environmental Management Plan should be taken to ensure that surface runoff is not contaminated by fuel and lubricant spillages.
Electromagnetic Interference	Where necessary: • Improve the directivity of receiving antennas; • Relocate receiving antennas; or • Addition of a repeater station.
Shadow Flicker	Where necessary: • Plant trees as to provide shade • Pre-program the turbine with dates and times when shadow flicker would cause a nuisance. The turbine would then be shut down, when the strength of the sun, wind speed and the angle and position of the sun combines to cause a flicker nuisance.
Waste Disposal	• Follow the recommended procedure for management of wastes as covered in the Environmental Management Plan included as Appendix E.
Accidents and Malfunctions	• Inclusion of thermal sensing in the nacelle to shut the turbine down if overheating occurs to prevent fires. • Reduce the need for hazardous substances by substituting for less harmful ones.

Valued Ecosystem Component (VEC)	Recommended Mitigation during Operations
	• Incorporate appropriate spill prevention and response measures. • Provide environmental awareness training to contractors and workers involved in the Project including handling, clean-up, reporting and disposal of contaminated material. • Maintain appropriate spill response equipment in a readily accessible location. • Report all spills to applicable authorities. • Ensure vehicles with obvious fuel or oil leaks do not enter the project area. • Incorporate management practices that prescribe the presence of mandatory spill kits, and spill management procedures as outlined in the contingency plan. • Frequent inspection of the turbines and transformers to ensure that any leaks are discovered promptly and repaired immediately. • Development and implementation of an Environmental Management Plan that includes contingency measures to address potential accidents or malfunctions. • Use of approved herbicides, when application is required.

10.0 CONCLUSIONS

With the assistance of input from the general public and regulatory agencies, and following detailed analysis by the Project Team, the environmental effects (both biophysical and socio-economic) associated with the construction and operation of the proposed Project have been assessed. This assessment has concluded that the Project is not likely to cause significant adverse environmental effects given implementation of the recommended mitigation measures.

Yours truly,
AMEC Earth & Environmental,
a division of AMEC Americas Limited

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Reviewed by:

Fred Meth, M.Sc.
Senior Consultant

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APPENDIX A

LAMBERT'S EAST WIND FARM TERMS OF REFERENCE

APPENDIX B

MOE NOISE GUIDELINES

APPENDIX C

CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

APPENDIX D

VESTAS INFORMATION BROCHURE

APPENDIX E

OPERATIONS ENVIRONMENTAL MANAGEMENT PLAN

APPENDIX F

PUBLIC CONSULTATION DOCUMENTS
(OPEN HOUSE)

APPENDIX G

PUBLIC CONSULTATION DOCUMENTS
(PUBLIC MEETING)

APPENDIX H

ADDENDUM TO FINAL REPORT