HOPE ENERGY DEVELOPMENT INC.

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA

ECO REPORT NO. 05/2020
DECEMBER 03, 2021

PREPARED BY

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EXECUTIVE SUMMARY

Background

Hope Energy Development Inc (HED) submitted an Application for an Environmental Permit for the construction and operation of the Hope Wind Farm on the 21st September, 2018. An updated Application was received on the 12th August 2019.

The Hope Wind Farm Project base-case scenario proposes the construction of four wind turbines along the coast at Hope Beach, outboard of the Lowland/Hope to Ann's Grove Villages and two additional wind turbines in the Chapman's Grove area, 2km further to the SE of Hope Beach.

The proposed Hope Wind Farm would be the first large scale wind energy facility to be constructed in Guyana. The base-case scenario calls for 6 wind turbines, each at 4.2MW capacity, for a total 25.2 MW wind farm capacity.

Project Phasing

Typical of project development phases in many industries, a wind farm project can be divided into five (5) distinct phases of development:

a) **Feasibility Stage** – Collecting wind data and information to determine whether project is technically feasible, commercially viable, likely to pass regulatory hurdles, securing the power purchase agreement and land rights. Typical studies at this stage include: wind resource assessment, wind engineering, selection from design options, initial environmental assessment, grid interconnection study, logistics study, geotechnical sense check, regulatory compliance screening and initiation of key regulatory approvals. This stage culminates with a Feasibility Stage Gate and draft PPA, with a decision on whether the project has sufficient technical and commercial merit to proceed to the next stage.

b) **Detailed Design Phase** – Preliminary plans from the feasibility stage are converted to detailed designs by contracted engineering consultancies, a detailed geotechnical study, procurement of equipment and services for the construction phase, detailed logistics planning, completion of regulatory permitting, additional environmental studies if required, and raising required financing and investor capital. This stage culminates with a Final Investment Decision Stage Gate, with a decision by investors on whether the project has sufficient merit to proceed to the Construction Phase.

c) **Construction Phase** – Long lead orders are placed for wind turbine and transformer equipment which typically require 6 to 12 months for delivery. In the meantime electrical and civil works are completed. Civil works entail the construction of site access roads, wind turbine foundations, crane pads and lay-down areas. Electrical works entail laying of buried and overhead medium voltage collector cables, construction of the substation,

and installation of the high-voltage transmission line to interconnect with the grid. When the wind turbine equipment ships the crane and specialised transport equipment are also mobilized. It usually takes 3 to 4 days to install a single wind turbine once the crane and equipment are on site. It is anticipated that this wind farm will be completed in 10 months. The Construction Phase ends when the installed equipment has passed all commissioning tests and relevant inspections, and the project is commissioned.

d) **Operation Phase** – The wind farm is set into operation. The electricity that is generated is sold onto the grid in accordance with contractual agreements, in particular the Grid Interconnection Agreement with GPL. The operator maintains the site, and contracts relevant services to monitor and maintain the equipment of the wind farm. The lifecycle of the wind farm is in excess of 20 years.

e) **Wind Farm Repowering and Decommissioning Phases** – The Hope Wind Farm leases are for 50 years. Wind turbines have a minimum design life of 20 years, and typically will keep functioning for 25 to 30 years without requiring any major upgrades. At the end of the functional life, the typical route is to do a partial or complete wind farm upgrade in order to provide another 20-to-30-year operation phase. It is our expectation that this site will remain a wind farm generation facility in the foreseeable future. Decommissioned equipment will be removed and either scrapped or be refurbished. At that point it can be decided whether the site should be returned to its original state, in which case the roads and crane pads would be removed. The foundations are already below grade and would most likely be abandoned in place.

Project Alternatives

Four configurations were considered, combining different size and numbers of wind turbines:

1) 25.2 MW from six (6) Vestas 4.2MW WTGs with four located at Hope Beach (HB), and two at Chapman's Grove (CHG). This is the selected scenario that easily meets all the critical stakeholder criteria, including for noise emissions, shadow effects, safety, and an attractive price to GPL.

2) 15 MW from six (6) Goldwind 2.5MW WTG's, having the same layout as option 1, but using a smaller class of wind turbine. This scenario also meets all the nuisance and safety criteria but cost per unit capacity is high due to the limited size of the project.

3) 13.5 MW from nine (9) Vensys 1.5MW WTG's, all at Hope Beach. This configuration was considered by a previous project developer, that explored the use of substantially smaller 1.5MW class machines and one of the quietest utility scale machines available at the time (similar noise output as the latest Vestas 4.2MW turbines). The small capacity requires installing more machines, and this results in higher noise emissions that are at best marginally acceptable. Also, the combination of smallest capacity machines with smallest total generation capacity results in the highest price to GPL, well above GPL's present cost of generation, which is unacceptable.

4) 26 MW from thirteen (13) CS WIndpower 2.0MW WTG's, all at Hope Beach. This configuration was considered by a previous project developer. A large number of very closely spaced machines were required in order to meet a minimum project size demanded by the turbine supplier, which resulted in unacceptable noise emissions that are substantially higher than the existing background noise levels, and unacceptably short safety standoff distances to nearby houses. The scale of the project was still not sufficient with this size wind turbine to achieve an acceptable sales price to GPL.

5) Do Nothing. In a case where any of safety, community nuisance, or environmental impacts are a significant concern, then the Do-Nothing option should be seriously considered versus the potential benefits of the project to all stakeholders. The result of Do Nothing would be a substantial delay until some other project at an alternative location could be developed. This would mean years of delay of the substantial benefits of utility scale wind energy to the nation, the improved power supply to GPL's grid, and the benefits to the electricity consumers along the entire Berbice branch of the grid.

Project Setting

Social Setting

- The project is located in the Hope Beach and Chapman's Grove areas, as defined by the following communities: Nooten Zuil, Hope, Douchfour, Two Friends, Anns Grove, Clonbrook, Beehive, Greenfield, Chapman's Grove and Unity.
- The total number of households in the project area was 1876 (based on the 2012 census), with the highest number of residents living in Ann's Grove.
- Electricity is commonly used by 93% of the households, although unstable electricity is frequently experienced. The residents without electricity (approximately 7%) use battery power or solar system lighting. Concerns about electricity were mostly indicated in Beehive, Douchfour/ Two Friends, Greenfield and Hope/ Lowland (over 20% of respondents), while Ann's Grove and Unity are relatively positive on this topic.
- Water supply is one of the poorly rated facilities in all communities in the project area, with around 20% and more respondents giving it a negative score. The same goes for Security which seems to score even worse with ratings around 30% and above in Douchfour - Two Friends, Greenfield, Hope-Lowland, Nooten Zuil and Unity (5 out of 7 communities).
- Residents in Ann's Grove and Douchfour are mostly positive about healthcare facilities that are available (more than 95%), while public transport had positive ratings in Nooten Zuil, Greenfield and Ann's Grove (95% or more).
- In the project area there are 5 schools, located in the neighbourhoods Ann's Grove (1 primary and 1 secondary school), Clonbrook (1 primary school) and Hope (1 primary and 1 secondary school). One secondary school is near the main road in Hope, closest to the project location.
- According to Census 2012 data, the largest percentages of residents in the communities near the project area mostly work in Agriculture, Forestry and Fishery (19%), Wholesale & Retail Trade (18%), Mining and Quarrying (12%) and Construction (also 12%). Approximately 11% of the residents were unemployed.

- The community surveys noted 36% of unemployed respondents (excluding retirees and school attending population). Of the employed (55% of total respondents), 74% work full-time, while the remaining 26% have a part-time job.

Profile of Fishermen

- Based on the fishermen survey, there are approximately 50 fishing vessels in the Hope Canal (out of a total of 100 in the entire area). An estimated total of 200-250 fishermen use the Hope canal for fishing activities.
- About 50% of the fisher folk live in nearby communities of Lowlands, Hope, Nooten Zuil and Enmore. The other 50% live further away. The Hope Canal area is thus very important for the fishermen, working and living there.
- Fishermen surveyed were positive and favourable about the project, although they also had some concerns which included the length and sustainability of the project and the maintenance of such a long-term project.
- They also requested to ensure that no damage is done to their fishing infrastructure.
- In addition, some were curious about their personal gain from the project (such as, full utilization of power).
- They all expressed their desire for cheaper energy and fewer black outs as a positive result of the project. They also would like to see the wind turbines in combination with a sea defence structure (sea wall) to protect the land from eroding, thereby protecting the Hope Canal outlet and fishing harbour.

Hope Beach Habitats and Drainage

The proposed Hope Beach project site is located on the relict beach ridge elevated above high tide. The habitat types in proximity to the Hope Beach site are as follows:

- Mangrove tidal flat;
- Beach / tidal flat transition;
- Beach ridge;
- Beach ridge Buttonwood;
- Mangrove swamp; and
- Freshwater marsh.

The area west of the Hope Canal and landward of the seawall, encompassing the marsh area and the Hope Secondary School, is drained by minor 12 ft wide drainage canals leading to the main 40ft wide drainage canal along the main road, and eventual discharge to the sea via the new Lowlands/Hope pump station. East of the Hope Canal, the Douch-Four to Clonbrook marshy area north of the main road and landward of the seawall, is drained by small 12 ft wide canals which eventually transport excess water to the Greenfield pump station for discharge into the sea. The sites where turbines are proposed are seaward of the seawall and thus drain into the sea through the mangrove habitat. The Hope Beach wind turbine site thus has no linkage to the drainage or flood control canals.

Chapman's Grove Habitats and Drainage

The proposed Chapman's Grove project site is located in a coconut plantation with a stand density of 205 trees/ha; the coconut plantation habitat type occupies approximately 19.79 ha. The habitat types in proximity to the Chapman's Grove site are as follows:

- Mangrove swamp;
- Mangrove (back mangal);
- Beach ridge; and
- Coconut.

At Chapman's Grove, the site is drained by a 15 ft wide drainage canal which feeds into a 40 ft drainage canal, with flow leading to the Greenfield pump station where excess water is pumped into the sea.

Stakeholder Consultation

This EIA included a program of inter-agency and stakeholder consultations as follows:

- Scoping Meetings,
- Meetings with Key Stakeholders,
- Questionnaire Surveys, and
- Survey of Fishermen.

Scoping Meetings - Three scoping meetings were held to provide information to the Guyana EPA to prepare Terms of Reference for the conduct of the EIA. These meetings were held as follows:

Meetings with Key Stakeholders - During the conduct of the EIA, stakeholder meetings were held to gather information on existing conditions. Stakeholders were also able to provide their questions and concerns on the proposed wind farm project. The following stakeholders were interviewed:

- The Environmental Protection Agency, (EPA);
- Ministry of Finance;
- Department of Environment;
- Office of Climate Change;
- Forestry Commission;
- National Drainage and Irrigation Authority (NDIA);
- National Agriculture Research and Extension Institute (NAREI);
- The Ministry of Public Infrastructure (MoPI);
- Ministry of Works – Roads and Bridges;
- Ministry of Works – Marine Administration department MARAD);
- Ministry of Agriculture (MoA);
- The Regional Democratic Council, Region #04;

- The Neighbourhood Democratic Council – Haslington / Grove
- The Neighbourhood Democratic Council – Unity / Vereeniging
- The Guyana Lands and Surveys Commission (GL&SC);
- Central Housing and Planning Authority (CH&PA);
- Guyana Power and Light (GPL);
- Guyana Wildlife Management and Conservation Authority;
- World Wildlife Fund (WWF-Guianas);
- Conservation International (CI – Guyana);
- Global Green Growth Institute (GGGI)
- Guyana Civil Aviation Authority;
- River and Sea Defense Board;
- Guyana Mangrove Restoration Commission; and
- Go Invest Guyana.

Questionnaire Surveys – Community surveys were carried out in June and October 2019 and again in February 2021. A total of 369 surveys were completed. These surveys were conducted along the Demerara Berbice Highway in the vicinity of Unity and Greenfield. Respondents were randomly approached door to door to complete the survey which was administered by use of a structured questionnaire. The objectives of the surveys were to gain insight on the basic characteristics of the residents in the vicinity of the project area, their knowledge about the project, their attitude towards the project and possible concerns.

Survey of Fishermen - An outreach session with a total of 20 fishermen at the large sluice (8-door sluice) at Hope was held in 2019. Additional group interviews with fishers (a group of 5 and another of 3 fishermen) were held in 2020. They were interviewed on their awareness and knowledge of the Hope Beach Wind Farm Project. Their attitudes and concerns regarding the project were also taken into consideration.

Impacts and Mitigation Measures

Beneficial Impacts

- Significant additional electrical capacity to the power grid in the form of renewable energy.
- Reduce power outages and improved grid stability and power quality.
- 10% Reduction in GPL's fuel oil generation requirement and 10% reduction in pollutants emitted by Georgetown located HFO generators (and impact to the city population), and 10% reduction in GHG emitted which is a significant step towards Guyana's Paris Agreement commitments.
- Significant impact to the economy: long-term low-cost power for GPL, substantial local ownership of the assets with long-term project revenues remaining in Guyana, and reduction in foreign exchange losses for fuel imports by over 10 million USD per year.
- Opportunities for employment (temporary during construction and permanent during operation).
- Skills training for local residents during construction and operation phase.

- Opportunities for local eco-tourism - guided tours of an iconic renewable energy installation.
- Fishing community can benefit from improved access road to fishing depot, renewable energy for manufacture of ice on-site, etc.
- HED support of local school - sponsorship of extracurricular activities etc.
- As the first significant step in transforming Guyana's energy requirements to renewable resources, lessons learnt from this project will help accelerate follow-on renewable energy projects at scale and achieve Guyana's goal of 100% renewable energy.

Adverse Impacts

The potential impacts of this project (beneficial as well as adverse) were identified from the likely construction methods to be employed, from general guidance documents, review of literature and Ecoengineering's experience on construction projects from 1991 to present.

The potential impacts of this development were assessed on both a qualitative and quantitative basis. Different degrees of sophistication were used in assessing different impacts. Impacts related to noise emissions, safety distance, shadow flicker, bird and bat mortality are considered of specific concern and these were assessed quantitatively. Where mitigation measures were recommended, the assessment assumes that these measures will be implemented.

After the significance of each impact was assessed, each potential impact was classified on a structured basis, assuming the worst-case scenario. The classification method is based on three criteria: Extent, Intensity, and Duration. Based on this, pre and post-mitigation impacts were classified as Low, Moderate, High or Extreme to show the effectiveness of mitigation measures. Where adverse impacts were considered to be insignificant, no classification was applied. A summary of the Post-Mitigation Classification for both the natural and socio-economic environment is provided in the tables below.

Natural Environment

SUMMARY OF POST MITIGATION CLASSIFICATION

IMPACT	EXTENT		INTENSITY	DURATION	CLASSIFICATION	
CONSTRUCTION PHASE						
Impaired Water Quality: Siltation	HB	Localised	Minor	Short Term	LOW	C
	CHG	Localised	Minor	Short Term	LOW	
Impaired Water Quality: Hydrocarbon Spills and Leaks	HB	Localised	Minor	Short Term	LOW	C
	CHG	Localised	Minor	Short Term	LOW	
Impaired Water Quality: Improper	HB	Eliminated				

IMPACT	EXTENT		INTENSITY	DURATION	CLASSIFICATION	
Disposal of Sewage	CHG	Eliminated				
Impaired Water Quality: Spillage of Paints and Solvents	HB	Eliminated				
	CHG	Eliminated				
Impaired Water Quality: Concrete Washings	HB	Localised	Very Small	Short Term	LOW	
	CHG	Localised	Minor	Short Term	LOW	
On-site Erosion	HB	Localised	Minor	Short Term	LOW	
	CHG	Localised	Minor	Short Term	LOW	
Slope Instability	HB	On-site	Very Small	Short Term	LOW	
	CHG	On-site	Very Small	Short Term	LOW	
Impaired Air Quality: Dust from Cleared Areas	HB	Localised	Very Small	Short Term	LOW	C
	CHG	Localised	Very Small	Short Term		
Impaired Air Quality: Exhaust Emissions from Vehicles	HB	Regional	Very Small	Short Term	LOW	C
	CHG	Regional	Very Small	Short Term	LOW	
Noise	HB	Localised	Minor	Short Term	LOW	C
	CHG	Localised	Minor	Short Term	LOW	
Clearing of Vegetation	HB	On site	Very Small	Long Term	LOW	
	CHG	On site	Very Small	Long Term	LOW	
Fragmentation	Not significant					
Disturbance to Terrestrial Species	HB	Localised	Minor	Short Term	LOW	
	CHG	Localised	Minor	Short Term	LOW	
Disturbance to Aquatic Species	HB	Localised	Very Small	Short Term	LOW	
	CHG	Localised	Very Small	Short Term	LOW	
Disturbance to Benthic Species	HB	Localised	Very Small	Short Term	LOW	
	CHG	Localised	Very Small	Short Term	LOW	
Loss of Benthic Species	Not Significant					
Impacts on Migratory Species	HB	Localised	Minor	Short Term	LOW	
	CHG	Localised	Very Small	Short Term	LOW	
Impacts to Rare and Endangered Species	HB	Localised	Very Small	Short Term	LOW	
	CHG	Localised	Very Small	Short Term	LOW	

IMPACT	EXTENT		INTENSITY	DURATION	CLASSIFICATION	
Damage to Existing Roads and Bridges		Regional	Very Small	Short Term	LOW	C
Obstruction of Traffic		Regional	Very Small	Short Term	LOW	C
Damage to Infrastructure and Utilities		Regional	Very Small	Short Term	LOW	C
Road Safety		Regional	Very Small	Short Term	LOW	C
Improper Waste Disposed	HB	Regional	Very Small	Short Term	LOW	
	CHG	Regional	Very Small	Short Term	LOW	
Impacts to Landscape and Aesthetics	HB	On site	Minor	Short Term	LOW	
	CHG	On site	Very Small	Short Term	LOW	
OPERATION PHASE						
Hydrocarbon Spills and Leaks	HB	Localised	Very Small	Medium Term	LOW	
	CHG	Localised	Very Small	Medium Term	LOW	
Shadow Flicker	Eliminated**					
Noise	Eliminated**					
Concerns for Birds	Not significant***					
Concerns for Bats	Not significant***					
Impacts to Landscape and Aesthetics	HB	On site	Very Small	Short Term	LOW	
	CHG	On site	Very Small	Short Term	LOW	

Notes:

*(C) – indicates cumulative impacts with other proposed and ongoing projects in the region are likely
Eliminated** - Meets available guidelines and/or has no significant impact to baseline levels
Not Significant*** - Impact to baseline population will be insignificant

Socio-Economic Environment

SUMMARY OF IMPACT SIGNIFICANCE

PROPOSED IMPACTS		SPREAD	DURATION	INTENSITY	OVERALL SIGNIFICANCE
Population	**Construction Phase** • Presence of migrant/ mobile workers	Regional	Short	Low	Low
Social infrastructure	**Construction Phase** • Increased road traffic,	Regional	Short	Moderate	Moderate
	• Damage to road infrastructure, utilities	Regional	Short	Low	Low
	• Loss of work after construction is completed	Community	Short	Low	Low
	• Loss of access (residents, fishermen)	Community	Short	Low	Low
	• Reduced emergency response time	Community	Short	Moderate	Moderate
	Operation Phase • Shadow flicker	Community	Long	Insignificant	Low
	• Noise emissions	Community	Long	Insignificant	Low
Health & Safety	**Construction Phase** • Occupational hazards	Local	Short	Moderate	Low
	• Health concerns related to (noise & air emissions)	Community	Short	Moderate	Moderate
	• Extra pressure on local Health facility	Regional	Short	Low	Low
	Operation Phase • Noise emissions	Community	Long	Insignificant	Low
	• Public safety	Community	Long	Insignificant	Low

PROPOSED IMPACTS		SPREAD	DURATION	INTENSITY	OVERALL SIGNIFICANCE
Fishing community	**Construction Phase** • Improper disposal of waste	Local	Short	Low	Negligible
	• Loss of Access	Local	Short	Moderate	Low
	• Potential for loss of earnings (fishermen)	Local	Short	Low	Negligible
	Operation Phase • Potential for loss of earnings	Local	Long	Low	Low
Hope Secondary School	**Construction Phase** • Health Concerns (air and noise emissions)	Local	Short	Moderate	Low
	• Loss of Access	Local	Short	Low	Negligible
	• Increased Road Traffic (students and teachers late arrival to school)	Local	Short	Moderate	Low
	Operation Phase • Shadow flicker	Local	Long	Insignificant	Negligible
	• Noise emissions	Local	Long	Insignificant	Negligible

Management Plans

The Environmental Management Plan and the Social Management Plan consists of a Mitigation Management Plan and a Monitoring Plan. These documents will be finalized prior to the start of the site preparation and construction works to ensure that all of the conditions of the Environmental Permit are addressed. The EMP will also be reviewed following the start of each phase to determine adherence to the stipulated mitigation measures and the effectiveness of the implemented measures.

In summary, adverse impacts to the natural environment that were not eliminated or determined to be insignificant, were classified as LOW assuming the effective implementation of available mitigation. Similarly, the majority of adverse impacts to the socio-economic environment were classified as LOW. The benefits to the local community and the nation that are expected to be realised from this project are expected to outweigh any potential adverse impacts.

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TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 AUTHORIZATION AND LAYOUT 1
1.2 PROJECT BACKGROUND 3
1.3 ORGANISATION PROFILES 4
1.3.1 Project Proponent 4
1.3.2 EIA Lead Consultant 5
1.3.3 Specialist Contractors 6
1.3.3.1 EMD International 6
1.3.3.2 MMI Thornton Tomasetti 7
1.3.3.3 Institute for Green Economy in Suriname (IGES) 8
1.3.3.4 Dr. Paul Kerlinger 9
1.3.3.5 Risk Assessment Specialist – Bob Stevens 10
1.3.3.6 Guyana Ecology Specialists 11
1.4 SCOPE OF THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT 13
1.5 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY TEAM 14

2 APPROACH AND METHODOLOGY 15

2.1 STUDY AREA AND AREA OF INFLUENCE 15
2.2 DATA COLLECTION 15
2.2.1 Surface Water Quality 16
2.2.2 Ambient Air Quality 17
2.2.3 Flora and Fauna 17
2.2.3.1 Flora 17
2.2.3.2 Fauna 18
2.2.4 Ambient Noise Monitoring 21
2.2.5 Socio-Economic Baseline 22
2.3 IMPACT IDENTIFICATION 23
2.4 ESTABLISHING THE SIGNIFICANCE OF IMPACTS 23
2.5 IMPACT CLASSIFICATION 23
2.6 CUMULATIVE IMPACTS 24

3 LEGAL AND REGULATORY FRAMEWORK 25

3.1 NATIONAL LEGAL AND POLICY FRAMEWORK 25
3.1.1 The Environmental Protection Agency 26
3.1.2 Ministry of Public Infrastructure 26
3.1.2.1 Guyana Energy Agency 27
3.1.2.2 Guyana Power and Light 27
3.1.2.3 Guyana Civil Aviation Authority 28
3.1.2.4 Sea and River Defense Board 29
3.1.2.5 Transport and Harbours Department 29
3.1.3 Public Utilities Commission 29
3.1.4 Ministry of Agriculture, National Drainage and Irrigation Agency 30
3.1.5 Ministry of Agriculture, National Agricultural Research Extension Institute 30
3.1.6 Office of Climate Change 31
3.2 ENERGY LAWS AND POLICIES 31
3.2.1 Electricity Sector Reform Act, 1999 31
3.2.2 The Public Utilities Commission Act, 1997 32

3.2.3 Draft National Energy Policy (2015) *33*
3.3 REGULATORY FRAMEWORK FOR LAND MANAGEMENT AND ENVIRONMENTAL PROTECTION 35
3.3.1 The Environmental Protection Act and Regulations *35*
3.3.1.1 The Environmental Protection Act, 2005 35
3.3.1.2 Applicable Regulations 36
3.3.2 Town and Country Planning Act *38*
3.3.3 Guyana Lands and Surveys Commission Act *39*
3.3.4 Guyana National Action Programme to Combat Land Degradation, 2015 ..... *39*
3.3.5 National Environmental Action Plan *40*
3.3.6 Green State Development Strategy: Vision 2040 ..... *41*
3.3.7 The Sea Defense Act *42*
3.3.8 Sea and River Defense Policy *42*
3.3.9 Roads Act *43*
3.3.10 Civil Aviation Act, 2018 ..... *43*
3.3.11 Waste Management *44*
3.4 REGULATORY FRAMEWORK FOR BIODIVERSITY PROTECTION 45
3.5 REGULATORY FRAMEWORK FOR WATER QUALITY AND QUANTITY 50
3.5.1 Environmental Impact (Water Quality) Regulations, 2000 ..... *50*
3.5.2 Guyana National Bureau of Standards Act *50*
3.5.3 Water and Sewerage Act *50*
3.5.4 Drainage Irrigation Act *51*
3.5.1 World Bank Ambient Water Quality Guidelines *51*
3.6 CLIMATE CHANGE POLICIES AND PLANS 52
3.6.1 Draft National Climate Change Policy and Action Plan (2019) *52*
3.6.2 Climate Change Action Plan (2001) *53*
3.6.3 Climate Resilience Strategy and Action Plan for Guyana *53*
3.7 HEALTH AND SAFETY AND EMERGENCY PREPAREDNESS 54
3.7.1 Occupational Safety and Health Act. *54*
3.7.2 Emergency Preparedness *54*
3.8 INTERNATIONAL TREATIES AND CONVENTIONS 55
3.9 APPLICABLE INTERNATIONAL GUIDELINES 56
3.9.1 EHS Guidelines for Wind Turbines *56*
3.9.1.1 Visual Impacts 57
3.9.1.2 Shadow Flicker 57
3.9.1.3 Aviation Safety 57
3.9.2 EHS Guidelines for Noise *57*
3.9.3 WHO Air Quality Guidelines *58*

4 PROJECT ALTERNATIVES 61

4.1 CONFIGURATIONS OF ALTERNATIVE OPTIONS: 64
4.2 NOISE EMISSIONS IMPACTS OF ALTERNATIVE OPTIONS: 65
4.3 SAFETY RISKS OF ALTERNATIVE OPTIONS: 66
4.4 SHADOW FLICKER IMPACTS OF ALTERNATIVE OPTIONS: 67
4.5 PRICE OF ELECTRICITY FROM ALTERNATIVE OPTIONS: 68
4.6 SUMMARY OF RESULTS FROM ALTERNATIVE OPTIONS: 69
4.7 COMPARISON OF ADVERSE AND BENEFICIAL EFFECTS OF OPTIONS 69
4.7.1 Public Safety *70*
4.7.2 Noise *70*
4.7.3 Clearing of Vegetation *70*
4.7.4 Shadow Flicker *71*

4.7.5 Pricing *71*

5 COMPREHENSIVE DESCRIPTION OF THE PROPOSED PROJECT **73**

5.1 WIND FARM BASICS 74
5.1.1 How Wind Energy is Generated *74*
5.1.2 Introduction to Wind Turbine Components *74*
5.1.3 Introduction to Project Development Phases *75*
5.2 THE PROJECT SITE 77
5.2.1 Project Layout and Access at Hope Beach *77*
5.2.2 Project Layout and Access at Chapman's Grove *78*
5.3 OVERVIEW OF WIND FARM CONSTRUCTION ACTIVITIES 78
5.3.1 Civil Works *78*
5.3.2 Electrical Works *80*
5.3.3 Wind Turbine Equipment Transport to Site *81*
5.3.4 Lifting and Assembly of Wind Turbine Generators *82*
5.4 OVERVIEW OF WIND FARM OPERATION AND MAINTENANCE ACTIVITIES 83
5.5 STAFFING REQUIREMENTS 83
5.5.1 Construction Phase *83*
5.5.2 Operation Phase *84*
5.6 PROJECT SCHEDULE 85

6 STAKEHOLDER IDENTIFICATION AND CONSULTATION PLAN **87**

6.1 SCOPING MEETINGS 87
6.1.1 Community Scoping Meetings *87*
6.1.2 Technical Scoping Meeting *88*
6.2 MEETINGS WITH STAKEHOLDERS 89
6.3 QUESTIONNAIRE SURVEYS 90
6.4 SURVEY OF FISHERMEN 90

7 ENVIRONMENTAL IMPACT ANALYSIS **91**

7.1 BENEFICIAL IMPACTS 91
7.1.1 Community Benefits *91*
7.1.2 National Benefits *91*
7.1.2.1 Green State Development Strategy (GSDS) 91
7.1.2.2 Positive Economic Impact 92
7.1.2.3 Enhanced Security of the Electrical Grid 92
7.1.2.4 Climate Change and Clean Air 92
7.1.2.5 Pilot Project for Greater Things to Come 93
7.2 SUMMARY OF IMPACT CLASSIFICATION 93
7.2.1 Natural Environment *93*
7.2.2 Socio-Economic Environment *96*
7.3 ENVIRONMENTAL MANAGEMENT PLAN 98
7.3.1 Steps involved in Preparation of the EMP *99*
7.3.2 Management Structure *99*
7.3.2.1 Construction Phase 100
7.3.2.2 Operation Phase 101
7.3.3 Record Keeping *101*
7.3.3.1 Construction Phase 101
7.3.3.2 Operation Phase 102
7.3.4 Reporting *103*

7.3.4.1 Construction Phase ... 103
7.3.4.2 Operation Phase ... 103
7.4 MONITORING PLAN ... 103

8 WATER RESOURCES ... 105

8.1 INTRODUCTION ... 105
8.2 KEY RELEVANT POLICY AND LEGISLATION ... 105
8.3 EXISTING INFORMATION, BASELINE STUDIES ... 106
8.3.1 Surface Water Quality ... 106
8.3.1.1 General Information ... 106
8.3.1.2 Study Area ... 106
8.3.1.3 Dry Season Results ... 107
8.3.1.4 Wet Season Results ... 109
8.3.1.5 Summary of Seasonal Results at Both Sites ... 109
8.3.2 Groundwater Quality ... 110
8.4 IMPACT PREDICTION AND ASSESSMENT ... 110
8.4.1 Site Preparation / Construction Phase ... 111
8.4.1.1 Siltation/ Sedimentation ... 111
8.4.1.2 Hydrocarbon Spills and Leaks ... 114
8.4.1.3 Improper Sewage Disposal ... 116
8.4.1.4 Spillage of Paints and Solvents ... 116
8.4.1.5 Concrete Washings ... 117
8.4.2 Operation Phase ... 119
8.4.2.1 Hydrocarbon Spills and Leaks ... 119
8.4.2.2 Improper Sewage Disposal ... 120
8.5 MITIGATION AND MONITORING - ENVIRONMENTAL MANAGEMENT PLAN ... 121
8.5.1 Site Preparation / Construction Phase ... 121
8.5.2 Operation Phase ... 126

9 SOILS, LAND, GEOLOGY ... 127

9.1 INTRODUCTION ... 127
9.2 DEFINITIONS AND SCOPE ... 127
9.2.1 Scope of Work ... 127
9.2.1.1 Drilling Program ... 127
9.2.1.2 Laboratory Testing ... 128
9.2.2 Definitions ... 128
9.3 KEY RELEVANT POLICY AND LEGISLATION ... 129
9.4 EXISTING INFORMATION, BASELINE STUDIES ... 129
9.4.1 Geology ... 129
9.4.1.1 Regional Geology ... 129
9.4.1.2 Surficial Geology ... 130
9.4.2 Present Day Coastal Morphology ... 131
9.4.2.1 Regional Coastal Morphology ... 131
9.4.2.2 Wind Farm Site Surface Morphology ... 132
9.4.2.3 Mangrove Tidal Flat Accretion and Erosion Cycles at Hope Beach ... 133
9.4.3 Soils ... 134
9.4.4 Key Findings of Geotechnical Report ... 135
9.4.4.1 Subsurface Stratigraphy ... 135
9.4.4.2 Groundwater Conditions ... 136
9.4.4.3 Summary of Test Results ... 136
9.4.4.4 Geotechnical Study Foundation Options Assessment ... 137
9.4.5 Seismicity ... 138

9.5 IMPACT PREDICTION AND ASSESSMENT 138
9.5.1 Construction Phase *138*
9.5.1.1 On-Site Erosion 138
9.5.1.2 Slope Instability 141
9.5.2 Operation Phase *143*
9.6 MITIGATION AND MONITORING - ENVIRONMENTAL MANAGEMENT PLAN 143

10 AIR QUALITY 147

10.1 INTRODUCTION 147
10.2 DEFINITIONS AND SCOPE 147
10.2.1 Scope *147*
10.2.2 Definitions *147*
10.3 KEY RELEVANT POLICY AND LEGISLATION 148
10.4 EXISTING INFORMATION, BASELINE STUDIES 149
10.4.1 Sources of Air Emissions *149*
10.4.2 Monitoring Programme *149*
10.4.3 Monitoring Results *150*
10.5 IMPACT PREDICTION AND ASSESSMENT 150
10.5.1 Dust from Cleared Areas *151*
10.5.1.1 Nature of Concern 151
10.5.1.2 Unmitigated Impact 151
10.5.1.3 Mitigation Measures 152
10.5.1.4 Cumulative Impact 153
10.5.2 Exhaust Emissions from Vehicles *153*
10.5.2.1 Nature of Concern 153
10.5.2.2 Unmitigated Impact 154
10.5.2.3 Mitigation Measures 155
10.5.2.4 Cumulative Impact 155
10.6 MITIGATION AND MONITORING - ENVIRONMENTAL MANAGEMENT PLAN 156

11 SHADOW EFFECTS (FLICKERS) 159

11.1 INTRODUCTION 159
11.2 DEFINITIONS AND SCOPE 159
11.2.1 Definition *159*
11.2.2 Scope of Work *159*
11.3 KEY RELEVANT POLICY AND LEGISLATION 159
11.4 EXISTING INFORMATION, BASELINE STUDIES 160
11.5 IMPACT PREDICTION AND ASSESSMENT 161
11.5.1 Nature of Concern *161*
11.5.2 Unmitigated Impact *162*
11.5.3 Mitigation Measures *162*
11.6 MITIGATION AND MONITORING – ENVIRONMENTAL MANAGEMENT PLAN 164

12 NOISE AND VIBRATIONS 165

12.1 INTRODUCTION 165
12.2 DEFINITIONS AND SCOPE 165
12.2.1 Scope *165*
12.2.2 Definitions *166*
12.2.3 Decibel Scale *166*
12.3 KEY RELEVANT POLICY AND LEGISLATION 169

12.3.1 Environmental Management (Noise Regulations) 2000 and the Guidelines for Noise Emissions into the Environment (First Revision) *169*
12.3.2 EPA's Proposed Noise Limits for Wind Farms *171*
12.3.3 World Health Organization Guidelines for Community Noise (1999) *171*
12.3.4 International Finance Corporation, World Bank Group, General Environmental Health and Safety Guidelines – Noise Management 2007 ..... *174*
12.4 EXISTING INFORMATION, BASELINE STUDIES 175
12.4.1 Method Statement *175*
12.4.1.1 Monitoring Locations and Schedule 175
12.4.1.2 Environmental Setting 178
12.4.1.3 Equipment 178
12.4.1.4 Data Processing 179
12.4.1.5 Quality Control 180
12.4.2 Findings – Hope Beach *180*
12.4.2.1 Average Background Noise Levels 181
12.4.2.2 Effect of Wind Speed on Background Noise 183
12.4.2.3 Peak Background Noise Level 189
12.4.2.4 Summary of Background Noise Findings at Hope Beach 192
12.4.3 Findings – Chapman's Grove *192*
12.4.3.1 Average Background Noise Level 193
12.4.3.2 Effect of Wind Speed on Background Noise 195
12.4.3.3 Peak Background Noise Level 198
12.4.3.4 Summary of Background Noise Findings for Chapman's Grove 199
12.5 IMPACT PREDICTION AND ASSESSMENT 200
12.5.1 Construction Phase *200*
12.5.1.1 Nature of Impact 200
12.5.1.2 Unmitigated Impact 201
12.5.1.3 Mitigation Measures 202
12.5.1.4 Cumulative Impact 203
12.5.2 Operational Phase *203*
12.5.2.1 Nature of Impact 203
12.5.2.2 Projected Impact of Wind Farm Noise Emissions 205
12.5.2.3 Cumulative Impact 207
12.6 MITIGATION AND MONITORING – ENVIRONMENTAL MANAGEMENT PLAN 207
12.6.1 Construction Phase *207*
12.6.2 Operation Phase *209*

13 BIOLOGICAL AND ECOLOGICAL RESOURCES AND ECOSYSTEM SERVICES 211

13.1 INTRODUCTION 211
13.2 DEFINITION AND SCOPE 211
13.2.1 Scope *211*
13.2.2 Definitions *211*
13.3 KEY RELEVANT POLICY AND LEGISLATION 216
13.4 EXISTING INFORMATION, BASELINE STUDIES 217
13.4.1 Habitat and Flora *217*
13.4.1.1 Method 218
13.4.1.2 Findings 218
13.4.2 Avifauna *220*
13.4.2.1 Method 221
13.4.2.2 Findings 221
13.4.3 Bats *228*
13.4.3.1 Method 228

13.4.3.2 Findings 229
13.4.4 Non-volant Mammals and Herpetofauna 234
13.4.4.1 Method 234
13.4.4.2 Findings 235
13.4.5 Ichthyofauna 236
13.4.5.1 Method 236
13.4.5.2 Findings 237
13.4.6 Summary of Biological Findings 248
13.5 IMPACT PREDICTION AND ASSESSMENT 250
13.5.1 Construction Phase 250
13.5.1.1 Clearing of Vegetation (Loss of Terrestrial Habitat) 251
13.5.1.2 Fragmentation 253
13.5.1.3 Disturbance to Terrestrial Species 255
13.5.1.4 Disturbance to Aquatic Species 256
13.5.1.5 Disturbance to Benthic Species 258
13.5.1.6 Loss of Benthic Species 259
13.5.1.7 Concerns to Migratory Species 259
13.5.1.8 Concerns to Rare and Endangered Species 260
13.5.2 Operational Phase 262
13.5.2.1 Concerns for Avifauna 262
13.5.2.2 Concerns for Bats 265
13.6 MITIGATION AND MONITORING – ENVIRONMENTAL MANAGEMENT PLAN 267
13.6.1 Construction Phase 267
13.6.2 Operation Phase 271

14 TRANSPORTATION 273

14.1 PROJECT LOCATION AND LAND USE 273
14.2 SITE ACCESS 273
14.2.1 Hope Beach site 273
14.2.2 Chapmans Grove 274
14.2.3 Type of Road Construction 274
14.3 CONSTRUCTION SCHEDULE 274
14.4 PROJECT LOADS 275
14.4.1 WTG 275
14.4.2 Civil & Electrical Works 276
14.5 TRANSPORT VEHICLES 276
14.6 OFFLOADING FACILITIES AND HAULAGE ROUTE 277
14.7 EXISTING INFORMATION, BASELINE STUDIES 278
14.7.1 Offloading facilities 278
14.7.2 Road Network 278
14.7.2.1 Demerara-Berbice Main Road 278
14.7.2.2 Secondary Roads 279
14.7.2.3 Public Transportation 279
14.8 IMPACT PREDICTION AND ASSESSMENT 281
14.8.1 Damage to Roads, Bridges and Culvert Crossings 281
14.8.1.1 Nature of Concern 281
14.8.1.2 Unmitigated Impact 282
14.8.1.3 Mitigation Measures 282
14.8.1.4 Cumulative Impact 283
14.8.2 Obstruction of Traffic 284
14.8.2.1 Nature of Concern 284
14.8.2.2 Unmitigated Impact 284

14.8.2.3 Mitigation Measures 284
14.8.2.4 Cumulative Impact 285
14.8.3 Damage to Infrastructure and Utilities 285
14.8.3.1 Nature of Concern 285
14.8.3.2 Unmitigated Impact 285
14.8.3.3 Mitigation Measures 286
14.8.3.4 Cumulative Impact 286
14.8.4 Road Safety 287
14.8.4.1 Nature of Concern 287
14.8.4.2 Unmitigated Impact 287
14.8.4.3 Mitigation Measures 287
14.8.4.4 Cumulative Impact 288
14.9 MITIGATION AND MONITORING - ENVIRONMENTAL MANAGEMENT PLAN 288

15 HAZARDOUS WASTE AND WASTE MANAGEMENT 295

15.1 KEY RELEVANT POLICY AND LEGISLATION 295
15.2 EXISTING INFORMATION, BASELINE STUDIES 296
15.2.1 General Solid Waste 296
15.2.2 Hazardous Waste 297
15.3 IMPACT PREDICTION AND ASSESSMENT 297
15.3.1 Construction Phase 297
15.3.1.1 Improper Disposal of Waste 298
15.3.1.2 Cumulative Impact 299
15.3.2 Operation Phase 300
15.4 MITIGATION AND MONITORING - ENVIRONMENTAL MANAGEMENT PLAN 301

16 LANDSCAPE AND AESTHETICS 303

16.1 KEY RELEVANT POLICY AND LEGISLATION 303
16.2 EXISTING INFORMATION, BASELINE STUDIES 303
16.2.1 Hope Beach 303
16.2.2 Chapmans Grove 305
16.3 IMPACT PREDICTION AND ASSESSMENT 306
16.3.1 Construction Phase 306
16.3.1.1 Nature of Concern 306
16.3.1.2 Unmitigated Impact 307
16.3.1.3 Mitigation Measures 307
16.3.1.4 Cumulative Impacts 308
16.3.2 Operation Phase 308
16.3.2.1 Nature of Concern 308
16.3.2.2 Cumulative Impacts 309
16.4 ENVIRONMENTAL MANAGEMENT PLAN 309

17 SOCIO-ECONOMIC IMPACTS 311

17.1 KEY RELEVANT POLICY AND LEGISLATION 311
17.2 EXISTING INFORMATION, BASELINE STUDIES 311
17.2.1 Demography 311
17.2.2 Utilities and Social Infrastructure 312
17.2.3 Employment 312
17.2.4 Health Services and Health Concerns 313
17.2.5 Fishing Profile 313
17.3 ENVIRONMENTAL IMPACTS, MITIGATION AND MONITORING 314

18 HEALTH AND SAFETY RISK ASSESSMENT AND EMERGENCY RESPONSE PLANNING.....323

18.1 HEALTH AND SAFETY RISK ASSESSMENT 323
18.1.1 Introduction.....323
18.1.2 Key Relevant Policy and Legislation 323
18.1.3 Existing Information, Baseline Studies.....324
18.1.4 HSE Leadership and Organisation 329
18.1.4.1 Project General Manager 331
18.1.4.2 HSE Manager and HSE Officers.....331
18.1.5 HSE Hazard Assessment and Mitigation.....333
18.1.5.1 Basic PPE 334
18.1.5.2 Transportation.....334
18.1.5.3 Excavation and Trenching 338
18.1.5.4 Heavy Machinery Operation 340
18.1.5.5 Working at Height and Dropped Objects. 341
18.1.5.6 Lifting Operations 343
18.1.5.7 Electrical Hazards 345
18.1.5.8 Wind Turbine Generator (WTG) Operations 347
18.1.5.9 Health and Safety of the Community.....350
18.2 EMERGENCY RESPONSE PLAN 354
18.2.1 Introduction.....354
18.2.2 Types of Emergencies.....355
18.2.3 Organisational structure for emergency response 355
18.2.4 Construction Phase Emergency Response Command Structure:.....355
18.2.5 Wind Farm Operating Phase Emergency Response Command Structure: 357
18.2.6 Incident Response Levels 1, 2 and 3:.....358
18.2.7 Emergency Planning and Response Drills 359
18.2.8 Incident Communication.....360
18.2.9 Key Emergency Support Services.....360
18.2.10 Initial Plans for Emergency Scenarios 363
18.2.11 Emergency Evacuation Plan.....363
18.2.12 Medical Emergency Plan 363
18.2.13 Wind Turbine Rescue Plan 364
18.2.14 Public Road Transport Accident Emergency Plan 367
18.2.15 Fire / Explosion Emergency Plan.....367
18.2.16 Security Breach Emergency Plan 368
18.2.17 Flooding Emergency Plan.....369
18.2.18 WTG Structural Failure Emergency Plan.....369
18.2.19 Security: Bomb Threat Emergency Plan.....371
18.2.20 Security: Civil Unrest Emergency Plan 371
18.2.21 Ending an Emergency 371

19 CLIMATE AND CLIMATE CHANGE.....373

19.1 DEFINITIONS 373
19.2 EXISTING INFORMATION, BASELINE STUDIES 374
19.3 CLIMATOLOGY 375
19.3.1 Temperature and Relative Humidity.....376
19.3.1.1 Country Profile.....376
19.3.1.2 Project Area 378
19.3.2 Rainfall.....378
19.3.2.1 Country Profile.....378

19.3.2.2 Region 4 380
19.3.3 Wind Speed and Direction 382
19.4 CLIMATE CHANGE 385
19.4.1 Environmental Agreements 385
19.4.2 Key Relevant Policy, Legislation, Guidelines and Standards 386
19.4.2.1 National Climate Change Policy 386
19.4.2.2 Other Policies, Legislation and Plans 387
19.4.3 Key Institutions and Organizations 390
19.4.3.1 Office of Climate Change (OCC) 390
19.4.3.2 National Climate Change Committee (NCCC) 391
19.4.3.3 Other Key Agencies 391
19.4.4 Climate Change 392
19.4.4.1 Temperature Increases 393
19.4.4.2 Precipitation 394
19.4.4.3 Sea Level Rise / Storm Surge 395
19.4.5 Potential Impacts and Mitigation Measures 396
19.4.5.1 General Potential Impacts 396
19.4.5.2 General Mitigation Measures 399
19.4.5.3 Project Specific Impacts and Mitigation Measures 400

20 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS 405

20.1 NATURAL ENVIRONMENT 405
20.1.1 Construction Phase 405
20.1.2 Operation Phase 429
20.2 SOCIAL MANAGEMENT PLAN 432

LIST OF APPENDICIES

APPENDIX A FINAL TOR AND CURRICULA VITAE OF KEY PREPARERS
APPENDIX B WATER QUALITY
APPENDIX C AMBIENT AIR QUALITY
APPENDIX D ASSESSMENT OF ONSITE VEGETATION
APPENDIX E BIRD SURVEY 2 & INTERIM REPORT (BIRDS, BATS, HERPETOFAUNA & MAMMALS)
APPENDIX F CHAPMAN'S GROVE BAT SURVEY
APPENDIX G ICHTHYOFAUNAL ASSESSMENT
APPENDIX H NOISE MONITORING REPORT
APPENDIX I SOCIO-ECONOMIC BASELINE
APPENDIX J IDENTIFICATION OF IMPACTS AND REGIONAL CASE STUDIES
APPENDIX K CLASSIFICATION OF IMPACTS
APPENDIX L COMMUNITY SCOPING MEETINGS
APPENDIX M NOTES OF STAKEHOLDER MEETINGS
APPENDIX N GEOTECHNICAL REPORT
APPENDIX O ENVIRONMENTAL IMPACT ASSESSMENT: NOISE, SHADOW FLICKER, SAFETY DISTANCES
APPENDIX P REVIEW OF NOISE EMISSIONS REGULATIONS
APPENDIX Q BIRD RISK ASSESSMENT
APPENDIX R BAT RISK ASSESSMENT
APPENDIX S TRANSPORTATION BRIEF
APPENDIX T PHOTOGRAPHIC RENDERING OF WIND TURBINES
APPENDIX U SAFETY DISTANCE QUANTITATIVE RISK ASSESSMENT

LIST OF TABLES

TABLE NUMBER	TABLE NAME	PAGE
2-1	NOISE MONITORING LOCATIONS	21
3-1	WORLD BANK AMBIENT WATER QUALITY GUIDELINES	51
3-2	KEY MEAS TO WHICH GUYANA IS A SIGNATORY	55
3-3	WORLD BANK GROUP NOISE GUIDELINES	58
3-4	WHO AMBIENT AIR QUALITY GUIDELINES	59
4-1	COMPARISON OF CONFIGURATION, NOISE IMPACT, SAFETY RISK, AND PRICE COMPETITIVENESS FOR 4 OPTIONS CONSIDERED	68
7-1	SUMMARY OF POST MITIGATION CLASSIFICATION (NATURAL ENVIRONMENT)	94
7-2	SUMMARY OF POST MITIGATION CLASSIFICATION (SOCIO-ECONOMIC ENVIRONMENT)	96
8-1	WORLD BANK AMBIENT SURFACE WATER QUALITY GUIDELINES	105
8-2	WATER QUALITY RESULTS (HOPE BEACH AND CHAPMANS GROVE)	108
9-1	DEFINITIONS	128
9-2	RELEVANT GEOTECHNICAL STANDARDS	129
10-1	DEFINITIONS	148
10-2	WHO AMBIENT AIR QUALITY GUIDELINES	148
10-3	HOPE BEACH AMBIENT AIR QUALITY RESULTS	150
10-4	CHAPMAN'S GROVE AMBIENT AIR QUALITY RESULTS	150
10-5	TRAFFIC SURVEY RESULTS (DECEMBER 2019)	154
11-1	SHADOW FLICKER RESULTS	163
12-1	DEFINITIONS	166
12-2A	GUYANA NATIONAL BUREAU OF STANDARD GUIDELINES FOR NOISE EMISSIONS INTO THE ENVIRONMENT	170
12-2B	PROPOSED EPA NOISE LIMITS FOR THE PROPOSED WIND FARM	171
12-3	WORLD HEALTH ORGANIZATION (1999) LIMITS FOR SCHOOLS (OUTDOOR AND INDOOR) AND PARKLANDS	173
12-4	INTERNATIONAL FINANCE CORPORATION, WORLD BANK GROUP (IFC) NOISE LEVEL GUIDELINES	174
12-5	MONITORING LOCATIONS AND SCHEDULE FOR HOPE BEACH	176
12-6	MONITORING LOCATIONS AND SCHEDULE FOR CHAPMAN'S GROVE	177
12-7A	SUMMARY OF GUYANA GENERAL GUIDELINE EXCEEDANCES FOR HOPE BEACH BACKGROUND NOISE SURVEY (1-HOUR AVERAGING TIME)	181
12-7B	SUMMARY OF GUYANA PROPOSED WIND TURBINE EXCEEDANCES FOR HOPE BEACH BACKGROUND NOISE SURVEY (10-MINUTE AVERAGING TIME)	182

TABLE NUMBER	TABLE NAME	PAGE
12-8	AVERAGE DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEVELS VERSUS WIND SPEED AT LOCATIONS HB 1, HB 2 AND HB 3	184
12-9	AVERAGE DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEVELS VERSUS WIND SPEED AT LOCATIONS HB 4, HB 5 AND HB 6	185
12-10	PEAK DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEQ AT LOCATIONS HB 1, HB 2 AND HB 3	189
12-11	PEAK DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEQ AT LOCATIONS HB 4, HB 5 AND HB 6	190
12-12A	SUMMARY OF GUYANA GENERAL GUIDELINE EXCEEDANCES FOR CHAPMAN'S GROVE BACKGROUND NOISE SURVEY (1-HOUR AVERAGING TIME)	193
12-12B	SUMMARY OF GUYANA PROPOSED WIND TURBINE EXCEEDANCES FOR CHAPMAN'S GROVE BACKGROUND NOISE SURVEY (10-MINUTE AVERAGING TIME)	194
12-13	AVERAGE DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEVELS VERSUS WIND SPEED AT LOCATIONS CHG 1, CHG 2 AND CHG 3	196
12-14	PEAK DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEQ AT LOCATIONS CHG 1, CHG 2 AND CHG 3	198
12-15	MAXIMUM NOISE IMPACT OF SIX VESTAS V150 4.2 MW WITH A HH OF 105, USING NOISE MODE PO1 (WITH SERRATED TRAILING EDGES), EXCEPT AT WTG4, USING SO1.	207
13-1	DEFINITIONS	212
13-2	TOTAL NUMBER OF BIRD SPECIES AND INDIVIDUALS RECORDED AT HOPE BEACH AND CHAPMAN'S GROVE (2018 AND 2020)	222
13-3	IUCN RED LIST SPECIES RECORDED IN THE STUDY AREA	223
13-4	MIGRATORY BIRDS COLLECTIVELY OBSERVED AT THE 2018 AND 2020 SURVEYS	224
13-5	BIRD ACTIVITY FOR 2018 AND 2020	248
13-6	BATS CAPTURED AT HOPE BEACH AND CHAPMAN'S GROVE	230
13-7	IUCN CONSERVATION STATUS	232
13-8	HERPETOFAUNA COLLECTIVELY OBSERVED AT BOTH SITES (2020 SURVEY)	235
13-9	NON-VOLANT COLLECTIVELY OBSERVED AT BOTH SITES (2020 SURVEY)	236
13-10	HABITAT DESCRIPTION OF FISH SAMPLING SITES AT HOPE BEACH	237
13-11	HABITAT DESCRIPTION OF FISH SAMPLING SITES AT CHAPMAN'S GROVE	239
13-12	FISH SPECIES RECORDED DURING SURVEY AT HOPE BEACH	242
13-13	FISH SPECIES RECORDED DURING SURVEY AT CHAPMAN'S GROVE	243

TABLE NUMBER	TABLE NAME	PAGE
13-14	IUCN AND CITES STATUSES OF FISH RECORDED DURING SURVEY AT HOPE BEACH	246
13-15	IUCN AND CITES STATUSES OF FISH RECORDED DURING SURVEY AT CHAPMAN'S GROVE	247
14-1	LISTING OF WIND TURBINE GENERATOR COMPONENTS	275
14-2	MATERIALS FOR CIVIL AND ELECTRICIAL WORKS	276
17-1	SUMMARY OF IMPACTS AND MITIGATION MEASURES	314
18-1	OCCUPATIONAL SAFETY INCIDENT STATISTICS SELECT INDUSTRIES, USA, 2019	325
18-2	FATALITIES FOR SPECIFIC JOBS, USA, 2019	326
19-1	AVERAGE, MAXIMUM AND MINIMUM, MONTHLY AND ANNUAL TEMPERATURES FOR GUYANA (1951-2018 AND 1986-2006)	376
19-2	MONTHLY MEAN MAXIMUM AND MINIMUM TEMPERATURES AND MONTHLY MEAN RELATIVE HUMIDITY FOR BOTANIC GARDENS, GEORGETOWN (2017-2019)	378
19-3	MONTHLY AND ANNUAL PRECIPITATION FOR GUYANA (1951-2018 AND 1986-2006)	379
19-4	PRECIPITATION DISTRIBUTION FOR LOCATIONS IN REGION 4 (1966-2008)	380
19-5	RAINFALL DATA FOR HYDROMET STATION AT BEEHIVE (2017-2019)	381
19-6	PROJECTIONS OF DIFFERENT CLIMATE VARIABLES FOR GUYANA	393
19-7	RANGE OF PROJECTED SEASONAL AND ANNUAL TEMPERATURES RELATIVE TO 1961-1990 BASELINE TEMPERATURE FOR 4 SCENARIOS	394
19-8	PREDICTED CHANGE IN SEASONAL AND ANNUAL PRECIPITATION (%) FOR 3 TIME PERIODS AND 4 SCENARIOS	395
19-9	CO_2 PAYBACK FOR HOPE WIND FARM	401

LIST OF FIGURES

FIGURE NO.	FIGURE NAME	AFTER PAGE
1-1	LOCATION MAP	2
2-1	AREA OF INTEREST – HOPE BEACH	16
2-2	AREA OF INTEREST – CHAPMAN'S GROVE	16
2-3	WATER QUALITY MONITORING LOCATIONS	16
2-4	AMBIENT AIR QUALITY MONITORING LOCATIONS	18
2-5	VEGETATION TRANSECT LOCATIONS – HOPE BEACH	18
2-6	VEGETATION TRANSECT LOCATIONS – CHAPMAN'S GROVE	18
2-7	TRANSECT AND BIRD COUNT LOCATIONS (2018 SURVEY)	18
2-8	TRANSECT LOCATIONS (2020 SURVEY)	18
2-9	NOISE MONITORING LOCATIONS – HOPE BEACH	22
2-10	NOISE MONITORING LOCATIONS – CHAPMAN'S GROVE	22
2-11	CLASSES OF EXTENT	24
3-1	EPA APPLICATION AND APPROVAL PROCESS	36
4-1	WIND FARM CONFIGURATIONS CONSIDERED FOR THE HOPE WIND FARM	62
4-2	RELATIONSHIP BETWEEN ROTOR SIZE AND NOISE EMISSIONS	66
5-1	LOCATION OF THE HOPE WIND FARM PROJECT SITE AND EXTENT OF LEASE BOUNDARIES	78
5-2	HOPE BEACH WIND FARM LAYOUT AND ACCESS ROUTES	78
5-3	CHAPMAN'S GROVE WIND TURBINE AND ACCESS ROAD LAYOUT	78
5-4	TYPICAL ACCESS ROAD CROSS SECTION	80
5-5	TYPICAL BRIDGE – SINGLE AND DOUBLE SPAN	80
5-6	TYPICAL PROJECT ACTIVITIES DURING CONSTRUCTION OF WIND TURBINE FOUNDATION	80
5-7	IMAGE OF THE TRANSPORT ROUTE FROM KINGSTON WHARF TO THE PROJECT SITE FOR THE HOPE WIND FARM	82
5-8	TYPICAL COMPONENTS FOR A WIND TURBINE GENERATOR (WTG)	82
5-9	PRELIMINARY CRANE-PAD AND EQUIPMENT LAY-DOWN AREAS AT EACH WIND TURBINE CONSTRUCTION SITE	82
5-10	CONSTRUCTION STAFFING REQUIREMENTS	84
5-11	PROJECT SCHEDULE	86
7-1	ORGANIZATION CHART (CONSTRUCTION PHASE)	100
7-2	ORGANIZATION CHART (OPERATION PHASE)	100
8-1	DRAINAGE AND WATER SAMPLING LOCATIONS AT HOPE BEACH	106
8-2	DRAINAGE AND WATER SAMPLING LOCATIONS AT CHAPMAN'S GROVE	106
9-1	MAP OF THE NATURAL REGIONS OF GUYANA (MODIFIED FROM: GUYANA NATIONAL LAND USE PLAN, 2013, GUYANA LANDS AND SURVEYS COMMISSION)	130
9-2	GEOLOGICAL MAP OF THE COASTAL PLAIN OF GUYANA	130

FIGURE NO.	FIGURE NAME	AFTER PAGE
	(MODIFIED FROM DANIELS, 1989)	
9-3	STRATIGRAPHIC CROSS SECTION X-X' ACROSS THE COASTAL PLAIN IN THE GEORGETOWN AREA, ILLUSTRATING STRATIGRAPHIC UNITS AND THE MAIN AQUIFERS, THE A-SAND AND THE B-SAND. (MODIFIED FROM ARAD, 1983, IN T.R. SPILLMAN ET AL., 1998)	130
9-4	ACCRETION AND EROSION CYCLES ASSOCIATED WITH MIGRATING MUD BANKS ALONG THE INNER SHELF OF THE GUIANAS COAST	132
9-5	MORPHOLOGICAL FEATURES IN THE VICINITY OF THE HOPE BEACH (HB) AND CHAPMAN'S GROVE (CHG) WIND FARM LEASE AREAS	132
9-6	TOPOGRAPHIC PROFILE AND GEOLOGICAL SECTION	132
9-7A	HISTORICAL SATELLITE IMAGES SHOWING ACCRETION OF THE SHORELINE AT HOPE BEACH BETWEEN 2008 AND 2016	134
9-7B	INITIATION OF EROSIONAL PHASE ILLUSTRATED BY SATELLITE IMAGES 2016 TO EARLY 2020	134
9-8	SOIL MAP OF GUYANA (MODIFIED FROM GL&SC 2013, ORIGINAL SOURCE UNDP FAO 1966 MAPPING OF SOILS IN GUYANA)	134
9-9	SUMMARY CROSS SECTION OF 9 GEOTECHNICAL BORINGS IN BLOCK X AND BLOCK Y OF THE HOPE BEACH LEASE	136
9-10	GEOSEISMIC HAZARD RISK OF GUYANA (GENERATED IN SUPPORT OF THE CARIBBEAN DISASTER MITIGATION PROJECT, COMPLETED IN 1999 BY THE JOINT EFFORTS OF OAS AND USAID)	138
11-1	TURBINES AND THE SELECTED SHADOW RECEPTORS	162
12-1	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 1 (RESIDENTIAL)	186
12-2	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 2 (SCHOOL)	186
12-3	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 3 (RESIDENTIAL)	188
12-4	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 4 (RESIDENTIAL)	187
12-5	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 5 (RESIDENTIAL)	188
12-6	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 6 (RESIDENTIAL)	188
12-7	COMPARISON OF OVERALL PEAK BACKGROUND NOISE LEVELS ACROSS LOCATIONS AT HOPE BEACH	191
12-8	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT CHG 1 (RESIDENTIAL)	196
12-9	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT CHG 2 (BEACH RIDGE)	197

FIGURE NO.	FIGURE NAME	AFTER PAGE
12-10	AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT CHG 3 (AGRICULTURAL)	197
12-11	COMPARISON OF OVERALL BACKGROUND PEAK NOISE LEVELS ACROSS LOCATIONS AT CHAPMAN'S GROVE	199
12-12	HOPE BEACH: MAXIMUM NOISE IMPACT OF SIX VESTAS V150 4.2MW WITH A HH OF 150 USING NOISE MODE P01 (SO1 AT WTG4) WITH SERRATED TRAILING EDGES, NO UNCERTAINTY APPLIED	206
12-13	CHAPMAN'S GROVE: MAXIMUM NOISE IMPACT OF SIX VESTAS V150 4.2MW WITH A HH OF 150 USING NOISE MODE P01 (SO1 AT WTG4) WITH SERRATED TRAILING EDGES, NO UNCERTAINTY APPLIED	206
13-1	HABITAT TYPES AT HOPE BEACH	218
13-2	HABITAT TYPES AT CHAPMAN'S GROVE	220
13-3	PERCENTAGES HIGH, MID AND LOW FLYING BIRDS	226
13-4	BAT NET DEPLOYMENT	230
13-5	PERCENTAGES OF BAT SPECIES CAPTURED AT HOPE BEACH	231
13-6	PERCENTAGES OF BAT SPECIES CAPTURED AT CHAPMAN'S GROVE	230
13-7	ICHTHYOFAUNA SAMPLING SITES AT HOPE BEACH	234
13-8	ICHTHYOFAUNA SAMPLING SITES AT CHAPMAN'S GROVE	234
13-9	SHANNON WIENER DIVERSITY INDEX OF HOPE BEACH VERSUS CHAPMAN'S GROVE	244
13-10	SPECIES ABUNDANCE OF FISH CAPTURED AT HOPE BEACH	244
13-11	SPECIES ABUNDANCE OF FISH CAPTURED AT CHAPMAN'S GROVE	245
13-12	IUCN CATEGORIES OF FISH CAPTURED AT HOPE BEACH	247
13-13	IUCN CATEGORIES OF FISH CAPTURED AT CHAPMAN'S GROVE	248
14-1	OFFLOADING AT FERNANDES WHARF	248
16-1	SURROUNDING LAND USE – HOPE BEACH	304
16-2	SURROUNDING LAND USE – CHAPMAN'S GROVE	306
18-1	US 2017 CONSTRUCTION SECTOR FATALITIES BY TOP CATEGORIES	327
18-2	TYPES OF INJURIES EXPERIENCED WITHIN THE WIND INDUSTRY IN THE USA IN 2018, AS REPORTED BY 50 ORGANISATIONS REPRESENTING SOME 45,566 FULL TIME EQUIVALENT WORKERS (AWEA, 2019)	328
18-3	ACTIVITIES IN THE US WIND INDUSTRY WHICH LED TO THE INJURIES LISTED IN FIGURE 18-2	328
18-4	PRELIMINARY PROJECT CONSTRUCTION PHASE ORGANISATION CHART, WITH HSE LEADERSHIP AND DEDICATED HSE STAFF. HIGHLIGHTED IN RED	329
18-5	ORGANISATION DURING THE 20 YEAR OPERATIONAL PHASE OF THE WIND FARM. PERSONS WITH RESPONSIBILITY DURING EMERGENCY RESPONSE ARE HIGHLIGHTED IN RED	330

FIGURE NO.	FIGURE NAME	AFTER PAGE
19-1	SEASONAL VARIATION IN RAINFALL (SOURCE: TNC FIRST DRAFT V&A CHAPTER)	375
19-2	HISTORICAL ANNUAL PRECIPITATION IN MILLIMETERS (BLUE BARS) AND ANNUAL TEMPERATURE IN ºC (RED LINE). (SOURCE: TNC FIRST DRAFT V&A CHAPTER -TABLE 4)	377
19-3	ANNUAL TEMPERATURE TRENDS 1951-2018 AND 1985-2006	377
19-4	GENERAL TREND OF PRECIPITATION IN GUYANA	380
19-5	2017-2019 TREND IN MONTHLY MEAN RAINFALL FOR BEEHIVE HYDROMET STATION	382
19-6	WIND DIRECTION	383
19-7	WIND SPEED 2010-2020	384
19-8	CROSS-CUTTING NATURE OF CLIMATE CHANGE IN GUYANA	394
19-9	LIFE CYCLE ASSESSMENT OF GREENHOUSE GAS IMPACT FOR ENERGY GENERATION TYPES	402

LIST OF PHOTOGRAPHS

PHOTO NO.	TITLE	PAGE NO.
16-1	NORTHWEST VIEW OF PROPOSED WIND TURBINES AT HOPE BEACH	304
16-2	SOUTH VIEW OF WIND TURBINES AT HOPE BEACH	305
16-3	NORTH EAST VIEW OF WIND TURBINES AT CHAPMAN'S GROVE	306

LIST OF ACRONYMS

ACRONYM	MEANING
AWEA	American Wind Energy Association
CBDRMP	Community Based Disaster Risk Management Plans
CDC	Civil Defense Commission
CDD	Consecutive Dry Days
CDM	Comprehensive Disaster Management
CEHI	Caribbean Environmental Health Institute
CGR	Community Grievance Redress
CH&PA	Central Housing and Planning Authority
CHG	Chapman's Grove
CI – Guyana	Conservation International
CMMC	The Coastal and Marine Management Committee
CRSAP	Climate Resilience Strategy and Action Plan
CWP	Country Work Programme
DBH	Diameter at Breast Height
EA	Environmental Assessment
EAB	Environmental Assessment Board
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ENSO	El-Nino Southern Oscillation
EPA	Environmental Protection Agency
ESIA	Environmental and Social Impact Assessments
ESRA	The Electricity Sector Reform Act
EWS	National Early Warning Systems
FAO	Food and Agriculture Organisation
GCMs	Global Circulation Models
GEA	The Guyana Energy Agency
GEF	Global Environment Facility
GGGI	Global Green Growth Institute
GHG	Green House Gas Emissions
GIIP	Good International Industry Practice
GL&SC	The Guyana Lands and Surveys Commission
GOG	Government of the Cooperative Republic of Guyana

ACRONYM	MEANING
GPL	Guyana Power and Light Incorporated
GPS	Global Positioning System
GSDS	The Green State Development Strategy
GSEC	Ground Structures Engineering Consultants Inc.
GUYWA	The Guyana Water Authority
GWO	Global Wind Organisation
HB	Hope Beach
HED	Hope Energy Development
HVSR	High Voltage Safety Rules
HWE	Hope Wind Energy Inc
HWE's	Healthy Work Environment
IED	Improvised Explosive Device
IFC	International Finance Corporation
IGES	The Institute for Green Economy Suriname
IPPs	Independent Power Producers
ITCZ	Inter-tropical Convergence Zone
IUCN	International Union for Conservation of Nature
KESL	Kaizen Environmental Service Limited
LV	Low Voltage
MARAD	Ministry of Works – Marine Administration Department
MEA	Multilateral Environmental Agreements
MHPRP	Multi-Hazard Preparedness and Response Plan
MLGRD	The Ministry of Local Government and Regional Development
MoA	Ministry of Agriculture
MoPI	The Ministry of Public Infrastructure
MRVS	Monitoring Reporting and Verification System
MT	Metric Tonnes
NACOSH	The National Advisory Council on Occupational Safety and Health
NAP	National Action Plan
NAREI	The National Agricultural Research and Extension Institute
NCCC	National Climate Change Committee
NCCPAP	National Climate Change Policy and Action Plan
NDC	Neighborhood Democratic Council
NDC	Nationally Determined Contribution
NDIA	The National Drainage and Irrigation Authority
NEAP	The National Environmental Action Plan
NEMS	National Emergency Management System
NIDRMPIS	National Integrated Disaster Risk Management Plan and Implementation Strategy
NISWMS	National Integrated Solid Waste Management Strategy
NLUP	National Land Use Plan
NOAA	National Oceanic and Atmospheric Administration
NPOSH	National Policy on Occupational Safety and Health
NREAC	The Natural Resources and Environment Advisory Committee
O&M	Operations and Maintenance

ACRONYM	MEANING
OCC	Office of Climate Change
OSH Act	Occupational Safety and Health Act
OSHA	Occupational Safety and Health Administration
PCM	Post Construction Monitoring
PGM	Project General Manager
PM	Particulate Matter
PPAs	Power Purchase Agreement
PPE	Personal Protective Equipment
PPEs	Perturbed Physics Experiments
PUC	Public Utilities Commission
QRA	Quantitative Risk Assessment
RDCs	Regional Democratic Councils
RDRMS	Regional Disaster Risk Management Systems
RE	Renewable Energy
REDD or REDD+	Reducing Emissions from Deforestation and Forest Degradation
RNASIS	Rainforest Nations and the Alliance of Small Island States
ROPS	Rollover Protective Structure
SCADA	Supervisory Control and Data Acquisition
SDB	The Sea Defense Board
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
SIMS	Suriname Institute of Management Studies
SLR	Sea Level Rise
SMP	Shelter Management Policy
SPAW	Specially Protected Areas and Wildlife Protocol
SSP	Shared Socioeconomic Pathways
STOW	Safe To Work
TMP	Traffic Management Plan
TNC	Third National Communication
TOR	Terms of Reference
UNCBD	UN Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNCED	UN Conference on Environment and Development
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USBLS	US Bureau of Labor Statistics
USCS	Unified Soil Classification System
V&A	Vulnerability & Adaptation
WBG	World Bank Group
WHO	World Health Organization
WTG	Wind Turbine Generator
WTSR	Wind Turbine Safety Rules
WWF-Guianas	World Wildlife Fund

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ECO REPORT No. 05/2020 **December 03, 2021**

HOPE ENERGY DEVELOPMENT INC.

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA (REVISION 1)

1 INTRODUCTION

This updated Environmental Impact Assessment is written in fulfilment of the Terms of Reference provided by the Guyana Environmental Protection Agency.

1.1 Authorization and Layout

Ecoengineering Consultants Limited (Ecoengineering) was contracted by the Hope Energy Development Inc. (HED) to prepare an Environmental Impact Assessment for the construction and operation of a wind farm at Hope Beach and Chapman's Grove, East Coast Demerara, Guyana (see Figure 1-1). This Report was prepared in accordance with the Terms of Reference for the Environmental Impact Assessment (EIA).

This report consists of 20 chapters and 21 appendices. The remainder of this introductory chapter presents the background to this assignment, profiles of the EIA team and the scope and objectives of the EIA. The remaining chapters of the EIA are laid out as follows:

- Chapter 2 details the approach and methodology for gathering data and undertaking analysis in the EIA;
- Chapter 3 discusses the legal framework which will guide the construction and operation of the wind farm;
- Chapter 4 outlines the alternative considered in developing the project;
- Chapter 5 provides a comprehensive description of the project including the location, components, scheduling and construction techniques;
- Chapter 6 summarizes the stakeholder identification and consultation exercise;
- Chapter 7 outlines our approach to the analysis of environmental impact;
- Chapters 8 describes the water resources in the study area, summarises the results of sampling and testing, and analyses the potential impacts of construction and operation of the project on these resources;
- Chapter 9 describes the soils and geology of the study area, summarizes the key findings of the geotechnical study and analyses the potential impacts of the construction and operation of the project on these resources;
- Chapter 10 summarises the results of air sampling and testing, and analyses the potential impacts of construction and operation of the project on ambient air quality;
- Chapter 11 summarizes the results of a study on shadow effects as a result of the operation of the wind farm based on a study conducted by EMD International A/S;
- Chapter 12 summarises the results of noise monitoring, and analyses the potential impacts of construction and operation of the project on ambient noise levels;
- Chapter 13 describes the biological and ecological resources of the study area based on several baseline studies conducted at both Hope Beach and Chapman's Grove and then analyses the potential impacts of the construction and operation of the project on these resources;
- Chapter 14 describes the existing transportation infrastructure within the study area and analyses the requirements for transportation of the wind farm components to Hope Beach and Chapman's Grove from the berthing facilities in Georgetown. It also analyses the potential impacts of the transport of material and equipment to the site on the existing infrastructure.
- Chapter 15 outlines the waste streams associated with this project including documenting any hazardous wastes that are likely to be used and disposed of during construction and operation;
- Chapter 16 describes the existing landscape within the study area and describes the changes anticipated as a result of this project.
- Chapter 17 summarizes the results of the socio-economic impact assessment conducted by IGES;
- Chapter 18 summarizes the results of a risk assessments conducted by Mr. Robert Stevens and MMI Thornton Tomasetti, on health and safety related to the construction and operation of the wind farm;

-57.957267 -57.949380 6.749265 -57.941493 -57.933606 -57.925719

6.749265 6.741378 -57.925719 6.725604 6.733491 -57.965154 6.725604 6.717717

N W E S

Atlantic Ocean

T1 T2 T3 T4

Hope Beach Lease X

Hope Beach Lease Y

Wind Mast

33KV Collector Line

Lowlands School Hope Douch Four Two Friends Ann's Grove Clonbrook Greenfield Beehive

Seawall

Chapman's Grove Leases

T5 T6

GPL L17a 69KV Transmission Line

Chapman's Grove Substation
Point of Interconnection (POI)
33KV/69KV 30MVA

Seawall Unity

GPL L17b 69KV Transmission Line

Unity

33KV Collector Line Lengths:

1) T1 to Hope Canal crossing (buried)	90 m
2) Hope Canal crossing overhead section	265 m
3) Hope Canal crossing to T2 (buried)	75 m
4) T2 to T3 (buried)	260 m
5) T3 to T4 (buried)	260 m
6) T4 to overhead transition	90 m
7) Overhead to Chapmans grove	2,320 m
8) End overhead to T5 (buried)	90 m
9) T5 to T6 (buried)	325 m
10) T6 to substation (buried)	330 m

69KV Feeder Line lengths:

1) Substation to GPL 69KV L17 Line `	90 m

0 0.375 0.75

Kilometers

FIGURE NUMBER 1-1: LOCATION MAP

-57.965154 -57.957267 -57.949380 -57.941493 -57.933606

HOPE WIND FARM AREA

HOPE WIND FARM SITE LAYOUT

Cartographer: M. Inniss
Authorised by: J. Sydow, Project Manager
Hope Wind Energy Limited
Version: 1.0, Date: 2020.04.12
Coordinate units: Lat Long Decimal Degrees
Projection: GCS WGS 1984

- Wind Turbine Generator
- 20 meter Foundation Slab
- Wind_Mast
- 69KV GPL Transmission Line
- 34KV Hope Wind Farm Coolecctor Line
- Seawall
- Main Road
- Access Roads
- Drain Canal
- Residential Areas
- Hope Beach Substation
- Hope Beach Lease Area
- Mangrove

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- Chapter 19 outlines the existing climatic conditions and describes the potential impacts to climate change;
- Finally, Chapter 20 presents a summary of the Environmental and Social Management Plans.

The following chapters that were listed in the TOR are not included in this EIA Report:

- Chapter 19: Risks and Risk Assessment – The information for this chapter will be merged with Chapter 18: Health and Risk Assessment
- Chapter 25: Land Acquisition and Resettlement – There will be no resettlement as part of this project.

1.2 Project Background

Hope Energy Development Inc (HED) submitted an Application for an Environmental Permit for the construction and operation of the Hope Wind Farm on the 21st September, 2018. An updated Application was received on the 12th August 2019.

The Hope Wind Farm Project base-case scenario proposes the construction of four wind turbines along the coast at the Hope Beach location, outboard of the Lowland/Hope to Ann's Grove Villages. The Project has secured a Land Lease No. A21823 File No.421146/9, as shown on (Attachment 1 - GL&SC Plan No.36967), comprising a total area of 27.057 acres, registered with the Guyana Lands and Surveys Commission, a term of 50 years commencing on the 1st of January 2007, intended use for Industrial Purposes, specifically the establishment of a wind farm for the generation of electricity. In addition, HED has obtained an option to lease private agricultural land in the Chapman's Grove area, 2km further to the SE for the location of two wind turbines and required access roads and infrastructure.

The proposed Hope Wind Farm would be the first large scale wind energy facility to be constructed in Guyana. The base-case scenario calls for 6 wind turbines, each at 4.2MW capacity, located at Hope Beach and Chapman's Grove for a total 25.2 MW wind farm capacity. The capacity factor averaged over a year will be close to 40% (i.e. an annual average capacity close to 10MW), this includes all derates typical for a wind farm. The highest monthly averaged capacity factor is in March, at close to 60% (i.e close to 16MW monthly averaged output). The lowest monthly averaged capacity factor is July, at close to 20% (i.e. close to 5MW monthly averaged output).

Winds are ideal for the latest generation of IEC category III "low wind" wind turbines. The annual energy production estimated by EMD International using these wind data are of sufficient quality to underpin the financing of the project at a PPA price to GPL which will be some 30% lower than existing HFO based generation costs.

A review of the Project Description submitted with the application highlights a number of critical environmental concerns that stem from the relatively close proximity of the wind farm to nearby residential areas and the Hope Secondary School. Noise Emissions, Shadow Flicker and Safety Offset Distance are the areas of particular concern given the nearby community that must be specifically addressed during the initial phase of the EIA studies.

1.3 Organisation Profiles

This EIA is being prepared in accordance with the Final Terms of Reference provided by the EMA. The following is a brief overview of the project Proponent, the Implementing Organization and Project Consultants:

1.3.1 Project Proponent

Hope Energy Development Inc (HED) JV – Project Development Company with three partners:

- SPI (Denmark and Colombia). Project developer and key investor, with more than 10 years of experience in Solar and Wind investments in Europe. Provide key technical support from Wind and solar networks, financing & project structure. Developing projects in South America. Backed by a broad group of Danish and international investors. Linkage to Danish wind industry expertise and financing.

- Innova Energy Ltd, Trinidad. SPI partner in Southern Caribbean, acting as Project General Manager and a key investor. Responsibilities include project origination, project management, regional procurement of services, materials, logistics support, cranes and heavy hauling, regulatory compliance, and key stakeholder engagement. Background in Oil and Gas industry project delivery now using skills learnt for developing renewable energy projects.

- Total Energy Solutions Inc, Guyana. Partnership representative in Guyana, interface with local stakeholders, support of Guyana based activities and local stakeholder engagements.

1.3.2 EIA Lead Consultant

Ecoengineering Consultants Limited is based in Trinidad, and offers Consulting Services in Environmental Engineering and Science throughout the Caribbean Region. In the early 1980's there was a strong demand for high-quality consulting services in the Environmental field, responsive to the special needs of our region. In April 1991, Ecoengineering Consultants Limited was incorporated in response to that demand.

Our name is indicative of our mission. Webster's Dictionary states that the prefix "eco" means "concerned with the environment". We offer a consulting service of "engineering concerned with the environment". We recognize the pressing need for development. We wish to offer the benefit of professional environmental analysis at the planning and execution stages of development projects, so as to facilitate informed decision-making.

Our objective is Environmentally Appropriate Development for the Caribbean. The operating philosophy of the Group is that any company undertaking an assignment has access to the full resources of the other companies in the Group.

Ecoengineering offers a wide range of services in the environmental field: Environmental Impact Assessments, Scoping Exercises, Initial Environmental Evaluations, Ecological Risk Assessments, Environmental Management Systems, Environmental Audits, Environmental Site Assessments, Waste Analysis and Design of Treatment Facilities, Ecological Surveys, Modelling of Environmental Impacts and Training.

Our professional experience includes work in Trinidad & Tobago, Anguilla, Antigua & Barbuda, Barbados, Belize, the British Virgin Islands, Dominica, Montserrat, St. Lucia, Grenada, Jamaica, St. Kitts & Nevis and St. Vincent and the Grenadines; as well as a number of Caribbean-wide assignments.

Ecoengineering Consultants is registered with the Central Tenders Board (Government of Trinidad & Tobago), the Caribbean Development Bank, the World Bank, the Inter-American Development Bank, the United Nations and the Guyana EPA. The Chief Executive Officer is a Registered Engineer with the Board of Engineering of Trinidad & Tobago.

1.3.3 Specialist Contractors

The following contractors also provided specialist inputs to the EIA:

- EMD International
- MMI Thornton Tomasetti
- IGES
- Expert Biologist - Dr. Paul Kerlinger
- Risk Assessment Specialist – Bob Stevens

- Guyana Ecology Specialists
  - Birding and Fauna Specialist: Leon Moore
  - Birding and Fauna Specialist: Waldyke Prince
  - Biologist and Bat Specialist: Dr Dierdre Jafferally
  - Biologist and Marine Ecology and Fish Specialists: Mark Ram
  - Botanist and Mangrove Specialist: Owen Bovell

1.3.3.1 EMD International

EMD International A/S (EMD) is a very experienced wind engineering consultancy from Denmark with a more than 30 year track record of providing engineering services, software, training and know-how to companies and institutions worldwide in the pre- and post-construction phases of wind farm projects, hybrid power solutions and complex energy systems schemes.

EMD was founded in 1986 and is a fully owned subsidiary of the Danish independent foundation Energi- og Miljødata (Energy and Environmental Data). EMD over 40 wind industry experts having an average of over 10 years' wind industry experience. Services include assessment of wind turbine technology, wind energy resource assessment, wind farm performance evaluation, wind farm environmental evaluations and permitting, and hybrid systems design. EMD have completed wind engineering assessments for 950 projects in over 50 countries, with a cumulative capacity of over 60 GW for onshore wind farms and 6 GW for offshore wind farms.
EMD's consultant for the Hope Wind Farm project is one of their most experienced contributors, Mr Maurizio Motta, with over 17 years in the wind industry, an MSc in Physics, wind engineering research at Risø, and senior technical trainer for EMD's advanced wind engineering and software courses.

EMD's software products (Windpro) are used by manufacturers, utilities, developers, consultants and public institutions in more than 100 countries and are recognized and

accepted worldwide by financing institutions and local authorities as independent and industry-standard assessment and analysis tools.

1.3.3.2 MMI Thornton Tomasetti

MMI Thornton Tomasetti provides technical consulting and engineering services to enable effective risk management. They assist clients in the analysis, mitigation and management of risks posed by natural and man-made hazards present in a range of industries including:

- Oil and gas & petrochemical
- Nuclear
- Clean energy
- Utilities & infrastructure
- Security & defence
- Aerospace
- Insurance

Their core skills include:

- Safety & Risk Management
  - Enterprise Risk Management Systems
  - Safety Case & COMAH Case Development
  - QRA & PSA
  - Health, Safety & Environmental Auditing
  - Performance Standards Development
  - Quantified Risk Assessment
  - Probabilistic Fire & Blast Risk Assessment
  - ALARP Studies
  - Fault Tree, Event Tree, FMEA, SIL, HAZOP, BowTie +
  - Fire & Gas Detection Layouts/Optimization Studies
  - Security Vulnerability Assessment

- Major Hazards Engineering
  - Fire & Explosion Hazard Derivation
  - Smoke & Gas Dispersion
  - Helideck Studies
  - CO2 & Hydrogen Gas Hazard Assessments
  - Seismic Hazard Evaluation
  - Blast Protection Assessment & Design
  - Seismic Design
  - Fire Response Analysis

- Fire Protection Systems, Inspection & Design
- Safety System Survivability Assessments & Audits

- Engineering Services
  - Structural/Stress Analysis & Design
  - Structural Reanalysis & Reassessment
  - Independent Peer Review
  - Ultimate Strength Analysis
  - Risk-Based Structural Integrity Assurance
  - Structural Health Monitoring
  - Fatigue & Fracture
  - Nonlinear Finite-Element Analysis
  - Geotechnical & Foundation Engineering

- Fluid Mechanics
  - CFD Analysis for Process Design
  - Process Equipment Optimisation
  - Conjugate Heat Transfer Assessment
  - Fire & Explosion Modelling
  - Fluid Network Modelling
  - Flow Assurance
  - Fluid System Design Optimisation
  - Process Systems, Fuel Supply Systems
  - Fire-Fighting Systems Design

- Technical Communication
  - Communication
  - Hazard & Safety Awareness
  - Multimedia Development
  - Process Safety Management
  - Situational Awareness

1.3.3.3 Institute for Green Economy in Suriname (IGES)

The Institute for Green Economy Suriname (IGES) was established in 2013 and originated from Suriname Institute of Management Studies (SIMS). SIMS was established in August 2007 as an educational institution to offer students a Bachelor program in Ecotourism and Sustainable Development Management. Following the execution of many consultancy projects and the discovery that those consultancies were no longer in line with SIMS' mission and vision, the decision was made to maintain responsibilities and authorities regarding the educational programs under SIMS and to establish IGES with the responsibilities for the execution of all Environmental and Social Impact Assessments (ESIA) and other consultancy activities. The objective of IGES is

to develop new strategic research methods to study changes of societies and in extension the causes and results of those changes, which then creates opportunities for Social- Economic and political decisions for the attainment of sustainable development both in Suriname and other countries in the world.

IGES's philosophy is to also associate on a project-by-project basis, as we seek to deliver a high quality product to the satisfaction of our client. We can work in Joint Venture, as sub-consultants, or as specialist, depending on the specifics of the work involved.
IGES has prepared itself by offering consultancies to national and international companies and entrepreneurs in the following fields:

- Strategic Planning
- Project Preparation and Appraisal
- Project Implementation and Management
- Financial Management I and II
- Strategic Market Planning I and II
- Strategic Operations Management
- Advanced Project Management
- Strategies for the profitable aquaculture enterprise
- Utilization of International Standards
- Hospitality and Tourism Management with the emphasis on ecotourism
- Environmental and Social Impact Assessments (ESIA's)

1.3.3.4 Dr. Paul Kerlinger

Dr. Paul Kerlinger is an expert biologist on the project team:

- Experience - Wind Energy and Communication Towers (1994-Present)
    - Member of teams that contributed to pre- or post-construction studies or testimony for 5,700+ turbines (8,500+ mw) now operating in the U.S. (23 states), Spain, Canada, Mexico, Jamaica
    - Lead Avian Biologist on first permits granted for offshore wind energy projects (Cape Wind and Fishermens' Energy)
    - Conducted 37 post-construction bird and bat fatality studies in 13 states
    - Provided expert testimony ~40 times for wind energy and communication tower industries, and NJ Department of Environmental Protection (hearings, trials, depositions) including 16 hearings in Ontario
    - Avian risk assessments, Eagle Take Permits, agency consultation, mitigation design and testing

- Pioneering and conservation award winning research on FAA aviation obstruction lighting on turbines and communication towers leading to proven fatality reduction and
- FAA lighting policy changes

- Expertise and Services

  - Design and conduct avian risk assessments and other preconstruction studies for proposed onshore and offshore wind projects
  - Design and conduct post-construction impact studies at wind turbine and communication tower facilities
  - Development of preventive and compensatory mitigation plans for birds and bats at wind
  - energy and communication tower projects
  - Provide expertise regarding habitat management at proposed and existing wind power
  - facilities
  - Liaison to conservation and regulatory community for wind power projects
  - Review consultant and government reports, and due diligence
  - Provide expert testimony and assist with cross examination of opposition witnesses for
  - wind energy and communication tower legal proceedings

1.3.3.5 Risk Assessment Specialist – Bob Stevens

Mr Bob Stevens has a career of over 50 years related to logistics, facility management, health and safety management. Bob spent some 27 years in the British Army stationed at various bases internationally, where he was responsible for logistics planning, fuel depot management, safety risk assessment and Occupational Health and Safety management. In the British Army Bob was also an Advanced Instructor, Train the trainer instructor and assessor, Chief instructor/Training Officer of Technical School, Petroleum Officer, Health and safety officer and Oil spill response trainer.

After an honourable discharge from the British Army whilst based in Belize, Bob remained in the Caribbean, working as Esso's Fuel Terminal Superintendent and Country Manager in Belize for 7 years, which included responsibility for Security, Emergency planning, Fire, Hurricane, Bomb Threat & Oil Spill, Safety, Health and Environmental issues. Accident investigator. Marine facility manager with responsibility for discharge of ocean tankers. Managing 2 miles of undersea pipelines. This posting was followed by a period as a Safety Consultant and logistics management, Logistics

manager for UTC Overseas, an international heavy hauling and logistics company, including 2 years as UTC's Director of Field Services for the Caribbean.

Bob has completed Industry safety related training over the years, which includes: Health & Safety Officer, UK and Canada and USA, Oil Spill Response Co-coordinator. Fire Prevention Officer, Canadian and British Qualified. Adult Trainer & instructor, Emergency logistics planning with NATO HQ, Logistic supply, warehouse inventory management, Project management Fuel/Gas terminal/supply systems construction and operation, Risk Assessment, Accident investigator, Occupational and Industrial safety.

1.3.3.6 Guyana Ecology Specialists

Birding and Fauna Specialist: Leon Moore

Considered as one of the most knowledgeable field naturalists and bird guides in Guyana. Leon has been active as a naturalist guide since 2008, starting at the Baganara Island Resort on the Essequibo River. Leon has observed over two thirds of Guyana's bird species in all parts of the country, also guiding in Suriname and Cuba. Leon is Guyana's top ranked eBird contributor, and has been involved in the official discovery of a number of new bird species in Guyana. eBird is an online database of bird observations providing scientists, researchers and amateur naturalists with real-time data about bird distribution and abundance. Leon held the post of Assistant Instructor for bird and tour guide training at the Iwokrama International Research Centre, operates a tour company for birding, wildlife and photography, and also leads tours for various other birding tour companies in Guyana. Leon has participated in numerous biodiversity surveys, including for Guyana Gold Fields, US Shorebirds Conservation, and Environmental and Resource Management.

Birding and Fauna Specialist: Waldyke Prince

Waldyke is a veteran bird guide and wildlife biologist, who has led expeditions of professional birders, documentary teams and scientific research in Guyana for many years and has worked in the field since the early 1990's. Waldyke has experience also with biodiversity field work for mammals, fish, reptiles, insects and plants. He served as the guide coordinator, resident wildlife biologist, and naturalist at the Iwokrama International Centre for Rainforest Conservation and Development for a period of 7 years. Waldyke has visually identified over 700 of the more than 800 bird species recorded in Guyana, and is intimately familiar with their habitats, behaviours and vocalisations. Waldyke has worked with many esteemed names in rainforest conservation and bird population studies, including international research teams working at the CEIBA Biological Research Station, expeditions to Mount Ayanganna, the remote Wai-Wai village of Gunns/Masakanari, the Acari Mountains, coastal Shell

Beach wetlands, the savannas and lakes of Berbice and Rupununi, and the forests and waterways of the Mazaruni, Potaro, Paruni, Waina and Baramita rivers. Waldyke also participated as an intern at the Smithsonian Institution in Washington DC, is a member of the American Society of Ichthyology and Herpetology, has attended various birding workshops and conferences, has co-authored publications on mammal behaviour, and has been featured in the National Geographic Magazine and on the Discovery Channel programmes. Wally is a tour guide trainer and contributes to various environmental impact assessments along the coast and interior of Guyana.

Biologist and Bat Specialist: Dr. Dierdre Jafferally

With more than 20 years of experience as a Biologist and Human Geographer, Dr. Jafferally has substantial expertise and experience in biodiversity assessments, and remote communities' studies and training for engagement in conservation in the Guyanas region. Many such initiatives occurred under the mentorship of renowned scientists such as Dr. Graham Watkins, Dr. Burton Lim, Dr. Mark Engstrom and Dr. Jay Mistry.

Dr. Jafferally's strengths include research and data management, project management, ecological monitoring and assessments, environmental laws and regulations, and the engagement of indigenous communities with ecological resource management. Dr Jafferally acted as a field research assistant for faunal assessments of the Iwokrama Forest, contributed as project coordinator to the Arapaima Management plan for sustainable community harvesting and conservation in the north Rupununi and Iwokrama forest region, undertook wetland research, supported fishing communities in developing fisheries management and conservation area plans. Dr Jafferally participated as a Doctoral Research Fellow for the 3-year EU funded Cobra Project which is focussed on grassroots community solutions to solving environmental management challenges in the Guyanas Shield region. Dr Jafferally trained for bat biodiversity surveys under Dr Burton Lim, bat specialist at the Ontario Museum, Canada, providing support for his bat survey work starting at Iwokrama in 2011, and continuing to support his ongoing field work efforts through the subsequent years.

Education: PhD Human Geography (Univ London), MSc Environmental Studies (Univ York), BSc Biology (Univ Guyana)

Biologist and Marine Ecology and Fish Specialists: Mark Ram

Mark Ram holds an MSc. in Forest Biology, a Post-Graduate Diploma in Education, and a BSc. in Biology from the University of Guyana. He is a lecturer in the Department of Biology at the University of Guyana, where he is keenly involved in lecturing, tutoring, and supervision of undergraduate research projects. He has conducted extensive research work on the impacts of mangrove habitat degradation on fish community structure along Guyana's coastal regions, socioeconomic survey and length-based fish stock assessment along Guyana and Suriname coasts, a survey of ecotourism resources and aquatic and terrestrial ecosystems at Orinduick Falls in the interior of Guyana, assessment of Sharks and Rays Diversity of the North Atlantic Ocean, stream quality assessment and mercury content analysis using fish and macroinvertebrates at Cuyuini, Guyana, and comparison of avian and fish diversity in disturbed and undisturbed mangrove ecosystems. Mark is also a consultant on coastal ecology and biodiversity assessments. He has presented papers and posters on various research topics.

Botanist and Mangrove Specialist: Owen Bovell

Owen Bovell has over 30 years of experience in forestry field work, botany, and teaching, with specialisation in coastal mangrove forests. Owen is the present Dean in the Faculty of Agriculture and Forestry at the University of Guyana, where he lectures on botany and forestry topics. Positions include field officer at the Canadian International Development Agency, Senior field officer and then Divisional Forestry Officer at the Guyana Forestry Commission, Lecturer at the Guyana School of Agriculture, Head of the Forestry Department and lecturer at University of Guyana. Mr Bovell has authored numerous reports on forestry and mangrove studies, has presented papers at regional botany conferences, and he has completed numerous consulting assignments and authored manuals in the field of mangrove ecology management. Mr Bovell has an MSc in Natural Resources Management (UWI), a BSc in Forestry (Univ Guyana), and is completing his PhD in Plant Science at UWI.

1.4 Scope of the Environmental and Social Impact Assessment

The scope of this ESIA covers the proposed wind turbines at Hope Beach and Chapman's Grove. It also includes the transportation of material and equipment. This ESIA Report is being guided by the Terms of Reference provided by the Guyana EPA.

This Report contains 20 chapters ordered as follows:

Chapter 2 – Approach and Methodology

Chapter 3 – Legislative and Regulatory Framework
Chapter 4 – Project Alternatives
Chapter 5 – Comprehensive Description of the Proposed Project
Chapter 6 – Stakeholder Identification and Consultation Plan
Chapter 7 – Environmental Impact Analysis
Chapter 8 – Water Resources
Chapter 9 – Soils, Land, Geology
Chapter 10 – Air Quality
Chapter 11 – Shadow Effects
Chapter 12 – Noise and Vibrations
Chapter 13 – Biological and Ecological Resources and Ecosystem Services
Chapter 14 – Transportation
Chapter 15 – Hazardous Waste and Waste Management Materials
Chapter 16 – Landscape and Aesthetics
Chapter 17 – Socio-Economic Impacts
Chapter 18 – Risks and Risks Assessment
Chapter 19- Climate and Climate Change
Chapter 20 – Environmental and Social Management Plan

1.5 Environmental and Social Impact Assessment Study Team

Appendix A contains a copy of the Final TOR as well as CVs of EIA preparers.

2 APPROACH AND METHODOLOGY

This chapter details the methods used in conducting the EIA. This will be discussed under the following headings:

- Study Area and Area of Influence
- Data Collection;
- Impact Identification;
- Impact Classification; and
- Assessment of Cumulative Impacts.

2.1 Study Area and Area of Influence

The study area for the project is the immediate areas of Hope Beach and Chapman's Grove. The Terms of Reference stipulates that the actual area of influence should consider "the extent of direct and indirect interactions between the proposed project and the physical, biological and socio-economic and cultural environments". Figures 2-1 and 2-2 shows the immediate areas of interest to the wind turbine sites. The immediate study area refers to the footprints of the wind turbines, substation and associated infrastructure.

The area of influence for Hope Beach is approximately 198 hectares, while the area of influence for Chapmans Grove is 46.4 hectares. The study areas extend beyond the areas of influence and varies between environmental components.

2.2 Data Collection

As required by the Terms of Reference provided by the Guyana EPA, the description of the existing environment relied on original data collection of the following:

- Surface Water Quality,
- Ambient Air Quality,
- Noise Monitoring,
- Flora and Fauna, and
- Socio-Economic Baseline.

2.2.1 Surface Water Quality

Kaizen Environmental Services Guyana Inc. was contracted by the Innova Energy Limited to conduct river water quality testing at Hope Beach and Chapman's Grove. A full description of the sampling and testing exercise is included as Appendix B.

Sampling and testing was conducted at four water locations, three at Hope Beach and one at Chapman's Grove (see Figure 2-3):

LOCATION	EASTINGS	NORTHINGS
Hope Beach		
HBWS4	394533	745700
HBWS1	394577	745769
HBWS3	395077	745118
Chapmans Grove		
WSCGH1	396836	743164

Water quality sampling locations were chosen based on the drainage at each site and specifically, where runoff from the proposed sites for the wind turbine would discharge. Sampling was conducted according to SMEWW Method number 1060, Collection and Preservation of Samples, in addition to the sampling requirements stipulated in each analytical method with the exception of Oil and Grease whose sampling methodology followed the requirements of USEPA Method 1664. KaizenLAB was responsible for the cleaning and preparation of the appropriate sample containers as specified by the test method.

Sampling activities were completed on October 1st and 28th 2020 at the Hope Beach locations and on November 23rd 2020 at the Chapman's Grove location. Information received from the Hydrometeorological Service revealed the following:

- The rainfall recorded on October 1 and 28 was 0.0mm and 1.5mm respectively.
- The first wet season of 2020 started in the last week of April and ended in the last week of July.
- The second wet season of 2020 started in the first week of November.
- Between the two wet seasons was the long dry season.

Samples were collected and analysed for a selected suite of chemical parameters including pH, Conductivity, Dissolved Oxygen, Biochemical Oxygen Demand, Total Suspended Solids, Total Dissolved Solids, Turbidity, Oil & Grease, Total Coliforms. Trained personnel took all samples as grab samples, which were transferred into iceboxes and maintained at 4°C to KaizenLab in High Street Guyana, where they were analysed as soon as possible. Sampling was conducted in accordance with the

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AREA OF INTEREST - HOPE BEACH

PROPOSED TURBINE LOCATIONS

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DATE:	03/12/21
CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	AREA OF INTEREST - HOPE BEACH
FIGURE NUMBER:	2-1

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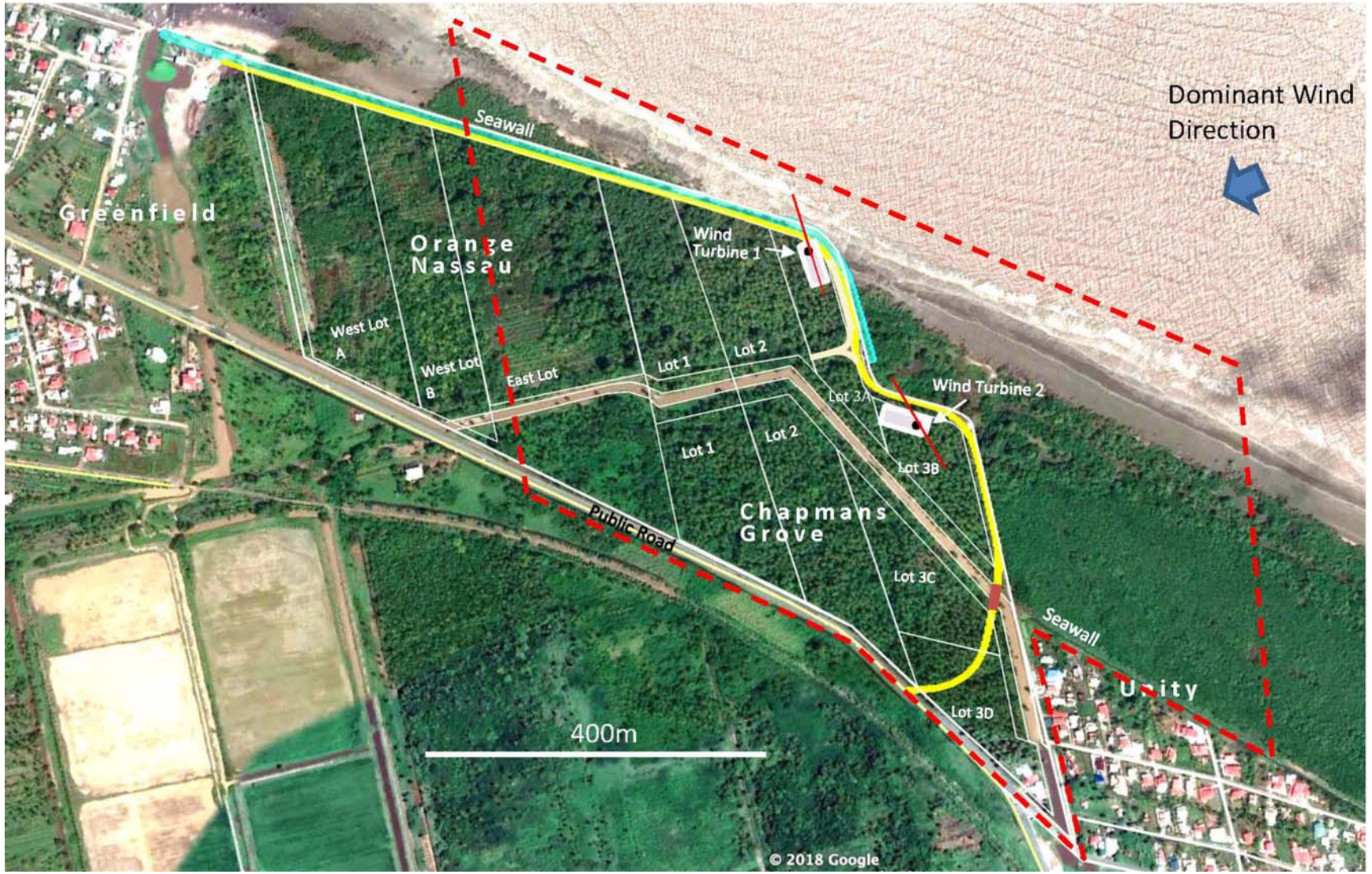

SOURCE: HOPE ENERGY DEVELOPMENT

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DWG. NAME:	AREA OF INTEREST - CHAPMAN'S COVE
FIGURE NUMBER:	2-2

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SOURCE: SATELLITE IMAGE, 2020

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DWG. NAME:	WATER QUALITY MONITORING LOCATIONS - HOPE BEACH
FIGURE NUMBER:	2-3 (a)

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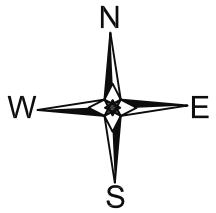

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DWG. NAME:	WATER QUALITY MONITORING LOCATION - CHAPMAN'S GROVE
FIGURE NUMBER:	2-3 (b)

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requirements of Internal Standard Operating Procedure - KLABG SOP 001 (Water Sampling).

2.2.2 Ambient Air Quality

Kaizen Environmental Services conducted ambient air quality at 5 locations: 3 at Hope Beach and 2 at Chapman's Grove (see Figure 2-4). This monitoring was conducted over 24-hour period at each location (based on the requirements of the EPA). In order to comply with the requirements of the Final TOR, the parameters monitored included total particulate matter (PM), PM_{10} and $PM_{2.5}$) using equipment detailed in Appendix C.

2.2.3 Flora and Fauna

2.2.3.1 Flora

The objectives of the survey were to:

a) Identify and describe the structure and composition of the broad habitat types (with clear distinction between natural and modified habitats) and the floristic diversity of the study area, with focus on threatened, endemic, protected, and invasive plant species; and
b) Ground truth, refine and update the draft habitat map prepared using satellite imagery (see below)

The three main habitats were observed:

- Back-barrier Lagoon mangroves at Hope Beach (modified)
- Tidal flat mangroves at Hope Beach (Natural)
- Back-barrier lagoon mangroves at Unity (Natural

Other key habitats were also observed:

- Hope Beach – Grassy relict beach terrace (super-tidal)
- Hope Beach – Fresh water marsh (modified habitat)
- Unity – Vegetated beach ridge (natural, outboard of seawall)
- ChGr mangroves landward of seawall (modified)
- ChGr Coconut Palm plantations (Modified)
- ChGr Open farmland (modified, Orange Grove & mostly landward of main road)

The vegetation survey for measuring the composition, structure and diversity of mangrove and identifying mangrove associates along with a coconut plantation survey was undertaken in October-November 2020. A line-transect method was employed. Line transects were installed at Hope Beach and Chapman's Grove (Figure 2-5 & 2-6). The transects commenced from the waterfronts towards to the landward margin with the lengths depending on the thickness of the mangrove patch (English et al 1997; Malik et al 2015b). A total of 47 plots were established along randomly selected transects using a measuring tape, flagging tapes and nylon rope. Each transect and plot was marked using Global Positioning System (GPS). The sizes for each plot were 0.1 ac (.04ha) for trees ≥10cm, 5m x 5m for saplings, and 2m x 2m for the seedlings (English et al 1997; Malik et al 2015b). The distance between plots was 30m where possible depending on the specific vegetation characteristics and the landscape (Malik et al 2015b). In each plot, the species name and a total number of mangrove trees, saplings and seedlings were identified, counted and recorded. In addition, all stem diameter at breast height (DBH) of trees (≥ 10 cm DBH). The DBH was measures at 1.3 m above the soil surface (Malik et al. 2015b). (see Appendix D).

2.2.3.2 Fauna

Fauna surveys were conducted to collect information on birds, bats, fish, mammals and herps (amphibians and reptiles). The methods used are described in the following sub-section.

Bird, Mammal and Herpetofaunal Surveys

Bird Surveys

The first survey (2018) was conducted at the Hope Beach site from June 21-30, 2018 and the second survey (2020) was conducted at Hope Beach and Chapman's Grove from November 20-24, 2020 and November 25-29, respectively (see Appendix E). The first survey was thus within the May to September period which corresponds to the Austral migration period (Birds which breed in the Southern hemisphere and migrate during the Southern winter period). The second survey was within the September to May Nearctic-Neotropical migration season (birds which breed in the Northern Hemisphere and migrate South to warmer climate during the Northern winter). The Hope Beach study area was divided into two sites: Hope East and Hope West relative to the position of the Hope Canal. The surveys utilised transect lines through the various habitat types (i.e. mudflat, mangrove and marsh at Hope Beach and sandflat, mangrove and coconut plantation for Chapman's Grove) with point counts generally taken at 200 m intervals where possible (see Figures 2-7 and 2-8).

During the 2018 survey (at Hope Beach), from Day 1-5, the transects were sampled during the morning, midday and afternoon periods with approximately 7 minutes being

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DWG. NAME: AMBIENT AIR QUALITY MONITORING LOCATIONS - HOPE BEACH

FIGURE NUMBER: 2-4 (a)

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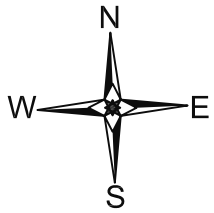

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DWG. NAME: AMBIENT AIR QUALITY MONITORING LOCATION - CHAPMAN'S GROVE

FIGURE NUMBER: 2-4 (b)

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DWG. NAME: VEGETATION TRANSECT LOCATIONS - HOPE BEACH

FIGURE NUMBER: 2-5

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DWG. NAME:	VEGETATION TRANSECT LOCATIONS - CHAPMAN'S GROVE
FIGURE NUMBER:	2-6

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DWG. NAME:	TRANSECT & BIRD COUNT LOCATIONS (2018 SURVEY)
FIGURE NUMBER:	2-7

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DWG. NAME: TRANSECT LOCATIONS (2020 SURVEY) - HOPE BEACH

FIGURE NUMBER: 2-8 (a)

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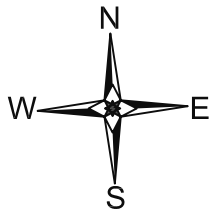

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DWG. NAME:	TRANSECT LOCATIONS (2020 SURVEY) - CHAPMAN'S GROVE
FIGURE NUMBER:	2-8 (b)

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spent at each point count. This method was repeated during the second survey (2020) for both the Hope Beach and Chapman's Grove sites. Additionally, from Day 6-10 special attention was placed on mornings (05:30 – 06:15) and evening (17:00 – 18:30) fly-overs of birds at Hope Beach. These observations were conducted at one fixed point for both East (i.e. end point for the east mangrove transect) and West (i.e. end point for the west mangrove transect) sites. Observations of the fly-over birds were also carried out during the second survey (2020) at both Hope Beach and Chapman's Grove.

Bat Surveys

The survey was conducted to capture the presence and activities of bats paying particular attention to high flying bats during the dark hours at Hope and Chapman's Grove, Guyana. The survey ran for five nights from August 13-17, 2018 at Hope Beach and from February 08-10, 2021 at Chapman's Grove (see Appendix E and Appendix F). Each night monitoring was conducted from 18:00 – 00:00 hrs.

The Hope area was divided into two survey sites, by the manmade canal and sluice. The sites were named East and West with respect to their location in relation to the Hope Canal. Each site comprised of similar vegetative habitats namely; mudflats followed by mangroves and finally marshes moving inland from the coast). The western section of mangrove is approximately 300 m long. The eastern section of the mangrove is approximately 650 m long.

On the western section, the southern mangrove area could be accessed by a dam running west to east. This dam is bordered on both sides by swamp. On the eastern section there were no paths leading into the mangrove and netting was done in the open space between the northern and southern areas.

Two transects, one running west of the sluice and the other east of the sluice to the end of the boundary for the leased land of HED were cleared. These transects were bordered by mangroves on each side. It is important to note that no mangroves were cleared, but only understory shrubs and grasses to facilitate the mist nets.

Originally, fixed points of 200 metres were to be marked along the length of the transect for the placement of nets. However, due to the uneven landscape (hills and old groins) as well as, special distribution of the trees and vegetation, the team chose random open spots in close proximities to the mangrove forest, and water ways to maximize on the chances of capture. G.P.S. coordinates of the sites for ground and canopy nets were recorded.

Mist nets are one of the best methods for sampling bat populations (Wilson et al, 1996). Due to the nature of the proposed activity for the area, it was particularly important to attempt sampling for high flying bats.

Nets were deployed along the dam on the south end of the western section, on the dams leading to the sea and within the open spaces between the mangroves in an attempt to sample both ground and high flying bats. Mist nets were placed in a "T" format to each other.

The nets were set in an area that provided a tunnel like effect acting as a pathway for bats to fly in an attempt to maximise the diversity of bats that maybe captured. In total, 14 nets were deployed. On the western section 8 nets were set, 3 canopy and 5 ground nets. On the eastern section 6 nets were deployed, 3 canopy and 3 ground nets. Due to the open spaces of the western section, more nets were placed than the Eastern section, as bats tend to fly in open spaces, as it is easier to echolocate. The nets deployed were all of dimensions 12 m x 3 m nets.

The nets were all opened by approximately 18:00 hrs and closed by 00:00 hrs (midnight) and checked every one and a half hour for captured individuals. After removal, bats were identified using the field key Bats of the Guianan Subregion developed by Lim and Engstrom from the Royal Ontario Museum and Mammals of the Neotropics by Emmons and Feer (first edition).

Fish Sampling

Fish sampling was done using a combination of gear types to capture the variation of habitats that exists at both locations (see Appendix G). At both locations, gillnets and cast nets were used to capture fishes from the larger canals, while a drag seine was used for the smaller channels. The gill nets were deployed in the morning and checked hourly until dusk. The cast nets were thrown until the boundaries of the canals were covered. The drag seine was set at random spots along the smaller channels, and the fishes were chased into the net; this was done until the entire length of the channels were covered. Sampling was conducted between 20-30 November 2020.
Once caught, fishes were removed from the nets, photographed, measured, identified, and released back into their native habitats. Fishes were measured using a tape, and they were identified using identification guides and taxonomic keys.

Mammals and Herpetofauna

A Visual Encounter Survey at each site were undertaken to determine the presence, distribution and relative abundance of mammals (see Appendix E). The survey team recorded all mammals and herpetofauna seen on each site.

2.2.4 Ambient Noise Monitoring

Environmental Noise Monitoring was conducted at six locations for a period of five days in the residential areas closest to Hope Beach and at the Hope Secondary School during April 25 to 30, 2018, and a second survey at the closest residential location at Unity and two non-residential locations at Chapman's Grove during June 01-11, 2020. The sites are representative of residence receptors nearest to the planned wind turbines, and the nearby school, and were selected by HED's wind engineering consultant in line with recognized industry practice (see Figures 2-9 and 2-10).

Ambient noise monitoring was conducted in accordance with World Bank guidelines. This provided guidance on duration or monitoring, choice of monitoring location and equipment to be used for monitoring. Ambient noise measurements were made at locations representative of all the closest residential receptors and the school, and additional receptors were chosen further away from the main road and away from residential areas.

Table 2-1 below shows the monitoring locations selected.

TABLE 2-1: NOISE MONITORING LOCATIONS

LOCATION NUMBER	LOCATION	DESCRIPTION	G.P.S. COORDINATES
1	Residential	Across the road from wetland, 250m south of flood control pumps	21 N 0394332 0745470
2	Hope Secondary School	Site borders the wetland and is a non-residential location only occupied during the daytime. This was the quietest monitoring location	21 N 0394828 0744829
3	Residential	Located next to a construction site where house-building activities were taking place weekdays	21 N 0394828 0744829
4	Residential	Close to Small Church, Wash Bay and Shop	21 N 0395059 074460
5	Residential	Close to a drainage Canal	21 N 0395421 0744571
6	Residential	Close to a Sawmill,	21 N 0395747

LOCATION NUMBER	LOCATION	DESCRIPTION	G.P.S. COORDINATES
		which was not in operation during the times of visit.	0744350

Further details of the method and the equipment used is included as Appendix H.

2.2.5 Socio-Economic Baseline

A full description of the methods used in the Socio-economic Impact Assessment is included in Appendix I.

In June and October 2020 scoping surveys were carried out along the Demerara. Berbice Highway from the beginning of the small sluice at Hope to the beginning of Ann's Grove.
A total of one hundred and seven (107) persons were randomly approached door to door to complete the survey. This was done to gain insight on the basic characteristics of the residents in the vicinity of the project area, their knowledge about the project, their attitude towards the project and possible concerns.

The survey was conducted using an online survey tool (Enketo Kobotoolbox). The surveys included only a third of the number required for statistical significance of the study (107 / 367 respondents, based on population data of 2012). Though the survey results are therefore not statistically representative for the area, they can be used to illustrate the current situation and where necessary to support outdated data. After the completion of the survey, online dashboards and analytical summaries were immediately generated and used for report writing purposes. The survey example is included in an Annex to Appendix I.

In February 2021 a third survey was conducted in the project area, including 262 respondents (including 70% of respondents from the 2nd survey who were questioned again). This survey was statistically significant, with a confidence interval of 85% based on population data of 2012.

In addition to the surveys, an outreach session with a total of 20 fishermen at the large sluice (8-door sluice) at Hope was also held. They were interviewed on their awareness and knowledge of the Hope Beach Wind Farm Project. Their attitudes and concerns regarding the project were also taken into consideration.
Interviews were also held with key persons in 2020. In contrast to the discussions held in 2019, these conversations were conducted during the Covid-19 pandemic and also provide new light with regard to the socio-economic situation against the background of

SOURCE: SATELLITE IMAGE, 2019

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ECO REPORT NO. 05/2020

DATE: 03/12/21

CLIENT: HOPE ENERGY DEVELOPMENT INC.

PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA

DWG. NAME: NOISE MONITORING LOCATIONS - HOPE BEACH

FIGURE NUMBER: 2-9

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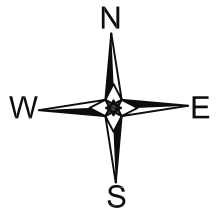

SOURCE: SATELLITE IMAGE, 2019

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DWG. NAME:	NOISE MONITORING LOCATIONS - CHAPMAN'S GROVE
FIGURE NUMBER:	2-10

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the Coronavirus and its impacts. A selection of 6 persons from different sectors were interviewed:

- Farmers in the Hope area;
- Business leaders;
- Key persons from the National Democratic council; and
- Additional one on one interviews with fishers

2.3 Impact Identification

The potential impacts of this project (beneficial as well as adverse) were identified from the likely construction methods to be employed, from general guidance documents, review of literature and Ecoengineering's experience on construction projects from 1991 to present (see Appendix J). Additionally, case studies for two regional wind farm projects in Curacao and Jamaica were studies to determine the potential impacts associated with such a project. These case studies are also presented in Appendix J)

2.4 Establishing the Significance of Impacts

The potential impacts of this development were assessed on both a qualitative and quantitative basis. Different degrees of sophistication were used in assessing different impacts. Where mitigation measures were recommended, the assessment assumes that these measures will be implemented.

2.5 Impact Classification

After the significance of each impact was assessed, each potential impact was classified on a structured basis, assuming the worst-case scenario. The classification method (see Appendix K) was based on three criteria: Extent, Intensity, and Duration. Figure 2-11 identifies the Classes of Extent. Based on this, pre and post-mitigation impacts were classified as Low, Moderate, High or Extreme. Where adverse impacts were considered to be insignificant, no classification was applied. The classification of each impact is indicated in the respective sub-section of Chapter 7 as well as the individual chapters where impacts are analysed and classified. A summary of the Post-Mitigation Classification is provided in Table 5-1.

2.6 Cumulative Impacts

A simple definition of cumulative impact (Canter, 1996) is as follows:

"The impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable actions..."

The following projects will be considered in the discussions on cumulative impacts:

- Housing Development located East of Mahaica Bridge;
- Agricultural activity in Hope located East of Hope Canal;
- Construction of Hilton Hotel in Mc Doom;
- Construction of Radisson Blu Hotel – Georgetown; and
- Seawall construction to Unity

It must be noted that for a project to have a cumulative impact with the wind farm project, it must be within the same geographic area and within the same timeline. The activities associated with EEPGL's FPSO are not expected to have a cumulative impact with the wind farm project.

In assessing cumulative impacts, it must be noted that HED is not responsible for the actions of other individuals / parties and therefore cannot mitigate against impacts associated with the actions of others. HED can only implement mitigation measures to reduce the impact of their own activities.

SOURCE: SATELLITE IMAGE, 2020

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DWG. NAME:	CLASSES OF EXTENT - HOPE BEACH
FIGURE NUMBER:	2-11 (a)

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SOURCE: SATELLITE IMAGE, 2020

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DWG. NAME:	CLASSES OF EXTENT - CHAPMAN'S GROVE
FIGURE NUMBER:	2-11 (b)

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3 LEGAL AND REGULATORY FRAMEWORK

This Chapter presents both the national and international legal framework for environmental and social protection in Guyana for renewable wind energy projects. In the absence of local standards, reference has been made to relevant regional and international standards. This EIA has been guided by the regulations of the Guyana EPA, and assessments have been undertaken to meet these requirements where available information and timescales have allowed. The project will be required to defer to the most stringent requirement except in cases where national law or regulations have been explicitly identified as taking precedence over more stringent international standards.

3.1 National Legal and Policy Framework

Guyana gained independence from the British Monarchy in 1966 and became a republic on February 23, 1970. The Constitution of Guyana, which came into effect on October 06, 1980, is the highest governing document in the Republic of Guyana, and it spells out the powers and branches of the government. There are three branches of government: the Legislature (National Assembly); the Executive (President, Cabinet and Government Departments) and the Judiciary (Courts).

The Executive Branch governs Guyana. According to the Constitution of Guyana, the President of Guyana is the head of government of the country, the head of state and the commander-in-chief of the Republic's armed forces. He appoints the Prime Minister and other Ministers and assigns responsibilities to them. He also supervises various ministries and the respective minsters who head them. The President is not required to be a member of parliament, but is granted the privilege of addressing Parliament either directly or via designation. The Presidency is an elective post, where an elected President serves a maximum of two consecutive 5-year terms.

The Legislature Branch (National Assembly) is the arm of government mandated to make, change and amend laws. The National Assembly is comprised of 65 seats, and a Speaker who is the leader of the National Assembly with the responsibility of overseeing the administration of the House. The Prime Minister (who is deputized by the President) is the official Executive's representative in the National Assembly, responsible for looking into government interest.

The final branch, the Judiciary vests its authority in the courts, with the Court of Appeal as the highest judicial body. The courts determine and interpret the law. They are independent and impartial and subject only to the Constitution and the law. The Court of Appeal is headed by the Chancellor of the judiciary who is appointed by the

President. The next body in the Judiciary is the High Court which is led by the Chief Justice who is also appointed by the President.

A full range of laws, regulations, policies, acts and decrees support the Constitution. The key government bodies in relation to the proposed wind energy project and their main responsibilities discussed in the following subsections.

3.1.1 The Environmental Protection Agency

The Environmental Protection Agency (EPA) is mandated under section 3 of the Environmental Protection Act (Amended, 2005), as a body corporate to establish, monitor and enforce environmental regulations, co-ordinate an integrated coastal zone management programme and carry out other functions in relation with environment protection and enhancement as set out in section 4. The same section sets out powers of the Agency, specific duties and principles of environmental management.

The EPA along with the Environmental Assessment Board (EAB) has developed guidelines for the conduct of Environmental Impact Assessments (EIA), which are required to be done by independent consultants, with the requisite skills, expertise and experience and approved by the EPA. The latest of these guidelines was issued in 2020. The EPA has also developed sector guidelines for electricity transmission which support the main EIA guideline document. Although this document does not specifically address wind farms, it does provide details of the contents of an ESIA for electricity transmission that are useful. In addition to guidelines for EIAs, guidelines for Environmental Baseline Studies, Environmental Assessments, Environmental Impact Statements and Environmental Management Plans have also been developed.

The Environmental Assessment Board (EAB) is mandated under the Environmental Protection Act to provide an independent contribution to the development and finalization of the EIA Report. The EAB recommends to the EPA the acceptance or rejection of the EIA Report and the conditions of the Environment Permit once a decision is taken to grant one.

3.1.2 Ministry of Public Works

Ministry of Public Works is a multifaceted Government organization with a large portfolio that encompasses sea and river defences; sea and air transport; sea and air security/safety; roads and bridges construction/maintenance; stellings and electricity

sectors. The main divisions that are applicable to the HED Wind Project are described below.

3.1.2.1 Guyana Energy Agency

The Guyana Energy Agency (GEA) is mandated under the Guyana Energy Agency Act (amended 2005) to advise and make recommendations to the Minister regarding measures necessary to secure the efficient management of energy and the source of energy in the public interest and to develop and encourage the development and utilization of sources of energy other than sources presently in use. Other core functions of the Agency that are applicable to the proposed HED Wind Farm are:

- To develop a national energy policy and secure its implementation (see Section 3.2.3);
- To carry out research into all sources of energy including those sources presently used in Guyana for the generation of energy, and securing more efficient utilization of energy and sources of energy.
- To disseminate information relating to energy management, including energy conservation and the development and utilization of alternative sources of energy.
- To study and keep under review, matters relating to the production, recovery, processing, transmission, transportation, distribution, sale, purchase, exchange and disposal of energy and sources of energy within and outside of Guyana.

3.1.2.2 Guyana Power and Light

Guyana Power and Light Incorporated (GPL) is the largest supplier of electricity in Guyana, which is 100 percent owned by the government and the people of Guyana. GPL generates, transmits and distributes electricity to most areas along the coastal plain of Guyana. The core sustainable objectives of GPL are to:

- Provide reliable, affordable and quality energy services to all our customers;
- Comply with all applicable regulations and standards,
- Safely and sustainably develop and operate our systems, and
- Develop the capabilities of our employees.

GPL, in accordance with the requirements of the company's License (Amended October 4th, 2010), the Public Utilities Commission Act, 1999, the Electricity Sector (Technical Standards) Regulations 2008 and the Electricity Sector Reform Act (1999) have developed their five-year development and Expansion Program (2016- 2020). Under this Plan, GPL has indicated their openness to renewable energy and their engagement

in a number of potential Independent Power Producers (IPPs). They further mentioned the consideration of the proposed Wind Energy project at Hope East Coast Demerara.

In light of them embracing the Government of Guyana's vision for a green state, GPL has established Technical Guidelines and an Interim Interconnection Agreement (with GPL) for the establishment and installation of solar and wind farms. In summary, these guidelines are as follows:

- Solar and wind installations must be compliant with the National Electric Code, and all interconnection equipment must conform with relevant standards;
- Solar systems with a generation capacity of 100kWac are allowed for customers, however, any systems with a capacity of more than 100kWac are subject to GPL's interconnection agreement.
- All installations over 100kWac and over will be subject to an interconnection assessment in accordance with GPL's Grid Code and Interim Interconnection Requirements

GPL requires that customers or companies interested in establishing these green energy systems must formally submit a request for interconnection of electricity with GPL's network. For this project, HED has applied to GPL for the installation of the proposed wind farm and interconnection with the grid.

3.1.2.3 Guyana Civil Aviation Authority

The Guyana Civil Aviation Authority was established in 2002 as mandated under the Guyana Civil Aviation Act (2000, amended 2018) and responsible for managing and regulating the aviation sector in Guyana and ensuring their compliance with international standards. Specifically, the Authority regulates and manages the aviation sector in accordance with the Civil Aviation Act (2000), and the Civil Aviation (Air Navigation) Regulations 2001, Air Transport (Licensing of Air Transport Services) Regulations 2001, The Civil Aviation (Security) Regulation 2004 and Civil Aviation (Air Traffic Services and Rules of the Air) Regulations 2006 made under the act.

The Guyana Civil Aviation Authority, under the Civil Aviation Act, in ensuring that the airspace is navigable and free from obstructions, will firstly determine whether the area of the proposed wind farm is a highly trafficked zone and will also grant an Aviation Permit (with conditions) (for the construction of structures greater than 200 feet tall).

3.1.2.4 Sea and River Defense Board

The Sea Defense Board (2018-2020) was established by the Ministry of Public Works to establish and manage Guyana's critical flood protection systems.

The Sea Defense Board is consulted on applications which involve the development of land located along watercourses or within the foreshore, sea river or outer dams to ensure that the proposed development in any way obstruct or destroy the sea defence. As part of the HED Wind Farm, consultations were held with the Guyana Sea Defense Board, regarding the placement of the wind turbines.

3.1.2.5 Transport and Harbours Department

Under the Transport and Harbours Act, The Transport and Harbours Department was developed with the mandate to plan, build and maintain a reliable, safe, efficient and cost-effective Road Network.

As part of this Wind Farm project, approvals will have to be sought from the Transport and Harbours Department to establish suitable access roads to the development, and to upgrade, as necessary, roads and bridges to accommodate the transport of components for the wind turbines.

3.1.3 Public Utilities Commission

The Public Utilities Commission is a body corporate established under the Public Utilities Commission Act (1990, Amended 2016). Currently, the Commission operates under the appointment of three Commissioners. The functions of the Commission are regulatory, investigatory, enforcement and such other as conferred on it by the Act. The core objectives of the Public Utilities Commission are to:

- Establish and enforce rules and procedures for the regulation of public utilities, commensurate with internationally accepted regulatory standards.
- Promote and regulate the efficient long-term provision of utility services for national development consistent with Government's policy.
- Provide a fair environment conducive to business interest, investment in the public utilities sector, and the interest of consumers.
- Investigate and seek to resolve in a timely manner, complaints filed with the Commission against any public utility.
- Carry out its functions in a fair, transparent and independent manner.

It should be noted that the Commission does not issue licenses for the operation of any utility. However, the Commission is responsible for approving the power purchase agreement between GPL and independent power producers (such as HED).

3.1.4 Ministry of Agriculture, National Drainage and Irrigation Agency

The National Drainage and Irrigation Authority (NDIA) was established under the Drainage and Irrigation Act (2006) to deal with all public matters pertaining to management, improvement, extension and provision of drainage, irrigation and flood control infrastructure services in the country. In meeting its mandate, the NDIA has focused on improving and upgrading drainage and irrigation services countrywide, thereby improving productivity. This includes constructing and rehabilitating sluices that are found to be functional through suitable foreshore conditions along the coast, particularly in areas with excess rainfall. The newly rehabilitated sluice at Hope Beach was one of the sluice gates under NDIA's mandate. As such, consultations with and approvals from the NDIA is required when conducting construction / development works near sluice gates.

3.1.5 Ministry of Agriculture, National Agricultural Research Extension Institute

The National Agricultural Research and Extension Institute (NAREI) was established following the assent of the National Agricultural Research and Extension Institute Act 2010 in March 2011. Its creation expanded the services offered by the then National Agricultural Research Institute, which was formed in 1984. NAREI continues to promote greater efficiency in the crops and agricultural product industry; providing enhanced services in Agricultural Research, Extension and Crop Protection thereby allowing effective administration and regulation of trade, commerce and export of crops and agricultural products.

In addition, under NAREI the Guyana Mangrove Restoration Project was executed during 2010-2013. Following completion of the Project phase and given the importance of mangroves to Guyana's coastal defences, mangrove restoration and management was integrated into NAREI in 2014. For the HED Project, there are coastal mangroves situated in close proximity to the footprint of the wind turbines. HED consulted with NAREI regarding the present mangrove system in the vicinity of the proposed wind farm. NAREI indicated that approval will be required once mangrove trees are to be removed to facilitate the wind turbines.

3.1.6 Office of Climate Change

The Office of Climate Change is the governmental agency responsible for leading the development and implementation of national policies and actions for 'climate change mainstreaming' and the coordination of efforts to mitigate and adapt to climate change. Originally conceived primarily to support the preparation and implementation of the Low Carbon Development Strategy in 2009 the Office is expanding its role to lead Guyana´s national climate change efforts.

The OCC is the National Focal Point for climate change and to the United Nations Framework Convention on Climate Change (UNFCCC) and therefore has a core responsibility to co-ordinate Guyana's international engagements with the UNFCCC and other climate change processes.
Specific to this project, HED will liaise and consult with the OCC regarding adaptation and mitigation measures related to climate change, sea level rise and coastal protection.

The applicable pieces of legislation and policies applicable to this project are described in the subsequent sections.

3.2 Energy Laws and Policies

3.2.1 Electricity Sector Reform Act, 1999

The Electricity Sector Reform Act (ESRA) was enacted in 1999 to provide for the regular, efficient, coordinated and economical supply of electricity and for matters incidental thereto or connected herewith. Under this Act, the Government of Guyana granted a license to Guyana Power and Light Incorporated (see Section 3.1.2.2) for the generation, transmission, distribution, storage, furnishing and sale of electricity. In addition, GPL can enter into power purchase agreements with independent power producers licensed under the Electricity Reform Act, for additions of generation capacity to the system, provided that such independent power producers generate electricity from alternative forms of energy using renewable resources and provided that such power purchase agreements (Section 4):

a) Are on terms and conditions acceptable to both the independent power producer and GPL,
b) That the terms affecting the rates have been approved by the Public Utilities Commission,
c) That the terms and conditions so approved are commercially prudent and viable, will not adversely affect or will enhance the system-wide capacity, reliability and efficiency of the public supplier, and are compatible with national energy policy.

The duties of the Minister responsible for the electricity sector includes (Section 65):

a) to secure a regular, efficient, coordinated and economical supply of electricity and to ensure that all reasonable demands for electricity are satisfied;
b) to protect the interests of consumers of electricity supplied by persons authorised by licences to supply electricity in respect of: the prices charged and other terms of supply; the continuity of supply; the quality of the electricity supply services provided; and the provision of electricity in rural areas;
c) to ensure that public suppliers are able to finance the activities that they are authorised by their licences to carry on, and to obtain the rate of return, if any, provided for in their licences or a written agreement with the Government, or, if no rate of return is provided for in a licence or such written agreement, to obtain a reasonable rate of return on capital invested;
d) to promote efficiency and economy on the part of persons authorised by licences to supply electricity, including, but not limited to, promotion of alternative forms of electricity generation using renewable resources wherever commercially feasible;
e) to promote the efficient use of electricity by consumers;
f) to protect the public from dangers arising from the supply of electricity;
g) to take into account the effect on and protection of the physical environment with regard to activities connected with the supply of electricity;
h) to enforce the provisions of this Act and any licence or exemption granted pursuant to this Act; and
i) to carry out national energy policy.

Specific to the HED Wind Farm, Part II of the ESRA, speaks to the requirements for licensing suppliers of electricity, including independent power producers and private suppliers. It requires that a persons or company obtain a license to supply electricity to his themselves, their premises and others in the immediate vicinity. The Act also prescribes the terms and conditions under which a license may be granted.

For this project, HED has applied to GPL for a license to install, operate and transmit electricity generated from the wind turbines into the national grid. GPL has listed various interconnection stipulations to which the turbines can be constructed and operated.

3.2.2 The Public Utilities Commission Act, 1997

The Public Utilities Commission Act passed on October 24, 1997 (updated 2016) makes provisions for the establishment, functions and procedure of the Public Utilities Commission (PUC) and related matters. The Act addresses the functions of the Commission and the duties of other utilities in complying with the Commission. Under

this Act development and expansion by other public utilities should obtain approval from the Commission.

The functions of the PUC listed under section 21 states that in carrying out its responsibilities the PUC is bound by the provisions of the Guyana Energy Agency Act and Electricity Sector Reform Act, the terms of any licence issued by the Government to a public utility, and the terms of agreement between the Government and a public utility, or between the government and an investor. The PUC is responsible for economic research in support of assessing rates and efficiency for public utility services, monitoring regulatory trends in Guyana and other countries to inform its decisions on standards, quality of service, pricing and evaluation development and expansion programmes. The PUC shall act in an advisory capacity to the Minister in matters related to public utilities in matters referred to it by the Minister.
Section 25(2) states that where an agreement for the privatization of a public utility between the Government and an investor, the license granted to the public utility or written law makes provisions for the standard quality of service. In keeping with this clause, The Guyana Energy Agency and Guyana Power and Light has prepared policies to guide green energy, and an Interconnection Agreement for the installation of green energy systems respectively.

Section 32 and 33 regarding rates states that rates must be just and reasonable, and in determining the rate the PUC shall have regard to consumer interest and investor interest and to the rate of return in other enterprises having similar risks, provision of safe and adequate service at a reasonable cost, and to ensure the financial integrity of the enterprise. Where the public utility purchases electricity from an independent power producer the PUC has the power and authority to investigate the cost of such generation.

3.2.3 Draft National Energy Policy (2015)

Under the Guyana Energy Agency Act, the Guyana Energy Agency (GEA) - the body charged with developing and implementing a coherent national energy policy - is required to tender any advice needed by the Minister assigned authority for the administration of the Electricity Sector Reform Act (ESRA). In some cases, the Minister is required to consult with the GEA before taking action under the ESRA. Under section 6 of the ESRA, for example, the Minister is precluded from granting a licence without requesting and receiving the advice of the Agency. The Minister is also required to seek the Agency's advice before modifying the terms and conditions of a licence

The 2015 draft National Energy Policy of Guyana updates the 1994 National Energy Policy of Guyana, while reflecting the current national, regional and international commitments made by the Government of Guyana and its agencies up until 2016. This updated Policy takes into account, factors such as the growing concerns about climate change, environmental sustainability, recent costs in renewable energy technologies and the maturity of energy efficiency technologies and techniques. The Policy lists eight overall objectives, as well as specific energy policy objectives that target energy demand and end use in the main economic sectors of Guyana. These overall objectives and goals for energy demand and use are to:

1. Decrease energy use through energy conservation and efficiency per unit of GDP;
2. Increase the demand for clean and sustainable energy from renewable energy resources;
3. Increase the likelihood that consumer energy consuming behaviour and decisions will be in keeping with the principles of the Green Development Strategy; and
4. Increase access to reliable, clean, least cost and affordable energy services that serve the basic needs and demands of the population.

For the electric sector, the goal is to work towards the achievement of 100% renewable energy penetration in the electric sector by 2025. Specific to the HED Wind Farm Project, the Government of Guyana's intentions, as listed in the Policy are:

- Facilitate the Guyana Power Company (GPL) in undertaking least cost expansion planning and considering grid scale wind energy;
- Develop a licensing procedure aimed at Independent Power Producers (IPLs) to produce bulk power from renewable energy and feed into the national electric grid;
- Encourage private sector participation in the development and installation of utility scale solar and wind farms;
- Identify and secure new solar wind energy sites, and commence investment grade resource measurements as inducements to the private sector developers;
- Mandate GPL with collaboration from the Guyana Energy Agency (GEA) and the private sector to implement an electric utility demand side management program;
- Investigate the technical, socio-economic and environmental impacts of the integration of distributed generation;
- Set policy guidelines for the Public Utilities Commission (PUC) to require that GPL develop and publish a grid code inclusive of an interconnection policy, for small scale distributed renewable energy systems, and a standardized power purchase agreement (PPAs) for IPPs to interconnect and integrate into the national grid;

- Set policy guidelines to determine an appropriate market share for distributed generation versus IPP's versus GPL in respect to the generation of renewable energy; and
- Identify potential Wind Energy Zones. Collaborate with GPL to define the wind farm zoning process, inclusive of resource assessment, geotechnical and environmental impact assessment, securing land rights, preliminary transmission planning and developing power purchase agreements.

3.3 Regulatory Framework for Land Management and Environmental Protection

In Guyana, the Guyana EPA, Department of the Environment (Department of Environment and Climate Change) and the Ministry of Communities are the main government agencies which are responsible for overall land management and environmental protection. In addition, several different pieces of legislation have been enacted and amended with the intention of providing the necessary legislative framework for the many different agencies dealing with these matters. The ones relevant to this project are summarized in the following sections.

3.3.1 The Environmental Protection Act and Regulations

3.3.1.1 The Environmental Protection Act, 2005

The Environmental Protection Act (Amended), 2005, establishes the basic institutional and regulatory framework within which all activities that may significantly impact on the natural, social, and cultural environments are assessed. The act establishes the EPA (Environmental Protection Agency), the Environmental Assessment Board, regulations for the prevention and control of pollution, Environmental Appeals Tribunal, the Environmental Trust Fund.

Under this Act the requirement for Environmental Impact Assessments are established. It becomes imperative that developers apply to the EPA for an environmental permit. This permit application in the form of an EPA Application form requires information concerning:

- the site, design and size of the project;
- possible effects on the environment;
- the duration of the project; and
- a non-technical explanation of the project.

Upon review of the application the EPA will determine whether or what level of environmental assessments would be required, the possibilities include an Environmental Impact Assessment (EIA), an Environmental Baseline Study, an Environmental Assessment (EA) or an Environmental Impact Statement. Hope Wind Energy, Inc. submitted the EPA Application on September 21, 2018. The EPA indicated that an EIA was required and prepared draft Terms of Reference. By way of an email dated February 2020, the EPA indicated that the TOR was mistakenly labelled 'Draft" and that it should be considered the final TOR. The flow chart below (Figure 3-1) outlines the EPA application and approval process.

The EIA comprises all three components, the Environmental Baseline Study, the Environmental Assessment and the Environmental Impact Statement. The Environmental Baseline Study records the present quality of the environment within the area influenced before project implementation. This data will be analyzed in the Environmental Assessment and used to predict and quantify impacts. The Environmental assessment identifies and assesses the impacts of the proposed project and of its alternatives. The EA also considers mitigation measures to offset negative impacts and will assess the impact of implementing these measures on the environment. The Environmental Impact Statement is a summary of the findings of the Environmental Impact Statement and the Environmental Assessments and includes an Environmental Management Plan.

3.3.1.2 Applicable Regulations

Regulations on Hazardous Waste Management, Water Quality, Air Quality and Noise Management were established under the Environmental Protection Act in 2000. These pollution management regulations were developed to regulate and control the activities of developmental projects during construction and operation. Standards establishing the permissible parameters under these regulations are being developed. The following are discussions of applicable regulations under the EPA Act.

Water Quality Regulations

These regulations require registration and environmental authorization by any person whose construction, installation, operation, modification or extension of any facility cause the discharge of effluents. They cover parameter limits of effluent discharges, new sources of effluent discharges, fees for registration and environmental authorization, sampling points, records and reports and general provisions for the registration of water effluent, biological integrity, spills or accidental discharges and standard methods of analysis. Guidelines on the discharge of effluents and disposal of sludge are detailed in these regulations. The Guyana National Bureau of Standards (GNBS) has established Interim Effluent Discharge Standards which have been adopted by the EPA. No effluent will be discharged by the project.

Stages in Obtaining an Environmental Permit - EIA Required

EPA will provide the developer with a list of consultants for selection. The developer will submit to the **EPA** the choice of consultants to conduct the EIA for approval

ration: 14 days

↓

EPA reviews the team of consultants so as to ensure that the required expertise is present and notifies the developer as to whether the consultants have been approved.

Duration 7 days

↓

The **developer** publishes in a daily newspaper notice of the project and makes available copies of the project summary. The **public** has 28 days to make written submission on issues/concerns they wish to be considered in the EIA.

ration: 28 davs

↓

EPA and the EIA consultants, facilitated by the **EAB**, carry out scoping exercises and develop the Terms of Reference for the EIA, taking into account both written submissions from the **public** and concerns raised at any public consultation during the 28-day period.

↓

EIA study and preparation of report

Note: The process should be interactive in so far as the (a) multidisciplinary approach, (b) baseline data, (c) Impact Assessment and (d) Environmental Management Plan, are concerned.

↓

EIA study completed

↓

The developer submits 8 copies of the EIA and 1 electronic copy to the **EPA** for evaluation and recommendation. The **EPA,** at the developer's expense, publishes in a daily newspaper notice confirming that the EIA has been submitted.

Duration: 3 days

↓

EPA and **sector agency** review EIA

↓

EIA submitted to the **EAB** for review, along with comments from the **EPA** and **sector agency**, and submissions from the **public**. The **EAB** recommends to the **EPA**:
- whether the EIA is acceptable
- whether an Environmental Permit should be granted
- what terms and conditions should be included in the Permit

The **public** has 60 days to make submissions to the **EPA/EAB**

↔ Additional information required

↓

EIA revised, addendum submitted*

30 days for review of the new EIA/Addendum

Total Duration 90 days

↓

EPA considers EIA review report in which the recommendations from the EAB and the views of the **public** are documented.

Duration: 10 days

↔ Consultation with developer

↓

Environmental Permit not granted.

↓

Developer may appeal against the **EPA**'s decision to the **EAT**. Notice must be filed within **14 days**.

Environmental Permit granted. The Permit is subject to conditions the **EPA** identifies as necessary to protect and conserve human health and the environment and promote the principles of sustainable development. The **EPA** shall publish its decision and the grounds upon which it is made.

*Depending on the significance of the information requested, the EIA may need to be re-submitted either as a revised document or as an addendum to the EIA.

Ecoengineering Consultants Ltd.

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ECO REPORT NO. 05/2020	CLIENT: HOPE ENERGY DEVELOPMENT INC.	FIGURE NUMBER: 3-1 (REV-1)
DATE: 03/12/21	PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA	
	DWG. NAME: EPA APPLICATION AND APPROVAL PROCESS	

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Air Quality Regulations

These regulations require the registration and environmental authorization by persons with facilities that emit air pollution from any process into the atmosphere and are outlined in these regulations. Elements related to parameter limits on air contaminants and emission samplings, the fees associated with registration, prohibitions against new and altered sources of air emissions, requirement and approval of plans, emission controls and offences and penalties are also stated in the regulations. The list of air contaminants for which parameter limits are to be set by the EPA are also detailed in the regulations.

Under these regulations it is necessary to register with the agency and at least 90 days prior to commencement of emissions submit an application for environmental authorization. The Regulations list the contaminants but the parameter limits are yet to be specified. The limits for the installation phase of the project would be specified by the EPA upon the application for environmental authorization. These included:

- Smoke
- Solid Particles
- Sulphuric acid mist or sulphuric trioxide
- Fluoride compounds
- Hydrogen Chloride
- Chlorine
- Hydrogen Sulphides
- Nitric acid or oxides of nitrogen
- Carbon monoxide.

The operation of the wind turbines will not generate significant air emissions.

Noise Management Regulations

Under these regulations operations that emit noise in the execution of various activities such as construction, transport, industry, commerce and any institution are required to apply to the Agency for an environmental authorization. The Regulations indicate the general requirements to apply for an authorization, the permissible noise levels, factors involved in the determination of the point of emissions, applications for variance, prohibitions against new and altered sources of noise pollution, requirements and approval of plans, restrictions on construction activities, power to waive restrictions, restrictions, penalties and fees. The GNBS (Guyana National Bureau of Standards) is responsible for the establishment of standards for permissible noise levels in industry, construction and other areas. GYS 263: 2010 Guidelines for Noise Emissions into the Environment' lists categories for which permissible noise levels are to be fixed and were identified as follows:

- Residential
- Institutional
- Educational
- Industrial
- Commercial
- Construction
- Transportation and
- Recreational.

The EPA has in collaboration with the GNBS developed interim noise standards for residential areas, which stipulate levels of:

- 60 decibels during the night for residential areas
- 75 decibels during the day for residential areas
- 60 decibels during the night for educational areas
- 75 decibels during the day for educational areas

Section 10 of the EPA's Noise Regulations has restrictions on construction activities that involve the operation of tools and equipment. It states that construction activities (other than public works) may be prohibited, even when permissible noise levels fixed under these regulations are not exceeded:

(a) Between the hours of 11:00 p.m. and 6:00 a.m. from Monday to Sunday; and
(b) Before 6:00 a.m. and after 6:00 p.m. on Sundays.

With respect to the proposed wind turbines, the project falls within residential and educational (due to the presence of the Hope Secondary School). Under these regulations, environmental authorization is required from the EPA. Notwithstanding, the proposed wind turbines are designed to be operated at a noise level of 45 dB (night-time) and 50 dB (day-time) which is significantly lower that the GNBS / EPA standards.

3.3.2 Town and Country Planning Act

Land Planning in Guyana focusses on the physical land development and its main regulatory framework is the Town and Country Planning Act of Guyana. The Town and Country Planning act makes provision for the orderly and progressive development of Land, Cities, Towns and other areas, to preserve and improve the amenities thereof, and for other matters connected therewith. The act establishes planning frameworks, which are intended to:

- Control land development in any urban or rural area;
- Ensure adequate sanitary conditions and the coordination of roads and public services;
- Protect and expand amenities; and
- Conserve and develop the resources of the management area.

The Act states specific requirements to establish a scheme, and once the necessary requirements are met, the Minister can grant approval. Specific to the wind farm development, Sections 42 and 43 of the Act speaks to agreements with statutory undertakers the use of land for the establishment of a scheme. In this case, it relates to Schedule II, Part V (Public Services) – Facilitating the construction of works by statutory undertakers in relation to lighting, water supply, sewerage, drainage, sewage disposal, refuse disposal and other services.

For this project, an agreement was made between the Government of Guyana and HED for the allocation of land along Hope Beach for the erection of the turbines. At Chapman's Grove, the allocated land is privately owned, and lease agreements with the owners have been secured which specify also consent by the land owners for the construction and operation of a wind farm, including consent to noise emissions, shadow effects and safety implications within the land area of each lease. We therefore do not consider there to be any land use conflicts associated with the wind farm.

3.3.3 Guyana Lands and Surveys Commission Act

The Guyana Lands and Surveys Commission Act passed in 1999 provides for the establishment of the Guyana Lands and Surveys Commission, its functions and other purposes connected therewith. The Commission has responsibilities including guarding over all public lands, rivers and creeks, to execute or cause to be executed, check, approve and record surveys in relation to land and water resources, on behalf of the President to address issues such as leases, grants and permits to occupy, to liaise with the public and other agencies concerning land records, registration of deeds and titles to lands and to administer and enforce all laws relating to public lands and land surveys.

3.3.4 Guyana National Action Programme to Combat Land Degradation, 2015

In collaboration with the Global Environmental Fund, the Guyana Lands and Surveys Commission, has prepared a National Action Plan to Combat Land Degradation. The Aligned National Action Plan provides the fundamental principles for guidance and

fulfilment of the country's obligation to align its National Action Plan (NAP) to the United Nations Convention to Combat Desertification (UNCCD) 10 - Year Strategy (2008-2018). The Aligned NAP provides consideration for the need for urgent efforts to integrate and strengthen existing National Policies, Strategies, Action Plans and the planning framework for conservation, promotion of sustainable land management and combating he exacerbated effects of degradation. The Plan contains the following strategic and operational objectives:

Strategic Objectives

1. To improve the living conditions of affected populations
2. To improve the condition of affected ecosystems
3. To generate global benefits through effective implementation of the UNCCD
4. To mobilize resources to support implementation of the Convention through building effective partnerships between national and international actors.

Operational Objectives

1. Advocacy, awareness raising and education
2. Policy framework: to support the creation of enabling environments for promoting solutions to combat desertification/land degradation and mitigate the effects of drought
3. Capacity building
4. Financing and technology transfer.

3.3.5 National Environmental Action Plan

The National Environmental Action Plan (NEAP 2001-2005) is a follow-on from the NEAP of 1994, it summarizes the national environment policy and focuses on coastal zone management and natural resources management including land resources, biodiversity, wildlife, forestry and ecotourism, waste management and pollution control, and mining. NEAP 2001-2005 identifies Guyana's commitment to sustainable development and provides a framework for integrating cross-sectoral environmental concerns into the wider context of Guyana's economic and social development programme. It identifies and recognizes the roles and functions of relevant stakeholders including private sector and non-governmental organizations in environmental management. Specifically, the NEAP emphasizes the critical importance of coastal zone management and natural resource management, and further identifies actions that should be taken at the national level to address these issues.

Twelve stated policy objectives were outlined. Those that are particularly applicable to this project are listed below:

- Ensure prior environmental assessments of proposed activities, which may significantly affect the environment.
- Raise consciousness of the population on the environmental implications of economic and social activities through comprehensive education and public awareness programmes.
- Maintain ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity and to observe the principle of optimum sustainable yield in the use of renewable natural resources and ecosystems, both on land and the sea.

In order to fulfil these objectives, the NEAP also states that the Government will:

- Institute punitive measures to deter possible violations of environmental norms.
- Ensure that, where environmental damage occurs, remedial action will be taken with the cost being covered by those responsible for causing the damage.
- Rehabilitate damaged ecosystems where possible and reverse any degradation of the environment.
- Ensure that conservation is treated as an integral part of the planning and implementation of development activities.
- Promote the pursuance of international cooperation on environmental issues.
- Involve the population, including indigenous peoples, women and youth, in the management of the environment and natural resources.

One of the policy objectives requires the Government of Guyana to ensure environmental assessments of proposed development activities which may significantly affect the environment are undertaken. In keeping with this environmental policy objective, the Environmental Protection Act (see Section 3.3.1) was introduced in June 1996 and the legal framework for undertaking environmental assessments established. Further, the Act established the Environmental Protection Agency and outlined the legal process for undertaking sustainable and effective management of the environment and its natural resources.

3.3.6 Low Carbon Development Strategy

This Strategy was initially launched in 2009 and updated in 2013 with the latest updated in 2021 being issued as a draft for public consultation from November 2021 to February 2022. This LCDS Draft for Consultation addresses the following objectives:

- **Forest Climate Services and other Ecosystem Services** - From early 2022, Guyana can access market-based mechanisms for forest climate services that includes private, as well as international public sector financing;

- **Stimulate future growth through clean energy and sustainable economic activities** - Guyana can grow the economy up to five-fold, while keeping greenhouse gas emissions from energy generation at around 2019 levels. This can be done through the replacement of expensive, polluting heavy fuel oil with natural gas as a bridge to an energy system built mainly from hydropower, solar and wind power;
- Protect against climate change; and
- Align with global climate goals - Guyana will act strategically and responsibly as the sector develops, supporting global energy security while diversifying and decarbonising Guyana's domestic economy and investing in development priorities for all Guyanese, including health, education and low-carbon opportunities.

3.3.7 The Sea Defense Act

The Sea Defense Act was passed in Parliament on July 01, 1933. This Act is defined as an act to make better provision for the maintenance and Construction of Sea Defences. The Act establishes a Sea Defense Board which is charged with the care, maintenance, management and construction of the sea defences of Guyana. The Act addresses the Publication of order for construction of sea defence and inspection of plan defence, emergency works, sea defences being the property of the state, how works on sea defences are to be executed, sluices, kokers, floodgates, power to enter on land adjacent to a sea defence to work and take materials for sea defence, making drain into the sea or construction on sea defence, obstruction to sea defence as an offence if consent is not obtained. In compliance with the Sea Defense Act consent for the passage of the lines in the vicinity of the sea wall as well as agreement/no objection to the method to be used to cross the sea wall is necessary prior to the start of installation.

3.3.8 Sea and River Defense Policy

Guyana Sea and River Defense Policy: Guyana's coast is vulnerable to increased coastal erosion as a result of the impacts of extreme weather and climate change. The Government has developed a Sea and River Defense Policy 6, which calls for alternative solutions to traditional sea defence structures and includes the re-establishment of mangroves for flood protection and safeguarding environmental resources. With this policy framework and with support from the EU, a national mangrove management project is being implemented that is seeking to manage and restore mangrove ecosystems as well as provide alternative livelihoods for local communities.

For this project, no mangrove trees will be removed from the coast to facilitate the construction of the wind turbines.

3.3.9 Roads Act

The Roads Act was passed on April 01, 1909 and basically makes provision for the construction and maintenance of the Public roads of Guyana. The Act gives the responsibilities and jurisdiction of the Chief Officer in controlling and managing the roads. The Act also addresses the appointment of road officers, the power of the road officer, notice to repair defects in dams or canals, procedures for bridge construction over roads or temporary roads, the settlement of disputes, laying out new roads or altering the existing road, entry on lands to survey for or construct new roads and regulations of traffic on land. The regulations under this law become relevant to the project as minor roads and bridge improvement works are intended to be carried out to facilitate the transport of the wind turbines, from King's Wharf to Hope Beach.

3.3.10 Civil Aviation Act, 2018

The Civil Aviation Act of Guyana is an act to establish the Guyana Civil Aviation Authority, to provide for offences relating to the safety and security of passengers, aircrafts and airports, for the regulation, control and orderly development of civil aviation in Guyana. Parts II to V of the Act speaks to the establishment of the Guyana Civil Aviation Authority, the appointment of a Board and a Director-General of the Authority, and the funds and resources to the Authority. Part VI of the Act is most applicable to the current HED project, as it speaks to the prohibitions and restrictions on the use of the air space at aerodromes and in areas in the vicinity of airports. Specifically, Section 31 of the Act requires that in the interest of civil aviation and to avoid danger to aircrafts being flown in darkness or in conditions of poor visibility, provisions should be made for the lighting of any building, structure and erection in the vicinity of an aerodrome.

Section 33 of the Act further gives the Minister power to control land in the interest of aviation. Specifically, the Minister may declare any land, structure, works or apparatus shall be subject to control in the interest of civil aviation. This includes the total or partial demolition of any buildings/structures, restricting the height of trees and restricting the installation of cables, main pipes, wires or other apparatus upon, across, under or over any land.

For this project, a meeting was held with the Civil Aviation Authority and HED made an application for permission to construct a structure greater than 200ft in height.

3.3.11 Waste Management

A summary of the key waste management pieces of legislations, regulations, policies and plans are provided as follows.

LEGAL POLICY OR INSTRUMENT	RELEVANT DETAILS
Environmental Protection (Expanded Polystyrene Ban) Regulations, 2015	The objectives of the regulations are to: a) Prohibit the importation, manufacture and sale of expanded polystyrene products; b) Prohibit the sale, use or provision of polystyrene containers by food services; c) Promote and encourage the use of biodegradable, recyclable and other environmentally friendly food packaging containers.
Environmental Protection (Litter Enforcement) Regulations, 2012	These Regulations lists the offences and relevant penalties for committing those offences. Some of the offences are: a) Disposal of Litter in or any public place (other than a receptacle or approved site) b) Disposal of litter from a motor vehicle; c) Failure of the owner of a bus/taxi to provide a receptacle for litter
Environmental Protection (Hazardous Wastes Management) Regulations, 2000	According to the Hazardous Waste Management Regulations, anyone who operates or proposes to operate a facility that generates, transports, treats, stores or disposes of hazardous waste, is required to submit a Notification of Activity and an application to the Agency for an Environmental Authorisation. The Notice of Activity will inform the Agency of the nature of the activities at the facility and will aid in guiding its decision on whether or not Environmental Authorisation is required. Application forms for Environmental Authorisation are available on the Agency's website and at our Georgetown and Berbice offices. The operation of the wind turbines will not generate hazardous wastes.
Customs Act	Section 7A of the Customs Act stipulates that an "environmental levy" be applied to non-returnable bottles (units of metal, plastic or glass container).
National Integrated Solid Waste Management Strategy (201-2030)	The National Integrated Solid Waste Management Strategy 2017-2030 aims to provide the roadmap by which the country can reduce and better manage its solid waste.

LEGAL POLICY OR INSTRUMENT	RELEVANT DETAILS
	It sets out six key goals and 44 strategic actions, which identify the government's expectations of waste management at the end of the strategic period, and into the future. For the HED Wind Farm, any waste generated during construction should be handled, transported and disposed of in keeping with the objectives of this Strategy.

3.4 Regulatory Framework for Biodiversity Protection

In addition to the general laws above, there are legal and policy instruments that address biodiversity, and the ones that are relevant to this Project are summarized below:

LEGAL OR POLICY INSTRUMENT	RELEVANT DETAILS
National Biodiversity Strategy and Action Plan (NBSAP) (2012-2020)	Through assistance from Global Environment Facility (GEF) and the United Nations Environment Program (UNEP), the Government of Guyana prepared its National Biodiversity Strategy Action Plan in accordance with the requirements of the United Nations Convention on Biological Diversity. This document constitutes a revision of the previous NBSAP and the principal instrument for implementing the Convention of Biodiversity at the national level (which was signed in 1992 and ratified in 1994). The NBSAP lists 9 strategic objectives: • Conserving ecosystems, species and genetic diversity and restoring biodiversity and ecosystem services in degraded areas; • Promote the conservation, sustainable use and value of biodiversity into key productive sectors used for growth, expansion and diversification of the economy. • Expand and improve awareness, appreciation and communication on biodiversity and ecosystems • Improve national implementation, monitoring and reporting for Multilateral Environmental Agreements and other bilateral commitments. • Create stronger and wider national, regional and international partnerships that contribute to achieving the goal and objectives of this Plan

LEGAL OR POLICY INSTRUMENT	RELEVANT DETAILS
	• Consolidate/harmonize policy, legal, regulatory and administrative frameworks that support the sustainable use, protection and management of biodiversity resources. • Improve substantially biodiversity monitoring at the national level and within key productive sectors. • Strengthen the knowledge base and capacity for conservation, management and sustainable use of biodiversity. • Secure adequate resources from national, regional and international sources for the implementation of the Plan.
Wildlife Management and Conservation Act, 2016 and Regulations	In accordance with Section 83 (1)(a) of the Wildlife Conservation and Management Act, 2016, the Wildlife Management and Conservation Regulations governs all aspects of hunting, trapping, trade, protection, conservation, management and sustainable use of wildlife in Guyana. The Regulations provides the legal framework for the conservation and management of all species of wildlife in Guyana. As part of this project, workers will not be allowed to hunt, trap or hurt any wildlife species within the area during construction of the wind turbines. In addition, several studies have been undertaken to determine what species can be affected during the operation of the wind turbines, and what measures can be implemented to mitigate any impacts to wildlife species.
Protected Areas Act, 2011	This Act provides for the protection and conservation of Guyana's natural heritage and natural resources, management and financing of a national system of protected areas, the maintenance of ecosystem services of national global importance (including climate regulation) the establishment of a protected areas commission, the establishment and management of a protected areas trust fund, the fulfilment of Guyana's international environmental responsibilities, public participation in protected areas and conservation. Hope Beach and Chapman's Grove are not listed as a protected area.
Forest Act, 2009	This Act promotes Amerindian and local community participation in sustainable forestry, establishes a comprehensive regulation of the multiple uses of forests including traditional uses, provides for the declaration of protected areas within a consultative process and in consultation with the EPA and defines the procedures for the

LEGAL OR POLICY INSTRUMENT	RELEVANT DETAILS
	approval of codes of practice for forest options. The Act make provisions for forest conservation of areas of State Forest, the regulation of forest operations through codes of practice, and establishes a requirement of consultation with the commission before granting any license for mineral prospecting, mining or petroleum production (Source: https://forestlegality.org/risk-tool/country/guyana). Based on a meeting with the Forestry Commission, the proposed site is not on Forested State Lands, and therefore, no permit to erect the turbines is required.
National Forest Plan, 2011	This Plan implements the Forest Act, 2009 (see above) and aims to manage and utilize the forest resources, while protecting and conserving vulnerable specie. The Plan also aims to ensure that productive capacity of the forest is maintained or enhanced. The National Forest Plan also provides the framework through which the National Forest Policy (see below) is implemented. The Plan comprises server programme areas which are executed through a number of activities, many of which are long-term and continuous, whilst other are short term (Source: https://forestlegality.org/risk-tool/country/guyana).
National Forest Policy, 2011	The National Forest Policy compliments the National Forest Plan with the main aims of promoting sustainable forest activities, improving sustainable forest resource yields, protecting watershed and quantifying environmental services to generate forest incentives.
Fisheries Act, 2002	The Fisheries Act regulates fishing in both fresh and marine waters of Guyana. It makes provisions for the registration of fishing boats and related matters, inspection of fishing boats, licenses for fishing and exportation of fish, enforcement, offences and penalties. The proposed Wind Farm does not affect fishing in the area, however, Fishermen in the area uses the Hope Canal as an area to moor their boats and bring in their catch. As such, HED held consultations with the fishermen to document their concerns with the proposed project.
Wild Birds Protection Act	The Wild birds Protection Act prohibits the wounding, capturing or killing of birds specified in the first schedule, as well as the protection of birds (listed in the Second Schedule) during the closed season. Birds listed on the First Schedule that are found at the project site include:

LEGAL OR POLICY INSTRUMENT	RELEVANT DETAILS
	• Neotropic Cormorant • Ashy Headed Greenlet • Straight billed Woodcreeper • White bellied Piculet • Southern House Wren • Mangrove Cuckoo • Dark billed Cuckoo • Bat falcon • Laughing Falcon • Magnificent Frigatebird • Lesser Night Hawk • Throated Emerald Hummingbird • White Chested Emerald Hummingbird • Black Throated Mango • Brown Pelican • Grey-necked Woodrail • Mangrove Rail • Grey breasted Martin • White winged Swallow • Laughing Gull • Least Tern • Large billed Tern • Black Skimmer
Plant Protection Act, 2011	The Plant Protection Act regulates the importation and exportation of plants, planting material and objects derived from them, to protect from the introduction of exotic pests and diseases to Guyana and to control and eradicate diseases and pests within the country. Any replanting of areas designated for the wind turbines will have to be in accordance with this Act.
Protected Areas Commission Guyana – Strategic Plan 2016-2020	The National Protected Areas System currently comprises of approximately 8.4% of Guyana's landmass: • Iwokrama Forest (established by separate legislation, the Iwokrama Act 1996, and a joint mandate from the Government of Guyana and the Commonwealth Secretariat) • Kaieteur National Park; • Kanashen Amerindian Protected Area;

LEGAL OR POLICY INSTRUMENT	RELEVANT DETAILS
	• Kanuku Mountains Protected Area; • Shell Beach Protected Area; and • Urban Parks: National Park, Botanical Gardens, Zoological Park, and Joe Vieira Park. The objectives for the protected areas are: • Assist in combating climate change; • Assist the state in meeting international obligations; • Recognise the intrinsic values of biodiversity and its components; • Conserve biodiversity, ecosystem services and ecosystems representative of all Guyana's natural land and seascapes. The Strategic Plan is intended to develop the protected area system to meet these objectives. None of these sites are in close proximity to the Hope Beach or Chapman's Grove project sites.
National Mangrove Management Action Plan (2010)	Developed as a key climate change adaptation initiative, the National Mangrove Management Action Plan's overall objective is to respond to climate change and to mitigate its effects through the protection, rehabilitation and wise use of Guyana's mangrove ecosystems through process that maintain their protective function, values and biodiversity while meeting the socio-economic development and environmental protection needs in estuarine and coastal areas. As part of this initiative, mangrove planting has occurred in the Hope Beach area and has been maintained and monitored over the years. There is also an areas of natural mangrove growth within the area of the proposed wind farm. As such, the construction of the wind turbines should be in keeping with preserving the mangrove trees in the area.

3.5 Regulatory Framework for Water Quality and Quantity

3.5.1 Environmental Impact (Water Quality) Regulations, 2000

The protection of the sources of water from contaminants is governed by the provisions of the EPA's Environmental Impact (Water Quality) Regulations, 2000, which prohibits the discharge of effluents into inland or coastal ways. These regulations were discussed in Section 3.1.1 above.

3.5.2 Guyana National Bureau of Standards Act

There are several water quality related standards which have been adopted and passed by the Guyana Bureau of Standards under the Guyana Bureau of Standards Act. The applicable standards include:

- GYS 229-4:2003 – Methods and Testing for Water and Wastewater: Part 4 – Chemical Oxygen Demand;
- GYS 207:2002 – Interim Guidelines for Industrial Effluent Discharge into the Environment
- 13.060.50 – Examination of Water for chemical substances
- 13.060.99 – Other standards related to water quality

The operation of the wind turbines will not result in any effluent discharges.

3.5.3 Water and Sewerage Act

The Water and Sewerage Act provides a water resource management system for the country of Guyana. It stipulates that the ownership of all water resources and the rights to use, abstract, manage, control, protect and conserve water resources, provide safe water, provide sewerage services are vested in the State. The management framework of this Act is to be guided by the National Water Policy. Specifically, Sections 6 and 7 of the act states that the contents of the policy may set out strategies, objective, plans, guidelines and procedures for:

- Water resources management for drought and flood mitigation;
- Environmental protection and pollution control in collaboration with other institutions;
- Efficient use of water resources by all

- Public awareness

The Water and Sewerage Act also makes provision for the protection of water quality, including the physical, biological and chemical characteristics of water, and the character of instream habitat. Under Section 8(3) of the Act, the Hydrometeorological Department is empowered as part of its functions to establish, manage and operate national systems to monitor the availability, quality and use of surface and groundwater.

3.5.4 Drainage Irrigation Act

The Drainage and Irrigation Act makes provisions for the establishment of the National Drainage and Irrigation Authority for ensuring that water resources are located, evaluated, conserved and utilized for the greatest advantage through appropriate water management strategies and water use planning. The Act is further intended to ensure that the drainage and irrigation systems are operated in a sustainable manner.

3.5.1 World Bank Ambient Water Quality Guidelines

Ambient surface water quality conducted for this EIA will be placed into context using World Bank guidelines provided Table 3-1 below.

TABLE 3-1: WORLD BANK AMBIENT WATER QUALITY GUIDELINES

Source: World Bank Group International Finance Corporation (IFC) Environmental, Health and Safety (EHS) Guidelines for Wastewater and Ambient Water Quality

PARAMETER	GUIDELINE VALUE	UNIT
pH	6 - 9	pH units
Conductivity	Not available	mg/L
Dissolved Oxygen	Not available	
Biochemical Oxygen Demand	30	
Total Suspended Solids	50	
Total Dissolved Solids	Not available	
Turbidity	Not available	
Oil & Grease	10	
Total Coliforms	400	MPN / 100 ml

3.6 Climate Change Policies and Plans

In its response to global climate change, Guyana signed onto the Convention on Climate Change, United Nations Framework Convention on Climate Change, acceded to the Kyoto and Montreal Protocols and the Paris Agreement. As part of their obligations to these International Agreements, the Office of Climate Change was established within the Office of the Presidents, and a series of policies and plans have been developed. The ones relevant to this project are summarized in the following subsections.

3.6.1 Draft National Climate Change Policy and Action Plan (2019)

This Draft National Climate Change Policy and Action Plan (NCCPAP) draws from previous national documents such as the Climate Change Action Plan (2001), Climate Change Adaptation Policy and Implementation Plan (2001) and the Draft Climate Resilience Strategy and Action Plan (2015). It was prepared to fulfil Guyana's commitment to the United Nations Framework Convention on Climate Change (Article 4), the Kyoto Protocol and to achieve the UN's Sustainable Development Goals. It provides a framework for addressing the issues that Guyana faces and will face in the future due to climate change. It provides a comprehensive framework for the continuance of national climate change actions and strengthening the efforts that are currently underway for adaption, resilience and mitigation. The National Climate Change Policy also plays an important foundational role in supporting Guyana's Low Carbon Development Strategy (see Section 3.3.6).

The primary Sustainable Development Goal that the NCCPAP directly addresses is: Goal 13: Take urgent action to combat climate change and its impacts. The Policy also lists 10 policy goals, of which the following is directly related to the proposed wind farm at Hope Beach:

- Transition to renewable energy sources and energy efficiency and reduce or eliminate all greenhouse gas emissions.
- Transition to climate resilient infrastructure and integrated physical land use plans; and
- Adopt new technologies and early warning systems.

Structurally, the policy consists of 19 Policy Objectives to address adaptation, mitigation, resilience –building and risk reduction. In order to aid implementation of these objectives, 9 Policy Directives have been established, of which the following is applicable to the proposed Hope Beach Wind Farm: ***The Implementation and use of***

green and clean technologies – transition to renewable energy technologies and practices to reduce climate risk and carbon emissions.

Efforts and support for this Policy Directive will focus on technologies and processes that create energy and fuel efficiencies, reduce energy demand and are cost effective. The priority sectors for interventions are power generation and transportation as they contribute the greatest volume of emissions. The policy also supports larger national infrastructure investments that yield carbon reductions including strengthening the national electricity grid and generation from renewable energy sources such as solar, wind and hydro.

3.6.2 Climate Change Action Plan (2001)

The Guyana Climate Change Action Plan was prepared to address Guyana's commitment to Article 4.1(b) of the UNFCC Convention – "formulating national programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removal by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change."

The Action Plan targets mostly the energy, forestry and agricultural sectors, and actions in the plan are geared towards the reduction of emissions of greenhouse gases by energy efficiency, improved forestry and agricultural management, and the use of renewable energy resources. The proposed wind farm at Hope Beach is in keeping with the adaptation options and response strategies under the Energy Sector – "…….and the possibility of wind and solar power."

3.6.3 Climate Resilience Strategy and Action Plan for Guyana

The Climate Resilience Strategy and Action Plan (CRSAP) provides a comprehensive and overarching framework for adapting and building resilience to climate change impacts. The CRSAP identifies potential changes in Guyana's climate, identifies current and projected cross-sectoral climate vulnerabilities and risks, and assesses Guyana's current capacity for building climate resilience. At present, Guyana's actions to build resilience to climate change include:

- The Mangrove Restoration Project which aims to bolster sea defences against rising sea levels;
- Upgrading critical water management infrastructure;

- Becoming signatory to several international and regional conventions such as United Nations Framework Convention on Climate Change, CARICOM Liliendaal Declaration and Regional Framework for Achieving Development Resilient to Climate Change;
- Preparing several Climate resilience Polices, Plans and Programs; and
- Undertaking several climate resilience projects, of which, Mangrove Planting and Maintenance along the Coast and Upgrading of Intake Structures are applicable to this project.

Specific to this project, the rising sea levels can pose a threat to the proposed wind turbines along Hope Beach. In light of this, HED, in collaboration with other key government agencies (such as the National Sea Defense Board) will factor in climate resilience in the construction of the wind turbines.

3.7 Health and Safety and Emergency Preparedness

3.7.1 Occupational Safety and Health Act.

The Occupational Safety and Health Act was passed on December 09, 1997. The Act replaced the Factories Act (Chap 95:02). The act provides for the registration and regulation of industrial establishments, for occupational safety and health of persons at work and matters related to these. The Act caters for industrial establishments, private residences and self- employed persons and outlines the duties of the employers, supervisors and employees and the requirements for incident and accident reports. Under the act an Advisory Council on Occupational Safety and Health and an Occupational Safety and Health Authority is established and given certain responsibilities. The OSH Authority comprises of Inspectors designated by the Ministry of Labour who are responsible for inspecting work places and equipment for compliance with the Occupational Safety and Health regulations.

All works related to the construction and operation of the wind turbines must be in compliance with the requirements of the OSH Act.

3.7.2 Emergency Preparedness

Guyana's main governing piece of legislation for disaster management is the draft Disaster Risk Management Policy, which establishes the guiding principles for disaster risk management in Guyana. It includes institutional structures, roles, responsibilities, authorities and key processes to achieve a coordinated approach to disaster risk management (Guyana Civil Defense Commission, 2014). Under this Policy, the Civil

Defense Commission is the main national mechanism for coordinating the policy. The CDC, in 2015 launched the National Emergency Management System which sets up a 24-hour system to handle disasters in Guyana.
In addition, there are several other plans and acts which guide disaster management in Guyana:

- Draft National Integrated Disaster Risk Management Plan and Implementation Strategy, which outlines actions to tackle floods and droughts and includes: risk identification, prevention and mitigation, financial risk management preparedness and response/recovery.
- Draft Multi-Hazard Preparedness and Response Plan which focuses on establishing roles and responsibilities of different actors for preparedness and response, and the mechanisms for early warning.
- Draft Shelter Management Policy and Standards which provides a framework for the establishment of a national shelter management body and a description of the coordination levels for activation and closure of shelters.
- Fire Service Act- which establishes and empowers fire-fighting services.

3.8 International Treaties and Conventions

Guyana is signatory to a number of international conventions and protocols aimed at addressing environmental protection, climate change, conservation of biodiversity and sustainable management of natural resources. In addition, Guyana participates in activities of the Ramsar Conventions (1971) Wetlands. The key International Multilateral Environmental Agreements (MEA) are included in Table 3-2.

TABLE 3-2: KEY MEAS TO WHICH GUYANA IS A SIGNATORY

Adopted from: Guyana's NBSAP (2012-2020), 2014 and Guyana's 2nd National Communication to UNFCCC, 2012

MULTILATERAL ENVIRONMENTAL AGREEMENTS	SIGNED	RATIFIED	ACCEDED
United Nations Convention on Biological Diversity	1992	1994	
Cartagena Protocol on Biosafety			2008
Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973) Amendment to the article XXI of CITES adopted in Gaborone in 1983, deposited in 2007	 Not yet in force	1977	
Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (1983)		2010	
Specially Protected Areas and Wildlife Protocol (SPAW) (1990)		2010	

MULTILATERAL ENVIRONMENTAL AGREEMENTS	SIGNED	RATIFIED	ACCEDED
International Plant Protection Convention (1952)			1970
United Nations Framework Convention on Climate Change (UNFCCC)	1992		1997
Montreal Protocol on Substances that Deplete the Ozone Layer			1993
Vienna Convention for the Protection of the Ozone Layer			1993
United National Convention on the Law of the Sea	1993		
Kyoto Protocol to UNFCCC			2003
United Nations Convention to Combat Desertification	1996	1997	
International Convention for the Prevention of Pollution (MARPOL 73/78)			1997
Basel Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal			2001
Minamata Convention on Mercury	2013		
Paris Agreement within the United Nations Framework Convention on Climate Change,	2016		2016

3.9 Applicable International Guidelines

In the absence of the national laws for wind turbines, water quality, air quality and noise, standards from the World Bank Group Environmental, Health, and Safety Guidelines (known as the "EHS Guidelines") are used as guidelines for the project. The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). It contains performance levels and measures that are generally considered to be achievable in new facilities. These are summarized in the following subsections

3.9.1 EHS Guidelines for Wind Turbines

The EHS Guidelines for wind energy include information relevant to environmental, health, and safety aspects of onshore and offshore wind energy facilities. It lists the specific activities during construction, operation and decommissioning of the wind turbines, as well as the environmental impacts associated with each activity. The EHS Guidelines which are specific for wind turbines are:

- Visual Impacts;
- Shadow Flicker

- Aviation Safety
- Noise;
- Air Quality

With respect to tonalities, distinct tonalities generated by the drivetrain/gearbox were a feature of some earlier model wind turbines. Such tonality issues are no longer an issue with modern wind turbines. A few regulatory standards do require a penalty for distinct tonalities in wind turbine noise if such are relevant (see Reference 11 in Appendix P). However, there are no distinct tonalities associated with the V150 model and none of these regulations provide standards, guideline values or permissible limits based on the type of noise being emitted

3.9.1.1 Visual Impacts

There are no separate guidelines that address visual impacts from wind turbines, however, Section 1.1.1 of the EHS Guidelines for Wind Energy lists some guidelines that can address the concerns of visual impacts. It states that proper siting (away from residents, tourist sites, legally protected and internationally protected areas) is important. It also requires that the consideration be given to turbine layout, size and scale in relation to the surrounding landscape and seascape character and surrounding visual receptors.

3.9.1.2 Shadow Flicker

There are no separate guidelines that address shadow flicker, however, Section 1.1.4 of the EHS Guidelines for Wind Energy lists some guidelines that can address the concerns relating to shadow flicker.
Shadow flicker occurs when the sun passes behind the wind turbine and casts a shadow. As the rotor blades rotate, shadows pass over the same point, causing the effect termed shadow flicker. The guidelines recommends that the predicted duration of shadow flicker effects experienced at a sensitive receptor not exceed 30 hours per year and 30 minutes per day on the works affected day.

3.9.1.3 Aviation Safety

There are no separate guidelines that address aviation safety; however, Section 1.3.2 of the EHS Guidelines for Wind Energy lists some guidelines that can address the concerns relating to aviation safety. It requires that consultations be held with the relevant aviation authorities to ensure that the turbines are placed well away from airports, low flying zones, radar stations, etc. It also requires that anti-collision lighting and markings be placed on the towers and blades.

3.9.2 EHS Guidelines for Noise

These EHS Guidelines state that noise associated with wind farms are of two kinds: construction and operation. Construction noise include piling, construction of roads, foundations and the erection of the turbines themselves. Operation noise include mechanical (movement of gearbox, generator and yaw motors) and aerodynamic (the interaction of air and the turbine blades).

The EHS Guidelines require the noise impacts should not exceed the limit values presented in Table 3-3, or result in a maximum increase in background levels of 3 dB(A) at the nearest sensitive receptor location off site.

TABLE 3-3: WORLD BANK GROUP NOISE GUIDELINES

Source: World Bank, 2007

AREA	PERIOD	NOISE LEVEL l_{eq},1 HOUR dB(A)
Residential, educational or institutional	Daytime (7 am to 10 pm)	55
	Night time (10 pm to 7 am)	45
Industrial or Commercial	Daytime (8 am to 8 pm)	70
	Night time (8 pm to 8 am)	70

In addition to the specific noise guidelines, Section 1.1.2 of the EHS Guidelines for Wind Turbines provide specific guidelines and mitigation measures to ensure that noise impacts are adequately addressed. It includes conducting noise modelling exercises and measuring ambient noise. Specific criteria for conducting noise monitoring are also stated; measuring at a noise sensitive receptor, the duration of the monitoring and the intervals to which noise should be measured.

3.9.3 WHO Air Quality Guidelines

The operation and maintenance of wind energy facilities do not typically involve air emissions. However, during construction, dust and vehicle emissions can be of concern. As such, the WHO sets recommended limits for health-harmful concentrations of key air pollutants both outdoors and inside buildings and homes, based on global synthesis of scientific evidence. Relevant parameters and their respective WHO Guideline limits are presented in Table 3-4 below.

TABLE 3-4: WHO AMBIENT AIR QUALITY GUIDELINES

Source: WHO Air Quality Guidelines, Global Update, 2005

PARAMETER	WHO GUIDELINE
$PM_{2.5}$	10 ($\mu g/m^3$) annual mean
	25 ($\mu g/m^3$) 24-hour mean
PM_{10}	20 ($\mu g/m^3$) annual mean
	50 ($\mu g/m^3$) 24-hour mean
NO_2	40 ($\mu g/m^3$) annual mean
	200 ($\mu g/m^3$) 1-hour mean
SO_2	20 ($\mu g/m^3$) 24-hour mean
CO*	100 mg/m^3 for 15 minutes
	60 mg/m^3 for 30 minutes
	30 mg/m^3 for 1 hour
	10 mg/m^3 for 8 hours.

Note: (*)- Carbon monoxide was not included in the 2005 Update, as such, the 2000 WHO Guidelines for Carbon Monoxide remains in effect.

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4 PROJECT ALTERNATIVES

Various wind farm configurations have been considered for the project during the past 4 years. The 25MW configuration that has been selected, with six (6) 4.2MW wind turbines spread between two lease sites, is the one that best meets the requirements for the two key stakeholders in the project:

1) The local community, which requires a wind farm that does not create a nuisance, health or safety hazard to the nearby residents and the Hope Secondary School.

2) Electricity consumers and the utility company (GPL), which require power that supports the technical requirements of the grid at a price that is ideally less than the present cost of generation for GPL Wind energy project economics are sensitive to economies of scale. Larger capacity projects and larger individual wind turbines generators (WTG) have better cost per unit metrics, and therefore result in lower electricity prices. The challenge with the Hope Beach lease is to configure a wind farm where wind turbines are not located too close to resident houses to cause a nuisance or safety hazard, yet still has sufficient MW generation capacity to obtain an acceptable price per unit electricity generated and fed into GPL's grid. Table 4-1 summarises the configurations, residential nuisance and safety risks, and price per kwh to GPL for the four options.

Four configurations were considered, combining different size and numbers of wind turbines (see Figure 4-1):

1) 25.2 MW from six (6) Vestas 4.2MW WTGs with four located at Hope Beach (HB), and two at Chapman's Grove (CHG) (Figure 4-1). These low wind machines in the large 3 to 4MW class of turbines include the latest cutting-edge technology from the world's leading wind turbine manufacturer, and is one of the quietest utility scale wind turbines on the market. This is the selected scenario that easily meets all the critical stakeholder criteria, including for noise emissions, shadow effects, safety, and an attractive price to GPL.

TABLE 4-1. COMPARISON OF CONFIGURATION, NOISE IMPACT, SAFETY RISK, AND PRICE COMPETITIVENESS FOR 4 OPTIONS CONSIDERED

Option:	1	2	3	4
Wind Farm Configuration	**6 x 4MW Vestas**	**6 x 2.5MW GW**	**9 x 1.5MW Vensys**	**13 x 2MW HZ**
Total Capacity (MW)	25.2 MW	15 MW	13.5 MW	26 MW
No. Wind Turbines at HB	4	4	9	13
No. Wind Turbines at CHG	2	2	0	0
Wind Turbine Generator (WTG) Specification				
WTG Manufacturer	Vestas	Goldwind	Vensys	CSIC/HZ Windpower
Manufacturer Country HQ	Denmark	China	Germany	China
WTG MW Capacity	4.2 MW	2.5 MW	1.5 MW	2.0 MW
Hub height / Maximum height	105m / 180m	90m / 144.5m	85m / 123m	80m / 135m
Rotor Diameter	150m	109m	82m	110m
Rotor RPM	4.9 - 12	7.5 - 13.5	9 - 17.3	8.3 - 16.8
Safety Offset Distance				
Offset to nearest residence	295m	295m	130m	85m
Offset/max height (IFC min 1.5)	1.6	2.0	1.1	0.6
Max Risk fatality at nearest residence	1 in 35million years	not calculated	not calculated	not calculated
Noise emissions at nearest residencies (worst case)				
Noise at WTG source (no noise reduction)	104.9dBA*	105 dBA*	104.4 dBA	107 dBA
Max noise at nearest receptors **	45 dBA	45 dBA	55 dBA	60 dBA
Max noise vs Background Noise at night**	-11 dBA	-11 dBA	+4 dBA	+9 dBA
Noise emissions at school (outdoors)				
Existing Noise Level (Leq daytime)	53dBA	53dBA	53dBA	53dBA
Max wind farm noise at school	43 dBA	43 dBA	50 dBA	55 dBA
Max noise vs Background Noise daytime	-10 dBA	-10 dBA	-3 dBA	+2 dBA
Shadow Flicker Curtailment (WTG shut in to satisfy acceptable limit)				
Curtailments avg hrs/day	0.7hr/day	0.5hr/day	1.0hr/day	1.3hr/day
Curtailments % Mwh/yr	-3% MWH/yr	-2% MWH/yr	-4% MWH/yr	-5% MWH/yr
Power Output & Price to GPL				
% of GPL annual electricity demand	10.8%	5.3%	4.7%	9.9%
Notional USD/KWH Price to GPL	0.097	0.14	0.173	0.125

Acceptable: (Noise less than ambient and 45dBA) (Safety Offset >1.5 x max height, risk <1 in million)(GPL price USD/kwh <0.11USD/kwh)

Marginal (Noise <5dBA above ambient and 55dBA) (Safety between 1.5 and 1.0 WTG max height)(GPL price USD/kwh 0.11-0.13USD/kwh)

Unacceptable: (Noise greater than 5dBA above ambient) (Safety Offset less than max WTG height)(GPL price USD/kwh >0.13USD/kwh)

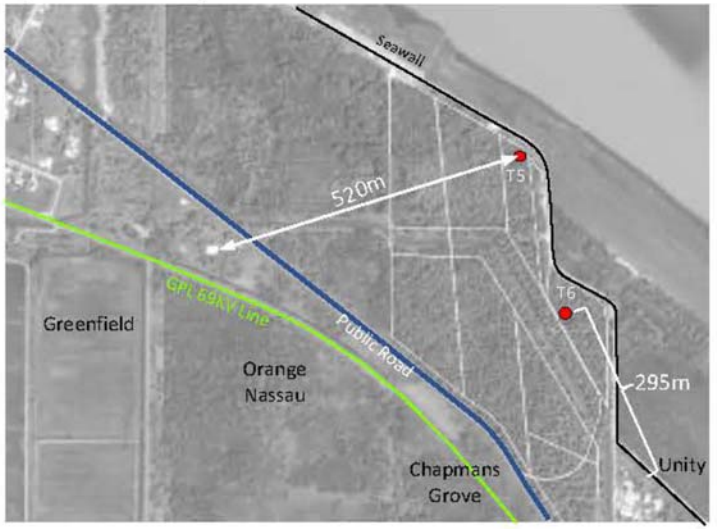
WTG - Wind Turbine Generator, HB - Hope Beach Lease, CHG - Chapman's Grove Lease

* Serrated trailing edge blades, reduces noise emissions

** worst case receptor and wind speed scenario for max noise minus ambient noise LAeq

Option 1 & 2 Hope Beach

Option 1 & 2 Chapman's Grove



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Option 3 Hope Beach

Option 4 Hope Beach

SOURCE: HOPE ENERGY DEVELOPMENT

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ECO REPORT NO.	05/2020
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CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	WIND FARM CONFIGURATIONS CONSIDERED FOR THE HOPE WIND FARM
FIGURE NUMBER:	4-1

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Note: The Project Alternatives used IFC's HSE guideline for wind farms as the basis for screening safety offset distances. IFC's guideline states a minimum of 1.5 times maximum wind turbine height distance for safety offset from residential houses. Scenarios 3 and 4 both failed on the basis of this safety offset guideline, and also on the noise emissions. In addition, Scenario 2 failed on the basis of commercial viability. The proposed scenario is the only viable scenario based on safety offset, noise emissions, and commercial viability and is thus the selected option. The quantitative risk assessment for safety associated with blade-throw was thus only done on this selected option in order to gain additional confidence that there would be no issue with safety risk levels.

2) 15 MW from six (6) Goldwind 2.5MW WTG's, having the same layout as option 1, but using a smaller class of wind turbine. This scenario also meets all the nuisance and safety criteria but cost per unit capacity is high due to the limited size of the project.

3) 13.5 MW from nine (9) Vensys 1.5MW WTG's, all at Hope Beach (Figure 4-1). This configuration was considered by a previous project developer, that explored the use of substantially smaller 1.5MW class machines and one of the quietest utility scale machines available at the time. The small capacity requires installing more machines, and this results in higher noise emissions that are at best marginally acceptable. Also, the combination of smallest capacity machines with smallest total generation capacity results in the highest price to GPL, well above GPL's present cost of generation, which is unacceptable.

4) 26 MW from thirteen (13) CS WIndpower 2.0MW WTG's, all at Hope Beach (Figure 4-1). This configuration was considered by a previous project developer. A large number of very closely spaced machines were required in order to meet a minimum project size demanded by the turbine supplier, which resulted in unacceptable noise emissions that are substantially higher than the existing background noise levels, and unacceptably short safety standoff distances to nearby houses. The scale of the project was still not sufficient with this size wind turbine to achieve an acceptable sales price to GPL.

5) Do Nothing. In a case where any of safety, community nuisance, or environmental impacts are a significant concern, then the Do-Nothing option should be seriously considered versus the potential benefits of the project to all stakeholders. Wind energy projects require a number of years to develop, and the data collected during this period is very site specific. The result of Do Nothing would be a substantial delay until some other project at an alternative location could be developed. This would mean years of delay of the substantial benefits of utility scale wind energy to the nation, the improved power supply to GPL's grid, and the benefits to the electricity consumers along the entire Berbice branch of the grid. As the selected configuration of six (6) Vestas wind turbines meet all the safety, health, community nuisance, environmental, and commercial criteria, there is no reason to consider a Do-Nothing option.

4.1 Configurations of Alternative Options:

Option 1 Configuration - 25 MW Vestas (6 x 4.2MW): This is the selected option, which minimises the environmental impacts and maximises economies of scale. The configuration utilises fewer and larger machines than any of the other options, resulting in the longest offset distance from residential houses and also 25MW total output, from six of Vestas's latest 4.2MW state of the art wind turbines from the top wind turbine supplier in the world. With only 4 machines at Hope Beach it is now possible to have offsets greater than 295m from nearby houses. This distance meets the IFC's (World Bank) guidelines on minimum offset distance of 1.5 times the total wind turbine height, which comes to 270m. The spacing between the machines is sufficient to avoid too much interference by the wake of an upwind rotor spoiling the flow of wind to a downwind rotor. The recent acquisition of the Chapman's Grove leases has allowed an additional two wind turbines to be added to the project, and a much shorter connection distance between the substation and GPL's 69KV transmission line. Each machine has a 150m rotor at 105m hub height. The area swept by the rotor determines the amount of energy harvested. A large rotor to generator ratio is important in low wind regions such as Guyana.

Option 2 Configuration - 15MW Goldwind (6 x 2.5MW): Same layout as Option-1, but using a smaller class wind turbine, with 6 of Goldwind's 2.5MW turbines for a total 15MW wind farm capacity. This option keeps the offset distance and low number of machines required for noise attenuation, and explores the economic impact of a smaller class machine on trying to meet the maximum price requirement for GPL. Goldwind is a reputable and internationally certified wind turbine manufacturer with leading technology and relatively quiet machines. Each machine has a 109m rotor and 90m hub height.

Option 3 Configuration - 13.5MW Vensys (9 x 1.5MW): This was an option considered by a previous developer, utilizing what was at the time one of the quietest wind turbines on the market, the Vensys 1.5MW, and using as many of these as possible at Hope Beach in order to try to achieve sufficient economies of scale. Spacing nine of these along both the Block X and Block Y sections of the lease in tight formation. The small 82m diameter rotors are attached at an 85m hub height.

Option 4 Configuration – 26MW HZ (13 x 2.0MW): This was the original option considered by a previous developer, driven by the minimum size of wind farm of 25MW required by the wind turbine supplier in order to support the project. The 2.0MW HZ Windpower machines have 110m diameter rotors at 80m hub heights. In order to fit 13 wind turbines along the Block X and Y leases at Hope Beach, spacing of the wind turbines was reduced to less than 125m, which is very tight.

4.2 Noise Emissions Impacts of Alternative Options:

Noise emissions is the most critical component to consider in the design of the wind farm at Hope Beach, and to a lesser degree, at Chapman Grove, as there are nearby residential houses. Chapter 12 is dedicated to the topic of noise emissions for Option 1. Table 4-1 summarises the noise emissions estimates for the four options.

Noise emissions of wind turbines is caused mainly by air disturbance at the tip and trailing edge of the outermost portions of the rotor blades, and to a much lesser degree by mechanical gearbox noise in the nacelle. The factors affecting the noise at the rotor is the speed of the rotating blade and the amount of air disturbance due to the aerodynamic shape of the blade.

The faster the blade moves through the air, the more noise it makes. As wind turbine designs have gotten larger the tip speed has remained the same as earlier smaller machines, typically in the 70 to 90 m/s range, by slowing down the revolutions per minute of the larger rotors. In addition, steady improvements in blade design have resulted in the latest and largest 3 to 5 MW class slow-rotating wind turbines having noise emission levels that are often less than much smaller 2MW class machines designed a decade ago (Figure 4-2). This is also helped by using serrated trailing edges on the blades, which reduces noise but does not affect the power output. The wind turbines can also be operated in additional noise attenuation modes by trimming the angle of the blades to reduce the maximum noise output during sensitive hours. Noise attenuation modes typically have a reduction in maximum power output.

Option 1 Noise - 25 MW Vestas (6 x 4.2MW): The four V150 machines with serrated blades at Hope Beach result in a maximum noise emission of 44.2 dBA at the nearest residence. The two V150 machines at Chapman's Grove result in a maximum 44.5 dBA at the nearest residence at Unity. Although the offset distance to the nearest residence at Unity is similar to Hope Beach, as there are only two machines and thus two sound sources at CHG, there is less additive effect than Hope Beach, which has four sound sources, hence it is necessary for one of the wind turbines at Hope Beach to operate in a noise reduced mode to meet the meet the WHO and World Bank nigh-time 45dBA maximum noise guidelines for residential areas. The resulting noise levels are also substantially below that of the existing ambient noise levels measured at night in the HB and CHG areas, and thus unlikely to cause any complaints. Option 1 is acceptable on the basis of noise emissions.

Option 2 Noise – 15MW Goldwind (6 x 2.5MW). As the configuration is the same as that of Option 1, with 6 wind turbines at the same locations as Option 1, and almost the same reference noise levels for the wind turbines (105dBA for Goldwind 2.5MW machine vs 104.9 dBA for Vestas), the noise levels at the nearby residences will be almost the same as Option 1. Option 2 is acceptable on the basis of noise emissions.

Option 3 Noise – 13.5MW Vensys (9 x 1.5MW). The small Vensys 1.5MW machines are marginally quieter than the Vestas V150 machines, at 104.4 dBA vs 104.9 dBA. However, the Vensys configuration has 9 machines at HB, and thus there is an additive effect due to the additional noise sources. Also, the offset distances are much less for Option 3, with the nearest distance to residential houses of 130m vs 295m for Option 1. The noise emissions are thus a maximum of 55 dBA at the nearest residential buildings at night, which is above the guidelines of WHO, although this would be acceptable in certain jurisdictions such as Spain and certain parts of the USA. Option 3 noise levels is also some 4dBA above ambient noise levels at night, and so likely to be noticed and may cause complaints. Option 3 is marginally acceptable on the basis of noise emissions.

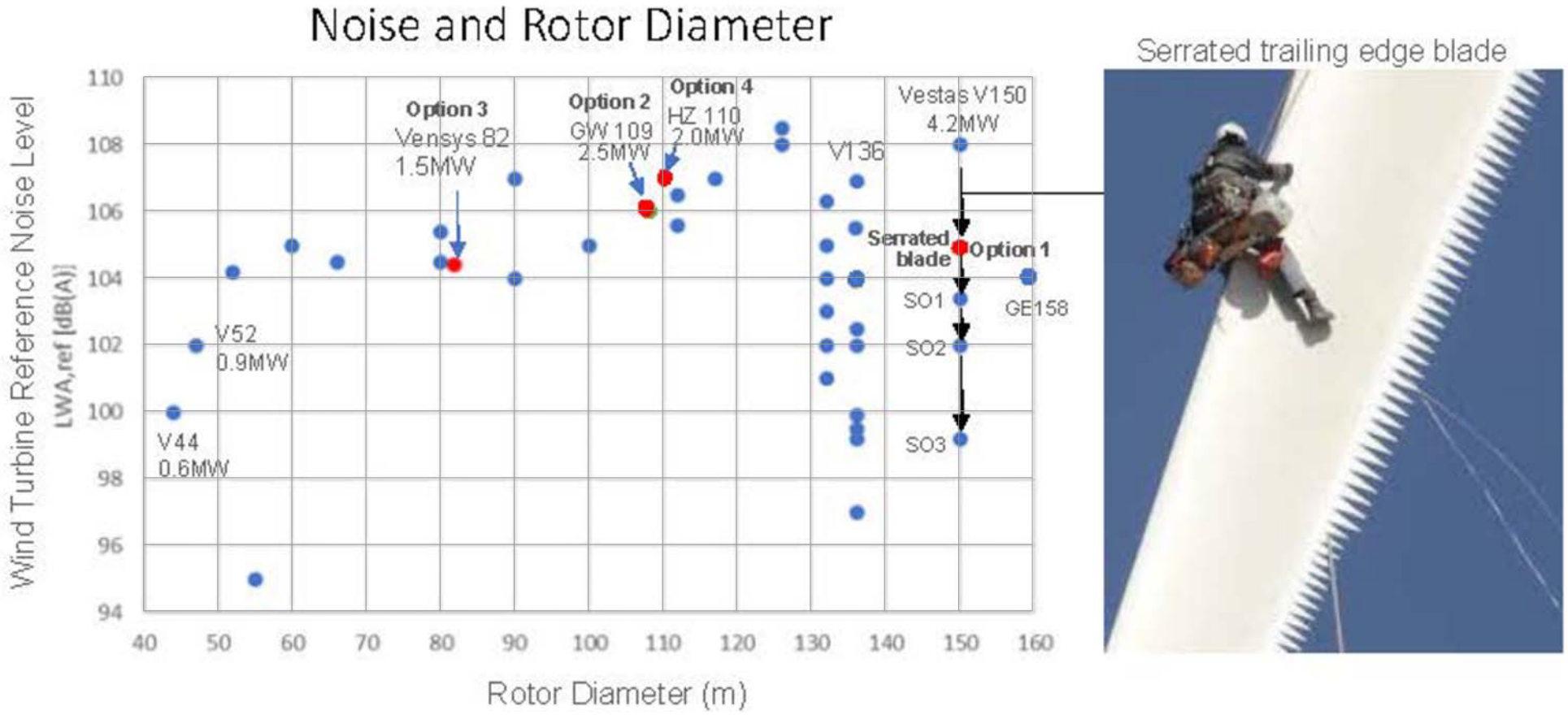
Option 4 Noise – 26MW HZ (13 x 2.0MW). The issues with noise highlighted for 9 relatively quiet machines for Option 3 are more severe with the 13 louder wind turbines for Option 4. This option was designed to meet the existing Guyana noise emissions standard of 60 dBA at night for residential areas. The 60 dBA level is well above ambient noise levels at night, and likely to cause complaints. Option 4 is unacceptable on the basis of noise emissions.

4.3 Safety Risks of Alternative Options:

Safety Offset distance and the risk of harm to residents due to wind turbines falling over or parts of rotor blades breaking off and being thrown some distance is an important consideration. Chapter 12 is dedicated to the topic of safety risk for Option 1. Table 4-1 summarises the safety offset distances for the four options.

The risk of a wind turbine collapsing, or a rotor blade breaking off and being flung is very low. IFC (World Bank) environmental and safety guidelines for the wind industry advise a minimum safety offset distance of 1.5 times the maximum height of a wind turbine in order to achieve acceptable levels of safety risk. IFC's guideline informed the location of wind turbines for Options 1 and 2.

Option 1 Safety Offset - 25 MW Vestas (6 x 4.2MW): The closest distance to nearby residential houses for Option 1 is 295m, which is greater the 270m required to meet the 1.5 time the total height IFC safety guideline. In addition, MMI Thornton Tomasetti completed a thorough quantitative risk assessment of safety for Option 1, their results are described in detail in Chapter 18 and MMI's report is included as Appendix U. MMI's assessment accounts for 2 years of wind data, the size, shape, weight, locations and rotor RPM of the V150 wind turbines, location of residential houses, the national road, Hope Secondary School, Flood Gate operators, Fishermen offloading area, occupancy and road traffic data. The worst-case scenario results in the risk of harm to a resident of 1-in-35 million years, which is considerably less than the chance of being



SOURCE: HOPE ENERGY DEVELOPMENT

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DWG. NAME:	RELATIONSHIP BETWEEN ROTOR SIZE AND NOISE EMMISIONS
FIGURE NUMBER:	4-2

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struck by lightning in the UK, and well below the broadly acceptable safety risk of 1-in-1-million years. Option 1 has an acceptable safety offset distance.

Option 2 Safety Offset – 15MW Goldwind (6 x 2.5MW). As the configuration is the same as that of Option 1, with 6 wind turbines at the same locations as Option 1, and with a maximum height that is less than Option 1. Offset distance is two times the Total height, which is a greater safety margin than advised by the IFC guidelines. Option 2 is well within the acceptable safety offset guideline set out by the IFC.

Option 3 Safety Offset – 13.5MW Vensys (9 x 1.5MW). Although these are the smallest machines, they are located much closer to residential houses, with the machines in block Y within 130m of houses. The offset distance is only 1.1 times the total height of the wind turbines. Option 3 is thus at best only marginally acceptable for safety offset distance.

Option 4 Safety Offset – 26MW HZ (13 x 2.0MW). Option 4 has machines that are far too close to residential homes, with locations in Block Y that are located a distance that is less than the total height of the wind turbine. Option 4 is clearly unacceptable for safety offset distance.

4.4 Shadow Flicker Impacts of Alternative Options:

Shadow flicker is caused when the sun is low on the horizon and causes a shadow from the rotating blades on houses that has a flickering effect as blades slice through the sun-disc. There is no health issue from this as frequencies are well below what is required to trigger epileptic seizures. However, the flickering shadow can be irritating to residents. The solution is simple, during the early morning sun the individual wind turbines are shut in. Eventually the sun rises high enough such that the shadow effects are no longer an issue. The evening sun is not an issue at the sites as the shadow effect is only affecting areas out to sea.

All four options can simply be shut in (curtailed) until they meet the international standard of maximum 30 hrs shadow flicker per year, and maximum 30 minutes per day. The closer a wind turbine is located to affected houses, the longer the shut-in. The shut ins result in energy production losses, and these will have an impact on the economics of the project.

Option 1 and Option 2 have the lowest impacts on energy curtailment, resulting in 3% and 2% energy losses over a year, respectively. Option 3 has 4% energy losses and Option 4 has 5% energy losses, as these wind turbines are closer to residences. These impacts are included in the calculation of the PPA price to GPL in the next section.

4.5 Price of Electricity from Alternative Options:

The price of electricity for renewable energy projects must be sufficient to pay for all capital and operational costs over the life of the project, and generate sufficient revenue to satisfy the minimum returns required by debt providers and investors. The PPA price is thus calculated using a discounted cash flow financial model. The model accounts for the amount of electrical energy generated each year, cost estimates to engineer and construct the wind farm, operate the wind farm, pay taxes, interest payments and dividend payments over a 20-year period.

The 4 options assumed the same methodology for estimating costs, same cost of capital and tax rates. Power output is wind turbine specific, and the applied losses varies according to how much losses is due to close spacing of wind turbines and amount of flicker curtailment.

The resulting PPA price in US cents per kWh should ideally be less or at least the same as what GPL is presently paying for electricity generation. The present cost of generation with heavy fuel oil pricing as set by Guyoil over 2018 and 2019 is estimated at US cents 12 per kwh. Table 4-1 summarises the PPA prices for the four Options considered.

The PPA prices indicated in this exercise are very much preliminary in nature. The actual price to GPL will reflect the final estimate of cost for the project, actual cost of capital offered by debt financiers, and the terms agreed to in the eventual offtake agreement with GPL when such items are finalised.

Option 1 PPA Price - 25 MW Vestas (6 x 4.2MW): The selected option benefits from economies of scale by having larger wind turbines and also an overall project size of 25MW. These larger machines are designed specifically to efficiently harvest wind energy in low wind regime areas. The cost per unit energy yield for Option 1 is thus lowest of all the options, and this translates to a notional PPA price of US cents 9.8 per kwh.

Option 2 PPA Price – 15MW Goldwind (6 x 2.5MW). The smaller machines and overall project size results in a PPA price of US cents 14 per kWh, which is too high to be competitive with GPL's existing generation costs.

Option 3 PPA Price – 13.5MW Vensys (9 x 1.5MW). This configuration is even smaller, and the small 82m diameter rotors are not ideal for low wind conditions. The result is a PPA price of US cents 17.3 per kwh, which is unacceptably high.

Option 4 Safety Offset – 26MW HZ (13 x 2.0MW). Option 4 has sufficient project size, the wind turbine has a relatively large rotor suitable for low wind conditions, however, the additional costs of installing more than twice as many machines as Option 1 results in an overall higher cost per unit energy yield. The resulting PPA price of US cents 12.5 per kwh is marginally acceptable.

4.6 Summary of Results from Alternative Options:

Option 1 and Option 2 are the only two scenarios that can satisfy all the environmental requirements and not cause a nuisance to the nearby communities. Of these two, Option 1 is the only option that can provide a competitive PPA price to GPL.

4.7 Comparison of Adverse and Beneficial Effects of Options

All 4 project options satisfy the following national policies and development goals specifically with respect to renewable energy and climate change:

- Sustainable Development Goal (SDG) 13 "Take urgent action to combat climate change and its impacts".
- The Government's Development Objective of "Transition to Renewable Energy".
- The Government's Development Goal of "Sustainable management of natural resources"
- The Draft National Energy Policy to achieve 100% renewable energy penetration in the electric sector by 2025.
- The National Climate Change Policy and Action Plan.

However, the options have different environmental impacts which are discussed in relation to international guidelines and country standards, policies and sustainable development goals under the following headings:

- Public Safety
- Noise
- Clearing of Vegetation
- Shadow Flicker
- Pricing

4.7.1 Public Safety

Wind farms present a risk of harm to residents due to wind turbines falling over or parts of rotor blades breaking off and being thrown some distance. There are residential houses close to the Hope Beach and Chapman Grove sites. Guyana has no public safety guidelines for the setback distances of wind turbines from residential areas. World Bank environmental and safety guidelines for the wind industry advise a minimum safety offset distance of 1.5 times the maximum height of a wind turbine in order to achieve acceptable levels of safety risk.

In Options 3 and 4 the location of turbines is very close to the neighbouring residences. Without the required safety offset distance, these two options are unacceptable. For the turbines that are proposed for Options 1 and 2, a minimum distance of 270 m from the nearest residence is required.

The proposed location of the wind turbines in the configurations in Options 1 and 2 is 295 m which meets the World Bank guideline requirements for public safety.

4.7.2 Noise

The source of noise from the wind turbines is from the turning of the rotor blades and the mechanical gearbox in the nacelle. Noise is a concern to neighbouring receptors (residents and school) particularly at night when background sound is reduced. Nighttime noise limits of 60dBA and 45 dBA in residential areas are stipulated by the Guyana Noise Rules and World Bank, respectively.

As previously discussed, Options 1 and 2 meet the noise requirements for nearby residences and the school. In both cases noise is less than background ambient noise for nighttime and daytime, is at or less than the World Bank guideline value of 45 dBA and is significantly lower than the 60 dBA stipulated for Guyana. On the other hand, Options 3 and 4 do not fully satisfy these requirements.

4.7.3 Clearing of Vegetation

Clearing of land will be required in any of the four options. The number of units ranges from 6 to 13 with Options 1 and 2 having the least (6 units) and Option 4 the most (13 units). The amount of land to be cleared will be greatest for Option 4 and least for Options 1 and 2, assuming that the greater the number of units, the larger the land area to be cleared.

Option 1 proposes no removal of mangrove from the coast and this is in keeping with the country's Sea and River Defense Policy, National Mangrove Management Action Plan and Climate Resilience Strategy and Action Plan.

4.7.4 Shadow Flicker

Shadow flicker can be a nuisance/disturbance to residences particularly in the morning periods. The World Bank EHS guidelines recommend that the predicted duration of shadow flicker effects experienced at a sensitive receptor should not exceed 30 hours per year and 30 minutes per day.

All four options can meet the World Bank guidelines but the number of hours that the units will have to be shut in varies. This time ranges between 0.5 hr (Option 2) to 1.3 hr (Option 4). Options 1 and 2 being furthest away from neighbouring residents have the lowest shut in times.

4.7.5 Pricing

The period of shut in translates to energy loss which is one of the many factors to be considered when pricing of the commodity. Options 1 and 2 with the least shut in times (0.7 hr/day and 0.5 hr/day, respectively) also have the lowest impacts on energy curtailment, resulting in 3% and 2% energy losses over a year, respectively.

Preliminary pricing calculations indicate US cents/kwh ranging between 9.8 to 17.3. Option 1 was indicated as having the lowest price of US 9.8 cents/kwh which is competitive with GPL's existing generation costs. This option therefore satisfies SDG 7 "Ensure access to affordable, reliable, sustainable and modern energy for all". All other options were considered marginally acceptable (Option 4) or unacceptable (Options 2 and 3).

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5 COMPREHENSIVE DESCRIPTION OF THE PROPOSED PROJECT

The planned Wind Farm represents the first substantial utility scale renewable energy project to be implemented in Guyana. The 25.2MW wind farm will generate over 80GWh per year, to be delivered to GPL's grid according to terms of a Power Purchase Agreement and Grid Interconnection Agreement. This wind energy represents over 10% of GPL's gross total electricity generation. The Hope Wind Farm is a pilot project that will inform all stakeholders on what is required to build and operate a wind farm in Guyana and how to integrate this energy into GPL's grid. The project will confirm the promising performance of wind energy, reduce the reliance on fossil fuels and its associated emissions of CO2, pollutants, and reduce substantial foreign exchange loss due to fuel imports. The wind farm will generate local jobs in construction operation and maintenance of a renewable energy facility.

The leases, all project rights, assets, and liabilities are owned by Hope Wind Energy Inc (HWE), which is a wholly owned subsidiary of Hope Energy Development Inc (HED), a project development company owned by a partnership comprising Guyanese, Danish and Trinidadian interests. The Environmental Permit application will be held in the name of Hope Wind Energy Inc (HWE). Once the project is ready to start construction and all financing is in place, additional Guyanese investors will be invited to participate, with an aim of achieving more than 50% Guyanese ownership of HWE and the project. Local ownership of renewable energy projects for the long term is an important consideration in maximising the benefits for Guyana's economy.

This chapter addresses:

- Wind Farm Basics,
- The Project Site,
- Layout and Access at Hope Beach,
- Layout and Access at Chapman's Grove,
- Overview of Wind Farm Construction Activities, and Project Schedule.

5.1 Wind Farm Basics

5.1.1 How Wind Energy is Generated

The four key components of a wind farm:

1) A spinning generator is driven by wind acting on a large rotor, and in this way converts wind energy into electrical energy. The larger the diameter of the rotor, and the stronger the wind, the more power that is generated by the wind turbine generator (WTG).
2) A transformer at each WTG increases the voltage for transmission to the wind farm electrical substation. This medium voltage power is collected from each WTG via a collector network of medium voltage cables, usually buried.
3) The wind farm substation collects the power from all WTGs in the wind farm, converts the power to high voltage electricity suitable for feeding onto the national power grid, and meters how much electricity is generated.
4) The utility company purchases the electricity at a wholesale price, distributes and sells the power in turn to its customers at a retail price determined by cost of generation, grid maintenance, overhead costs and profit margin of the utility company.

5.1.2 Introduction to Wind Turbine Components

Rotor and Blades: The most obvious feature of a wind turbine is the spinning rotor, comprised of three long blades constructed from glass/carbon composite fibres and connect to a central hub. Each individual WTG has a rotor hub height of 105m (344 ft) as determined by the height of the tower. Each blade is 73.7m long (242 ft), weighs 17.4Metric Tonnes (MT), and the rotor diameter is 150m (492ft). Maximum height of the rotor tip will be 180m (590 ft) above ground level. The blades are usually the biggest challenge to transport due to their length, requiring a wide turning radius of at least 70m.

Nacelle and Tower: Each individual WTG has a nacelle located at the top of a tower, which houses the drive-train, gearbox, generator, power converter and electrical kit. Nacelle dimensions are a little larger than a standard 40ft container, at 12.9m long, 4.2m wide, and 3.5m tall, and without the drivetrain weighs 70 metric tonnes when transported.

The tower is made of four tubular steel sections stacked on top of one another, from 4.4m diameter at the base, to 3.5m diameter at the top, for a total height of just over 100m. The tower components weigh between 60 to 70 metric tonnes each.
The low/medium voltage transformer and electrical switchgear is located in the base of the tower. The tower is accessed via a steel door, which is locked.

Foundations: As with most tall structures constructed in the coastal belt the wind turbines will require piles inserted to depths where firm strata are encountered, at 25-30m depth. A reinforced concrete slab some 15 to 18m in diameter and 1 to 2m thick is cast at ground level on top of the piles. The overall land requirement for each wind turbine is quite small, and it is possible to farm all the way to the foundation slab – farming and wind energy go well together.

Transport Loads: The heaviest components will be transported via modular THP type trailer/truck transport equipment with multiple steerable axels and up to 8 wheels per axle, towed by a heavy haul trailer truck. The modular THP trailer units can be added until the required weight distribution, weight per axel, and weight per unit width tire is achieved, as per regulations.

The heaviest loads, such as the 70MT nacelle and tower sections, together with transport equipment, results in total vehicle weights of up to 150MT, and axel loads of up to 10 metric tonnes per axel. An assessment of maximum loads versus bridge and culvert capacity has been completed along the transport route to ensure that there is no damage to road infrastructure.

The site access roads will be built to Vestas specifications in order to handle the heavy loads and the required turning radius.

Vestas will be responsible for the shipping and transport to site. Vestas transport specialists will complete a full route survey during the detailed design phase in 2021.

5.1.3 Introduction to Project Development Phases

Typical of project development phases in many industries, a wind farm project can be divided into five (5) distinct phases of development:

a) Feasibility Stage – Collecting wind data and information to determine whether project is technically feasible, commercially viable, likely to pass regulatory hurdles, securing the power purchase agreement and land rights. Typical studies at this stage include: wind resource assessment, wind engineering, selection from design options, initial environmental assessment, grid interconnection study, logistics study, geotechnical sense check, regulatory compliance screening and initiation of key regulatory approvals. Typical timeline is 18 to 24 months. The Hope Beach Wind Farm

project is in the advanced feasibility phase. This stage culminates with a Feasibility Stage Gate and draft PPA, with a decision on whether the project has sufficient technical and commercial merit to proceed to the next stage.

b) Detailed Design Phase – Preliminary plans from the feasibility stage are converted to detailed designs by contracted engineering consultancies, a detailed geotechnical study, procurement of equipment and services for the construction phase, detailed logistics planning, completion of regulatory permitting, additional environmental studies if required, and raising required financing and investor capital. Typical timeline is 4 to 12 months, but may take longer in some jurisdictions where regulatory and legal hurdles are considerable. This stage culminates with a Final Investment Decision Stage Gate, with a decision by investors on whether the project has sufficient merit to proceed to the Construction Phase.

c) Construction Phase – Long lead orders are placed for the wind turbine equipment and select electrical equipment, such as the substation transformer. Wind turbine equipment lead times are typically 6 to 12 moths till delivery. Whilst waiting on wind turbine equipment the project completes the electrical and civil works. Civil works entails the construction of the site access roads, the wind turbine foundations, crane pads and lay-down areas. Electrical works entails laying of buried and overhead medium voltage collector cables, construction of the substation, and installation of the high-voltage transmission line to interconnect with the grid. When the wind turbine equipment ships the crane and specialised transport equipment is also mobilized. It usually takes 3 to 4 days to install a single wind turbine once the crane and equipment are on site. Typical construction timeframe for a small wind project is 6 to 12 months, depending on equipment lead times. During the Construction Phase all activities are in accordance with relevant Regulatory Permit requirements, international safety standards, and adherence to the Environmental and Social Management Plan. The Construction Phase ends when the installed equipment has passed all commissioning tests and relevant inspections, and the project is commissioned.

d) Operation Phase – The wind farm is set into operation, generating and selling renewable energy onto the grid in accordance with contractual agreements, in particular the Grid Interconnection Agreement with GPL. The operator maintains the site, and contracts relevant services to monitor and maintain the equipment of the wind farm. Operation of a wind farm is considerably simpler than that of a fossil fuel power plant, as there are almost no consumables, and maintenance requirements are much lower. The Environmental and Social Management Plan will guide monitoring and reporting activities for the life of the plant, which is typically in excess of 20 years for a wind farm.

e) Wind Farm Repowering and Decommissioning Phases – The Hope Wind Farm leases are for 50 years. Wind turbines have a minimum design life of 20 years, and typically will keep functioning for 25 to 30 years without requiring any major upgrades. Electrical substations typically have a technical life of more than 30 years. Once the

initial WTG's reach the end of their functional life, the typical route is to then renew the PPA offtake agreement, and then to either upgrade specific equipment in the existing wind turbines in order to provide another 20-year operational phase, or to completely upgrade all the equipment by replacing the entire wind turbine structure to more modern designs. The renewed PPA typically has much lower pricing as the cost of a repowered wind farm is less than building the initial facility. It is our expectation that this site will remain a wind farm generation facility in the foreseeable future. Should it be decided to cease using the site as a wind farm, then the crane and transport equipment would return to the site, disassemble all the wind turbines down to foundation level, and remove all the equipment to be scrapped or to be refurbished. At that point it can be decided whether the site should be returned to its original state, in which case the roads and crane pads would be removed. The foundations are already below grade and would most likely be abandoned in place.

5.2 THE PROJECT SITE

The project is located on a 27-acre state owned lease at Hope Beach (HB), and private leases at Chapman's Grove (CHG), some 28km and 30km, respectively, SE of Georgetown centre. The HB lease is the location of four wind turbines (see Figure 5-1), on the seaward side of the existing seawall, North of the plantations: Hope, Douchfour, Two Friends, Anns Grove, Clonbrook and Beehive. The CHG lease is the location of two additional wind turbines, on coconut plantation lands inboard of the seawall, bounding Unity Village (see Figure 5-1). The project falls under the jurisdiction of the Grove-Haslington Neighbourhood Democratic Council (NDC). The 50 year HB lease was awarded on the 9th March 2007 by the President of the Cooperative Republic of Guyana, Mr Bharrat Jagdeo, specifically for industrial purposes: the establishment of a windfarm for electricity generation. The open lands between the seawall and the Demerara-Berbice main road at Hope Beach belong to the Hope Estate, and are designated for agricultural use, not to be developed for housing as the area is required as a holding basin for water discharge during heavy rains.

5.2.1 Project Layout and Access at Hope Beach

The Hope Beach site is dissected by the recently constructed Hope Canal, which splits the main lease area into a Western portion, HB-W, with a single wind turbine, and an Eastern portion, HB-E, with three wind turbines. The WTG locations are aligned along the relict beach ridge, which is elevated above spring high-tide levels, underlain by clayey silts and sands, and covered with grasses and brush. There are no Mangroves growing on this elevated relict beach ridge. The location and spacing of the wind turbines are determined by the wind farm design noise emissions limit of maximum

45dBA at the nearby houses and the school, and safety offset margins that are in line with IFC (World Bank) and other international guidelines.
HB-W will be accessed via the existing and recently upgraded access road along the 40ft wide drainage canal dam (embankment) which connects the newly constructed Hope pump house to the main road. The access road will cross the existing seawall near this pumphouse (see Figure 5-2).

HB-E will be accessed from the main road via the existing access road to the Hope Canal Flood Gate facility, to be extended adjacent to the Hope Canal embankment North to the site. This access road will cross an area where the old seawall appears to have been removed during construction of the flood gate facility. The two proposed access roadways have minimal if any impact on Mangrove vegetation, and no structural risk to the flood facility infrastructure and drainage canal embankment integrity. An alternative option to access HB-E via an access road directly though the mangroves was deemed unacceptable due to the impact on the mangroves.

5.2.2 Project Layout and Access at Chapman's Grove

Chapman's Grove will be accessed off the Demerara-Berbice main road via private leased lands and then across a 40ft wide drainage canal, the road then turns left and follows the boundary with Lot 3C and NDIA's drainage reserve area passing wind turbine T6, and a final bend to pass North through Lot 3A to wind turbine T5 (see Figure 5-3).

5.3 Overview of Wind Farm Construction Activities

5.3.1 Civil Works

Activities during the construction of the civil works are typical of any industrial construction site including transport of prefabricated concrete piles, steel reinforcement bars, and concrete. The site will have the temporary amenities typical of any construction site, such as a mobile site office, portable bathroom facilities, lay-down areas, a portable field workshop, security, portable generator/s and fuel depot, etc. Preliminary estimate of the time required to complete this set of activities is six (6) to eight (8) months. The civil and electrical works occur during the long-lead waiting period required for delivery of the wind turbines.

SOURCE: SATELLITE IMAGE, 2019

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ECO REPORT NO. 05/2020

DATE: 03/12/21

CLIENT: HOPE ENERGY DEVELOPMENT INC.

PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA

DWG. NAME: LOCATION OF THE HOPE WIND FARM PROJECT SITE AND EXTENT OF LEASE BOUNDARIES - HOPE BEACH

FIGURE NUMBER: 5-1 (a)

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SOURCE: SATELLITE IMAGE, 2019

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DWG. NAME: LOCATION OF THE HOPE WIND FARM PROJECT SITE AND EXTENT OF LEASE BOUNDARIES - CHAPMAN'S GROVE

FIGURE NUMBER: 5-1 (b)

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DWG. NAME:	HOPE BEACH WINDFARM LAYOUT AND ACCESS ROUTES
FIGURE NUMBER:	5-2

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DWG. NAME:	CHAPMAN'S GROVE WIND TURBINE AND ACCESS ROAD LAYOUT
FIGURE NUMBER:	5-3

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- **Clearing of vegetation:** Total area occupied by access roads, crane pads, foundations and temporary lay-down areas and construction site offices amounts to 4.5 hectares (11.2 acres) distributed as follows:

Undisturbed habitat, permanent:	1.1 ha
Undisturbed habitat, temporary:	1.0 ha
Modified habitat, permanent:	1.9 ha
Modified habitat, temporary:	0.5 ha

  Undisturbed habitat is comprised exclusively of relict beach ridge habitat at Hope Beach. Disturbed habitat includes upgrading of existing access roads, roads built within the disturbed Hope Canal reserve area, and coconut plantation area at Chapman's Grove.

- **Utility requirements:** Power requirements during the construction phase will be provided via on-site generators. Water requirements will be brought in by truck and stored in temporary tanks. The site will have portable ablution facilities.

- **Sources of material**: All materials for civil and electrical works, and also the wind turbine equipment will be transported by truck from Georgetown. Aggregate materials will be transported in from the aggregate wharfs in Georgetown, with white sand brought in from areas South of Georgetown. Concrete requirements of cement and steel will also be trucked in from suppliers in Georgetown. The total amount of white sand may be reduced from local quarries for "reef" sands if suitable materials can be confirmed, hence reducing the amount of truck traffic. Over the estimated 10-month construction period an estimated 5,100 truckloads will be transported to the site, averaging 25 truckloads per work day, with peaks of up to 50 trucks per day during certain overlapping activities.

- **Access roads**: The first activity during the construction phase is the construction of 5m wide access roads from the National Road to each WTG site. This will entail grubbing (removal of organic rich top-soils) of the top 0.3 to 0.6m of substrate, build-up of some 0.6 to 1.0m of compacted construction sand, followed by 0.3 to 0.5m of compacted silty sand, and finally a layer of graded and compacted aggregate of some 0.15 to 0.3m thick (see Figure 5-4). Any excavated material will be trucked and deposited at the Chapman's Grove private lease area. All sands and aggregates will be trucked to the site using the national road network. A total of some 3.5km of 5m wide access roadway is planned (see Figures 5-4). The access roads make use of existing roads and land areas disturbed by drainage canal construction activity, and are designed to minimize impact to mangroves.

- **Access Bridges:** The Chapman's Grove lease will be accessed via an 8m bridge connecting the lease to the main road which crosses a 5m wide drainage ditch (see

Figure 5-5). The access road will then cross the main 15m wide drainage canal at an angle which requires an 18m long bridge. The project will be advised by NDIA and local civil engineers as to the requirements for minimum spans in order to ensure proper functioning of the drainage canal. The bridge design will likely entail the installation of pre-stressed concrete piles as the vertical supports between spans. Prefabricated concrete beams will then span the canal (see Figure 5-5).

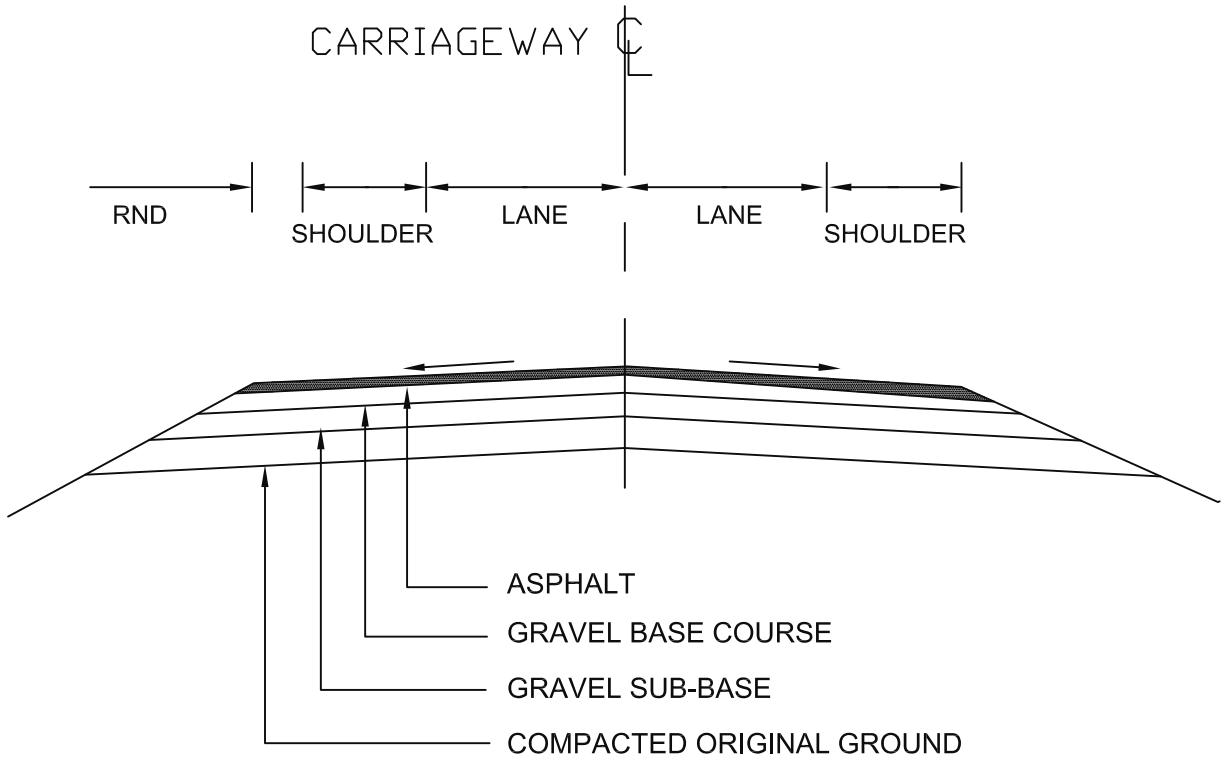
- **Wind Turbine Foundations:** The 2009 preliminary geotechnical borings confirmed some 20 to 30m thickness of the unconsolidated and weak Demerara Clays at the HB site. Typical of the Guyana coastal plain, this is underlain by a transition zone to the firmer, mottled silty clays of the Coropina Formation. The wind turbine foundation will require piles to this firmer level in order to support the weight and dynamic loads expected. The top of the piles will be linked by a reinforced concrete raft foundation some 18m in diameter, varying from some 1m at the outer edge, to over 2m thick at the centre. The concrete raft will contain the steel anchor tube at the centre, which is what the base of the steel tower will be connected to (see Figure 5-6). Electrical ducting and the electrical grounding system will be installed in coordination with construction of the foundation. Civil works are expected to be undertaken by local contractors supervised by civil engineering consultants experienced in wind turbine foundation design and construction, and in compliance with codes relevant to International standards and Guyana.

- **Crane Pads and Lay-down areas**: Similar to the access roads, the crane pad will require grubbing, infill and build-up of a compacted sand and aggregate substrate. The Crane pad is an area of some 120m2 which requires a thicker base, and possibly requires a reinforced cast concrete slab at its base. The lay-down areas for each WTG site covers approximately 2,000m2 (0.5ac) and also require compacted sand and aggregate substrate, but not as thick as the crane pads.

- **Substation foundations and wind farm site office / switchgear building:** Most of the substation components will likely require simple raft foundations, except for the large 34/69KV transformer, which will likely require piles. The entire surface of the substation will be covered by a layer of compacted aggregate, which acts as a form of insulating safety barrier from electrical shock for persons inside the substation area.

5.3.2 Electrical Works

Encompasses 3 main activity sets – installation of medium voltage collector lines, substation electrical equipment, and the 69KV feeder transmission line.



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DWG. NAME:	TYPICAL ACCESS ROAD CROSS SECTION
FIGURE NUMBER:	5-4

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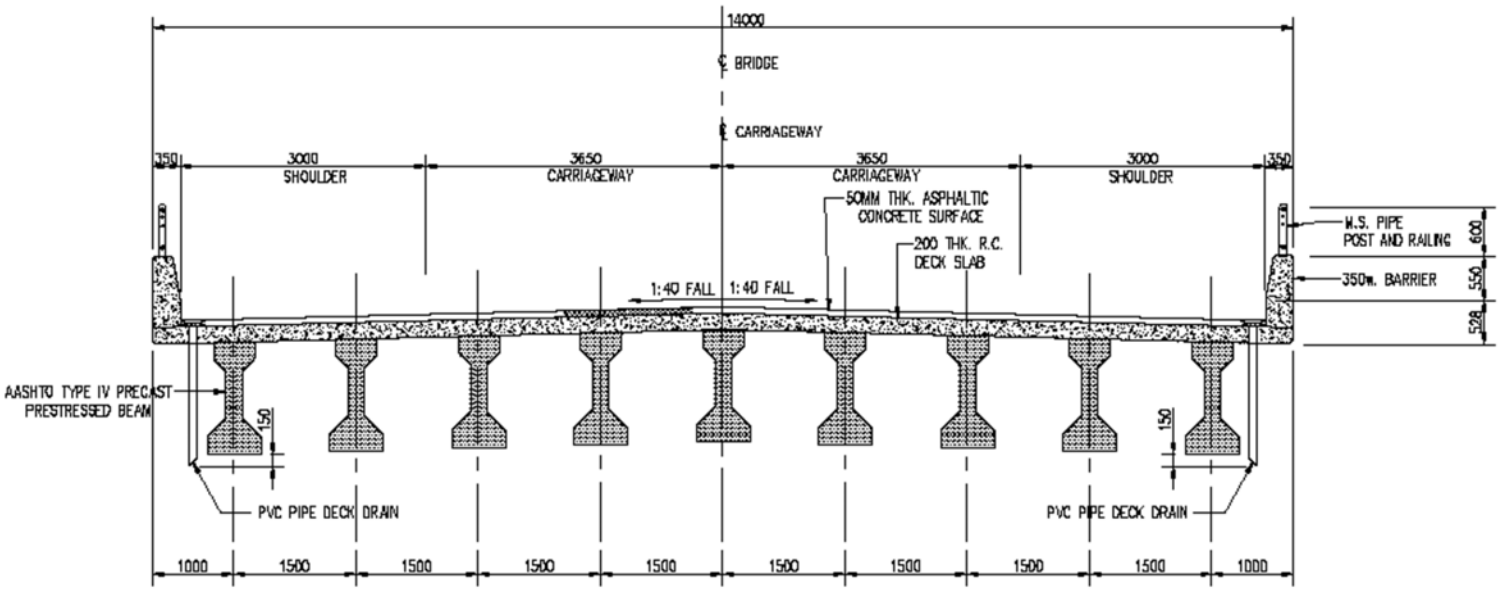

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DWG. NAME:	TYPICAL BRIDGE - SINGLE AND DOUBLE SPAN
FIGURE NUMBER:	5-5

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DWG. NAME:	TYPICAL PROJECT ACTIVITIES DURING CONSTRUCTION OF WIND TURBINE FOUNDATION
FIGURE NUMBER:	5-6

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Each wind turbine will be connected to the substation via a medium voltage (34KV) electrical collector line. The line will be routed into the base foundation of the turbines via electrical ducts. The line starts as a buried cable at Wind Turbine 1 (T1) at HB-W, passes across the Hope Canal as an overhead line, is buried again linking T2 to T4 at HB-E, then as a 2.4 Km overhead line along the Seawall reserve to Chapman's Grove, and then a buried line again, linking T5 and T6, and finally to the substation at Chapman's Grove.

Trenching, installation of overhead pole, laying of the lines, and backfilling the trenches, installation of substation equipment and the 69KV overhead lines are typical of electrical works activities common to Guyana and previously commissioned by GPL for its transmission line and substation network.

The electrical works will be undertaken by existing local contractors and supervised by electrical engineering consultants familiar with design and construction of similar works, and in compliance with codes relevant to International standards and Guyana.

5.3.3 Wind Turbine Equipment Transport to Site

Vestas will be responsible for the shipping and transport to site. Vestas transport specialists will complete a full route survey during the detailed design phase in 3Q/4Q 2020. The site access roads will be built to Vestas specifications in order to handle the heavy loads and the required turning radius.

The two controlling factors in selection of offloading wharf and the feasibility of the route for transport are the length of the blades, and the weight of the heaviest components. The six Vestas V150 wind turbines will be shipped by Vestas to a Wharf in Georgetown. The electrical transformer will be shipped separately. A wharf suitable for offloading of heavy and oversize components will be required, this wharf would be used also as a temporary laydown/staging area.

The biggest challenge is typically the transportation of the long blades. The blades are transported by a long extendable trailer with steerable rear assembly. The most viable option would be to transport the blades via barge from the laydown wharf to the Kingston Wharf, which affords a relatively straight road access to transport the blades along the recently upgraded East Coast Demerara Roadway.

The heaviest components, such as the 70-tonne nacelle, drivetrain, or tower sections, will be transported via modular THP type trailer/truck transport equipment with multiple steerable axels and up to 8 wheels per axel, towed by a heavy haul trailer truck. The modular THP trailer units can be added until the required weight distribution, weight per axel, and weight per unit width tire is achieved, as per regulations. The heaviest loads

together with the transport equipment, results in total vehicle weights of up to 150MT, and axel loads of up to 10 metric tonnes per axel.

The entire 30km route is flat, with the exception of 2.5m elevation gain when crossing the Hope Canal bridge near the site (see Figure 5-7). The route crosses 18 bridges and 31 culverts, which have been assessed for heavy loads by Gaskin and Associated civil engineers. The bridges and culverts are relatively recent vintage and in good condition, designed to comply with AASHTO HS20 loads. All bridges and culverts along the route will to bear the wind project loads. Culverts will be reinforced by a mobile modular jumper bridge. The route was assessed for tight bends for transportation of the long blades. Only one bend requires modification via widening onto the shoulders, at km20, in the Covington/Non-Pareil area.

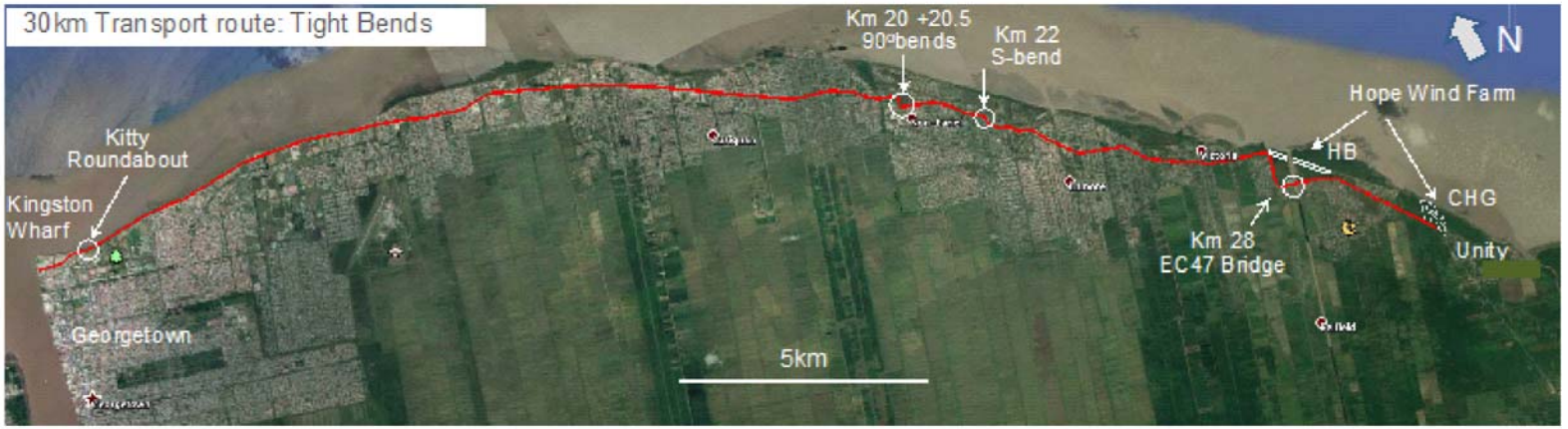
The selected route benefits from recent upgrades of almost all the road crossings and widening and upgrade of the road substrate for more than half the route completed in 2019.

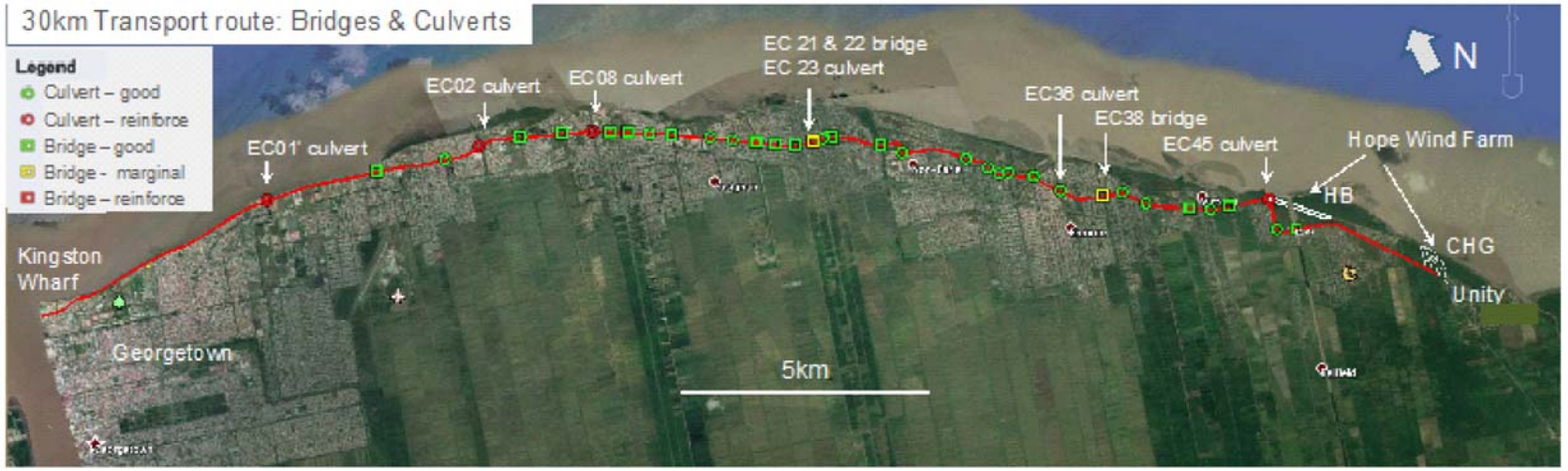
The transportation of the loads is being assessed by the Roads and Bridge Department at the Ministry of Works, and will require special transport permits and a police escort. Transportation of components is likely to occur mostly at night in order to minimise the impact to other road users. It is expected that some 2 weeks of night-time transport is required to move all components to the site.

5.3.4 Lifting and Assembly of Wind Turbine Generators

Once all the wind turbine components have been delivered to the construction site, the assembly of each wind turbine can commence. The main crane for lifting and assembly will be a 600 to 750 metric tonne unit with extended boom to 120-130 m height. The main crane is assisted by a smaller 150-200 tonne unit. The 5 tower sections are assembled, followed by the nacelle and drivetrain, hub, and finally the three blades (see Figure 5-8). The entire assembly of a single WTG usually takes 3 to 4 days. Including assembly and breakdown of the crane, moving the crane to each site, the entire wind farm assembly will likely take 6 to 8 weeks. Each wind turbine is then connected to the medium voltage collector line, and the wind farm completes all inspections and tests in order to commission the wind farm.

Crane Pads and Equipment Lay-Down Areas: During the wind farm construction phase the wind turbine components are transported onto the site and will require lay-down areas (see Figure 5-9). Logistically the most efficient means to do this is to have all the equipment required for each wind turbine laid down within reach of the main installation crane at each WTG location. The Crane Pad itself is an area of





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ECO REPORT NO.	05/2020
DATE:	03/12/21
CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	IMAGE OF THE TRANSPORT ROUTE FROM KINGSTON WHARF TO THE PROJECT SITE FOR THE HOPE WIND FARM PROJECT
FIGURE NUMBER:	5-7

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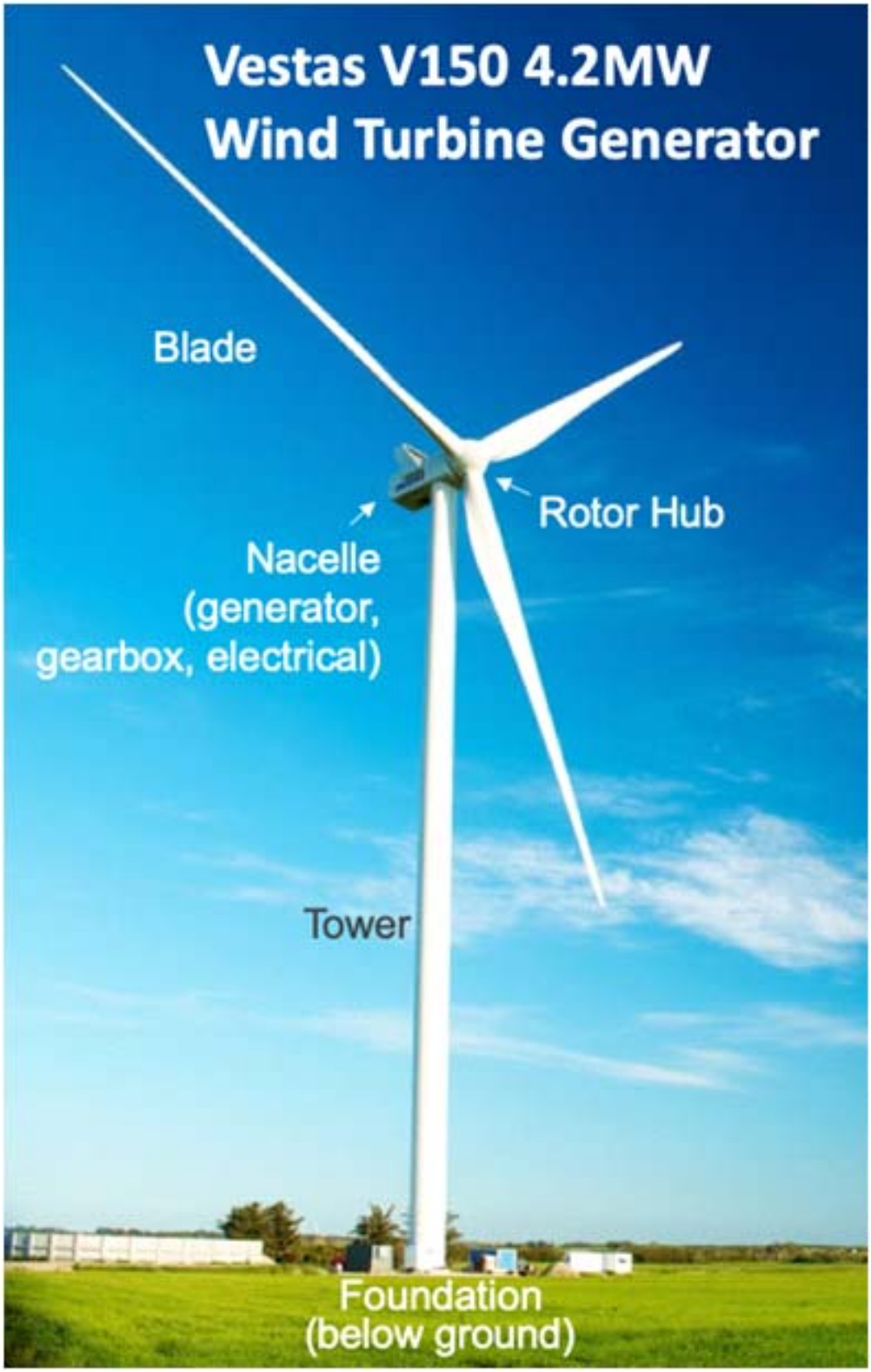

SOURCE: HOPE ENERGY DEVELOPMENT

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ECO REPORT NO. 05/2020	CLIENT: HOPE ENERGY DEVELOPMENT INC.	FIGURE NUMBER: 5-8
DATE: 03/12/21	PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA	
	DWG. NAME: TYPICAL COMPONENTS OF A WIND TURBINE GENERATOR (WTG)	

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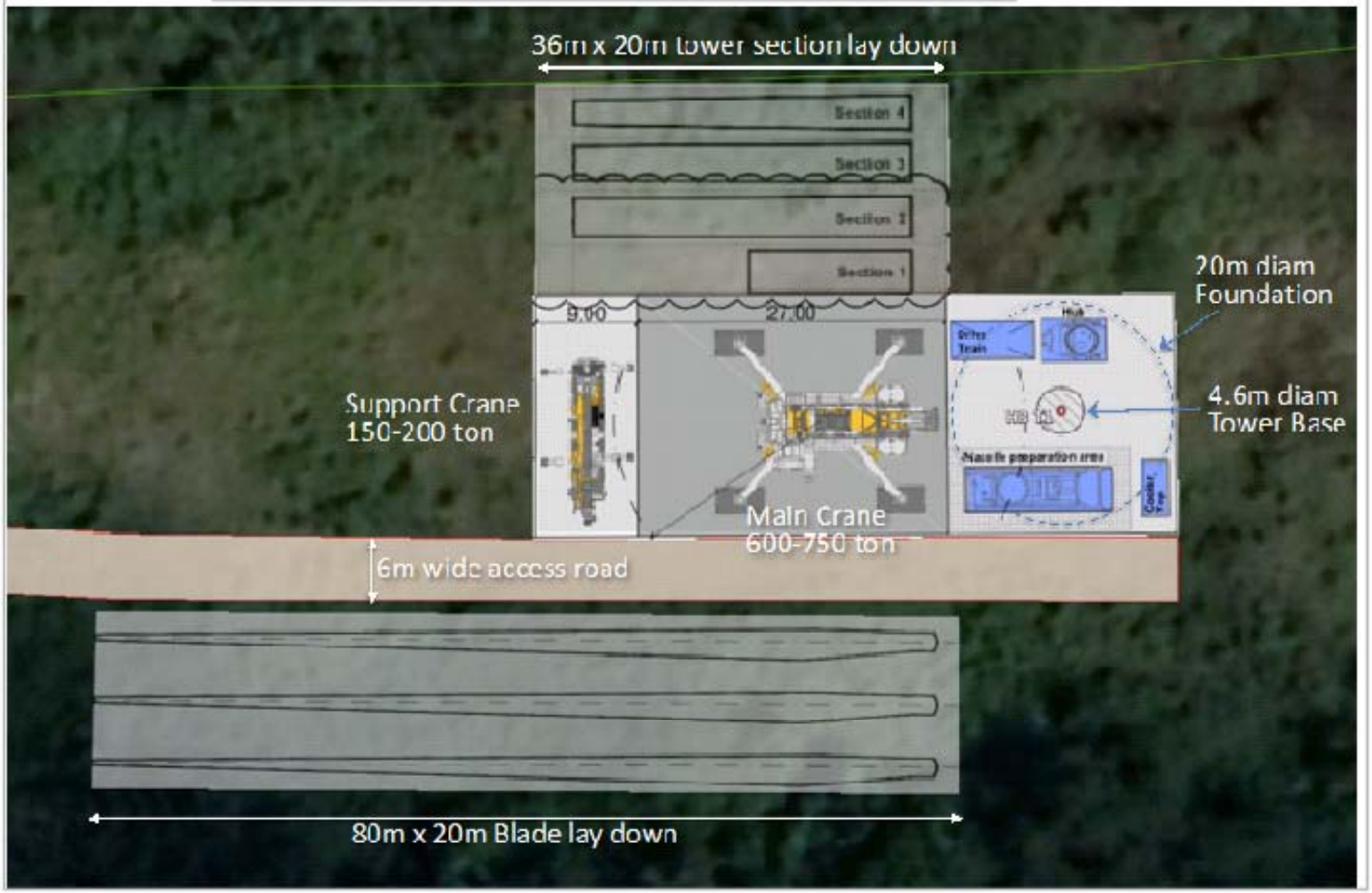

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PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	PRELIMINARY CRANE-PAD AND EQUIPMENT LAY-DOWN AREAS AT EACH WIND TURBINE CONSTRUCTION SITE
FIGURE NUMBER:	5-9

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approximately 40m by 20m comprising a built-up and compacted substrate to provide a stable base for the large installation crane and its loads.

5.4 Overview of Wind Farm Operation and Maintenance Activities

Operation of the wind farm will be via remote monitoring and controlled via a dedicated SCADA (supervisory control and data acquisition) system connected to Vestas and HED's control rooms, with a feed also to GPL's control centre. Onsite operations will include oversight by security personnel, technicians undertaking regular visual and drone assisted inspection of wind turbines, overhead electrical cables and substation equipment, and planned maintenance of wind turbine and substation equipment. Maintenance frequency and intensity is much lower than a fossil fuel plant, with weekly inspection and quarterly planned maintenance activities being the norm. Based on industry statistics it should be expected that a crane will be required for maintenance or replacement of heavy drivetrain equipment in the nacelle on average every 3 to 5 years for a wind farm of this size. The required cranes are available from the nearby region and will be contracted on a retainer basis for maintenance support together with required logistical support.

5.5 Staffing Requirements

5.5.1 Construction Phase

Construction phase staffing requirements are shown in Figure 5-10. These are made up of the following classes of workers:

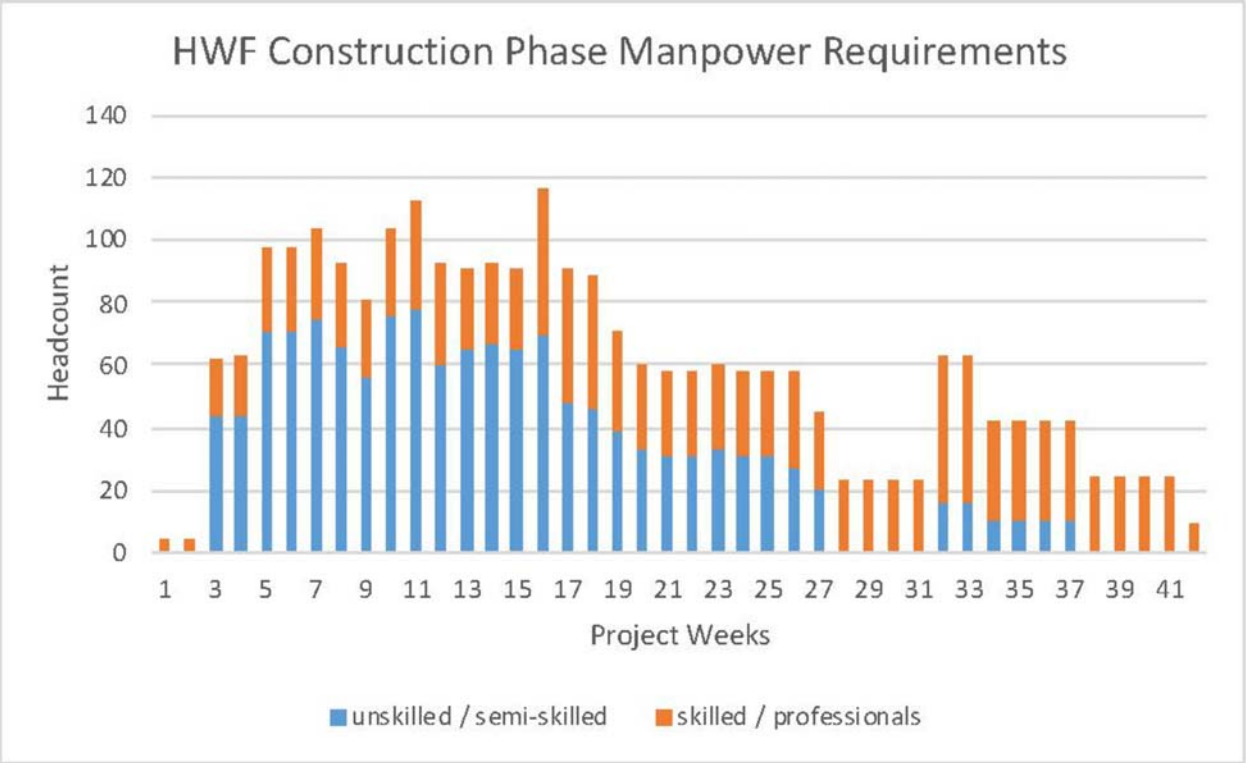
CLASS OF WORK	NUMBER
PROJECT MANAGEMENT	
Project General Manager	1
Civil Works QA/QC Engineer	1
Electrical Works QA/QC Engineer	1
Project Engineer	1
Health and Safety Manager	1
Health and Safety Officers	2
Project Administrators	2
CIVIL WORKS	
Project Director	1
Field Managers	2
Civil Engineers	2
Geotechnical Engineers	2

CLASS OF WORK	NUMBER
Surveyors	2
Team Supervisors	6-10
Equipment Operators	10-15
Truck Drivers	15-25
Construction Labour	25-35
ELECTRICAL WORKS	
Project Director	1
Senior Electrical Engineers	2
Electrical Engineers	2
Electricians/Technicians	4-6
Electrical Assistants	4-6
Labour	4-10
Equipment Operators	2-4
Truck Drivers	2
WIND TURBINE INSTALLATION	
Project Director	1
Supervisors	2
Engineers	2
Electricians/Technicians	2-4
Mechanical Technicians	2-4
Equipment Operators	4-6
Riggers	4-10
Truck Drivers	5-10

Civil and electrical works will be performed by mostly Guyanese contractors with support from senior international engineers for quality control while the wind turbine installation will be conducted by mostly international specialists with Guyanese support for some trucking / rigging / crane assist.

5.5.2 Operation Phase

PLANT OPERATION AND MAINTENANCE	
Project General Manager	1
Senior Asset Manager	1
Senior Electrical Engineer	1
Electrical and Mechanical Technicians	4
Security	4
Grounds Maintenance	4
Project Administrators	2



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ECO REPORT NO. 05/2020	CLIENT: HOPE ENERGY DEVELOPMENT INC.	FIGURE NUMBER: 5-10
DATE: 03/12/21	PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA	
	DWG. NAME: CONSTRUCTION STAFFING REQUIREMENTS	

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No economic multipliers were used in this analysis since the numbers to be directly employed are not significant. However, it is expected that the presence of the wind farm will lead to indirect employment such as through the sale of food to workers or the provision of transportation for employees.

The operations will also be supported remotely via the wind turbine manufacturers remote monitoring and operations team, located outside of Guyana, and specialist technicians brought in for any required larger maintenance or repair requirements, rope-work blade inspection and repairs.

5.6 Project Schedule

The end of the Feasibility Phase is expected in early 2022, marked by a signed PPA and the Environmental Permit. Actual dates of subsequent stages are dependent on the time it takes to obtain a signed PPA. Detailed design and finalisation of financing terms follows, estimated at 6 to 12 months after the signed PPA, with Financial close and start of construction possible before the end of 2022. Wind Farm commissioning is expected 8 to 12 months later. (see Figure 5-11).

Regulatory approval processes commence during the Feasibility Stage and must all be completed during the Detailed Design Phase and before the Final Investment Decision (FID) Stage Gate in order for the project to proceed.

Construction starts with the civil and electrical works, which require some 8 to 10 months to complete (access road construction, foundations and crane pad construction, installation buried and overhead electrical lines, construction of the substation).

Shipping of wind turbine components, transportation equipment and the crane, with transport of the wind turbine equipment to site, would occur at the end of the construction period and would be completed within 2 months of the arrival of the shipment in Guyana.

The plant is planned for commissioning some 18 to 24 months following the signing of the PPA, and may occur as early as 3Q2023.

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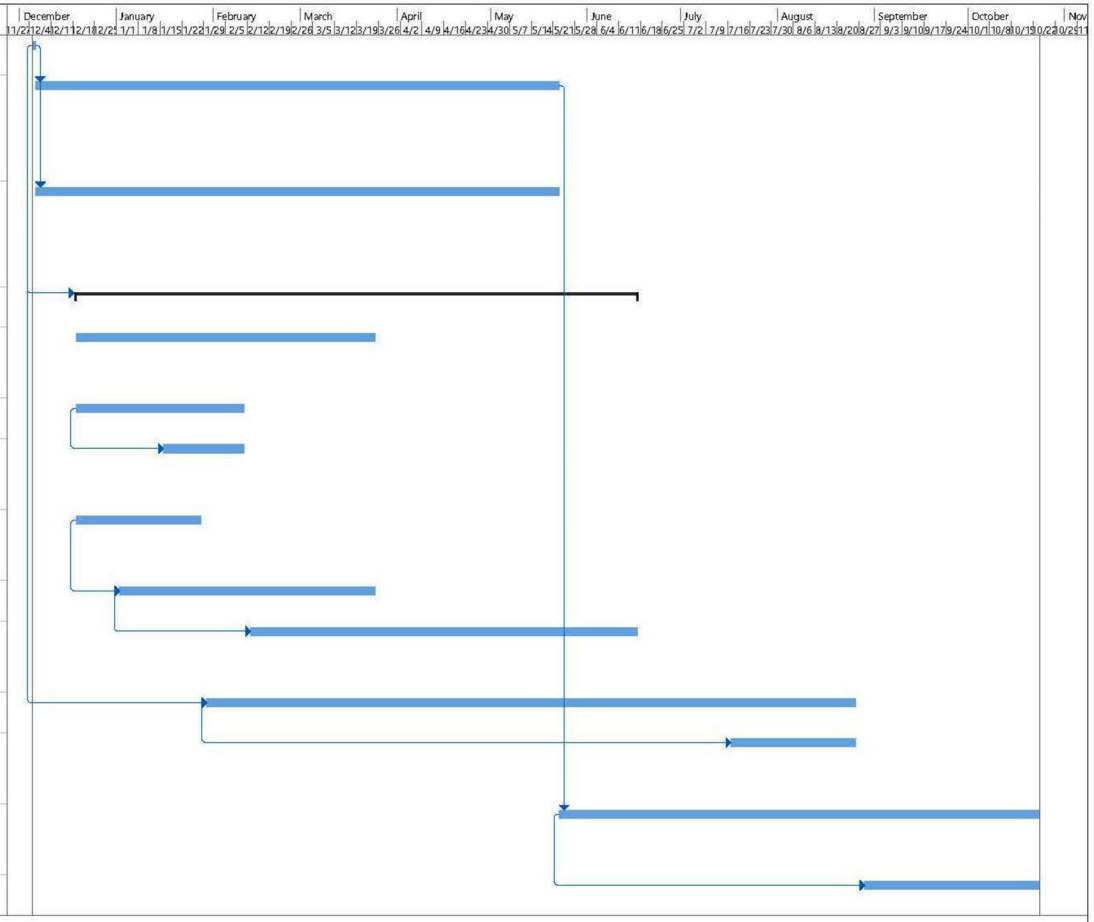
ID	Task Mode	Task Name	Duration	Start	Finish
1		Start of Construction	1 day	Mon 12/5/22	Mon 12/5/22
2		Long Lead Transformer & Electrical Switchgear	6 mons	Tue 12/6/22	Mon 5/22/23
3		Wind Turbine Equipment Order & Shipping	6 mons	Tue 12/6/22	Mon 5/22/23
4		**Civil Works**	**130 days**	**Mon 12/19/22**	**Fri 6/16/23**
5		Access Road Construction	3.5 mons	Mon 12/19/22	Fri 3/24/23
6		Bridge Installation	2 mons	Mon 12/19/22	Fri 2/10/23
7		Substation Civil Works	1 mon	Mon 1/16/23	Fri 2/10/23
8		Foundation Excavation	1.5 mons	Mon 12/19/22	Fri 1/27/23
9		Foundation Piling	3 mons	Mon 1/2/23	Fri 3/24/23
10		Laydown Areas and Crane Pads	4.5 mons	Mon 2/13/23	Fri 6/16/23
11		Electrical Works	7.5 mons	Mon 1/30/23	Fri 8/25/23
12		Substation Pre-Energise Testing	1.5 mons	Mon 7/17/23	Fri 8/25/23
13		Wind Turbine Installation	5.5 mons	Tue 5/23/23	Mon 10/23/23
14		Test & Commission	2 mons	Tue 8/29/23	Mon 10/23/23



Project: Construction Schedule
Date: Mon 12/6/21

Task | Project Summary | Manual Task | Start-only | Deadline
Split | Inactive Task | Duration-only | Finish-only | Progress
Milestone | Inactive Milestone | Manual Summary Rollup | External Tasks | Manual Progress
Summary | Inactive Summary | Manual Summary | External Milestone

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PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA

DWG. NAME: PROJECT SCHEDULE

FIGURE NUMBER: 5-11

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6 STAKEHOLDER IDENTIFICATION AND CONSULTATION PLAN

This EIA included a program of inter-agency and stakeholder consultations. Details of inter-agency and stakeholder consultations are presented under the following headings:

- Scoping Meetings,
- Meetings with Key Stakeholders,
- Questionnaire Surveys, and
- Survey of Fishermen.

6.1 Scoping Meetings

Three scoping meetings were held to provide information to the Guyana EPA to prepare Terms of Reference for the conduct of the EIA. These meetings were held as follows:

- Community Scoping Meeting on June 06, 2019,
- Community Scoping Meeting on June 18, 2019, and
- Technical Scoping Meeting on June 07, 2019.

6.1.1 Community Scoping Meetings

The objectives of these meetings were as follows:

- to present an overview of the project; and
- to get feedback from stakeholders on the presented information.

The first meeting, held on June 06, 2019 was poorly attended. A second meeting was therefore arranged and held on June 18, 2019.

HED used a PowerPoint presentation to introduce the project under the following headings:

- Who is HED?
- What is a Wind Farm?
- Introduction to the Hope Beach wind farm Project
- Environmental considerations
- Safety Offset analysis intro (MMI)
- Noise analysis intro (EMD)

- Construction Phase Activities
- List of Consultants
- Benefits of a wind farm to Guyana and the Community
- Q&A and stakeholder feedback

A copy of the presentation is included in Appendix L.

A total of 127 persons including residents of the Hope community and surrounding villages, representatives from the Environmental Protection Agency (EPA), Mangrove Rangers, fishermen and media personalities were in attendance at the June 18, 2020 meeting. Residents were given an opportunity to voice their opinions and concerns on the project.

Their concerns, questions and suggestions were as follows:

Concerns

- Commencement of the project
- Noise level and measures to control the noise generated by the blades
- Plans to combat erosion in the beach area
- Disaster preparation measures
- Reliability and maintenance of the turbines
- Job opportunities for residents

Questions

- What was regarded a safe distance from the blades of the turbines?
- Would residents be restricted from the Hope beach area where the turbines would be erected?
- Would the erection of the wind turbine increase erosion?
- Would the power be distributed more to specific homes?
- Where would the renewable energy generated by the turbines go?

6.1.2 Technical Scoping Meeting

The objectives of this meeting were as follows:

- to present an overview of the project;
- to present preliminary findings of specialist studies; and
- to get feedback from stakeholders on the presented information.

HED used a PowerPoint presentation to introduce the project under the following headings:

- Who is HED?
- What is a Wind Farm?
- Introduction to the Hope Beach wind farm Project
- Environmental considerations
- Safety Offset analysis intro (MMI)
- Noise analysis intro (EMD)
- Construction Phase Activities
- List of Consultants
- Benefits of a wind farm to Guyana and the Community
- Q&A and stakeholder feedback

A copy of the presentation is included in Appendix L.

6.2 Meetings with Stakeholders

During the conduct of the EIA, stakeholder meetings were held to gather information on existing conditions. Stakeholders were also able to provide their questions and concerns on the proposed wind farm project. The following stakeholders were interviewed:

- The Environmental Protection Agency, (EPA);
- Ministry of Finance;
- Department of Environment;
- Office of Climate Change;
- Forestry Commission;
- National Drainage and Irrigation Authority (NDIA);
- National Agriculture Research and Extension Institute (NAREI);
- The Ministry of Public Infrastructure (MoPI);
- Ministry of Works – Roads and Bridges;
- Ministry of Works – Marine Administration department MARAD);
- Ministry of Agriculture (MoA);
- The Regional Democratic Council, Region #04;
- The Neighbourhood Democratic Council - Unity
- The Guyana Lands and Surveys Commission (GL&SC);
- Central Housing and Planning Authority (CH&PA);
- Guyana Power and Light (GPL);
- Guyana Wildlife Management and Conservation Authority;
- World Wildlife Fund (WWF-Guianas);

- Conservation International (CI – Guyana);
- Global Green Growth Institute (GGGI)
- Guyana Civil Aviation Authority;
- River and Sea Defense Board;
- Guyana Mangrove Restoration Commission; and
- Go Invest Guyana.

Notes of meetings held are included in Appendix M.

6.3 Questionnaire Surveys

Surveys were carried out in June and October 2019 and again in February 2021. A total of 369 surveys were completed. These surveys were conducted along the Demerara Berbice Highway in the vicinity of Unity and Greenfield.
Respondents were randomly approached door to door to complete the survey which was administered by use of a structured questionnaire. The objectives of the surveys were to gain insight on the basic characteristics of the residents in the vicinity of the project area, their knowledge about the project, their attitude towards the project and possible concerns. Results of these surveys are included in Appendix I.

6.4 Survey of Fishermen

In addition to the survey of residents, an outreach session with a total of 20 fishermen at the large sluice (8-door sluice) at Hope was held in 2019. Additional group interviews with fishers (a group of 5 and another of 3 fishermen) were held in 2020. They were interviewed on their awareness and knowledge of the Hope Beach Wind Farm Project. Their attitudes and concerns regarding the project were also taken into consideration. Results of these surveys are included in Appendix I.

7 ENVIRONMENTAL IMPACT ANALYSIS

Sections 2.3 and 2.4 details our approach to impact identification and analysis in this EIA. Similarly, impacts associated with specific media are discussed in the respective chapters. This chapter therefore presents the results of the classification of impacts and provides a summary of the Environmental Management Plan.

7.1 Beneficial Impacts

Expected benefits associated with the proposed project have been identified as:

7.1.1 Community Benefits

While the project will bring country-wide benefits, there will also be benefits to the local communities:

- It is a cheaper and more sustainable energy alternative since wind is never ending
- This Project will provide more than 10% of GPL's power, enough to supply 7,000 homes
- Community development since the Wind Farm will be an added attraction for residents and visitors

7.1.2 National Benefits

How can Guyana benefit from the Wind Farm Project?

- It opens a new energy sector for Guyana
- Less blackouts and load shedding
- Job opportunities in construction, maintenance and operation of wind farm facilities
- No fuel imports required
- Energy independence for present and future generations

7.1.2.1 Low Carbon Development Strategy (LCDS)

The development of renewable energy (RE) sources is now clearly endorsed by the Government of the Cooperative Republic of Guyana's (GOG), driven by the combined

imperatives to combat climate change, provide energy security, and to meet rising energy demands together with the development of sustainable growth and competitiveness in the economy. The Government of Guyana (GoG) has ratified the Paris Agreement and adopted the UN Agenda 2030 for Sustainable Development and the Sustainable Development Goals (SDG's). Guyana's target contribution is ambitious, stated as 65% renewable energy by 2035.

The project is estimated to replace over 80,000 MWh of GPL's gross electricity generation from existing fossil-fuel power plants and meet 10% of Guyana's stated goal in renewable energy (RE) penetration. The project will add substantial momentum to Guyana's journey towards true energy security based on renewable energy.

7.1.2.2 Positive Economic Impact

Investment of over USD 45million, with some USD 10 million of local contracts. Avoided imports of fuel oil and foreign exchange loss worth over USD 11m per year, reduced exposure to volatile fossil fuel pricing, 30 to 40 construction related jobs, 5 to 10 permanent/part-time technician, security and administrative jobs. RE projects present an ideal opportunity for substantial local ownership of both equity and debt side of the investment for long term investors such as insurance companies and pension funds. It is the intent of HED to attain more than 75% project ownership by Guyanese investors, and so ensuring maximum benefits to Guyana via local ownership and local vesting of future revenues.

7.1.2.3 Enhanced Security of the Electrical Grid

Initial grid interconnection study concludes that the Hope Beach Wind Farm will provide reactive-power and voltage support to a weak portion of Guyana's grid, even if the wind is not blowing, and improves the ability for the Berbice branch of the grid to operate in islanded mode if the Georgetown portion of the grid is shut-in. As long as the wind is blowing the wind farm will provide much needed additional capacity to the grid. The average wind-speed diurnal profile peaks during the evening hours, which corresponds to the maximum demand on GPL's grid.

7.1.2.4 Climate Change and Clean Air

With most of the population in Guyana living 1m below mean high-tide Guyana is highly exposed to the effects of climate change. The project will reduce 10% of GPL's CO2 footprint from power generation, offsetting some 60,000 tonnes of CO2 per year, and reducing harmful pollutants associated with burning of HFO fuels at GPL's plants in and near Georgetown.

7.1.2.5 Pilot Project for Greater Things to Come

The Hope Beach Wind Farm serves as a pilot project and learning opportunity for all the stakeholders involved, which will benefit all future RE projects in Guyana. The project will remove much of the country start-up related uncertainties with regards to developing any wind or larger RE project in Guyana. Based on the project wind data HED estimates that only 40 wind turbines are required in order to provide some 60-70% of Guyana's energy needs at present. The combination of solar-PV and wind is ideal, with wind peaking during the evening peak demand period, and solar during the midday peak demand period, which could allow some 80% RE penetration levels onto Guyana's grid without requiring substantial energy storage.

By deploying a few larger RE projects HED believes Guyana's vision for high levels of RE energy supply can become a reality, and at an affordable cost well below 10c/kWh. This project will be a key stepping stone towards that not too distant future.

With the prospect of electric transportation for both cars and trucks becoming an affordable reality within a similar time-frame, this future vision becomes even more enticing, as it will then also be possible to transition much of Guyana's transportation needs onto renewable power, with substantial savings to all consumers.

7.2 Summary of Impact Classification

The classification systems for assessing the significance of impacts to the natural and socio-economic environments are described below.

7.2.1 Natural Environment

After the significance of each impact on the natural environment was assessed, each potential impact was classified on a structured basis, assuming the worst-case scenario. The classification method (see Appendix K) was based on three criteria: Extent, Intensity, and Duration. Based on this, pre and post-mitigation impacts were classified as Low, Moderate, High or Extreme. Where adverse impacts were considered to be insignificant, no classification was applied. The classification of each impact is indicated in the respective chapters, and a summary of the Post-Mitigation Classification is provided in Table 7-1.

TABLE 7-1: SUMMARY OF POST MITIGATION CLASSIFICATION (NATURAL ENVIRONMENT)

IMPACT	EXTENT		INTENSITY	DURATION	CLASSIFICATION	
CONSTRUCTION PHASE						
Impaired Water Quality: Siltation	HB	Localised	Minor	Short Term	LOW	C
	CHG	Localised	Minor	Short Term	LOW	
Impaired Water Quality: Hydrocarbon Spills and Leaks	HB	Localised	Minor	Short Term	LOW	C
	CHG	Localised	Minor	Short Term	LOW	
Impaired Water Quality: Improper Disposal of Sewage	HB	Eliminated				
	CHG	Eliminated				
Impaired Water Quality: Spillage of Paints and Solvents	HB	Eliminated				
	CHG	Eliminated				
Impaired Water Quality: Concrete Washings	HB	Localised	Very Small	Short Term	LOW	
	CHG	Localised	Minor	Short Term	LOW	
On-site Erosion	HB	Localised	Minor	Short Term	LOW	
	CHG	Localised	Minor	Short Term	LOW	
Slope Instability	HB	On-site	Very Small	Short Term	LOW	
	CHG	On-site	Very Small	Short Term	LOW	
Impaired Air Quality: Dust from Cleared Areas	HB	Localised	Very Small	Short Term	LOW	C
	CHG	Localised	Very Small	Short Term		
Impaired Air Quality: Exhaust Emissions from Vehicles	HB	Regional	Very Small	Short Term	LOW	C
	CHG	Regional	Very Small	Short Term	LOW	
Noise	HB	Localised	Minor	Short Term	LOW	C
	CHG	Localised	Minor	Short Term	LOW	
Clearing of Vegetation	HB	On site	Very Small	Long Term	LOW	
	CHG	On site	Very Small	Long Term	LOW	
Fragmentation	Not significant					

IMPACT	EXTENT		INTENSITY	DURATION	CLASSIFICATION	
Disturbance to Terrestrial Species	HB	Localised	Minor	Short Term	LOW	
	CHG	Localised	Minor	Short Term	LOW	
Disturbance to Aquatic Species	HB	Localised	Very Small	Short Term	LOW	
	CHG	Localised	Very Small	Short Term	LOW	
Disturbance to Benthic Species	HB	Localised	Very Small	Short Term	LOW	
	CHG	Localised	Very Small	Short Term	LOW	
Loss of Benthic Species	Not Significant					
Impacts on Migratory Species	HB	Localised	Minor	Short Term	LOW	
	CHG	Localised	Very Small	Short Term	LOW	
Impacts to Rare and Endangered Species	HB	Localised	Very Small	Short Term	LOW	
	CHG	Localised	Very Small	Short Term	LOW	
Damage to Existing Roads and Bridges		Regional	Very Small	Short Term	LOW	C
Obstruction of Traffic		Regional	Very Small	Short Term	LOW	C
Damage to Infrastructure and Utilities		Regional	Very Small	Short Term	LOW	C
Road Safety		Regional	Very Small	Short Term	LOW	C
Improper Waste Disposed	HB	Regional	Very Small	Short Term	LOW	
	CHG	Regional	Very Small	Short Term	LOW	
Impacts to Landscape and Aesthetics	HB	On site	Minor	Short Term	LOW	
	CHG	On site	Very Small	Short Term	LOW	
OPERATION PHASE						
Hydrocarbon Spills and Leaks	HB	Localised	Very Small	Medium Term	LOW	
	CHG	Localised	Very Small	Medium Term	LOW	
Shadow Flicker	Eliminated**					
Noise	Eliminated**					
Concerns for Birds	Not significant***					
Concerns for Bats	Not significant***					
Impacts to	HB	On site	Very Small	Short Term	LOW	

IMPACT	EXTENT		INTENSITY	DURATION	CLASSIFICATION
Landscape and Aesthetics	CHG	On site	Very Small	Short Term	LOW

Notes:

*(C) – indicates cumulative impacts with other proposed and ongoing projects in the region are likely
Eliminated** - Meets available guidelines and/or has no significant impact to baseline levels
Not Significant*** - Impact to baseline population will be insignificant

7.2.2 Socio-Economic Environment

For the assessment of socio-economic impacts during the construction and operation phase of the Project, an impact evaluation and significance criteria is used (see Appendix I). These criteria are based on existing criteria used in similar projects in other countries and settings. A thorough literature review combined with identification of impacts based on the review of available project information and discussions and in-depth interviews with the local community, resulted in the use of criteria as presented in Table 6 and 7 in Appendix I for the classification of potential impacts and extent of their severity on environment, socio-economic resources, demographics, livelihoods, as well as access and infrastructure issues. A summary of the Post-Mitigation Classification is provided in Table 7-2.

TABLE 7-2: SUMMARY OF POST MITIGATION CLASSIFICATION (SOCIO-ECONOMIC ENVIRONMENT)

PROPOSED IMPACTS		SPREAD	DURATION	INTENSITY	OVERALL SIGNIFICANCE
Population	**Construction Phase** • Presence of migrant/ mobile workers	Regional	Short	Low	Low
Social infrastructure	**Construction Phase** • Increased road traffic,	Regional	Short	Moderate	Moderate
	• Damage to road	Regional	Short	Low	Low

PROPOSED IMPACTS		SPREAD	DURATION	INTENSITY	OVERALL SIGNIFICANCE
	infrastructure, utilities				
	• Loss of work after construction is completed	Community	Short	Low	Low
	• Loss of access (residents, fishermen)	Community	Short	Low	Low
	• Reduced emergency response time	Community	Short	Moderate	Moderate
	Operation Phase • Shadow flicker	Community	Long	Insignificant	Low
	• Noise emissions	Community	Long	Insignificant	Low
Health & Safety	**Construction Phase** • Occupational hazards	Local	Short	Moderate	Low
	• Health concerns related to (noise & air emissions)	Community	Short	Moderate	Moderate
	• Extra pressure on local Health facility	Regional	Short	Low	Low
	Operation Phase • Noise emissions	Community	Long	Insignificant	Low
	• Public safety	Community	Long	Insignificant	Low
Fishing community	**Construction Phase** • Improper disposal of waste	Local	Short	Low	Negligible
	• Loss of Access	Local	Short	Moderate	Low
	• Potential for loss of	Local	Short	Low	Negligible

PROPOSED IMPACTS		SPREAD	DURATION	INTENSITY	OVERALL SIGNIFICANCE
	earnings (fishermen)				
	Operation Phase • Potential for loss of earnings	Local	Long	Low	Low
Hope Secondary School	**Construction Phase** • Health Concerns (air and noise emissions)	Local	Short	Moderate	Low
	• Loss of Access	Local	Short	Low	Negligible
	• Increased Road Traffic (students and teachers late arrival to school)	Local	Short	Moderate	Low
	Operation Phase • Shadow flicker	Local	Long	Insignificant	Negligible
	• Noise emissions	Local	Long	Insignificant	Negligible

7.3 Environmental Management Plan

Information in the EIA Report was a primary input to the EMP, as well as Ecoengineering's experience on other related projects. It also relied on information from the following sources:

- Commonwealth Secretariat GTASD (1993): Environmental Impact Assessment: A Practical Handbook, commissioned by the General Technical Assistance Services Division of the Commonwealth Secretariat and prepared by Environmental Resources Limited, October 1993, London, England.

- World Bank Environment Department (1991): "Environmental Assessment Sourcebook Volume II, Sectoral Guidelines", World Bank Technical Paper No. 140.

- Terms of Reference provided by the Guyana EPA.

7.3.1 Steps involved in Preparation of the EMP

The preparation of this EMP involved the following steps:

- Adverse environmental impacts of the proposed project were identified and assessed (see Chapters 8-19 of this EIA Report).
- Appropriate mitigation measures were prescribed for each adverse environmental impact (see Chapters 8-19).
- The party responsible for carrying out the mitigation actions was identified in the context of the institutional arrangements for the proposed project. The timing for each action was defined, along with specialized equipment or material required and competence and specialized environmental training needed.
- Monitoring requirements were also recommended for each adverse environmental impact.
- The party responsible for monitoring was identified in the context of the institutional arrangements for the proposed project (see Appendix J).
- The timing and location for monitoring events were described, along with specialized equipment or material required and competence and specialized environmental training needed.

This EMP will be finalized prior to the start of the site preparation and construction works to ensure that all of the conditions of the Environmental Permit are addressed. The EMP will also be assessed following the start of each phase to determine adherence to the stipulated mitigation measures and the effectiveness of the implemented measures. An assessment report will be prepared supported by relevant monitoring results collected during each phase and the EMP will be revised (if necessary) to ensure continued effective pollution control and protection of the surrounding environment. The EMP assessment report and revised EMP (if prepared) will be made available to the Guyana EPA.

7.3.2 Management Structure

This EMP is prepared to cover the site preparation, construction and operation phases of the proposed wind farm Project. Figures 7-1 and 7-2 show the likely management structure during both phases.

Key employees with responsibilities for implementing the EMP are described below:

7.3.2.1 Construction Phase

Developer (HED)

HED will be responsible for the decision to proceed with construction. HED will have the overall responsibility of overseeing all aspects of construction and monitoring of the wind farm once it is operational. During the construction phase, HED will have a Project General Manager who will liaise with the Project Engineer, the Health, Safety and Environmental (HSE) Manager, and the EPC contractor regarding all aspects of the construction phase.

Project General Manager

The Project General Manager will be responsible for ensuring that the construction works are executed in accordance with the engineering design and supervising the Contractor's progress to ensure that the project is on schedule. The Project General Manager will also liaise with regulatory agencies (such as the Guyana EPA) and ensure that any complaints during construction are adequately addressed.

EPC Contractor

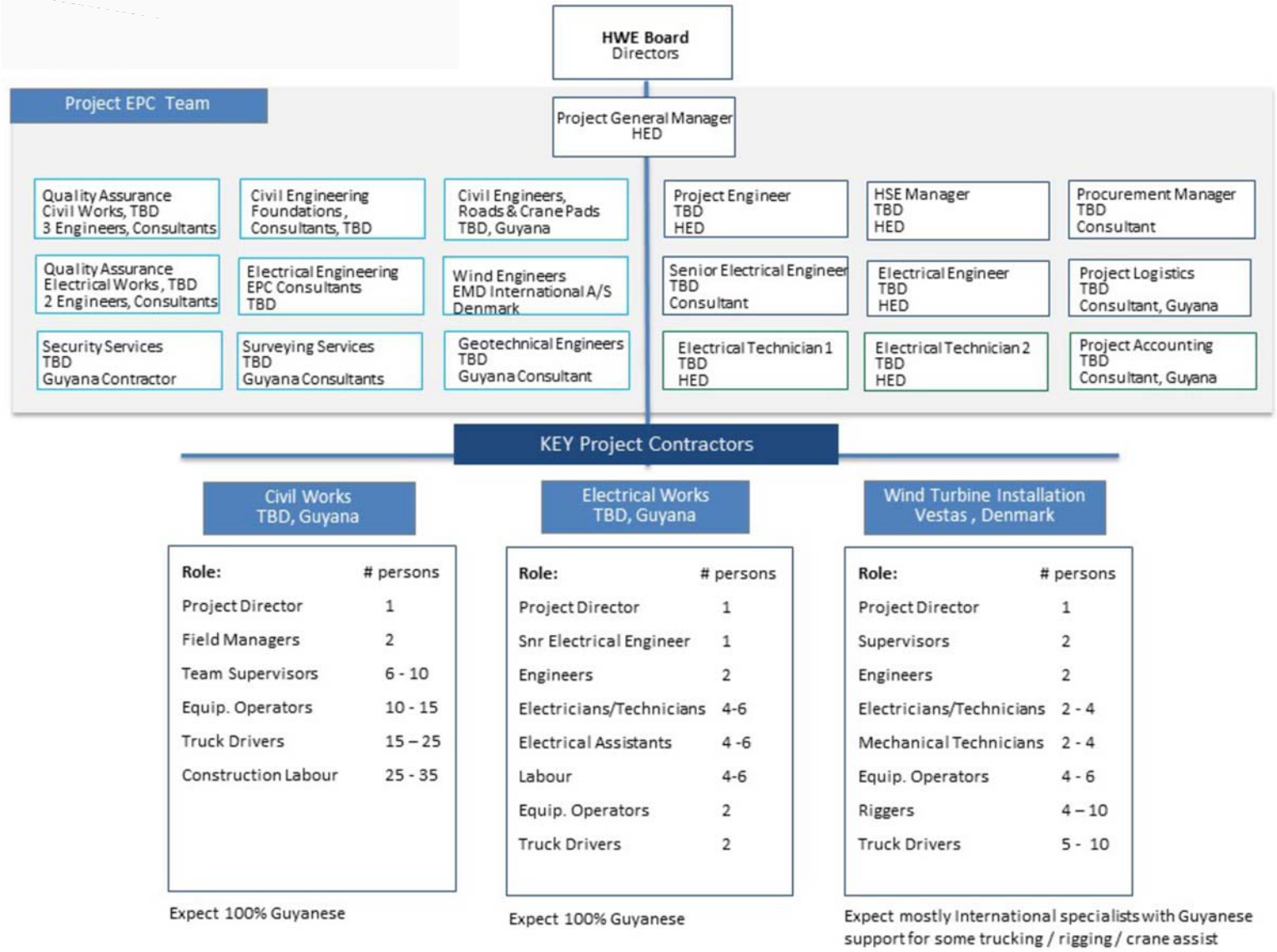
The EPC Contractor is in charge of all Engineering, Contracts management, and Construction aspects of the project. The EPC contractor will be in charge of managing all subcontractors for the civil and electrical works, and the installation and commissioning of the wind turbines and the substation.

Contractors

The Contractors will be responsible for constructing the wind farm in accordance with the design drawings and specifications as provided and guided by the EPC contractor. The Contractor's team will be headed by a Project Director, who will manage the work of his staff, supported by project engineers and an HSE manager. The Contractor's Health, Safety and Environmental (HSE) Manager will report to the Project Director. The Contractor's HSE Manager and HSE Officer will assist the Project Director in managing the environmental and occupational health and safety aspects of the contract.

Project Engineer and QA/QC Engineers

HED's Project Engineer will track the project progress according to HSE performance, scope, schedule, budget, and quality assurance. The Project Engineer provides the Project General Manager with progress reports in the day-to-day oversight of the construction works, and will provide communications on progress to the contractors. The Quality Assurance and Quality Control Engineers will provide assurance and



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ECO REPORT NO. 05/2020

DATE: 03/12/21

CLIENT: HOPE ENERGY DEVELOPMENT INC.

PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA

DWG. NAME: ORGANIZATION CHART (CONSTRUCTION PHASE)

FIGURE NUMBER: 7-1

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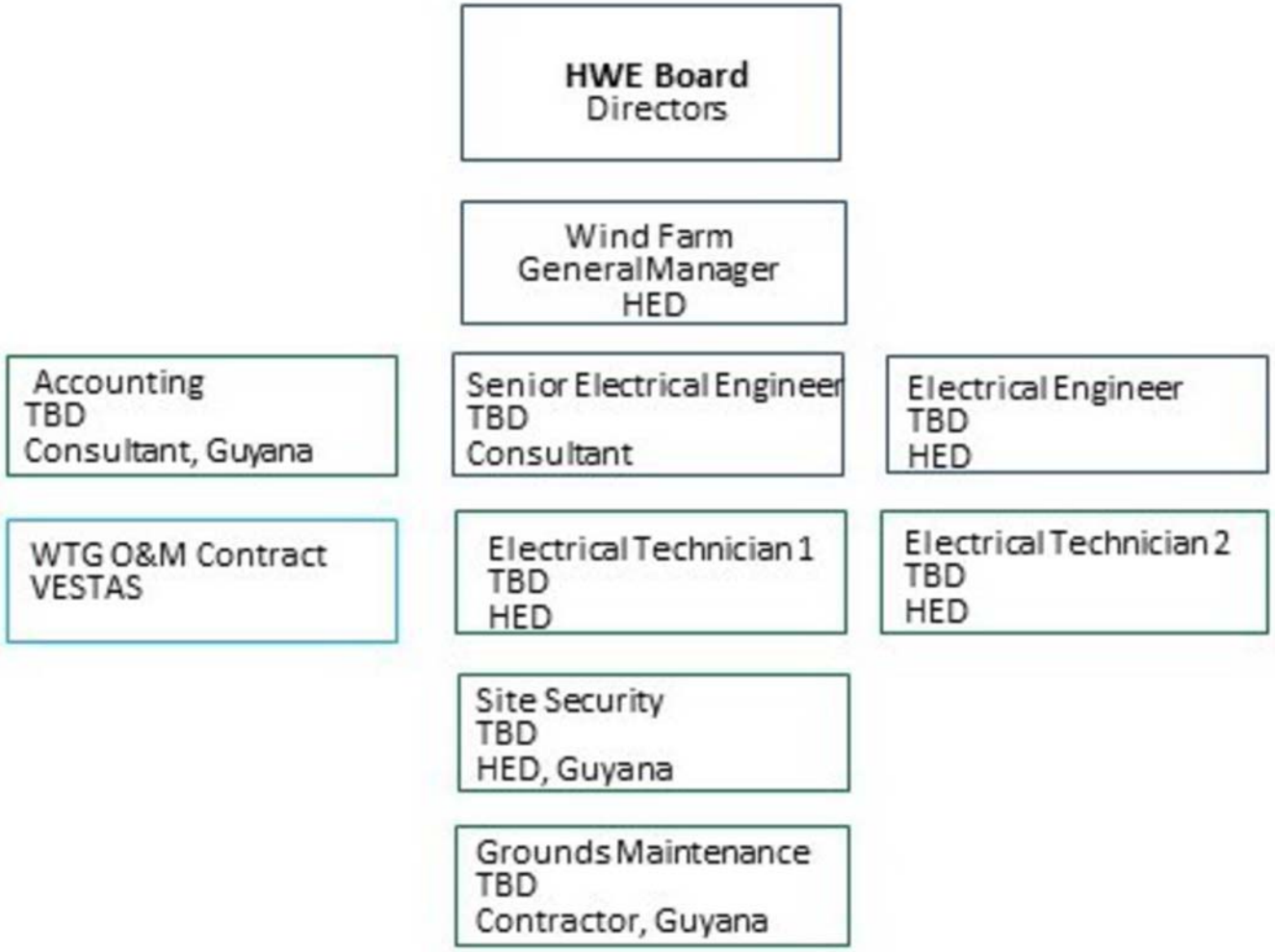

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DWG. NAME:	ORGANIZATION CHART (OPERATION PHASE)
FIGURE NUMBER:	7-2

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guidance to ensure all scope, materials and equipment meets the minimum requirements, in accordance with the design and specifications.

Guyana Environmental Protection Agency (Guyana EPA)

The Guyana EPA will be responsible for overseeing the environmental performance of the project (based on terms and conditions set out in the Environment Permit, and review any environmental monitoring reports prepared by HED's HSE Unit. Environmental Officers of the Guyana EPA may also visit the area from time to time to make independent observations and take independent measurements of environmental parameters, as well as to ensure compliance conditions with terms and conditions set out in the Environment Permit.

7.3.2.2 Operation Phase

Wind Farm General Manager

The Wind Farm General Manager will manage all aspects of the commissioned wind farm, including compliance with any environmental requirements. The day-to-day Operations and Maintenance (O&M) of the facility will be managed by the Asset Manager Engineer, supported by engineers, technicians, and the wind farm O&M Contractor and their technicians. The HSE Manager and supporting officers will be responsible for implementing HSE mitigation and monitoring measures, site security, and managing onsite emergency response activities. The HSE Officer will report to the Wind Farm General Manager. The Ground Maintenance Crew will be responsible for undertaking any ground maintenance works and will report to the Asset Manager.

Community Liaison Officer(s)

Liaison Officers will facilitate communication between HED and the communities during the construction and operation phases. Liaison officers will be members of the communities.

7.3.3 Record Keeping

7.3.3.1 Construction Phase

During the construction works, a variety of records will have to be maintained onsite by the HSE Officer. These include:

- A register for public complaints arising from impacts such as noise, air quality, traffic, damage to infrastructure, loss of access, and health and safety concerns.

- A register for documenting how frequently garbage bins are emptied, including the haulage and disposal records.
- A register for accidents and incidents arising as a result of construction works.
- A register of spills and leaks of hydrocarbons.
- A register documenting the maintenance of vehicles and equipment.
- Inspection Checklists for instances where features being constructed are verified for compliance with the design and monitoring is undertaken.
- A register for other types of waste disposal and or remediation (hazardous wastes, remediation, etc.).

In addition, the HSE Officer will have to maintain a manifest of all inspections undertaken by him and any other Contractor personnel. Non-compliance observations or complaints, accidents, incidents will require reporting (see Section 7.3.4) so that such an issue can be addressed.

7.3.3.2 Operation Phase

During the operation phase, records will similarly need to be kept for the following items:

- A register for public complaints.
- A register for documenting how frequently the area is maintained (including landscaping, cleaning of drains and culverts, etc.)
- A register for accidents and incidents occurring within the study area.

The General Manager will be in charge of updating these registers.

7.3.4 Reporting

7.3.4.1 Construction Phase

For the procedures provided in Chapters 8 to 19 of the EIA Report, the reporting will be as follows, unless otherwise stated:

- The Contractor's HSE Officer will relay any observation of non-compliance to the HSE Manager immediately through verbal communication followed by a written report (including proposed solutions to address the non-compliance) within 48 hours of the observance of the non-compliance. This report will be forwarded to the General Manager. Copies of these reports will be retained by the General Manager and be made available to the Guyana EPA upon request.

- The HSE Officer will prepare an inspection report to be forwarded to the HSE Manager. Reports indicating non-compliance will be forwarded to the General Manager for his/her attention.

- Where environmental monitoring reports are to be prepared, the HSE Officer will prepare monitoring reports within 5 days of receipt of results from the sampling and submit to the HSE Manager for onward submission to the General Manager for his/her attention. The HSE Officer and HSE Manager will discuss any improvements which may be necessary with the General Manager.

7.3.4.2 Operation Phase

For the operation phase procedures provided in Chapters 8 to 19, the HSE Manager and Officer will relay any observance of non-compliance to the Asset Manager immediately through verbal communication followed by a written report. This report will then be forwarded to the Wind Farm General Manager for his/her attention, and may include proposed solutions to address the non-compliance.

7.4 Monitoring Plan

A summary of the monitoring recommended to verify the effectiveness of mitigation measures is included in Chapter 20.

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8 WATER RESOURCES

8.1 Introduction

This chapter presents information on the water resources at the two sites chosen for the installation of the proposed wind turbines. This information comes from general sources as well as a water quality monitoring programme undertaken by Kaizen Environmental Services Limited (see Appendix B).

8.2 Key Relevant Policy and Legislation

Section 3.5 outlines the water quality guidelines applicable to water quality. Local water quality guidelines are limited to effluent discharge quality. Therefore, ambient surface water quality conducted in October and November 2020, will be placed into context using World Bank guidelines provided in Table 8-1, below.

TABLE 8-1: WORLD BANK AMBIENT SURFACE WATER QUALITY GUIDELINES

Source: World Bank Group International Finance Corporation (IFC) Environmental, Health and Safety (EHS) Guidelines for Wastewater and Ambient Water Quality

PARAMETER	GUIDELINE VALUE	UNIT
pH	6 - 9	pH units
Conductivity	Not available	mg/L
Dissolved Oxygen	Not available	
Biochemical Oxygen Demand	30	
Total Suspended Solids	50	
Total Dissolved Solids	Not available	
Turbidity	Not available	
Oil & Grease	10	
Total Coliforms	400	MPN / 100 ml

8.3 Existing Information, Baseline Studies

General information about Guyana's water resources was obtained from the following report:

> *Water Resources Assessment of Guyana, US Army Corps of Engineers Mobile District & Topographic Engineering Center, December 1998.*

Guyana has an extensive network of rivers and streams. Surface water is primarily used for agricultural and industrial purposes. Only about 10 percent of the country's drinking water comes from surface water.

The Guyana Water Authority (GUYWA) has the responsibility for domestic water supply outside of the Georgetown area. Since almost all the population lives along the coast in numerous autonomous villages and communities, the water supply is furnished by a series of wells drilled along the coast. The most important aquifers are in the unconsolidated, poorly sorted deltaic sands that underlie the coastal lowlands.

The coastal aquifer system is composed of three connected but hydrogeologically distinct aquifers. Overlying layers of clays confine the lower two aquifers, protecting them from contamination by overlying sources. The three aquifers are named, from upper to lower, the Upper Sands, the A Sand, and the B Sand, with each capable of yielding large amounts of water.

8.3.1 Surface Water Quality

8.3.1.1 General Information

Information from the Water Resources Assessment indicates that surface water quality in urban areas may be contaminated from inadequate waste disposal. Chemical contamination of surface water occurs primarily near manufacturing areas and from the production of rice and sugarcane.

8.3.1.2 Study Area

Figures 8-1 and 8-2 show the drainage in the Hope Beach and Chapman's Grove areas as well as the water sampling locations.

SOURCE: SATELLITE IMAGE, 2020

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DWG. NAME:	DRAINAGE AND WATER SAMPLING LOCATIONS AT HOPE BEACH
FIGURE NUMBER:	8-1

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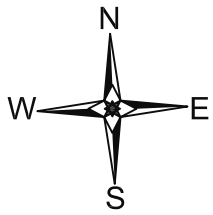

SOURCE: SATELLITE IMAGE, 2020

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DWG. NAME:	DRAINAGE AND WATER SAMPLING LOCATION AT CHAPMAN'S GROVE
FIGURE NUMBER:	8-2

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Appendix B contains the results of ambient water quality testing in Hope Beach and Chapman's Grove. The following is a summary of the results put into context using the World Bank Water Quality Guideline values.

8.3.1.3 Dry Season Results

Monitoring conducted on October 1 and 28, 2020 are considered representative of dry season conditions:

- Measured pH values in both Hope Beach and Chapmans Grove were well within the recommended range in the World Bank guidelines.
- BOD values at Hope Beach and Chapmans Grove were well below the World Bank guideline.
- Conductivity values at Hope Beach and Chapmans Grove were well below the World Bank guideline value.
- No Guideline value was available for DO. Measured values ranged between 5.2 mg/L and 6.3mg/L.
- No Guideline value was available for total dissolved solids. Measured values ranged between 32 mg/L and 26,398mg/L.
- Measured TSS values for both Hope Beach and Chapmans Grove were below the available World Bank guideline value.
- No Guideline value was available for turbidity. Measured values ranged between 53 FTU and 264.5 FTU.
- Measured oil & grease values were all in exceedance with the World Bank guideline value at both Hope Beach and Chapmans Grove.
- All total coliform values were above the method detection limit and potentially above the World Bank guideline value.

TABLE 8-2 (REVISION 1): WATER QUALITY RESULTS (HOPE BEACH AND CHAPMANS GROVE)

SAMPLE ID	pH (pH)	BOD ($mg.L^{-1}$)	Conductivity µS/cm	DO ($mg.L^{-1}$)	TDS ($mg.L^{-1}$)	TSS ($mg.L^{-1}$)	Turbidity FTU	Oil & Grease ($mg.L^{-1}$)	Total Coliforms CFU/100mL
DRY SEASON									
01-Oct-2020 **HBW S4**	7.0	8.5	19.2	6.1	26398	10.0	203	50.6	>80
HBW S3	7.67	5.03	19.0	5.2	15464	21.3	204	44.4	>80
WS CHG 1	6.64	<3.00	4.55	6.3	2110	17.0	53	42.6	>80
28-Oct-2020 - **HBWS1**	7.94	3.45	19.99	5.6	32.0	36.0	264.5	11.0	>80
Guideline Values (maximum)	**6 -9**	**30**	**125**	**na**	**na**	**50**	**na**	**10**	**400**
WET SEASON									
23-Nov-2020 - **WS CHG 1**	6.43	7.3	1.40	6.2	776	17.6	127.0	28.2	>80
HBS W3	7.89	9.7	19.99	5.8	19250	35.0	276.0	35.0	>80
HBS W4	6.9	7.4	19.99	5.7	22840	615.0	281.0	39.0	>80
HBW S1	7.37	<3.00	19.99	6.0	27562	657.0	285.0	27.0	>80
Guideline Values (maximum)	**6 -9**	**30**	**125**	**na**	**na**	**50**	**na**	**10**	**400**

Note: na – not available
DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, TDS = Total Dissolved Solids, TTS = Total Suspended Solids,

8.3.1.4 Wet Season Results

Monitoring conducted on November 23, 2020 is considered representative of wet season conditions:

- Measured pH values in both Hope Beach and Chapmans Grove were well within the recommended range in the World Bank guidelines.
- BOD values at Hope Beach and Chapmans Grove were well below the World Bank guideline and therefore compliant.
- Conductivity values at Hope Beach and Chapmans Grove were well below the World Bank guideline value and therefore compliant.
- No Guideline value was available for DO. Measured values ranged between 5.7 mg/L and 6.2mg/L.
- No Guideline value was available for total dissolved solids. Measured values ranged between 776 mg/L and 27,562mg/L.
- Measured TSS values for two Hope Beach locations were in November 2020 were well in excess of the World Bank guideline value.
- No Guideline value was available for turbidity. Measured values ranged between 127 FTU and 285 FTU.
- Measured oil & grease values were all in exceedance with the World Bank guideline value at both Hope Beach and Chapmans Grove.
- All total coliform values were above the method detection limit and potentially above the World Bank guideline value.

8.3.1.5 Summary of Seasonal Results at Both Sites

The following is a brief summary of the surface water sampling and testing exercise:

- With the exception of oil & grease concentrations and total coliforms, the measured results were in compliance with the available World Bank guidelines.
- There was generally no significant difference between concentrations of parameters at Hope Beach and at Chapmans Grove.

- There was generally no seasonal difference in the measured results with the exception of turbidity (CHG1 where the dry season value was higher than the wet season value) and oil & grease where dry season values were higher than wet season values at both Hope Beach and Chapmans Grove.

8.3.2 Groundwater Quality

Biological contamination of shallow aquifers by pathogens due to improper disposal of animal and human wastes is a common problem (US Army Corps of Engineers, 1998). Chemical contamination is primarily related to the use of fertilizers in the sugarcane and rice fields of the coastal lowlands. The Upper Sands aquifer, which is not normally used for water supply, is highly susceptible to biological and chemical contamination, particularly in the Georgetown area, and the water is generally brackish to saline. Overuse of aquifers in coastal areas may result in saltwater intrusion. During the dry seasons in the interior, shallow wells may temporarily go dry until sufficient aquifer recharge occurs.

Ground water is generally not contaminated along the coast in the A Sand and B Sand aquifers. The Upper Sands and A Sand aquifers have elevated iron contents, and the B Sand has elevated temperatures and a hydrogen sulphide odour. While data concerning the deeper A and B Sand aquifers indicate that while they are sealed off by overlying shales from surface contamination, contamination is still possible from recharge areas or improperly constructed wells.

Contamination plumes generally follow the flow direction and slope of the ground water, making areas downslope of the populated sites susceptible. Fracture systems typically transport contamination in a variety of directions very quickly and not necessarily downslope.

8.4 Impact Prediction and Assessment

The area west of the Hope Canal and landward of the seawall, encompassing the marsh area and the Hope Secondary School, is drained by minor 12 ft wide drainage canals leading to the main 40ft wide drainage canal along the main road, and eventual discharge to the sea via the new Lowlands/Hope pump station. East of the Hope Canal, the Douch-Four to Clonbrook marshy area north of the main road and landward of the seawall, is drained again by small 12 ft wide canals which eventually transport excess water to the Greenfield pump station for discharge into the sea. The 120ft wide Hope Canal and its 10 ft high canal embankments and 7 door sluice gate is intended for flood

control and drainage of the Conservancy water reservoir located some 10 km further inland (see Figure 8-1). However, the sites where turbines are proposed are seaward of the seawall and thus drain into the sea through the mangrove habitat. The Hope Beach wind turbine site thus has no linkage to the drainage or flood control canals.

At Chapman's Grove, the site is drained by a 15 ft wide drainage canal which feeds into a 40 ft drainage canal, with flow leading to the Greenfield pump station where excess water is pumped into the sea (see Figure 8-2). There is no "effluent" anticipated from this project. However, runoff from the project site is expected during the site preparation/ construction phase.

8.4.1 Site Preparation / Construction Phase

During construction, the proposed works may result in impaired surface quality from:

- Siltation/ Sedimentation,
- Hydrocarbon Spills and Leaks,
- Improper Sewage Disposal,
- Spillage of Paints and Solvents, and
- Concrete Washings.

Impaired water quality may affect aquatic fauna and these potential impacts are discussed in Sections 13.5.1.4.

Contaminants from the above activities would be transported to adjacent watercourses and streams and eventually may end up in the nearshore marine environment. Some may also percolate into the ground.

8.4.1.1 Siltation/ Sedimentation

Nature of Concern

Siltation in the site preparation and construction phases, is closely related to erosion (see Section 9.5.1.1). Exposed land may be eroded, and stored, excavated and fill material have the potential to be washed away during periods of heavy rainfall. This silt load can increase turbidity in the nearby watercourses within the study area. Baseline suspended solids exceeded the World Bank guideline in the wet season at two locations located in the drainage channel, mangrove and discharge from the Hope Canal. The entrainment of silt into water courses and the nearshore marine area can result in

increased turbidity and suspended solids which can impact aquatic fauna (see Sections 13.5.1.4 and 13.5.1.5).

Unmitigated Impact

Concerns are expected to be greater during access road works since these works are in close proximity to the nearby 12 ft drainage canals in Douch Four landward of the seawall, and the mangrove lagoon waterbody adjacent to the construction site at Hope Beach. The access road at Chapman's Grove is expected to cross the existing drainage canals. Impacts are expected to occur at the project site and have the potential to extend off-site into the localised area via these drainage canals.

This impact will be temporary and is expected to have serious impairment on social groups and ecosystems. The unmitigated impact associated with sedimentation/ siltation as a result of these works is summarized as follows:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Major	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Major	Short Term	**MODERATE**

Mitigation Measures

Mitigation measures discussed for on-site erosion (see Section 9.5.1.1) are applicable for reducing the impact associated with siltation. The following mitigation measures can also help reduce the impact of sediment migration and the entrainment of silt in water bodies (surface and marine):

- Keep material stored on site to a practical minimum. Where aggregate is to be stored on site, confine using wooden cribs or cover with geotextile coverings. These should be stored at least 30m away from major watercourses and drains.

- Construct bale dikes, silt fences, diversion berms or swales along the edge of the river bank to prevent loose dirt and debris from entering the watercourse.

- Consider using floating or land-based silt barriers to reduce the migration of silt into the canals or nearshore marine environment.

These mitigation measures if implemented effectively are expected to reduce the intensity of the impact of sedimentation/siltation relating to road works, slope stabilization, bridge works and drainage:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Cumulative Impact

Only two activities identified in Section 2.6 have the potential to result in a cumulative impact in terms of siltation: construction of the seawall and farming activity east of the Hope Canal. While the farming at Hope has the potential to result in a cumulative impact with the construction of turbines at Hope Beach, this is not the case at Chapman's Grove. However, the seawall construction is expected to have a cumulative impact at both sites. Runoff from these activities may drain into the same watercourses as well as the nearshore marine environment. As such, the concern for silt will be cumulative if silt from all these sources is not properly controlled. Therefore, the cumulative impact is rated as:

Hope Beach

EXTENT	INTENSITY	DURATION	CLASSIFICATION
Localised	Medium	Short Term	**MODERATE**

Chapman's Grove

EXTENT	INTENSITY	DURATION	CLASSIFICATION
Localised	Minor	Short Term	**LOW**

8.4.1.2 Hydrocarbon Spills and Leaks

Nature of Concern

Fuels and lubricants can travel significant distances in surface water and in the subsoil, depending on the volume of the contaminant source, the size, flow rate and velocity in streams, the permeability of the soil and the hydraulic gradient in the subsoil. This impact relates to contamination of surface water and nearshore marine water from lubricants and other hydrocarbons that may occur during site preparation and construction from fuel spills and leaks, and improper disposal of spent lubricants and light repair work onsite. Fuel spills and leaks of hydrocarbons may arise from the use of heavy equipment during site preparation and construction. At present, oil & grease concentrations in the watercourses at both Hope Beach and Chapman's Grove exceeded the Word Bank guideline value. Hydrocarbons and chemicals are harmful to marine and fresh water animals and at higher concentrations can also result in the die-off of plants. Oily films on water surfaces are aesthetically unpleasing, while thicker layers may impede oxygen exchange.

Unmitigated Impact

Unmitigated, there is the potential for hydrocarbon spills to travel offsite affecting the localised area. At the Hope Beach project site, storm water runoff is facilitated seawards through the mangrove system into the nearshore marine area. The extent of the impact is not expected to exceed a 1 km radius and is therefore considered to be 'Localised'. It is expected that fuel, lubricants and hydraulic fluid required for earth-moving equipment and piling rigs will be stored on-site, as portable fuel tanks. Trucks will be fuelled offsite. There is therefore the potential for hydrocarbon contamination from spills and leaks from stored fuels as well as from machinery and vehicles. As such the impact is expected to have significant effects on the functioning or sustainability of the associated ecosystems or resources. This impact is likely wherever fuel and equipment is stored. The classification of this unmitigated impact on surface and nearshore marine water quality is therefore:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Major	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**MODERATE**

Mitigation Measures

Mitigation measures available to address this concern during the construction phase include:

- Prohibit fuelling or servicing of vehicles on-site (to the extent practical) or designate a specific area for fuelling and servicing of vehicles.
- If necessary, fuel should be stored in bunded areas to ensure that any spills or leaks are contained and not allowed to runoff into the receiving environment. Designated storage areas should be located at least 50 m away from drainage pathways.
- Keep spill kits with absorbent pads on site to respond to spills, rather than "washing-down" the area.
- Use appropriate pumps, hoses and nozzles for refuelling and place disconnected hoses in containers after refuelling to prevent spills of residual fuel.
- Vehicles and construction machinery should be routinely serviced to ensure that there is no leakage from equipment.
- Transport collected spent lubricants off-site to a facility capable of treating and/or disposing of waste of this kind.
- In the event of a spill, collect contaminated soil and remove from the site to a suitable remediation facility.

The effective implementation of these mitigation measures is expected to effectively control the impact of hydrocarbon contamination to the nearshore area and therefore the intensity is reduced and the classification is:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Cumulative Impact

Of the projects listed in Section 2.6, only seawall construction has the potential to result in a cumulative impact of spills of hydrocarbons. Fuel spills and leaks of hydrocarbons may arise from the use of heavy equipment during construction of the seawall. This cumulative impact is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

8.4.1.3 Improper Sewage Disposal

This concern arises from improper disposal of faecal matter which can reduce water quality by increasing the quantities of faecal coliform bacteria within water bodies. Untreated sewage contains bacteria and viruses that can endanger human health and harm aquatic organisms. This can lead to an increase in pathogenic diseases (among downstream users), as well as a reduction in dissolved oxygen levels (enough to kill fish and other aquatic life).

It is common practice that during construction activities, portable toilets or other appropriate toilet facilities be provided on-site for workers and they should be instructed to make use of these. Portable units should be regularly removed from site for emptying and cleaning, and the waste disposed of at an approved facility. It is expected that if this course of action is implemented, concerns associated with discharge of improperly treated sewage will effectively be eliminated, so no cumulative impact is anticipated.

8.4.1.4 Spillage of Paints and Solvents

Nature of Concern

During construction, paint and paint wastes (including solvents, rags, paint chips/dust, paint containers, solvent containers, etc.) may be used for road white-lining, signage, bridge rails, buildings, etc. Due to their chemical composition, paint and paint wastes can be toxic to aquatic life if released into the environment.

Unmitigated Impact

Unmitigated, such compounds may be transported beyond the limits of the project site. Given that it is not expected that a large volume of paints and solvents will be used during the construction phase of the project, the impact is not anticipated to have

significant effects on the functioning or sustainability of social groups, specific ecosystems, services or resources. Unmitigated the impact is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Mitigation Measures

This impact can be addressed by implementing the following appropriate measures:

- Bring to the site only the amount of paint required for the job.
- Keep all paint products and wastes away from drainage courses and highly trafficked sections of the site. Never clean brushes or rinse paint containers into drainage that leads to surface water.
- Use drip pans and tarp to collect any spilt paint and / or solvents.
- Sawdust or other such absorbent material should be added to unused paint (oil based and water based) and left to dry prior to disposal.
- To the extent practical, white-lining and other painting are to be conducted during dry weather conditions.

The concern related to spillage of paints and solvents would be eliminated using the mitigation measures above and as such, no cumulative impact is anticipated.

8.4.1.5 Concrete Washings

Nature of Concern

Concrete washings arise mainly from the rinsing of concrete trucks after they have dispensed their load at the site. The offloading chute and the drum of the truck are normally sprayed with fresh water to prevent concrete from accumulating and hardening on these parts. The chemical content of cement and concrete slurry - especially lime, can be lethal to fish, insects and plants. Concrete washings can have a high pH (of 12–13) and so causes alkali burns. This high pH also renders dilution of concrete washings impractical, and a single bucket of concrete washings could result in a fish kill.

Unmitigated Impact

Water quality impairment impacts associated with concrete washings will arise from drainage construction, building construction, culvert construction and bridge construction and to a lesser extent, foundations for the turbines. This impact has the potential to affect the localised area through the migration of runoff off-site, and will be limited to the construction phase. Therefore, the classification of this unmitigated impact is:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

Mitigation Measures

Impacts relating to impaired water quality from concrete washings can be managed with the following measures:

- Prohibit the discharge from concrete washings into any watercourses or in surface drains.
- Establish a well-identified earthen pit on the site into which concrete washings will be allowed to enter. This pit should be lined with plastic to avoid groundwater contamination. After evaporation of the water, the hardened material should be regularly removed and sent for disposal at an approved landfill.
- All tools and equipment that came into contact with concrete or cement must also be washed such that the wash water flows into the pit, or they must be washed in a designated area where the wash water can similarly be allowed to evaporate, and the hardened material sent for disposal at an approved landfill.

The effective implementation of these mitigation measures is expected to effectively control the impact of concrete washings of adjacent watercourses and the nearshore area and therefore the classification is reduced to:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Cumulative Impact

None of the projects identified which will involve significant concrete works are close to the wind turbine sites and therefore no cumulative impacts are anticipated.

8.4.2 Operation Phase

During the operation phase impaired water quality is likely to arise from hydrocarbon spills and leaks and improper sewage disposal. It is not anticipated that any of the activities during the operation phase will result in siltation/ sedimentation, spillage of paints and solvents, and concrete washings.

8.4.2.1 Hydrocarbon Spills and Leaks

Nature of Concern

As mentioned in Section 8.5.1.1 above lubricants and other hydrocarbons from fuels and spills and leaks, from equipment may runoff into nearby watercourses and the nearshore marine areas. As noted in Section 8.5.1.1, it is unlikely that large volumes of fuel will be stored on site. Instead, all mobile machinery (trucks, cranes, hoists, personnel transport etc) equipment will be fuelled or serviced/lubricated offsite. There will be fairly minor quantities of lubricants, hydraulic fluid, and coolant fluids in the wind turbines up in the nacelle that will require topping up or change out.

Unmitigated Impact

Unmitigated, the impact associated with impaired water quality will be minor, having marked effects on the functioning or sustainability of specific ecosystems or resources due to the small quantities of hydrocarbons and/ or lubricants to be used during any

maintenance works. This concern will be medium term, as repairs will be conducted intermittently throughout the life of the project. The impact is therefore classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Medium Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Medium Term	**MODERATE**

The effective implementation of the mitigation measures mentioned in Section 8.5.1.1 are also applicable here. The rating after mitigation is therefore:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Very Small	Medium Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Very Small	Medium Term	**LOW**

Cumulative Impact

None of the projects identified are expected to result in releases of hydrocarbons into the same waterways as the wind farm project and therefore no cumulative impacts are anticipated.

8.4.2.2 Improper Sewage Disposal

During the operation phase, sewage associated with the substation will be treated using a septic tank/soakaway system. It is not expected that discharges from this system will impact the quality of nearby canals or groundwater.

8.5 Mitigation and Monitoring - Environmental Management Plan

8.5.1 Site Preparation / Construction Phase

8-3	POTENTIAL IMPACT	IMPAIRED WATER QUALITY (SILTATION / SEDIMENTATION)
MITIGATION MEASURES		Mitigation measures discussed for on-site erosion (see Section 9.5.1.1) are applicable for reducing the impact associated with siltation. The following mitigation measures can also help reduce the impact of sediment migration and the entrainment of silt in water bodies (surface and marine): • Keep material stored on site to a practical minimum. Where aggregate is to be stored on site, confine using wooden cribs or cover with geotextile coverings. These should be stored at least 30m away from major watercourses and drains. • Construct bale dikes, silt fences, diversion berms or swales along the edge of the river bank to prevent loose dirt and debris from entering the watercourse. • Consider using floating or land-based silt barriers to reduce the migration of silt into the river or nearshore marine environment.
ACTION BY		▸ EPC Contractor to schedule phased construction works ▸ The Civil Engineer to develop Erosion and Sediment Management Plan and to design runoff control measures. ▸ HSE Manager to ensure effective implement of mitigation measures
TIMING		▸ Throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Silt Barriers; ▸ Wooden cribs; or ▸ Geotextile material
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ EPC Contractor to confirm that design criteria are conducive to soil properties. In addition, the HSE Manager and Field Managers will verify (via daily inspections) that erosion control measures are constructed according to design specifications and that they are adequately located. ▸ The Field Managers to:

8-3	POTENTIAL IMPACT	IMPAIRED WATER QUALITY (SILTATION / SEDIMENTATION)
		- oversee the extent and/or phasing of site clearing, - inspect erosion control measures for functionality and effectiveness (weekly). ▸ The HSE Manager to: - monitor exposed areas for signs of erosion on a weekly basis and/or following rainfall events. - inspect drains and channels for visible turbidity and solid deposits ▸ The HSE Manager to ensure weekly inspections of the site (or within 24 hours of significant rainfall events) to ensure that mitigation measures are being implemented. The HSE Manager to ensure inspection of the embankments and stockpiles of excavated material once per week to ensure that material is secured with crib and/or covered with geotextile material. ▸ The HSE Manager to ensure monitoring of Total Suspended Solids (TSS) in the neighbouring watercourses, drains and the nearshore area monthly during the construction phase. ▸ The HSE Manager to ensure the conduct of weekly inspections the site to ensure that mitigation measures are implemented and effective.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Inspection Checklists ▸ Sealed, sterilized sample bottles ▸ Cooler for storing samples
COMPETENCE AND TRAINING		▸ Accredited Laboratory to conduct testing
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

8-4	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (HYDROCARBON SPILLS AND LEAKS)
MITIGATION MEASURES		▸ Prohibit fuelling or servicing of vehicles on-site (to the extent practical) or designate a specific area for fuelling and servicing of vehicles. ▸ If necessary, fuel should be stored in bunded areas to ensure that any spills or leaks are contained and not allowed to runoff into the receiving environment. Designated storage areas should be located at least 50

8-4	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (HYDROCARBON SPILLS AND LEAKS)
		m away from drainage pathways. ▸ Keep spill kits with absorbent pads on site to respond to spills, rather than "washing-down" the area. ▸ Use appropriate pumps, hoses and nozzles for refuelling and place disconnected hoses in containers after refuelling to prevent spills of residual fuel. ▸ Vehicles and construction machinery should be routinely serviced to ensure that there is no leakage from equipment. ▸ Transport collected spent lubricants off-site to a facility capable of treating and/or disposing of waste of this kind. ▸ In the event of a spill, collect contaminated soil and remove from the site to a suitable remediation facility.
ACTION BY		▸ EPC Contractor to designate area for re-fuelling. ▸ HSE Manager to implement all other mitigation measures.
TIMING		▸ Area for re-fuelling should be designated prior to the start of construction works. ▸ Other measures to be implemented throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Appropriately sized and sealed containers for the storage of spent lubricants ▸ Spill kits
MONITORING / VERIFICATION		
HOW / BY WHOM/,WHAT / WHERE/, FREQUENCY		▸ The HSE Manager to ensure conduct of weekly inspections to ensure that all mitigation measures are being implemented and that they are effective. ▸ The HSE Manager to ensure monitoring of TPH in the neighbouring watercourses, drains and in the nearshore area monthly during the construction phase. ▸ Contractor's HSE Officer to conduct daily visual inspections on vehicles and equipment for evidence of spills and leaks in the terrestrial and aquatic environment.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Inspection Checklists ▸ Sealed, sterilized sample bottles ▸ Cooler for storing samples
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

8-5	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (SPILLAGE OF PAINTS AND SOLVENTS)
MITIGATION MEASURES		▸ Bring to the site only the amount of paint required for the job. ▸ Keep all paint products and wastes away from drainage courses and highly trafficked sections of the site. Never clean brushes or rinse paint containers into drainage that leads to surface water. ▸ Use drip pans and tarp to collect any spilt paint and / or solvents. ▸ Sawdust or other such absorbent material should be added to unused paint (oil based and water based) and left to dry prior to disposal. ▸ To the extent practical, white-lining and other painting are to be conducted during dry weather conditions.
ACTION BY		▸ EPC Contractor to monitor paint volumes ▸ Field Managers to implement other mitigation measures.
TIMING		▸ Measures to be implemented throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Appropriately sized and sealed containers for the storage of waste paint and paint related waste. ▸ Sawdust or other such absorbent material.
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ The Contractor's HSE Officer to maintain a log of the disposal of waste from the site as they occur. ▸ The HSE Manager to ensure that the proper implementation of mitigation measures, monitor activities of workers and check signs of spilt or improperly disposed paint on the site and its drains (via daily inspections). ▸ The HSE Manager to inspect log book weekly.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Checklists ▸ Log book
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

8-6	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (CONCRETE WASHINGS)
MITIGATION MEASURES		▸ Prohibit the discharge from concrete washings into any watercourses or in surface drains. ▸ Establish a well-identified earthen pit on the site into which concrete washings will be allowed to enter. This pit should be lined with plastic to avoid groundwater contamination. After evaporation of the water, the hardened material should be regularly removed and sent for disposal at an approved landfill. ▸ All tools and equipment that came into contact with concrete or cement must also be washed such that the wash water flows into the pit, or they must be washed in a designated area where the wash water can similarly be allowed to evaporate, and the hardened material sent for disposal at an approved landfill.
ACTION BY		▸ EPC Contractor to designate an area for concrete washings to enter. ▸ Field Managers to implement other mitigation measures.
TIMING		▸ Designate and establish concrete washings pit prior to the start of construction works. ▸ Implement all other mitigation measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ The Civil Engineer to verify that the concrete wash pit is adequately located, sized and of impermeable layer. ▸ The HSE Manager to ensure the proper implementation of mitigation measures, monitor the activities of workers and check for signs of improper disposal of concrete washings (daily during concrete works).
SPECIALIZED EQUIPMENT OR MATERIAL		Checklist
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

8.5.2 Operation Phase

8-7	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (HYDROCARBON SPILLS AND LEAKS)
MITIGATION MEASURES		▸ See Table 8-4
ACTION BY		▸ General Manager.
TIMING		▸ Area for re-fuelling should be designated prior to the start of operation. ▸ Other measures to be implemented throughout the operation phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Appropriately sized and sealed containers for the storage of spent lubricants ▸ Spill kits
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ The HSE Manager to ensure conduct of weekly inspections to ensure that all mitigation measures are being implemented and that they are effective. ▸ The HSE Manager to ensure monitoring of TPH in the neighbouring watercourses, drains and in the nearshore area monthly during the operation phase. ▸ Contractor's HSE Officer to conduct daily visual inspections on vehicles and equipment for evidence of spills and leaks.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Inspection Checklists ▸ Sealed, sterilized sample bottles ▸ Cooler for storing samples
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

9 SOILS, LAND, GEOLOGY

9.1 Introduction

This chapter presents information on the geology and geotechnical conditions at the two sites chosen for the installation of the proposed wind turbines, and identifies what is needed to ensure that these structures are designed with stable and safe foundations. This information comes from general sources as well as a geotechnical investigation undertaken by Ground Structures Engineering Consultants Inc. (GSEC) (see Appendix N).

9.2 Definitions and Scope

9.2.1 Scope of Work

This chapter summarizes the findings of the GSEC Report, pertaining to geological and geotechnical conditions at this site, and consideration relative to the design of foundations. The geotechnical investigation conducted by GSEC consisted of the following tasks:

- Drilling of nine boreholes on the alignment of the towers at Hope Beach;
- Performing laboratory analysis on representative soil samples recovered during the field exercise; and
- Analysing the field and laboratory results to outline subsurface conditions and make recommendations concerning foundation design and other geotechnical engineering concerns.

More information on the scope of the drilling and laboratory testing programs are provided hereunder.

9.2.1.1 Drilling Program

The drilling program consisted of the boring of nine boreholes. Each borehole was terminated at depths ranging from 26.5 m to 31.1 m. Samples (both disturbed and undisturbed) were recovered at 1.5 m intervals in each borehole; the disturbed samples being recovered while performing the Standard Penetration Test (Split Spoon). Undisturbed samples were recovered using a Thin Wall Tube (Shelby Tube) sampler. A minimum of four undisturbed soil samples were recovered from each boring. All soil samples were classified in accordance with the Unified Soil Classification System

(USCS). Ground water levels were recorded both during drilling and 24 hours after the completion of drilling at all locations.

9.2.1.2 Laboratory Testing

Soil samples were tested in the laboratory for Soil Moisture Content, Specific Gravity, Atterberg Limits, One-Dimensional Consolidation and Unconsolidated, Undrained Triaxial Compression.

9.2.2 Definitions

Technical terms used in the geotechnical report and in this chapter are defined in Table 9-1:

TABLE 9-1: DEFINITIONS

TERM	DEFINITION
Borehole	A borehole is a narrow shaft (typically less than 150 mm diameter bored vertically into the ground to determine soil conditions and take soil samples at various depths.
Groundwater	Groundwater is water held underground in the soil or in pores and crevices in rock.
Pile Foundation	Pile foundations are deep foundations, where the load of the structure is transferred to stronger soil at a greater depth using wooden, concrete or steel piles.
Pier Foundation	A pier foundation is a relatively shallow foundation, where the load of the structure can be supported by competent soils closer to the surface.
Sediment	Sediment is a naturally occurring material that is broken down by processes of weathering and erosion
Seismicity	Seismicity is the occurrence or frequency of earthquakes in a region
Shear Strength	Shear strength is the ability of the material to resist shear forces (loads) before failure.
Standard Penetration Test	A record of the number of blows of a 63.5 kg hammer, free falling over a distance of 75 cm, required to advance a standard split spoon over a distance of 30 cm.
Stratigraphy	Stratigraphy is a branch of geology concerned with the study of rock and soil layers (strata) and layering (stratification).

9.3 Key Relevant Policy and Legislation

Table 9-2 lists of geotechnical standards which governed the drilling and laboratory testing which formed part of the geotechnical investigation.

TABLE 9-2: RELEVANT GEOTECHNICAL STANDARDS

ACTIVITY	STANDARD
Atterberg Limits	ASTM D-4318
One-Dimensional Consolidation Test	ASTM D-2435
Standard Penetration Test	ASTM D-1586
Soil Moisture Content	ASTM D-2216
Specific Gravity	ASTM D-854
Taking Undisturbed Samples	ASTM D-1587
Unconsolidated Undrained Triaxial Compression Test	ASTM D-4767

9.4 Existing Information, Baseline Studies

This section begins with information on the geology of the study area, then presents the key results of the geotechnical report, and ends with a summary of findings and recommendations pertaining to foundations.

9.4.1 Geology

9.4.1.1 Regional Geology

The site is on the coastal plain of Guyana, located within the onshore extension of the Tertiary to Quaternary Guyana sedimentary basin, a stratigraphic succession overlying the Precambrian basement, expanding seawards beneath the shelf and into the deep water (Yang, Escalona, 2011), and thinning to the South to where the basement outcrops in the forested highlands interior of Guyana. The Guyana basin is present across the coastal region of Guyana and Suriname, with the thickest onshore portion of some 1,800m beneath the coast between the Berbice and Corentyne Rivers.

The onshore stratigraphy has been mapped across the coastal plain from water borings and early onshore hydrocarbon exploration wells (Spillman et al., 1988; GSEC Geotechnical Report, 2009). The surface expression of the Guyana basin comprises the distinct flat Coastal Plain and the Hilly Sand and Clay natural regions, as defined in

the Natural Regions map of the Lands and Survey Commission's 2013 Land Use Plan (Figure 9-1).

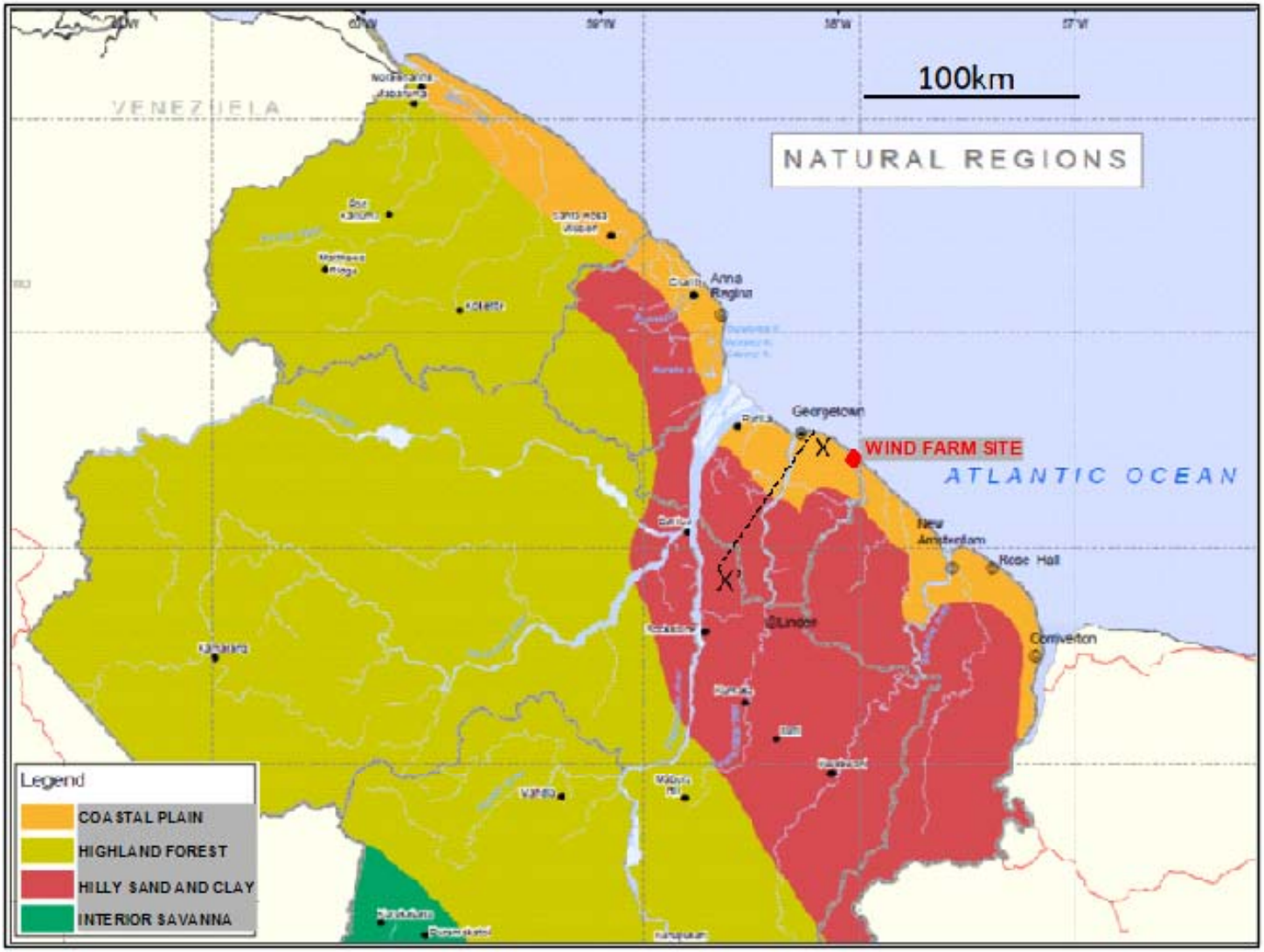
The flat coastal plain is a distinct regional physiographic feature, a narrow belt extending 8 to 65km inland from the coastline, which is present across the width of Guyana and Suriname (GL&SC, 2013; Daniels, 1989; Wong, 2009; GSEC, 2009). The recent coastal plain occurs at elevations below sea level, occasionally elevated above sea level by up to 2m where old beach ridges form higher ground. The inner coastal plain occurs at elevations of 3 to 9m above sea level. Organic wetland 'pegasse' deposits occur to a limited extent on the inner coastal plain. The inland boundary is marked by the topographically elevated and undulating Hilly Sand and Clay Region, where the white sands of the Plio-Pleistocene Berbice Formation outcrop, creating an undulating landscape which attains elevations of 15m to 150m and distinct scrubby vegetation (see Figure 9-2).

The coastal plain is underlain by marine clays of the Holocene Demerara Formation and the deeper Pleistocene Coropina Formation. These two units overlie the white sands of the Berbice Formation, which are also termed the "Upper Sands" in water wells, the shallowest of the three main aquifer sands in the coastal region (Spillman et al., 1998; GSEC, 2009) {see Figure 9-3}.

The Intermediate Clay unit separates the Upper Sand from the deeper A Sand aquifer, at 150 to 215m depth, which overlies alternating clays and sands and the deepest B Sand aquifer, at 350m to 800m depth. The Upper sand is no longer used for water resources, the A and B sands are the two main artesian aquifers in the coastal region (Spillman et al., 1998) {see Figure 9-3}.

9.4.1.2 Surficial Geology

The Coropina Formation – The Pleistocene Coropina Formation is a regional marine clay dominated unit with interbedded silts and sands which extends across Guyana and Suriname. The unit was subaerially exposed during the Pleistocene glacial low stands in sea level, which subjected the clays to strong erosion and weathering, dewatering and oxidation which resulted in a firm to hard consistency and highly mottled colours, and sand units being podsolised (GSEC, 2009), and makes it very distinct from the overlying Demerara clays. Towards its contact with the lower White Sands of the Berbice Fm a number of transition zones occur, and an increasing sand content. The Coropina Fm outcrops to a limited extent along the inner fringe of the coastal plain, typically as forested erosional remnants with slight elevation above the surrounding onlapping Demerara clays.



SOURCE: MODIFIED FROM - GUYANA LAND USE PLAN, 2013, GUYANA LANDS AND SURVEYS COMMISSION

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ECO REPORT NO.	05/2020
DATE:	03/12/21
CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	MAP OF THE NATURAL REGIONS OF GUYANA
FIGURE NUMBER:	9-1

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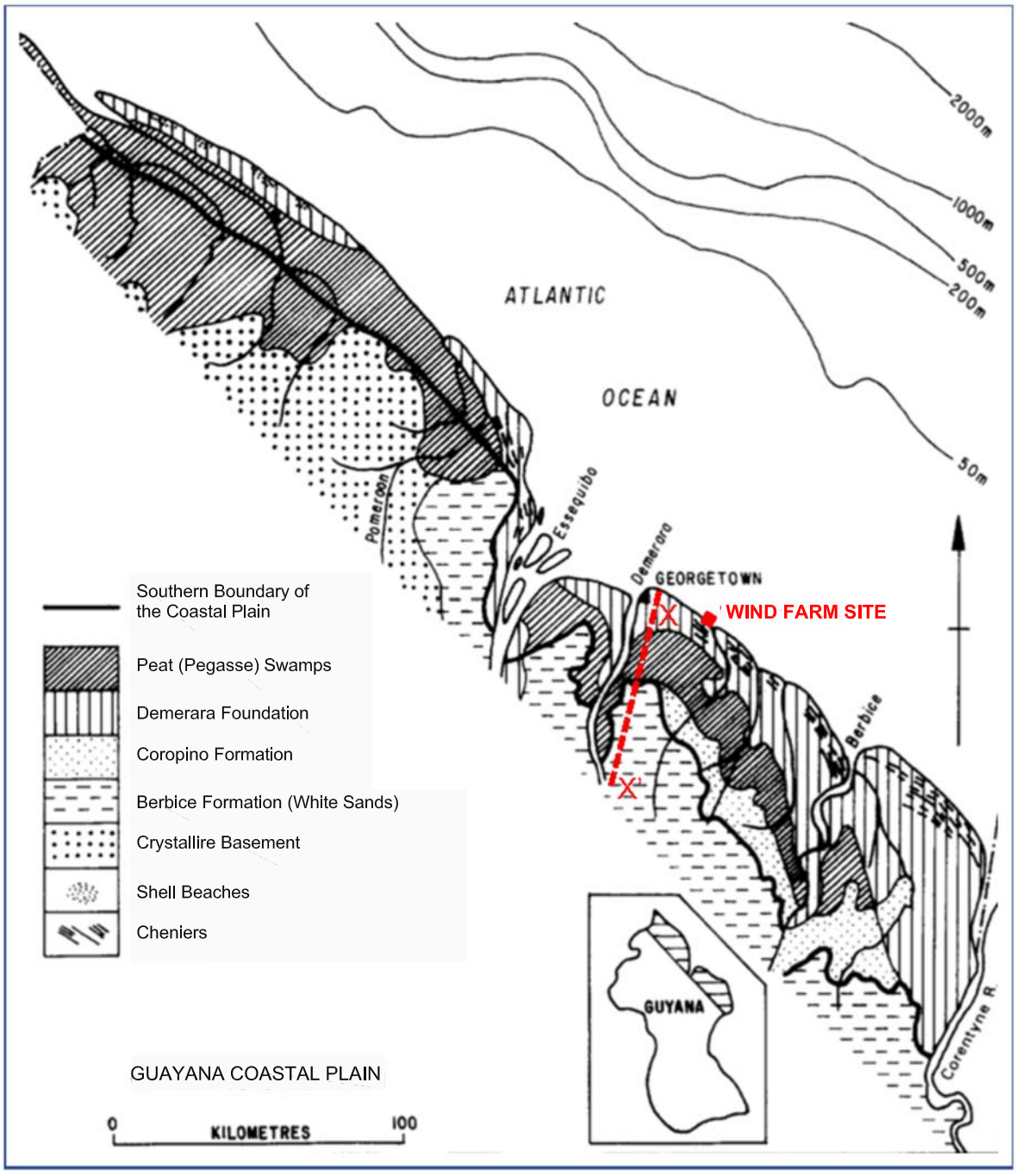

SOURCE: MODIFIED FROM DANIELS, 1989

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ECO REPORT NO. 05/2020	CLIENT: HOPE ENERGY DEVELOPMENT INC.	FIGURE NUMBER: 9-2
DATE: 03/12/21	PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA	
	DWG. NAME: GEOLOGICAL MAP OF THE COASTAL PLAIN OF GUYANA	

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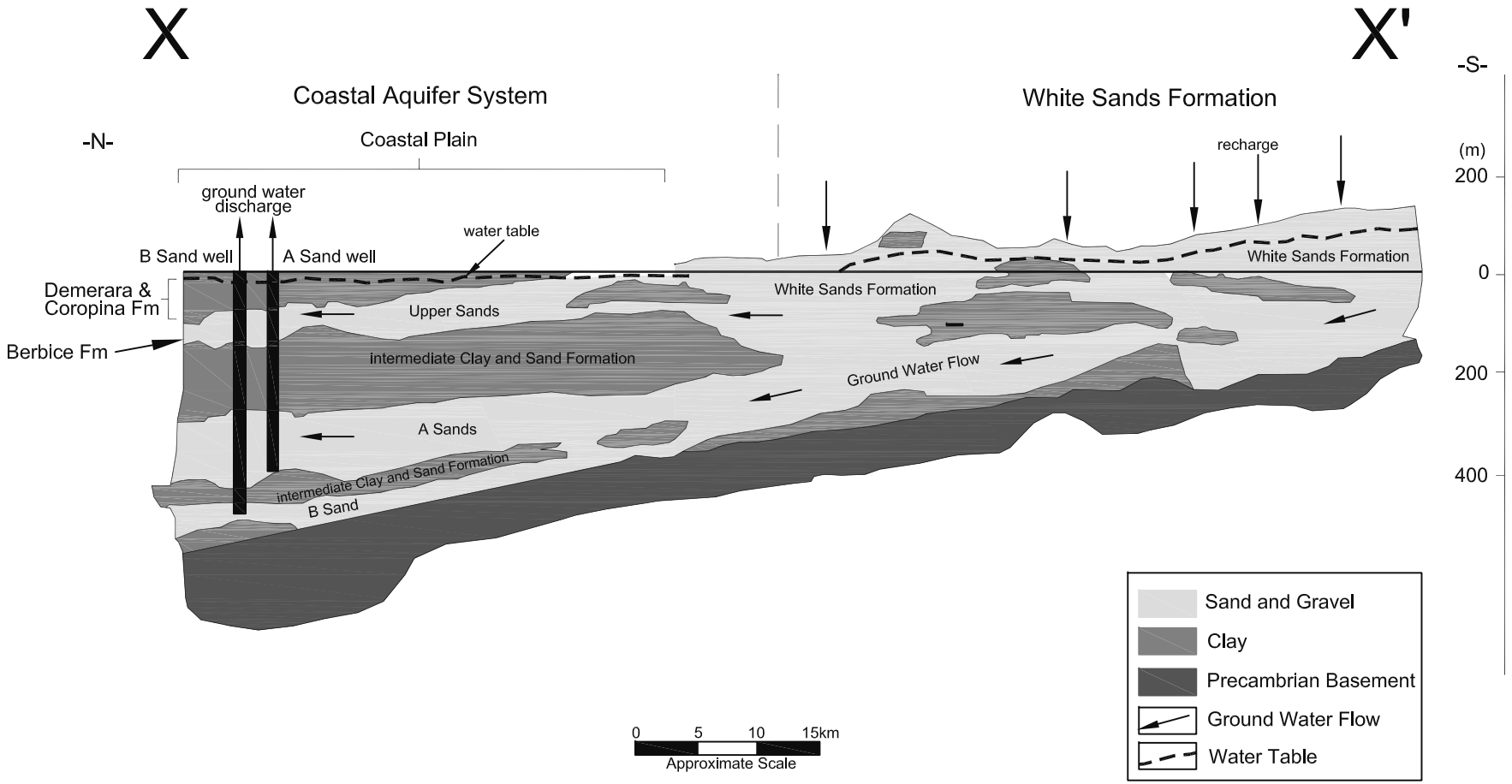

SOURCE: MODIFIED FROM ARAD, 1983, IN T.R. Spillman et al., 1998

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DATE: 03/12/21

CLIENT: HOPE ENERGY DEVELOPMENT INC.

PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA

DWG. NAME: STRATIGRAPHIC CROSS SECTION X-X' ACCROSS THE COASTAL PLAIN IN GEORGETOWN AREA, ILLUSTRATING STRATIGRAPHIC UNITS AND THE MAIN AQUIFERS, THE A SAND AND THE B SAND.

FIGURE NUMBER: 9-3

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The Demerara Formation – These Holocene clays represent marine flooding of the previously exposed coastal plain due to interglacial sea-level rise, with deposition of soft grey-blue marine clays across the entire flat coastal plain, which buried the underlying Coropina Fm. The Demerara Fm is dominated by clays, however, towards the coast occurs a belt of stranded beach ridges, termed Cheniers, comprised of sands and shell material, or shell beaches (Daniel, 1989). Such Cheniers are commonly referred to as "reefs" in Guyana, these are narrow strips typically 10 to 600m wide, 2 to 5m thick, aligned parallel to the coast, slightly elevated (0.5 – 2.5m), to the surrounding flat coastal plain, and are suitable for habitation, infrastructure, and coconut plantations (Daniel, 1989).

9.4.2 Present Day Coastal Morphology

9.4.2.1 Regional Coastal Morphology

Present day coastal processes are largely similar to those which deposited the Holocene Demerara formation in Guyana and Suriname (Daniels, 1989; Wong, 1992; Anthony et al, 2010). The Guyana coastline is part of the world's longest mud dominated coastline, starting from the mouth of the Amazon River, stretching to the NW along the 1,600km Guianas shelf to the Orinoco River delta in Eastern Venezuela (Anthony et al., 2010). The mud supply originates from the Amazon River, and moves as large mud banks towards the NW, along the inner shelf, each bank containing enough mud for an entire year's supply from the Amazon River. Longshore currents, easterly trade wind, wave energy, and meso-tidal processes are responsible for the transport of the mud along the inner shelf, with individual mud banks set up by seasonal variation in these processes. Mud banks are typically up to 5m thick, 10 to 60km long (shore-parallel), and 20 to 30km wide (shore-normal), composed of fluidised muds, migrating to NW at speeds of 0.2 to 3 km/yr,

Depositional-Erosional Cycles: Where the mud banks impinge onto the coast wave dampening and rapid accretion of muddy intertidal flats occur, with seeding and very rapid colonisation of dense mangrove stands along the inner tidal flats. Once the trailing edge of the mud bank migrates past a point along the coast, interbank water depths return, and without the dissipation effect of fluid muds, the full energy wave regime also returns, initiating a period of rapid coastal erosion, including the destruction of the mangrove flats. Such erosional-depositional cycles occur on timescales of decades, up to 30 years, and have been well documented offshore the French Guiana and Suriname coast (Anthony et al., 2010) and also off the Guyana coast at 10-to-20-year cycles, although not as well documented in the literature (K. Samad, Chief Officer Sea-defence, pers. comm. 2019; Daniels, 1989; Toorman et al., 2018). Typically, a

sliver of each accretionary phase survives the erosional phase, which is subsequently preserved when the next coastal depositional bank-phase begins, and in this way the coastline accretes in the seaward direction.

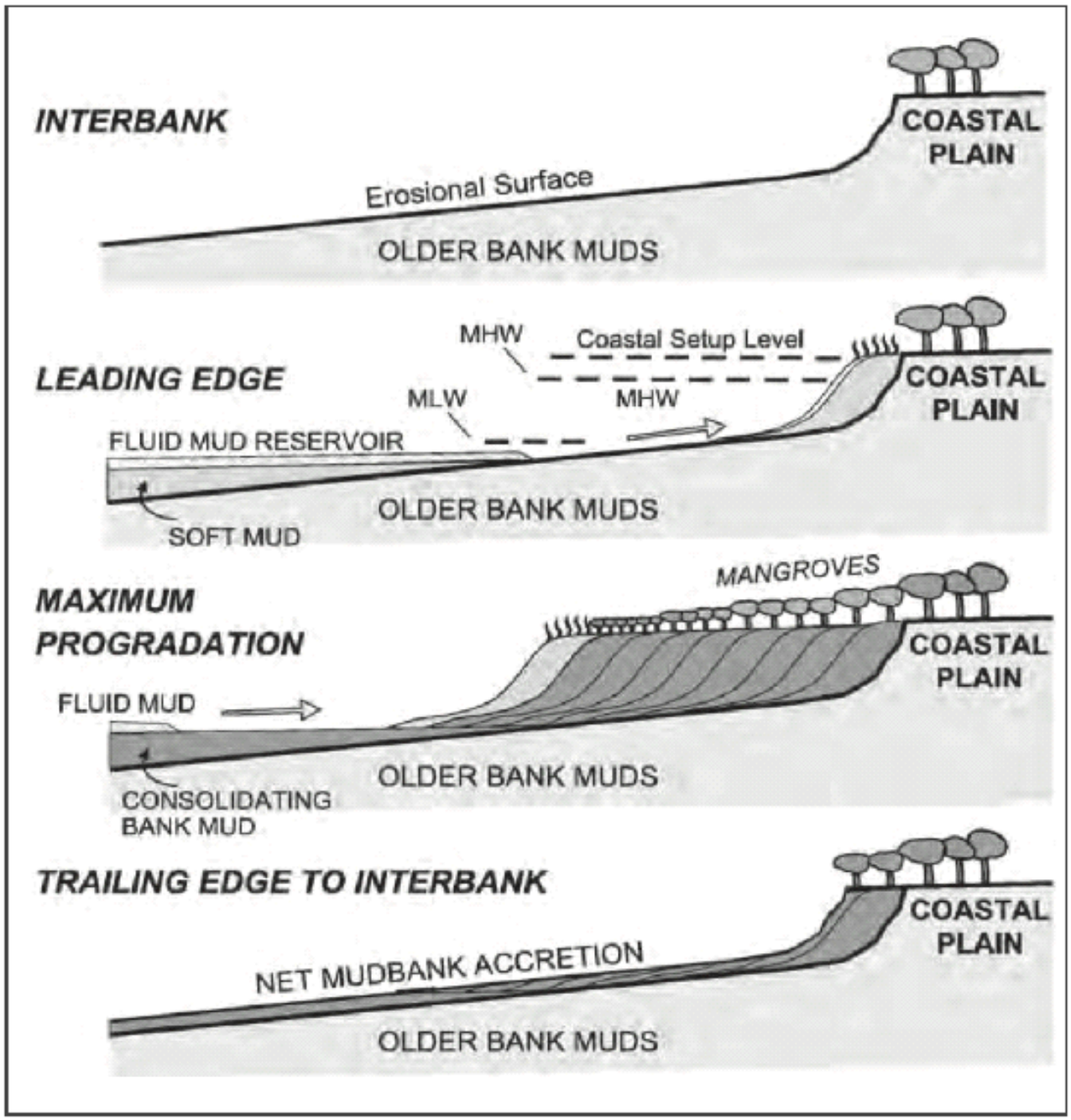
"The dynamic 'connection' of a mud bank with the shore commonly creates an intertidal mudflat of several square kilometres within a few months, with very dense mangrove development in a few years, followed by rapid erosion of mangroves and their substrate during the inter-bank phase. These processes have created one of the most extensive and most sedimentologically dynamic mangrove coasts in the world" (Anthony et al., 2010) {see Figure 9-4}.

Cheniers: Where interbank cycles occur in regions with a source of sand on the inner shelf, typically offshore and downdrift (NW) of local river mouths, then the erosional cycle can result in landward reworking of coastal sands, often accompanied by shell clastics, deposited on top of the eroded inner tidal mudflat, thus forming beach ridges, called cheniers (Daniels, 1989; Anthony et al., 2010). Assisted by wind transport, the chenier sand ridges accumulate above the high tide level, and can be an important component of coastal plain flood defence.

9.4.2.2 Wind Farm Site Surface Morphology

The wind turbines and associated infrastructure will be located seawards of the seawall at Hope Beach (HB) and landward of the seawall at Chapman's Grove (CHG). The seawall barrier separates areas seaward that are dominated by marine processes, and areas landwards that are cut-off from the marine influence and influenced by fresh water supply (see Figure 9-5).

Since construction of the sea-defence and coastal plain drainage system in the 1800's by the Dutch settlers the flat coastal-plain areas landwards of the seawall have been starved of marine mud sediment supply whilst recent Holocene Demerara muds have been dewatering and compacting. Subsidence combined with sea-level rise has resulted in the present coastal plain at CHG elevated now some 1.5m to 1.8m below the average high-tide in sea-level (see Figure 9-6). The areas landward of the seawall are thus highly modified by the seawall, drainage infrastructure, agricultural or residential development, and road construction.



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ECO REPORT NO. 05/2020	CLIENT: HOPE ENERGY DEVELOPMENT INC.	FIGURE NUMBER: 9-4
	PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA	
DATE: 03/12/21	DWG. NAME: ILLUSTRATION OF THE PROCESSES OF ACCRETION AND EROSION CYCLES ASSOCIATED WITH MIGRATING MUD BANKS ALONG THE INNER SHELF OF THE GUIANAS COAST	

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NOTE: SAT IMAGE, 21-04-2020

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PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	MORPHOLOGICAL FEATURES IN THE VICINITY OF THE HOPE BEACH (HB) AND CHAPMAN'S GROVE (CHG) WIND FARM LEASE AREAS
FIGURE NUMBER:	9-5

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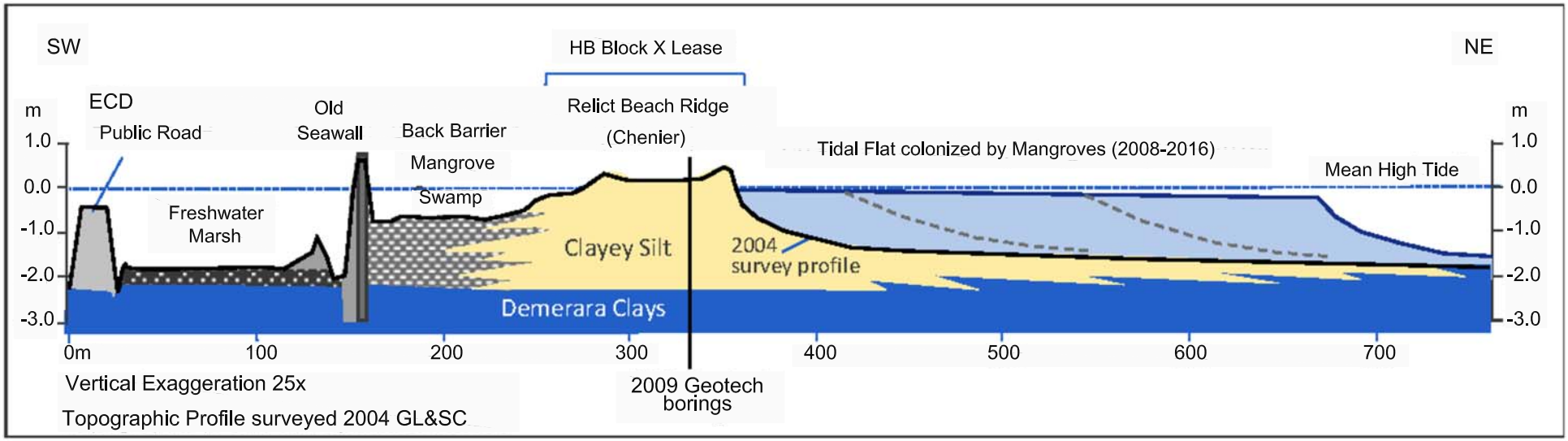

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PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	TOPOGRAPHIC PROFILE AND GEOLOGICAL SECTION
FIGURE NUMBER:	9-6

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Areas seaward of the seawall are dominated by marine processes, the inner tidal flats at HB are impacted by recent mud, silt and sand accretion and rapid mangrove colonization, and outer tidal flats which are covered by silty sands interbedded with mud layers. East of CHG (Unity) and at HB the recessed seawall alignment is associated with accumulation of an elevated beach barrier composed of silty sands. The areas landward between the beach barriers and the seawall are flooded and covered in mangrove swamp. Since 2008 the inner tidal flat at HB has experienced very rapid accretion of a muddy mangrove tidal flat, and the beach barrier is now a relict feature covered in grasses and brush.

The HB wind turbines are located on this relict beach barrier (Chenier) with elevation some 0.3 to 0.5m above high tide. The CHG wind turbines are located in a drained coconut plantation, some 1.5 to 1.8m below high tide levels.

9.4.2.3 Mangrove Tidal Flat Accretion and Erosion Cycles at Hope Beach

The mangrove tidal flat accretion and erosion cycles were described through an examination of historical satellite imagery using the Google Earth mapping software, together with observations by the developer during site visits, records of recent accretion and erosion of the Hope Beach to Chapman's Grove coastal setting (Figures 9-7A and 9-7B). At the time of the initial wind mast installation in 2001 and up till 2008 the Hope Beach lease was an active sandy beach, with no evidence of mangrove flat accretion from Unity all the way to NW past Hope Beach. From 2008 the coastal area from Lowlands/Hope to Greenfield experienced rapid accretion of a muddy inner tidal flat with associated colonisation of mangroves, with more than 500m of seaward accretion and 78 hectares of mangrove tidal flat growth achieved at its apex in 2016. Construction of the Hope Canal and associated flood gate facility was completed in 2014.

Accretion of mangrove tidal flats continued till 2016, at which point the areas W of the canal inlet experienced erosion, and in 2018 erosion of mangrove tidal flats was also initiated East of the canal in the Clonbrook to Greenfield segment. By early 2020 Google Earth images indicate that some 30% of the maximum extent of mangrove tidal flats established in 2016 have been eroded.

The Sea and River Defence Unit is actively upgrading the seawall near the Hope pump station, by constructing a "Rip-Rap" earthen seawall armoured with boulders. This seawall will also be extended to the SE to meet the Hope Canal outlet embankment, outboard (seaward) of the wind farm lease area (see Section 13.5.1). This seawall will protect the newly constructed Hope Canal flood gate and Hope pump station facilities, the local fishing fleet landing area and harbour, and will also protect the wind farm turbines.

9.4.3 Soils

The United Nations Food and Agriculture Organisation (FAO) mapped the soils of Guyana in 1966 as part of their Soil Map of the World initiative, published in 1971. FAO worked closely with the Department of Agriculture. NAREI has since renamed the soils using the nomenclature of the US Department of Agriculture. The map presented in Figure 9-8 is based on the Guyana Lands and Survey Commission rendition of the FAO map, and USDA soil nomenclature, as published in the GL&SC National Land Use Plan of 2013. The low lying, flood prone and muddy coastal plain is dominated by Gleyic soils (see Figure 9-8).

4 soil types dominate the coastal plain:

1a) Low humic gleys of high base status (USDA soil class Hydraquent), colloquially termed "frontland clay". These are the soils present in the wind farm project area, which are deep soils with poor drainage, and medium to high fertility. Limiting factors for agriculture are poor drainage, acid sulphate and aluminium toxicity, and saline conditions near the coast. These soils are suitable for rice and sugar cultivation (GL&SC, 2013).

2a) Low humic gleys of high and medium base status associated with riverine areas (USDA soil class Fluvaquents). These are deep soils with poor drainage, medium to high fertility, and no risk for erosion. Limiting factors for agriculture are poor drainage.

3a) Bog soils, peat and muck phases, local term deep pegasse, USDA soil class Medihemist. These are deep soils with very poor drainage and extremely low fertility. Limiting factors for agriculture are poor drainage, low fertility, toxicity AcS

4a) Low humic gleys of low base status, including groundwater laterites and planosols, USDA soil class Endoaquept. These are deep soils with poor drainage and low fertility. Limiting factors for agriculture are poor drainage, low fertility, toxicity AcS.

5a) Groundwater laterites, USDA soil class Humaquepts. These are deep soils with poor to moderate drainage and low fertility. Limiting factor for agriculture is low fertility.

In addition, the FAO soil documentation (FAO 1971) specifically states that the relict beach ridges (Cheniers) are comprised of Regosols, Albic Arenosols, and Humic Podzols. The sandy reefs are suitable for coconut plantation.

There has been no land use of the lease area in Hope Beach block X. The Chapman's Grove lease area has been used for agriculture only. There has been no mining or industrial use with toxic chemicals in this area.

Coastal Accretion Phase at Hope Beach: 2008 - 2016

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ECO REPORT NO. 05/2020	CLIENT: HOPE ENERGY DEVELOPMENT INC.	FIGURE NUMBER: 9-7 (a)
DATE: 03/12/21	PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA	
	DWG. NAME: HISTORICAL SATELLITE IMAGES SHOWING ACCRETION OF THE SHORELINE AT HB BETWEEN 2008 AND 2016	

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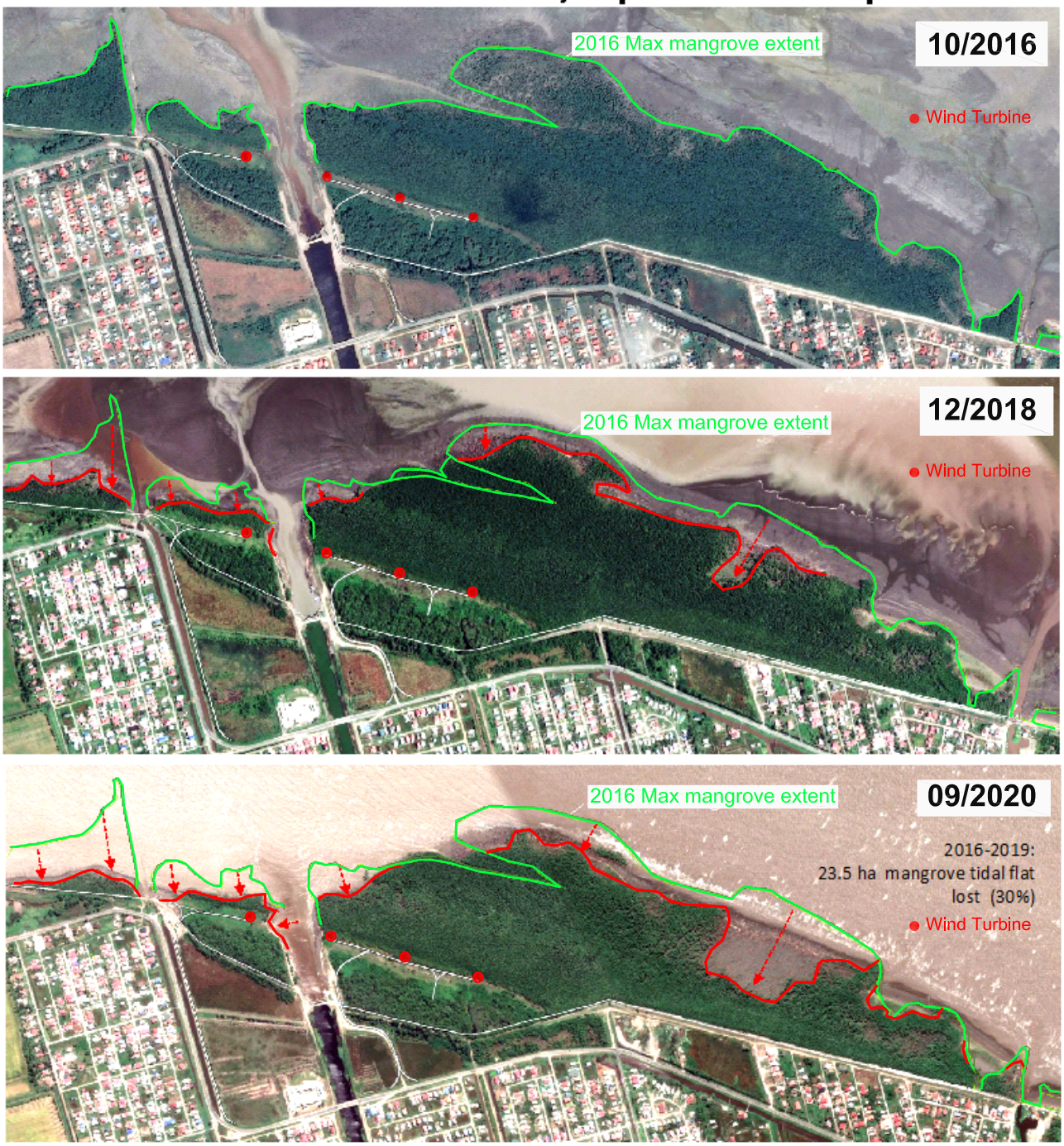
Initial Coastal Erosional Phase, Hope Beach: 2016 - present



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ECO REPORT NO. 05/2020	CLIENT: HOPE ENERGY DEVELOPMENT INC.	FIGURE NUMBER: 9-7 (b)
	PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA	
DATE: 03/12/21	DWG. NAME: INITIATION OF EROSIONAL PHASE ILLUSTRATED BY SATELLITE IMAGES 2016 TO EARLY 2020	

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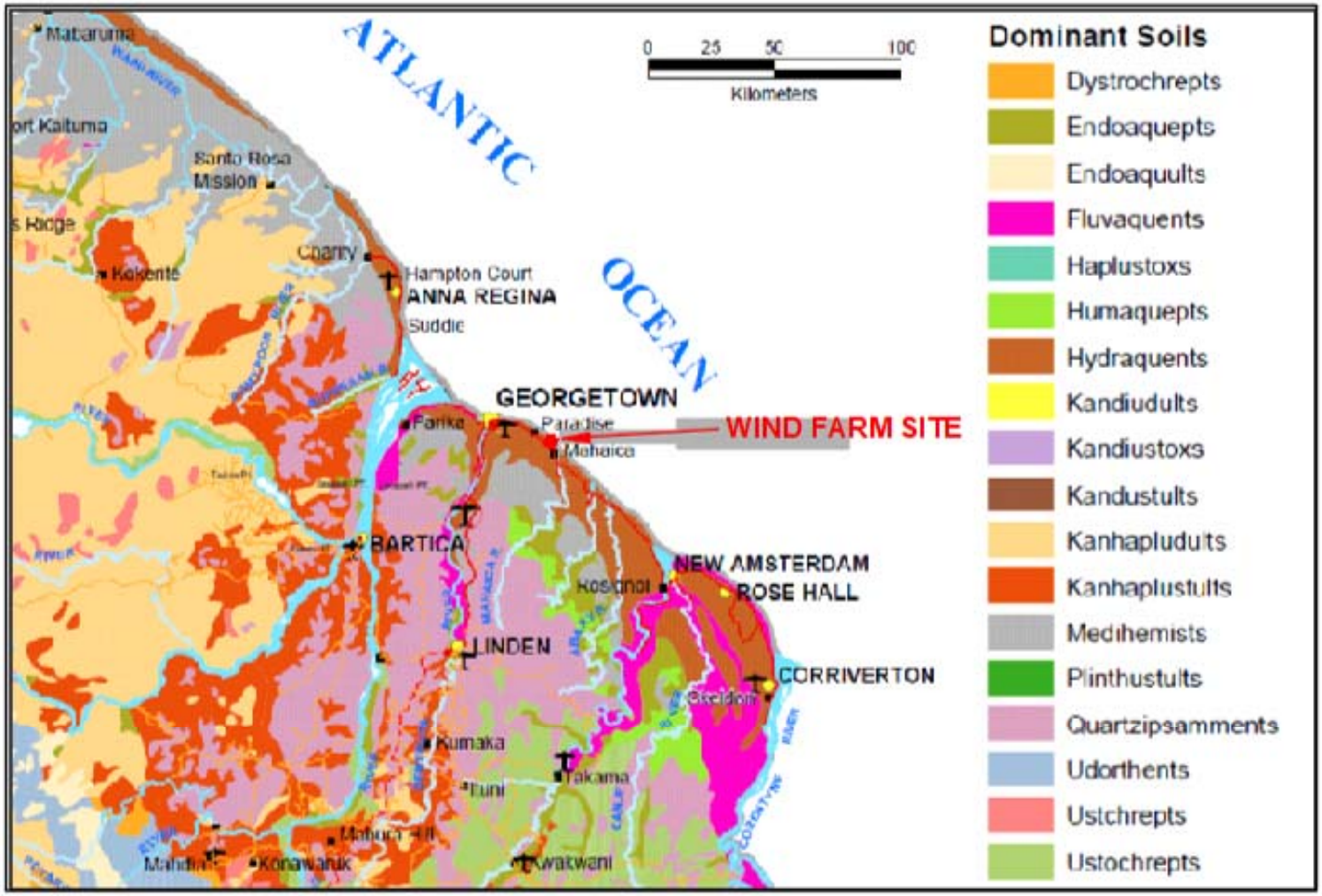

SOURCE: MODIFIED FROM GL&SC 2013, ORIGINAL SOURCE UNDP FAO 1966 MAPPING OF SOILS IN GUYANA

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DWG. NAME:	SOIL MAP OF GUYANA
FIGURE NUMBER:	9-8

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9.4.4 Key Findings of Geotechnical Report

9.4.4.1 Subsurface Stratigraphy

Nine geotechnical borings were drilled in Block X and Block Y lease areas of Hope Beach by Ground Structures Engineering Consultants Ltd (GSEC) in 2009. Based on the results of drilling and laboratory testing, the geotechnical report concluded that the stratigraphy encountered in Block X consisted of a surface layer of firm to stiff orange and orange-brown and red clayey silt with traces of shell material some 1.2 to 3.0m thick, overlying very soft to soft bluish-grey silty clay and below that firm to stiff bluish-grey clays, both of the Demerara Formation. The top of the Coropina Formation is marked by an abrupt and distinct change to mottled red to yellow bluish-grey stiff to hard silty clays. The top of the Coropina Fm is variable, occurring as shallow as 10.6m and deeper than total boring depth of 31m in BH-2. The undulating and hard over consolidated nature of the top Coropina contact is consistent with a subaerial exposure surface associated with Pleistocene glacial low stand in sea level. The top Coropina is the competent bearing stratum for the piled foundations of the wind turbines. Each of these stratigraphic units is described below (see Figure 9-9).

Demerara Formation:

Unit 1: Firm to Stiff Clayey SILT, red to brown in colour, was encountered as the surface unit at all borings. The stratum extended to depths ranging from 1.2 m to 3.0 m at the locations investigated. The geotechnical analysis did not include grain size analysis, however, surficial examination of this unit in Block X indicates presence of fine grained sands and silts, and corresponds to the topographically raised relict beach ridge (Chenier). Penetrometer tests typically achieved 5 to 15 blows per foot, with one outlier at 38 blows.

Unit 2: Soft to Very Soft Silty CLAY (CH), bluish-grey, was encountered in all borings, penetrometer tests always less than 5 blows per foot and typically the weight of the drill rod and spoon was sufficient to penetrate the unit. This stratum extends down to 8.5 m to 19 m depth below surface.

Unit 3: Firm to Stiff Silty CLAY (CH), bluish-grey, a firmness transition between the normally consolidated upper Demerara Clays and the over-consolidated Coropina Formation at depth. This stratum progresses to depths ranging from 16.5 m to 29.5 m, in BH-2 extends beneath the total depth of the 31.1m boring, and was not encountered in BH-6 where the Coropina Fm was encountered very shallow. The average depth to the top of this stratum was approximately 14 m.

Coropina Formation:

Unit 4: Stiff to Hard Silty CLAY (CH), mottled red, yellow and bluish grey, encountered in all borings except BH-2 where it occurs below the total depth of the 31.1m boring. This stratum reflects the occurrence of the Coropina Formation, the competent bearing stratum at the site. N-values in excess of 16 blows and up to 65 blows per 30 cm were recorded in this stratum. All boreholes were terminated in this stratum.

9.4.4.2 Groundwater Conditions

Groundwater was encountered at depths ranging from 0.81m to 1.7m in the boreholes. The water levels are for the times noted on the drilling logs only (see Appendix N). These levels do not reflect flood, tidal or seasonal fluctuations in groundwater levels.

9.4.4.3 Summary of Test Results

Penetrometer tests were obtained at 1.5m intervals in all borings. In addition, Atterberg, Triaxial Compression, and One Dimensional Consolidation tests were obtained from undisturbed samples in the Demerara Clays in BH-1 through BH-6, Sample locations are shown in summary cross section in Figure 9-9. The shallow firm silts at surface were not sampled.

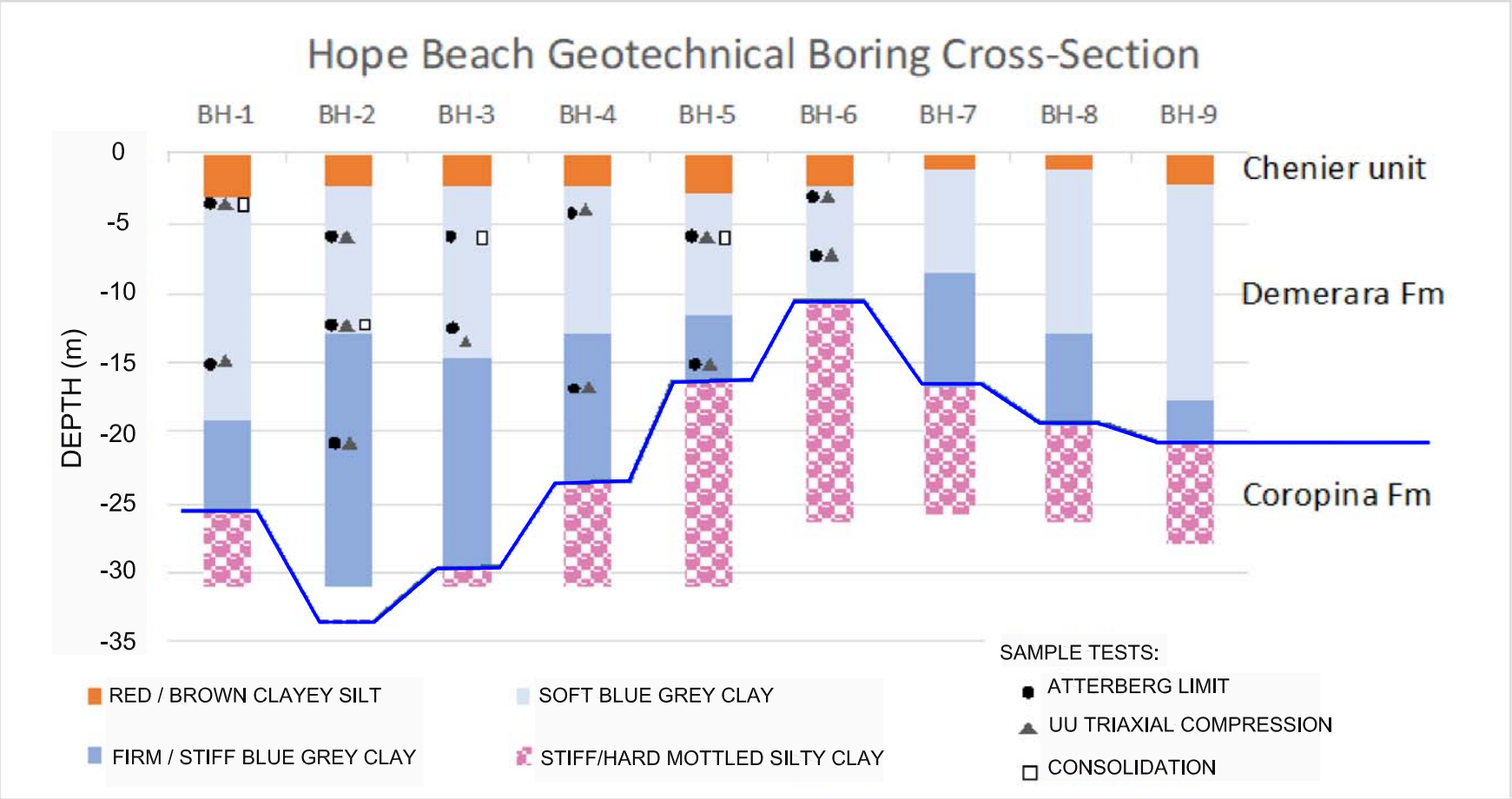
Atterberg Classification Test indicate that Demerara clays from both upper soft to lower firm/stiff unit are high plasticity clays.

Unconsolidated Undrained Triaxial Compression Tests showed that, in general, the shear strength of the very soft to soft silty clay (Demerara Clay) does not exceed 15 kPa and the shear strength of the deeper stiff to hard silty clay (Demerara Formation) is not lower than 20 kPa.

One-dimensional Consolidation Tests were obtained for the upper Demerara Clays, and showed that, in general, the Compression index (Cc) is greater than 0.5 for these very soft to soft silty clays. Coefficient of consolidation was between 0.12 to 0.43.

The results confirmed the low strength, high compressibility nature of the Demerara clays.

The results obtained from the investigation of the Demerara clays are similar to those obtained from equivalent tests on samples of very soft to soft silty clays recovered from Coastal Plain deposits elsewhere in Guyana. Gaskin and Associates Civil Engineers have data from some 86 geotechnical boreholes along the East Coast Highway four



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DWG. NAME:	SUMMARY CROSS SECTION OF 9 GEOTECHNICAL BORINGS IN BLOCK X AND BLOCK Y OF THE HOPE BEACH LEASE
FIGURE NUMBER:	9-9

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lane extension project, from Better Hope to Belfield, which supports the data from the Demerara Formation at this site.

9.4.4.4 Geotechnical Study Foundation Options Assessment

Deep Foundations for Wind Turbines and bridges:

GSEC also assessed the geotechnical data in order to provide input to wind turbine foundation designs. Both shallow pier and deep piled foundation options were analysed. The assessment of concrete piled foundation is relevant to the concrete raft with deep pile design being considered for the V150 wind turbines. Vestas requires geotechnical borings to drill to a depth that obtains a minimum standard penetration test PTS_{30} N value of 45 or greater, which was achieved in most borings within the upper Coropina Formation.

GSEC recommends that should precast concrete piles be used; these should have a minimum dimension of 35 cm and should be designed to transfer loads through both adhesion and end bearing. If the axial loads are excessive, square, precast concrete piles may be used to support the facilities and to develop the required uplift resistances. The geotechnical report recommends that the pile capacities be determined by pile load tests. GSEC's preliminary assessment results in Piles of 25m depth having axial load capacities of up to 62 metric tonnes, and uplift capacities of 45 tonnes, with 23mm of settlement. The geotechnical report recommends that the pile capacities be determined by pile load tests.

Shallow Foundations for Access Roads

Gaskin and Associates (G&A), Civil Engineers for the project, have based the access road design on geotechnical parameters typical for the shallow, soft Demerara Clays along the coastal plain of Guyana. G&A obtained information from GSEC's geotechnical study at Hope Beach, and in addition, the benefit of data from an additional 86 geotechnical borings along the East Coast Highway.

Further Geotechnical Studies

The initial Geotechnical study by GSEC is suitable for preliminary feasibility-stage assessment of foundation options, understanding the depth to the structurally competent stratum, and to confirm that wind turbine construction is feasible at the site. At the detailed design phase of the project, additional geotechnical borings will be acquired at each of the final wind turbine locations, new bridge structures, and the substation transformer site. Such borings shall establish the depth to the Coropina hardground foundation, and more detailed geotechnical data for the final design of each foundation. Additionally, penetration tests will be completed along the length of the

planned access roads in order to confirm the suitability of the access road design. Relevant tests to confirm structural compliance will be undertaken during the civil works construction phase and for the crane pads before the cranes undertake heavy lifts.

9.4.5 Seismicity

Seismicity in the northern part of the South American continent is largely controlled by plate boundary events occurring along the southern rim of the Caribbean Basin. Major earthquakes frequently occur along the plate boundary between the South American and Caribbean Plates. A search of the National Oceanic and Atmospheric Administration (NOAA) Earthquake Database revealed that five events have occurred within recorded history within 400 km of the project area. One of these events occurred in Guyana, in 1964, at a point defined by 2.64° North and 59.62° West at a depth of 50m and a magnitude of 4.5.

As part of the Caribbean Disaster Mitigation Project, the Organisation of American States prepared Seismicity risk maps (http://www.oas.org/cdmp/). The wind farm site is in a region with 10% probability of exceeding in 50 years a Horizontal Ground Acceleration of just over 45 gals (0.046g) and between 5 and 6 on the Maximum Mercalli Intensity scale, which equates to a moderate perception in shaking intensity, and potential for light to very light structural damage (see Figure 9-10).

9.5 Impact Prediction and Assessment

9.5.1 Construction Phase

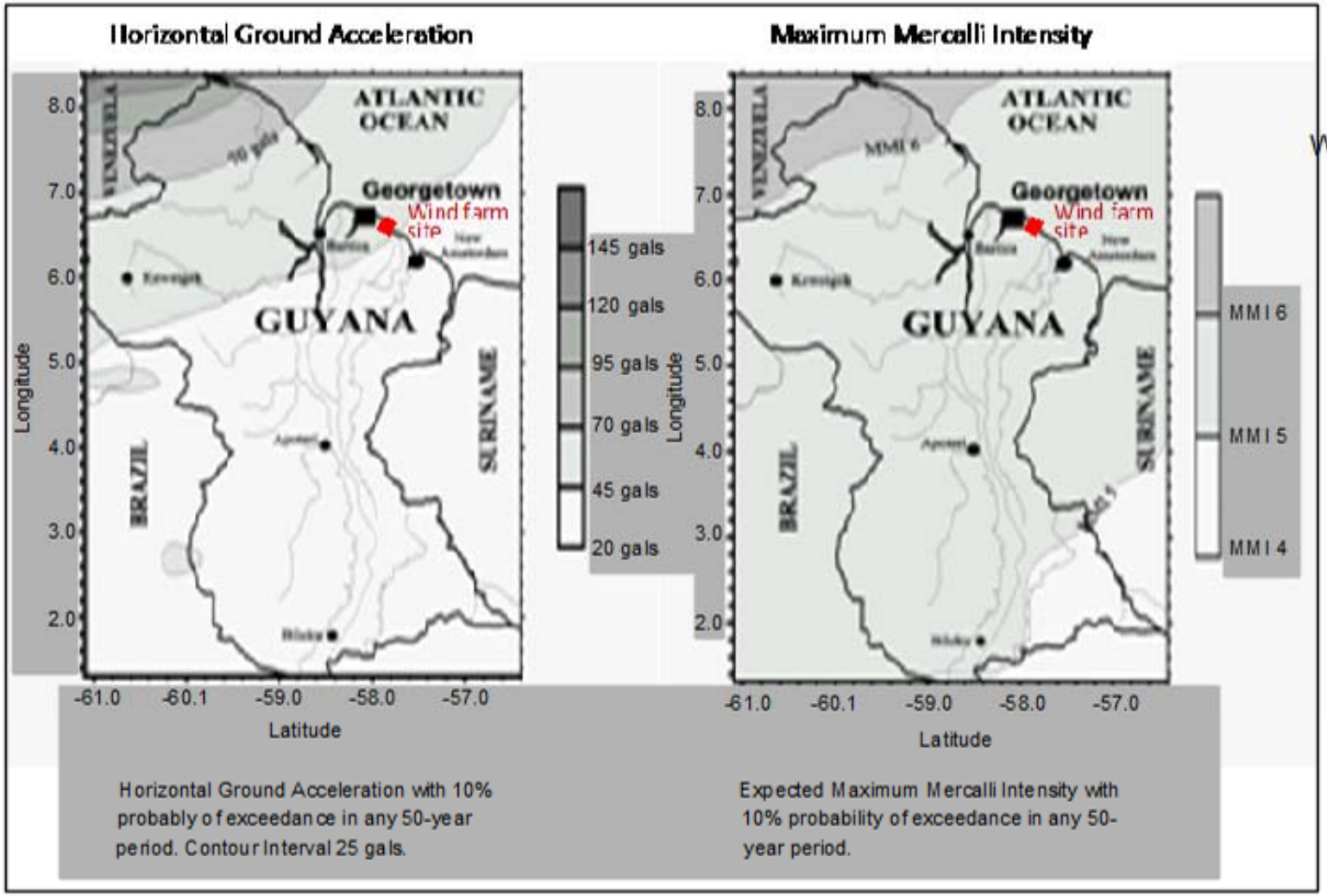
The potential significant impacts related to the geotech and geology during site preparation and construction include:

- On Site Erosion, and
- Slope Instability.

9.5.1.1 On-Site Erosion

Nature of Concern

The potential for soil erosion with the resultant loss of soil is dependent on wind and incident wave energy, precipitation, characteristics of the soil, length and steepness of



NOTE: (GENERATED IN SUPPORT OF THE CARIBBEAN DISASTER MITIGATION PROJECT, COMPLETED IN 1999 BY THE JOINT EFFORTS OF OAS AND US AID)

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DWG. NAME:	GEOSEISMIC HAZARD RISK OF GUYANA
FIGURE NUMBER:	9-10

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slopes, and the presence of canopy and vegetative cover. It can contribute to slope instability, flooding, siltation within watercourses; and a reduction in the ability of soil to store water and nutrients. Increased surface runoff associated with changes in site topography and drainage pathways can also accelerate soil erosion.

Soils with faster infiltration rates, higher levels of organic matter and improved soil structure have a greater resistance to erosion. Soils in Segments 1, 3 and 10 are characterized by imperfect drainage which makes them more susceptible to erosion (see Section 9.4.3). Sand, sandy loam and loam textured soils tend to be less erodible than silt, very fine sand, and certain clay textured soils (Ritter, 2012). Soil types in the study area include a surface layer of firm to stiff clayey silt with traces of shell material (see Section 9.4.3).

Loss of habitat due to wave erosion is also a concern but is unrelated to project activities. Instead, the present large-scale erosion may be due to natural erosion cycles as well as in response to canal works. The mitigation measure is the planned re-alignment of new rip-rap seawall planned by the River and Sea Defence Board, and stabilisation of canal embankment at Hope Canal outlet.

Unmitigated Impact

As stated in Section 5.3.1.1 above, small areas will be cleared to facilitate construction of the wind turbines, access roads and the substation. The extent of the impact is expected to be localised. High silt loads can impact various fish species within the area. Therefore, the intensity of this potential unmitigated impact has been classed as "Medium". However, this impact is expected to be temporary, lasting only as long as the construction phase.

The unmitigated impacts at these sites are summarized as follows:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

Mitigation Measures

In practice, these concerns can be effectively mitigated using the following measures:

- Identify soil properties, engineering constraints and design criteria and develop an Erosion and Sediment Management Plan to identify areas of disturbance, areas of cut and fill, slope during and after grading, existing vegetation, and measures to protect stored aggregate, slope, drainage pathways, and existing vegetation in the project area. These measures will also aid in minimizing soil loss and reducing sedimentation to protect water quality.
- Undertake a phased approach to clearing and grading.
- Schedule earthworks for the dry season (to the extent practical).
- If scheduling earthworks for the dry season is not possible and work must be carried out during extensive wet weather conditions, consideration must be given to using gravel working pads, cross ditching, soil stabilization or synthetic geotextiles to maintain stable subgrade conditions. Monitor exposed areas for signs of erosion.
- Natural vegetative cover and canopy cover should be maintained as far as practical. Areas not required for construction works should not be cleared.
- Re-vegetate or otherwise cover cleared areas as early as practical.
- Design runoff control features to minimize soil erosion.
- Use special construction techniques in areas of steep slopes and erodible soils.
- Maintain natural vegetative cover as far as practical, especially in the vicinity of watercourses, existing drains and steep slopes. Ensure that adequate measures, such as clearing on a phased basis, be undertaken so as to minimize soil disturbance.
- Ensure that clearing takes place immediately prior to excavation and earthworks to minimize the length of time that soils are exposed.
- Cover bare, cut slopes with geotextiles, tarpaulins or plastic.
- Keep all approach roads clear of mud, debris, gravel, sediments or other materials generated from construction activities. These include the installation of a stone-stabilized pad or temporary gravel entrance/exit and a wash bay. The wash bay area shall have a gravel base, which shall be installed in such a manner so as to allow the removal of sediments by directing the water from the area to a temporary holding basin or to any temporary on-site-drain.
- Incorporate and construct embankments along main drains/watercourses to contain fill as well as to prevent run-off from earthworks.

These mitigation measures if implemented, are expected to reduce the intensity of the impact relating to soil erosion, from Medium to Minor and the classification is LOW.

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Cumulative Impact

There are no activities to be undertaken simultaneously on-site. The question of cumulative on-site erosion therefore does not arise.

9.5.1.2 Slope Instability

Nature of Concern

Slope instability concerns arise from construction activities associated with the clearing of slopes (including along river banks), excavations during general earthworks or for foundations. Slope instability concerns also arise where trenches will be dug to facilitate drains, etc. If the side slopes of these trenches are not adequately shored, they may collapse.

Landslip potential increases when slopes are cleared or when artificial slopes are cut, and if not adequately mitigated, such failure can be progressive. Slope failure may also occur when clay soils become water-logged and lose strength. Unstable slopes can result in siltation of the nearby river and nearshore marine area and could also result in damage to site infrastructure and buildings.

The project site is flat so the concern for unstable slopes is expected where bridge works are to be conducted (such as widening of the bridge or bridge construction), or where excavations are to be made for foundations of the wind turbines and the substation.

Unmitigated Impact

Given the topography of both sites, the extent of the impact is 'onsite' and the intensity 'Minor'. In all cases, the duration of this impact is expected to be 'Short Term', lasting

only as long as construction works are in progress. Unmitigated, the impact relating to slope instability is rated as:

Hope Beach

Extent	Intensity	Duration	Classification
On-site	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
On-site	Minor	Short Term	**LOW**

Mitigation Measures

Mitigation measures available to address slope instability concerns during the site preparation and construction phases include:

- Ensure that slopes are cut to a minimum slope angle based on the recommendations of the geotechnical investigation to minimize the potential for future slippage.
- Ensure that excavated areas are adequately shored including temporary shoring where necessary.
- Construct surface drains at the top of major cuts or along cleared slopes to facilitate run off and prevent the formation of ruts along the slope. Ensure that these are maintained until permanent growth of vegetation has been firmly established.
- Construct bale dikes, silt fences, diversion berms or swales along the top of the river bank to prevent loose dirt and debris from entering the watercourse.
- Where heavy equipment are to be used on site, ensure that the toe of the slope is secured. Do not store material or operate heavy equipment close to the edge of excavations.
- Vegetate cleared areas as soon as practical after construction to stabilize slopes using Vetiver, for example.

These mitigation measures if implemented are expected to reduce the impact associated with slope instability resulting from slope stabilization works, road works, and bridge construction:

Hope Beach

Extent	Intensity	Duration	Classification
On-site	Very Small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
On-site	Very Small	Short Term	**LOW**

Cumulative Impact

There are no activities to be undertaken simultaneously on-site. The question of cumulative on-site erosion therefore does not arise.

9.5.2 Operation Phase

There is not expected to be any operation phase activities that would result in impacts related to on-site erosion or slope instability.

9.6 Mitigation and Monitoring - Environmental Management Plan

9-3	POTENTIAL IMPACT	ONSITE EROSION AND SEDIMENT MIGRATION
MITIGATION MEASURES		• Identify soil properties, engineering constraints and design criteria and develop an Erosion and Sediment Management Plan to identify areas of disturbance, areas of cut and fill, slope during and after grading, existing vegetation, and measures to protect stored aggregate, slope, drainage pathways, and existing vegetation in the project area. These measures will also aid in minimizing soil loss and reducing sedimentation to protect water quality. • Undertake a phased approach to clearing and grading. • Schedule earthworks for the dry season (to the extent practical). • If scheduling earthworks for the dry season is not possible and work must be carried out during extensive wet weather conditions, consideration must be given to using gravel working pads, cross ditching, soil

9-3	POTENTIAL IMPACT	ONSITE EROSION AND SEDIMENT MIGRATION
		stabilization or synthetic geotextiles to maintain stable subgrade conditions. Monitor exposed areas for signs of erosion. • Natural vegetative cover and canopy cover should be maintained as far as practical. Areas not required for construction works should not be cleared. • Re-vegetate or otherwise cover cleared areas as early as practical. • Design runoff control features to minimize soil erosion. • Use special construction techniques in areas of steep slopes and erodible soils. • Maintain natural vegetative cover as far as practical, especially in the vicinity of watercourses, existing drains and steep slopes. Ensure that adequate measures, such as clearing on a phased basis, be undertaken so as to minimize soil disturbance. • Ensure that clearing takes place immediately prior to excavation and earthworks to minimize the length of time that soils are exposed. • Cover bare, cut slopes with geotextiles, tarpaulins or plastic. • Keep all approach roads clear of mud, debris, gravel, sediments or other materials generated from construction activities. These include the installation of a stone-stabilized pad or temporary gravel entrance/exit and a wash bay. The wash bay area shall have a gravel base, which shall be installed in such a manner so as to allow the removal of sediments by directing the water from the area to a temporary holding basin or to any temporary on-site-drain. • Incorporate and construct embankments along main drains/watercourses to contain fill as well as to prevent run-off from earthworks.
ACTION BY		▸ EPC Contractor to schedule phased construction works ▸ The Civil Engineer to develop Erosion and Sediment Management Plan and Project Engineer to design runoff control measures. ▸ Field Managers to implement other measures.
TIMING		▸ Revision of the Erosion and Sediment Management Plan and scheduling of works to be conducted prior to the start of construction.

9-3	POTENTIAL IMPACT	ONSITE EROSION AND SEDIMENT MIGRATION
		▸ All other works to be implemented throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Geotextiles ▸ Tarpaulins or plastic ▸ Silt Fences
MONITORING / VERIFICATION		
HOW / BY WHOM/, WHAT / WHERE/, FREQUENCY		▸ EPC Contractor to confirm that design criteria are conducive to soil properties. In addition, the Field Managers will verify (via daily inspections) that erosion control measures are constructed according to design specifications and that they are adequately located. ▸ The Field Managers to: - oversee the extent and/or phasing of site clearing, - inspect erosion control measures for functionality and effectiveness (weekly). ▸ The HSE Manager to ensure: - monitor exposed areas for signs of erosion on a weekly basis and/or following rainfall events. - inspect drains and channels for visible turbidity and solid deposits ▸ The HSE Manager to ensure the conduct of weekly inspections of the site (or within 24 hours of significant rainfall events) to ensure that mitigation measures are being implemented.
SPECIALIZED EQUIPMENT OR MATERIAL		Inspection Checklist
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

9-4	POTENTIAL IMPACT	SLOPE INSTABILITY
MITIGATION MEASURES		▸ Ensure that slopes are cut to a minimum slope angle based on the recommendations of the geotechnical investigation to minimize the potential for future slippage. ▸ Ensure that excavated areas are adequately shored including temporary shoring where necessary. ▸ Construct surface drains at the top of major cuts or along cleared slopes to facilitate run off and prevent the

9-4	POTENTIAL IMPACT	SLOPE INSTABILITY
		formation of ruts along the slope. Ensure that these are maintained until permanent growth of vegetation has been firmly established. ▸ Construct bale dikes, silt fences, diversion berms or swales along the top of the river bank to prevent loose dirt and debris from entering the watercourse. ▸ Where heavy equipment are to be used on site, ensure that the toe of the slope is secured. Do not store material or operate heavy equipment close to the edge of excavations. ▸ Vegetate cleared areas as soon as practical after construction to stabilize slopes using Vetiver, for example.
ACTION BY		Civil Engineer and HSE Manager to implement all mitigation measures.
TIMING		▸ Slope angle to be determined prior to the start of construction works. ▸ Surface drains at the top of cuts/along cleared slopes to be constructed as soon as slopes are cut. ▸ All other mitigation measures to be implemented throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		Geotextiles, tarpaulins and/or plastic.
MONITORING / VERIFICATION		
HOW / BY WHOM/, WHAT / WHERE/, FREQUENCY		▸ The Civil Engineer to verify that the slopes are cut at the correct angle of repose, to visually inspect slopes for signs of failure and to inspect temporary shoring structures (weekly) for functionality and effectiveness. ▸ The Civil Engineer to oversee the construction of cut drains ▸ The HSE Manager to ensure the conduct of weekly inspections of the site to ensure that mitigation measures are being implemented. ▸ The Civil Engineer and HSE Officer to inspect all cut sections after significant rainfall events
SPECIALIZED EQUIPMENT OR MATERIAL		Inspection Checklist
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

10 AIR QUALITY

10.1 Introduction

This Chapter presents information on ambient air quality at the two sites, Hope Beach and Chapman's Grove, chosen for the installation of the proposed wind turbines (see Figure 2-4). A baseline air quality monitoring report prepared by Kaizen Environmental Services Limited is included as Appendix C.

10.2 Definitions and Scope

10.2.1 Scope

This chapter summarizes the findings of the ambient air quality monitoring conducted at Hope Beach and at Chapman's Grove in 2020 by Kaizen Environmental Service Limited (KESL) at 2 locations: one at Hope Beach and one at Chapman's Grove (see Figure 2-4). The potential air quality impacts of the construction and operational phases of the proposed wind farm are also discussed.

10.2.2 Definitions

Technical terms used in the ambient air quality monitoring reports and in this chapter are defined in Table 10-1:

TABLE 10-1: DEFINITIONS

TERM	DEFINITION
Particulate Matter ($PM_{2.5}$)	PM stands for particulate matter which is a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. $PM_{2.5}$ are fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.
Particulate Matter (PM10)	PM_{10} are inhalable particles, with diameters that are generally 10 micrometers and smaller
STEL	Short-term Maximum Permissible Level

10.3 Key Relevant Policy and Legislation

Section 3.9.3 details the legal framework related to air emissions that are applicable to the construction and operation of the wind turbines. The WHO sets recommended limits for health-harmful concentrations of key air pollutants both outdoors and inside buildings and homes, based on global synthesis of scientific evidence. Relevant parameters and their respective WHO Guideline limits are presented in Table 10-2 below.

TABLE 10-2: WHO AMBIENT AIR QUALITY GUIDELINES

Source: WHO Air Quality Guidelines, Global Update, 2005

PARAMETER	WHO GUIDELINE
$PM_{2.5}$	10 ($\mu g/m^3$) annual mean
	25 ($\mu g/m^3$) 24-hour mean
PM_{10}	20 ($\mu g/m^3$) annual mean
	50 ($\mu g/m^3$) 24-hour mean
	60 mg/m^3 for 30 minutes
	30 mg/m^3 for 1 hour
	10 mg/m^3 for 8 hours.

10.4 Existing Information, Baseline Studies

This section describes the ambient air quality at Hope Beach and Chapman's Grove based on field reconnaissance and the results of ambient air quality monitoring.

10.4.1 Sources of Air Emissions

Hope Beach and Chapman's Grove are both located in close proximity to the Demerara Berbice Highway. The movement of vehicles along this roadway as well as along unpaved secondary roads within the project area are the existing main sources of exhaust fumes and dust. Additionally, the construction of the seawall at Hope Beach is also a source of dust and exhaust from construction vehicles and equipment.

10.4.2 Monitoring Programme

Ambient air quality monitoring was conducted by Kaizen Environmental Service Limited (KESL) at Hope Beach and at Chapman's Grove from December 18-22, 2020. Two locations were monitored: one at Hope Beach and one at Chapman's Grove (see Figure 2-4). Parameters monitored included $PM_{2.5}$ and PM_{10}. A full description of the monitoring programme is included as Appendix C.

As noted in Section 10.5.1.1, dust is the most significant concern to ambient air quality during any construction project. During field surveys, it was noted that the proposed sites at Hope Beach and Chapman's Grove are both coastal with excellent dispersion characteristics but there were many sources of dust from unpaved lands and roadways as well as from existing construction works on the seawall. It was therefore necessary to measure the baseline concentrations of PM_{10} and $PM_{2.5}$. Exhaust emissions were not considered a significant concern as experience on previous projects suggests that, under local conditions (such as in open areas under constant breezes), these are not noticeable for more than about 20 m from the source (see Section 10.5.2.1).

10.4.3 Monitoring Results

The results of monitoring are shown in Tables 10-3 and 10-4 below:

TABLE 10-3: HOPE BEACH AMBIENT AIR QUALITY RESULTS

LOCATION	DATE	$PM_{2.5}$ (µg / m³)	PM_{10} (µg / m³)
HBA S3	Dec. 20th	8.2	15.0
HBA S2	Dec. 21th	6.3	13.0
HBS S1	Dec.22nd	8.0	14.1
WHO Guidelines		**25 (µg/m³) 24-hour mean**	**50 (µg/m³) 24-hour mean**

TABLE 10-4: CHAPMAN'S GROVE AMBIENT AIR QUALITY RESULTS

LOCATION	DATE	$PM_{2.5}$ (µg / m³)	PM_{10} (µg / m³)
CHG AS1	Dec. 18th	8.2	15.0
CHG AS2	Dec. 19th	8.3	14.4
WHO Guidelines		**25 (µg/m³) 24-hour mean**	**50 (µg/m³) 24-hour mean**

At both locations, the 24-hour average concentrations obtained for Particulate Matter ($PM_{2.5}$ and PM_{10}) were in compliance with the WHO guidelines.

10.5 Impact Prediction and Assessment

This section discusses the potential air quality impacts associated with this proposed project during the construction phase. There are no activities during the operation / maintenance phase that are expected to contribute to impaired air quality. Instead, the operation of the wind turbines is expected to have a beneficial reduction of emissions due to conventional methods of electricity generation and thus contribute to Guyana's Green State Development Strategy to achieve 100% renewable energy by 2025 (see Section 7.1.2.1).

Air quality concerns during the site preparation and construction phases of this project relate to:

- Dust from cleared areas, earthworks and stockpiling and transportation of materials; and

- Exhaust emissions from vehicles.

These impacts will last only as long as there is site preparation or construction in progress on the site. The discussions of air quality below must be placed in the context of existing air quality (see Section 10.4). Specifically, in all instances the values obtained for particulate matter parameters (PM_{10} and $PM_{2.5}$) were significantly lower than the WHO guideline values.

10.5.1 Dust from Cleared Areas

10.5.1.1 Nature of Concern

Dust may arise from earthworks, material stockpiles and the movement of vehicles on unpaved surfaces on-site and on public roadways adjacent to the site. Dust is the primary air quality concern arising from cleared areas and the movement of construction vehicles and equipment. Dust is released into the air from the contact of tyres and working parts with the ground, particularly when equipment and vehicles travel over unpaved areas, thereby contributing to the 'kick-up' of dust into the air. In addition, dust may be blown off trucks transporting granular material to or from the site. Apart from dust being blown off trucks during transportation, dust could be blown from surfaces of exposed stockpiles of dirt and aggregates stored onsite, especially during dry and windy conditions.

Dust is a nuisance, causing discomfort among persons affected and also exacerbating illnesses such as asthma and bronchitis. Results from the socio-economic survey revealed that there are residents who do suffer from asthma and would therefore be vulnerable to elevated dust levels**.** At high concentrations, dust can also affect plants by coating the leaves and impeding photosynthesis. The potential impact of dust on air quality is most pronounced in the dry season.

10.5.1.2 Unmitigated Impact

Concerns for dust generation are greater where road works, clearing and excavations for foundations are proposed. The establishment of new roads will require the clearing of vegetation, resulting in the exposure of bare soil to wind. While both the Hope Beach and Chapman's Grove sites are vegetated, they are also coastal and there is therefore effective dispersal of emissions due to the wind speeds (see Section 19.3.3). While this impact is expected to be temporary, it is expected to extend beyond the project area

and have marked effects on social groups. Considering the number and nature of the receptors within the immediate area (and downwind at Hope Beach), the concerns relating to dust can potentially be significant and are therefore classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

10.5.1.3 Mitigation Measures

The following mitigation measures can be employed for the control of dust emissions from cleared areas and stockpiles:

- Clear only the area needed for construction, leaving vegetation in other areas intact as far as practical, thereby reducing the area from which dust can be formed.
- Pave or vegetate cleared areas as early as practical.
- Keep stockpiles to a minimum and use as soon as practical, thereby reducing a source of dust.
- Enforce traffic speed regulations within the construction zone as speeding along roads can contribute to dust emissions.
- Cover smaller stockpiles or store fine aggregates in bins or silos. This prevents exposure of material to the wind.
- Wash truck tyres before exiting the construction site onto existing paved roads, eliminating the chance for trapped earth to become suspended in the air as dust.
- During earthworks implement dust control measures at source, including frequently wetting bare surfaces and access ways, thereby limiting opportunities for the formation of atmospheric dust.
- Cover all transport vehicles (with tarpaulins etc.) moving materials and fill to and from the site to prevent material flying up from the load into the air as dust.
- Erect a dust barrier (preferably natural vegetation) to shield residential communities at Hope Beach.

The effective implementation of these mitigation measures is expected to reduce the intensity of the impact relating to dust and is classified as follows:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

10.5.1.4 Cumulative Impact

While it is expected that dust will be generated from other projects listed in Section 2.6, these construction sites are sufficiently far away that a cumulative impact with the construction activity for the wind farm does not arise. However, dust associated with the construction of the seawall to Unity is expected to result in a cumulative impact. Again, this impact is expected to be short-term lasting only as long as the construction phase. This impact is expected to be cumulative to the works at both Hope Beach and Chapman's Grove and is therefore classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

10.5.2 Exhaust Emissions from Vehicles

10.5.2.1 Nature of Concern

The existing major source of exhaust emissions along the proposed alignment is the movement of vehicles along the Demerara Berbice Highway which is considered to be moderately trafficked. Equipment and vehicles associated with site preparation and construction will emit carbon monoxide, carbon dioxide, sulphur dioxide, nitrogen oxides, volatile organic compounds and soot (dust). Exhaust fumes emanating from construction vehicles travelling along roadways or operating on-site could also be of

concern. Experience on previous projects suggests that, under local conditions (such as in open areas under constant breezes), these are not noticeable for more than about 20 m from the source. This is especially the case at Hope Beach and Chapman's Grove which are both coastal and subject to constant winds (see Section 19.3.3).

10.5.2.2 Unmitigated Impact

It is expected that a large fleet of vehicles will be required for the transport of the materials and equipment for the site preparation and construction. Over the estimated 10-month construction period an estimated 5,100 truckloads will be transported to the site, averaging 25 truckloads per work day, with peaks of up to 50 trucks per day during certain overlapping activities.

Table 10-5 below shows results of a traffic survey conducted in December of 2019 over a two-day period along the Demerara East Coast Main Road. Traffic was counted for both the SE bound and NW bound lanes by a team over a two-day period. During peak project transport truck traffic would increase some 6-8 vehicles per hour, and average at 3 to 4 vehicles per hour. This represents an increase of 0.8 – 1.2% of total vehicles during peak periods, and 1.0 – 2.0% during off-peak hours.

TABLE 10-5: TRAFFIC SURVEY RESULTS (DECEMBER 2019)

TIME	TRUCKS (VEHICLES/HR)	BUS/MINI-BUS (VEHICLES/HR)	CARS (VEHICLES/HR)	TOTAL (VEHICLES/HR)
Fri 16:30 - 18:30	136	156	415	707
Fri 20:00 – 21:30	46	68	230	344
Sat 07:00 – 11:30	78	103	308	489
Sat 17:00 – 18:30	70	96	341	507
Sat 20:00 – 21:30	28	69	257	354

Exhaust emissions from the passage and operation of vehicles and equipment is expected to have marked effects on several individuals. This may be exacerbated by the need to transport the extra wide and heavy loads such as the rotor blades at night to reduce the impact to commuters. At night, receptors that may be sensitive to reduced air quality due to respiratory illnesses are more likely to be at home. Notwithstanding the above, this impact will be temporary. Unmitigated, this impact can be rated as:

Hope Beach

Extent	Intensity	Duration	Classification
Regional	Medium	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Regional	Minor	Short Term	**MODERATE**

10.5.2.3 Mitigation Measures

It is recommended that the Contractor properly service all vehicles and equipment to ensure that there are no visible sooty emissions. Defective vehicles should be taken out to service and should not be permitted to operate until they are repaired. These mitigation measures are expected to effectively control the impact of impaired air quality due to exhaust emissions and the classification is therefore:

Hope Beach

Extent	Intensity	Duration	Classification
Regional	Very Small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Regional	Very Small	Short Term	**LOW**

10.5.2.4 Cumulative Impact

Impacts related to exhaust emissions are expected to be cumulative with the construction of the seawall to Unity. Again, this impact is expected to be short-term lasting only as long as the construction phase and there may be marked effects on several individuals. This impact is expected to be cumulative to the works at both Hope Beach and Chapman's Grove and is therefore classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Regional	Minor	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Regional	Minor	Short Term	**MODERATE**

10.6 Mitigation and Monitoring - Environmental Management Plan

10-6 POTENTIAL IMPACT	IMPAIRED AIR QUALITY (DUST)
MITIGATION MEASURES	▸ Clear only the area needed for construction, leaving vegetation in other areas intact as far as practical, thereby reducing the area from which dust can be formed. ▸ Pave or vegetate cleared areas as early as practical. ▸ Keep stockpiles to a minimum and use as soon as practical, thereby reducing a source of dust. ▸ Enforce traffic speed regulations within the construction zone as speeding along roads can contribute to dust emissions. ▸ Cover smaller stockpiles or store fine aggregates in bins or silos. This prevents exposure of material to the wind. ▸ Wash truck tyres before exiting the construction site onto existing paved roads, eliminating the chance for trapped earth to become suspended in the air as dust. ▸ During earthworks implement dust control measures at source, including frequently wetting bare surfaces and access ways, thereby limiting opportunities for the formation of atmospheric dust. ▸ Cover all transport vehicles (with tarpaulins etc.) moving materials and fill to and from the site to prevent material flying up from the load into the air as dust. ▸ Erect a dust barrier (preferably natural vegetation) to shield residential communities at Hope Beach.
ACTION BY	▸ EPC Contractor to ensure civil contractors implement all of above measures
TIMING	▸ Throughout the construction phase
SPECIALIZED EQUIPMENT OR MATERIAL	▸ Geotextile Material ▸ Tarpaulin

10-6	POTENTIAL IMPACT	IMPAIRED AIR QUALITY (DUST)
MONITORING / VERIFICATION		
HOW / BY WHOM/, WHAT / WHERE/, FREQUENCY		▸ The Civil QA/QC Engineer to ensure that the area to be cleared is not exceeded. ▸ HSE Manager to ensure conduct of daily inspections to ensure that all dust control measures are implemented and maintained in a complaints register. ▸ The HSE Manager to ensure monitoring of particulate air quality for TSP and PM_{10} fortnightly during the dry seasons and monthly during the wet seasons. ▸ HSE Manager to ensure weekly inspection of the site, that mitigation measures are effective and to review the complaints register.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register ▸ An air sampler with the ability to measure ambient dust concentrations and a laboratory with experience in providing the support required for the sampler.
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

10-7	POTENTIAL IMPACT	IMPAIRED AIR QUALITY (EXHAUST EMISSIONS FROM VEHICLES)
MITIGATION MEASURES		Properly service all vehicles and equipment to ensure that there are no visible sooty emissions. Defective vehicles should be taken out to service and should not be permitted to operate until they are repaired.
ACTION BY		▸ EPC Contractor to send vehicles and equipment for maintenance. ▸ Project Engineer and HSE Manager to implement all other measures.
TIMING		Throughout the construction phase
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/,WHAT / WHERE/, FREQUENCY		▸ Contractor's HSE Officer (in collaboration with the Project Engineer) to maintain a log book of records of vehicle and equipment maintenance. ▸ HSE Manager to maintain complaints register relating to exhaust emissions from the passage of vehicles and equipment.

10-7	POTENTIAL IMPACT	IMPAIRED AIR QUALITY (EXHAUST EMISSIONS FROM VEHICLES)
		▸ The HSE Manager to ensure daily inspections on the site and to note any instances of vehicles and equipment emitting abnormal quantities and quality of exhaust. The HSE Manager will also ensure the review of maintenance records for vehicles and equipment.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Log Book ▸ Inspection Checklist ▸ Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

11 SHADOW EFFECTS (FLICKERS)

11.1 Introduction

This chapter discusses the impacts of shadow flicker arising from the operation of these wind turbines, based on a report EMD International A/S, dated October 29, 2018 (see Appendix O).

11.2 Definitions and Scope

11.2.1 Definition

Shadow Flicker is described as "alternating changes in light intensity that can occur at times when the rotating blades of wind turbines cast moving shadows on the ground or on structures" (Priestly, 2011).

11.2.2 Scope of Work

EDM International's objectives vis-à-vis shadow flicker was to quantify the amount of shadow flicker which is predicted to arise from these turbines, and to recommend methods of reducing the amount of shadow flicker to tolerable limits.

11.3 Key Relevant Policy and Legislation

The results of this analysis were compared to the guidelines of the International Finance Corporation, which set a requirement that "the predicted duration of shadow flicker effects experienced at a sensitive receptor not exceed 30 hours per year and 30 minutes per day on the worst affected day, based on a worst-case scenario". This same requirement also appears in the Queensland (Australia) Wind Farm State Code (AECOM, 2016).

Other international guidelines are as follows:

COUNTRY / REGION	GUIDELINE	RECEPTOR
USA – National Level	30 hours/year 30 minutes/day	Occupied buildings
New Hampshire Model	30 hours per year on	Occupied buildings

COUNTRY / REGION	GUIDELINE	RECEPTOR
Small Wind Energy Systems Ordinance		
Wisconsin Wind Siting Rules, Public Service Commission of Wisconsin	Limit is 30 hours per year, Mitigation if impacts are above 20 hours per year	Limits applicable at nonparticipating residences, occupied community buildings, or for buildings planned to be built (plans for construction on file)
German Guideline (WEA-Schattenwurf-Hinweise)	Worst-case calculations (maximum astronomical shadow) o Maximum of 30 hours per year o Maximum of 30 minutes per day	Living rooms, lounges, bedrooms, classrooms in school buildings, offices laboratories and workplaces within a distance in which rotor blade covers at least 20% of the sun disk
Brasil	Worst case o 30 hours/year o 30 minutes/year	Sensitive buildings

11.4 Existing Information, Baseline Studies

Information used by EDM International in their analysis included:

- Design and Operating Information on the Turbines (height, blade dimensions, rotating speed, etc);
- Positions of the Sun over the course of a day and a year;
- Topography; and
- Positions and Heights of Mangrove Trees.

This information was obtained from the turbine manufacturer, other general sources and other members of the Study Team. No baseline studies were conducted specifically for the shadow flicker analysis.

11.5 Impact Prediction and Assessment

Shadow flicker is only a concern during the operation of the wind turbines.

11.5.1 Nature of Concern

Shadow flicker may occur when the sun is on the opposite side of a turbine from receptors, leading to moving shadows being projected to the receptor. The effect is most pronounced in buildings, when the flickering light enters through windows (AECOM, 2016; Parsons Brinkerhoff, 2011). It is commonly agreed that shadow flicker is a nuisance (Parsons Brinkerhoff, no date; Priestly, 2011); but there is a minor disagreement whether it can trigger epileptic episodes. One source (Parsons Brinkerhoff, 2011) indicates that it may trigger epileptic episodes among a very small fraction (< 0.1%) of the population. However, another source (Priestly, 2011) indicates that "shadow flicker effects created by wind turbines do not have the potential to trigger epileptic seizures", because the range of light flashes (cycles per second) produced by wind turbines is much lower than the range of light flashes that triggers epileptic seizures.

Factors affecting the effects of shadow flicker (AECOM, 2016) include:

- Direction and Distance of the Affected Property relative to the turbine (the greater the distance, the less pronounced the effect will be).
- Wind Direction, which determines the orientation of the turbine blades relative to the sun and hence the shape of the shadow.
- Turbine Height and Rotor Diameter.
- Time of Year and Day, which determines the position of the sun in the sky.
- Weather Conditions, because cloud cover reduces the occurrence of shadow flicker.

As noted above, it is commonly agreed that shadow flicker is a nuisance. A review of guidelines in various jurisdictions revealed that all were in relation to residential buildings, offices or schools (see Section 11.3). None of these guidelines make any reference to motorists. There are no specific guidelines to address the potential impact of shadow flicker on motorists cast by wind turbines across roads. The concern for both residents and motorists would be whether there is the likelihood of shadow flicker triggering epileptic episodes which is addressed above. It is expected that the mitigation measure of temporarily shutting down the turbines whose cumulative shadow flicker results in exceedence of the guideline values will ensure compliance with the IFC standard and the potential for nuisance as a result of shadow flicker is eliminated.

11.5.2 Unmitigated Impact

Without any mitigation, this impact is expected to be long term in duration lasting for the life of the turbines. It is expected that this impact would be minor having marked effects on a few individuals who may be disturbed by the nuisance. The socio-economic surveys did not reveal any particular group that may be susceptible to more significant effects of shadow flicker. This impact is therefore classified as:

Extent	Intensity	Duration	Classification
Regional	Minor	Long Term	**HIGH**

11.5.3 Mitigation Measures

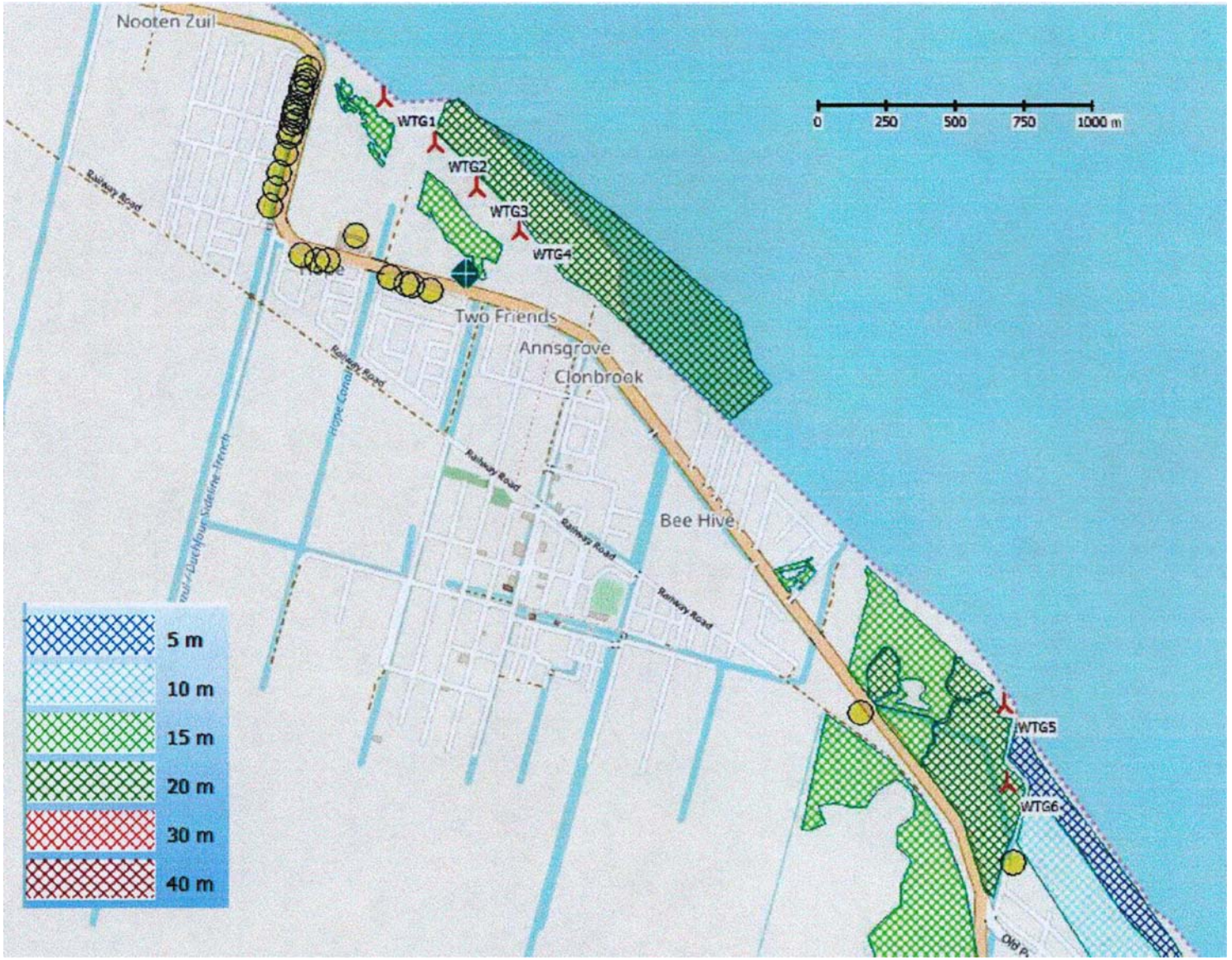
A total of 28 buildings were selected for analysis, representing those most likely to experience significant shadow flicker (see Figure 11-1). Calculation of the potential shadow impact at each receptor was carried out by simulating the position of the sun relative to the WTG rotor disk.

The resulting shadow was calculated in steps of 1 minute throughout a complete year. If the rotor disk (assumed to be solid) casts a shadow on a receptor at any time, this was registered as 1 minute of potential shadow impact. Furthermore, the calculation is done for a worst-case scenario; that is, assuming:

- astronomical maximum shadow,
- sky always clear of clouds, and
- turbine rotors always perpendicular to each receptor.

These results therefore represent the maximum potential risk of shadow impact.

The results of this analysis are listed in Table 11-1, which show that without mitigation there will be significant exceedences of the hours per year guideline in Section 11.3.



SOURCE: EMD INTERNATIONAL A/S, 2020

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ECO REPORT NO.	05/2020
DATE:	03/12/21
CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	TURBINES AND THE SELECTED SHADOW RECEPTORS
FIGURE NUMBER:	11-1

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TABLE 11-1: SHADOW FLICKER RESULTS

BUILDING	SHADOW HOURS PER YEAR WITHOUT CURTALMENT	AFTER CURTAILMENT	
		HOURS PER YEAR	MAX. HOURS PER DAY
A	194:42	00:00	00:00
B	262:88	00:31	00:02
C	299:53	4:05	00:07
CHG1	00:00	00:00	00:00
D	316:70	5:39	00:09
E	304:67	6:54	00:08
F	307:55	6:38	00:08
G	319:77	4:32	00:08
H	340:95	02:55	00:03
I	351:65	03:19	00:03
J	389:84	02:40	00:05
K	396:02	02:49	00:05
L	405:44	9:43	00:07
M	384:28	04:25	00:09
N	350:02	10:46	00:10
O	331:46	11:02	00:09
ON1	162:34	00:00	00:00
P	220:06	00:55	00:03
Q	144:34	5:08	00:12
R	170:51	00:00	00:00
S	152:20	16:03	00:23
T	114:72	03:23	00:05
U	107:35	1:13	00:02
V	102:38	00:20	00:01
W	132:20	00:00	00:00
X	105:01	6:50	00:09
Y	91:85	6:50	00:09
Z	18:21	00:00	00:00

The only way to mitigate this impact is by temporarily shutting down the turbines whose cumulative shadow flicker results in exceedence of the guideline values. This is done in an iterative process at each receptor, until the violation is eliminated. The results of such curtailment are also shown in Table 11-1. Since the impact of flicker only occurs for particular times of day and year, curtailment will be limited to those times. As a result, the loss of electricity production due to curtailment will be of the order of 4% per year.

The effective implementation of the mitigation measure will effectively eliminate this impact. Therefore, classification with mitigation is not appropriate.

11.6 Mitigation and Monitoring – Environmental Management Plan

L.6.1.10	POTENTIAL IMPACT	SHADOW FLICKER
MITIGATION MEASURES		Temporary shutdown the turbines whose cumulative shadow flicker results in exceedence of the guideline values.
ACTION BY		▸ Asset Manager Engineer
TIMING		▸ Throughout the operation phase
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/, WHAT / WHERE/, FREQUENCY		▸ The Wind Farm General Manager to verify the curtailment schedule. ▸ The Community Liaison Officers to record any complaints regarding shadow flicker concerns.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

12 NOISE AND VIBRATIONS

12.1 Introduction

This Chapter presents information on noise at the two sites, Hope Beach and Chapman's Grove, chosen for the installation of the proposed wind turbines (see Figures 2-1 and 2-2). There are two Appendices attached as follows:

- Appendix O: Environmental Impact Assessment: Noise, Shadow Flicker, Safety Distances (EMD International A/S); and
- Appendix P: A Review of: The Nature of Wind Turbine Sound, Health and Annoyance Impacts from Wind Turbine Noise and Infrasound, and International and Regional Wind Farm Noise Emissions Regulations.

In addition, baseline noise monitoring reports prepared by Kaizen Environmental Services Limited are included as a separate pdf document.

Vibration concerns are not addressed in this Chapter since, as noted in Appendix P, vibration effects at the low and ultra frequency levels are not strong enough even at short distances from WTG's to result in sensory perceptions.

12.2 Definitions and Scope

12.2.1 Scope

This chapter summarizes the findings of the Environmental Noise Monitoring conducted at Hope Beach in April, 2018 and at Chapman's Gove in June, 2020. Baseline noise level monitoring for the Hope Beach study area was conducted by Kaizen Environmental Service Limited (KESL) at 6 locations for 5 days (April 25 to 30, 2018) [see Figure 2-9]. Baseline noise level monitoring for the Chapman's Grove study area was conducted by KESL at three locations over the period June 01 to 12, 2020 with monitoring ranging from two to four days per location [see Figure 2-10].

Based on observations from the 2018 fieldwork up to present, variations in the residential neighbourhood layouts, land-use, road networks and traffic are not significant. No changes were observed in the study area which would contribute to new significant sources of noise pollution. We therefore respectfully suggest that the noise monitoring conducted is representative of baseline conditions at this present time.

The potential noise and vibration impacts of the construction and operational phases of the proposed wind farm are also discussed. Operational phase impacts are discussed based on the findings of noise modelling conducted by EMD International.

12.2.2 Definitions

Technical terms used in the Environmental Noise Monitoring Reports and in this chapter are defined in Table 12-1:

TABLE 12-1: DEFINITIONS

TERM	DEFINITION
Equivalent Continuous Sound Pressure Level (L_{eq}, L_{Aeq}, L_{avg})	This is the steady sound level which over a given period of time has the same energy as the fluctuating noise. It is measured in decibels (dB). For the purpose of this Chapter and the Noise Monitoring Reports, L_{eq}, L_{Aeq} and L_{avg} all denote the A-weighted continuous sound pressure level which is measured in dBA.
Peak Sound Pressure Level (L_{peak})	This is a measurement of the maximum instantaneous sound pressure at a specified location. It is measured in decibels (dB). For the purpose of this Chapter, the maximum L_{eq} values will be taken as the peak sound pressure levels.

12.2.3 Decibel Scale

The decibel scale dB is a logarithmic representation of sound intensity or pressure levels measured in Pa.

For reference, the following are some examples of various noise levels and their effect on the observer (CDC, 2019):

- Sounds at these levels typically do not cause any hearing damage:
  - Ticking Watch – 20 dB ($2x10^{-4}$ Pa)
  - Normal Conversation – 60 dB ($2x10^{-2}$ Pa)

- The observer may feel annoyed by this noise:
  - Washing machine – 70 dB ($6.3x10^{-2}$ Pa)
  - Traffic (inside car) – 80-85 dB ($2.0x10^{-1}$ - $3.5x10^{-1}$ Pa)

- Hearing loss possible in less than 5 minutes:
  - Loud entertainment venues – 105-110 dB (3.6 - 6.3 Pa)

- Pain and ear injury:
  - Standing beside or near sirens – 120 dB (20 Pa)
  - Firecrackers – 140-150 dB (200 – 632 Pa)

The following is a hierarchy showing the sensitivity of the ear to changes in the decibel level:

- 1dB change - is barely noticeable,
- 3dB change – most observers will notice this change,
- 5dB change - this is an obvious change (this change is clearly observed)
- 10 dB change – this change is perceived as a doubling/halving of the noise level (note that the sound pressure levels change by a factor of 10),

The examples below demonstrate how the observed noise level varies when sounds are summed:

1. Summation of two equal noise levels:
   40 dB + 40 dB = 10^4+10^4= 20,000 = $10\log_{10}(20,000)$ = 43dB

The change is 3 dB.

50 dB + 50 dB = 10^5+10^5 = 200,000 = $10\log_{10}(100,000)$ = 53dB

The change is 3 dB. This noise level change is sufficient for most persons to perceive a slight change in noise levels.

2. Summation of two sound levels, one perceived as twice as loud as the other:
   40 dB + 50 dB = $10^4 + 10^5$ = 110,000 = $10\log_{10}(110,000)$ = 50.5dB

The change with respect to the louder sound is not noticeable since the sum is almost the same as the level of the louder sound. Noise level changes below 1 dB are not perceptible by the human ear.

3. Summation of two sound levels with 5 dB difference, i.e. one perceived as significantly louder than the other:
   45 dB + 50 dB = $10^{4.5} + 10^{5}$ = 31,623 = $10\log_{10}(31{,}623)$ = 51.1dB

The total value is 1.1 dB greater than the level of the louder sound, which is a difference that is barely noticeable compared to the louder sound.

The ear recognises changes in sound pressure and as such averaging of data is done using sound pressure and not logarithmic decibel data (i.e. noise levels should not be averaged as decibel values.)

12.3 Key Relevant Policy and Legislation

This section summarises the legislative and regulatory framework under which the monitoring for the proposed project will be undertaken. Additional detail is provided in Chapter 3 of the EIA Report. Appendix P provides a comparison of national, regional and international noise emissions guidelines and standards.

The three pieces of applicable legislation which puts the results from monitoring into context are:

- Environmental Protection Agency (EPA) of Guyana, Environmental Management (Noise Regulations), 2000;
- Guyana National Bureau Standards, GYS 263: 2010 Guidelines for Noise Emissions into the Environment, (First Revision);
- World Health Organization (WHO) Guidelines for Community Noise (1999); and
- International Finance Corporation, World Bank Group, General Environmental Health and Safety Guidelines – Noise Management (IFC Noise Level Guidelines), 2007;

12.3.1 Environmental Management (Noise Regulations) 2000 and the Guidelines for Noise Emissions into the Environment (First Revision)

Noise emissions in Guyana are regulated, on the basis of the Environmental Management (Noise Regulations 2000), by the Environmental Protection Agency (EPA) of Guyana. The Schedule of the Regulations lists categories to which permissible noise levels are to be fixed. These permissible levels, which are not be exceeded, are defined in the Guyana National Bureau Standards 'GYS 263: 2010 Guidelines for Noise Emissions into the Environment, (First Revision)' (see Table 12-2A). This standard does not stipulate an averaging time for noise measurements, so the 1-hour averaging time cited for the IFC guidelines (2007) were used here as well (see Section 12.3.4).

TABLE 12-2A: GUYANA NATIONAL BUREAU OF STANDARD GUIDELINES FOR NOISE EMISSIONS INTO THE ENVIRONMENT

CATEGORY	DAY-TIME LIMIT (DBA) (06:00 H – 18:00 H)	NIGHT-TIME LIMIT (DBA) (18:00 H – 06:00 H)
Residential	**75**	**60**
Institutional	75	60
Educational	**75**	**60**
Industrial	100	80
Commercial	80	65
Construction	**90**	**75**
Transportation	**100**	**80**
Recreational	100	70

The proposed Hope Beach project site is located in proximity to residential communities and a school; thus, the residential and educational categories are applicable. The Chapman's Grove site is also located in proximity to a residential area. Limits for construction and transportation are also applicable to the construction phase of the project.

Part III of the Noise Regulations (2000), deals with restrictions on constructions activities:

"10. Construction activities, other than public works, that involve the operations of tools and equipment may be prohibited on the complain of a neighbour, even when permissible levels fixed to these regulations are not exceeded -

(a) between the hours of 11.00 p.m. and 6.00 a.m. from Monday to Saturday; and
(b) before 6.00 a.m. and 6.00 p.m. on Sundays.

11. Regulation 10 does not apply to operation of tools and equipment –

(a) in cases of emergency;
(b) for emergency work by a public utility service agency in the exercise of any of its functions;
(c) where such operation or use is required to eliminate or reduce any dangerous or hazardous condition, which endangers life or property."

12.3.2 EPA's Proposed Noise Limits for Wind Farms

Table 12-2B gives the day-time and night-limits noise emission limits which the EPA is considering for wind farms. Since the proposed noise limits do not specify the time periods for day-time and night-time, the periods quoted in the IFC Guidelines (Section 12.3.4), which are consistent for other jurisdictions, have been applied to these proposed guidelines; that is, daytime from 07:00 to 22:00 and nighttime from 22:00 to 07:00.

These proposed noise limits do not specify the averaging time for continuous noise monitoring, nor the elevation for such monitoring. It was therefore assumed that these parameters would be as set out in the IFC EHS Guidelines for Wind Energy (2015); that is, that background noise should be measured over a series of five or more 10-minute intervals for each integer of wind speed at 10 m reference height between cut-in wind speed and maximum output wind speed of the wind turbines.

As required by the EIA terms of reference, Appendix P, presents a comparison of international and regional limits and suggests the EPA might give consideration to a night-time limit of 50 dBA and daytime limit of 55 dBA for wind farm development near residential and mixed residential/commercial areas. For the purposes of the impact analysis for the proposed wind farm, the limits used are 45 dBA and 50 dBA for night-time and daytime, respectively (see Section 12.5.2) and 50 dBA outside the school, which is more restrictive than the WHO 1999 guideline of 55 dBA for schools outdoors.

TABLE 12-2B: PROPOSED EPA NOISE LIMITS FOR THE PROPOSED WIND FARM

CATEGORY	DAY-TIME LIMIT (DBA)	NIGHT-TIME LIMIT (DBA)
Residential	50	45
Educational	50	45

12.3.3 World Health Organization Guidelines for Community Noise (1999)

The World Health Organization (WHO) Guidelines for Community Noise (1999) values are summarized according to specific environments and effects. These guideline values take into consideration the identified health effects and are set based on the lowest level of noise that can affect health for general populations. By contrast, guideline values for annoyance represent daytime levels below which a majority of the

adult population will be protected from becoming moderately or seriously annoyed, respectively.

The available knowledge of the adverse effects of noise on health is sufficient to propose guideline values for community noise for the following:

- Annoyance.
- Speech intelligibility and communication interference.
- Disturbance of information extraction.
- Sleep disturbance.
- Hearing impairment.

The different critical health effects are relevant to specific environments, and guideline values for community noise are proposed for each environment. These are:

- Dwellings, including bedrooms and outdoor living areas.
- Schools and preschools, including rooms for sleeping and outdoor playgrounds.
- Hospitals, including ward and treatment rooms.
- Industrial, commercial shopping and traffic areas, including public addresses, indoors and outdoors.
- Ceremonies, festivals and entertainment events, indoors and outdoors.
- Music and other sounds through headphones.
- Impulse sounds from toys, fireworks and firearms.
- Outdoors in parkland and conservation areas.

The guidelines state that it is not enough to characterize the noise environment in terms of noise measures or indices based only on energy summation (e.g. LAeq), because different critical health effects require different descriptions. Therefore, it is important to display the maximum values of the noise fluctuations, preferably combined with a measure of the number of noise events. A separate characterization of noise exposures during night-time would be required. For indoor environments, reverberation time is also an important factor. Table 12-3 below shows the limits for schools (outdoor and indoor) and parklands.

TABLE 12-3: WORLD HEALTH ORGANIZATION (1999)
LIMITS FOR SCHOOLS (OUTDOOR AND INDOOR) AND PARKLANDS

SPECIFIC ENVIRONMENT	CRITICAL HEALTH EFFECTS	LA_{eq} (dB)	TIME BASE (HRS)	LA_{max} (dB)
School class rooms and pre-schools, indoors	Speech intelligibility, disturbance of information extraction, message communication	35 - 	during class	--
School, playground outdoor	Annoyance (external source)	55	during play	--
Outdoors in parkland and conservation areas	Disruption of tranquillity	existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low;		
Residential – Outdoor	Serious annoyance	55	16	--
Residential – Bedroom (inside)	Sleep disturbance (night time)	30	8	45
Residential – Bedroom (outside)	Sleep disturbance (night time)	45	8	60
Outdoor living area	Serious annoyance, daytime and evening	55	16	--

12.3.4 International Finance Corporation, World Bank Group, General Environmental Health and Safety Guidelines – Noise Management 2007

The General Environmental Health and Safety Guidelines – Noise Management, of the International Finance Corporation (IFC), World Bank Group (WBG) provides guidance on noise emissions. These limits are based on guidance set by the WHO in 1999. The IFC also provides guidelines as it relates to wind farm noise emissions (2015), specifically on measurement of background noise whilst accounting for wind speed, as both wind turbine and background noise generally increase with increasing wind speed. According to these guidelines, noise impacts should not exceed the levels presented in Table 12-4, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

For the purpose of this project, the noise levels recorded during the baseline monitoring constitute the background noise levels and therefore the proposed project must not generate noise that exceeds 3 dB above these levels if the background noise is equal to or greater than the daytime or nighttime limits. The night time period is defined between 22:00 h and 07:00 h and is used for all noise analysis in this chapter, as this corresponds to the typical sleep period, is the most critical time for quiet and is in line with majority of noise guidelines for other jurisdictions. The IFC guidelines also state that a project cannot exceed the IFC limits, or the limits required by the project country regulator, whichever is the most conservative. In instances where the background levels are higher than the IFC Guidelines, the IFC Guideline limit is set by the background noise level.

TABLE 12-4: INTERNATIONAL FINANCE CORPORATION, WORLD BANK GROUP (IFC) NOISE LEVEL GUIDELINES

RECEPTOR	ONE HOUR L_{Aeq} (dBA)	
	DAYTIME (07:00 – 22:00)	NIGHT-TIME (22:00 – 07:00)
Residential, Institutional, Educational	**55**	**45**
Industrial, Commercial	70	70

This proposed project must meet the IFC guidelines, and also must meet the project country guidelines, whichever is the most conservative, in order to qualify for financing. In this case, as the EPA's proposed 50 dBA daytime limit is more conservative, IFC requires the use of the more restrictive 50 dB daytime limit. The proposed Hope Beach

project site is located in proximity to residential communities and a school; thus, the residential, institutional and educational category is applicable. The Chapman's Grove site is also located in proximity to a residential area.

12.4 Existing Information, Baseline Studies

This section summarises the baseline noise level monitoring events at Hope Beach (6 locations for 5 days) and Chapman's Grove (3 locations for 2-4 days) in April 2018 and June 2020, respectively (see Figures 2-9 and 2-10). Monitoring was carried out by Kaizen Environmental Service Limited (KESL); see Baseline Noise Monitoring Reports.

12.4.1 Method Statement

The method used for the noise monitoring is summarised under the following sub-sections:

- Monitoring Locations and Schedule;
- Environmental Setting;
- Equipment;
- Data Processing; and
- Quality Control.

12.4.1.1 Monitoring Locations and Schedule

Noise monitoring was conducted by KESL at 6 locations at Hope Beach for 5 days (April 25 to 30, 2018) [see Table 12-5 and Figure 2-9]. These sites are representative of the nearest residential receptors (HB 1 and HB 3-HB 6) and the Hope Secondary School (HB 2), and were selected by HEDI's wind engineering consultant in-line with recognized industry practice. Ambient noise monitoring was conducted in accordance with World Bank guidelines. This provided guidance on duration or monitoring, choice of monitoring location and equipment to be used for monitoring. Ambient noise measurements were made at locations representative of all the closest residential receptors and the school, and in additional receptors were chosen further away from the main road and away from residential areas.

At Chapman's Grove, monitoring was carried out by KESL at 3 locations over the period June 01 to 12, 2020 as follows: four days at CHG 1 (June 01-05) and two days CHG 2 (June 08-10) and CHG 3 (June 10-12). CHG 1 is the nearest residential receptor while the other two sites represent background noise of a natural beach ridge zone (CHG 2), and an agricultural zone (CHG 3) away from residential areas and close to the wind

turbines (see Table 12-6 and Figure 2-10). The monitoring locations were again selected by HED's wind engineering consultant.

Monitoring was conducted for Equivalent Continuous Sound Pressure Level (L_{eq} or L_{avg}) with noise measurements logged at 1-minute intervals for 24-hour periods over the course of the monitoring period (5 days for Hope Beach and 2-4 days for Chapman's Grove). Wind speed data coinciding with the various noise monitoring timeframes were obtained from the HED 87 m met-mast which is close to Location HB 5 and is representative of the entire study area (see Figure 2-9).

TABLE 12.5: MONITORING LOCATIONS AND SCHEDULE FOR HOPE BEACH

LOCATION	DATE	DISTANCE TO NEAREST WIND TURBINE (M)	CATEGORY	DESCRIPTION	GPS COORDINATES WGS, ZONE 21 N
HB 1	Wed. Apr. 25 – Mon. Apr. 30, 2018.	325	Residential (Lowlands)	Across the road from wetland, 250m south of flood control pumps.	0394332 E 0745470 N
HB 2		454	Educational (Hope Secondary School)	Site borders the wetland and is a non-residential location, only occupied during the daytime. This was the quietest location.	0394494 E 0745058 N
HB 3		382	Residential (Douch Four)	Located next to a construction site where house-building activities were taking place on weekdays.	0394828 E 0744829 N
HB 4		290	Residential (Two Friends)	Close to small church, wash bay and shop.	0395059 E 0744760 N
HB 5		542	Residential (Clonbrook)	Close to a drainage	0395421 E 0744571 N

LOCATION	DATE	DISTANCE TO NEAREST WIND TURBINE (M)	CATEGORY	DESCRIPTION	GPS COORDINATES WGS, ZONE 21 N
				canal.	
HB 6		915	Residential (Clonbrook)	Close to sawmill, which was not in operation during the survey period.	0395747 E 0744350 N

TABLE 12.6: MONITORING LOCATIONS AND SCHEDULE FOR CHAPMAN'S GROVE

LOCATION	DATE	DISTANCE TO NEAREST WIND TURBINE (M)	CATEGORY	DESCRIPTION	GPS COORDINATES WGS, ZONE 21 N
CHG 1	Mon. Jun. 01 – Fri. Jun. 05, 2020.	270	Residential (Unity)	Residence closest to Chapman's Grove site. Located along northern boundary of residential area. Has a goat pen.	0396950 E 0742771 N
CHG 2	Mon. Jun. 08 – Wed. Jun. 10, 2020.	120	Rural*	Beach ridge with nearby informal cremation site	0397033 E 0743046 N
CHG 3	Wed. Jun. 10 – Fri. Jun. 12, 2020.	235	Rural*	Agricultural area, on old drainage embankment on western edge of mangrove, approximately 60-70m from seawall.	0396714 E 0743463 N

* CHG 2 and CHG 3 will be compared to guidelines for residential receptors/areas since neither the IFC nor Guyana has noise limit guidelines for rural areas.

12.4.1.2 Environmental Setting

Hope Beach

Table 12-5, gives the potential sources of noise in proximity to each monitoring locations. The flood control pumps at HB 1 which previously impacted the entire neighbourhood has been recently replaced by a new pump house and electric pumps. Any noise associated with these pumps is considered part of the regular background noise. The school site (HB 2) is located towards the wetland boundary, away from the noisy playground fields. The construction site adjacent to HB 3 did not include activities that are considered especially noisy. Construction activities at this site took place during the weekdays only. There was no sawmilling activity at HB 6 during the monitoring. Additionally, HB 1 and HB 3-HB 5 are located in proximity to the Demerara Berbice Highway (see Figure 2-9), therefore traffic is a source of noise during the day and evening.

The main sensitive receptor in the Hope Beach study area is the Hope Secondary School in proximity to HB 2. Apart from this, the area is mostly residential with communities such as Lowlands, Hope, Douch Four, Two Friends and Clonbrook (see Figure 2-9).

Chapman's Grove

Tidal action (breaking waves) was the main source of background noise at the three monitoring locations in the Chapman's Grove study area. The main sensitive receptor is at CHG 1 which is the closest residence to this project site and is located along the northern boundary of the nearby residential area (see Table 12-6 and Figure 2-10). Other potential sources of noise at this location include goats, residential activities and vehicles. CHG 2 and CHG 3 are vegetated rural sites that are not in close proximity to any residential areas (Table 12-6 and Figure 2-10). CHG 2 is a beach ridge with a nearby informal cremation site and therefore other potential noise sources may include cremation activities and vehicles which were not present during the survey. CHG 3 is located on an old drainage embankment separating agricultural lands from a mangrove stand, approximately 60-70m from the seawall. Other potential noise sources at this location include faunal sounds and other natural noises.

12.4.1.3 Equipment

Two models of sound levels meters were used:

- Quest Sound PRO DL Integrating/Data Logging Sound Level Meter (used at Locations HB 1 and HB 3-HB 6); and
- Pulsar Nova Model 43 Sound Level Meter (used at HB 2 and CH1,2 &3).

Both these meters meet the standards required for undertaking environmental monitoring of the type conducted at both Hope Beach and Chapmans Grove (see Section 1.2 of Appendix H for Hope Beach and Section 1.2.2 of Appendix H for Chapmans Grove).

12.4.1.4 Data Processing

Average Noise Levels

As noted earlier (see Section 12.3.1), the Guyana General Guidelines do not define the averaging time to be used for continuous noise monitoring, so a 1-hour averaging time was used as prescribed in the IFC EHS Noise Guidelines (2007). 1-hour averages were calculated from the raw L_{eq} data (1-min. averages) and these values were compared to the Guyana National Bureau of Standards 2010 Guidelines for Noise Emissions into the Environment for the residential and educational categories see Section 12.4.2, Table 12-7A and Section 12.4.3, Table 12-12A).

The Guyana proposed wind turbine guidelines (see Section 12.3.2) do not define the averaging time to be used for continuous noise monitoring, so a 10-minute averaging time was used as prescribed in the IFC EHS Guidelines for Wind Energy (2015). 10-min averages were calculated from the raw L_{eq} data (1-min. averages) and these values were compared to the Guyana proposed wind turbine guidelines for the residential and educational categories see Section 12.4.2, Table 12-7B and Section 12.4.3, Table 12-12B).

Effect of Wind Speed

For noise data, 10-minute averages were calculated from the raw L_{eq} data (1-min. averages). Data collected during rainfall was discarded as these represented anomalous readings that were 5 dBA over the 10-minute average levels. For Hope Beach and Chapman's Grove, over 95% and 96%, respectively, of the data collected was useable therefore the surveys had very good data acquisition.

The remaining data were then aligned in time with the 10-minute wind speeds recorded by the local mast at 87 m a.g.l. (extrapolated to 10 m according to the international Standard ISO 9613-2 (ISO, 1996) and following the procedures from the UK Institute of Acoustics (2013). In this way, a time series of 10-minute noise records at each monitoring locations was obtained, concurrent to wind speeds records at 10 m. Finally, for each wind speed bin of 1 m/s and two diurnal periods (day, 07:00-22:00 and night, 22:00-07:00) averages of these noise data were calculated (see Section 12.4.2: Tables 12-8 and 12-9 and Section 12.4.3: Table 12-13).

These timeframes (day, 07:00-22:00 and night, 22:00-07:00) are stated in the International Finance Corporation, World Bank Group (IFC) Guidelines. The night-time 2200 h – 0700 h time has been used throughout the "Hope Wind Farm Guyana – Environmental Impact Assessment: Noise Shadow Flicker, Safety Distances" prepared by EMD International A/S (see Appendix O), as this corresponds to the typical sleep period, and is the most critical time for quiet and is in line with majority of noise guidelines for other jurisdictions.

At each location, for the various wind speeds, the average noise levels (10-min. averages) were compared to the Guyana proposed wind turbine guidelines (10-min. averages) for residential and educational categories (see Section 12.4.2: Tables 12-8 and 12-9 and Section 12.4.3: Table 12-13).

Peak Noise Levels

The Draft Terms of Reference and Scope for this project requires a discussion of peak noise levels. Monitoring did not include peak values (L_{peak}) therefore the highest 1-minute average noise levels for daytime (7am – 10pm) and night-time (10pm – 7am) (as defined by the IFC Guidelines) were taken as representative of peak levels. Since neither the IFC Guidelines nor the Guyana Guidelines set peak limits, the peak values are discussed in terms of absolute values rather than by comparison to standards or guidelines (see Section 12.4.2: Tables 12-10 and 12-11 and Section 12.4.3: Table 12-14).

12.4.1.5 Quality Control

The sound level meters are factory calibrated annually (see Baseline Noise Monitoring Reports for calibration certificates). In addition, prior to the start of monitoring, and at set periods throughout the survey the microphones of the meters were field calibrated. KESL's technicians are trained and experienced in the use of the noise monitoring equipment. Calibration certificates are included in KESL's field reports.

12.4.2 Findings – Hope Beach

This section presents the findings of the noise monitoring conducted at Hope Beach under the following sub-sections:

- Average Background Noise Levels;
- Effect of Wind Speed;
- Peak Noise Level; and
- Summary of Findings.

The raw data is provided in the Baseline Noise Monitoring Report for Hope Beach.

12.4.2.1 Average Background Noise Levels

This sub-section discusses the average background noise levels at Hope Beach in the context of the Guyana National Bureau of Standards 2010 Guidelines for Noise Emissions into the Environment for the residential and educational categories as well as the Guyana proposed wind turbine guidelines for the residential and educational categories. The first are general noise standards, while the second are specific to wind turbines. Table 12-7A summarizes the exceedances of the General Guyana Noise Guidelines and is based on 1-hour average noise levels. Table 12-7B summarizes the exceedances of the Guyana proposed wind turbine guidelines and is based on 10-min average noise levels.

Day-time background noise levels were in compliance with the Guyana general daytime residential and educational limits of 75 dB at all locations with maximum 1-hour averages ranging from 56.9 dB (HB 2) to 66.0 dB (HB 4). There were exceedances of the Guyana general night-time residential and educational limits of 60 dB at all locations with maximum 1-hour averages ranging from 61.0 dB (HB 2) to 72.0 dB (HB 1). The highest percentage of exceedance (30%) was observed at location HB 4. At all other locations, the percentage exceedance was less than 12%. HB (school) was the quietest location while the residential locations HB 1 and HB 4 were the loudest. Both of these locations are in proximity to the Demerara Berbice Highway therefore traffic may be a contributing factor to their noise levels.

Measured background noise significantly exceeds the proposed Guyana wind turbine noise guidelines for daytime (50 dBA) and night-time (45 dBA) at all locations. The percentage exceedance of both day-time and night-time limits was greater than 90%, except at HB 2 (school) where 47% exceedances were noted during the day-time and 77% exceedances were noted at night and during the day-time at HB 6 where 78% exceedances were noted.

TABLE 12.7A: SUMMARY OF GUYANA GENERAL GUIDELINE EXCEEDANCES FOR HOPE BEACH BACKGROUND NOISE SURVEY (1-HOUR AVERAGING TIME)

LOCATION	NO. OF 1-HOUR AVERAGE VALUES	MAXIMUM VALUE (dBA)	GUYANA GENERAL GUIDELINES (dBA)	NO. OF EXCEEDANCES	PERCENTAGE OF EXCEEDANCES (%)
DAY					
HB1 (Residential)	59	63.5	75	0	0.00
HB2	58	56.9		0	0.00

LOCATION	NO. OF 1-HOUR AVERAGE VALUES	MAXIMUM VALUE (dBA)	GUYANA GENERAL GUIDELINES (dBA)	NO. OF EXCEEDANCES	PERCENTAGE OF EXCEEDANCES (%)
(School)					
HB3 (Residential)	59	64.3		0	0.00
HB4 (Residential)	59	66.0		0	0.00
HB5 (Residential)	59	62.8		0	0.00
HB6 (Residential)	56	60.0		0	0.00
NIGHT					
HB1 (Residential)	57	72.0	60	7	12.28
HB2 (School)	56	61.0		2	3.57
HB3 (Residential)	57	62.4		3	5.26
HB4 (Residential)	57	67.3		17	29.82
HB5 (Residential)	57	61.6		5	8.77
HB6 (Residential)	57	65.7		4	7.02

Note: Day-time – 06:00 to 18:00; Night-time 18:00 to 06:00

TABLE 12.7B: SUMMARY OF GUYANA PROPOSED WIND TURBINE EXCEEDANCES FOR HOPE BEACH BACKGROUND NOISE SURVEY (10-MINUTE AVERAGING TIME)

LOCATION	NO. OF 10-MINS AVERAGE VALUES	MAXIMUM VALUE (dBA)	GUYANA PROPOSED WIND TURBINE GUIDELINES (dBA)	NO. OF EXCEEDANCES	PERCENTAGE OF EXCEEDANCES (%)
DAY					
HB1 (Residential)	443	71.0	50	439	99.10
HB2 (School)	427	63.5		197	46.14

LOCATION	NO. OF 10-MINS AVERAGE VALUES	MAXIMUM VALUE (dBA)	GUYANA PROPOSED WIND TURBINE GUIDELINES (dBA)	NO. OF EXCEEDANCES	PERCENTAGE OF EXCEEDANCES (%)
HB3 (Residential)	438	71.0		396	90.41
HB4 (Residential)	422	69.3		412	97.63
HB5 (Residential)	430	66.2		400	93.02
HB6 (Residential)	424	68.9		329	77.59
NIGHT					
HB1 (Residential)	270	67.6	45	270	100.00
HB2 (School)	264	61.6		204	77.27
HB3 (Residential)	269	61.1		266	98.88
HB4 (Residential)	269	69.6		269	100.00
HB5 (Residential)	270	65.4		268	99.26
HB6 (Residential)	269	60.3		269	100.00

Note: Day-time – 07:00 to 22:00; Night-time 22:00 to 07:00

12.4.2.2 Effect of Wind Speed on Background Noise

This sub-section discussed the effect of wind speed on background noise levels at Hope Beach in the context of the IFC Noise Level Guideline methodology, and compares these to the EPA's proposed wind turbine noise limits for Guyana (Guyana WT Limits). Background noise typically increases with increasing wind speed, and wind turbine noise also is correlated with wind speed. Tables 12-8 and 12-9 are based on 10-minute average background noise levels and projected 10m reference height wind speeds. Wind speeds during night-time monitoring fluctuated between 3 – 9 m/s, therefore there was no data for wind speeds at 0 – 2 m/s and 10 m/s. Tables 12-8 and 12-9 give data for wind speed 3 – 9 m/s. Maximum noise output from the wind turbines occurs at wind speeds above 9 m/s at hub height (105m), which is equivalent to 7 m/s wind speed at the 10m reference height.

With the exceptions of HB 5, there was a weak relationship between average background noise level and wind speed (see Tables 12-8 and 12-9 and Figures 12-1 to 12-6). At HB 5 there appeared to be no relationship between average noise level and wind speed. These observations suggest that wind speed is not a very important contributing factor to background noise levels at the proposed Hope Beach project locations. Other sources contributed to the background noise levels at the various locations during the monitoring session are described in Section 12.4.1.2.

The proposed Guyana wind turbine noise limits (L_{Aeq}) for residential and educational receptors for daytime (50 dBA) and night-time (45 dBA) were used to put the results into context. As shown in Tables 12-8 and 12-9 and Figures 12-1 to 12-6, the daytime and night-time Leq background sound values at all monitoring locations generally exceeded the proposed Guyana wind turbine day-time and night-time limits.

At all locations the background night-time noise levels were generally lower in comparison to the day-time noise levels. The two quietest locations were HB 2 (school) and HB 6 (residential). These two monitoring locations are located further from the Demerara Berbice Highway compared to the other locations which may be a possible explanation for their overall lower noise levels (see Figure 2-9). Residential locations HB 1 and HB 4 were the noisiest sites. Both of these locations are in proximity to the Demerara Berbice Highway therefore traffic may be a contributing factor to their noise levels. Additionally, HB 1 is located in proximity to the Flood Control Pumps and HB 4 is located to a small church, wash bay and shop.

TABLE 12-8: AVERAGE DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEVELS VERSUS WIND SPEED AT LOCATIONS HB 1, HB 2 AND HB 3

WIND (m/s)	AVERAGE BACKGROUND NOISE LEVEL (dBA)					
	HB 1 (RESIDENTIAL)		HB 2 (SCHOOL)		HB 3 (RESIDENTIAL)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
1	59.8	-	50.3	-	58.9	-
2	60.3	-	49.3	-	51.6	-
3	61.4	-	47.5	-	59.4	-
4	60.4	55.7	52.2	45.5	55.4	48.5
5	61.8	58.2	50.9	46.7	58.7	52.6
6	63.8	57.9	52.6	48.1	58.7	54.4
7	62.0	59.4	54.1	49.9	57.2	53.4
8	60.6	60.9	54.2	52.3	59.5	53.1
9	61.9	63.2	-	53.9	61.2	53.2
W. Mean (dBA)	62.3	59.1	52.1	49.7	58.1	53.1
Range of Average	59.8 –	55.7 –	47.5 –	45.5 –	51.6 –	48.5 –

WIND (m/s)	AVERAGE BACKGROUND NOISE LEVEL (dBA)					
	HB 1 (RESIDENTIAL)		HB 2 (SCHOOL)		HB 3 (RESIDENTIAL)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Noise Levels (dBA)	63.8	63.2	54.2	53.9	61.2	54.4
Guyana Proposed Wind Turbine Guidelines	**50**	**45**	**50**	**45**	**50**	**45**

Note: Wind speed bins with less than five 10-minute measurements are below the minimum indicated by IFC (2015), and therefore are subject to a higher uncertainty and are highlighted in red.

TABLE 12-9: AVERAGE DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEVELS VERSUS WIND SPEED AT LOCATIONS HB 4, HB 5 AND HB 6

WIND (m/s)	AVERAGE BACKGROUND NOISE LEVEL (dBA)					
	HB 4 (RESIDENTIAL)		HB 5 (RESIDENTIAL)		HB 6 (RESIDENTIAL)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
1	64.1	-	61.5	-	52.0	-
2	63.9	-	60.9	-	51.0	-
3	61.0	-	57.5	-	52.0	-
4	59.6	53.6	58.8	54.0	51.7	47.8
5	59.7	55.8	60.5	57.0	52.9	49.7
6	59.4	56.3	59.9	54.4	54.9	50.9
7	60.6	60.1	57.8	55.8	57.6	52.0
8	61.6	62.6	55.8	51.8	57.3	53.9
9	61.8	63.3	60.3	50.6	59.6	54.5
W. Mean (dBA)	59.5	59.4	59.4	54.9	54.6	51.7
Range of Average Noise Levels (dBA)	59.4 – 64.1	53.6 – 63.3	55.8 – 61.5	50.6 – 57.0	51.0 – 59.6	47.8 – 54.5
Guyana Proposed Wind Turbine Guidelines	**50**	**45**	**50**	**45**	**50**	**45**

Note: Wind speed bins with less than five 10-minute measurements are below the minimum indicated by IFC (2015), and therefore are subject to a higher uncertainty and are highlighted in red.

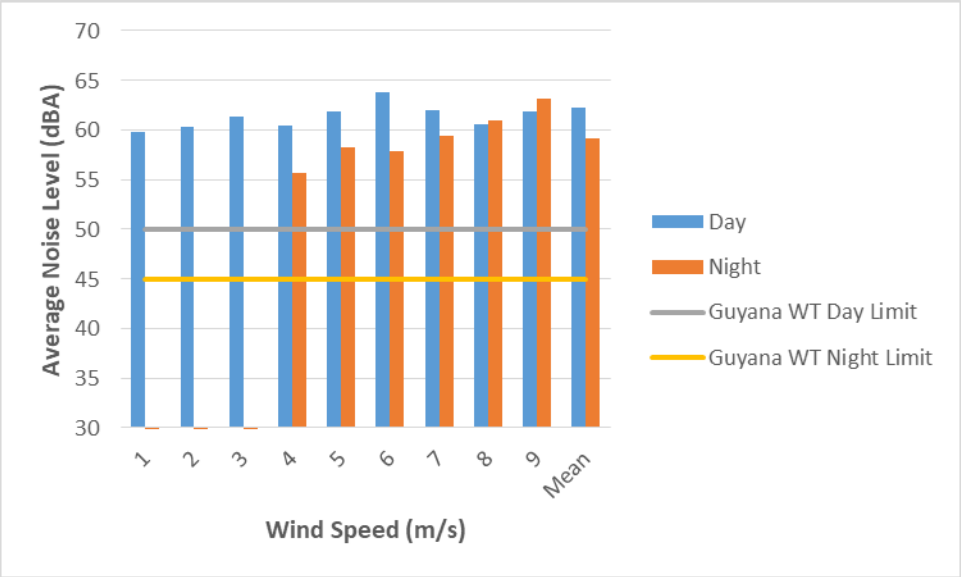

FIGURE 12-1: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 1 (RESIDENTIAL)

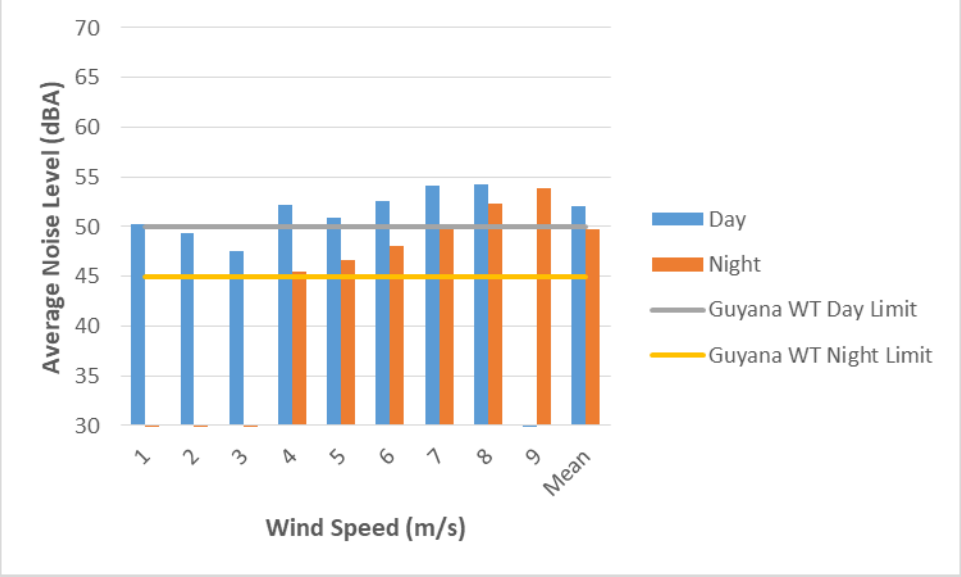

FIGURE 12-2: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 2 (SCHOOL)

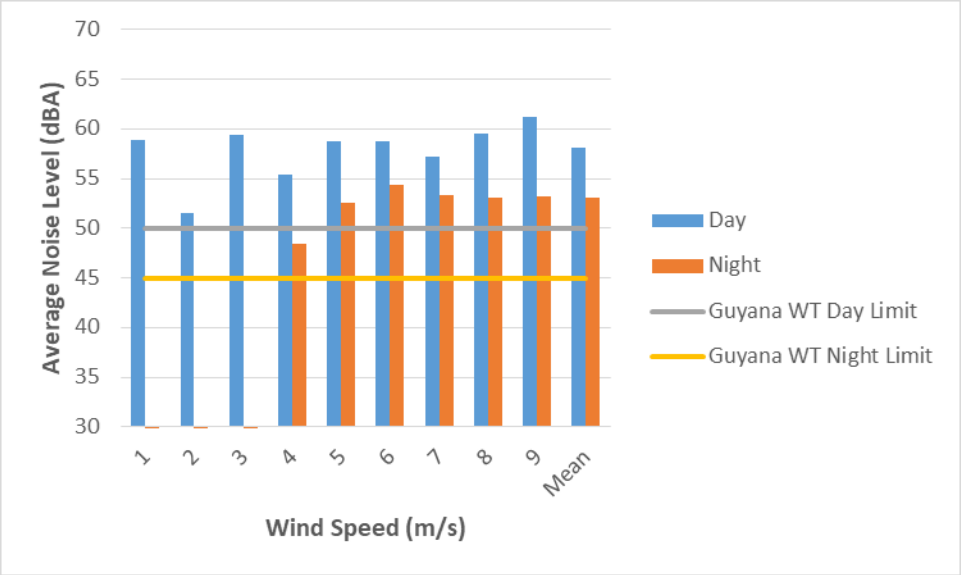

FIGURE 12-3: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 3 (RESIDENTIAL)

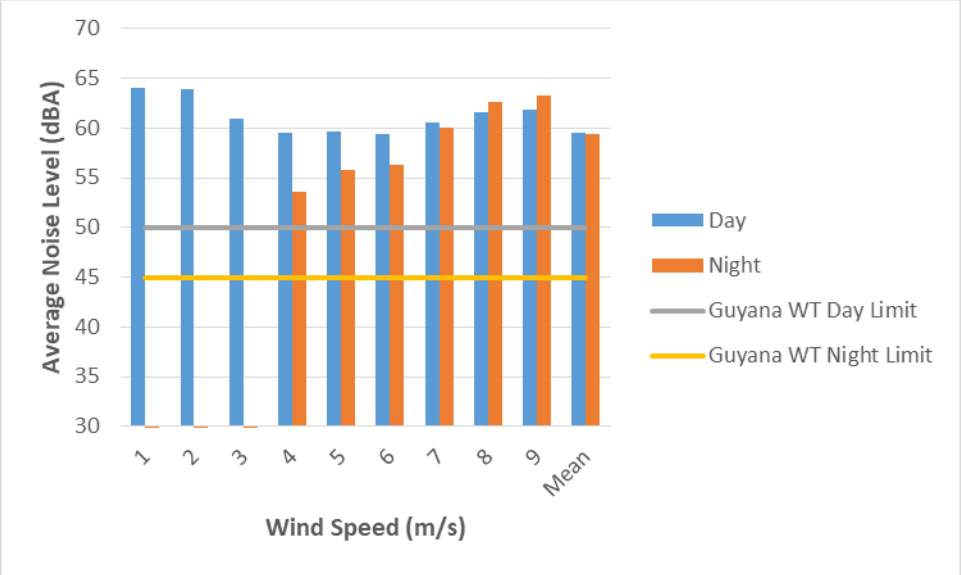

FIGURE 12-4: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 4 (RESIDENTIAL)

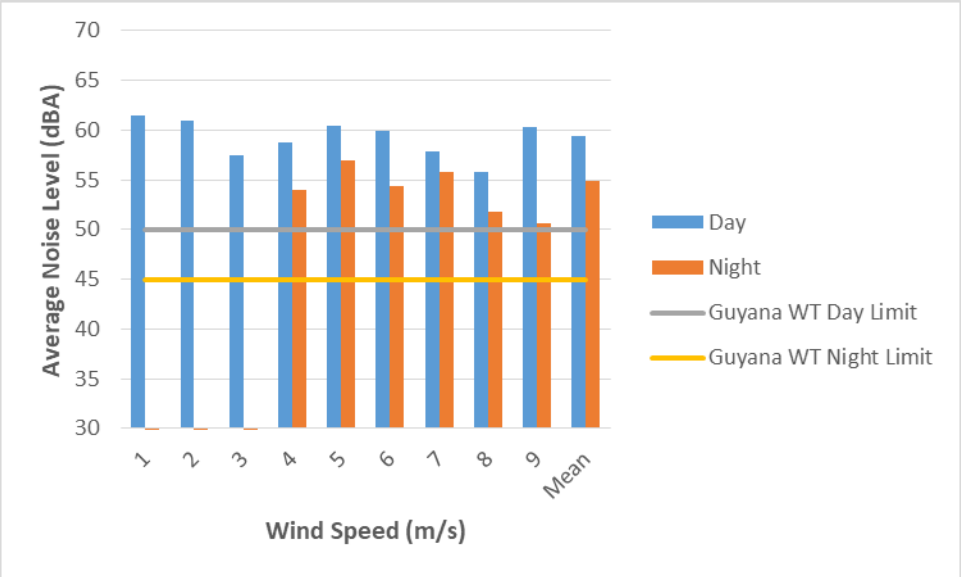

FIGURE 12-5: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 5 (RESIDENTIAL)

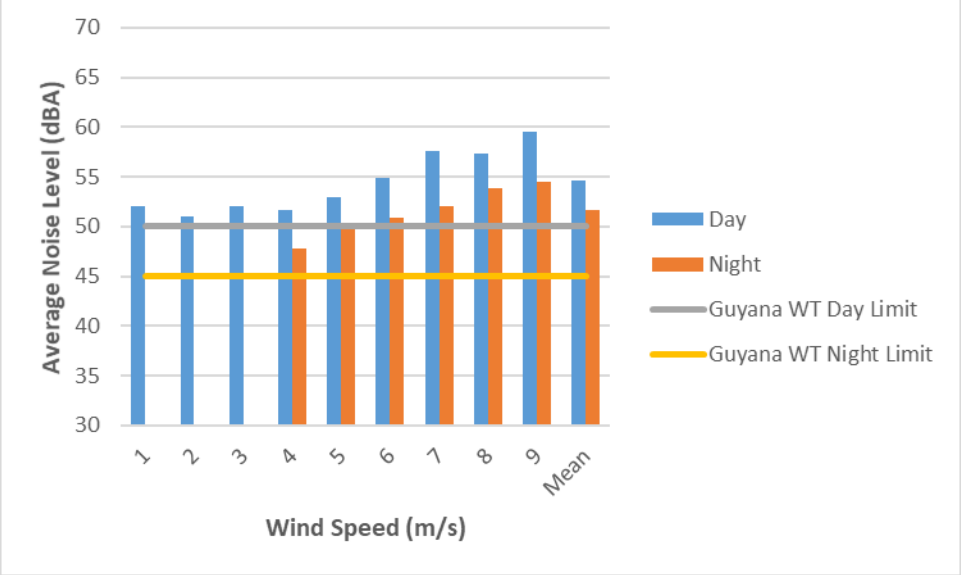

FIGURE 12-6: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT HB 6 (RESIDENTIAL)

12.4.2.3 Peak Background Noise Level

The highest 1-minute average noise levels for daytime (7am – 10pm) and night-time (10pm – 7am) were taken as the peak levels (see Tables 12-10 and 12-11). It should be noted that while the data is representative of the date stated, on some days a full 24-hrs of data was not collected. As noted in Section 12.4.1.1, monitoring for noise at Hope Beach was conducted at 6 locations for 5 days, while monitoring at Chapmans Grove was conducted for four days at CHG 1 and two days at CHG 2 and CHG 3. This resulted in many hours of useable monitoring data collected at Hope Beach and Chapmans Grove (see Table 1 in Appendix H for Hope Beach and Chapmans Grove). This far exceeds the requirements for baseline noise monitoring as set out in the IFC EHS Guidelines for Wind Energy (2015) that is, that background noise should be measured over a series of five or more 10-minute intervals for each integer of wind speed at 10 m reference height between cut-in wind speed and maximum output wind speed of the wind turbines (see Section 12.3.2).

The daytime and night-time L_{eq} peaks were generally higher on the weekends compared to the weekday at all locations with the exception of daytime peak at HB 1 and night-time peaks at HB 3 and HB 5 (see Tables 12-10 and 12-11). A possible explanation for this trend may be increased noise levels associated with increased activity in the residential locations (HB 1, HB 3-HB 6) during the weekends.

As shown in Figure 12-7, the overall daytime L_{eq} peaks were generally higher compared to the night-time peaks at all locations with the exception of HB 2 where day and night peaks were similar and HB 4 where the night-time peak was higher. The daytime peaks ranged from 67.9 dBA (HB 2) to 75.4 dBA (HB 1) and the night-time peaks ranged from 67.0 dBA (HB 6) to 73.2 dBA (HB 4). Both HB 1 and HB 4 are located in proximity to the Demerara Berbice Highway so these peaks maybe attributed to traffic sounds. Other potential sources of these peaks include a small church, wash bay and shop near to HB 4.

TABLE 12-10: PEAK DAYTIME AND NIGHT-TIME BACKGROUND NOISE L_{EQ} AT LOCATIONS HB 1, HB 2 AND HB 3

DATE	Peak Background Noise L_{eq} (dBA)					
	HB 1 (RESIDENTIAL)		HB 2 (SCHOOL)		HB 3 (RESIDENTIAL)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Apr. 25, 2018 Weekday	75.3	63.1	59.9	51.5	66.2	61.7
Apr. 26, 2018	**75.4**	66.3	59.7	53.0	69.6	**67.8**

DATE	Peak Background Noise L_{eq} (dBA)					
	HB 1 (RESIDENTIAL)		HB 2 (SCHOOL)		HB 3 (RESIDENTIAL)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Weekday						
Apr. 27, 2018 Weekday	68.5	65.5	62.0	52.8	73.6	55.3
Apr. 28, 2018 Weekend	70.6	**72.3**	66.7	**68.0**	**74.5**	61.4
Apr. 29, 2018 Weekend	70.6	67.1	**67.9**	62.3	69.6	59.1
Apr. 30, 2018 Weekday	61.7	69.5	52.8	54.4	61.4	61.8
Overall	**75.4**	**72.3**	**67.9**	**68.0**	**74.5**	**67.8**

TABLE 12-11: PEAK DAYTIME AND NIGHT-TIME BACKGROUND NOISE L_{EQ} AT LOCATIONS HB 4, HB 5 AND HB 6

DATE	PEAK BACKGROUND NOISE L_{eq} (dBA)					
	HB 4 (RESIDENTIAL)		HB 5 (RESIDENTIAL)		HB 6 (RESIDENTIAL)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Apr. 25, 2018 Weekday	68.8	55.4	68.6	62.8	64.6	57.9
Apr. 26, 2018 Weekday	69.8	59.4	67.1	**68.7**	61.7	65.6
Apr. 27, 2018 Weekday	68.7	66.9	69.3	66.8	67.0	66.8
Apr. 28, 2018 Weekend	**71.1**	**73.2**	68.3	67.8	66.4	61.5
Apr. 29, 2018 Weekend	68.8	68.4	**69.2**	52.4	**69.7**	**67.0**
Apr. 30, 2018 Weekday	64.8	66.6	56.5	51.5	61.5	62.5
Overall	**71.1**	**73.2**	**69.3**	**68.7**	**69.7**	**67.0**

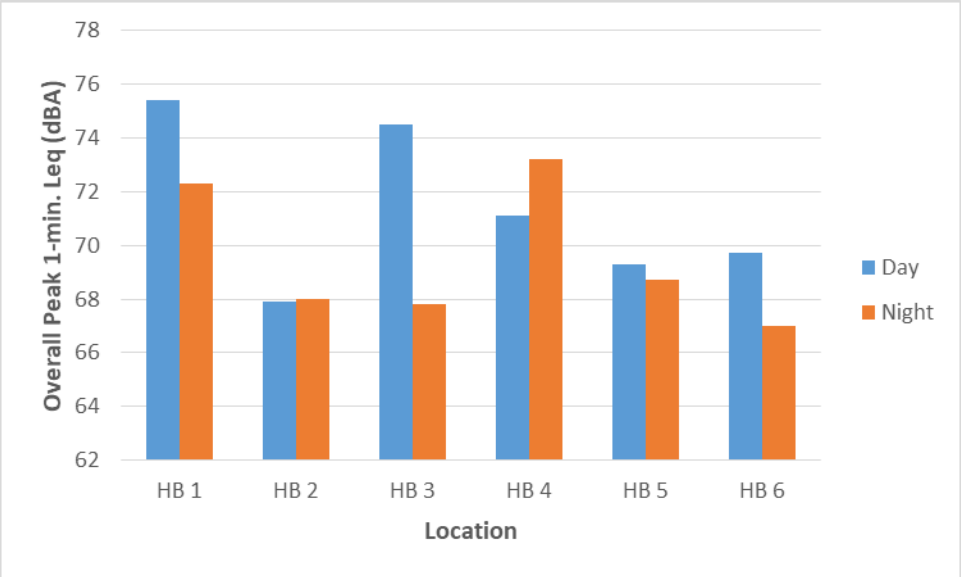

FIGURE 12-7: COMPARISON OF OVERALL PEAK BACKGROUND NOISE LEVELS ACROSS LOCATIONS AT HOPE BEACH

12.4.2.4 Summary of Background Noise Findings at Hope Beach

The following is a summary of the main findings for background noise Hope Beach:

- All locations were in compliance with the Guyana Guidelines daytime limit (75 dBA) for residential and educational receptors while the night-time limit (60 dBA) was exceeded at all locations.
- The proposed Guyana wind turbine daytime limit (50 dBA) and night-time limit (45 dBA) for residential and educational categories were generally exceeded by the existing levels of background noise at all monitoring locations. A similar trend was observed for the noise versus wind speed comparisons.
- Background noise daytime at the school exceeds the proposed Guyana wind turbine daytime limit of 50 dBA, but satisfies the WHO 1999 Guideline of 55 dBA for outdoor school playground noise levels. Daytime background noise passing through the open louvered windows of the school is likely to cause the interior classroom noise levels to exceed the WHO 1999 guideline of 35 dBA.
- There was a weak relationship between average noise levels (L_{eq}) and wind speed, therefore wind speed does not appear to be an important contributing factor at the proposed Hope Beach project location.
- The IFC Guidelines give a limit (3 dBA) above background conditions which must not be exceeded by noise impacts. Should the EPA consider using a background noise component to modify the limits as is done in some jurisdictions, as the background noise is louder than the proposed 50 dBA and 45 dBA limits, the effective limit would then be raised to match the background noise at the nearest residential receptors.
- Daytime and night-time peak L_{eq} values were generally higher on the weekend than during the week at the monitoring locations.

12.4.3 Findings – Chapman's Grove

This section presents the findings of the noise monitoring conducted at Chapman's Grove under the following sub-sections:

- Average Background Noise Levels;
- Effect of Wind Speed;
- Peak Noise Level; and
- Summary of Findings.

The raw data is provided in the Baseline Noise Monitoring Report for Chapman's Grove.

12.4.3.1 Average Background Noise Level

This sub-section discusses the average background noise levels at Chapman's Grove in the context of the Guyana National Bureau of Standards 2010 Guidelines for Noise Emissions into the Environment for the residential and educational categories as well as the Guyana proposed wind turbine guidelines for the residential and educational categories. The first are general noise standards, while the second are specific to wind turbines. Table 12-12A summarizes the exceedances of the General Guyana Noise Guidelines and is based on 1-hour average noise levels. Table 12-12B summarizes the exceedances of the Guyana proposed wind turbine guidelines and is based on 10-min average noise levels.

Both the daytime and night-time background noise levels were in compliance with the Guyana general noise guidelines (for residential and educational categories) for daytime (75 dBA) and night-time (60 dBA) at all locations. Maximum 1-hour daytime averages ranged from 49.6 dBA (CHG 3) to 60.8 dBA (CHG 2) while night-time averages ranged from 55.1 dBA (CHG 3) to 57.5 dBA (CHG 2). CHG 2 (beach ridge) was the loudest location and noise sources included tidal wave noise and vehicles. The quietest location was the agricultural CHG 3 site. Potential noise sources at this location were natural (*i.e.* waves action, rustling leaves and faunal sounds).

There were exceedances of the Guyana proposed wind turbine noise guidelines for daytime (50 dBA) and night-time (45 dBA) background noise at all locations. At all locations, for the daytime and night-time, the percentage exceedance was greater than 25%, with the exception of CHG 3 where 11% exceedance was noted for the daytime.

TABLE 12-12A: SUMMARY OF GUYANA GENERAL GUIDELINE EXCEEDANCES FOR CHAPMAN'S GROVE BACKGROUND NOISE SURVEY (1-HOUR AVERAGING TIME)

LOCATION	NO. OF 1-HOUR AVERAGE VALUES	MAXIMUM VALUE (dBA)	GUYANA GENERAL GUIDELINES (dBA)	NO. OF EXCEEDANCES	PERCENTAGE OF EXCEEDANCES (%)
DAY (07:00 to 18:00)					
CHG 1 (Residential)	48	52.5	75	0	0.00
CHG 2 (Rural)	24	60.8		0	0.00
CHG 3 (Rural)	24	49.6		0	0.00
NIGHT (18:00 to 07:00)					

LOCATION	NO. OF 1-HOUR AVERAGE VALUES	MAXIMUM VALUE (dBA)	GUYANA GENERAL GUIDELINES (dBA)	NO. OF EXCEEDANCES	PERCENTAGE OF EXCEEDANCES (%)
CHG 1 (Residential)	48	55.5	60	0	0.00
CHG 2 (Rural)	23	57.5		0	0.00
CHG 3 (Rural)	24	55.1		0	0.00

Note: Day-time – 07:00 to 18:00; Night-time 18:00 to 07:00

TABLE 12-12B: SUMMARY OF GUYANA PROPOSED WIND TURBINE EXCEEDANCES FOR CHAPMAN'S GROVE BACKGROUND NOISE SURVEY (10-MINUTE AVERAGING TIME)

LOCATION	NO. OF 10-MIN AVERAGE VALUES	MAXIMUM VALUE (dBA)	GUYANA PROPOSED WIND TURBINE GUIDELINES (dBA)	NO. OF EXCEEDANCES	PERCENTAGE OF EXCEEDANCES (%)
DAY					
CHG 1 (Residential)	364	56.2	50	91	25.00
CHG 2 (Rural)	182	57.8		94	51.64
CHG 3 (Rural)	182	57.5		20	10.99
NIGHT					
CHG 1 (Residential)	216	56.5	45	208	96.29
CHG 2 (Rural)	108	56.9		107	99.07
CHG 3 (Rural)	108	55.7		45	41.66

Note: Day-time – 07:00 to 22:00; Night-time 22:00 to 07:00

12.4.3.2 Effect of Wind Speed on Background Noise

This sub-section discussed the effect of wind speed on background noise levels at Chapman's Grove in the context of the IFC Noise Level Guideline methodology, and compares these to the EPA's proposed wind turbine noise limits for Guyana (Guyana Wind Turbine Limits). Background noise typically increases with increasing wind speed, and wind turbine noise also is correlated with wind speed. Table 12-13 is based on 10-minute average background noise levels and projected 10m reference height wind speeds. Wind speeds during monitoring fluctuated between 1 – 7 m/s, therefore there was no data for wind speeds at 0 m/s and 8-10 m/s. Maximum noise output from the wind turbines occurs at wind speeds above 9 m/s at hub height (105m), which is equivalent to 7 m/s wind speed at the 10m reference height.

As shown in Figures 12-8 to 12-10 and Table 12-13, there is hardly any correlation between wind speed and background noise at the three monitoring locations (CHG 1, CHG 2 and CHG 3). This suggests that wind speed is not an important contributing factor to background noise levels at the proposed Chapman's Grove project location. At Chapman's Grove, background noise patterns are clearly related to tide cycles, with high tides having louder noise levels as the breaker zone is closer to the sites. At CHG 1, other potential sources of noise included residential activities, vehicular sounds and animal vocalizations. Other potential noise sources at CHG 2 includes infrequent passing of vehicles along the old seawall road, while faunal sounds and other natural noises contribute to background sounds at CHG 3.

The measured background noise levels are compared to the proposed Guyana wind turbine noise limits (L_{Aeq}) for residential and education receptors for daytime (50 dBA) and night-time (45 dBA). As explained previously, although CHG 1 is the only residential location, noise levels at CHG 2 and CHG 3 were also compared to these guidelines since the proposed Guyana wind turbine limits do not have noise limits specifically for rural areas (see Table 12-2). As shown in Table 12-13 and Figures 12-8 to 12-10, the daytime L_{eq} background noise values at CHG 1 and CHG 3 were compliant with the proposed Guyana wind turbine guidelines while at CHG 2 there were exceedances. The night-time L_{eq} background noise values at CHG 1 and CHG 2 were somewhat higher than the guideline noise limit while at CHG 3 they marginally exceeded the limit.

Locations CHG 1 (residential) and CHG 2 (beach ridge) were the noisiest sites. As discussed previously, CHG 1 is subject to noise from tidally modulated wave noise, residential activities, animals and vehicles while noise sources at CHG 2 includes tidal wave noise and vehicles. The quietest location was the agricultural CHG 3 site. This location is not situated in a residential area and unlike the other two sites, its potential noise sources were natural (*i.e.* waves action, rustling leaves and faunal sounds) which may be a possible explanation for its overall lower noise levels (see Table 12-13).

TABLE 12-13: AVERAGE DAYTIME AND NIGHT-TIME BACKGROUND NOISE LEVELS VERSUS WIND SPEED AT LOCATIONS CHG 1, CHG 2 AND CHG 3

WIND (m/s)	AVERAGE BACKGROUND NOISE LEVEL (dBA)					
	CHG 1 (RESIDENTIAL)		CHG 2 (BEACH RIDGE)		CHG 3 (AGRICULTURAL)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
1	-	-	-	47.5	-	-
2	46.5	-	49.0	49.8	48.4	46.9
3	47.6	51.9	50.0	53.2	48.7	46.6
4	48.6	53.4	53.6	52.6	48.3	45.8
5	49.6	51.8	56.0	49	47.5	45.9
6	47.5	49.5	47.6	-	49.2	-
7	47	-	-	-	-	-
W. Mean (dBA)	48.8	52.2	53.3	51.0	48.2	45.9
Range of Average Noise Levels (dBA)	46.5 – 49.6	49.5 – 53.4	47.6 – 56.0	47.5 – 53.2	47.5 – 48.7	45.8 – 46.9

Note: Wind speed bins with less than five 10-minute measurements are below the minimum indicated by IFC (2015), and therefore are subject to a higher uncertainty and are highlighted in red.

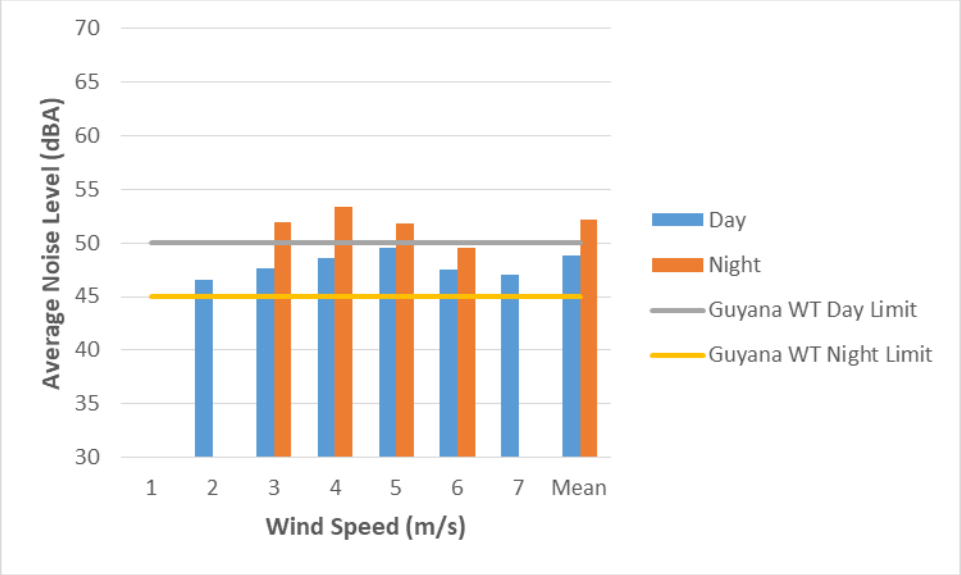

FIGURE 12-8: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT CHG 1 (RESIDENTIAL)

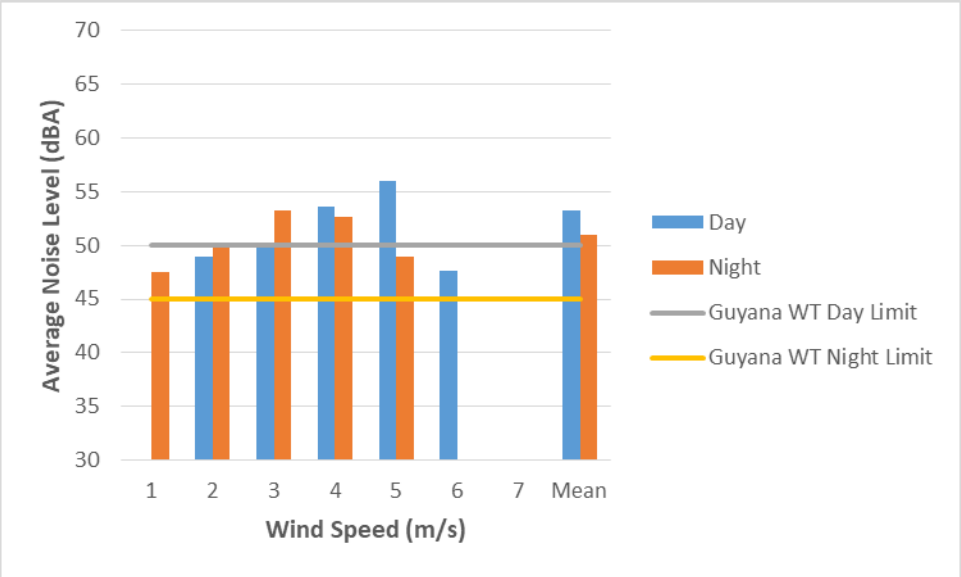

FIGURE 12-9: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT CHG 2 (BEACH RIDGE)

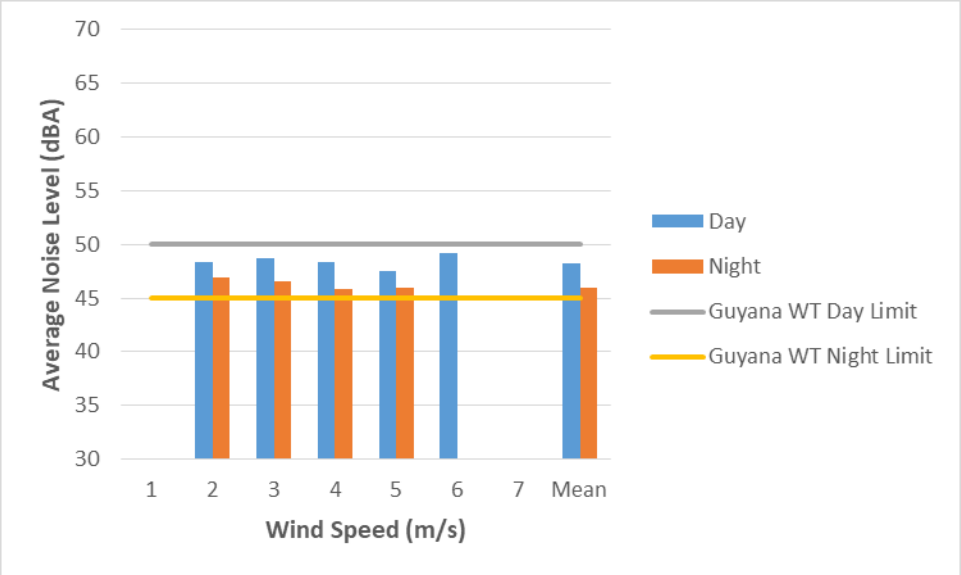

FIGURE 12-10: AVERAGE BACKGROUND NOISE LEVEL VERSUS TO WIND SPEED AT CHG 3 (AGRICULTURAL)

12.4.3.3 Peak Background Noise Level

The highest 1-minute average noise levels for daytime (7am – 10pm) and night-time (10pm – 7am) were taken as the peak levels (see Table 12-14). It should be noted that while the data is representative of the date stated, on some days a full 24-hrs of data was not collected. Additionally, monitoring was only conducted on weekdays.

As shown in Figure 12-11, the overall daytime and night-time L_{eq} peaks were comparable at all locations with differences in the values being marginal. The daytime peaks ranged from 59.4 dBA (CHG 2) to 61.0 dBA (CHG 1) and the night-time peaks ranged from 60.2 dBA (CHG 3) to 61.4 dBA (CHG 1). As discussed previously, tidal action (breaking waves) is the main source of background noise at all three monitoring locations. Additionally, CHG 1 is located in a residential area in proximity to a roadway and has a goat pen; therefore, peaks at this location may be attributed to residential activities, vehicular sounds or animal vocalizations. Other potential sources of the peaks recorded at CHG 2 (cremation site) included vehicles. At CHG 3 (old drainage embankment) other potential noise sources included faunal sounds and other natural noises.

TABLE 12-14: PEAK DAYTIME AND NIGHT-TIME BACKGROUND NOISE L_{EQ} AT LOCATIONS CHG 1, CHG 2 AND CHG 3

DATE	PEAK BACKGROUND NOISE L_{eq} (dBA)					
	CHG 1 (RESIDENTIAL)		CHG 2 (CREMATION SITE)		CHG 3 (EMBANKMENT)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Jun. 01, 2020 Weekday	56.5	56.6	-	-	-	-
Jun. 02, 2020 Weekday	56.3	56.0	-	-	-	-
Jun. 03, 2020 Weekday	**61.0**	61.1	-	-	-	-
Jun. 04, 2020 Weekday	56.7	**61.4**	-	-	-	-
Jun. 05, 2020 Weekday	56.7	59.7	-	-	-	-
Jun. 08, 2020 Weekday	-	-	**59.4**	50.1	-	-
Jun. 09, 2020 Weekday	-	-	57.3	**60.8**	-	-

DATE	PEAK BACKGROUND NOISE L_{eq} (dBA)					
	CHG 1 (RESIDENTIAL)		CHG 2 (CREMATION SITE)		CHG 3 (EMBANKMENT)	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Jun. 10, 2020 Weekday	-	-	56.2	**60.8**	48.2	58.3
Jun. 11, 2020 Weekday	-	-	-	-	58.6	59.5
Jun. 12, 2020 Weekday	-	-	-	-	**60.8**	**60.2**
Overall	**61.0**	**61.4**	**59.4**	**60.8**	**60.8**	**60.2**

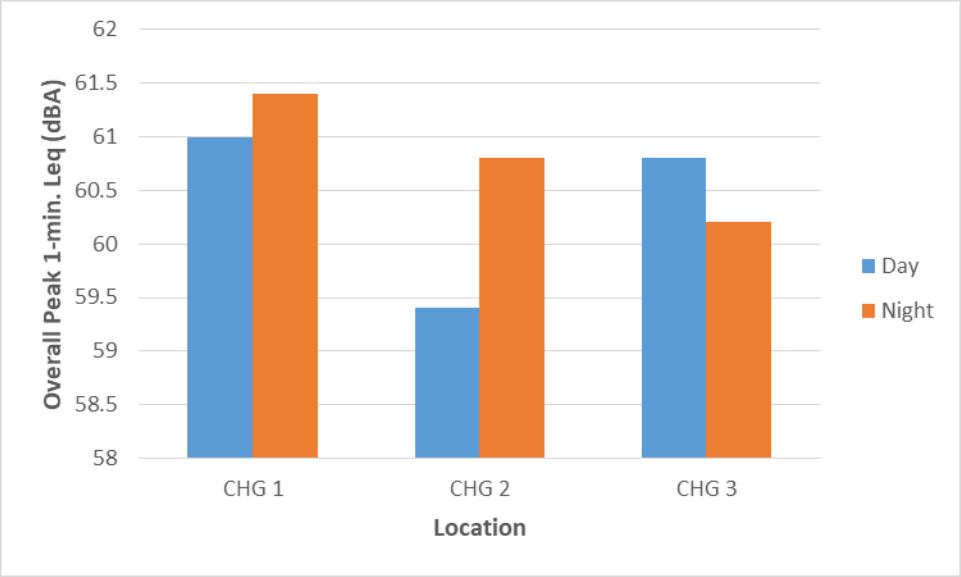

FIGURE 12-11: COMPARISON OF OVERALL BACKGROUND PEAK NOISE LEVELS ACROSS LOCATIONS AT CHAPMAN'S GROVE

12.4.3.4 Summary of Background Noise Findings for Chapman's Grove

The following is a summary of the main findings for Chapman's Grove:

- All locations were in compliance with the Guyana Guidelines daytime limit (75 dBA) and nighttime limit (60 dBA) for residential and educational receptors at all locations.
- Average background noise levels exceeded the Guyana proposed wind turbine noise guidelines of daytime (50 dBA) and night-time (45 dBA) at all locations for the average background noise levels.

- From the background noise level versus wind speed comparison, the Guyana proposed wind turbine noise guidelines for daytime (50 dBA) and night-time (45 dBA) were exceeded at all locations with the exceptions of the day-time limit for CHG 1 (residential receptor) and CHG 3 (rural receptor). This difference in the findings compared to the analysis of the average background noise levels is as a result of data processing.
- Average background noise levels (L_{eq}) did not show a correlation to wind speed, therefore wind speed does not appear to be an important contributing factor at the proposed Chapman's Grove project location, instead there is a clear relationship with tidally modulated noise from the wave breaker zone.
- The IFC Guidelines give a limit (3 dBA) above background conditions which must not be exceeded by noise impacts. Should the EPA consider using a background noise component to modify the limits as is done in some jurisdictions, as the background noise is louder than the proposed 50 dBA and 45 dBA limits, the effective limit would then be raised to match the background noise at the nearest residential receptors.
- Daytime and night-time peak L_{eq} values were lower than at the Hope Beach locations, marginally loudest at the residential CHG 1 site exceeding 61 dBA.

12.5 Impact Prediction and Assessment

This section discussed the potential noise impacts associated with this proposed project during the construction and operational phases.

12.5.1 Construction Phase

12.5.1.1 Nature of Impact

During the site preparation and construction phase of this project, noise and vibration will be generated during activities such as pile driving and the operation of heavy equipment. This noise will be experienced by area residents as well as wildlife. The main concerns associated with the level of noise anticipated during the construction phase include it being an annoyance and potentially disturbing sleep. Very young persons and older persons may be particularly sensitive to noise disturbance. While there will also be noise associated with the movement of trucks transporting material to the project site, this noise is not expected to be significant.

As shown in Figure 2-9, communities and sensitive receptors within a 1 km radius of the Hope Beach site include: Lowlands, Hope, Douch Four, Two Friends, Anns Grove, Clonbrook and Beehive, and the Hope Secondary School (approximately 430 m from

wind turbine T2). The community of Unity is located within a 1 km radius of the Chapman's Grove site, with the nearest residence located approximately 270 m from wind turbine T6 (see Figure 2-10). At Hope Beach, the average continuous background noise levels generally exceeded the IFC Guideline and Guyana proposed wind turbine limits (daytime 50 dBA and night-time 45 dBA). At all locations background noise levels were in compliance with the Guyana Guidelines daytime limit (75 dBA) for residential and educational receptors while the night-time limit (60 dBA) was exceeded at all locations. At Chapman's Grove, the average continuous background noise levels were generally in compliance with the IFC and Guyana proposed wind turbine daytime limits at CHG1 and CHG 3 while CHG 2 was exceeded. The night-time limits of both guidelines were exceeded at all three locations. All Chapman's Grove locations were in compliance with the Guyana Guidelines daytime limit (75 dBA) and nighttime limit (60 dBA) for residential and educational receptors.

Pile driving is required for some aspects of the proposed project, specifically the construction of the wind turbine foundations at both Hope Beach and Chapman's Grove and the construction of bridges at Chapman's Grove. All construction activity will be undertaken in compliance with the Guidelines for Noise Emissions into the Environment GYS 263:2010. Experience on other projects in the region suggests that this activity can be disruptive to schools, churches and health facilities up to a distance of the order of 250 m if there is a clear "line of sight". At Hope Beach, the Hope Secondary School at 450m from nearest wind turbine site, and the nearest residence at 290m (HB), are both more than 250 m from the anticipated pile driving activity, and are therefore not expected to be significantly impacted. At Chapman's Grove, residences in proximity to the bridge (100m) and substation (150m) construction sites are likely to be impacted by pile driving noise during the day. It is anticipated that less than 30 piles in total will be required for the bridge and substation construction.

12.5.1.2 Unmitigated Impact

Noise and vibration generated by project works such as clearing, grading, road works, foundation and bridge construction will be temporary, lasting only for the relatively short duration of these activities. Noise may be audible at Hope Secondary School and the nearest neighbouring residences at both Hope Beach and Chapman's Grove. This impact is expected to be temporary lasting only for the duration of the construction phase however, if unmitigated, it may have significant effects on sensitive receptors.

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

12.5.1.3 Mitigation Measures

Several mitigation measures may be implemented to reduce the potential impact of construction noise and vibration on the neighbouring communities and sensitive receptors:

- Regularly inspect and maintain construction vehicles and equipment (including mufflers on this equipment) to ensure noise emission control systems are properly functioning;
- Schedule noise-intense construction activities (such as pile driving) between the hours 7:00 am and 6:00 pm on weekdays in order to avoid disturbance during sensitive evening and night-time periods, to the extent practical;
- Schedule the movements by truck between the hours of 7:00 am and 6:00 pm (in order to limit disturbance to evening and night-time activities) on weekdays, to the extent practical;

- Schedule pile driving at Hope Beach when school is not in session (*i.e.* during the vacation period), to the extent practical.
- Avoid night-time work to the extent that is practical. However, if night work involving noise intense activities is necessary, consultation with the EPA should be conducted first. Section 12.3.1 details the time restrictions with respect to weekend and night-time construction activities in accordance with Noise Regulations (2000).
- Inform the public of noisy construction activities in the area; and
- Conduct condition survey of structures in close proximity to road works before construction begins.

Implementation of these mitigations measures is expected to reduce the intensity of the potential impact of noise and vibrations.

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

12.5.1.4 Cumulative Impact

While it is expected that noise will be generated from other projects listed in Section 2.6, these construction sites are sufficiently far away that a cumulative impact with the construction activity for the wind farm does not arise. However, noise associated with the construction of the seawall to Unity is expected to result in a cumulative impact. Again, this impact is expected to be short-term lasting only as long as the construction phase. This impact is expected to be cumulative to the works at both Hope Beach and Chapman's Grove and is therefore classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

12.5.2 Operation Phase

12.5.2.1 Nature of Impact

Appendix P (Guideline Noise Emission Limits Comparison) provides an explanation of the nature of wind turbine generated noise. The greatest component of wind turbine noise comes from the aerodynamic interactions of air with the spinning blades of the rotor. Mechanical noise from the drivetrain (gearbox, generator, driveshaft) contributes to a much lesser extent. Wind turbines have modulation of the sound in the regular frequency range, often described as a "swish" effect. Modern wind turbines are designed to reduce the noise emitted:

- As wind turbine models have become larger, the manufacturers have kept the tip speed of the blade within a constant range of 70 to 90 m/s by reducing the rpm rotational speed of the rotors.

- The shapes of the blades have become more aerodynamically efficient and effective at reducing noise. Serrated edges are now typically added to the trailing edges of the outermost blade which substantially reduces the aerodynamic noise.
- Additional noise reduction modes which reduce the maximum speed of the rotor are achieved by trimming the blades during sensitive time periods during periods of high wind speeds. Such noise reduction modes also reduce the power output of the wind turbines.

Sound generated at the wind turbine is attenuated with distance away from the turbine. At ground level right beneath the wind turbines, sound levels do not exceed 55 dBA, and decrease with distance away from the wind turbine.

There are several residential communities and a school (the Hope Secondary School) in the vicinity of the proposed wind farm (Figures 2-9 and 2-10). The most important potential health impact from wind turbines is that of disturbed sleep. Good sleep is essential for mental and physical health. Disturbed sleep is associated with increased heart rate, blood pressure and breathing rate. Disturbed sleep interferes with night-time physiological recovery, and thus has adverse impacts the day after such as tiredness, poor concentration and performance. The WHO (1999) advises that noise has measurable effects on sleep patterns at indoor bedroom noise levels above 30dB, and their guideline is for continuous sound indoors to be limited to 30dB and peak sound events to less than 45 dB LAmax. The WHO outdoors limits assume 15 dB reduction in sound through a partially open window, and is set at 45 dBA for continuous sound outdoors, and peak noise at 60 dB LAmax.

For school classrooms, the WHO 1999 guidance is for maximum 35 dBA indoors in order to permit clear communication, and 55 dBA for outdoor playgrounds. The WHO (2018) advises noise reduction through windows of 10 dBA for open window, 15 dBA for partially open, and 20 dBA for closed windows. During the daytime the issue is that of annoyance, and the WHO advises a 50 dBA limit to result in few people having moderate annoyance, and below 55 dBA to achieve few people having serious annoyance. Additionally, the USEPA (1974) guidance is 45 dBA indoors, and 55 dBA outdoor, to ensure no interference with speech intelligibility for teaching indoors or outdoors.

The modulated swishing sound produced by wind turbine blades is noticeable very close to the wind turbines (<50m) but this high frequency sound attenuates rapidly and becomes much less significant with distance, and thus is not factored into wind regulations. Distinct tonalities generated by the drivetrain/gearbox were a feature of some earlier model wind turbines. Such tonality issues are no longer an issue with modern wind turbines. A few regulatory standards do require a penalty for distinct tonalities in wind turbine noise if such are relevant (see Reference 11 in Appendix P). There are no distinct tonalities associated with the V150 model.

Chapter 3 of the ESIA report summarizes the applicable noise limits outlined in the Noise Regulations under the Environmental Protection Act 2000 while Appendix P summarizes noise regulations specific to wind farms from various jurisdictions around the world. With the exception of tonality related penalties in a few European jurisdictions mentioned above, none of these regulations provide standards, guideline values or permissible limits based on the type of noise being emitted. Rather, these limits are based on surrounding land use and the presence of sensitive receptors. The only other distinction relates to day time and night time limits.

12.5.2.2 Projected Impact of Wind Farm Noise Emissions

This section summarises the main findings of the "Hope Wind Farm Guyana – Environmental Impact Assessment: Noise, Shadow Flicker, Safety Distances" prepared by EMD International A/S (see Appendix O). The proposed wind farm was designed to satisfy the wind farm noise limits (Night-time: 45 dB and Day-time: 50 dB) under consideration by the Guyana EPA (see Section 12.3.3). Table 12-15 and Figures 12-12 and 12-13 show the maximum noise impact for residential and school Noise Sensitive Areas (NSAs) from six Vestas V150 4.2 MW with a HH of 105, using Noise Mode PO1 (with serrated trailing edges), except at wind turbine 4, which operates at more restrictive noise reduction mode SO1. Section 4.1.2 in the EMD Report (see Appendix O) give a description of the methodology used to model the propagation of the noise in the environment in accordance with ISO 9613-2.

The key outcomes of this assessment are as follows:

- The wind farm configuration respects the maximum noise limits both daytime (50 dBA) and night-time (45 dBA) at all the nearest residential receptors. This is achieved by operating all but one wind turbine in standard noise emissions configuration, and downgrading turbine No. 4 to a lower noise emission (and production) configuration.

- The maximum outdoor noise limit of 50 dBA daytime is satisfied also at the Hope Secondary School, which is below the WHO recommended school outdoor limit of 55 dBA. Indoor noise levels at the school are impacted by existing outdoor background noise levels, which are reduced indoors by an uncertain amount via passage through louvered windows. Maximum wind farm noise levels at the school are 42.6 dBA, and average noise levels is 39.6 dBA, which are substantially below daytime background noise levels measured at the school such that the wind farm contribution to background noise outdoors (and consequently indoors) is less than 1 dBA and thus unlikely to be noticed.

- The environmental noise measured at all of the nearest residential and school receptor locations is well above the noise emitted by the turbines most of the

time. The added contribution of the wind farm to the existing background noise levels is deemed negligible, including at the particularly sensitive receptor at the Hope Secondary School.

Therefore, operational noise of the proposed wind farm is not anticipated to have a significant impact on nearby communities or the Hope Secondary School. Once these limits are included in the conditions to the Environmental Permit, HED will be legally bound to meet these limits during operation. There is no significant impact to the commercial viability of the wind farm in meeting these noise limits.

SOURCE: EMD International A/S

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ECO REPORT NO.	05/2020
DATE:	03/12/21
CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	HOPE BEACH: MAXIMUM NOISE IMPACT OF SIX VESTAS V150 4.2 MW WITH A HH OF 105, USING NOISE MODE PO1 (SO1 AT WTG4) WITH SERRATED TRAILING EDGES. NO UNCERTAINTY APPLIED
FIGURE NUMBER:	12-12

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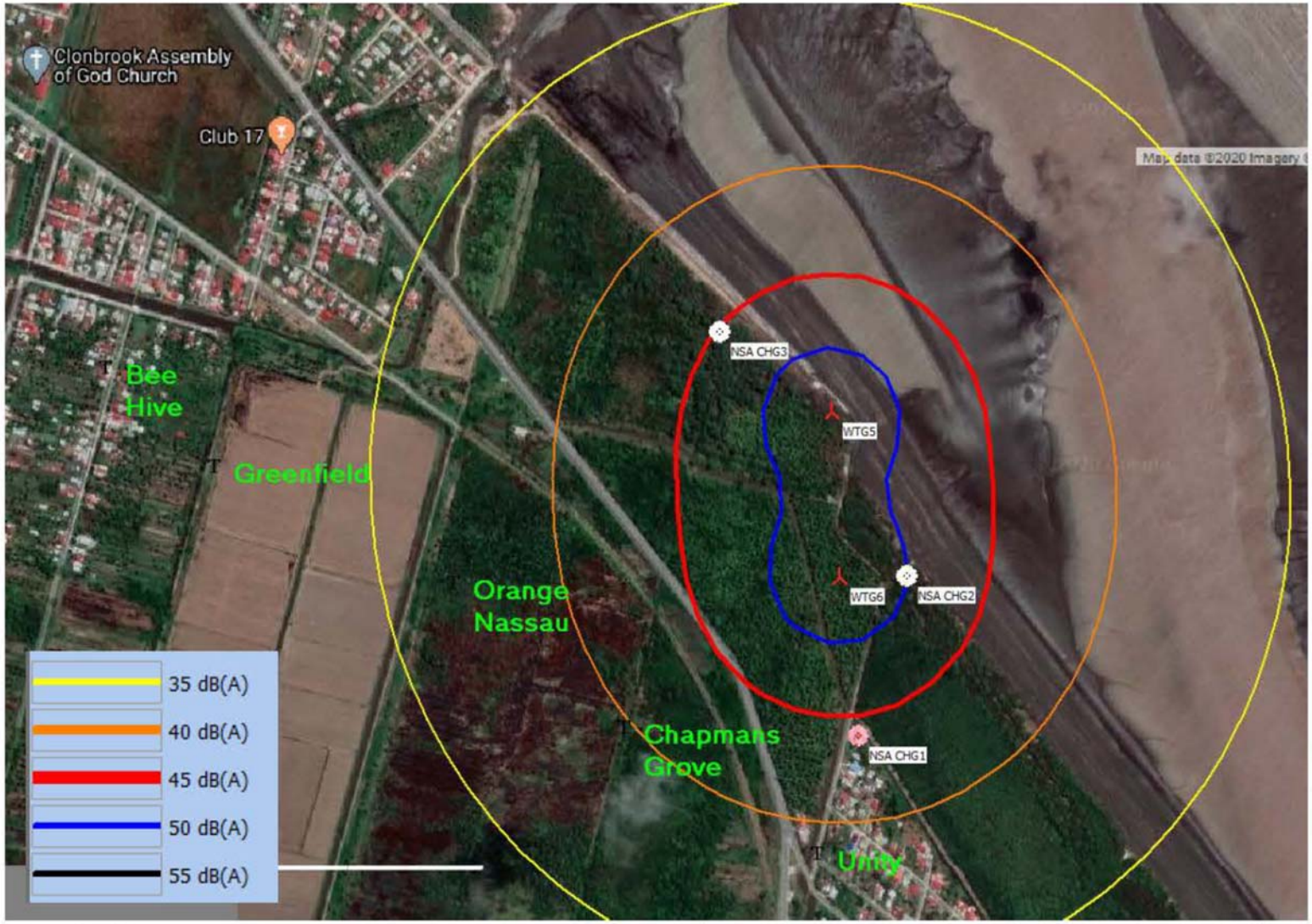

SOURCE: EMD International A/S

Ecoengineering Consultants Ltd. 62 EASTERN MAIN ROAD ST. AUGUSTINE PHONE: (868) 645-4420 FAX: (868) 662-7292 e-mail : ecoeng@ecoenggroup.com	ECO REPORT NO. 05/2020 DATE: 03/12/21	CLIENT: HOPE ENERGY DEVELOPMENT INC. PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA DWG. NAME: CHAPMANS GROVE: MAXIMUM NOISE IMPACT OF SIX VESTAS V150 4.2 MW WITH A HH OF 105, USING NOISE MODE PO1 (SO1 AT WTG4) WITH SERRATED TRAILING EDGES. NO UNCERTAINTY APPLIED	FIGURE NUMBER: 12-13

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TABLE 12-15: MAXIMUM NOISE IMPACT OF SIX VESTAS V150 4.2 MW WITH A HH OF 105, USING NOISE MODE PO1 (WITH SERRATED TRAILING EDGES), EXCEPT AT WTG4, USING SO1.

NSA	NAME	HEIGHT AGL	MAX NOISE FROM WTGS	MAX NOISE FROM WTGS + UNCERTAINTY
1	Resident (HB 1)	1.5 m	43.2	43.7
2	Hope Secondary School (HB 2)	1.5 m	42.6	43.1
3	Resident (HB 3) - next to residential construction site	1.5 m	43.4	43.9
4	Resident (HB 4) - close to church	1.5 m	43.7	44.2
5	Resident (HB 5) - close to canal	1.5 m	37.9	38.4
6	Resident (HB 6)	1.5 m	33.6	34.1
CHG1	Nearest Resident	1.5 m	43.9	44.4

12.5.2.3 Cumulative Impact

There are no projects in the project vicinity that are expected to result in a cumulative impact with the operation phase of the wind farm. Noise impacts from this project will be cumulative with existing man-made noise sources in the area, but such sources are already reflected in the background noise measurements and so do not need to be assessed separately.

12.6 Mitigation and Monitoring – Environmental Management Plan

12.6.1 Construction Phase

12-16	POTENTIAL IMPACT	NOISE AND VIBRATION
MITIGATION MEASURES		▸ Regularly inspect and maintain construction vehicles and equipment (including mufflers on this equipment) to ensure noise emission control systems are properly functioning; ▸ Schedule noise-intense construction activities (such as pile driving) between the hours 7:00 am and 6:00 pm on weekdays in order to avoid disturbance during

12-16	POTENTIAL IMPACT	NOISE AND VIBRATION
		sensitive evening and night-time periods, to the extent practical; ▸ Schedule the movements by truck between the hours of 7:00 am and 6:00 pm (in order to limit disturbance to evening and night-time activities) on weekdays, to the extent practical; ▸ Schedule pile driving at Hope Beach when school is not in session (i.e. during the vacation period), to the extent practical. ▸ Avoid night-time work to the extent that is practical. However, if night work involving noise intense activities is necessary, consultation with the EPA should be conducted first. ▸ Inform the public of noisy construction activities in the area; and ▸ Conduct condition survey of structures in close proximity to road works before construction begins.
ACTION BY		▸ Contractor's Project Director to send vehicles and equipment for maintenance. ▸ EPC Contractor to coordinate schedules. ▸ HSE Manager and Community Liaison Officers to coordinate communications with the communities.
TIMING		▸ Notify adjacent receptors of noisy works prior to the start of noise intensive activities. ▸ Implement all other mitigation measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ Project General Manager (in collaboration with EPC Contractor) to investigate claims of damage caused by vibration. ▸ HSE Manager (in collaboration with the Project Director) to maintain a log of vehicle and equipment maintenance records.

12-16	POTENTIAL IMPACT	NOISE AND VIBRATION
		▸ HSE Manager to maintain complaints register relating to noise and vibrations during the construction phase. ▸ The HSE Manager to ensure the conduct of daily inspections and note any instances of vehicles and equipment creating excessive noise. The HSE Officer will also review the maintenance records of vehicles and equipment, as well as the complaints register. ▸ If a noise variation is required, the HSE Manager to verify that works are being conducted in accordance with the variance. ▸ HSE Manager to ensure the conduct of noise monitoring monthly during the construction phase at the fence line of the closest human receptor or otherwise and during specific noisy activities such as pile driving.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register ▸ Vehicle Log ▸ A Sound Pressure Level Meter to measure sound pressure levels
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

12.6.2 Operation Phase

12-17	POTENTIAL IMPACT	NOISE
MITIGATION MEASURES		• The wind farm will be configured to meet the maximum noise limits both daytime (50 dBA) and night-time (45 dBA) at all the nearest residential receptors. This will be achieved by operating all but one wind turbine in standard noise emissions configuration, and downgrading turbine No. 4 to a lower noise emission (and production) configuration. • The design also ensures that the maximum outdoor noise limit of 50 dBA daytime is satisfied at the Hope Secondary School, which is below the WHO recommended school outdoor limit of 55 dBA. Indoor noise levels at the school are impacted by existing

12-17	POTENTIAL IMPACT	NOISE
		outdoor background noise levels, which are reduced indoors by an uncertain amount via passage through louvered windows. Maximum wind farm noise levels at the school is 42.6 dBA, and average noise levels is 39.6 dBA, which are substantially below daytime background noise levels measured at the school such that the wind farm contribution to background noise outdoors (and consequently indoors) is less than 1 dBA and thus unlikely to be noticed.
ACTION BY		Wind Farm General Manager
TIMING		Prior to construction
SPECIALIZED EQUIPMENT OR MATERIAL		
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ The Wind Farm General Manager to ensure that wind farm design and configuration meet the criteria for the noise standards. ▸ Community Liaison Offers to register complaints from community and the school.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints log
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

13 BIOLOGICAL AND ECOLOGICAL RESOURCES AND ECOSYSTEM SERVICES

13.1 Introduction

This Chapter presents information on the biological and ecological resources at the two sites, Hope Beach and Chapman's Grove, chosen for the installation of the proposed wind turbines (see Figures 2-1 and 2-2). There are 5 Appendices attached as follows:

- Appendix D: An assessment of on-site vegetation for the sustainability of wind energy project in Chapman Grove Unity-Hope, East Coast Demerara Guyana (January, 2020). Prepared by Owen Bovell, Department of Forestry, Faculty of Agriculture and Forestry, University of Guyana;
- Appendix E: Hope Beach Wind Farm Project, Guyana Birds and Bat Biodiversity Baseline Study Interim Report (Rev 01), Eco Report No. 16/2018 (September 2018). Prepared by Ecoengineering Consultants Limited;
- Appendix E: Interim Report: Coastal Bird Survey 2, Hope and Chapman Grove, Guyana (December 2020). Prepared by Waldyke Prince and Leon Moore;
- Appendix F: Bat Survey at Chapman's Grove (February 2020). Prepared by Dr. Deidre Jafferally; and
- Appendix G: Ichthyofaunal Assessment at Hope and Chapman's Grove, Guyana (December 2020). Prepared by Mark Ram.

13.2 Definition and Scope

13.2.1 Scope

This Chapter summarises the biological baseline surveys (flora, avifauna, bats, ichthyofauna and opportunistically observed non-volant mammals and herpetofauna) carried out at the proposed Hope Beach and Chapman's Grove sites in 2018 and 2020 (see Figures 2-1 and 2-2). It also discusses the potential biological and ecological impacts of the construction and operation phases of the proposed wind farm.

13.2.2 Definitions

Technical terms used in the Baseline Reports and in this Chapter are defined in Table 13-1:

TABLE 13-1: DEFINITIONS

TERM	DEFINITION
Avifauna	The birds of a particular region, habitat, or geological period.
Basking	To lie exposed to warmth and light, typically from the sun.
Beach ridge	A wave-swept or wave-deposited ridge running parallel to a shoreline. It is commonly composed of sand as well as sediment worked from underlying beach material.
Biodiversity	The variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.
Canopy	The uppermost branches of the trees in a forest, forming a more or less continuous layer of foliage.
Critically Endangered (CR) (IUCN Red List of Threatened Species)	Species that possess an extremely high risk of extinction as a result of rapid population declines of 80 to more than 90 percent over the previous 10 years (or three generations), a current population size of fewer than 50 individuals, or other factors (such as severely fragmented populations, long generation times, or isolated habitats).
Community	A group or association of populations of two or more different species occupying the same geographical area at the same time.
Diameter at breast height (DBH)	A standard method of expressing the diameter of the trunk or bole of a standing tree.
Dimorphism	The existence of two different forms of a species especially in the same population.
Ecology	A branch of biology that studies how organisms interact with their environment and other organisms.
Ecosystem	A community of living organisms in conjunction with the non-living components of their environment, interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows.
Ecosystem service	The outputs, conditions, or processes of natural systems that benefit humans or enhance social welfare.

Endangered (EN) (IUCN Red List of Threatened Species)	Species that possess a very high risk of extinction as a result of rapid population declines of 50 to more than 70 percent over the previous 10 years (or three generations), a current population size of fewer than 250 individuals, or other factors.
Endemic species	A species being native to a single defined geographic location, such as an island, state, nation, country or other defined zone.
Foraging	The act of searching for wild food resources.
Fauna	The animals of a particular region, habitat, or geological period.
Feeding guild	A group of unrelated species that feed on similar foods (e.g., benthivore, detritivore, herbivore, insectivore, omnivore, planktivore, piscivore), or the types of food that an individual organism feeds upon.
Flora	The plants of a particular region, habitat, or geological period.
Frugivore	An animal that thrives mostly on raw fruits, succulent fruit-like vegetables, roots, shoots, nuts and seeds.
Generalist	Species that can feed on at a variety of foods and thrive in a range of habitats.
Habitat	The natural home or environment of an animal, plant, or other organism.
Herpetofauna	The reptiles and amphibians that inhabit a given area
Ichthyofauna	Assemblages of fish in a water body or zoogeographic region.
Insectivore	An animal that feeds on insects, worms, and other invertebrates.
Least Concern (LC) (IUCN Red List of Threatened Species)	A category containing species that are pervasive and abundant after careful assessment.
Mangrove swamp	A tidal swamp which is dominated by mangroves.
Mangal	Mangrove swamp.
Migratory species	Any species or lower taxon of wild animals, in which a significant proportion of the members of the entire population or any geographically separate part of the population cyclically and predictably crosses one or more national jurisdictional boundaries.
Marsh	A type of wetland, or an area of land where water covers ground for long periods of time.
Mudflat	Essentially horizontal and commonly muddy or marshy land that is covered and uncovered by the rise and fall of tides. Also called tidal flats.

Near Threatened (NT) (IUCN Red List of Threatened Species)	Species that are close to becoming threatened or may meet the criteria for threatened status in the near future.
Nectarivore	An animal which derives its energy and nutrient requirements from a diet consisting mainly or exclusively of the sugar-rich nectar produced by flowering plants.
Non-volant mammal	Land-based mammals that cannot fly.
Niche	The position of a species within an ecosystem, describing both the range of conditions necessary for persistence of the species, and its ecological role in the ecosystem.
Passerine	Relating to or denoting birds of a large order distinguished by having feet that are adapted for perching, including all songbirds.
Pelagic Bird	Seabirds that spend most of their time (except when they are nesting) on the ocean away from land.
Perching	Alight or rest on something.
Piscivore	A carnivorous animal that eats primarily fish.
Plot sampling	In ecology this is a method of abundance estimation in which plots are selected from within a survey region and sampled.
Raptor	Generally a medium-sized or large bird that hunts and kills other animals for food, including small birds, fish, mammals, lizards, and insects.
Relative abundance	Refers to the evenness of distribution of individuals among species in a community.
Roosting	Settle or congregate for rest or sleep.
Sandflat	An extension of unconsolidated sediment located preferentially in the lower intertidal zone. It is an unstable area characterized by the constant re-suspension of sediment by tidal flood and ebb currents.
Sanguivore	An animal that consumes blood from another living animal.
Shorebird	A bird that frequents the shore.
Species abundance	The number of individuals per species.

Species diversity	The number of different species that are represented in a given community (a dataset). The effective number of species refers to the number of equally abundant species needed to obtain the same mean proportional species abundance as that observed in the dataset of interest (where all species may not be equally abundant).
Species richness	Describes the number of different species present in an area (more species = greater richness).
Specialist	Species that have a limited diet and stricter habitat requirements.
Tidal flat	Essentially horizontal and commonly muddy or marshy land that is covered and uncovered by the rise and fall of tides. Also called mudflats.
Transect	A straight line or narrow section through an object or natural feature or across the earth's surface, along which observations are made or measurements taken.
Understory	The underlying layer of vegetation in a forest or wooded area, especially the trees and shrubs growing between the forest canopy and the forest floor.
Vulnerable (VU) (IUCN Red List of Threatened Species)	Species that possess a very high risk of extinction as a result of rapid population declines of 30 to more than 50 percent over the previous 10 years (or three generations), a current population size of fewer than 1,000 individuals, or other factor.
Wader	Waders or shorebirds are birds of the order Charadriiformes commonly found along shorelines and mudflats that wade in order to forage for food (such as insects or crustaceans) in the mud or sand.

13.3 Key Relevant Policy and Legislation

This section summarises the legislative and regulatory framework relevant to the discussion of biological and ecological resources. Additional detail is provided in Chapter 3 and Appendix B of the EIA Report. These are summarized below:

National Biodiversity Strategy and Action Plan (NBSAP) (2012-2020)	The NBSAP lists 9 strategic objectives: • Conserving ecosystems, species and genetic diversity and restoring biodiversity and ecosystem services in degraded areas. • Promote the conservation, sustainable use and value of biodiversity into key productive sectors used for growth, expansion and diversification of the economy. • Expand and improve awareness, appreciation and communication on biodiversity and ecosystems. • Improve national implementation, monitoring and reporting for Multilateral Environmental Agreements and other bilateral commitments. • Create stronger and wider national, regional and international partnerships that contribute to achieving the goal and objectives of this Plan. • Consolidate/harmonize policy, legal, regulatory and administrative frameworks that support the sustainable use, protection and management of biodiversity resources. • Improve substantially biodiversity monitoring at the national level and within key productive sectors. • Strengthen the knowledge base and capacity for conservation, management and sustainable use of biodiversity. • Secure adequate resources from national, regional and international sources for the implementation of the Plan.
Wildlife Management and Conservation Act, 2016 and Regulations	The Regulations provide the legal framework for the conservation and management of all species of wildlife in Guyana.
Forest Act, 2009	Based on a meeting with the Forestry Commission and follow up correspondence (see Appendix M), the proposed site is not on Forested State Lands, and therefore, no permit to erect the turbines is required.
Wild Birds	The Wild Birds Protection Act prohibits the wounding,

Protection Act	capturing or killing of birds specified in the first schedule, as well as the protection of birds (listed in the Second Schedule) during the closed season. Birds in the First Schedule that are found at the project site are listed in Section 3.4.
Plant Protection Act, 2011	The Plant Protection Act regulates the importation and exportation of plants, planting material and objects derived from them, to protect from the introduction of exotic pests and diseases to Guyana and to control and eradicate diseases and pests within the country. Any replanting of areas designated for the wind turbines will have to be in accordance with this Act.
National Mangrove Management Action Plan (2010)	The National Mangrove Management Action Plan's overall objective is to respond to climate change and to mitigate its effects through the protection, rehabilitation and wise use of Guyana's mangrove ecosystems. As part of this initiative, mangrove planting has occurred in the Hope Beach area and has been maintained and monitored over the years. The proposed wind turbines at Hope Beach will be sited on a relict beach ridge in a natural mangrove growth area. As such, the construction of the wind turbines must consider the impacts to the mangrove system.

13.4 Existing Information, Baseline Studies

This section summarises the biological baseline studies carried out at the proposed Hope Beach and Chapman's Grove sites in 2018 and 2020 (see Figures 2-1 and 2-2).

The biological baseline is summarised under the following sub-sections:

- Habitat and Flora;
- Avifauna;
- Bats;
- Non-volant Mammals and Herpetofauna; and
- Ichthyofauna.

13.4.1 Habitat and Flora

This section summarises an assessment of the on-site vegetation at the proposed project sites (Hope Beach and Chapman's Grove) carried out in October-November, 2020 (see Appendix D for On-site Vegetation Assessment).

13.4.1.1 Method

A vegetation survey of mangrove, mangrove associates and coconut plantation were carried in October-November, 2020 using line-transects at the Hope Beach and Chapman's Grove sites (see Figure 2-5 and 2-6). Forty-seven plots were randomly established along the transects**.** Plot sizes were 0.1 ac (0.04ha) for trees ≥10cm DBH (diameter at breast height), 5m x 5m for saplings, and 2m x 2m for the seedlings (English *et al*. 1997; Malik *et al.* 2015b). The distance between plots was 30m where possible (Malik *et al.* 2015b). For each plot, species type, number of mangrove trees, saplings and seedlings and DBH of trees (≥ 10 cm DBH, taken at 1.3 m above soil surface) were recorded. Further details on the methodology including data analysis are provided in Appendix D (On-site Vegetation Assessment).

13.4.1.2 Findings

Hope Beach

As shown in Figure 13-1, the habitat types in proximity to the Hope Beach site are as follows:

- Mangrove tidal flat;
- Beach / tidal flat transition;
- Beach ridge;
- Beach ridge Buttonwood;
- Mangrove swamp; and
- Freshwater marsh.

The proposed Hope Beach project site is located on the relict beach ridge elevated above high tide (see Figure 13-1). The area west of the Hope Canal is colonized by the dominant *Jatropha gossypiifolia* (Bellyache Bush), *Fimbristalys spathacea*, *Thespesia populnea* (Wild Physic Nut) and *Ipomea biloba* along with the fruit plants *Syzygium cumunii* (Jamoon) and Cocos nucifera (coconut). The beach ridge east of the canal is dominated by grasses (*Cynodon dactylon* and *Dactylis glomerata*). *Conocarpus erectus* (Buttonwood) occurs on the fringes of the beach ridge with young and mature stands occurring in the beach/tidal flat transition and the beach ridge Buttonwood zones, respectively (see Figure 13-1). The beach ridge, beach/tidal flat transition and beach ridge Buttonwood habitat types occupy approximately 3.50 ha, 1.20 ha and 2.40 ha, respectively.

Within the study area, three mangrove species were recorded of which the density of *Avicennia germinans* (Black Mangrove) was the highest followed by *Conocarpus erectus* (Buttonwood) and *Laguncularia racemosa* (White Mangrove). The frequency of mangrove was dominated by *A. germinans* at all growth levels. The coverage of

SOURCE: VEGETATION ASSESSMENT, Owen Bovell, 2020

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ECO REPORT NO.	05/2020
DATE:	03/12/21
CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	HABITAT TYPES AT HOPE BEACH
FIGURE NUMBER:	13-1

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mangrove was dominated by *A. germinans* and the importance value index (IVI) indicated that *A. germinans* was the dominant species. Additionally, 26 non-mangrove species from 13 families were recorded (see Appendix I in Appendix A for complete floral list). There were no observations of non-mangrove species in the muddy tidal flat area (approximately 32.90 ha) (see Figure 13-1). The mangrove swamp (approximately 14.44 ha) was dominated by Black Mangrove with *Batis maritima* being the dominant undergrowth species (see Figure 13-1). Additionally, *Acrostichum danaeifolium* (Giant Leather Fern) and the medicinal tree *Morinda citrifolia* (Noni) were prominent in the understory of the mature Black Mangrove.

Batis maritima was observed to be among the prominent species in the open freshwater marshland located on the landward side of the seawall, adjacent to the mangrove swamp forest where mangrove trees may have died out or the vegetation may have been cleared for farming in the distant past (see Figure 13-1). A number of sedges including *Carex flacca*, *Cyperus javanicus*, *Cyperus articulatus* as well as common species such as *Cordia macrostachya* (Black Sage), *Senna alata* (Carrion Crow Bush), *Solanum stramoniifolium* (Bura Bura) were found in the freshwater marsh areas east and west of the Hope canal. The freshwater marsh habitat type occupies approximately 22.87 ha.

Chapman's Grove

As shown in Figure 13-2, the habitat types in proximity to the Chapman's Grove site are as follows:

- Mangrove swamp;
- Mangrove (back mangal);
- Beach ridge; and
- Coconut.

The proposed Chapman's Grove project site is located in coconut plantation with a stand density of 205/ha (83/ac) (see Figure 13-2); the coconut plantation habitat type occupies approximately 19.79 ha. The mature mangrove swamp (approximately 9.17 ha) is located north of the Unity Village seawall and is dominated by *Avicennia germinans* (Black Mangrove) (see Figure 13-2). There is also a small patch of Black Mangrove (i.e. Mangrove [back mangal], approximately 1.90 ha) to the western edge of the coconut plantation on the landward side of the seawall (see Figure 13-2). The beach ridge (approximately 4.70 ha) is elevated above high tide with vegetation dominated by shrubs with *Conocarpus erectus* (Buttonwood) also occurring (see Figure 13-2).

Mangrove Diversity

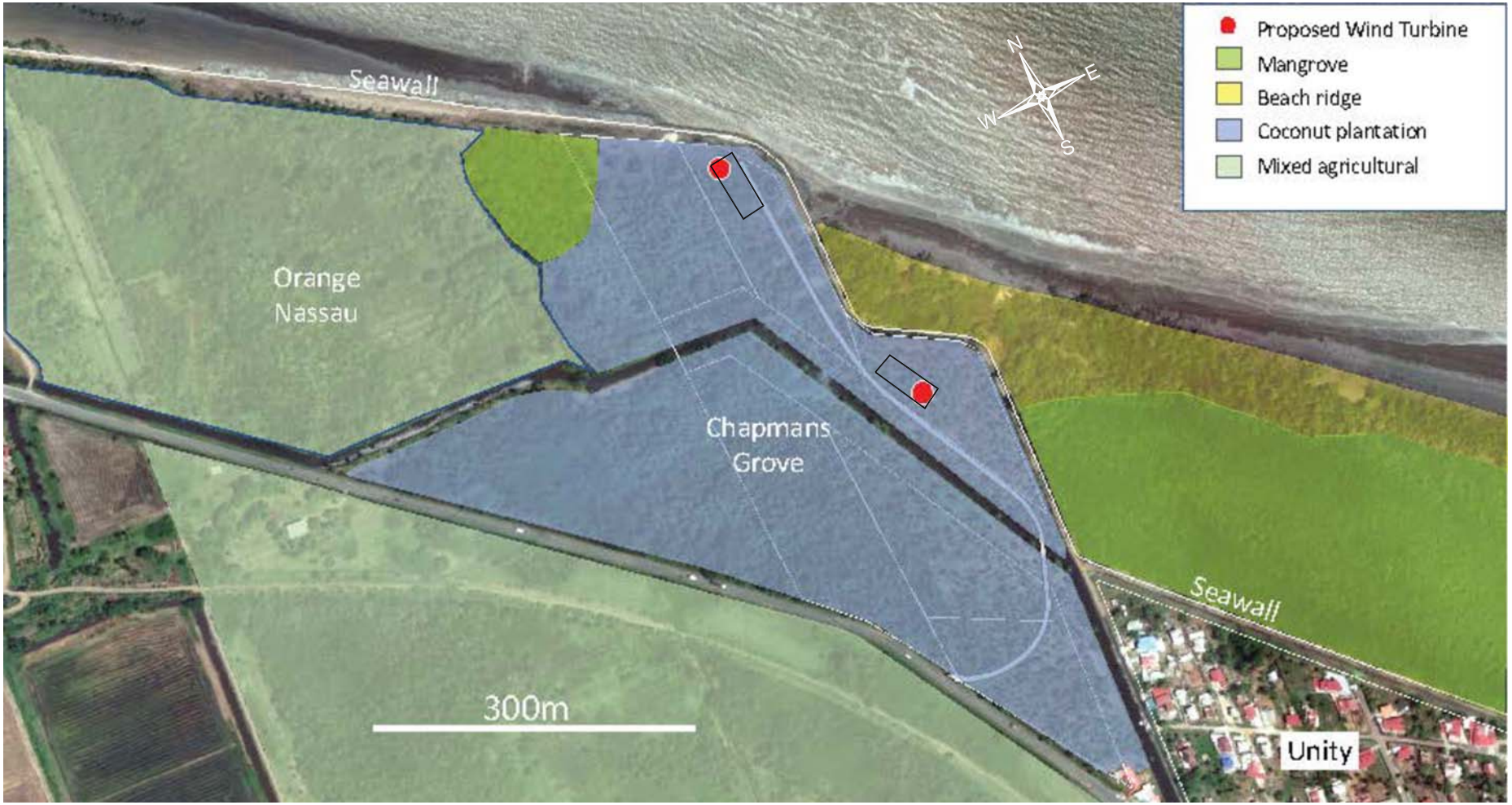
Pastikia (1991) reported that the coastal area of Demerara was dominated by *Rhizophora mangle* (red mangrove), *Avicennia germinans* (black mangrove) and *Laguncularia racemosa* (white mangrove) and to a lesser extent *Conocarpus erectus* (button wood). During this survey, Red Mangrove was not recorded, this suggest that the mangrove species number has decreased over the last three decades at this site. *A. germinans* remains dominant as indicated by highest relative density, frequency, and coverage observed during the study.

Of note was the absence of seedlings and saplings on more than half of the plots established for the study. This may be due to ponding in the mangrove areas as a result of adjacent dam construction. Mature conspecific shading may also be a contributing factor. Pickering & Hill (2007) suggested that vegetation cover may result in reduction and damage of seedlings, which can change in species composition. The observations of the mangrove seedlings and saplings in this area seem to confirm the decline in mangrove regeneration after a disturbance, which is quite evident in the natural erosion process that is currently taking place. Also, previous estimates of mangrove forests in Guyana revealed that the mangrove cover has reduced significantly from 80,432 hectares in 1992 to 22,632 hectares over the twenty-year period ending in 2009 (Persaud, 2011). Consequently, this may have resulted in the reduction in mangrove biodiversity in the area.

Although mangrove restoration and management have improved at the national level over the past 10 years, unsustainable use of this forest still continues through land conversion, over-harvesting and other impacts (CI 2018b). The national rehabilitation program for preserving of mangrove areas, preventing coastal erosion and mitigating climate change was introduced in 2010 by the EU and GOG (Landell Mills Limited, 2013) however, this has not resulted in the increase the diversity of mangrove. This may be as a result of mangrove re-planting focused on a single species, *Avicennia.* Additionally, the establishment of structures such as geotextile tubes and brush wood dams to assist mangrove regeneration resulted in the *Avicennia* becoming more abundant in this area. However, the loss of biodiversity due to human activities is seen as the major potential threat to the sustainability of mangroves in the wind energy project area.

13.4.2 Avifauna

This section summarises the findings of two avifaunal baseline studies carried out in the study area in June 2018 and November 2020. The complete studies are provided in Appendices B and C to this Chapter.



SOURCE: VEGETATION ASSESSMENT, Owen Bovell, 2020

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CLIENT: HOPE ENERGY DEVELOPMENT INC.

PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA

DWG. NAME: HABITATS AT CHAPMAN'S GROVE

FIGURE NUMBER: 13-2

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13.4.2.1 Method

The first survey (2018) was conducted at the Hope Beach site from June 21-30, 2018 and the second survey (2020) was conducted at Hope Beach and Chapman's Grove from November 20-24, 2020 and November 25-29, 2020, respectively. The first survey was within the May to September period which corresponds to the Austral migration period (Birds which breed in the Southern hemisphere and migrate during the Southern winter period). The second survey was within the September to May Nearctic-Neotropical migration season (birds which breed in the Northern Hemisphere and migrate South to warmer climate during the Northern winter).
The Hope Beach study area was divided into two sites: Hope East and Hope West relative to the position of the Hope Canal. The surveys utilised transect lines through the various habitat types (*i.e.* mudflat, mangrove and marsh at Hope Beach and sandflat, mangrove and coconut plantation for Chapman's Grove) with point counts generally taken at 200 m intervals where possible (see Figures 2-7 and 2-8).

For the first survey (at Hope Beach), during Days 1-5, the transects were sampled during the morning, midday and afternoon periods with approximately 7 minutes being spent at each point count. This method was repeated during the second survey (2020) for both the Hope Beach and Chapman's Grove sites. Additionally, during the Days 6-10 of the first survey (2018) special attention was placed on mornings (05:30 – 06:15) and evening (17:00 – 18:30) fly-overs of birds at Hope Beach. These observations were conducted at one fixed point for both East (*i.e.* end point for the east mangrove transect) and West (*i.e.* end point for the west mangrove transect) sites. Observations of the fly-over birds were also carried out during the second survey (2020) at both Hope Beach and Chapman's Grove. For detailed methodology see Appendices B and C.

13.4.2.2 Findings

The findings of the two studies are summarised under the following headings:

- Species Richness and Abundance;
- IUCN Status and Important Mangrove Species;
- Migratory Species;
- Fly-over Habit;
- Foraging, Nesting and Other Activities; and
- Habitat Utilization.

Species Richness and Abundance

A total of 127 species, representing 39 families and comprising 6,732 individuals were recorded during both the 2018 and 2020 bird surveys at Hope Beach and Chapman's Grove. The 2020 survey recorded 106 species of birds representing 36 families and

comprised of 2214 individuals while the 2018 survey recorded 102 species of birds representing 33 families comprising 4518 individuals. Based on the Shannon's Diversity Index, the Hope east (H=3.35) and Hope west (H=3.30) sites have a similar diversity of species while the lowest diversity occurs at the Chapman's Grove site (H=2.03).

In terms of species richness, of the 127 species recorded over both surveys, the large majority were passerine species (48), followed by shorebirds and seabirds (17), raptors (15) and wetland birds (13) (Table 13-2). In terms of species abundance, waders/wetland birds accounted for the largest number of individuals (3,017), followed by passerines (1,481 individuals) and seabirds/shorebirds (1,246 individuals) (Table 13-2).

TABLE 13-2: TOTAL NUMBER OF BIRD SPECIES AND INDIVIDUALS RECORDED AT HOPE BEACH AND CHAPMAN'S GROVE (2018 AND 2020)

BIRD GROUP	NUMBER OF SPECIES	NUMBER OF INDIVIDUALS
Passerines	48	1481
Doves / Pigeons	5	256
Raptors	15	233
Vultures	3	74
Owls	1	1
Shorebirds	9	134
Seabirds	8	1112
Waterfowl (Ducks only)	1	4
Waders / Wetland Birds)	13	3017
Cuckoos and Rails	7	168
Parrots and Parakeets	3	132
Woodpeckers and Piculets	4	52
Hummingbirds and Swifts	5	27
Kingfishers	4	38
Nighthawk	1	3
TOTAL	**127**	**6732**

Bird diversity and abundance at the survey points was highly variable and influenced primarily by time of day (for mangrove resident birds) and tidal stage (for shore and coastal birds). Scarlet Ibis (*Eudocimus ruber*), Snowy Egrets (*Egretta thula*) and Magnificent Frigatebird (*Fregata magnificens*) were the most abundant birds during both survey periods (2018 and 2020). Additionally, Little Blue Heron (*Egretta caerulea*) and Tricolored Heron (*Egretta Tricolor*) were abundant in the 2018 survey and Grey-breasted Martin (*Progne chalybea*) and Great Kiskadee (*Pitangus sulphuratus*) were abundant in the 2020 survey.

Based on the field checklist for Guyana (Braun et. al., 2007) the large majority of species identified over both surveys were resident species of Guyana (108 species, representing 85% of total number of species), while the remainder were migratory species. One species was listed as a Guianan endemic. Of the resident species, the large majority were either common or fairly common in Guyana, while only 10 species were uncommon in Guyana. The Crested Caracara was not listed on Braun's et. al., (2007) field checklist.

IUCN Status and Important Mangrove Species

Based on the IUCN Redlist, no Critically Endangered or endangered species were observed during either survey. The majority of species (90%) were categorised as Least Concern. Three species were listed as near threatened or vulnerable on the IUCN Red List species (Table 13-3). These three species were observed during both the 2018 and 2020 surveys.

TABLE 13-3: IUCN RED LIST SPECIES RECORDED IN THE STUDY AREA

COMMON NAME	SCIENTIFIC NAME	IUCN STATUS	LOCAL ABUNDANCE	OTHER NOTES
Rufous Crab Hawk	*Buteogallus aequinoctialis*	NT	F	Specialized mangrove species. Restricted to coasts
Bicolored Conebill	*Conirostrum bicolor*	NT	F	Specialized mangrove species. Restricted to coasts
White Bellied Piculet	*Picumnus spilogaster*	V	F	

Notes: (NT) – Near Threatened
(V) – Vulnerable
F – Fairly Common

One endemic species was recorded during both the 2018 and 2020 surveys at both Hope Beach and Chapman's Grove. The Blood Colored Woodpecker (Veniliornis sanguineus) was listed as a Guianan Endemic (i.e. restricted to the Guianas and adjacent Venezuela and Brazil) (Braun, et. al., 2007) and as Least Concern under the IUCN Red List. This species is listed as fairly common to Guyana.

In addition, several species recorded in the area, were known to be highly specialized mangrove species. They included:

- Mangrove Rail (*Rallus longirostris*);
- Mangrove Cuckoo (*Coccyzus minor*);
- Yellow Warbler (*Setophaga petechia*)
- Northern Waterthrush *Parkesia noveboracensis* ()

All species were listed as Least Concern according to the IUCN Red List and either as common or fairly common to Guyana (Braun, et. al., 2007). The Yellow Warbler and the Northern Waterthrush are migrants to Guyana which usually prefers mangrove habitats when they winter there. These two species were only observed during the 2020 Survey at Hope Beach only.

Migratory Species

Eighteen species (18) of migratory birds were collectively recorded at Hope Beach and Chapman's Grove for the 2018 and 2020 surveys (Table 13-4). Based on the Field Checklist of Guyana (Braun, et. al., 2007), these species are either Nearctic or Austral migrants. Nearctic migrants are present in Guyana during September to May, while Austral migrants are present from May to September.

TABLE 13-4: MIGRATORY BIRDS COLLECTIVELY OBSERVED AT THE 2018 AND 2020 SURVEYS

Braun et al. (2007)

COMMON NAME	SCIENTIFIC NAME	MIGRANT TYPE	
Peregrine Falcon	*Falco peregrinus*	Nearctic	Raptor
Osprey	*Pandion haliaetus*	Nearctic	Raptor
Semipalmated Plover	*Charadrius semipalmatus*	Nearctic	Shorebird
Whimbrel	*Numenius phaeopus*	Nearctic	Shorebird
Spotted Sandpiper	*Actitis macularius*	Nearctic	Shorebird
Solitary Sandpiper	*Tringa solitaria*	Nearctic	Shorebird
Least Sandpiper	*Calidris minutilla*	Nearctic	Shorebird
Semipalmated Sandpiper	*Calidris pusilla*	Nearctic	Shorebird
Sanderling	*Calidris alba*	Nearctic	Shorebird
Greater Yellow-leg	*Tringa melanoleuca*	Nearctic	Shorebird
Least Tern	*Sternula antillarum*	Nearctic	Seabird

COMMON NAME	SCIENTIFIC NAME	MIGRANT TYPE	
Dark billed Cuckoo	*Coccyzus melacoryphus*	Austral	Cuckoo
Tropical Kingbird	*Tyrannus melancholicus*	Austral	Passerine
Fork-tailed Flycatcher	*Tyrannus savana*	Austral	Passerine
Streaked Flycatcher	*Myiodynastes maculatus*	Austral	Passerine
Lined Seedeater	*Sporophila lineola*	Austral	Passerine
Yellow Warbler	*Setophaga petechial*	Nearctic	Passerine
Northern Waterthrush	*Parkesia noveboracensis*	Nearctic	Passerine

Fly Over Habitat

With respect to the morning and evenings fly-over counts, at Hope Beach during the 2018 survey, the highest numbers of observed species were: 1,600 Scarlet Ibis; 464 Magnificent Frigatebirds; 113 Little Blue Heron; 140 Tricolored Heron; 121 Snowy Egret; 9 Brown Pelicans; and 35 Blue-headed Parrots. In comparison, no early morning or evening fly-overs were observed at this location during the 2020 survey. At Chapman's Grove (2020) the highest single number of sightings for Magnificent Frigatebirds and Scarlet Ibis was 189 and 27 individuals, respectively.

The canopy height for the mangroves is approximately 15-20 meters (based on drone survey), and the lower arc of the disc for the turbine blades is between 30-45 meters. Figure 13-3 gives the percentages of high, mid and low flying birds. Low flyers were averaged to fly 20 metres and under, mid flyers between 20- 40 metres and high flyers more than 40 metres.

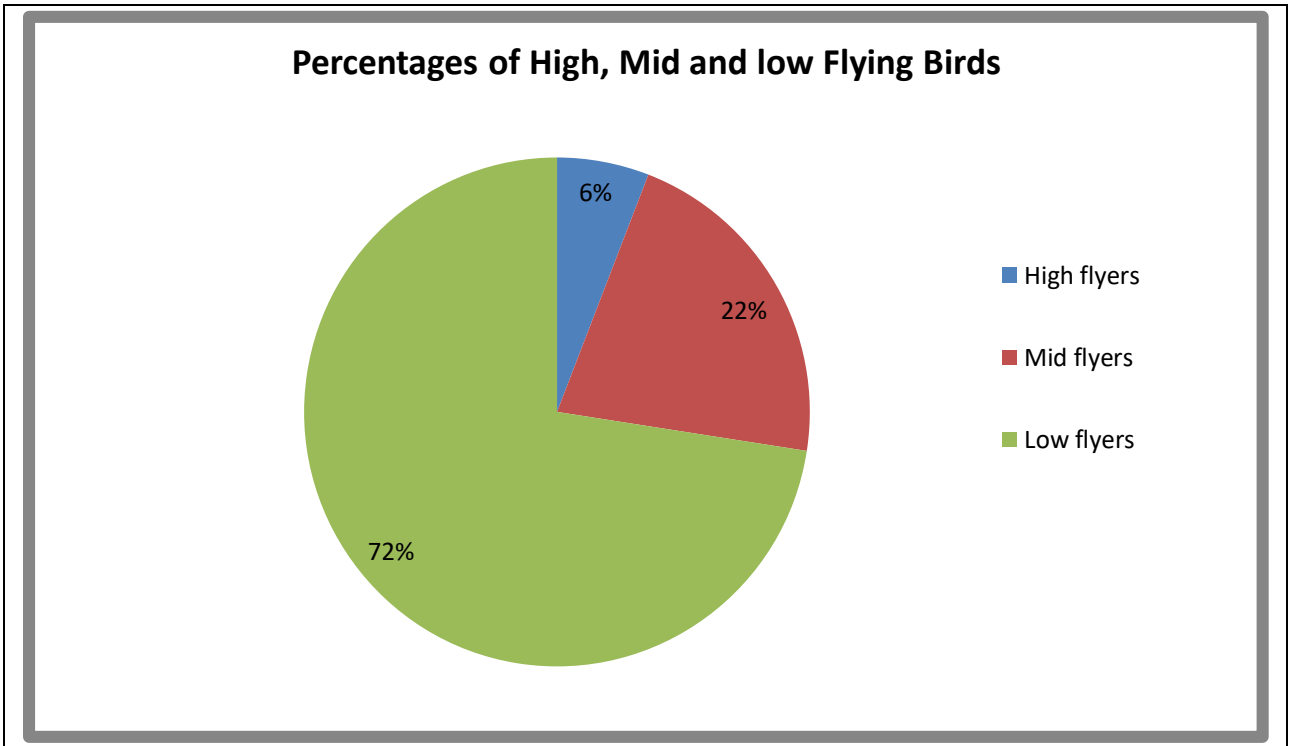

FIGURE 13-3: PERCENTAGES OF HIGH, MID AND LOW FLYING BIRDS

Overall for Hope Beach, both surveys (2018 and 2020) indicated that only 6% of the bird species observed were able to reach heights greater than 40 metres (see Figure 13-3. The Ibises, herons, egrets, vultures and kites were observed at heights similar to the proposed turbine blade heights. The frigatebirds were also seen soaring at the wind tower height (87 metres) (used by HED for collection of wind data, situated close to the study area) (see Figure 13-3).

The two bird species that reside in the mangrove and are high and mid flyers are Snail Kites (*Rostrhamus sociablis*) and Greater Kiskadee (*Pitangus sulphuratus*) respectively. Of the three species listed as Near Threatened or Vulnerable only one, the Rufous Crab Hawk was observed to be a mid-flyer.

However, the majority of bird species observed (72%) were low flyers. Some of those species such as the Northern Scrub Flycatcher (*Sublegatus arenarum*), Black-throated Mangos (*Anthracothorax nigricollis*), Yellow Oriole (*Icterus nigrogularis*) and Ringed Kingfisher (*Megaceryle torquata*) reside in the mangrove areas and fly at canopy height (approximately 25 meters). These species forage and perch below the canopy height and thus, they will be located well below the proposed turbine blade heights.

For the Chapman Grove site, which contains Coconut plantation, birds such Brown-throated Parakeet (Eupsittula pertinax), Palm Tanager (*Thraupis palmarum*), Yellow-rumped Cacique (*Cacicus cela*) and Yellow-hooded Blackbirds (*Chrysomus*

icterocephalus) and those mentioned in the preceding paragraph, fly at canopy height (approximately 20 meters). At least 70% of the species observed during the bird survey, forage and perch below the canopy height and thus, they will be located well below the proposed turbine blade heights.

Fly-overs and Proximity to Study Area

Flight- Shoreline and Mangroves: More than 75% of the flyovers occurred over the border between the shoreline and the mangroves, with the birds utilizing the shoreline as guidance.

Flight- Shoreline and Mudflats: The herons and egrets were observed flying mainly over the shoreline and mudflat about 1–2 meters above the water heading east in the morning to their foraging grounds, and on their return flight in the evenings to their roost, they fly higher; 20–30 meters.

During the mornings the birds fly into the winds (generally north east and east trades) and therefore fly more inland; over the mangrove and marshes, while during the afternoon they fly downwind back over the shoreline flight-path (Note: that the distance travelled across the three habitats is between 400 - 700 meters). The birds seek less resistance when flying into the winds and thus fly more inland.

Foraging, Nesting and Other Activities

Over 60% of the birds collectively recorded for the 2 surveys (2018 and 2020) in the study area (Hope Beach and Chapman's Grove) were residents. Non-resident species include Scarlet Ibis, Frigatebirds, Herons, Shorebirds and some Raptor species. Six species of shorebirds (family Scolopacidae) were observed resting and flying during the Hope Beach mudflat transects. During the 2020 survey, there was notable reduction in the Scarlet Ibis, Magnificent Frigatebirds and several heron species flying over the study area to foraging in comparison to 2018 numbers.

For the 2020 survey, nests of Rufous Crab-Hawk, Great Kiskadee and Yellow Oriole were observed in the mangrove forest at Hope Beach while no nesting was recorded at Chapman's Grove. Species observed nesting at Hope Beach during the 2018 survey included: Snail Kites; Greater Kiskadee; Northern Scrub Flycatcher; Black-throated Mangos; Yellow Oriole; and Ringed Kingfisher. Additionally, the coconut trees along the dam at the Hope west site that had Snail Kites nests during 2018 survey were no longer present in 2020.

Other observed activities included basking/drying-off after rain. Flycatchers and hummingbirds were seen active during the 'heat of the day' (midday periods).

Habitat Utilization

To assess habitat utilization, the activity of birds (i.e. percentage foraging, flying and perching) in each habitat (tidal flat, mangrove, marsh and plantation) was observed (see Table 13-5). For both surveys more foraging and perching activity was observed in the mangrove in comparison to the marshes and tidal flats that primarily had flyover bird species. The tidal flat flyover percentage decreased from 2018 (93%) to (69%) 2020 as fewer birds were sighted. For Chapman's Grove (plantation) 50% forging and 35% fly-overs were observed.

TABLE 13-5: BIRD ACTIVITY FOR 2018 AND 2020

HABITAT	FORAGING (%)		PERCHING (%)		FLYING (%)	
	2018	2020	2018	2020	2018	2020
Tidal flat	2	13	5	18	93	69
Mangrove	19	48	50	28	31	24
Marsh	14	13	36	24	50	63
Plantation	-	49	-	16	-	35

13.4.3 Bats

This section summarises the findings of bat baseline studies carried out in Hope Beach and Chapman's Grove in June 2018 and February 2020, respectively. The complete studies are provided in Appendix F.

13.4.3.1 Method

Hope Beach

The Hope Beach bat survey (2018) was conducted for 5 days from August 13- 17, 2018. Mist nets consisting of ground and canopy nets of dimension 12m x 3m were used to survey low-flying and high-flying bats, respectively. Nets were all opened by approximately 18:00 hrs and closed by 00:00 hrs (midnight) and checked every 1.5 hours for captured individuals.

The Hope Beach study area was divided into two sites: Hope East and Hope West relative to the position of the Hope Canal. Random open spots in close proximity to the mangrove forest, and waterways were chosen to maximize the chances of capture. In

total, 14 nets were deployed: 3 canopy and 5 ground nets on the western side and 3 canopy and 3 ground nets on the eastern side (see Figure 13-4). Mist nets were placed in a "T" format to each other at heights of 7.6 m (25 ft) for the canopy nets and 3.6 m (12 ft) for the ground nets. During the five days a total netting area of 11,925 m^2 was expended in sampling the survey site for a total of 29 net hours.

Chapman's Grove

The Chapman's Grove bat survey was conducted from February 8 – 13, 2020 at primary (February 8 - 10, 2020) and secondary (February 12 – 13, 2020) survey areas (see Figure 13-4). On February 13, 2020 Nets 4 and 5 were missing. To maintain the net hours, 2 older nets were deployed at locations 4a and 5a and Net 7 was relocated closer to the canal (i.e. 7a); (see Figure 13-4). Mist nets consisting of ground and canopy nets of dimension 12m x 3m were used to survey low-flying and high-flying bats, respectively. Nets were all opened by approximately 18:00 hrs and closed by 10:00 hrs and checked every half hour for the first 2 hours and every hour on the hour until closing for captured individuals. The nets were set in a T pattern to maximise the number of bats that may be captured. During the five days a total net effort of 6,651 m^2 was expended in sampling the survey site for a total of 20.49 net hours.

13.4.3.2 Findings

The findings at the two sites are summarised under the following headings:

- Species Richness, Abundance and Diversity;
- IUCN Status and Regional Status;
- Feeding Guilds, Dimorphism and Development;
- Bat Flight in relation to proposed Wind Turbine Height; and
- Economic Importance and Ecological Significance

Species Richness, Abundance and Diversity

The 2020 survey captured 10 species of bats representing 2 families and comprised of 37 individuals while the 2018 survey recorded 5 species of bats representing 3 families comprising 36 individuals (Table 13-6). During the 2018 survey, all 5 species were recorded at Hope west, while a single species *Artibeus planirostris* (Flat-face fruit-eating Bat) was captured at Hope east. At Chapman's Grove, all 10 species of bats were captured at Survey Station 1, while 3 species: *Carollia persicillata, Carollia brevicauda* and *Artibeus planirostris* were the only species captured at Survey Station 2 (Table 13-6). The most unique species captured at the site was Desmodus rotundus, the Common Vampire Bat, which was captured at Chapman's Grove.

TABLE 13-6: BATS CAPTURED AT HOPE BEACH AND CHAPMAN'S GROVE

SPECIES	COMMON NAME	FEEDING GUILD	NUMBER CAPTURED	
			HOPE BEACH	CHAPMAN'S GROVE
Rhychonycteris naso	Proboscis Bat	Aquatic Insectivore	1	0
Noctilio leporinus	Greater Bulldog Bat	Piscivore	6	4
Macrophyllum macrophyllum	Long-legged Bat	Aquatic Insectivore	3	0
Carollia perspicillata	Seba's Short-tailed Bat	Fructivore	1	9
Artibeus planirostris	Flat-face fruit-eating Bat	Fructivore	25	13
Carollia brevicauda	Silky Short-tailed Bat	Fructivore	0	1
Dermanura cinerea	Gervais's Fruit-eating Bat	Fructivore	0	1
Dermanura glauca	Silver Fruit-eating bat	Fructivore	0	1
Dermanura gnoma	Dwarf Fruit-eating Bat	Fructivore	0	1
Platyrrhinus brachycephalus	Broad-nosed Bat	Fructivore	0	3
Sturnira lilium	Little Yellow-shouldered Bat	Fructivore	0	3
Desmodus rotundus	Vampire Bat	Sangivore	0	1

For both surveys, the most abundant species was *Artibeus planirostris* (Flat-face fruit-eating Bat) comprising 69% of the individuals captured at Hope Beach and 35% of the individual captures at Chapman's Grove (Figure 13-5 and Figure 13-6, respectively). The data set of the 2018 survey was too small to attempt any significant statistical analysis, while for the 2020 survey, the Shannon's Diversity Index, at Chapman's Grove was calculated as H=1.849.

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PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	BAT NET DEPLOYMENT
FIGURE NUMBER:	13-4

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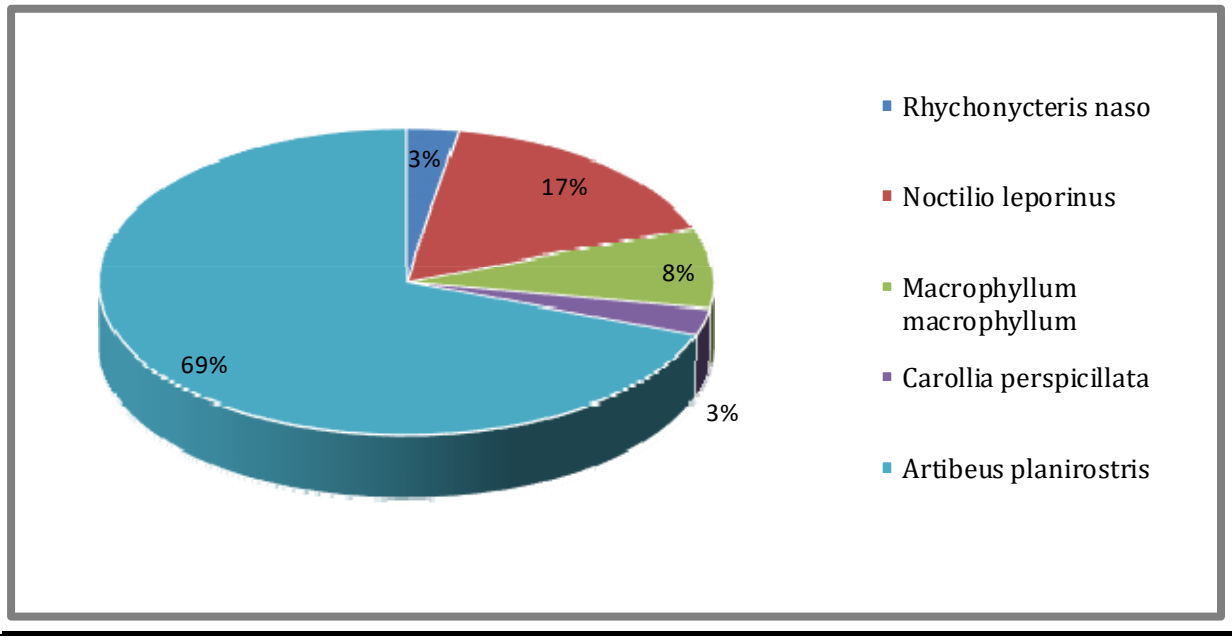

FIGURE 13-5: PERCENTAGES OF BAT SPECIES CAPTURED AT HOPE BEACH (2018 SURVEY)

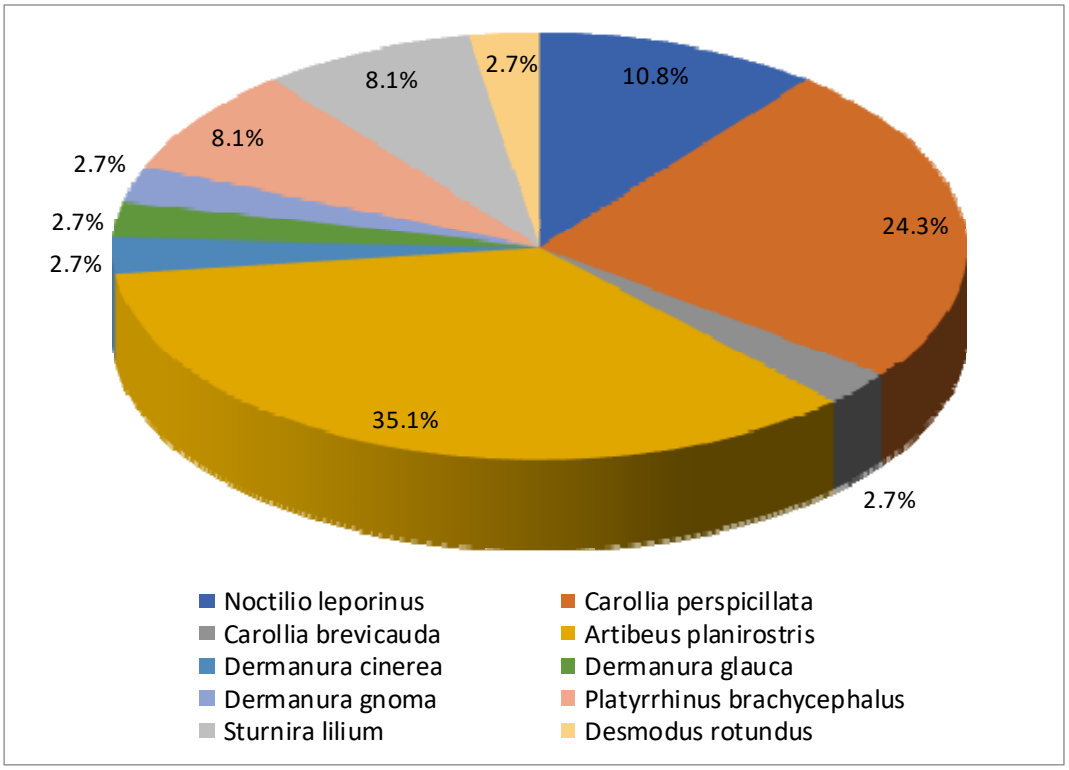

FIGURE 13-6: PERCENTAGES OF BAT SPECIES CAPTURES AT CHAPMAN'S GROVE

IUCN Status and Regional Status

Based on the IUCN Redlist, no Critically Endangered or endangered species were observed during the surveys with all captured species being of Least Concern (Table 13-7). There were no new species recorded for the country with all species captured being common to the region. None of the thirty-one species believed to be endemic to the Guiana Shield Regions (based on Lim, Engstrom and Ochoa, 2005) or to Guyana were recorded during this survey.

TABLE 13-7: IUCN CONSERVATION STATUS

SPECIES	COMMON NAME	IUCN STATUS	POPULATION STATUS
Rhychonycteris naso	Proboscis Bat	Least Concern	Unknown
Noctilio leporinus	Greater Bulldog Bat	Least Concern	Unknown
Macrophyllum macrophyllum	Long-legged Bat	Least Concern	Unknown
Carollia perspicillata	Seba's Short-tailed Bat	Least Concern	Stable
Artibeus planirostris	Flat-face fruit-eating Bat	Least Concern	Stable
Carollia brevicauda	Silky Short-tailed Bat	Least Concern	Stable
Dermanura cinerea	Gervais's Fruit-eating Bat	Least Concern	Unknown
Dermanura glauca	Silver Fruit-eating bat	Least Concern	Unknown
Dermanura gnoma	Dwarf Fruit-eating Bat	Least Concern	Unknown
Platyrrhinus brachycephalus	Broad-nosed Bat	Least Concern	Stable
Sturnira lilium	Little Yellow-shouldered Bat	Least Concern	Stable
Desmodus rotundus	Vampire Bat	Least Concern	Stable

Feeding Guilds, Dimorphism and Development

Of the 36 individual bats captured at Hope Beach, the majority of the bats captured were frugivores (72%) while a minority were piscivores (17%) or insectivores (11%). Of the 37 individuals captured at Chapman's Grove, the majority of bats captured were also frugivores (86%), followed by piscivores (11%), and one sangivore (blood drinking/vampire bat) (3%). When combining both surveys, the majority of bats recorded were frugivores (80%), followed by piscivores (14%), insectivores (5%) and sangivores (1%). No insectivorous bats were captured at Chapman's Grove and no

high-flying insectivorous bats were captured at either site. Although a total of 7 individuals were seen flying above the canopy at Chapman's Grove the exact species could not be identified, but they were assumed to be insectivorous bats based on their flight patterns.

The insectivorous bats captured (two species and four individuals) were *Rhynchonycteris naso* and *Macrophyllum macrophyllum*, which are known to prey on aquatic insects – these were found only at Hope Beach. *Noctilio leporinus* is classed as a piscivore, though the species is known to also feed occasionally on insects – these were found at both sites. In particular, this species was observed trawling in the tidal pools, suggesting that they feed on both marine and freshwater fish. *Desmodus rotundus* is classed as a sangivore (blood drinker), and was observed only at Chapman's Grove. The remaining bats: *Carollia perspicillata*, *Carollia brevicauda, Dermanura cinerea, Dermananura glauco, Dermanura gnoma, Platyrrhinus brachycephalus, Sturnira lilium* and *Artibeus planirostris* are frugivores.

For the 2018 survey, of the 36 individuals captured 16 (44%) were male and 20 (56%) were female. Of the females, 6 were lactating, while 8 were post-lactating. Two females were sub-adults and one was a juvenile. In contrast, at Chapman's Grove, of the 37 individuals captured during the 2020 survey, 80% were females and 20% were males. Only two (2) individuals had any indicative signs of reproduction (one was a pregnant female, while the other was post-lactating).

Bat Flight in Relation to the Proposed Wind Turbine Height

During the course of the 2018 survey there were no high-flying bats observed or captured (i.e. those that fly regularly over the canopy). The bats that were observed flying were well within the reach of the ground nets. The canopy height for the mangroves is approximately 15 meters, and the lower arc of the disc for the turbine blades is between 30-45 meters. Thus, almost all bat species now known to frequent the project site generally rarely fly to turbine blade height and generally fly five to 20 m below that height. Thus, all the species captured at Hope Beach can be classified as understory bats.

At Chapman's Grove, 5 aerial insectivores were observed feeding above the coconut trees on February 12, 2020, while on the following evening, two (2) individuals were observed. The coconut trees are approximately 15 -20 m tall and are therefore lower than the turbine blades. All other species captured at Chapman's Grove were observed flying below the canopy and are therefore classified as understory bats.

The mangrove system and other plants in the area, make conditions ideal for the large numbers of frugivorous species that have been captured at both sites, as these frugivores are known to feed within the canopy of the forest and use the understory for moving around. Species like *Rhychonycteris naso* and *Macrophyllum macrophyllum*

are known to prefer areas close to water for roosting and hunting. Hence, these species would not need to fly at great heights to forage and would therefore be unlikely to have interaction with wind turbine structures. The Vampire Bat, once it finds a source of food would return to that food location as long as the food source remains. As with the piscivorous bats, these vampire bats are unlikely to be flying at great heights for a food source.

None of the bat species captured on site are considered migratory. Tropical bats in general are not known to do the kinds of long-distance migration as seen in North America. Rather, most tropical bats engage in lateral, short distance migration in search for food. However, given the nature of the study area and the abundance of fruit trees, canals and mangroves, there will be little need for lateral migration and therefore these bats are present year-round.

Economic Importance and Ecological Significance

The majority of bats sampled at Hope Beach were frugivores or insectivores while at Chapman's Grove, the majority were frugivores (see Section 13.4.3.2). At Chapman's Grove frugivores are more likely to have negative economic impacts for the villagers since most of the economic activities are dependent on selling produce from farming (including fruit from surrounding fruit trees). Based on the survey, the population of the fruit eating *Artibeus planirostris* in this area is high. The mangrove forest and the fruit trees identified in the floral surveys would not be adequate to support the species identified. The aerial insectivores would lend the service of feed on mosquitoes and other species of insects that may impact humans and their farms. Prolong sampling may identify other species that would have more positive benefits to human populations.

13.4.4 Non-volant Mammals and Herpetofauna

This section summarises the findings of the non-volant mammal and herpetofauna baseline studies carried out in the study area in November 2020. Additional data are provided in Appendix E to this report.

13.4.4.1 Method

Herpetofauna and non-volant mammals were surveyed during the second avifaunal survey (2020) at Hope Beach and Chapman's Grove from November 20-24, 2020 and November 25-29, 2020, respectively. The herpetofauna and non-volant mammal surveys involved walking the same transects along which the birds were surveyed (see Figures 13-7 and 13-8). The Herpetofauna was surveyed using Visual Encounter

SOURCE: Ichthyofaunal Assessment, Mark Ram, 2020

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DWG. NAME:	ICHTHYOFAUNA SAMPLING SITES AT HOPE BEACH
FIGURE NUMBER:	13-7

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SOURCE: Ichthyofaunal Assessment, Mark Ram, 2020

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DWG. NAME: ICHTHYOFAUNA SAMPLING SITES AT CHAPMAN'S GROVE

FIGURE NUMBER: 13-8

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Survey (VES) and Audio Encounter Survey (AES), to record the species by the identification of their vocalisations. The mammals were surveyed using Visual Encounter Survey (VES), and looking for their scat, trails and tracks/footprints.

13.4.4.2 Findings

Herpetofauna

Fourteen herpetofaunal species, representing 8 families comprised of 44 individuals were observed collectively at the Hope Beach and Chapman's Grove sites (see Table 13-8). The amphibians consisted of 6 species of frogs. The reptiles consisted of 2 snake species, 5 lizard species and the Spectacled Caiman (*Caiman crocodilus*). All the Herpetofauna recorded have an IUCN status of Least Concern.

Residents of the Chapman's Grove area and the mangrove rangers stated that Green Anaconda (*Eunectes murinus*) and the Labaria snake (*Bothrops atrox*), a very venomous pit-viper, inhabit the water-ways and landmass within the Chapman's Grove plantations, respectively.

Biogeographically, all frogs and reptiles recorded are widespread and common throughout Guyana and the wider Amazonian region.

TABLE 13-8: HERPETOFAUNA COLLECTIVELY OBSERVED AT BOTH SITES (2020 SURVEY)

FAMILY	SPECIES	COMMON NAME
Bufonidae	*Rhinella murina*	Marine Toad
Hylidae	*Scinax rubra*	Scinax rubra
	Pseudis paradoxa	Paradoxical Frog
Leptodactylidae	*Leptodactylus fuscus*	Whistling Frog
	Leptodactylus sp.1	frog 1
	Leptodactylus sp.2	frog 2
Colubridae	*Lygophis lineatus*	Grass Snake
Boidae	*Boa constrictor*	Red-tailed Boa
Teiidae	*Gymnophthalmus underwoodi*	Microteiid Lizard
	Tupinambis teguixin	Gold Tegu Lizard
	Ameiva ameiva	Green Garden Lizard
Iguanidae	*Anolis aeneus*	Bronze Anole
	Iguana iguana	Green Iguana
Alligatoridae	*Caiman crocodilus*	Spectacled Caiman

Non-volant Mammals

Four non-volant mammalian species, representing four families comprised of 10 individuals were observed collectively at the Hope Beach and Chapman's Grove sites (see Table 13-9). All the mammals recorded have an IUCN status of Least Concern.

TABLE 13-9: NON-VOLANT COLLECTIVELY OBSERVED AT BOTH SITES (2020 SURVEY)

FAMILY	SPECIES	COMMON NAME
Cebidae	*Sapajus (Cebus) apella*	Brown Capuchin
Muridae	*Rattus sp.*	Field Rat
Herpestidae	*Herpestes edwardsi*	Grey Mongoose
Procyonidae	*Procyon cancrivorus*	Crab-eating Raccoon

13.4.5 Ichthyofauna

This section summarises the findings of ichthyofaunal baseline studies carried out in the study area in November 2020. Additional data are provided in Appendix G to this report.

13.4.5.1 Method

The Ichthyofaunal (Fish) Survey was carried from November 20 – 30, 2020 at 10 sites: 5 sites at Hope Beach (Sites 1-5) and 5 sites at Chapman's Grove (Sites 6-10) (see Figures 13-7 and 13-8). At both sites the habitat was evaluated based on biophysical characteristics including habitat types, water type, adjacent land use, aquatic vegetation and physicochemical conditions (*i.e.* turbidity, temperature, pH and dissolved oxygen) *et cetera* (see Tables 13-10 and 13-11 for descriptions).

At both locations, gillnets and cast nets were used to capture fishes from the larger canals, while a drag seine was used for the smaller channels. The gill nets were deployed in the morning and checked hourly until dusk. The cast nets were thrown until the boundaries of the canals were covered. The drag seine was set at random spots along the smaller channels, and the fishes were chased into the net; this was done until the entire length of the channels was covered. Fish caught were photographed, measured, identified, and released back into their native habitats.

13.4.5.2 Findings

The findings at the two sites are summarised under the following headings:

- Habitat Description;
- Species Richness, Abundance and Diversity; and
- IUCN Status and CITES Status.

Habitat Description

Tables 13-10 and 13-11 give the habitat descriptions for the Hope Beach and Chapman's Grove sites, respectively. A description of the drainage associated with the canals being sampled is also included in Section 8.4. The Hope area was characterized by lower pH, turbidity, dissolved oxygen (DO) than Chapman's Grove. Lower surface temperatures existed at Chapman's Grove due to shade provided by surrounding coconut trees, while this is absent at the sites sampled in the Hope area. Lower DO at Hope implies that some of the sites had a higher concentration of dissolved minerals such as salt.

TABLE 13-10: HABITAT DESCRIPTION OF FISH SAMPLING SITES AT HOPE BEACH

LOCATION	SITE NO.	HABITAT DESCRIPTION	PICTURE
Hope	1	Type: Canal pH: 8.7 Temperature: 34.5 °C DO: 0.02 mg/L Width:24.6 m Length: 388.6 m Depth: 1.0 m Turbidity: 19 cm Water colour: Brackish Substrate: Clay, silt, woody debris, pebbles, cobbles and gravel.	

LOCATION	SITE NO.	HABITAT DESCRIPTION	PICTURE
Hope	2	Type: Small canal pH: 10.3 Temperature: 33.5 °C DO: 0.01 mg/L Turbidity: 22 cm Width: 12.1 m Length: 85.4 m Depth: 0.3 m Water type: Brackish Substrate: Clay, silt woody debris, pebbles, scrubs, and grass.	
Hope	3	Type: Canal pH: 7.3 Temperature: 31°C DO: 4.01mg/L Turbidity:26.7 cm Width: 73.6 m Length:304.3 m Depth: 4.2 m Water type: Freshwater Substrate: clay, scrubs, and grass	
Hope	4	Type: Small canal pH: 7.0 Temperature: 35.5 °C DO: 1.69 mg/L Turbidity:15.5 cm Width:3.3 m Length:10.6m Depth: 0.3 m Water type: Freshwater Substrate: Clay, scrubs and grass	

LOCATION	SITE NO.	HABITAT DESCRIPTION	PICTURE
Hope	5	Type: Small canal pH: 9.8 Temperature: 36.5 °C DO: 12.1mg/L Turbidity: 14.5 cm Width: 3.6 m Length: 35.5 m Depth: 0.3 ft Water type: Brackish Substrate: Clay and grass	

TABLE 13-11: HABITAT DESCRIPTION OF FISH SAMPLING SITES AT CHAPMAN'S GROVE

LOCATION	SITE NO.	HABITAT DESCRIPTION	PICTURE
Chapman's Grove	6	Type: Canal pH: 12.2 Temperature: 31.8 °C DO: 3.9 mg/L Turbidity: 25.5 cm Width: 12.1 m Length: 35.5 m Depth: 1.2 m Water type: Brackish Substrate: Clay, silt, sand, woody debris, leave litter and pebbles	

Chapman's Grove	7	Type: Canal pH: 12.5 Temperature: 33.6 °C DO: 1.7 mg/L Turbidity:24.9 cm Width: 9.1 m Length: 69.5 m Depth: 1.5 m Water type: Brackish Substrate: Clay, silt, sand, woody debris, leave litter, grass, shrubs, and trees	
Chapman's Grove	8	Type: Canal pH: 12.8 mg/L Temperature: 34.0 °C DO: 2.89 mg/L Turbidity:30.9 cm Width: 1.8 m Length: 265.1 m Depth: 0.6 m Water type: Brackish Substrate: clay, silt, wood debris, leave litter, aquatic vegetation, trees, shrubs, and grass	
Chapman's Grove	9	Type: Ponded water pH: 12.5 Temperature: 32.7 °C DO: 0.8 mg/L Turbidity:23.8 cm Width: 8.3 m Length: 52.6 m Depth: 0.4 m Water type: Brackish Substrate: clay, silt, sand, woody debris, leave litter, pebbles, cobbles, trees, shrubs, and grass	

Chapman's Grove	10	Type: Stream pH: 11.7 Temperature: 31.7 °C DO:1.3 mg/L Turbidity:22.5 cm Width: 2.2 m Length: 286.4 m Depth: 2.4 m Water type: Brackish Substrate: clay, woody debris, aquatic vegetation, shrubs, and trees	

Species Richness, Abundance and Diversity

At Hope Beach, 256 individual fish from 18 species representing 11 families were recorded while at Chapman's Grove, 172 individual fish from 21 species representing 16 families were recorded (see Tables 13-12 and 13-13). Overall, Chapman's Grove had a higher species richness (21) than Hope (18). Similarly, the species diversity was greater at Chapman's Grove than at Hope (see Figure 13-9). The higher fish species diversity and richness at Chapman's Grove is due to interconnectivity and diverse habitats at Chapman's Grove in comparison to Hope Beach. The habitats at Chapman's Grove were rich with detritus from the fallen leaves and stems of the trees in the area, and this is a major food source for a variety of fish species.

The dominant (abundant) species were the *Hypostomus spp.* at Hope Beach and *Centropomus mexicanus* at Chapman's Grove (see Figures 13-10 and 13-11). *Hypostomus spp.* typically inhabits slow-flowing, lower reaches of rivers between the lower falls and the estuarine zone, such as at Hope, where they feed on algae/vegetal matter, periphyton, detritus, and benthic aquatic invertebrates (Pond, 2014; Froes & Pauly, 2014; Weber *et al*., 2012). *Centropomus mexicanus* favors the estuarine environment at Chapman's Grove, where they easily spawn on banks and feed on small fish and crustaceans. Most of the species recorded at both locations were juveniles which suggest that these sites are healthy breeding grounds.

TABLE 13-12: FISH SPECIES RECORDED DURING SURVEY AT HOPE BEACH

ORDER	FAMILY	SPECIES	NO. OF INDIVIDUALS
Perciformes	Cichlidae	*Aequidens tetramerus*	2
		Cichlasoma bimaculatum	15
		Crenicichla saxatilis	1
		Oreochromis aureus	1
		Oreochromis niloticus	25
	Centropomidae	*Centropomus ensiferus*	2
		Centropomus mexicanus	4
	Polycentridae	*Polycentrus schomburgkii*	6
Characiformes	Characidae	*Astyanax bimaculatum*	1
		Astyanax spp.	12
		Serrasalmus rhombeus	2
	Curimatidae	*Curimata cyprinoides*	2
	Erythrinidae	*Hoplias malabaricus*	2
Cyprinodontiformes	Poeciliidae	*Poecilia parae*	7
Elopiformes	Megalopidae	*Metynnis altidorsalis*	5
	Elopidae	*Elops saurus*	1
Siluriformes	Pimelodidae	*Pimelodus blochii*	1
	Loricariidae	*Hypostomus spp.*	168

TABLE 13-13: FISH SPECIES RECORDED DURING SURVEY AT CHAPMAN'S GROVE

ORDER	FAMILY	SPECIES	NO. OF INDIVIDUALS
Siluriformes	Ariidae	*Amphiarius rugispinis*	1
		Sciades couma	10
	Loricariidae	*Hypostomus spp.*	1
	Pimelodidae	*Pimelodus spp.*	1
	Auchenipteridae	*Pseudauchenipterus nodosus*	5
Cyrinodontiformes	Anablepidae	*Anableps anableps*	1
	Poeciliidae	*Poecilia parae*	14
Characiformes	Characidae	*Ctenobrycon spilurus*	3
		Serrasalmus rhombeus	1
	Carangidae	*Oligoplites palometa*	1
	Curimatidae	*Curimata crprinoides*	2
Characiformes	Erythrinidae	*Hoplias malabaricus*	1
Perciformes	Centropomidae	*Centropomus mexicanus*	74
	Cichlidae	*Cichlasoma bimaculatum*	13
		Crenicichla alta	8
		Oreochromis aureus	2
		Oreochromis niloticus	11
	Gobiidae	*Gobioides oceanicus*	2
	Polycentridae	*Polycentrus sp.*	1
Elopiformes	Megalopidae	*Megalops atlanticus*	11
Mugiliformes	Mugilidae	*Mugil incilis*	9

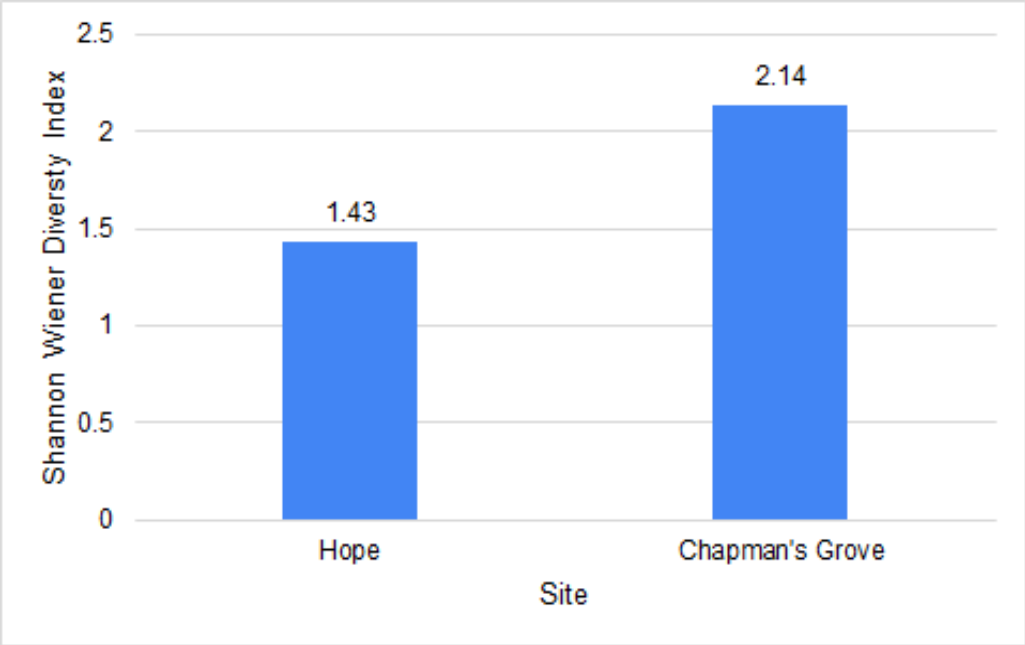

FIGURE 13-9: SHANNON WIENER DIVERSITY INDEX OF HOPE BEACH VERSUS CHAPMAN'S GROVE

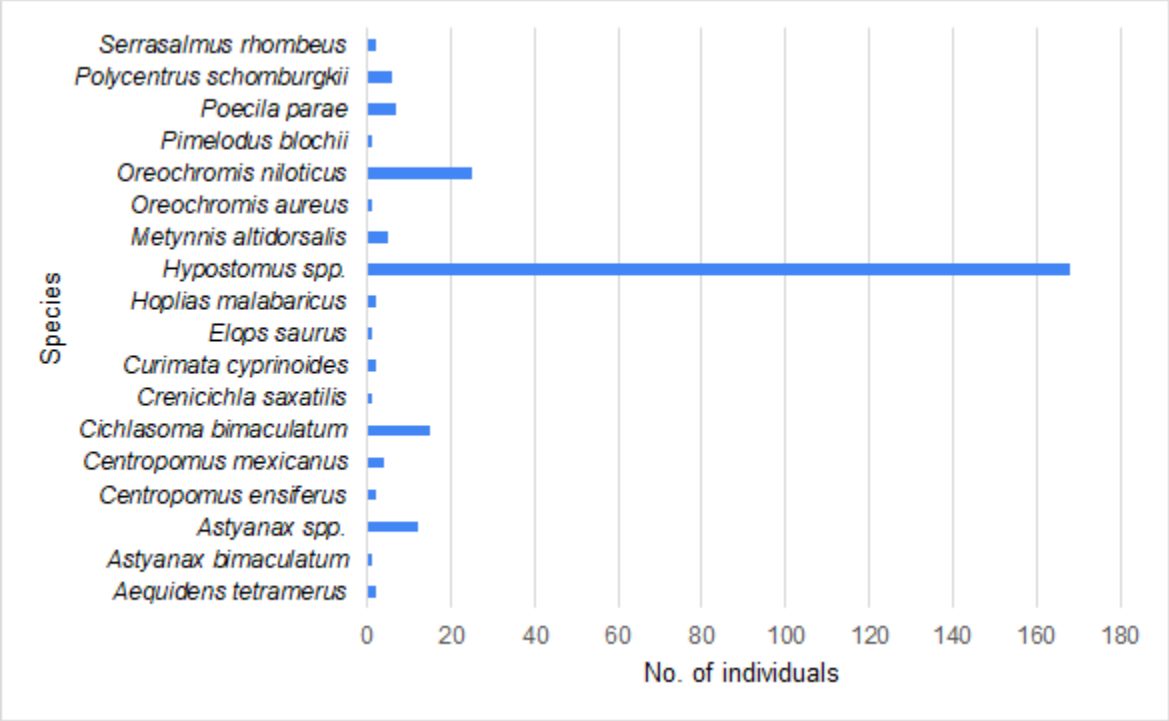

FIGURE 13-10: SPECIES ABUNDANCE OF FISH CAPTURED AT HOPE BEACH

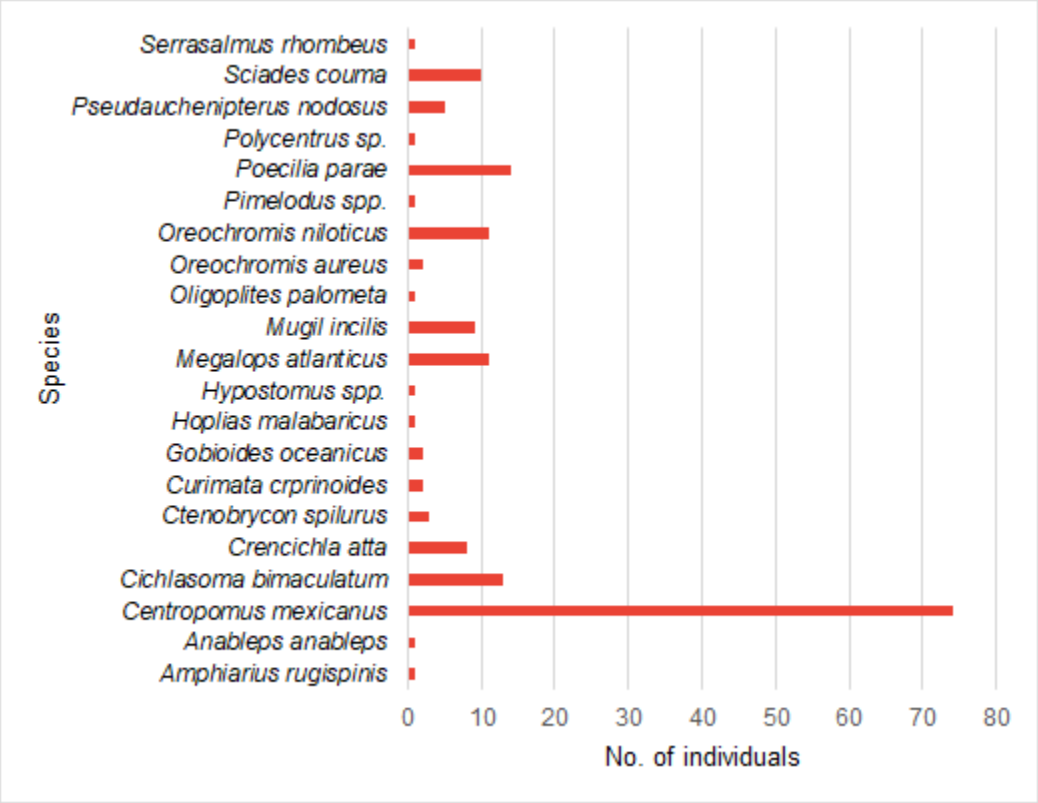

FIGURE 13-11: SPECIES ABUNDANCE OF FISH CAPTURED AT CHAPMAN'S GROVE

IUCN and CITES Status

Based on the IUCN Red List, there were no endangered species with most species being classified as "Not Listed" or "Least Concern"; this indicates that there are no immediate threats to their populations (see Tables 13-14 and 13-15). At Hope Beach "Not Listed" and "Least Concern" where 67% and 22%, respectively while at Chapman's Grove these percentages were 52% and 29%, respectively (see Figures 13-12 and 13-13).

At Chapman's Grove, one species (*Megalops atlanticus* – the Atlantic Tarpon) was classified as "Vulnerable" on the IUCN Red List (see Table 13-15). While there has been no formal stock assessment of this species, multiple lines of evidence suggest that populations of *Megalops atlanticus* are declining from their historic levels throughout their range. This decline is largely due to regional commercial harvest, especially in Brazil. To conserve this and other species with their habitats, many countries are using marine protected areas in conjunction with existing fisheries regulations to build

sustainable fisheries and protect marine biodiversity. Catch-and-release is commonly practiced by recreational anglers with strong conservation in regions where *Megalops atlanticus* is distributed.

All of the fish species captured during this survey were not listed on the CITES checklist which indicates they are not endangered or threatened and they can be traded (see Table 13-14 and 13-15).

TABLE 13-14: IUCN AND CITES STATUSES OF FISH RECORDED DURING SURVEY AT HOPE BEACH

SPECIES	IUCN STATUS	CITES STATUS
Aequidens tetramerus	Not Listed	Not Listed
Astyanax bimaculatum	Not Listed	Not Listed
Astyanax spp.	Unknown	Not Listed
Centropomus ensiferus	Least Concern	Not Listed
Centropomus mexicanus	Least Concern	Not Listed
Cichlasoma bimaculatum	Not Listed	Not Listed
Crenicichla saxatilis	Not Listed	Not Listed
Curimata cyprinoides	Not Listed	Not Listed
Elops saurus	Least Concern	Not Listed
Hoplias malabaricus	Not Listed	Not Listed
Hypostomus spp.	Unknown	Not Listed
Metynnis altidorsalis	Not Listed	Not Listed
Oreochromis aureus	Not Listed	Not Listed
Oreochromis niloticus	Least Concern	Not Listed
Pimelodus blochii	Not Listed	Not Listed
Poecila parae	Not Listed	Not Listed
Polycentrus schomburgkii	Not Listed	Not Listed
Serrasalmus rhombeus	Not Listed	Not Listed

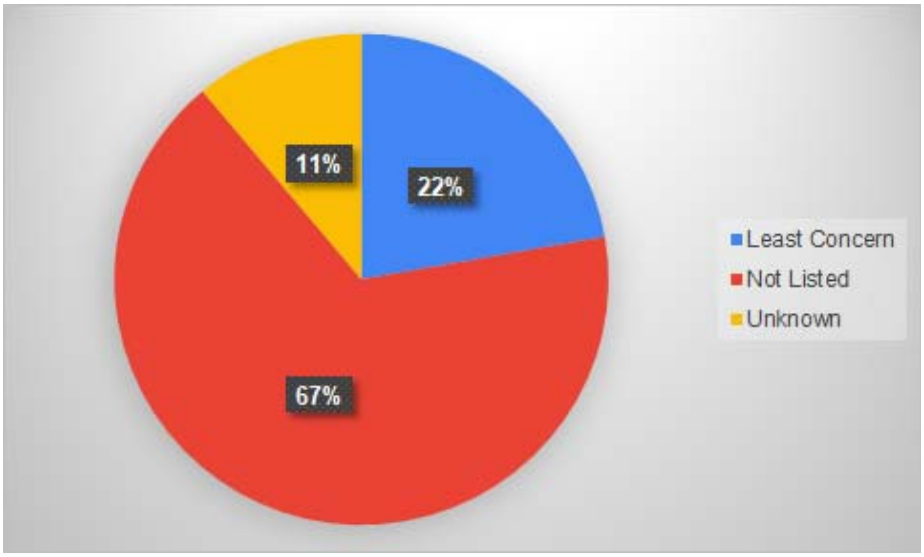

FIGURE 13-12: IUCN CATEGORIES OF FISH CAPTURED AT HOPE BEACH

TABLE 13-15: IUCN AND CITES STATUSES OF FISH RECORDED DURING SURVEY AT CHAPMAN'S GROVE

SPECIES	IUCN STATUS	CITES STATUS
Amphiarius rugispinis	Least Concern	Not Listed
Anableps anableps	Not Listed	Not Listed
Centropomus mexicanus	Least Concern	Not Listed
Cichlasoma bimaculatum	Not Listed	Not Listed
Crencichla alta	Not Listed	Not Listed
Ctenobrycon spilurus	Not Listed	Not Listed
Curimata crprinoides	Not Listed	Not Listed
Gobioides oceanicus	Not Listed	Not Listed
Hoplias malabaricus	Not Listed	Not Listed
Hypostomus spp.	Unknown	Not Listed
Megalops atlanticus	Vulnerable	Not Listed
Mugil incilis	Least Concern	Not Listed
Oligoplites palometa	Least Concern	Not Listed
Oreochromis aureus	Not Listed	Not Listed
Oreochromis niloticus	Least Concern	Not Listed
Pimelodus spp.	Unknown	Not Listed
Poecilia parae	Not Listed	Not Listed
Polycentrus sp.	Unknown	Not Listed
Pseudauchenipterus nodosus	Not Listed	Not Listed
Sciades couma	Least Concern	Not Listed
Serrasalmus rhombeus	Not Listed	Not Listed

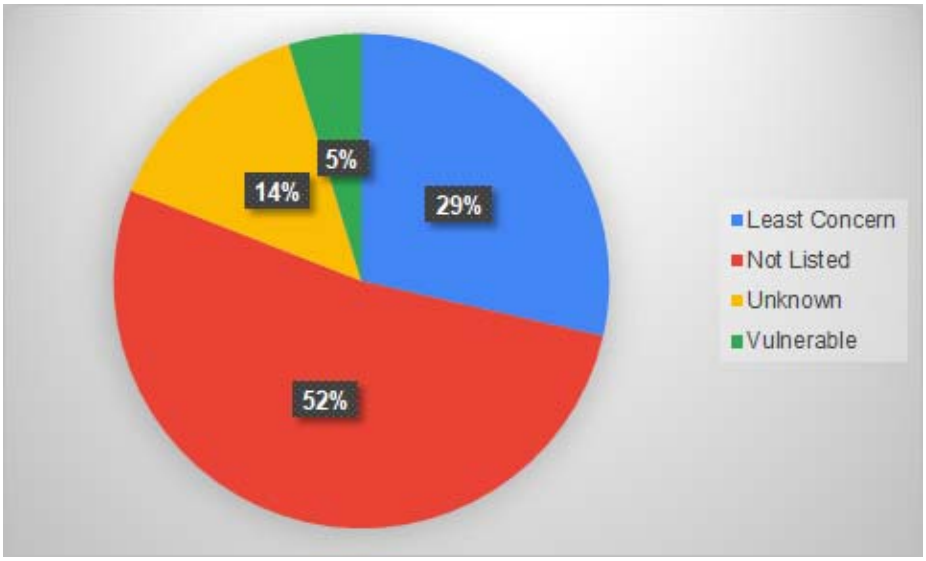

FIGURE 13-13: IUCN CATEGORIES OF FISH CAPTURED AT CHAPMAN'S GROVE

13.4.6 Summary of Biological Findings

The following is a summary of the main findings of the biological background for the study area:

- The proposed Hope Beach project site is located on the beach ridge and floral species include the dominant *Jatropha gassypiifolia* (Bellyache Bush), *Fimbristalys spathacea*, *Thespesia populnea* (Wild Physic Nut), *Ipomea biloba*, *Cynodon dactylon*, *Dactylis glomerata, Syzygium cumunii* (Jamoon) and *Cocos nucifera* (Coconut).
- The Hope Beach site is located in proximity to mangroves, with young tidal flat mangroves to seaward and mature mangrove swamps landward. Marine erosional processes are rapidly reducing the extent of the tidal flat mangroves.
- The proposed Chapman's Grove project site is located in a coconut plantation. There is mangrove in proximity to the site.
- At both the Hope Beach and Chapman's Grove site, *Avicennia germinans* (Black Mangrove) was the dominant mangrove species.

- For both sites, the 2020 avifaunal survey recorded 106 species of birds representing 36 families and comprised 2214 individuals, while the 2018 survey recorded 102 species of birds representing 33 families and comprising 4518 individuals. Based on Shannon's diversity index between 2.03 and 3.35 the populations are considered fairly diverse, in line with an overall high diversity for Guyana.
- One IUCN Vulnerable species and two IUCN Near Threatened Species which are also specialized mangrove species were recorded during the pre-construction surveys. All other species were listed as Least Concern by the IUCN. The majority of birds observed are common to the coastal areas of Guyana.
- Eighty-five (85%) of the birds recorded for both surveys were resident species. Eighteen (18) species of migratory birds were identified during the surveys, and included shorebirds, raptors, pelagic birds and some wetland birds. Very few night-time migratory passerine birds were identified during the surveys.
- The vast majority of birds (72%) observed during the surveys were low flyers (<20 m), while only 6% of the bird species observed were able to reach heights greater than 40 m. The vast majority of bird species forage and perch below the 15 to 25m high canopy at both Hope Beach and Chapman's Grove.
- Fly-overs along the shoreline accounted for the largest numbers of birds observed, the majority of these birds passed the study area without stopping (Scarlet Ibis, Magnificent Frigatebird, Snowy Egret, and Herons). Their flight paths occurred mostly between the sea and mangrove tidal flats during moderate to low winds, and further inland over the marshes during stronger winds. Birds fly at a low elevation heading upwind to the southeast in the morning, and at moderate to high elevation heading downwind during the late afternoon return flight to the northwest.
- Thirty-six (36) individual bats belonging to 5 species (representing 3 families) were recorded at Hope Beach in 2018, while thirty-seven (37) individual bats belonging to 10 species (representing 2 families) were recorded at Chapman's Grove in 2020.
- Diversity was only calculated for Chapman's Grove since the Hope Beach dataset (2018) was too small to calculate species diversity index. The Chapman's Grove index was H=1.849, indicating a fairly low diversity.
- For both locations, the most abundant species was *Artibeus planirostris* (Fruit Eating Bat). Overall, the large majority of species observed were fructivores (81%), followed by piscivores (13%), aquatic insectivores (5%) and sangrivore (1%). The Vampire Bat (sangrivore) was the most unique species encountered, and it was only observed at Chapman's Grove.
- None of the species recorded were critically endangered or endangered. All species observed are IUCN Least Concern status, and are widespread across Guyana's coastal plain

- All recorded bats, including the insectivore bats, were understory bats. Only 7 high flying bats were observed at Chapman's Grove during the entire survey, but the species could not be identified.
- Fourteen herpetofaunal species, representing 8 families comprised of 44 individuals were observed collectively at the Hope Beach and Chapman's Grove sites. All species have an IUCN status of Least Concern, are common in Guyana and are not endemic.
- Four non-volant mammalian species, representing four families comprised of 10 individuals were observed collectively at the Hope Beach and Chapman's Grove sites. All species have an IUCN status of Least Concern.
- At Hope Beach, 256 individual fish from 18 species representing 11 families were recorded with *Hypostomus spp*. Being the most abundant species.
- At Chapman's Grove, 172 individual fish from 21 species representing 16 families were recorded with *Centropomus mexicanus* being the most abundant species.
- Both the species richness and species diversity of fish were higher at Chapman's Grove compared to Hope Beach due to the interconnectivity and diverse habitats at Chapman's Grove.
- With the exception of the "Vulnerable" *Megalops atlanticus* at Chapman's Grove, no threatened species of fish based on the IUCN Red List were recorded at either site.
- None of the fish captured at either survey were listed on the CITES checklist which indicates they are not endangered or threatened and they can be traded.

13.5 Impact Prediction and Assessment

This section discusses the potential biological impacts associated with this proposed project during the construction and operation phases.

13.5.1 Construction Phase

During the construction phase concerns with respect to the biological environment arise from:

- Clearing of Vegetation (Habitat Loss);
- Fragmentation;
- Disturbance to Terrestrial Species;
- Disturbance to Aquatic Species;
- Disturbance to Benthic Communities;
- Loss of Benthic Communities;

- Concerns to Migratory Species; and
- Concerns to Rare and Endangered Species.

13.5.1.1 Clearing of Vegetation (Loss of Terrestrial Habitat)

Both the Hope Beach and Chapman's Grove sites are highly modified and fragmented by existing development such as the seawall, farming, roads, residential areas and canals including the Hope Canal. The only existing natural habitats are the mangrove and beach ridge, and these too are already fragmented and isolated due to surrounding highly modified terrain. In addition, the extensive tidal flat mangroves are likely to be completely removed by natural erosion in the near term, a process which has already begun and is accelerating.

The mangrove tidal flat accretion and erosion cycles along the entire coastline including at Hope Beach are well understood as described in Section 9.4.2.3. This data provided enough information to understand the need to ensure that the proposed wind farm is protected and therefore it was not considered necessary to undertake any modelling to project changes to the coastline especially since the proposed wind farm will not be built on the shoreline and therefore has no potential to impact the coastline. As noted in Appendix M, the Sea and River Defense Board (SRDB) has committed to construction of the seawall from Greenfield to Unity. Plans are also in place to construct a realigned seawall at Hope Beach via a straightened seawall which will protect the Hope Canal outlet, flood gate facility, fishing boat anchorage, back-barrier mangroves, the Hope Secondary School, the residential and farming community and also the Hope Wind Farm. The SRDB Chief Officer has indicated that this section of seawall is high on their priority list as the existing old seawall is already experiencing overflow on the west side of Hope Canal during extreme high-tide events, and they plan to complete the project in 2022. HED's base-case scenario is thus that the SRDB will construct the seawall. Should the SRDB delay the seawall construction, then HED would need to either construct the seawall as part of the HWF project, with impacts on total capex and PPA cost to GPL (in effect, the seawall upgrade costs will be carried by GPL customers), or delay the project till the SRDB has completed the seawall upgrade. HED has been informed of the Capex impact by the SRDB, and either option is possible. Such a back-up option will be assessed in greater detail during the detailed engineering design phase.

Nature of Concern

The Hope Beach project site is located on the beach ridge and floral species include the dominant *Jatropha gossypiifolia* (Bellyache Bush), *Fimbristalys spathacea*, *Thespesia populnea* (Wild Physic Nut), *Ipomea biloba*, *Cynodon dactylon*, *Dactylis glomerata, Syzygium cumunii* (Jamoon) and *Cocos nucifera* (Coconut). The proposed Chapman's Grove project site is located in a coconut plantation. There is mangrove in proximity to both of these sites. Removal of vegetation is directly related to loss of habitat for

terrestrial and riparian fauna. Clearing of vegetation also increases the potential for on-site erosion and slope instability (see Sections 9.5.1.1 and 9.5.1.2).

Unmitigated Impact

During the construction phase, civil works will entail the construction of the site access roads (including 2 bridges at Chapman's Grove) and the wind turbine foundations and the installation of the wind turbines. Electrical works will entail laying of buried and overhead medium voltage collector cables, construction of the substation (at Chapman's Grove), and installation of the high-voltage transmission line to interconnect with the grid. Figures 5-2 and 5-3 show the site layouts, access routes, crane pads and temporary laydown areas required during the construction phase for Hope Beach and Chapman's Grove. The crane pad is an area of 120 m^2 while the lay-down area for each WTG site covers approximately 2,000 m^2. A total of some 2.5km of 5m wide access roadway is planned, of which 30% will be on existing agricultural land, 40% along upgraded existing access roads and modified terrain, and 30% on beach ridge terrain.

As shown in Figures 13-1 and 13-2, mangrove is found in proximity to both project sites. Vegetation along/at the site access roads, crane pads, temporary laydown areas, wind turbine foundations and substation will have to be cleared as part of site preparation and construction activities. Any clearing of trees during site preparation and construction will be a permanent and unavoidable impact of this development. However, most of the area to be used are existing roads, and farmland, with only the crane pads and foundation and roads to be permanently cleared. This equals 4,500m^2 (1.1 acre) of original beach ridge habitat being permanently affected. Plants and grasses are expected to regrow at some areas such as along the roadways and at the temporary laydown areas after these activities are completed.

Five bird species which are classified as "Near Threatened" or "Vulnerable" on the IUCN Red List (*i.e.* Rufous Crab Hawk, Bicolored Conebill and White-bellied Piculet) or are of least concern (*i.e.* Mangrove Rail and Mangrove Cuckoo) were recorded in the study area. These species are specialized to mangrove forests. It is expected that any displaced fauna will be able to inhabit similar continuous areas and their functioning may only be impaired for a short-period until they re-establish themselves in adjacent suitable habitats.

Unmitigated, the potential impact of clearing of vegetation is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Onsite	Minor	Long Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Onsite	Very Small	Long Term	**LOW**

Mitigation Measures

The following mitigation measures are recommended to address this concern:

- The routes of the proposed site roads will avoid mangrove to the extent practicable to limit the need to clear mangrove trees;
- Avoid clearing vegetation in areas not required for construction works;
- Burning of cleared vegetation to be prohibited;
- Use of herbicides to aid in removal of vegetation to be prohibited;
- All necessary permits relating to the felling of trees to be obtained; and
- Re-vegetate as far as practicable and as soon as possible.

Hope Beach

Extent	Intensity	Duration	Classification
Onsite	Very Small	Long Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Onsite	Very Small	Long Term	**LOW**

13.5.1.2 Fragmentation

Nature of Concern

Fragmentation is another potential impact which is expected to start during site preparation and construction and extend into the operation phase. The concerns related to fragmentation include:

- Reduction in the total area of habitat (see Section 13.5.1.1 above); and
- The creation of edge effects.

The clearing of vegetation associated with the proposed works has the potential to create 'edges'. As a benefit, 'edges' can lead to increased diversity, as new saplings and dense undergrowth provide both shelter from predators as well as food sources for

a variety of species, making it preferred areas for foraging. On the other hand, increased light penetration and the resultant increased undergrowth density increase predation at these 'edges'. Additionally, the presence of the access roads, crane pads, laydown areas *et cetera* may act as a physical barrier, deterring the movement of small animals such as mammals, lizards and insects.

Unmitigated Impact

As discussed in Section 13.5.1.1, the proposed works involved the construction of access roads, crane pads, laydown areas, wind turbine foundations and a substation mainly through habitat that is already disturbed (*i.e.* secondary vegetation on the beach ridge at Hope Beach and coconut estate at Chapman's Grove). While this may potentially result in fragmentation and its associated concerns, the degree of fragmentation is not expected to have a major impact as there are no animals that require large ranges of undisturbed habitat within the study area. The habitat is already disturbed as indicated by the presence of secondary vegetation; therefore, the animals inhabiting the study area are adapted to surviving in disturbed habitats. Additionally, the access roads have been designed to reduce the effects of fragmentation by crossing along the edges of the mangrove and freshwater marsh habitats in Hope Beach. Small terrestrial animals such as Grey Mongoose, Crab-eating Raccoon, lizards, and snakes are expected to cross the access roads and go around structures such as the wind turbine foundations. As discussed previously in Section 13.5.1.1, the majority of animals displaced by removal of habitat will be able to inhabit similar contiguous areas and their functioning may only be impaired for a short period until they re-establish themselves in another suitable habitat.

Unmitigated, the potential impact of fragmentation is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Very Small	Long Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Very Small	Long Term	**LOW**

The mitigation to reduce the impact related to fragmentation was to design roads and WTG sites to use existing disturbed land for access roads and to avoid the mangroves altogether.as much as possible. Since some habitat fragmentation is an unavoidable adverse impact of the proposed works, the classification of this impact "with mitigation" is not appropriate.

13.5.1.3 Disturbance to Terrestrial Species

Nature of Concern

The construction of the proposed wind farm is expected to create noise and light conditions which have the potential to impact terrestrial fauna. This is separate from the concerns related to clearing of vegetation and loss of terrestrial habitat discussed in Sections 13.5.1.1 and 13.5.1.2 above. Heavy transport vehicles and equipment are expected to generate some noise and pile driving will generate intense noise. Noise disturbance may result in mobile animals temporarily leaving the area during site clearing and construction activities. Artificial light may be required during the night to supplement existing lighting for site safety and security. Artificial lighting has the potential to impact the behaviour of nocturnal animals which may include these animals avoiding areas with increased lighting. Additionally, the influx of workers in the area during site preparation and construction may result in unauthorized hunting of animals.

Unmitigated Impact

More than 100 species of avifauna as well as several bats, non-volant mammals, lizards, and amphibians were recording during the surveys for both sites. As stated in Section 13.5.1.1, with the exception of 5 avifaunal species, no rare, endanger or threatened species were recorded. Noise impacts on wildlife must be considered in two categories: impacts on wildlife on the site; and impacts on wildlife in adjacent areas. With regard to wildlife on site, noise is not a predominant concern because it is anticipated that the majority of wildlife will leave the site due to the clearing of vegetation or take refuge in areas of the site which will not be cleared. Noise impacts during site preparation and construction are expected to be transitory, lasting only while noise-intensive activities are in progress on the site. Similarly to noise, the potential impacts associated with artificial lightning on nocturnal species will be temporary lasting only during the site preparation and construction phase of the project.

Unmitigated, the potential impact of noise and artificial light on terrestrial fauna is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Medium	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Mitigation Measures

In addition to the mitigation measures recommended for noise in Chapter 12, the following mitigation measures are recommended to address the impact of disturbance to terrestrial species:

- Limit construction works to daylight hours to the extent practical;
- If night work is to occur, shield light from the vegetation and avoid use of bare and upturned bulbs;
- The minimum light intensity that can be safety used should be employed for night work and for security purposes; and
- Prohibit hunting or harassing of animals by workers on the construction site.

By implementing these measures, this potential construction impact is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

13.5.1.4 Disturbance to Aquatic Species

Nature of Concern

Impacts to aquatic species in the rivers and nearshore areas relate particularly to the impairment of water quality from entrainment silt, hydrocarbons and lubricant spills and leaks, concrete washings and improper disposal of sewage; most of which can impact aquatic fauna. Impacts related to water quality during site preparation and construction are discussed in Chapter 8. Entrainment of silt can physically smother sessile aquatic biota, can clog the gills of aquatic fauna, may reduce the visibility in the environment making it harder for them to navigate and may also reduce the oxygen availability in the water. Hydrocarbon spills and concrete washings may be toxic to aquatic fauna. Improper sewage disposal can introduce excess nutrients (nitrates and phosphates) into the riverine environment which can lead to eutrophication within the watercourses.

Unmitigated Impact

Several aquatic and semi-aquatic species such as fish (18 species at Hope Beach and 21 Species at Chapman's Grove), Spectacle Caiman and frogs were recorded during the baseline surveys. With the exception of the "Vulnerable" *Megalops atlanticus* (Atlantic Tarpon), no rare, endangered or threatened species were recorded. As noted in Appendix G to the EIA report, many of the species are common throughout Guyana, and there are no significant impacts from the project to destroy their habitats or alter their populations. This is also true for the Atlantic Tarpon since the project area is not the sole dwelling or breeding area of this species as it can do so in the larger connecting streams. Further, this species also inhabits other estuarine areas along Guyana's coast. As shown in Figure 13-7 and 13-8 there are waterways in proximity to the proposed works at both locations which flow to the coast. The duration of the potential impact of water quality to aquatic fauna is limited to the site preparation and construction phase of the project. It is likely that discharges from the site preparation and construction will travel downstream and may enter the nearshore area at both Hope Beach and Chapman's Grove. Motile aquatic fauna are expected to move away from the disturbance caused during the construction.

Unmitigated, the potential impact of impaired water quality on aquatic fauna is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Mitigation Measures

Assuming the effective implementation of the mitigation measures listed in Chapter 8 this impact is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

13.5.1.5 Disturbance to Benthic Species

Nature of Concern

The impairment of water quality may affect benthic communities in the nearshore marine environment. During site preparation and construction, impaired water quality may occur as a result of improper sewage disposal, spilled/ leaked hydrocarbons and siltation (see Chapter 8). The effects of impaired water quality are similar to those discussed previously for the aquatic fauna (see Section 13.5.1.4 above). The introduction of these pollutants into the nearshore marine environment can impair benthic organisms altering their normal biological processes and causing them to become stressed. If the presence of these pollutants causes the death of pollution-intolerant benthic organisms, this may cause benthic communities to undergo a shift in their species composition, as the recolonisation of the location may be by pollution tolerant benthic organisms leading to a reduction in the diversity of the benthic community.

Unmitigated Impact

As discussed in Section 13.5.1.4 above, the duration of the potential impact of water quality is limited to the site preparation and construction phase of the project and will be localised to mainly downstream of the site, entering the nearshore marine environment in some areas. Benthic communities are known to re-colonise disturbed areas relatively quickly after the disturbance has passed and are therefore expected to recover once construction activities cease.

Unmitigated, the potential impact of impaired water quality on benthic fauna is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Mitigation Measures

Assuming the effective implementation of the mitigation measures listed in Chapter 8 this impact is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

13.5.1.6 Loss of Benthic Species

Nature of Concern

The placement of hard structures such as supports for bridges will result in the permanent loss of benthic organisms in the areas where these structures cover the sediment and effectively bury the sessile benthic organisms that live in the sediment.

The construction phase of the proposed project involves the construction of 2 bridges across the waterways at Chapman's Grove; no bridge construction is necessary at the Hope Beach site. The loss of benthic organisms due to the construction of these structures is a permanent and unavoidable impact. However, taking into consideration the fact that these canals are paved and dredged in order to maintain the function for flood control, it is not expected that these sediments support a diverse benthic community and therefore this impact is not considered significant.

13.5.1.7 Concerns to Migratory Species

Nature of Concern

The nature of concern described in Section 13.5.1.3 is also relevant here. During field studies in June 2018 and November 2020, there were eighteen species of migratory birds observed at the two sites. All of these species are listed as Least Concern under the IUCN red list.

Unmitigated Measures

This concern is expected to be temporary lasting only during the site preparation and construction phase. Additionally, it is not expected that these temporary impacts would affect the populations of these species. Unmitigated, the potential impact of noise and artificial light on migratory species is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Mitigation Measures

The mitigation measures recommended for noise in Chapter 12 and those listed above in Section 13.5.1.3, are also applicable here.

By implementing these measures, this potential construction impact is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

13.5.1.8 Concerns to Rare and Endangered Species

Nature of Concern

The rare and endangered species are highlighted in Section 13.4.2.2 above. These include two near threatened bird species, Rufous Crab Hawk (*Buteogallus aequinoctialis*) and Bicolored Conebill (*Conirostrum bicolor*) and one vulnerable bird

species, the White-bellied Piculet (*Picumnus spilogaster*. During site preparation and construction, these species may be impacted by noise and light conditions as described in Section 13.5.1.3, above.

Unmitigated Impact

This impact is expected to be temporary lasting only as long as the site preparation and construction phase. However, only a few individuals are expected to be impacted and not the local populations of these species. Unmitigated, the potential impact of noise and artificial light on rare and endangered species is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Minor	Short Term	**LOW**

Mitigation Measures

Apart from the mitigation measures recommended for noise in Chapter 12, the additional measures recommended in Section 13.5.1.3 to address the impact of disturbance to terrestrial species are also applicable.

By implementing these measures, this potential construction impact is classified as:

Hope Beach

Extent	Intensity	Duration	Classification
Localised	Very small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Localised	Very Small	Short Term	**LOW**

13.5.2 Operation Phase

During the operation phase the primary concerns with respect to the biological environment arise from interactions of the turbines with birds and bats. Risk assessments were conducted for both birds and bats and are included as Appendix Q and Appendix R. The specific objectives of these assessments are to evaluate the following types of impacts:

- The removal and/or alteration of existing habitat;
- Behavioural displacement/disturbance (indirect impact) of birds/bats as a result of the presence of turbines and other infrastructure; and
- Fatalities (direct impact) of birds/bats resulting from collisions with turbines or other infrastructure on site.

13.5.2.1 Concerns for Avifauna

Nature of Concern

As noted above in Section 13.5.2, the concern for birds during the operation phase relate to:

- The removal and/or alteration of existing habitat;
- Behavioural displacement/disturbance (indirect impact); and
- Fatalities (direct impact).

As a result, an Avian Risk Assessment was conducted to evaluate the potential for impacts to birds as a result of the wind farm project. The details of this risk assessment are included as Appendix Q. The following is a brief summary of the findings:

The proposed wind farm at Hope Beach and Chapman's Grove will comprise 6 turbines, which is considered a small wind farm in comparison to the wind farms across North America. The pre-construction surveys revealed a high diversity of bird species within the area, but based on their activities and occurrence in the mangrove and coconut plantation (feeding and perching) and their flight patterns (the large majority were low flyers occurring – below the rotor swept zone), the risk of collision with turbines blades were rated as low. The bird species most impacted by wind turbines in North America are migrant passerines, in particular, night migrant species, accounting for more than half of all fatalities. A small portion (only six) migrant passerine species were observed

at the sites and based on their wintering habits, these species are often restricted to their feeding and roosting grounds. A large proportion of the birds observed are wetland, waterfowl and seabird species, which are typically not affected by wind farms based on North American studies. In addition, most of the species observed are diurnal species and can therefore see the blades and avoid them.

The small size of the wind farm, lack of birds at risk, bird fatalities/turbine/year at Hope Beach is likely to be lower than bird fatalities/turbine/year at wind farms in North America, which are on average between 5 and 9 bird fatalities per wind turbine per year.

Despite almost 30 years of rapid wind farm development in North America, studies now show that the bird fatalities caused by wind farms have had no significant impact to any bird species, and are orders of magnitude less than other anthropogenic impacts, such as buildings, windows, communication towers, domestic cats, traffic and power lines. Similarly, as most of the bird species recorded on site had 'abundant, fairly common or common' national statuses, while a smaller percentage had 'uncommon' statuses. It is not likely that impacts to any species will affect in national population levels or ecosystem functioning

In terms of risks to specific groups of birds, the following were noted:

- Approximately 28% of all bird species found on site were either mid- or high-flyers, indicating that they can potentially fly within the rotor swept zone. Of these, only the Rufous Crab Hawk had 'near threatened' status under the IUCN Red List of Threatened Species.
- While the risk to nocturnal migrant passerines were high in the North American Studies, only six night-time migratory passerine species were identified in the study area. It should be clearly noted that some behavioural patterns of night migrants in North America are different from their behaviour at their wintering grounds. Most of the passerines observed within the study displayed diurnal activities (feeding) and were categorized as low flyers (occurring only within the canopy) – this suggests that the risks to passerines will be low.
- The Yellow Warbler and Northern Waterthrush, which are nocturnal passerine species were observed in the area. Although its large-scale migratory flight pattern suggests nighttime flights, the Yellow Warbler and Northern Waterthrush may be at a lower risk for collision with the proposed wind turbines, on the basis of its diurnal activities within Guyana, its movement outside the rotor swept zone and its restriction to the mangrove canopy for feeding and perching.
- 13 species of raptors were identified in the study area. Of these, 2 species – the Gray Lined Hawk and Osprey had a higher risk of collision since these species tend to hunt aerially and within the rotor swept zone of the proposed turbines. Both of these species are common across the coastal plain of Guyana. The remaining raptors had a lower risk of collision with wind turbines, due to their

hunting behaviour (i.e. remained perched in tree tops in search of prey and then swoop in swiftly).

- Wetland, shorebird and pelagic species had a potential low risk of collision based on the fact that the large majority of birds were observed as flyovers, occurring well away from the potential turbines and outside of the rotor swept areas. Where shorebirds were present, they were observed foraging on the tidal flats.
- All of the five of the species of special concern had a minimal risk of collision with the proposed turbines, based on their occurrence in the mangrove habitat and behavioural patterns.
- The significantly small number turbines to be installed, as well as their spacing reduced the risk of bird collisions significantly.
- There were some variations in the conclusions regarding avian mortality in relation to turbine height and size. There is some level of uncertainty surrounding the height of the turbines, as well as its capacity as different studies reported different trends. As such, the proposed PCM studies at Hope Beach and Chapman's Grove can assist in determining the effect of hub height on avian fatalities.

- Displacement factors were considered a low risk; as very minimal vegetation will be removed to facilitate the establishment of the proposed wind turbines.

This impact is expected to be permanent lasting throughout the life of the operation of the wind farm. However, the impact is likely to have marked effects on individuals. As noted above, it is not likely that impacts to any species will affect national population levels or ecosystem functioning.

The Hope Wind Farm project is a small wind farm which will have a low impact on bird species. The post construction bird mortality studies for this wind farm will reveal the impact of behaviours for the birds in this tropical coastal setting, and will be very informative for any future wind farm developments along the Guyana coastal plain. As a result, classification without and with mitigation is not justified.

13.5.2.2 Concerns for Bats

Nature of Concern

As noted above in Section 13.5.2, the concern for bats during the operation phase relate to:

- The removal and/or alteration of existing habitat;
- Behavioural displacement/disturbance (indirect impact); and
- Fatalities (direct impact).

As a result, a Bat Risk Assessment was conducted to evaluate the potential for impacts to bats as a result of the wind farm project. The details of this risk assessment are included as Appendix R. The following is a brief summary of the findings:

The tree cover, warm humid tropical climate and canal water bodies at the project sites provides ideal roosting and food sources for fructivorous, insectivorous and piscivorous bats year-round. However, steady trade winds result in wind speeds above 5.5 m/s for more than 80% of the time at night above the tree canopy, which has been shown to significantly decrease high flying insectivorous bat activity and related fatalities from wind turbines in North America. More than 80% of bat species killed by wind farms in North America are migrant insectivorous bats. Migrant bats are not present in the coastal plains of Guyana. All the bats captured at the site were dominantly understory species, mostly fructivores and piscivores, and are therefore not exposed to the wind turbine rotor swept zone. Very few bats were observed above the tree canopy flying within the heights of the rotor swept zone, most likely due to the steady wind speeds which subdue insect activity at such heights.

Based on the lack of the most at-risk bat species at the project site, and the dominance of understory bat species, the fatality rate for bats due to impact with the wind turbine rotors is expected to be substantially lower than the average 11 to 13 bats per wind turbine per year seen in North American studies.

The bats observed at the site are all common to the coastal plain of Guyana, no IUCN endangered species were found. As such, given the small size of the wind farm, and low risk for bat fatalities, it is not likely that impacts to any species will affect the national population levels or ecosystem functioning. In terms of risks to specific groups of bats, the following were noted:

- All of the bats observed within the project site are low flying (understory bats), and they are unlikely to occur within the rotor swept zone of the turbine blades.

- Further to this, only 6 turbines will be installed at the proposed site, and for each turbine, the rotor swept area is clear of the canopy cover by approximately 20 m.
- All the species in the area are resident species, and based on the abundance of food and roosting areas year-round, these bats are unlikely to conduct large scale migration patterns across Guyana.
- None of the species observed on site had national or international statuses of ecological concern. In addition, in terms of their ecological significance, many of the frugivores observed on site play an important role in seed dispersal. However, any fatalities are not expected to have significant population impacts or affect ecosystem functioning. This is similar for the other piscivorous and insectivorous species observed on the site.

The habitats in closest proximity (each within 500 m of the turbines) to the proposed turbines are marsh, mangrove and coconut plantation, open agricultural fields, and residential gardens (see Figures 13-1 and 13-2), which provide ideal conditions for bat activity (feeding and roosting). However, it should be noted that there will be minimal clearing of marsh or mangrove or disturbance to wetland areas (including the canals). As such, displacement of bats due to habitat removal is not considered a significant risk.

As part of this study, a robust Post Construction Monitoring Study has been developed in accordance with the US Fish and Wildlife Services Guidance Document. Based on the review of literature and the risk factor summarized at Hope Beach and Chapman's Grove, there are still some levels of uncertainty with respect to the behaviour and vulnerability of specific tropical species in relation to factors such as size of turbines, wind speed, landscape, seasonal patterns, etc. Also, the extent of bat population research in coastal Guyana is somewhat limited, in particular the understanding of bat populations, their species abundance and distribution.

As such, it is recommended that in parallel to the PCM studies planned for the wind farm operation phase, ecological studies of coastal plain bats (particularly near the proposed study area) focussed on better understanding the bat populations and behaviour (with emphasis on aerial insectivorous species) be conducted. Such studies would be initiated after the construction phase when turbines are operating and could be conducted by researchers and students at the University of Guyana, supported by the Hope Wind Farm, if required. Results of these studies would be very informative for impact assessments of any additional future wind farms in Guyana.

In the unlikely event that PCM studies determine that certain bat species are impacted to such an extent that their bat populations and ecological functioning are at risk, mitigation measures can be employed to reduce such impacts. These include implementation of acoustical deterrents and/or adjusting cut in speed and feathering of blades during low wind periods. Both these techniques have had success at wind farms in North America.

13.6 Mitigation and Monitoring – Environmental Management Plan

13.6.1 Construction Phase

This Section addresses the potential biological impacts during the site preparation and construction phases under the following headings:

- Clearing of Vegetation (Habitat Loss);
- Fragmentation;
- Disturbance to Terrestrial Species;
- Disturbance to Aquatic Species;
- Disturbance to Benthic Communities;
- Loss of Benthic Communities;
- Concerns to Migratory Species; and
- Concerns to Rare and Endangered Species.

13-16	POTENTIAL IMPACT	CLEARING OF VEGETATION (LOSS OF TERRESTRIAL HABITAT)
MITIGATION MEASURES		• The routes of the proposed site roads will avoid mangrove to the extent practicable to limit the need to clear mangrove trees; • Avoid clearing vegetation in areas not required for construction works; • Burning of cleared vegetation to be prohibited; • Use of herbicides to aid in removal of vegetation to be prohibited; • All necessary permits relating to the felling of trees to be obtained; and • Re-vegetate as far as practicable and as soon as possible.
ACTION BY		• Project General Manager to ensure final designs for access roads and other site infrastructure avoid the need to clear mangroves. • HSE Manager to implement all other mitigation measures.
TIMING		• Approve final designs for access roads and other site infrastructure prior to clearing activities. • Implement all other measures throughout the construction phase.

13-16	POTENTIAL IMPACT	CLEARING OF VEGETATION (LOSS OF TERRESTRIAL HABITAT)
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT/ WHERE/, FREQUENCY		• The EPC Contractor to ensure only areas required for construction are cleared. • Community Liaison Officers to record any complaints of removal of vegetation (outside of designated areas) and or burning.
SPECIALIZED EQUIPMENT OR MATERIAL		• Complaints Register • Permits
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

13-17	POTENTIAL IMPACT	FRAGMENTATION
MITIGATION MEASURES		• Design access roads to avoid the clearing of mangrove trees to the extent practicable;
ACTION BY		• Project General Manager to ensure final designs for access roads and other site infrastructure avoid the need to clear mangroves.
TIMING		• Approve final designs for access roads and other site infrastructure prior to clearing activities.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT/ WHERE/, FREQUENCY		• The EPC Contractor to ensure only areas required for construction are cleared. • Community Liaison Officers to record any complaints of removal of vegetation (outside of designated areas).
SPECIALIZED EQUIPMENT OR MATERIAL		• Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

13-18	POTENTIAL IMPACT	DISTURBANCE TO TERRESTRIAL SPECIES
MITIGATION MEASURES		The potential impacts on terrestrial fauna from the proposed wind farm relate to impaired noise quality. Therefore, the mitigation measures listed in Table 12-16 are also applicable here. In addition, the following additional measures can be implemented: • Limit construction works to daylight hours to the extent practical; • If night work is to occur, shield light from the vegetation and avoid use of bare and upturned bulbs; • The minimum light intensity that can be safety used should be employed for night work and for security purposes; and • Prohibit hunting or harassing of animals by workers on the construction site.
ACTION BY		• See Table 12-16 • Project Director to implement all other mitigation measures.
TIMING		• See Table 12-6 • Implement all other measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		• The EPC Contractor to schedule the construction works and verify that lights, if they are to be used, as adequately located and oriented. • HSE Manager to document any complaints of hunting within the area.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

13-19	POTENTIAL IMPACT	DISTURBANCE TO AQUATIC SPECIES & BENTHIC COMMUNITIES
MITIGATION MEASURES		The potential impacts on aquatic and benthic fauna from the proposed works relate to impaired water quality. Therefore,

13-19	POTENTIAL IMPACT	DISTURBANCE TO AQUATIC SPECIES & BENTHIC COMMUNITIES
		the mitigation measures listed in Tables 8-3 to 8-6 are also applicable here.
ACTION BY		See Tables 8-4, 8-5 and 8-6
TIMING		
SPECIALIZED EQUIPMENT OR MATERIAL		
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		See Tables 8-4, 8-5 and 8-6
SPECIALIZED EQUIPMENT OR MATERIAL		
RECORD KEEPING		
REPORTING		

L.6.2.4	POTENTIAL IMPACT	CONCERNS TO MIGRATORY AND RARE AND ENDANGERED SPECIES
MITIGATION MEASURES		Concerns about impacts to migratory species are related to noisy activity during construction. Therefore, the mitigation measures listed in Table 12-16 are also applicable here.
ACTION BY		See Table 12-16
TIMING		See Table 12-16
SPECIALIZED EQUIPMENT OR MATERIAL		See Table 12-16
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		See Table 12-16
SPECIALIZED EQUIPMENT OR MATERIAL		See Table 12-16
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

13.6.2 Operation Phase

L.6.2.5	POTENTIAL IMPACT	CONCERNS FOR AVIFAUNA AND BATS
MITIGATION MEASURES		Undertake Post Construction Mortality studies in accordance with U.S. Fish and Wildlife Service: Land Based Wind Energy Guidelines (2012). No later than 3 months after start-up of the wind farm.
ACTION BY		HSE Manager
TIMING		Throughout the operation phase
SPECIALIZED EQUIPMENT OR MATERIAL		None required
COMPETENCE AND TRAINING		Specialist Ecologist to design the study Trainees to undertake the actual surveys
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		Review of the study protocols prior to start of monitoring; Weekly review of data.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
COMPETENCE AND TRAINING		Specialist Ecologist
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

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14 TRANSPORTATION

Information presented in this Chapter was obtained from the Transportation Brief prepared by Dr Johan Sydow, Project General Manager, Hope Wind Energy Inc. (HWE). February 2020. The full report is provided in Appendix S of this ESIA Report.

14.1 Project Location and Land Use

The proposed wind farm project is located on a 27-acre state-owned lease at Hope Beach (HB), and private leases at Chapman's Grove (CHG), some 28km and 30km, respectively, SE of Georgetown centre (see Figure 2-1). The HB lease is the location of four wind turbines, seaward of the existing seawall, north of the plantations: Hope, Douchfour, Two Friends, Anns Grove, Clonbrook and Beehive (see Figure 2-1).

The CHP lease is the location of two additional wind turbines, on coconut plantation lands inland of the existing seawall, bounding Unity Village (see Figure 2-2). The project at both sites falls under the jurisdiction of the Grove-Haslington Neighbourhood Democratic Council (NDC).

14.2 Site Access

14.2.1 Hope Beach site

The Hope Beach site is dissected by the recently constructed Hope Canal, which splits the main lease area into a Western portion, HB-W with a single wind turbine, and an Eastern portion, HB-E, with three wind turbines. HB-W will be accessed via the existing and recently upgraded access road along the 40ft wide drainage canal dam (embankment) which connects the newly constructed Hope pump house to the main road (see Figure 5-2).

HB-E will be accessed from the main road via the existing access road to the Hope Canal Flood Gate facility, to be extended adjacent to the Hope Canal embankment North of the site with the roadway located on previously disturbed and modified terrain. These two proposed access roadways have no impact on the Mangrove vegetation, and no structural risk to the existing flood facility infrastructure and drainage canal embankment integrity.

14.2.2 Chapman's Grove

Chapman's Grove will be accessed off the Demerara-Berbice main road via private leased lands and NDIA's drainage access area. The Chapman's Grove lease will be accessed via an 8m bridge connecting the lease to the main road which crosses a 5m wide roadside drainage ditch (see Figure 8-2). The access road will then cross the main 15m wide drainage canal at an angle which requires an 18m long bridge. The project will be advised by NDIA and local civil engineers as to the requirements for minimum spans in order to ensure proper functioning of the drainage canal. The bridge design will likely entail the installation of pre-stressed concrete piles as the vertical supports between spans. Prefabricated concrete beams will then span the canal (see Figure 5-5).

14.2.3 Type of Road Construction

Access roads will be 5m wide and constructed from the main road to each WTG site. A total of some 3.5km of 5m wide access roadway is planned. Road construction will entail grubbing (removal of organic rich top-soils) of the top 0.3 to 0.6m of substrate, build-up of some 0.6 to 1.0m of compacted construction sand, followed by 0.3 to 0.5m of compacted silty sand, and finally a layer of graded and compacted aggregate of some 0.15 to 0.3m thick. Any excavated material will be trucked to and deposited at the Chapman's Grove private lease area. All sands and aggregates will be trucked to the site using the national road network (see Section 14.6).

1 km of this access road runs parallel to the shoreline along the relict beach ridge. A preliminary geotechnical survey (2009) describes the substrate as a 1 to 5m thick layer of firm to stiff silty clays (see Section 9.4.3). It may be possible to reduce the amount of imported sand for this relict beach ridge section by making use of compacted in-situ substrate – to be confirmed by further geotechnical sampling. The existing NDIA access road is built up on top of unconsolidated, flood-land clays underlain by the thick unconsolidated Demerara Clay formation. This section of road will likely require build-up of additional compacted sand and aggregate in order to meet the load requirements for the wind farm. The Chapman's Grove site is a clay prone agricultural site and will require the full programme of grubbing and aggregate base build up.

14.3 Construction Schedule

Construction of the wind farm is expected to begin in the fourth quarter of 2021. Wind Farm commissioning is scheduled for August 2022. Transportation related to civil and

electrical works would occur during an 8-month period starting in 4Q 2021. This will include construction of access roads, foundations and crane pad, installation of buried and overhead electrical lines and construction of the substation (see Figure 5-11).

Shipping of wind turbine components, transportation equipment and the crane, with transport of the wind turbine generator (WTG) equipment to site, would occur at the end of the construction period, likely 3Q/4Q 2021, and would be completed within a month of the arrival of the shipment in Guyana.

14.4 Project Loads

14.4.1 WTG

Vestas V150 wind turbines will be used on this project. The dimensions and weight of the various WTG components are summarized in Table 14-1. The heaviest loads are the nacelle and base tower sections (both 70MT), while the longest are the rotor blades at 73.7 m.

TABLE 14-1: LISTING OF WIND TURBINE GENERATOR COMPONENTS

COMPONENT (# UNITS)	DIMENSIONS (M)			WEIGHT (MT)
	LENGTH	WIDTH	HEIGHT	
Nacelle (w/out installed drive train, roof kit, cooler top) (6)	13	4.2	3.4	70
Drive train on transport frame (6)	7.3	3.4	2.9	67
Rotor hub (6)	5.5	4.7	4.7	33
Cooler top (unassembled) – 2 loads (6)	5.0	2.3	2.5	2.7
Tower – bottom section 1 (6)	10.3	4.4	4.1	70
Tower – bottom section 2 (6)	13.7	4.1	3.7	68
Tower – bottom section 3, 4 & 5 (18)	15 - 30	3.7 – 3.5	3.7 – 3.3	42 - 62
Blades (18)	73.7	4.2	3.2	17.2
Electrical Transformer (1)	7.1	3.0	3.4	65

All components will be shipped by chartered cargo vessels to a wharf in Georgetown suitable for offloading and laydown of equipment. The equipment will then be loaded onto a barge and transported to the Kingston Wharf, Georgetown from where they will be transported by road to the project site using specialized transportation vehicles imported for the task.

14.4.2 Civil & Electrical Works

The civil and electrical works will span an 8-month period and will be completed prior to the transport and installation of the wind turbines. The quantities of material needed for constructing the access roads, foundations, crane pad and substation and installing buried and overhead electrical lines are shown in Table 14-2.

TABLE 14-2: MATERIALS FOR CIVIL AND ELECTRICAL WORKS

MATERIAL	VOLUME (m^3)	TRUCKLOADS
Aggregates	42,000	4,200
Readymix concrete	3,950	540
Steel		45
Piles (20 – 30 m long)		255
Containerized loads		50
	Total truck loads	5,090
	Average daily truck loads	23

14.5 Transport Vehicles

Transport vehicles must meet the requirements of the Guyana Road Regulations Chapter 51.02 for maximum vehicle weight and axle loads.

Standard transport trucks will be used for hauling materials for civil and electrical works (see Table 14-2). However, specialized transport vehicles will be needed for the WTG because of the weight and length of some of these components.

The heaviest loads in the Vestas shipment are the nacelle and base tower sections, both weighing 70MT (see Table 14-1). These loads require load distribution using modular heavy transport THP type trailers with multiple axels, and up to 8 wheels per axel, towed by a heavy haul trailer truck. The trailers are connected to the truck via a hydraulic "gooseneck" assembly linked to the heavy-duty hitch (fifth wheel) on the truck. The gooseneck is capable of transferring up to 20 to 35 MT of trailer load onto the truck back axels in order to evenly distribute the loads. The axels of the trailers are capable of individually steering by up to 60deg, which allows for great flexibility in navigating bends and lay-down sites.
Transport of the 73.8 m long blades will require specifically designed extendable rear steerable trailer/truck. The steerable trailer has a telescopic extendable main carrier beam, which connects a rear steerable trailer assembly to the truck via a heavy-duty hitch (fifth wheel). The root of the blade is loaded on the truck (front) end of the trailer, and the blade is clamped onto the rear assembly, with the tip of the blade usually

extending beyond the back of the trailer. More advanced trailers allow for raising and lowering of the blade and are also able to lengthen or shorten the extendible boom and rear blade stand should particularly tight corners require this.

14.6 Offloading Facilities and Haulage Route

Three alternatives were considered for offloading and transport of the wind farm components to the project site: offloading at Fernandes Wharf or at Kingston Wharf and transport by road; and transport of the long rotor blades via sea by barge to Hope Canal and offloading at the project site. Sea transport was not deemed feasible because of the substantial dredging and requirements for construction of offloading infrastructure at the destination project site. The Fernandes Wharf though suitable for offloading and temporary storage however, did not meet the transportation requirement to the project site for the long rotor blades, which the Kingston Wharf provides. The loads will be offloaded at a wharf in Georgetown suitable for heavy lifts and laydown of the equipment. The loads will then be loaded onto the transportation vehicles, which will be driven onto a barge and transported to the Kingston Wharf, to be offloaded there with direct access to the coastal transport route which leads to the project site.

The more regular sized WTG components can likely be transported directly from the Fernandes Wharf to the coastal route via Main/High street, pending verification of the structural limits of the bridges across the Lamaha and Cowan Street canals. However, for the heavier and oversized components, the selection of haulage route will be based on the following requirements as determined by load and tight-corner analysis:

- Minimum turn radius wind turbine blades: 70m
- Maximum gradient: 10%
- Minimum vertical clearance: 4.8m (hub)
- Minimum load bearing: 2kg/cm2 (28 psi)
- Useful road width: 5m wide for straight sections, up to 6.8m wide in bends @ 70m turn radius.

Two transport route alternatives from the Kingston Wharf to the project site were considered: the recently upgraded East Coast Demerara Roadway and the Railway Embankment Road. The latter was ruled out because of the state of bridges and culverts. The more suitable route starts at Kingston Wharf, via Water Street and to the Seawall Road past the Pegasus Hotel, through the Kitty Roundabout, and then onto the Rupert Craig Highway and its continuation along the Demerara-Berbice Highway all the way to the Hope Wind site (see Figure 14-1 and Figure 5-7).

The route is flat with the exception of a 2.5 m elevation gain when crossing the Hope Canal Bridge in the vicinity of the project site. The total route from the Kingston Wharf is 28km to the Hope Beach site access road, and 30km to the Chapman's Grove site access road. Almost all the road crossings and widening and upgrade of the road substrate for more than half the route was recently undertaken. Analysis of all crossings and bends along the proposed route has been conducted and recommendations made for further upgrades to facilitate the transport requirements.

14.7 Existing Information, Baseline Studies

14.7.1 Offloading facilities

Two offloading facilities were considered (see Figure 14-1). The Fernandes Wharf is suitable for offloading and temporary storage of all wind farm components. Regular size components can be transported from here to the project site along the coastal route via Main/High Street. However, it would not be feasible to move the long rotor blades from this wharf along the available road network because of the required 70 m turning radius. The Kingston Wharf was deemed the more suitable offloading facility for these components as it has a relatively straight route access to the coastal Seawall Road.

14.7.2 Road Network

14.7.2.1 Demerara-Berbice Main Road

The road network from Fernandes Wharf is via Main/High Street onto the coastal road crossing the Lamaha and Cowan canals. However, the structural limits of these bridges will have to be verified. Alternatively, all equipment is remobilized via barge to the Kingston Wharf and offloaded there.

Almost all the road crossings and widening and upgrade of the road substrate for more than half the route from Plaisance to Victoria was recently undertaken. The entire roadway has been reconstructed, with new sub-base, base aggregate, drainage, surfacing, including the shoulders, which has resulted in substantial widening of the roadway, improvement in load capacity and road smoothness. Sub-standard bridges and culverts have also been upgraded. The roads and bridges recently constructed in Guyana meet the AASHTO HS20 Truck and alternative military load standard.

Figure 14-2a. Offloading at Fernandes Wharf, transport by barge to Kingston wharf

Figure 14-2b.. Offloading blades on trailers via barge at Kingston Wharf

SOURCE: HOPE ENERGY DEVELOPMENT

Ecoengineering Consultants Ltd.
62 EASTERN MAIN ROAD
ST. AUGUSTINE
PHONE: (868) 645-4420 FAX: (868) 662-7292
e-mail : ecoeng@ecoenggroup.com

ECO REPORT NO.	05/2020
DATE:	16/04/21
CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	OFFLOADING AT FERNANDES WHARF
FIGURE NUMBER:	14-1

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There are four tight bends along the proposed route which required detailed assessment of turning radius and road widths: two 90-degree bends at Km 20 and 20.5 (Coldingen/Non-Pareil), and the open S-bend at KM 22.5 (Bachellor's Adventure) (see Figure 5-7). The assessment indicated that the bend at Km 20 would have to be upgraded via widening of the shoulder areas by some 2 to 4m on the outside bend approach and exit, and 2m on the inner bend to facilitate the movement of the long rotor blades. Such widening is done simply via construction of a compressed aggregate base along the shoulders of the bend, and the detailed engineering of this will be done as part of the detailed engineering design phase. Discussions will then be had with the Chief Roads and Bridges Officer within the Ministry of Works as to whether the MoW will be in charge of this upgrade (compensated by HED for any expense), or whether HED's EPC contractor will be responsible for contracting and constructing the upgraded bend.

14.7.2.2 Secondary Roads

Within the study area, there are a number of secondary public roads including:

- Access road to Hope Estate,
- Access road to Clonbrook/Anse Grove,
- Railway Embankment from Greenfield to Anse Grove,
- Access road to Greenfield South, and
- Access road to Unity/Lancaster.

These roads are asphalt paved roads with two lanes. These roads are generally in fair to poor condition.

Other residential roads within the surrounding communities are dirt roads which are generally in poor condition.

14.7.2.3 Public Transportation

The following information was obtained from household surveys conducted in the study area (see Appendix I). Residents mainly use public transportation (bus, taxi, hired car) to commute to and from work and school.

COMMUTING	%
Bus only	38%
Private car only	16%
Taxi/ hired car only	10%
Private car in combination with other transportation	12%
Combination of Taxi/ hired car, bus, carpool	23%

There are seventeen bridge crossings at canals along the route, all of which were assessed:

- Thirteen of these are of precast prestressed concrete built between 2003 and 2011 and are all in good condition. The design load for these bridges is given as an AASHTO HS 20 truck and alternative military load. They consist primarily of standardized precast prestressed planks 400 mm thick and 1470 mm wide. The length of these planks varies from 4.8m to 12.5m and each plank has forty (40) 12 mm diameter prestressing strands. Each bridge has eight (8) such planks which sit on reinforced concrete abutments on either side of the canal. Each bridge sits on twelve (12) prestressed concrete piles 360 mm x 360 mm. Based on a safe load of thirty (30) tonnes per pile it is estimated that the foundation on its own has about. thirty (30) tonnes spare capacity after prescribed dead and live loads are taken into account and as such are deemed suitable for transport of project loads.

- Two concrete bridges with simple concrete abutments at Buxton (EC21) and Friendship (EC22) constructed in the early 1960s and one vintage bridge at Haslington-Grove (EC38) with greenheart timber supports have been recently replaced (see Figure 5-7) with bridges designed to the AASHTO HS20 standard.

- All bridges and the triple box culvert crossing were visually inspected and project loads were modelled for all crossings and compared against technical load limits for the AASHTO HS20 truck standard loads. The loads are less than the AASHTO HS20 standard for all crossings when using assumptions for overweight transport protocols (only one vehicle on bridge crossing at a time, at slow speed).

There are a large number of culverts along the route for passage of water through the road embankments for drainage or irrigation: the majority are double or single reinforced concrete box or pipe culverts and only one is a triple span; two culverts are of HDPE pipe. Figure 5-7 identifies the culverts and their status. Most of the culverts showed signs of minor spalling. Small amounts of exposed steel reinforcement and honeycombing of the concrete due to poor workmanship were also observed. There

was cracking and joint separation at the wing walls at culvert EC2. There were no visible signs such as large deformations associated with structural failure of any culverts. All the pipe culverts and those box culverts with less than three (3) m spans as well as EC46 triple span box culvert were deemed capable of supporting the load possible by a single axle of the trucks transporting the loads. Modular jumper bridge sections of suitable length may have to be used to cross other culverts that span more than 3m.

14.8 Impact Prediction and Assessment

The following potential adverse impacts may occur during the construction phase based on the project loads and the baseline condition of the road network:

- Damage to Roads, Bridges and Culvert Crossings;
- Obstruction of Traffic;
- Damage to Infrastructure and Utilities; and
- Public Safety.

It is not expected that there will be significant operation phase impacts related to transportation since most of the monitoring and operation of the facility will be done remotely via digital networks and the on- site work force will be very small.

Mitigation measures that have been or will be implemented to minimize these potential impacts are discussed in the Transportation Brief (see Appendix S) and summarized in the following sub-sections.

14.8.1 Damage to Roads, Bridges and Culvert Crossings

14.8.1.1 Nature of Concern

A baseline description of the bridge and culvert crossings along the proposed haulage route was provided in Section 14.7.2, above. Transport of anticipated project loads listed in Table 14-1 have the potential to damage roads and bridges if these loads exceed the load capacity of the existing infrastructure. Since the Demerara-Berbice Main Road is a major roadway connecting east and western Guyana, any significant damage to this roadway will cause severe disruptions.

14.8.1.2 Unmitigated Impact

The impacts to roads are the same for the Hope Beach and Chapman's Grove sites since the main roads to be used are the same. These impacts are expected to be short term in duration since repairs will be conducted during the construction phase. Given the importance of the Demerara-Berbice Road to the regional road network, the intensity of this impact is expected to be medium. Unmitigated, the impact of damage to roads and crossings is expected to be:

Extent	Intensity	Duration	Classification
Regional	Medium	Short Term	**MODERATE**

14.8.1.3 Mitigation Measures

The following mitigation measures will be implemented by HWD to minimize damage to roads and road crossings.

Prior to the transportation activity:

- Obtain Transport Permits prior to transportation of heavy loads along public roads.
- Reconfirm initial load modelling of all crossings using the final transport vehicle and load configurations
- Undertake detailed route inspection before transport commences in order to confirm results of previous surveys and to account for any changes along the route. This includes visual inspection of all bridge and culvert crossings.
- In consultation with the Ministry of Public Infrastructure, upgrade bridges and culverts, and move any road signage as necessary to the required load bearing capacity (see Section 14.7.2.1). In consultation with GPL and telecoms companies, move any power poles and raise power and communication lines, as may be necessary
- Use a suitable length modular jumper bridge is used to cross those culverts that span more than three meters at EC01', EC02, EC08, EC23, EC36 and EC45.
- Ensure that transport vehicles meet the requirements of the Guyana Road Regulations Chapter 51.02 for maximum vehicle weight and axle loads.
- Undertake test runs of the route using the transport equipment without the full loads.
- Ensure plans are in place for any emergency repair works of the transport infrastructure should any damages be caused by the transportation of loads, and also plans for deviations of traffic onto alternative transport routes.

During the transportation activity the following mitigation measures will be employed:

- Transportation will occur at night, during the lowest traffic congestion periods, and will end before morning rush hour traffic commences
- Public notice will be given by radio, TV, newspaper media, and road signage in order to inform the public of transport restrictions and alternative route deviations
- Transport vehicles will be accompanied by both police and contractor escort vehicles to assist with traffic flow control, and to warn traffic of approaching transport vehicles
- Traffic flow will be temporarily restricted by traffic police when and where transport vehicles pass key sections of the route (tight bends and bridge/culvert crossings)
- Mobile jumper bridges will be used temporarily to reinforce the road sections over culverts that are more than 3 m wide
- During crossing of bridges and culverts by heavy loads only the transport vehicle will be allowed to cross, all other traffic will be temporarily blocked, and the transport vehicle will travel at slow speeds in order to minimize both static and dynamic loads on any crossings
- Routine inspection of the haulage route for signs of damage to roads, bridges and culverts.
- Maintain a complaint register relating to damage to roads, bridges and culverts.
- Collaborate with the Ministry of Public Infrastructure to immediately repair damage to road infrastructure caused by the transportation of project loads.

The effective implementation of these measures is expected to reduce the classification of the impact of damage to roads and crossings to:

Extent	Intensity	Duration	Classification
Regional	Very Small	Short Term	**LOW**

14.8.1.4 Cumulative Impact

The project identified in the nearby region in section 2.6 do have the potential to contribute to the damage of roads and crossing but it is not likely to be as significant as the potential from the wind farm project. The impact is therefore classified as:

Extent	Intensity	Duration	Classification
Regional	Minor	Short Term	**MODERATE**

14.8.2 Obstruction of Traffic

14.8.2.1 Nature of Concern

A baseline description of the proposed haulage route highlighting potentially road conditions was provided in Section 14.7.2, above and Figure 5-7 shows the locations of tight bends. Transport of wide and long loads such as the rotor blades which are 73.7 m long (see Table 14-1) has the potential to obstruct the normal flow of traffic as they will be travelling at a much slower speed than normal traffic flow and will require the full width of the entire road (the two lanes for both directions of traffic flow) in the areas of bends. At bridge and culvert crossings of heavy loads all other traffic will be temporarily blocked from crossing at the same time as the transport vehicle in order to minimize loads. The installation and removal of temporary jumper bridges over 3m or wider culvert crossings will be done in parallel to the transport loads passing, and will also cause obstruction to traffic. Calculations show that the 73.7 m long rotor blades require a 70 m turning radius. As such, there is the potential for these transport vehicles to become stuck at tight corners which do not meet these requirements, so creating an obstruction to traffic. Again, as noted above, these loads will be transported along the Demerara-Berbice Highway which is a significant coastal roadway and any obstructions to traffic will result in regional transportation disruptions.

14.8.2.2 Unmitigated Impact

The impacts related to obstruction of traffic to roads are the same for the Hope Beach and Chapman's Grove sites since the main roads to be used are the same. These impacts are expected to be short term in duration since transportation activities will only occur during the construction phase. Given the importance of the Demerara-Berbice road to the regional road network, the intensity of this impact is expected to be medium. Unmitigated, the impact of damage to roads and crossings is expected to be:

Extent	Intensity	Duration	Classification
Regional	Medium	Short Term	**MODERATE**

14.8.2.3 Mitigation Measures

The mitigation measures recommended in Section 14.8.1.3 for damage to roads, bridges and culverts are also applicable here.

The effective implementation of these measures is expected to reduce the classification of the impact of obstruction of traffic to:

Extent	Intensity	Duration	Classification
Regional	Very Small	Short Term	LOW

14.8.2.4 Cumulative Impact

The projects identified in Section 2.6 have the potential to contribute to the obstruction of traffic due to long convoys of construction materials. The impact is therefore classified as:

Extent	Intensity	Duration	Classification
Regional	Minor	Short Term	**MODERATE**

14.8.3 Damage to Infrastructure and Utilities

14.8.3.1 Nature of Concern

This concern relates to the potential damage to infrastructure and utilities that exist both in proximity to the proposed site and along the routes taken by haulage vehicles during site preparation and construction activities. Utility poles carrying electricity and communications (telephone and cable TV) lines may be located along the existing road networks. In addition, water lines supplying communities along the route may be located under these roads. Heavy trucks and equipment travelling along the road network may cause damage to underground water lines and pull down overhead lines. This has the potential to cause significant disruption to neighbouring communities and may take several days to repair.

14.8.3.2 Unmitigated Impact

The impacts related to damage to infrastructure and utilities are the same for the Hope Beach and Chapman's Grove sites since the transportation routes are the same. These impacts are expected to be short term in duration since transportation activities will only occur during the construction phase. Given the potential for disruption to essential services such as electricity, the intensity of this impact is expected to be medium. Unmitigated, the impact of damage to infrastructure is expected to be:

Extent	Intensity	Duration	Classification
Regional	Medium	Short Term	**MODERATE**

14.8.3.3 Mitigation Measures

Prior to transporting construction equipment (such as trucks, tractors, bulldozers, graders et cetera), materials and WTG components, HED will:

- Survey the haulage route to identify any buried or overhead utilities (water lines, telecommunication lines, electricity lines) which may be affected by the passage of project-related vehicles / equipment and map these.
- Consult with the relevant owners of utility lines along the haulage route to determine setbacks, restrictions and precautions to be adhered to in order to ensure that equipment / vehicles will not damage any existing utilities.
- Consult with the relevant utility owners to relocate affected infrastructure as necessary.

During the transportation exercise HWD will:

- Ensure that electrical and telecommunication lines crossing roadways which are marginal obstacles to tall oversize loads will be temporarily raised by accompanying technicians, if required, in order to allow oversize transports to pass.
- Conduct routine inspections of the haulage route for damage to infrastructure and utilities.
- Maintain a complaint register relating to damage to infrastructure and utilities.

The effective implementation of these measures is expected to reduce the classification of the impact of damage to infrastructure and utilities to:

Extent	Intensity	Duration	Classification
Regional	Very Small	Short Term	**LOW**

14.8.3.4 Cumulative Impact

The projects identified in Section 2.6 have the potential to contribute to the damage to infrastructure and utilities since the main transport routes will be the same. The impact is therefore classified as:

Extent	Intensity	Duration	Classification
Regional	Minor	Short Term	**MODERATE**

14.8.4 Road Safety

14.8.4.1 Nature of Concern

Road safety concerns arise from project-related vehicles using public roads, particularly trucks transporting construction equipment and material. The danger to members of the public relates to road accidents. Additionally, a lack of signage on the roadway indicating the entrance to the construction site may also increase the potential for collisions. The access roads to the project site are narrow and winding and do not have shoulders. As such there is also risk to pedestrians who are using the road.

14.8.4.2 Unmitigated Impact

This impact is expected to be temporary in nature lasting only as long as the construction phase. The lack of signage and adequate signage makes the potential intensity medium. Without mitigation, this impact is rated as:

Extent	Intensity	Duration	Classification
Regional	Medium	Short Term	**MODERATE**

14.8.4.3 Mitigation Measures

Prior to the transportation activity HED will:

- Develop a Traffic Management Plan for the construction works, in consultation with the Police Service in the affected areas.
- Drivers of project-related vehicles, including haulage vehicles, in Defensive Driving techniques
- Provide signage clearly indicating the construction zone and marking the entrance to the project site from the roadway. This signage should be properly positioned and lit so that it can clearly be seen by oncoming traffic.

During the transportation exercise, HED will:

- Ensure that drivers comply with the Motor Vehicle and Road Traffic Act.
- Ensure that project-related vehicles including haulage vehicles are routinely maintained in accordance with manufacturer's specifications.
- Monitor traffic flow in the area to ensure that TMP is effective.
- Transport oversize and overweight loads at night, during the lowest traffic congestion periods, and will end before morning rush hour traffic commences.

- Give public notice by radio, TV, newspaper media, and road signage in order to inform the public of transport restrictions and alternative route deviations.
- Ensure that oversize and overweight transport vehicles will be accompanied by both police and contractor escort vehicles to assist with traffic flow control, and to warn traffic of approaching transport vehicles.
- Maintain a register of complaints, accidents or incidents regarding traffic flow within the area.

The effective implementation of these measures is expected to reduce the intensity of the impact but not the overall classification of the impact of public safety during construction:

Extent	Intensity	Duration	Classification
Regional	Very Small	Short Term	**LOW**

14.8.4.4 Cumulative Impact

The projects identified in Section 2.6 have the potential to contribute to public safety concerns since the main transport routes will be the same. The impact is therefore classified as:

Extent	Intensity	Duration	Classification
Regional	Minor	Short Term	**MODERATE**

14.9 Mitigation and Monitoring - Environmental Management Plan

14-3	POTENTIAL IMPACT	DAMAGE TO ROADS, BRIDGES AND CULVERTS
MITIGATION MEASURES		▸ Obtain Transport Permits prior to transportation of heavy loads along public roads. ▸ Reconfirm initial load modelling of all crossings using the final transport vehicle and load configurations ▸ Undertake a final detailed route inspection before transport commences in order to confirm results of previous surveys and to account for any changes along the route. This includes visual inspection of all bridge and culvert crossings. ▸ In consultation with the Ministry of Public Infrastructure, upgrade bridges and culverts and widen roadway bends as necessary to the required load bearing

14-3	POTENTIAL IMPACT	DAMAGE TO ROADS, BRIDGES AND CULVERTS
		capacity and transport lengths. ▸ Public notice will be given by radio, TV, newspaper media, and road signage in order to inform the public of transport restrictions and alternative route deviations, implementation of traffic plan. ▸ Transport vehicles will be accompanied by both police and contractor escort vehicles to assist with traffic flow control, and to warn traffic of approaching transport vehicles. ▸ Use a suitable length modular jumper bridge is used to cross those culverts that span more than three meters ▸ Ensure that transport vehicles meet the requirements of the special transport permit. ▸ Routinely inspect the haulage route for signs of damage to roads, bridges and culverts. ▸ Maintain a complaint register relating to damage to roads, bridges and culverts. ▸ Collaborate with the Ministry of Public Infrastructure to immediately repair damage to road infrastructure caused by the transportation of project loads.
ACTION BY		Project General Manager to ensure that Transport Permits are obtained. EPC Contractor to implement all other mitigation measures
TIMING		Prior to construction phase During transportation of materials and equipment for the last three mitigation measures.
SPECIALIZED EQUIPMENT OR MATERIAL		Modular jumper bridge sections, oversize and overweight transport equipment
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		QA/QC Engineer to verify the transport permits were obtained. Civil Engineer to verify crossings structural limits QA/QC Engineer and HSE Officer to undertake visual inspections and maintain a complaints register to document any damage to roads or bridges
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

14-4	POTENTIAL IMPACT	OBSTRUCTION OF TRAFFIC
MITIGATION MEASURES		• Check all bends along the route for turn-radius limitations, paying specific attention to the turning radius and road widths at: two 90-degree bends at Km 20 and 20.5 (Coldingen/Non-Pareil), and the open S-bend at KM 22.5 (Bachellor's Adventure). • Upgrade any bends that may require widening to meet the turning requirements such as the 90deg right-hand bend at km 20, at Coldingen/Non-Pareil. • In consultation with the Police, prepare a Traffic Management Plan (TMP) that will include but not be limited to: o Notifying the travelling public in advance of the start of construction and keep them updated with respect to the movement and transportation of heavy equipment, machinery and materials as well as any special arrangements such as detours or diversions or temporarily closure of certain sections of the roadway to facilitate the passage of the load. o Schedule transport of oversize loads material and equipment for off-peak hours. During the transportation exercise HED will: • Monitor traffic flow in the area to ensure that TMP is effective. • Transport vehicles will be accompanied by both police and contractor escort vehicles to assist with traffic flow control, and to warn traffic of approaching transport vehicles • Maintain a register of complaints, accidents or incidents regarding traffic flow along the haulage route. • Avoid the use of convoys of trucks transporting material and equipment to the site. • Use Police outriders when making deliveries of long or wide loads.

14-4	POTENTIAL IMPACT	OBSTRUCTION OF TRAFFIC
ACTION BY		• EPC Contractor to prepare Traffic Management Plan and verify all bends. • HSE Manager to: o Monitor traffic flow; o Maintain register of complaints. • Civil and QA/QC Engineers to implement all other mitigation measures
TIMING		▸ Develop Traffic Management Plan and inspect and upgrade road sections prior to the start of construction. ▸ Implement all other measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ Project Engineers to verify upgrades to transportation routes. ▸ HSE Officer to maintain a register of complaints, accidents or incidents regarding traffic flow within the area. HSE Officer to monitor traffic flow in the area (daily) for signs of congestion.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

14-5	POTENTIAL IMPACT	DAMAGE TO INFRASTRUCTURE AND UTILITIES
MITIGATION MEASURES		▸ Survey the haulage route to identify any buried or overhead utilities (water lines, telecommunication lines, electricity lines) which may be affected by the passage of project-related vehicles / equipment and map these. ▸ Consult with the relevant owners of utility lines along the haulage route to determine setbacks, restrictions and precautions to be adhered to in order to ensure that equipment / vehicles will not damage any existing utilities. ▸ Consult with the relevant utility owners to relocate

14-5	POTENTIAL IMPACT	DAMAGE TO INFRASTRUCTURE AND UTILITIES
		affected infrastructure as necessary. During the transportation exercise HED will: ▸ Conduct routine inspections of the haulage route for damage to infrastructure and utilities. ▸ Electrical and telecommunication lines crossing roadways which are marginal obstacles to tall oversize loads will be temporarily raised by accompanying technicians, if required, in order to allow oversize transports to pass ▸ Maintain a complaint register relating to damage to infrastructure and utilities.
ACTION BY		EPC Contractor to implement the first three mitigation measures. Civil and QA/QC engineers to conduct routine inspections along haulage route. HSE Manager to maintain complaints register.
TIMING		▸ Survey routes, identify utility lines and consult with utility companies prior to the start of construction works. ▸ Adhere to guidelines throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		Project Engineers to verify consultations with utilities. Civil Engineer and Project Manager to review inspection reports. HSE Officer to maintain complaints register.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

14.6	POTENTIAL IMPACT	ROAD SAFETY
MITIGATION MEASURES		• Develop a Traffic Management Plan for the construction works, in consultation with the Police Service in the affected areas. • Train drivers of project-related vehicles, including haulage vehicles, in Defensive Driving techniques • Provide signage clearly indicating the construction zone and marking the entrance to the project site from the roadway. This signage should be properly positioned and lit so that it can clearly be seen by oncoming traffic. • Public notice will be given by radio, TV, newspaper media, and road signage in order to inform the public of transport restrictions and alternative route deviations, implementation of traffic plan During the transportation exercise, HED will: • Ensure that drivers comply with the Motor Vehicle and Road Traffic Act. • Ensure that project-related vehicles including haulage vehicles are routinely maintained in accordance with manufacturer's specifications. • Monitor traffic flow in the area to ensure that TMP is effective. • Oversize/overweight transport vehicles will be accompanied by both police and contractor escort vehicles to assist with traffic flow control, and to warn traffic of approaching transport vehicles • Maintain a register of complaints, accidents or incidents regarding traffic flow within the area.
ACTION BY		• EPC Contractor to prepare Traffic Management Plan. • HSE officer to: o Train drivers; o Provide signage; o Maintain registers.
TIMING		▸ Develop Traffic Management Plan, train drivers and provide signage prior to the start of construction. ▸ Implement all other measures throughout the construction phase.

14.6	POTENTIAL IMPACT	ROAD SAFETY
SPECIALIZED EQUIPMENT OR MATERIAL		None required.
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ HSE Officer to maintain a register of complaints, accidents or incidents regarding traffic flow within the area.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints Register.
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

15 HAZARDOUS WASTE AND WASTE MANAGEMENT

15.1 Key Relevant Policy and Legislation

Section 3.3.11 of the EIA report outlines the applicable waste management legislation that will govern the construction and operation of the wind farm project. These include:

- Environmental Protection (Expanded Polystyrene Ban) Regulations, 2015
- Environmental Protection (Litter Enforcement) Regulations, 2012
- Environmental Protection (Hazardous Wastes Management) Regulations, 2000
- Customs Act
- National Integrated Solid Waste Management Strategy (2017-2030)
- Transportation, Storage and Occupational Handling of Chemical/Industrial Hazardous Waste (EPA, 2011)

In addition, it is important to emphasize the following with regards to hazardous wastes:

- According to the Hazardous Waste Management Regulations, anyone who operates or proposes to operate a facility that generates, transports, treats, stores or disposes of hazardous waste, is required to submit a Notification of Activity and an application to the Agency for an Environmental Authorisation. The Notice of Activity will inform the Agency of the nature of the activities at the facility and will aid in guiding its decision on whether or not Environmental Authorisation is required.

These regulations are not applicable to the following:

(a) facilities that generate or store hazardous wastes in quantities less than one hundred kilograms per month;
(b) facilities that generate less than one kilogram of acutely hazardous wastes per month;
(c) facilities that accumulates up to one thousand kilograms of hazardous wastes onsite at any time.

- The National Integrated Solid Waste Management Strategy 2017-2030 provides the roadmap for Guyana to reduce and better manage its solid waste. It sets out six key goals and 44 strategic actions, which identify the government's expectations of waste management at the end of the strategic period, and into the future.

For the HED Wind Farm, any waste generated during construction should be handled, transported and disposed of in keeping with the objectives of this Strategy.

This strategy outlines the organizations / agencies responsible for waste management:

- The Ministry of Local Government and Regional Development (MLGRD) is responsible for formulating national waste management policies and providing waste management oversight of RDCs, NDCs, and city councils.
- The Environmental Protection Agency (EPA) administers the environmental impact assessment process pertaining to waste management systems, prescribes standards for waste management facilities and issues permits for certain solid waste management activities (such as landfills).
- Regional Democratic Councils (RDCs) operate as decentralised offices of central government and oversee the waste management activities of Neighbourhood Democratic Councils.
- Neighbourhood Democratic Councils (NDCs) administer smaller divisions within each region, and are responsible for ensuring the delivery of waste management, street sweeping and drain cleaning services to the residents within their boundaries.
- City/Town Councils such as the Georgetown City Council are responsible for delivering management, street sweeping and drain cleaning services to the residents within their boundaries.

15.2 Existing Information, Baseline Studies

Information for this section came from a number of sources including:

- National Integrated Solid Waste Management Strategy 2017-2030;
- A Hazardous Waste Inventory for 2007 (Caribbean Environmental Health Institute, 2009)

15.2.1 General Solid Waste

The combined household and commercial waste generation for Region 4 was estimated to be 0.73 kg/person per day in 2010 (Hydroplan, CEMCO Inc, 2010). The total solid waste load (household, commercial, self-haul, etc.) was found to be 545.66 tonnes/day from a catchment area of 405,225 people, or equivalently, 1.35 kg/person per day. The waste consisted of over 50% vegetable and putrescible waste. The other major components of the waste included plastics (14.2%), paper (10.7%), rubber and textiles (6.8%) and diapers (5.6%).

As noted above, NDCs and town/city councils are legally responsible for providing waste collection services to residents within their jurisdictions. The main waste disposal methods in Guyana are open burning, open dumping and controlled dumping. The largest waste disposal site is the Haags Bosch Sanitary Landfill located in Eccles in Region 4, which covers an area of 50 hectares (123 acres) with an active disposal area of 26 hectares (64 acres) and expected lifetime of 25 years. The facility opened in 2011 and receives approximately 110,000 tonnes of waste annually. This facility is approximately 35 km from the Hope Beach site and approximately 37 km from the Chapman's Grove site.

15.2.2 Hazardous Waste

A hazardous waste inventory for 2007 (Caribbean Environmental Health Institute, 2009) showed that over 741,780 kilograms of hazardous wastes (or 1.0 kg per person) were generated in Guyana in 2007. Four waste streams accounted for almost 95% of the total waste reported as follows:

- Waste oils/water, and hydrocarbons/water mixtures and emulsions = 42.7%
- Waste from the production, formulation and use of organic solvents = 24.3%
- Clinical wastes from medical care in hospitals, medical centres and clinics = 14.4%
- Acidic solutions or acids in solid form = 7.2%

Information for Region 4 estimates annual hazardous waste generation rates of 615 tonnes of industrial solid waste, 494 tonnes of semi-solid hazardous waste, 694,000 m^3 of organic wastewater, and 134,000 litres of waste oil (SENES Consultants Ltd, 2010).

15.3 Impact Prediction and Assessment

15.3.1 Construction Phase

During wind farm construction, solid waste that will be generated includes: felled vegetation, excavated material, contaminated soil (in the event of spills and leaks of hydrocarbons), crates and packaging, waste paving material, cement and cement bags, timber, plywood, nails, screws, etc., for formwork and other carpentry, PVC pipes and fittings and waste electrical ducting. Some wastes will require special handling and treatment, such as spent lubricants and hydraulic fluid from construction vehicles and equipment. The following impacts are likely to arise as a result of the generation of construction waste:

- Impaired Water Quality (see Section 8.4.1);
- Improper Disposal of Wastes; and
- Localised Flooding (see Sections 18.2.17 and 19.4.4.3).

Impacts related to spills and leaks of hydrocarbons were discussed in Section 8.4.2.

15.3.1.1 Improper Disposal of Waste

Nature of Concern

Improper disposal of these construction wastes is a cause for concern since they can be blown or washed off the site. This can directly cause blockage of roadside drains and adjacent watercourses, creating flooding in upstream areas and stagnation (leading to mosquito infestations).

Unmitigated Impact

While large volumes of wastes are not expected to be generated given the small number of turbines being installed, there will still be some wastes that must be disposed. As noted in Section 15.2.1, the nearest landfill is located some 35-37 km away and construction wastes must therefore be transported to the landfill. Littering has been identified as a significant impact in Guyana (National Integrated Solid Waste Management Strategy 2017-2030). There is therefore the likelihood that any contractor hired to dispose of this waste may illegally dump the material at a convenient location off-site. This is especially a concern in the Hope Beach area due to the significance of the mangrove vegetation which can be adversely impacted by illegal dumping.

This is therefore expected to have a regional impact but only last as long as the construction activities are ongoing. Unmitigated, the impact of improper disposal of solid wastes are rated as:

Hope Beach

Extent	Intensity	Duration	Classification
Regional	Medium	Short Term	**MODERATE**

Chapman's Grove

Extent	Intensity	Duration	Classification
Regional	Minor	Short Term	**MODERATE**

Mitigation Measures

The following may be implemented to mitigate against improper waste disposal:

- Require that the Contractor develop a comprehensive Waste Management Plan utilizing the re-use, reduce and recycle approach. It is recommended that as far as practicable, scrap metal, glass and paper be recycled.
- Prohibit the burning of waste on site (packaging material, construction scraps or felled vegetation), as burning will produce unacceptable air emissions and also poses the danger of bush and forest fires.
- Encourage the sorting of recyclable material (such as glass and plastics containers) for later collection and disposal by an approved recycling company**.**
- Encourage the composting of biodegradable material (e.g. felled vegetation) on site. Suitable areas can be set aside for composting.
- Secure excavated material well away from roadside drains, adjacent watercourses and nearshore areas, so as to minimize the possibility of siltation or blockage.
- Collect all domestic garbage in secure receptacles for disposal at an approved landfill. No garbage will be left open or accessible to animals or allowed to litter the ground or drains.
- Require that all spills be cleaned with appropriate absorbent materials and disposed of at an appropriate waste management facility.
- Ensure that fuels are stored in a bunded area to contain any spills. Collect spent lubricants and fluids and send to an approved waste facility for disposal.

By implementing the above measures, this potential impact will effectively be reduced to:

Hope Beach

Extent	Intensity	Duration	Classification
Regional	Very Small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Regional	Very Small	Short Term	**LOW**

15.3.1.2 Cumulative Impact

It is not expected that any of the projects identified in Section 2.6 will have a cumulative impact related to improper disposal of solid and hazardous wastes.

15.3.2 Operation Phase

During the operation phase it is expected that a limited volume of solid wastes will be generated which will arise from the small number of employees (see Section 5.5.2). Sewage generated at the substation will be disposed through a septic tank soakaway system. In addition, a small volume of oily wastes may be generated during maintenance activities.

The table below summarizes the lubricants and fluids that will be generated during the operation phase:

Fluid	Component	Type / brand	Volume	Frequency
Oil	Gearbox	Castrol Optigear CT 320	900kg	Yearly oil sample (The results of the oil analysis determine if a change of gear oil is necessary).
Hydraulic fluid	Hydraulic system	Texaco Rando WM 32/Mobil DTE 10-Excel32	250lt.	Yearly oil sample (The results of the oil analysis determine if a change of hydraulic oil is necessary).
Coolant fluids	Generator and converter Gearbox and hydraulic oil	HAVOLINE XLC PREMIX 50/50 20L HAVOLINE XLC PREMIX 50/50 20L	270lt. 215lt.	7 years
Any other	Blade bearing grease	Shell Gadus S5 T460 1.5	3kg (3.2lt)	Yearly the blade bearing is lubricated. The grease is not changed, only grease is put on annually.

Given the quantities and the frequency that these fluids will be required, it is expected that there will not be any significant volumes stored on site. Instead, these fluids will be brought to site as needed. Any storage will be within a bunded area to ensure that any spills will be contained and not be able to migrate off the site.

Finally, as noted in Section 15.3.1.1, a Waste Management Plan will be developed which will include:

- Waste Identification and Management - All waste materials will be properly classified, labelled and segregated.

- Waste Transport Manifest and Waste Disposal Record - the waste transport manifest will summarize the waste type, amount, transport, and final disposal location.

The nature of the concern will be the same as described in Section 15.3.1.1. Once the Waste Management Plan discussed in Section 15.3.1.1 is implemented, it is expected to eliminate the concern for improper waste disposal during the operation phase.

15.4 Mitigation and Monitoring - Environmental Management Plan

15-1	POTENTIAL IMPACT	IMPROPER SOLID WASTE DISPOSAL
MITIGATION MEASURES		▸ Require that the Contractor develop a comprehensive Waste Management Plan utilizing the re-use, reduce and recycle approach. It is recommended that as far as practicable, scrap metal, glass and paper be recycled. ▸ Prohibit the burning of waste on site (packaging material, construction scraps or felled vegetation), as burning will produce unacceptable air emissions and also poses the danger of bush and forest fires. ▸ Encourage the sorting of recyclable material (such as glass and plastics containers) for later collection and disposal by an approved recycling company. ▸ Encourage the composting of biodegradable material (e.g. felled vegetation) on site. Suitable areas can be set aside for composting. ▸ Secure excavated material well away from roadside drains, adjacent watercourses and nearshore areas, so as to minimize the possibility of siltation or blockage. ▸ Collect all domestic garbage in secure receptacles for disposal at an approved landfill. No garbage will be left open or accessible to animals or allowed to litter the ground or drains. ▸ Require that all spills be cleaned with appropriate

15-1	POTENTIAL IMPACT	IMPROPER SOLID WASTE DISPOSAL
		absorbent materials and disposed of at an appropriate waste management facility. ▸ Collect spent lubricants and fluids and send to an approved waste facility for disposal.
ACTION BY		▸ Project Engineer and HSE Manager to prepare the Waste Management Plan. ▸ Project Engineer and HSE Manager to implement all other measures.
TIMING		▸ Develop the Waste Management Plan prior to the start of construction works. ▸ Implement all other mitigation measures (including the Waste Management Plan) throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ HSE Manager to verify that the Waste Management Plan has been approved by the EPA. ▸ HSE Officer (in collaboration with the Project Engineer) to maintain a log book of all disposal certificates. ▸ HSE Officer to maintain complaints register relating to the improper disposal of wastes. ▸ The HSE Officer to undertake daily inspections on the site, note any instances of improper waste disposal and review disposal certificates and complaints register.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register ▸ Log Book
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

16 LANDSCAPE AND AESTHETICS

This chapter presents information related to the landscape of both sites under the following sections:

- Policy and Legal Framework
- Existing Land Use,
- Impacts to Aesthetics

16.1 Key Relevant Policy and Legislation

Information from this section was derived from the Guyana National Land Use Plan, Government of Guyana, Ministry of Natural Resources and Environment, 2013. Section 3.3.4 of the EIA Report outlines the main points of the National Land Use Plan of 2013 which provides a framework to guide land development in Guyana. The National Development Strategy also outlines policies for long term development of which the following are relevant to the project:

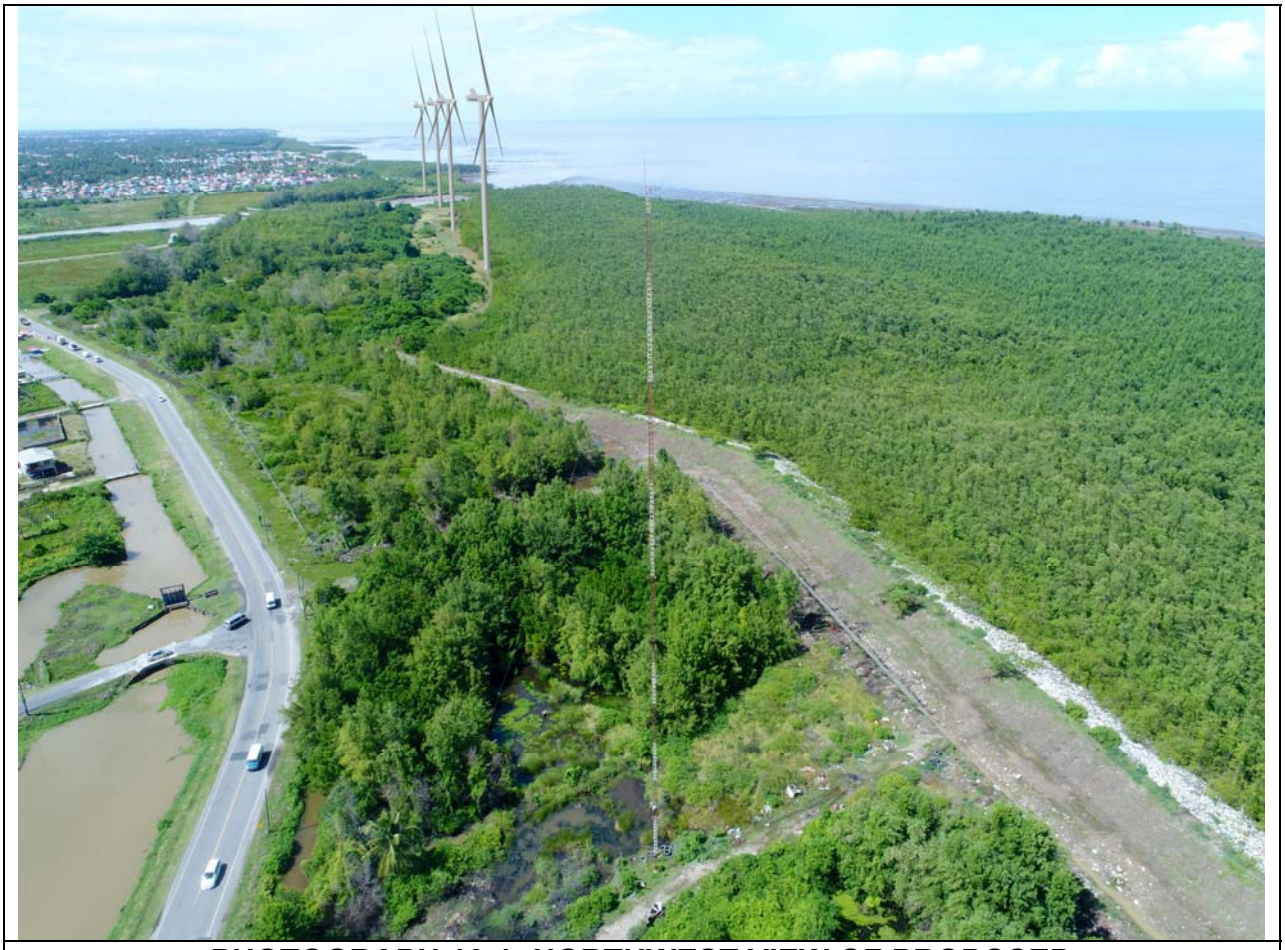
- Access to agricultural land should be made easier (lease conditions, selection criteria, improved decision making etc) and a rural land tax should be introduced to discourage under-use of land.
- The potential for non-traditional crops should be studied in certain geographical zones based on suitability and markets.
- Forestry should be developed to increase economic benefits and improve sustainability.
- Transport links should be developed including all-weather roads to resource rich areas (mining, forestry, soils), complete the Georgetown-Lethem road link, construct bridges across major rivers, develop a water port, upgrade airport facilities and develop the hinterland.
- Water Resources and Flood Control. Protection of mangroves, encouragement of participation in D&I maintenance, climatic zoning for land use planning.
- Environment. Protection of mangroves, develop Codes of Practice for mining and forestry, introduce EIA legislation, set up Protected Areas system.

16.2 Existing Information, Baseline Studies

16.2.1 Hope Beach

Figure 16-1 shows the land use in the area surrounding the wind turbine locations in Hope Beach. The land use is a mixture of residential communities to the west and

south, agricultural area between seawall and main road, and extensive agricultural area south of residential areas, and natural vegetation including mangrove, marsh and scrub (see Sections 13.4.1 and 17.2). Photographs 16-1 and 16-2 show the project site. The first was taken from SE of the meteorological mast looking to the north west with the communities of Lowlands and Nootenzuil in the distance. The grassy relict beach ridge where the turbines will be constructed is clearly shown. The second image was taken from the north side of the mast looking to the south. The Hope Canal is clearly shown as well as the communities of Douch Four agricultural fields, Two Friends, Anse Grove, and Clonbrook residential areas.



PHOTOGRAPH 16-1: NORTHWEST VIEW OF PROPOSED WIND TURBINES AT HOPE BEACH

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ECO REPORT NO.	05/2020
DATE:	03/12/21
CLIENT:	HOPE ENERGY DEVELOPMENT INC.
PROJECT:	ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA
DWG. NAME:	SURROUNDING LAND USE - HOPE BEACH
FIGURE NUMBER:	16-1

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PHOTOGRAPH 16-2: SOUTH VIEW OF WIND TURBINES AT HOPE BEACH

16.2.2 Chapman's Grove

Figure 16-2 shows the land use in the area surrounding the wind turbines at Chapman's Grove. The land use is a mixture of residential communities to the south and east and agriculture (mainly coconut plantations to the west), and extensive rice farming areas south of the main road (see Photograph 16-3).

PHOTOGRAPH 16-3: NORTH EAST VIEW OF WIND TURBINES AT CHAPMAN'S GROVE

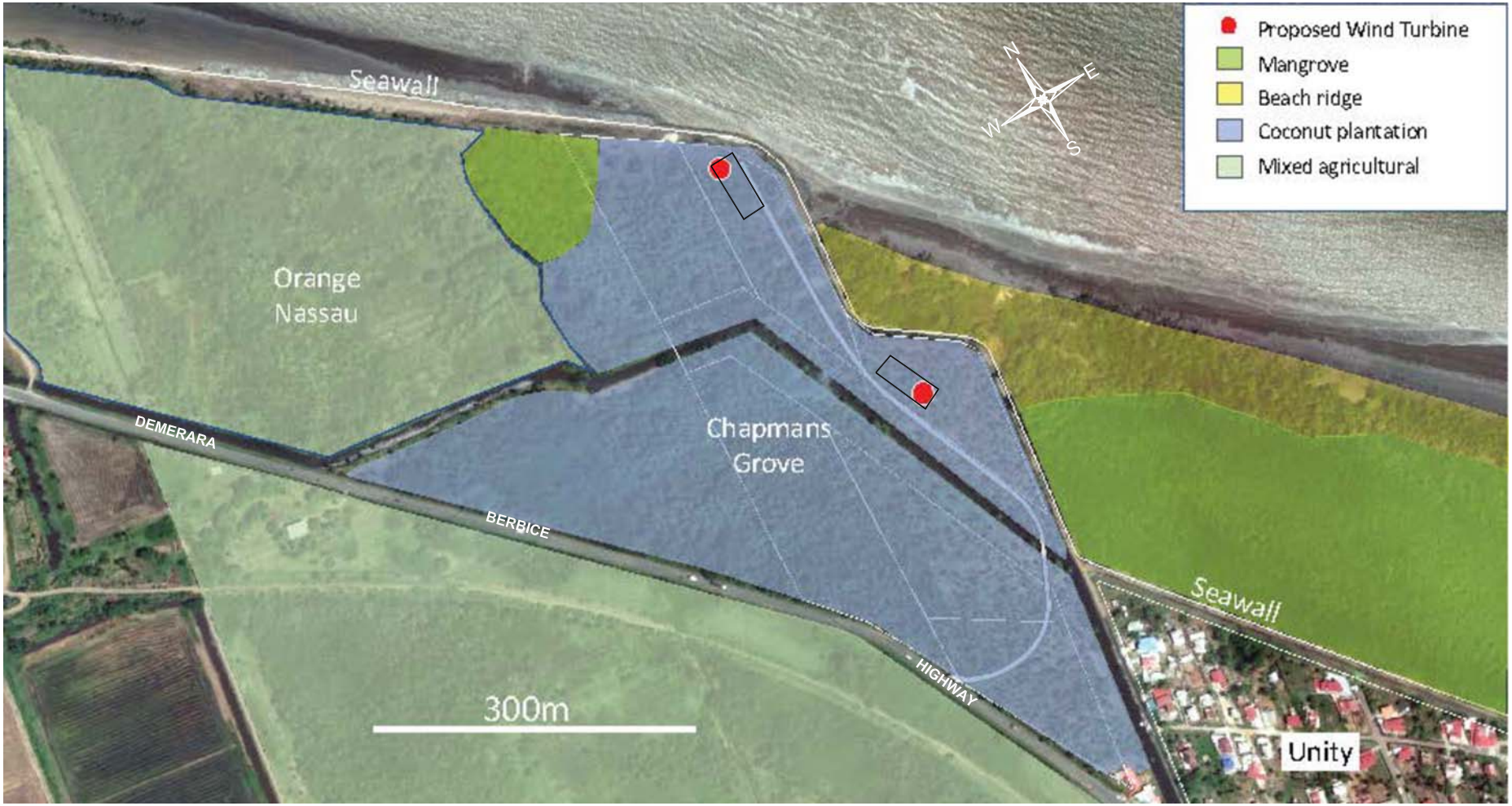
16.3 Impact Prediction and Assessment

16.3.1 Construction Phase

16.3.1.1 Nature of Concern

During the construction phase the following activities are expected to have some impact on the landscape:

- Clearing and grubbing for access roads and turbine foundations;
- Excavations for turbine foundations; and
- Presence of heavy equipment on site.



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ECO REPORT NO.	05/2020
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DWG. NAME:	SURROUNDING LAND USE - CHAPMAN'S GROVE
FIGURE NUMBER:	16-2

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It is expected that residents who are normally treated to a view of the canals, mangrove and the marine environment, will now have their view impeded by construction equipment. Additionally, the earthworks will leave bare areas where there once was vegetation. It is important to note that HED has stated that no mangrove trees will be removed for the construction of the wind turbines.

16.3.1.2 Unmitigated Impact

The concern for changes in landscape is greater at Hope Beach because of the larger number of turbines to be installed and the fact that the vegetation at Hope Beach is more significant (see Section 13.4.1). However, this concern is expected to be temporary and limited to the construction site.

The unmitigated impact associated with construction on the surrounding landscape is summarized as follows:

Hope Beach

Extent	Intensity	Duration	Classification
Onsite	Medium	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Onsite	Minor	Short Term	**LOW**

16.3.1.3 Mitigation Measures

Measures available to mitigate the impact of construction on the surrounding landscape include:

- Clearing only areas needed for the construction;
- Plan construction works so that it is finished within the allotted time;
- Limit the amount of time that equipment is left on site.

The implementation of these mitigation measures is expected to effectively address the impacts on the surrounding landscape.

The impact after mitigation associated with construction on the surrounding landscape is summarized as follows:

Hope Beach

Extent	Intensity	Duration	Classification
Onsite	Minor	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Onsite	Very Small	Short Term	**LOW**

16.3.1.4 Cumulative Impacts

None of the proposed projects identified in Section 2.6 have the potential to result in a cumulative impact to this project since they are too far away from the two project sites.

16.3.2 Operation Phase

16.3.2.1 Nature of Concern

Appendix T provides views of the wind farm from various vantage points in the community. These show the residents' perspective. As shown in the photos, the wind turbines will be distinct features along the shoreline. At both Hope Beach and Chapman's Grove the turbines will be above the existing canopy. At Hope Beach the canopy is approximately 15 to 20 m while at Chapman's Grove, the canopy is at 20 m. The wind turbines have been designed to be a dull greyish colour which is expected to blend into the background sky surroundings and therefore reduce the visual impact. Additionally, the turbines are adequately spaced to ensure that line of sight to the coast is maintained.

It is not reasonable to rate the impact of construction on the surrounding environment without mitigation since the measures that are available to reduce these operation phase impacts are addressed in the design phase. These include:

- Installation of a low number of turbines so as not to crowd the available land space;
- Installation in a single row, one after the other;
- Use a greyish colour for the turbines to allow them to blend into the background;
- Adequate spacing of the turbines to maintain line of sight;
- Maintaining a low rotational speed to be less obtrusive (6 to 12 rpm).

The rating of this impact with mitigation is as follows:

Hope Beach

Extent	Intensity	Duration	Classification
Onsite	Very Small	Short Term	**LOW**

Chapman's Grove

Extent	Intensity	Duration	Classification
Onsite	Very Small	Short Term	**LOW**

16.3.2.2 Cumulative Impacts

None of the proposed projects identified in Section 2.6 have the potential to result in a cumulative impact to this project since they are too far away from the two project sites.

16.4 Environmental Management Plan

16-1	POTENTIAL IMPACT	IMPACTS TO LANDSCAPE AND AESTHETICS
MITIGATION MEASURES		• Clearing only areas needed for the construction; • Plan construction works so that it is finished within the allotted time; • Limit the amount of time that equipment is left on site.
ACTION BY		Project Engineer to implement all other measures.
TIMING		▸ Clear areas and plan construction works prior to construction. ▸ Monitor equipment schedules during construction.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ Project Engineer to verify the project progress against the schedule. ▸ HSE Manager to maintain complaints register.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register ▸ Log Book

16-1	POTENTIAL IMPACT	IMPACTS TO LANDSCAPE AND AESTHETICS
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

17 SOCIO-ECONOMIC IMPACTS

This chapter summarizes the findings of Socio-Economic Impact Assessment and Stakeholder Engagement Plan under the following sections:

- Key Relevant Policy and Legal Framework,
- Baseline Conditions,
- Socio-Economic Impacts and Mitigation Measures, and
- Environmental Management Plan.

The full Socio-Economic Assessment is included as Appendix I.

17.1 Key Relevant Policy and Legislation

The legal framework which will govern the construction and operation of the wind farm is detailed in Chapter 3 of this ESIA.

17.2 Existing Information, Baseline Studies

17.2.1 Demography

- As per Census 2012, the total number of households in the project area was 1876, with the highest number of residents living in Ann's Grove. The population estimate is calculated based on the count of buildings/ houses combined with the average number of persons per household and shows that, Hope-Lowland is the largest and Unity-Lancaster the smallest community in the project area.
- A comparison of aerial views generated through Google Earth shows that a number of additional houses were built in some of the communities in the period 2012 / 13 to the end of 2020.
- The survey's respondents' sex distribution in the communities reflected the national picture from the 2012 census, with slightly more females (51%), than males (49%).
- The households consist of an average of 3-4 persons. This number differs between the different communities.
- Houses in region 4 usually date from before 1980 (31%). Only 5% of houses were built in more recent years (2011 or later). This also applies to the project area.

Properties in the project area are mostly owned by the residents (81%) or by a family member or other acquaintance (5%), while 14% of the residential facilities in the communities are rented.

17.2.2 Utilities and Social Infrastructure

- Electricity is commonly used by 93% of the households, although unstable electricity is frequently experienced. The residents without electricity (approximately 7%) use battery power or solar system lighting.
- The opinions of the residents of the different communities about the social infrastructure of their community vary. Water supply is one of the poorly rated facilities in all communities in the project area, with around 20% and more respondents giving it a negative score. The same goes for Security which seems to score even worse with ratings around 30% and above in Douchfour - Two Friends, Greenfield, Hope-Lowland, Nooten Zuil and Unity (5 out of 7 communities).
- Residents in Ann's Grove and Douchfour are mostly positive about healthcare facilities that are available (more than 95%), while Public transport had positive ratings in Nooten Zuil, Greenfield and Ann's Grove (95% or more). Concerns about electricity were mostly indicated in Beehive, Douchfour/ Two Friends, Greenfield and Hope/ Lowland (over 20% of respondents), while Ann's Grove and Unity are relatively positive on this topic.
- The 2012 census showed that the majority of people living in the project area have no educational degree (67%). The majority of respondents in the project area had secondary school (60%) and primary school (28%) education.
- In the project area there are 5 schools, located in the neighbourhoods Ann's Grove (1 primary and 1 secondary school), Clonbrook (1 primary school) and Hope (1 primary and 1 secondary school). One secondary school is near the main road in Hope, closest to the project location.

17.2.3 Employment

- According to Census 2012 data, the largest percentages of residents in the communities near the project area mostly work in the following major industry sectors: Agriculture, Forestry and Fishery (19%), Wholesale & Retail Trade (18%), Mining and Quarrying (12%) and Construction (also 12%). Approximately 11% of the residents were unemployed.

- The community surveys noted 36% of unemployed respondents (excluding retirees and school attending population). Of the employed (55% of total respondents), 74% work full-time, while the remaining 26% have a part-time job.

The project site is located on the outskirts of the greater Georgetown urban sprawl, within reasonable transportation distance from any area in Georgetown. Workers that reside outside of the immediate project areas are expected to travel to and from the sites on a daily basis. There is therefore a low probability for an adverse impact on the housing capacity within the communities. The potential for migrant workers was referenced in Table 17-1 in relation to a large housing development proposed for the wider study area and not for the wind farm project.

17.2.4 Health Services and Health Concerns

- In the project area there are two-day care health centers, one in Ann's Grove-Clonbrook and at Mahaica, and the regional hospital is at Nabaclis, 3km from the site, which has one ambulance but does not have overnight service. Medical emergency treatment is only available in Georgetown, 25 km from the site.

- The use of alcohol and smoking/ drug use are the main health concerns in the communities, followed by Diabetes and Hypertension which are typically linked to alcohol use and smoking. The fifth mentioned health issue the communities are facing is teen pregnancy.

- 29% of the respondents registered a health concern they or a member of the household currently suffers from. The main personal health concerns indicated are Hypertension (35%) and Diabetes (33%). Amongst the remaining 32% of personal health concerns are Arthritis, Asthma, Kidney stones and Sickle cell anaemia etc. Nevertheless, only 7% of the respondents are in possession of health insurance (8% refused to answer the question).

17.2.5 Fishing Profile

- Based on the fishermen survey, there are approximately 50 fishing vessels in the Hope Canal (out of a total of 100 in the entire area). One vessel hosts 2 to 6 fishermen, depending on the size of the boat. An estimated total of 200-250 fishermen use the Hope canal for fishing activities.
- The boats are owned by individual fishermen who are not grouped in any kind of organization or statutory group. Some fishermen own more than one vessel.

- About 50% of the fisher folk live in nearby communities Lowlands, Hope, Nooten Zuil and Enmore. The other 50% live further away. The Hope canal area is thus very important for the fishermen, working and living there.
- Challenges faced by the fishing community are: security for their boats and equipment; timely availability of ice to match the tides and fishing schedules; and worries about coastal erosion and its impact to the safe harbour provided by the Hope Canal outlet
- Fishermen surveyed were positive and favourable about the project, although they also had some concerns. The most important responses and concerns were about the length and sustainability of the project. The fisher folks were concerned about maintenance of such a long-term project.
- They also requested to ensure that no damage is done to their fishing infrastructure.

- In addition, some were curious about their personal gain from the project (such as, full utilization of power).
- They all expressed their desire for cheaper energy and fewer black outs as a positive result of the project. They also would like to see the wind turbines in combination with a sea defence structure (sea wall) to protect the land from eroding, thereby protecting the Hope Canal outlet which is used as their fishing harbour.

17.3 Environmental Impacts, Mitigation and Monitoring

Table 17-1 summarizes the potential impacts to the socio-economic environment. Details are included in Appendix I. Monitoring to determine the effectiveness of mitigation is also included in the table.

TABLE 17-1: SUMMARY OF IMPACTS AND MITIGATION MEASURES

BENEFITS	
	• Significant additional electrical capacity to the power grid in the form of renewable energy, • Reduce power outages and improved grid stability and power quality • 10% Reduction in GPL's fuel oil generation requirement and 10% reduction in pollutants emitted by Georgetown located HFO generators (and impact to the city population), and 10% reduction in GHG emitted which is a significant step towards Guyana's Paris Agreement commitments • Significant impact to the economy: long-term low-cost power for GPL,

	substantial local ownership of the assets with long-term project revenues remaining in Guyana, and reduction in foreign exchange losses for fuel imports by over 10 million USD per year • Opportunities for employment (temporary during construction and permanent during operation) • Skills training for local residents during construction and operation phase • Opportunities for local eco-tourism - guided tours of an iconic renewable energy installation • Fishing community can benefit from improved access road to fishing depot, renewable energy for manufacture of ice on-site, etc. • HED support of local school - sponsorship of extracurricular activities etc. • As the first significant step in transforming Guyana's energy requirements to renewable resources, lessons learnt from this project will help accelerate follow-on renewable energy projects at scale and achieve Guyana's goal of 100% renewable

POTENTIAL ADVERSE IMPACTS			
PROPOSED IMPACTS		**MITIGATION**	**MONITORING**
Population	**Construction Phase** • Presence of migrant/ mobile workers	<u>Presence of migrant/ mobile workers:</u> - Ensure local contracting as far as possible. - Provide training for local community members where possible. - Provide adequate information to workers on expected social behaviour when in and interacting with the community (esp. in relation to fisher folk).	- Frequent community consultations to verify experienced nuisance; with frequency such as weekly, during peak construction periods and fortnightly afterwards. - Contractor agreements to spell out all required mitigations, and adherence monitored and confirmed.
Social infrastructure	**Construction Phase** • Increased road traffic,	<u>Increase of traffic:</u> - Transportation through community areas shall be avoided as much as	- Set up a Community Grievance Redress (CGR) mechanism

	• Damage to road infrastructure, utilities • Noise emission • Loss of work after construction is completed • Loss of access (residents, fishermen) • Reduced emergency response time • Dust emission	possible. - Planned transport routes for construction material shall strictly be followed. - Communicate the transportation of critical components early to allow the public to make required arrangements. - High noise transportation activities shall not be carried out at night as far as possible. <u>Damage to road infrastructure, utilities:</u> - All vehicles engaged for transportation shall be verified as suitable for the roads to be accessed and loads transported. - Training of drivers in defensive driving techniques, specifically targeting project area. <u>Noise emission:</u> - Utilizing construction techniques (especially noise intensive activities like pile driving) that minimize the production of noise. - Avoid night-time work to the extent that is practical - Strict adherence to site working hours. - Communicate scheduled noise intensive activities to communities. <u>Loss of work at completion of construction:</u>	enabling residents to communicate their grievances to the developer via appointed liaisons officers within the community. - Regularly address complaints received through CGR officers in the different communities; set frequency such as weekly during peak construction periods and fortnightly afterwards. - Contractor agreements to spell out all required mitigations, and adherence monitored and confirmed - Set boundaries to construction area with clear directions.

		- Explicitly inform workers about duration of work. - Clearly inform workers about the expected schedule and completion of each activity. - Where possible provide training of workers to transition from construction to operation phase employment. <u>Loss of access to project area:</u> - Clearly outline the area to be accessed during construction - Schedule construction activities to maintain access as far as possible. - Provide alternative access options. <u>Reduced emergency response time:</u> - Schedule construction activities to maintain road access as far as possible. - Prepare and implement a Traffic Management Plan in conjunction with Police. <u>Dust emission:</u> - Enforce traffic speed regulations within the construction zone to reduce dust emissions due to speeding along roads. - Frequent wetting of bare surfaces and access ways, thereby limiting opportunities for the formation of atmospheric dust.	

		- Cover all transport vehicles to prevent dust flying up from the materials into the air. **See applicable recommended measures in Chapter 10.*	
	Operation Phase • Shadow flicker • Noise emissions	<u>Shadow flicker:</u> - Turning off the wind turbines when appropriate to minimize flicker at any residences within acceptable limits <u>Noise emission:</u> - Location of wind turbines with sufficient offset distance from nearby homes such that maximum noise-emissions are below a maximum of 45 dB at nearby receptors at night, and 50 dBA during the day, including at the school.	- complete community survey at residential homes in flicker affected areas.
Health & Safety	**Construction Phase** • Occupational hazards • Health concerns related to noise & air emissions • Extra pressure on local Health facility • Public safety.	<u>Occupational hazards:</u> - Ensure that workers are well trained - Provide on-site first aid facilities. - Ensure provision and use of Personal Protection Equipment. **Measures listed in Chapter 18: Risk Assessment, are also applicable here.* <u>Health concerns related to noise & air emissions:</u> - Utilizing construction techniques that minimize the production of noise. - Avoid working between 7.00PM and 7.00AM to	- Ongoing daily inspections to ensure strictly following of standard operation procedures. - Monitor traffic flow in the area to ensure that Traffic Management Plan is effective.

		avoid / minimize interruption of residents' night sleep. <u>Pressure on local health facility:</u> - Engage health authorities to provide in a dedicated ambulance service in collaboration with the local health clinic. **See chapter 18 for Emergency Response Plan* <u>Public safety:</u> - Develop a Traffic Management Plan (TMP) for construction workers - Provide clear signage for construction zone **Also see chapter 14 for mitigation on road safety*	
	Operation Phase • Noise emissions	<u>Noise emission:</u> - Operate wind turbine 4 in noise reduction mode at night	- Address complaints on noise emission received through CGR officers in the different communities.
Fishing community	**Construction Phase** • Improper disposal of waste • Loss of Access • Potential for loss of earnings (fishermen)	<u>Waste generation:</u> - All waste generated shall be collected and disposed of at designated disposal site - Develop and use Waste management plan. <u>Interruption of road access:</u> - Provide an alternative route to reach canal <u>Loss of earnings:</u> - Minimize impediment of	- Frequent consultations with fisher folk to assess any experienced nuisance (see comments on grievance redress above - Frequent site inspections to note any waste disposal issues.

		fishers as much as possible.	
Hope Secondary School	**Construction Phase** • Health Concerns (air and noise emissions) • Loss of Access • Increased Road Traffic (students and teachers late arrival to school).	<u>Health Concerns:</u> - Utilizing construction techniques that minimize the production of noise. - Frequent wetting of bare surfaces and access ways, thereby limiting opportunities for the formation of atmospheric dust surrounding the schoolyard - Provide extra cleaning service for dusty classrooms - Provide mouth and nose masks for use at school in case of excessive dust. <u>Loss of Access:</u> - Minimize impediment of schoolchildren and teachers entering the schoolyard as much as possible - Adjust work schedule as much as possible with school times (e.g. after school hours and vacations) <u>Increased Road Traffic:</u> - Adjust work schedule as much as possible with school times (e.g. avoid drop-off and pick-up periods)	- Assign liaisons officers from the Community Grievance Redress (CGR) mechanism with specific duties for school grievances.
	Operation Phase • Shadow flicker • Noise emissions	<u>Shadow flicker:</u> - Shadow flicker impact is not expected to occur during school hours.	

		Noise emissions: - Turbines designed to meet international and local noise standards with negligible impact at the school.	

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18 HEALTH AND SAFETY RISK ASSESSMENT AND EMERGENCY RESPONSE PLANNING

18.1 Health and Safety Risk Assessment

18.1.1 Introduction

This chapter presents information on the risk to health and safety posed by the Hope Wind Farm Project to jobsite employees and the public during both the 10-month construction phase and 20-year operation phase of the project. Sources of information for this chapter include:

- Baseline annual severe-incident statistics from OSHA and American Wind Energy Association sources.
- A Quantitative Risk Assessment completed for the risk of blade-throw by MMI Thornton-Tomasetti engineering consultants from the UK (see Appendix U).
- The feasibility stage jobsite Risk Assessment and Emergency Response Plan completed by HSE Consultant, Mr Robert Stevens.

18.1.2 Key Relevant Policy and Legislation

Section 3.7 outlines the Occupational Safety and Health Act (OSH Act) and also the Emergency Preparedness guidelines. The Guyana Government's Ministry of Social Protection in collaboration with The National Advisory Council on Occupational Safety and Health (NACOSH) published a National Policy on Occupational Safety and Health in 2018. As stated in the 2018 National Policy "The Government of Guyana through the Ministry of Social Protection and partner agencies endeavour to improve working conditions and environment generally in Guyana by promoting the integration of safety and health principles in workplaces as an important prerequisite for the reduction of occupational accidents and diseases".

In terms of disaster management, the draft Disaster Risk Management Policy establishes the guiding principles for disaster risk management in Guyana. It includes institutional structures, roles, responsibilities, authorities and key processes to achieve a coordinated approach to disaster risk management (Guyana Civil Defense Commission, 2014). Under this Policy, the Civil Defense Commission (CDC) is the main national mechanism for coordinating the policy. The CDC, in 2015 launched the National Emergency Management System which sets up a 24-hour system to handle disasters in Guyana.

In addition, there are several other plans and acts which guide disaster management in Guyana:

- Draft National Integrated Disaster Risk Management Plan and Implementation Strategy, which outlines actions to tackle floods and droughts and includes: risk identification, prevention and mitigation, financial risk management preparedness and response/recovery.
- Draft Multi-Hazard Preparedness and Response Plan which focuses on establishing roles and responsibilities of different actors for preparedness and response, and the mechanisms for early warning.
- Draft Shelter Management Policy and Standards which provides a framework for the establishment of a national shelter management body and a description of the coordination levels for activation and closure of shelters.
- Fire Service Act- which establishes and empowers fire-fighting services.

The Emergency Response Plan prepared for the Wind Farm Project must align with the National Plan especially where offsite resources are needed to respond to an incident / accident onsite.

18.1.3 Existing Information, Baseline Studies

Health and safety risk and mitigation must consider all work activities associated with the 10-month construction phase and the subsequent 20-year operation and maintenance phase of the project.

During construction the majority of the manhours will be dedicated to the civil works, constructing roads, foundations, crane pads and lay-down areas, and the electrical works. The electrical works involve installation of electrical lines from the wind turbine sites back to the substation, installation of the electrical equipment at the substation, and installation of an electrical line from the substation to the 69KV transmission line. These activities are largely the same as for other construction projects that occur in Guyana, and the occupational health and safety incident rates will likely be similar as for other construction projects in Guyana.

The final stage of construction involves the offloading of the oversize and overweight wind turbine equipment at the wharf in Georgetown, transporting the equipment to site, installing the wind turbines, and finally testing, connecting to the live electrical grid, and commissioning the system. This final wind turbine installation phase will last some 2 months in total and will require experienced and highly skilled labour familiar with wind turbine installations.

Guyana's Occupational Health and Safety department has data on fatalities per year for various industrial sector, but no manhours or employment numbers that can be used to convert these to more meaningful rate related incident data. The more extensive data from the United States Occupational Health and Safety Administration (OSHA) are used here to illustrate the risk levels associated with construction, and specific activities within the construction sector.

In addition, the number of occupational injuries, days away from work cases and fatalities occurring in the wind industry in the United States are contrasted with the same types of statistics from more general countrywide industrial sectors in the United States for the year 2018. These data are taken from the American Wind Energy Association (2019), and the US Bureau of Labor Statistics publications (2020a&b).

	per 100 FTE		Per 100,000
Industry	**Recordable**	**DAFW**	**Fatalities**
Agriculture, forestry, fishing, hunting	2.8	0.9	23.1
Mining, quarrying, oil&gas extraction	5.2	1.7	14.6
Transport and warehousing	4.4	2.0	13.9
Wind Industry construction 2018	1.2	0.2	13.3
Construction (all)	2.8	1.1	9.7
Wind Industry O&M 2018	1.0	0.2	8.3
Wholesale trade	2.7	1.0	4.9
All Workers	2.8	0.9	3.5
Retail trade	3.4	1.0	2.0
Utilities	2.2	0.5	2.0
Education	2.0	0.6	1.0
Finance and insurance	0.5	0.1	0.3

DAFW - Days Away From Work cases
FTE - Full Time Equivalent employees
Source: US Bureau of Labour Statistics (www.bls.gov), AWEA (www.awea.org)

TABLE 18-1: OCCUPATIONAL SAFETY INCIDENT STATISTICS SELECT INDUSTRIES, USA, 2019

Table 18-1 shows the HSE statistical rates in the United States for selected industrial sectors during the year 2019 (US Bureau of Labor Statistics, 2020). Also shown are the same statistics for the American wind industry recorded for the last available year in 2018 (AWEA, 2019) for 50 industrial participants representing some 45,560 employees in the industry, specifically for the construction and operations and maintenance (O&M) sectors of the wind industry. In 2018 the American wind industry employed a total of over 111,160 persons, supporting 7,400MW of wind turbine installations in that year, and O&M for a total 96,487MW installed capacity.

Typical activities associated with construction of a wind farm, such as construction and transport related activities, not specific to the wind industry, can be considered sectors with moderately high HSE incidents, when compared to low-risk work categories such as indoor-based education, finance and insurance industries, similar to the mining and extractive industries, but considerably safer than the agriculture, forestry, fishing and hunting sectors. The wind industry specific data shows overall much lower recordable incidents and DAFW statistics than the general construction sector, however, a similar number of fatalities per 100,000 full time equivalent employees each year.

	per 100,000 FTE
Job Type	**Fatalities**
Fishing and hunting workers	145.0
Logging workers	68.9
Roofers	54.0
Construction trades and helpers	40.0
Driver/sales workers and Truck drivers	26.8
Structural iron and steel workers	26.3
Farmers, agricultural managers	23.2
Ground maintenance workers	23.2
All Workers	**3.5**

FTE - Full Time Equivalent employees
Source: US Bureau of Labour Statistics (www.bls.gov)
https://www.bls.gov/news.release/cfoi.t05.htm#

TABLE 18-2: FATALITIES FOR SPECIFIC JOBS, USA, 2019

When summarised at an industry level incident, data includes statistics for all employees associated with each industry sector, and this includes for example lower risk office-based workers that may be supporting construction. Industry based statistics thus under-represent the health and safety risk of the workers that are actually on the construction site. The US Bureau of Labor also publishes HSE statistics for job related categories, shown in Table 18-2. The risk exposure of the site employees is clearly highlighted in the job specific fatality data, with statistics that are an order of magnitude higher than the industry segment statistics, and this underlines the importance of rigorous implementation of good safety practice on site.

As per statistics tabulated by the Occupational Safety & Health Administration (OSHA), out of 5,147 worker fatalities in the private industry in 2017, 971 fatalities (almost 20%), were in the construction industry (see Figure 18-1). This equates to one in five worker deaths in 2017, yet construction workers only make up 4% of the workforce (US Bureau of Labor Statistics, 2017)

The leading causes of these accidents include falls, transportation, electrocution, and being caught in or between heavy equipment. These "Fatal Four" causes were responsible for almost 60% of the construction worker deaths in 2017, as reported by

the Bureau of Labor Statistics (2017). It is noteworthy that worksite violence, non-subscription drugs and alcohol together account for almost 10% of occupational fatalities, which underlines the importance also of drug and alcohol testing, and onsite security.

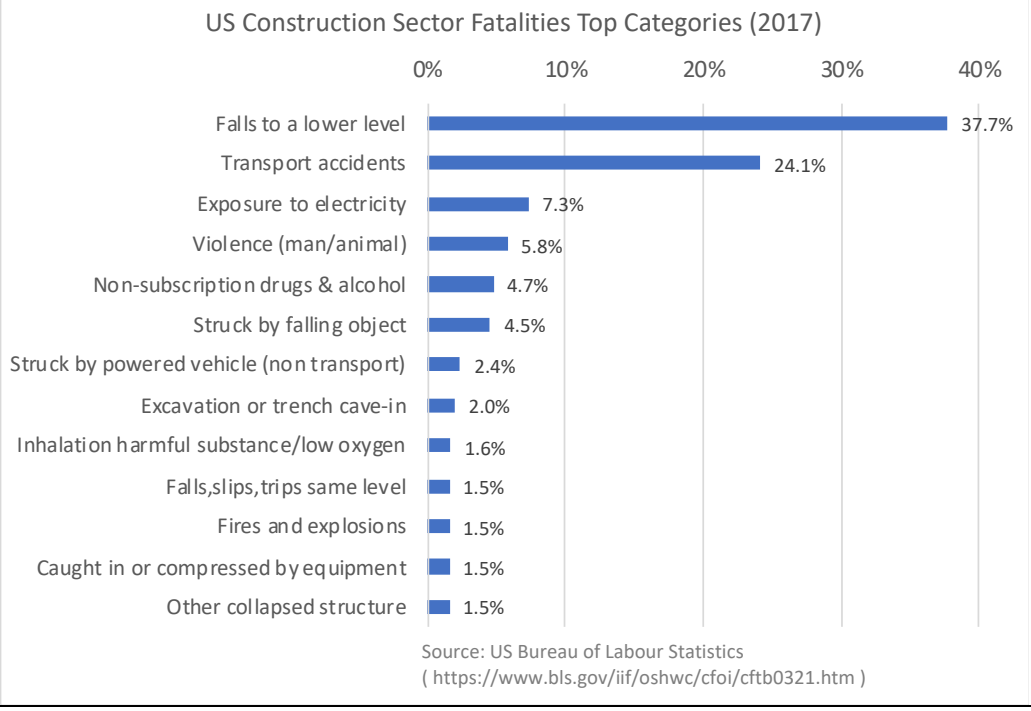

FIGURE 18-1: US 2017 CONSTRUCTION SECTOR FATALITIES BY TOP CATEGORIES

AWEA (2019) summarise the types of injuries and how these were incurred within the wind industry for the year 2018 in the Figures 18-2 and 18-3 below. It is noteworthy that in the wind industry the activities which cause injuries have a different ranking in risk compared to those of fatalities in the construction industry as a whole. The highest cause of incidents is related to lifting and handling equipment, followed by falling to a lower level, of which most were related to accidents from ascending/descending ladders.

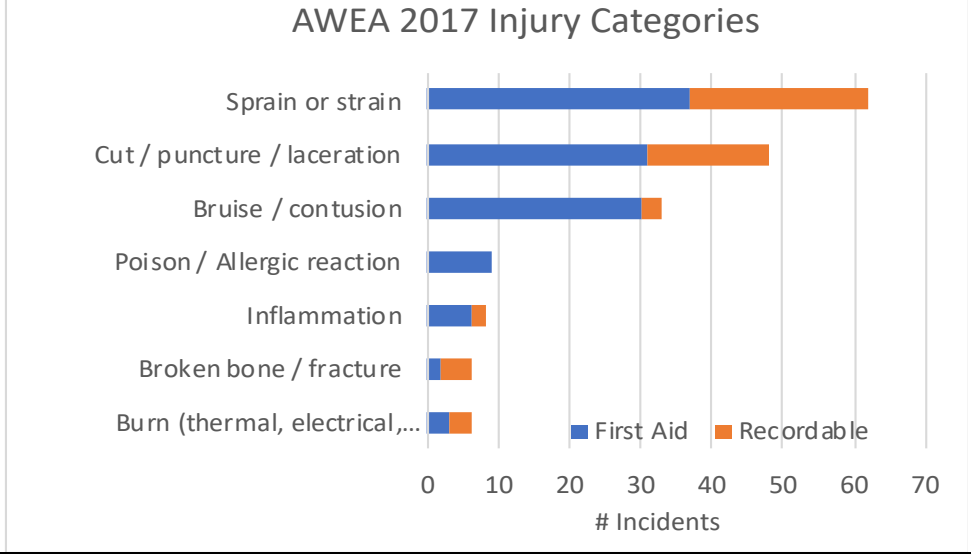

FIGURE 18-2. TYPES OF INJURIES EXPERIENCED WITHIN THE WIND INDUSTRY IN THE USA IN 2018, AS REPORTED BY 50 ORGANISATIONS REPRESENTING SOME 45,566 FULL TIME EQUIVALENT WORKERS (AWEA, 2019)

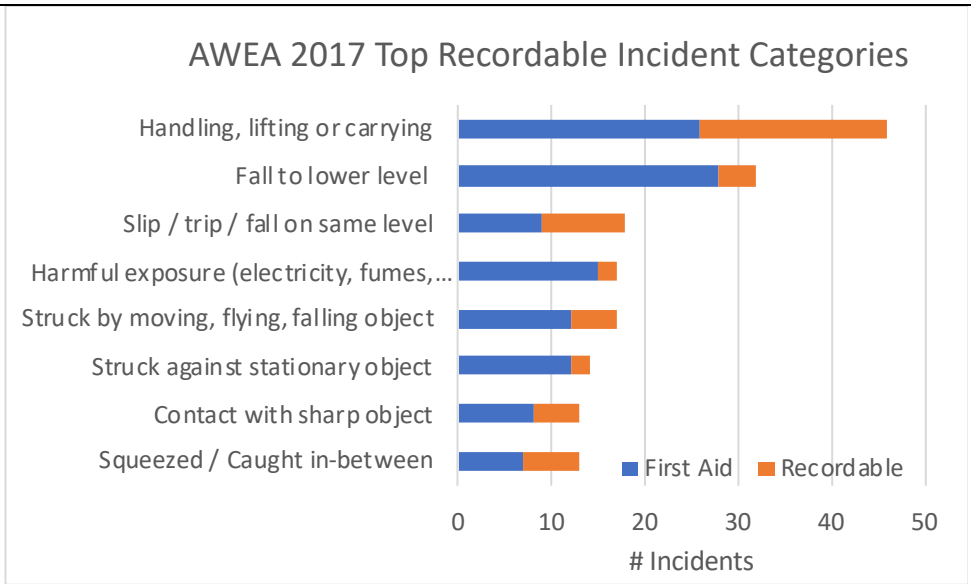

FIGURE 18-3: ACTIVITIES IN THE US WIND INDUSTRY WHICH LED TO THE INJURIES LISTED IN FIGURE 18-2

18.1.4 HSE Leadership and Organisation

High standards of health and safety performance depend on the commitment and leadership of senior management of the project development organisation. Health and safety must be regarded as a key risk-management issue, to be driven from the highest levels of an organisation.

The Responsibility for Safety, Health and the Environment are well as emergency response within the project organisation during the construction phase is illustrated by the organisational chart below (see Figure 18-4).

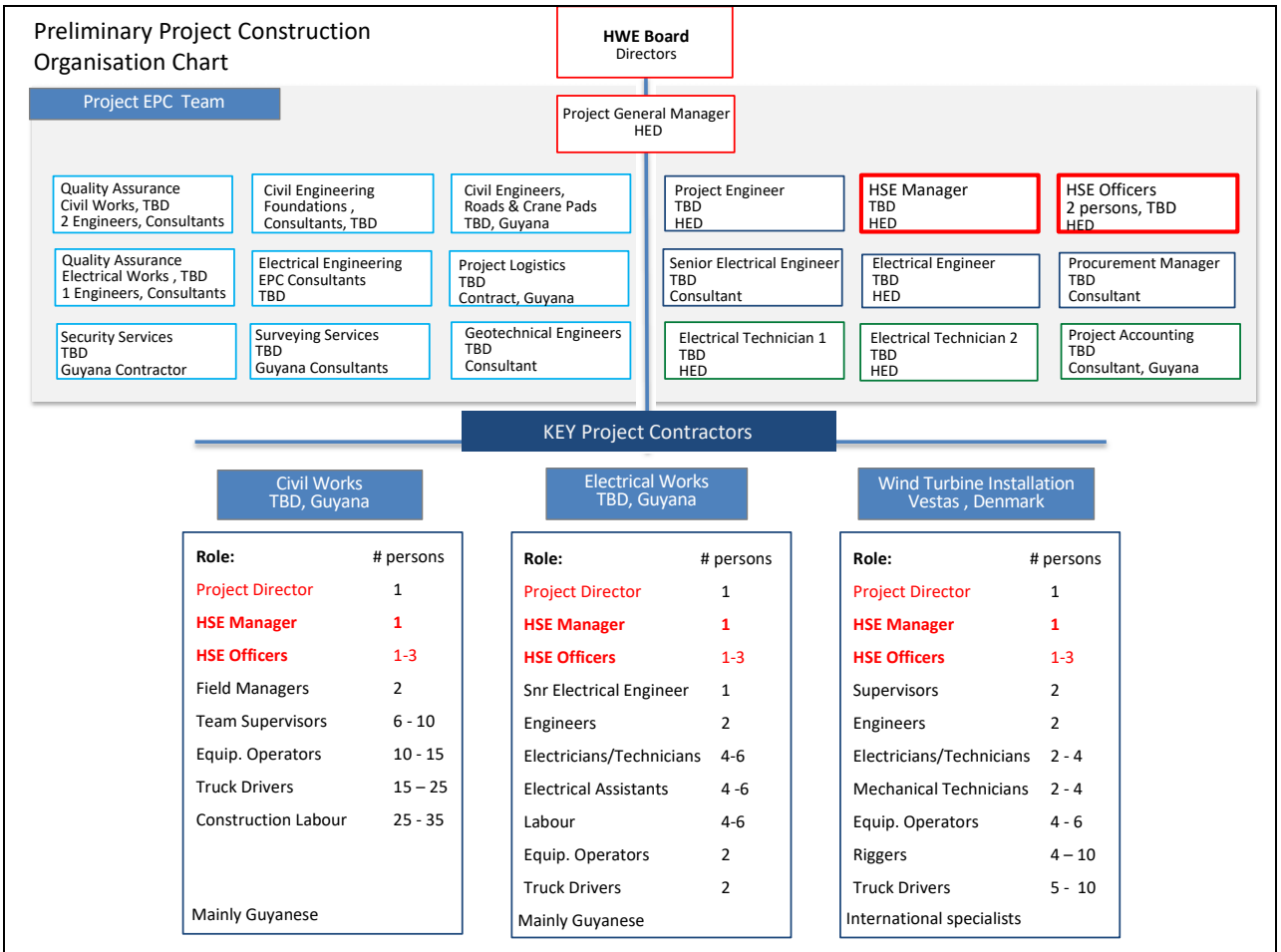

FIGURE 18-4. PRELIMINARY PROJECT CONSTRUCTION PHASE ORGANISATION CHART, WITH HSE LEADERSHIP AND DEDICATED HSE STAFF. HIGHLIGHTED IN RED

Organisation during the 20-year wind farm operation phase, and persons with responsibility for health, safety, environment and emergency response matters are illustrated in Figure 18-5, below.

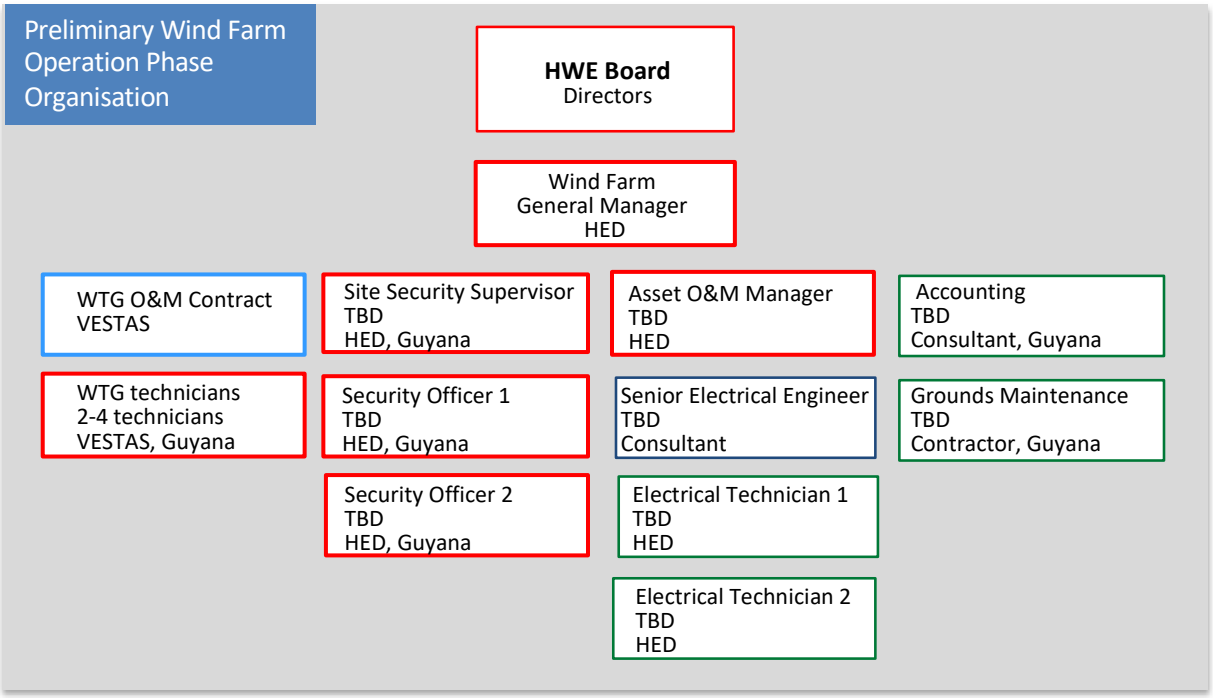

FIGURE 18-5. ORGANISATION DURING THE 20 YEAR OPERATIONAL PHASE OF THE WIND FARM. PERSONS WITH RESPONSIBILITY DURING EMERGENCY RESPONSE ARE HIGHLIGHTED IN RED

Management is responsible for the following areas relating to HSE:

- Defining a health and safety policy and implementing this policy.
- Ensuring a Safe System of Work is in place to manage health and safety, authorise and control workplace activities.
- Ensuring that hazards and their risk levels are assessed and protections put in place to protect from such hazards.
- Operation of emergency response plans.
- Ensuring suitable supervision is in place.
- Ensuring all workers are trained in health and safety
- Ensure that employees are consulted regarding workplace safety risks and precautions.

- Provide employees with personal protective equipment necessary for the safe conduct of all job tasks.

18.1.4.1 Project General Manager

The Project General Manager has overall responsibility for Safety, Health, Environmental (HSE) and Security of the site during construction and operation. He will also ensure that Safety, Health, Environmental and Security policies are in place and have been read and signed off by anyone working on the site. The policies will be placed in visible areas and communicated to all jobsite workers so that everyone is familiar with them.

The Project General Manager will also ensure implementation of a Safe System of Work, with adequate control-of-work procedures, and that they are enforced. All Sub-contractors will be pre-qualified and must have their own Safety, Health, Environmental & Security policies and work control procedures, that have been reviewed and approved by the Project Manager responsible for HSE & Security.

18.1.4.2 HSE Manager and HSE Officers

The HSE Manager and Officers will have under their responsibility the day-to-day HSE, security and emergency response preparedness of the site for all phases of the project.

Trained and certified Health Safety and Environmental (HSE) officers will report to the HSE Manager and will also be the first responders for any Emergency. They will have qualified First Aiders on site at all times and have first aid equipment to carry out triage and manage any injured person to get them to a medical facility.

The HSE Manager and HSE Officers will:

i. Develop the details of the HSE policy and Safe System of Work procedures in line with established OSHA and industry best practice guidelines,
ii. Ensure that all contracted organisations have HSE policies and practices that are aligned with HWE's policies, that such policies are effectively communicated to their employees, and qualified dedicated HSE officers are employed to enforce effective HSE practice. Contractors must also demonstrate adequate worker compensation and all-risk and liability insurance.
iii. Ensure that all worksite personnel have HSE training, Personal Protective Equipment (PPE) and certification in line with OSHA requirements
iv. Ensure safe working practices are followed at all work sites. This includes amongst others HSE basics such as wearing of proper PPE, Permit to Work

practices, safety meetings at the start of each shift, pre-task jobsite HSE hazards assessment and workplan review, use of tools suitable for the task and use of necessary safety and health protection equipment, proper signage and demarcation to warn of hazards, work area and equipment isolations with lock-out/tag-out.

v. Ensure that all worksite safety related equipment, including lifting slings and equipment, firefighting, warning systems, self-rescue, first aid, safety barriers etc, are in safe working condition with valid inspection/testing certificates.

vi. Ensure all workers have valid qualifications for operating equipment and machinery, have the proper tools for the task at hand which are in good working order and are used in a safe manner.

vii. Ensure there are first aid safety personnel on site at all times who can respond to any medical emergency until medical emergency services can attend.

viii. Ensure there are fire-trained personnel with the correct fire extinguishers to be the first response to any fire that may occur on the site until the local fire service can attend.

ix. Ensure emergency backup plans are in place to handle any incidents, such as medical and fire emergency support, with medivac options.

x. Lead the investigation of reportable incidents, propose measures to avoid a repeat occurrence, and communicate such learnings to all relevant persons.

xi. Hazardous activities that can be expected at a wind facility construction site should have pre-task reviews with clear method statement and execution plan. Such hazardous activities include:

- Excavation and trenching
- Heavy machinery operation on the jobsite, oversize equipment and material transportation to the site
- Lifting operations
- Working at heights and in confined spaces
- High voltage electrical work

xii. Testing for drugs and alcohol.

xiii. Ensure workers' rights are protected: providing a work environment that is safe; inform and train workers about safety hazard identification and mitigation of those hazards; are informed of records of work related injuries and illnesses; are encouraged to raise concerns regarding safety issues with the employer and safety regulator without any risk of retaliation; feel empowered to stop worksite activity if they assess the activity to be unsafe in accordance with best practice safety guidelines.

18.1.5 HSE Hazard Assessment and Mitigation

Occupational health and safety hazards during the construction, operation, and decommissioning of onshore wind energy facilities are generally similar to those of most large industrial facilities and infrastructure projects. This is particularly true of the activities during the civil works and electrical works phases of the construction period, which encompass most of the project activity for 8 of the 10-month installation period. Prevention and control of these and other physical, chemical, biological, and radiological hazards are the same for wind energy facilities as for other typical jobsites, and encompass safety hazards in the following top hazard categories:

- Transportation
- Excavation and trenching
- Heavy Machinery operation
- Working at height
- Lifting operations
- Electricity
- Working in a confined space
- Community safety

However, the nature of wind turbines being very tall structures, with limited access via a steel tubular tower, and with confined working areas in the Nacelle at the top of the tower with rotating mechanical parts and high voltage electrical equipment, requires some additional hazard mitigation, PPE, self-rescue, emergency response and work routine planning. The wind industry has developed specific Safe Systems of Work for this particular work environment, called the Wind Turbine Safety Rules, which apply to the low voltage and all mechanical systems in a wind turbine generator (WTG), and the High Voltage Safety Rules, which apply to the high voltage systems of a WTG (anything above 1,000V ac or 1,500V DC). These wind turbine specific hazards are relevant during the final 2 months of the construction period when the wind turbines are being installed, and also during the 20-year operation and maintenance phase.

The various construction and operation activities and typical associated risks and mitigation measures are discussed briefly at this preliminary stage below. During the detailed project planning phase once all contractors have been signed on to the project, such HSE planning will be done at a more detailed level suitable for start of activities.

Rotating blades from wind farms can create radar signal interference, either as radar clutter or shadowing effects beyond the wind farm. Such impacts are typically assessed by aviation authorities for wind farms in close proximity to airports in line with FAA guidelines. HED held meetings with the Guyana National Civil Aviation Authority. The purpose of this meeting was to determine the procedure to make an application for

permission to construct a structure greater than 200ft in height, and this information has been submitted as part of the Central Housing and Planning outline approval application at Chapman's Grove, as per the application protocol of the GCAA. HED will commit to any conditions imposed by the Civil Aviation Authority as a result of this application.

18.1.5.1 Basic PPE

As a minimum, during the construction phase no one will be allowed on the worksite without the following minimal PPE in proper working condition.

- Hard hat
- Safety glasses
- High Visibility Jacket
- Work gloves for the task in hand
- Safety Shoes

During the operations phase this will also apply for entry into the fenced off substation area and entry into the base of the wind turbines. Additional PPE and training will be required for ascent higher up in the tower as discussed below.

18.1.5.2 Transportation

HAZARDS

Transportation is an important HSE category which is dealt with in detail in chapter 14. It is included here for completeness as a high-level summary of risks and mitigation measures, with additional input on specific OSHA guidelines on this topic. This category is number two of the "Fatal Four" causes of fatalities at construction sites in the USA (see Section 18.1.3), and was responsible for the second highest category of construction related fatalities in the US in 2017, including fatalities to persons in the public, such as pedestrians and fellow road users (Figure 18-1).

With over 5,000 truck-loads of aggregate, materials and equipment to be delivered to the site, with an estimated peak of 50 truckloads per day, plus transport of the 30 to 100 (peak) workers to and from the site each day, this is an important risk category. In addition, leading up to the installation of the wind turbines in the final month of the project construction phase some 67 overweight and oversize loads will be transported to the site, which require specialised transport, as described in Chapter 14.

Transportation is a safety risk that is most relevant to the construction phase of the project. During the operation phase there will be smaller volumes of transport, such as daily transport of security personnel, weekly transport for grounds maintenance personnel, quarterly visits by maintenance personnel, and on very few occasions transport of oversize and overweight equipment when there is need to replace a drivetrain component or rotor blade. The hazards include:

- Pedestrians being struck by moving vehicles which typically result in serious and life-threatening injuries - sections of the route pass through areas with roadside market stalls, pedestrian traffic walking along the edges of the road or crossing the roadway, and persons riding bicycles.
- Accidents related to animals along transport route - untethered horses, donkeys, and cows may be encountered along the route for certain sections, both day and night.
- Vehicle rolls due to loss of control or evasive action, causing vehicle to roll over; in serious cases of load shift, the vehicle can become unbalanced and overturn.
- Loads coming loose, falling into roadway, or shifting resulting in loss of control, or danger to the driver cabin occupants. Aggregate loads spilling onto roadway, or sand loads blown into roadway, creating a traffic hazard.
- Drivers not following safe driving protocols creating unsafe driving situations which can result in collision with other vehicles on the road, either due to transport driver or other party driving errors, hazardous driving and roadway conditions.
- Fatigue caused by driving excessive distances or periods without an appropriate break, or due to poor sleep recovery. Sleep-related accidents are most likely to occur between 2 a.m. and 6 a.m. and between 2 p.m. and 4 p.m., which are times when abnormal loads are being transported,
- The number of trucks per day creating added traffic congestion, broken down transport vehicles creating a traffic hazard.
- Worksite dust stirred up by trucks and mobile heavy machinery is a silicosis risk to workers, and possible nuisance and health risk to nearby sluice gate operator, fishermen, and the public.

Risks specific to transport of the overweight and oversize wind turbine components, covered extensively in Chapter 14, include:

- Damage to bridges, culverts and roadways due to heavy loads.
- Damage to infrastructure along the transport route, such as lighting, traffic signs, buried pipes, overhead power and telecommunication lines, with risk also for electrocution.
- Traffic dangers due to removed traffic signage in order to accommodate oversize loads.

- Blocking of traffic lanes due to oversize nature of transport, creating traffic congestion.

- Drivers not following good and safe driving protocols, such as moving off the centre line of the road in order to avoid road obstacles, which can place wheels on less stable roadside verge and lead to vehicle becoming stuck or a dangerous instability situation.

Mitigation for Regular Construction Transport

Transport risk mitigation must be planned and implemented for the entire construction phase by the relevant contractors. During the 8-month civil and electrical works period, the following mitigation will be required from the contractors:

- Develop a Traffic Management Plan (TMP) for the construction works period, in consultation with the Police Service in the affected areas.
- Train drivers of project-related vehicles, including all haulage vehicles, in Defensive Driving techniques.
- Ensure that drivers comply with the Motor Vehicle and Road Traffic Act.
- Monitor route traffic to ensure the TMP is effective.
- Use of vehicle speed monitoring devices in all project and contractor vehicles in order to ensure adherence to maximum speed limits.
- Ensure all supplier and project vehicles are roadworthy, are regularly inspected, operate within manufacturer specified limitations and have the required insurance.
- Ensure all loads are secured and aggregate loads are covered to avoid dust and spillage on roadways. Trucks leaving the worksite to be washed down from any cement, concrete or dust before returning to public roadway.
- Plan the transport routes from each point of origin, to the jobsite, and back to origin. To the extent that is practical, avoid transportation during congested traffic periods such as morning and evening rush hour periods.
- Provide signage clearly indicating the construction zone entrance and exits and marking the entrance to the project site from the roadway. This signage should be properly positioned and lit so that it can clearly be seen by oncoming traffic.
- Manage the movement of transport trucks on the jobsite, treat as one would any other moving heavy machinery, including signal persons to guide trucks.
- Ensure sufficient staging area is available and manage transport schedules in order to avoid congestion of trucks waiting to offload at the worksite.

- Reduce dust at site by wetting exposed areas and roadways with water truck as may be required.
- Maintain a register of complaints, accidents or incidents regarding traffic flow along the haulage route.

Mitigation for Oversize/Overweight Transport

For the 67 or so oversize and overweight loads associated with transport of wind turbine components and the substation transformers, additional mitigation is required. It is expected that these loads will be transported over a two-week period:

- A preliminary route assessment has been completed, assessing the structural limits of all bridge and culvert crossings. All such crossings are suitable for transport of heavy loads when following specific heavy load transport protocols, which include only one vehicle crossing at a time, under slow speed, and certain culverts being reinforced with suitable length modular-jumper bridge.
- The route assessment also identified tight corners for the 74m long blade transport, with one such corner requiring modest widening via compacted aggregate shoulders.
- A detailed route assessment to be completed during the detailed design phase, and confirmed via inspection again before the transport of oversize goods can proceed.
- Develop a Traffic Management Plan (TMP) specifically for oversize and overweight loads, in consultation with the Police Service in the affected areas.
- Obtain Transport Permits prior to transportation of heavy loads along public roads.
- Inform the public via road signage, news-ads, and radio broadcasts of the transport schedule, route restrictions, alternative routing, and temporary roadway signage.
- Implement all required transport route modifications and reinforcements, removal of roadside obstacles, inspect widened sections and test to ensure these can withstand loads.
- Ensure all transport drivers and riggers assisting with transport are suitably qualified and experienced in specialised transport protocols, and that they follow the transport plan, with good inter-vehicle communication.
- Transport to occur during the lowest traffic periods, at night, with police and contractor escort vehicles, traffic signage and traffic control, maintaining low transport speeds as required.

- Inspect the route regularly for any damages, report to Ministry of Works, collaborate with Ministry to immediately repair damage to road infrastructure caused by the transportation of project loads and ensure transport route is safe to use by regular traffic.
- Maintain a register of complaints, accidents or incidents regarding traffic flow along the haulage route.

18.1.5.3 Excavation and Trenching

Hazards

This risk is relevant only during the construction phase, related to excavation for foundations and trenching for buried electrical cables. Excavation collapses were responsible for 2% of worksite fatalities in 2017 in the USA (see Section 18.1.3). Working in trenches and excavations is considered hazardous for depths greater than 5ft, to both the workers who work inside them, and to workers on the surface. The hazards include:

- Cave-ins or collapses that can trap workers and lead to asphyxiation.
- Stationary equipment, moving machinery, tools, materials or excavated soil falling on workers (e.g. equipment or soil/debris stored too close to the excavation), resulting in being struck by or caught in-between.
- Falling into the trench or excavation, potential impalement onto vertical reinforced steel bars.
- Flooding or water accumulation.
- Exposure to a hazardous atmosphere (e.g., exhaust fumes, carbon monoxide or other vapour, dust, or lack of oxygen), resulting in poisoning or asphyxiation.
- Contact with buried service lines such as electrical, natural gas, water, sewage, telecommunications, resulting in electrical burns, fire, explosion, infections.
- Contact with overhead electrical lines resulting in electrical burns.
- Slips, trips and falls as workers climb on and off equipment, or from inappropriate access and egress methods.
- Hazards related to materials handling (e.g., lifting, struck by, crushed between, etc.).
- Dust related to excavation is a silicosis risk to workers, and possible nuisance and health risk to nearby sluice gate operator, fishermen, and the public.

Mitigation Excavation & Trenching

OSHA (2015) publication 2226 provides guidance on best practice for safe trenching and excavation. At all stages of the excavation, a competent person must supervise the work and the workers given clear instructions on working safely in the excavation.

- Assessment should be made by a competent person on the class and cohesiveness/stability of soil types being excavated (based on the results of the geotechnical investigations), which shall inform excavation and shoring plan.
- Area must be scanned for underground services & permit to excavate issued before work commences.
- Excavations must not be adjacent to buildings and heavy plant kept away from edges.
- Shoring should be in place if depth of trench warrants it along with extended poling boards & ladders for safe access/egress. HSE Officer should ensure that shoring etc has been done to their satisfaction before descending into trench & gain access only by suitable access equipment.
- Inspect trenches at the start of each shift. Test for low oxygen, hazardous fumes and toxic gases if more than 4ft deep.
- Inspect trenches for water ingress and following a rainstorm. Remove water using pumps.
- Do not work beneath raised loads.
- Stop blocks should be placed behind wheels of vehicles tipping into excavation.
- Do not store materials, waste materials or plant adjacent to excavation.
- Excavation work is at minimum a two-man operation by competent personnel. Make correct use of ladders to ingress/egress excavated area.
- If plant is being used above the trench, then no workers should be in the trench when the machine is in use.
- Keep heavy equipment away from trench edges.
- Keep surcharge loads at least 2 feet (0.6 meters) from trench edges.
- Digging with hand tools only in the vicinity of underground services. Electric cables adjacent to excavation should be isolated by qualified electricians issuing permit to isolate with lock out and tagged.
- Open trenches to be demarcated and barricaded to prevent accidental falls.
- Reduce dust with visibility and silicosis risk at excavation sites by wetting exposed areas and roadways with water truck as may be required.

18.1.5.4 Heavy Machinery Operation

Hazards

This risk relates to operation and movement of heavy machinery on the construction worksite (backhoes/excavators, mobile cranes, road grading and surfacing machinery, loaders, bulldozers, and tractors). This activity is mainly during the construction period. Accidents related to being caught in or between heavy equipment is one of "the Big Four" causes of worksite accidents (see Section 18.1.3), responsible for 2.4% of all construction industry fatalities in 2017 (US Bureau Labor Statistics, 2017).

The main causes of serious injuries and fatalities are:

- Workers on foot are struck by equipment or get caught in-between machinery and objects usually when it's backing up or changing direction.
- Equipment rolls over and injures the operator while on a slope or when equipment is loaded or unloaded from a flatbed/lowboy truck.
- Operators or mechanics are run over or caught in equipment when the brakes aren't set, equipment is left in gear, wheel chocks are not used, or the equipment and controls aren't locked out.
- Workers on foot or in a trench are crushed by falling equipment loads, backhoe buckets, or getting caught in other moving parts.
- Workers and operators are exposed to silica dust, noxious exhaust fumes stirred up by mobile equipment
- Workers and operators are exposed to loud noise emissions for extended periods, which can lead to permanent hearing damage.

Mitigation Heavy Machinery Operation

OSHAcademy safety course notes on operation of heavy equipment (2017) provides guidance on recognition of hazards and mitigation steps. Operation of heavy equipment such as excavators, loaders, graders, rollers, and bulldozers, should always be done by skilled operators who have demonstrated the ability and necessary skills to operate safely. Ground-based workers should be trained in how to work safely around the equipment, and how to stay clear. Unsafe practices by either the operator or those around the equipment can create dangerous situations. Serious injuries can occur if the equipment strikes a worker, or if the equipment is rolled over.

Safety practices for operators and ground-based workers to consider:

- Heavy equipment must always operate with a signal-person/spotter on the ground. Good communication is essential. A standardized set of hand signals should be used by the operator and signal person. Operators should always know exactly where all ground-based workers are located, and all site personnel must wear high visibility vests. The equipment should have a reverse-direction warning alarm that can be heard by all nearby workers. Two-way radios are also valuable communication tools.
- Heavy equipment must have a rollover protective structure (ROPS) meeting OSHA requirements. The ROPS is designed to protect the operator if the machine tips over. A seat belt must be worn so that the operator will not be thrown out of the seat during a rollover or upset situation. If working on slopes, try to avoid moving across the face of the slope. Try to operate up and down the slope face if possible. Use extreme caution when operating near open excavations.
- Wear hearing protection when required. If it has been determined that noise levels around the equipment could potentially cause hearing loss, always use protective plugs or muffs when working on or around the equipment.
- Never jump onto or off the equipment. Operators should always use the three-point contact rule when climbing onto or off heavy equipment. The three-point rule means having both feet and one hand, or one foot and both hands in contact with the ladder access at all times.
- Inspect and service the equipment regularly. Complete equipment service in accordance with the manufacturer's recommendation. Periodic safety inspections on all components of the equipment should be done regularly by qualified personnel. Inspect the steering system and brake systems carefully. A pre-shift walk around inspection by the operator is highly recommended.
- Reduce dust emissions by wetting exposed areas, as required.

18.1.5.5 Working at Height and Dropped Objects.

Hazards

This is the number one cause of fatalities at construction sites in the US (Figure 18-1), and very relevant to the construction phase and operation phase of the wind farm (see Section 18.1.3). Activities such as installation of overhead power lines, substation equipment installation, working near trenches and excavated areas, and during the installation of the tall wind turbines all have this risk exposure. During the operation phase this is a significant risk while undertaking maintenance of the towers, nacelles, and blade repairs.

- Risk of falling, slipping, or being dragged down or struck by heavy equipment whilst working at height are the most obvious dangers.
- Operators and riggers climbing up and down in the cranes or setting lifting slings and equipment are also typically more than 6 ft off the ground, and thus exposed to this risk.
- These hazards are exacerbated by strong winds and not wearing suitable PPE.
- One of the greatest hazards of working at heights is posed by falling tools on persons below, which are responsible for numerous serious injuries and fatalities each year, and also damages equipment.

Mitigation Working at Height

OSHA's website contains resources useful for identifying and mitigating fall hazards (https://www.osha.gov/fall-protection). The main focus when managing working at height should be the prevention of a fall. However, additional hazards that may also need to be considered include falling objects and adverse weather conditions (wind speed, extreme temperatures, humidity, and wetness). Managing working at height activities requires suitable planning and the allocation of sufficient resources. Preferred mitigation methods may include, in this order:

- Eliminate or reduce the requirement to work at height. During the planning and design phases of an installation, specific tasks should be assessed with the aim of removing the need to work at height, if practicable. Examples of this would include assembling structures and carrying out ancillary works at ground level, then lifting the complete structure into position to the extent that is feasible and cost effective. Remote monitoring of equipment such as blade inspections with drones, and remote monitoring of wind turbine performance and wear and tear via sensors and SCADA to reduce the need for onsite inspections.
- If working at height cannot be eliminated, use work equipment or other methods to prevent a fall from occurring, including also a self-rescue system for descending from tower if exit via regular ladder or lift is not possible. Collective protection systems, such as edge protection or guardrails, should be implemented before resorting to individual fall arrest equipment. In addition, safety nets or airbags can be used to minimize the consequences of a fall should it occur.
- Working at height introduces the need for additional PPE, including full body harnesses, work position belt and lanyard, energy absorbing lanyards, helmet and safety glasses suitable for climbing.

- Ensure all employees working at height are trained and competent in the use of all working-at height and rescue systems in place, and are deemed physically fit for this type of work.
- Ensure all structures are designed and built to the appropriate standards and have the appropriate means of working-at-height systems fitted.
- Suitable exclusion zones should be established and maintained underneath any working-at height activities, where possible, to protect workers from falling objects. All safe to work (STOW) protocols tags/lock-outs must be followed.
- Provide workers with a suitable work-positioning device; also ensure the connectors on positioning systems are compatible with the tower components to which they are attached.
- Ensure that all hoisting equipment and lifting slings are properly rated, maintained, with current inspection certificates, and that hoist operators are properly trained.
- When working at height, all tools and equipment should be fitted with a lanyard, where possible, and capture netting should be used if practicable.
- Job-site obstructions should be removed from poles or structures prior to undertaking work.
- An approved tool bag should be used for raising or lowering tools or materials to workers on elevated structures.
- Avoid conducting tower installation or maintenance work during poor weather conditions and especially where there is a risk of lightning strikes.
- An emergency rescue plan should be in place detailing the methods to be used to rescue operatives should they become stranded or incapacitated while at height.

18.1.5.6 Lifting Operations

Hazards

Lifting operations occur throughout the construction period of the wind farm, in relation to foundation steel works, installation of electrical lines and substation equipment, and of course during the major lifts associated with installation of the wind turbines. During the wind turbine installation phase components are typically assembled and transported to the site where assembly will take place. This involves using large, complex pieces of lifting equipment to lift loads of varying dimensions and weights numerous times making

use of a large 600 to 750 ton main crane, and smaller 150 to 200 ton support crane working in tandem. The lifting requirements during the construction of an onshore wind facility are similar to lifting operations which also occur during maintenance of the wind turbines and the substation, although to a lesser degree. Poorly planned lifting operations can lead to significant risks to people working in the area.

Hazards related to lifting include:

- Improper crane set up is responsible for more than 50% of crane related accidents according to OSHA (https://www.osha.gov/cranes-derricks-construction/presentations), with loads and conditions which exceed the cranes capability, or improper use of the equipment, causing collapse of lifting equipment and dropped loads.
- Crane pads which are not stable enough for the required loads.
- Failure of lifting equipment, lifting slings and cables which result in falling loads.
- Reduced lifting capacity due to prevailing winds or wear and tear of equipment not being accounted for.
- Multiple cranes operating simultaneously and not properly coordinated.
- Workers being crushed by a moving load or lifting equipment.

Mitigation Lifting

OSHA provides standards, guidelines and learning tools in regards to use of cranes and derricks in the construction industry (https://www.osha.gov/cranes-derricks-construction/presentations). Lifting of large equipment is a highly specialised field and will be the domain of the wind turbine installation and crane contractor/s, including all aspects of safety. The management of lifting operations requires the use of competent personnel, thorough planning, effective communication, and a high level of supervision when carrying out a lift. Consideration should be given to the following areas:

- Ensure all lifting operations are planned ahead, all relevant information is known about the load, e.g., the size, weight, method of slinging, and attachment points, a suitable crane is sourced, and that loads are within the lifting limitation of the crane for the given site conditions at the time.
- Ensure the crane pad has been designed and constructed with sufficient stability to support the crane during all load conditions. The ground compression limits should be tested by qualified geotechnical consultants, and test lifts with the crane should be completed before lifting any large loads in order to ensure

sufficient crane pad stability. Crane pad reinforcement must be completed if such tests are deemed to be unacceptable.

- Ensure all lifting equipment (including load attachment points) is suitable, capable of supporting the load, in good condition, and in receipt of any statutory inspections required.
- Ensure all supervisors, equipment operators, and slingers are trained and competent in the lifting equipment and intended lifting techniques.
- Where possible, exclusion zones are to be established and maintained in order to prevent any unauthorized access to lifting areas.
- When lifting large loads, ensure weather conditions are favourable for the task. Heavy lifting equipment typically has safe operating parameters included in its operating manual and these parameters should not be exceeded at any time. A planning meeting between all parties involved in the lift should be carried out and should include: the details of the lift, the roles of each party involved in the lift, and the methods used to communicate instructions among the parties.
- A lifting plan will be drawn up with all personnel involved and signed off by the HSE officer, prior to any lift taking place.

18.1.5.7 Electrical Hazards

Hazards

Electrical accidents are one of the "Fatal Four" causes of deaths in the United States occupational health and safety statistics (see Section 18.1.3). The hazards posed by electric current, that of electric shock, burns, and fire caused by arcing and explosion, are present at both low (24V to 1000 V) and high voltage, but the likelihood of serious injury or damage is greatly magnified at higher voltages. Voltages encountered at the worksite during construction will generally be less than 1000V. During testing and commissioning of the substation and wind turbines, and during the life of plant operations, medium voltages of 34KV and high voltages of 69KV will also be encountered. Workers in wind farms are potentially exposed to a variety of serious electrical hazards, such as arc flashes (which include arc flash burn and blast hazards), electric shock, resulting falls, and thermal burn hazards that can cause injury and death. Hazards are related to the following scenarios:

- Any work where there is a potential for live electricity above 24V poses a potentially fatal risk and fire hazard.

- This includes any work during the early construction period that is supplied by mobile generators or battery banks and electrical tools connected to such sources, and any associated temporary electrical cords and lines.
- Trenching and excavation close to existing electrical services.
- Onsite repairs of machinery and equipment which have batteries.
- Working with any live electrical panels and switchgear, such as up in the nacelle, base of wind turbine tower, in the substation, or when connecting the substation to the main 69KV transmission line.
- Working with any equipment that is connected to battery storage and capacitors which have not yet discharged.
- Lifting and crane work in the vicinity of overhead electricity lines, transport of oversize equipment along routes passing beneath overhead electricity lines.
- All electrical work presents fire hazards

Mitigation Electrical

Wind farm employers must comply with *electric power generation, transmission, and distribution* standards and are required to implement the safe work practices and worker training requirements of OSHA's Electric Power Generation, Transmission and Distribution standard, 29 CFR 1910.269.

- Mitigation starts with code compliant electrical design, with proper regards for equipment grounding, overcurrent and overvoltage protection, electrical panels, correct conductor and equipment sizing, equipment layouts which allow for sufficient safe working distances, minimum clearance of overhead lines, safety offsets and depth of burial, equipment locations with respect to potential conductors and personnel.
- All temporary electrical supply installed during the construction phase must also follow electrical code standards, as listed above, including equipment grounding and overcurrent protection, with competent licenced electricians installing the equipment
- Workers need to pay attention to overhead power lines at wind farms. Hazards result from using tools and equipment that can contact power lines, including cranes and their loads, which must stay at least at least 10 feet away from electrical lines of up to 50 KV, and longer distances when working near 69KV lines.
- Ensure buried electrical cables are at the correct depth, with correct fill, cable armouring and protection/markings within fill, and surface markings and

mapping of cables to ensure the safety of any subsequent trenching or excavation work.

- Fire-fighting equipment and extinguishers suitable for fires caused by electrical sources.
- Coordination between the utility, project developer, electrical contractor, O&M contractor and systems commissioning workers to ensure connection to the grid, testing and commissioning procedures are coordinated in a safe manner.
- A site-specific electrical safety program will be developed with the electrical contractor responsible for all the electrical installations. This should cover the following:
    - Job hazard analysis & hazard risk analysis
    - Insulated tools & personal protection equipment
    - Personal safety ground
    - Permit to work, Lock out/Tag out, Hot work permits
    - Work zones& safe approach distances
    - Switching procedures
    - Arc flash hazard analysis
    - Confined space entry
    - Electrical maintenance program
- During wind turbine installation and operation and maintenance of wind turbines, the wind turbine safety rules safe to work practices apply for voltages below 1,000 Vac, and the High Voltage Safety Rules used in the wind industry will apply for portions of the wind turbines which have voltages higher than 1,000 Vac. All personnel exposed to either low voltage or high voltage must have the required certified training for working with such systems and the relevant safety rules.

18.1.5.8 Wind Turbine Generator (WTG) Operations

Hazards

Working up in the confined space of the nacelle of a wind turbine generator (WTG), on top of a 100 m tall steel tower introduces additional hazards and risks. Such risks are relevant to the final stage of the construction period when wind turbines are being installed, tested and commissioned, and for all maintenance work of the wind turbines during the 20-year operation phase. The Nacelle meets the definition of confined space

as it is difficult to access, requires specialised evacuation procedures for injured personnel that introduce additional hazards, and contains electrical low voltage and high voltage hazards and mechanical hazards within limited work area (RenewableUK, 2015). The hazards associated with maintenance of wind turbines during generator operation phase include:

- Confined space hazards, associated with the nacelle, tower and hub which are difficult to access, have limited space for undertaking work, may not be well ventilated, which require specialised rescue and self-rescue procedures, and may pose risk of noxious fumes, lack of oxygen and high temperature. Difficulty in accessing injured personnel, providing first aid, or rescuing injured personnel from wind turbine tower and nacelle increases the risk potential of any injury.
- Mechanical hazards, moving parts related to the rotor, hub, driveshaft, gearbox and generator, hydraulic and coolant pumps, yaw and pitch motors, which pose a threat of severe injuries to limbs from moving mechanical parts.
- Electrocution with both low and high voltage equipment located in the Nacelle, with risk levels increased due to limited space to create safe working distance from live electrical circuits.
- Fire risk and flammable atmosphere within the confined space due to potential electrical fire, which in turn can spread via ignition of flammable hydraulic fluid, electrical conductor insulation materials, with associated smoke and toxic fumes.
- Working at height hazards, dropped tools hazards, including workers undertaking rigging activities on the exterior of the WTG to inspect/repair blades.
- Lifting operation hazards if maintenance requires crane work or hoisting equipment.
- Excessive Heat. The enclosed nature of a confined space can increase the risk of heat stroke or collapse from heat stress, if conditions are above average temperature, such as within a high voltage transformer compartment in the nacelle. The risk may be exacerbated by the wearing of personal protective equipment or by lack of ventilation. Workers undertaking nacelle or rigging work on exterior of WTG may be exposed to excessive tropical heat which they may not be accustomed to.
- Hazardous substances, present in WTG such as coolant, lubricants, hydraulic fluids.
- Working alone, or as a small team, remotely away from office, on a site with limited support, which limits timely assistance, communication, and emergency response.

Mitigation WTG Operations

OSHA provides standards and guidelines on working in confined spaces related to construction (https://www.osha.gov/confined-spaces-construction). However, working in the tower of up in the nacelle, or on the outside of the nacelle and on the blades introduces hazards that is beyond the typical levels encountered in general construction and requires specialised training. The wind turbine O&M contractor must ensure WTG technicians have completed specialised safety training with wind industry recognised certification. Such training is provided by, amongst others, the Global Wind Organisation (GWO, 2019). The wind industry in Europe has developed specialised safe system of work practices for use in operational wind turbines which are called the Wind Turbine Safety Rules (WTSR) and the High Voltage Safety Rules (HVSR) (RenewableUK, 2015):

WTSR is a Safe system of work for all work tasks exposed to low voltage (LV) electrical system, mechanical system, and standard work procedures which are exposed to electricity voltages below 1,000V ac or 1,500V DC. The system manages mechanical and LV risks in a unique situation where wind turbine technicians are typically working in remote locations as part of small independent teams.

HVSR is a safe system of work for all work tasks which exposes the technicians to high voltages above 1,000V ac or 1,500V DC, which is typically at the medium voltage transformer in the nacelle, collector electrical lines to the substation, the substation, and the electrical grid connection lines and protection systems.

Inherent to both processes are the following:

- Control of work practices: authorisation procedures, approved written procedures, hazard/risk assessment, permit to work system, control of job-site, isolation and safety of job site.
- Specialised training in hazard identification, risk assessment, mitigations.
- Specialised tools, PPE safety and self-rescue equipment, rescue procedures.
- Specialised requirements and training for emergency response.
- Specialised training for job tasks for both routine operating procedures and hazardous task procedures such as working at height on the exterior of a WTG, or HV work in a confined space.
- Safety precautions relevant to working in a confined space environment.
- Specify WTG with elevator to avoid ladder climbing, which is responsible for many incidents in AWEA 2019 report.
- Remote monitoring equipment and alarms for air quality, smoke detectors, video, back-up communication, ability for emergency responders to enter WTG structure.

18.1.5.9 Health and Safety of the Community

The nearby community and the public along the transport routes to the site will be exposed to safety hazards and potential nuisance from the construction phase and operating phase of the wind farm, and these must also be considered and mitigated.

Hazards

During the construction phase the key health and safety hazards are related to:

- **Transportation** of construction materials and oversize equipment along public roads, with risks for accidents, pedestrians, traffic congestion and nuisance to fellow drivers, as discussed previously under transport in this section, and at length in Chapter 14.
- **Dust and fumes** from the construction activity, discussed in detail under Chapter 10.
- **Noise emissions** related to construction activities, such as operation of heavy equipment and pile hammers, discussed in detail under Chapter 12.

During the Operate phase over a 20-year period, the key health and safety hazards to the community and public are related to:

- **Noise emissions** from the rotating wind turbine blades, which could cause health issues related to sleep disturbance, or be a nuisance to daytime activities and teaching at the school.
- **Shadow Flicker** due to rotating blades cutting through the sun in the early morning period creating a flickering shadow at the houses along the Western boundary of the wind farm at Hope Beach. The frequency is expected to be below that which can cause epilepsy, and so it is less of a health issue and more of a nuisance issue.
- **Blade Throw and Collapsed Tower** risk of serious or fatal injury from being struck by the collapsing tower, or thrown blade or blade fragment onto residential dwellings, traffic on the public road, fishermen, the Hope Canal sluice gate operator, or wind farm maintenance technicians. Tower collapse or blade failures are extremely rare, Thornton-Tomasetti (Appendix U) cites blade failure rates in North America and Europe of between 1 in 1,000 and 1 in 10,000 wind turbines per year. Tower collapse can be caused by poorly designed and constructed wind turbine foundations, or from tower being struck by a thrown rotor blade. Blade failures are typically caused by manufacturing defects, extreme wind conditions, excessive lightning strikes. The entire blade or portion

of the blade may become detached and thrown by the rotating wind turbine rotor. Ice throw is a more common safety issue in colder climates, but is not an issue at this tropical location.

Quantitative risk assessment of these offset distances was completed by MMI Thornton-Tomasetti, and described in their report (Appendix U). MMI's risk assessment methodology was developed for the UK HSE, and takes into account the location of the wind turbines, location of residential dwellings, occupancy data, the location of the public road, road traffic and vehicle occupancy data, location of the Hope Canal operator control facility, fishing boat loading location, selected wind turbine components dimensions and weight, the wind data from the site, and data on blade throw incidents frequency from Europe and North America. Generally acceptable levels of risk for the general public in the UK is for risk levels of a serious injury or fatality incident to occur less than 1 in 1 million years. Resulting risk assessment concludes as follows:

- The greatest risk levels to residents at the closest houses is for a serious injury less than one in 35 million years.
- The risk exposure to the operator at the Hope Canal sluice gate facility is 1 in 24 million years.
- The risk exposure for wind farm maintenance technicians is 1 in 55 million years.

As a reference point, the risk of being struck by lightning in the UK is 1 in 17 million years, which is thus twice the level of risk compared to being struck by wind turbine blade throw at the project site. The risk levels are all well below the generally acceptable level of 1 in 1 million, and so the risk to the community is extremely low and well within acceptable limits.

Maximum wind gusts in coastal Guyana is only 33 m/s, and the level of lightning strikes is relatively low, further reducing the risk of excessive blade damage.

According to the WHO, electric fields are created by differences in voltage: the higher the voltage, the stronger will be the resultant field while magnetic fields are created when electric current flows: the greater the current, the stronger the magnetic field. It should be noted that humans are continuously exposed to time-varying low-frequency EMFs from natural sources (solar activity, earth and human body magnetic fields), radio and TV transmission devices, electrical power lines and wiring, and electrical appliances. The impact of external exposure to EMF on the human body and its cells depends mainly on the EMF frequency and magnitude or strength (WHO 2002). Heating is the main biological effect of the electromagnetic fields of radiofrequency fields. The levels of radiofrequency fields to which people are normally exposed are very much lower than those needed to produce significant heating. In fact, the WHO

states that "To date, no adverse health effects from low level, long-term exposure to radiofrequency or power frequency fields have been confirmed"

For wind farms, EMF is emitted from grid connection lines, underground collector network cabling, electrical transformers and turbine generators. Grid connection lines generate low levels of EMF that are comparable to those emitted from household appliances. On this project, cables will be installed underground and will therefore generate no EMF at the surface. Additionally, turbine generators will be sufficiently elevated above ground level and so there is little or negligible EMF at ground level.

Mitigation HSE Risk to the Community

The following mitigation strategies will be employed:

Mitigation: Transportation on public roads and traffic related hazards previously covered in Section 18.1.5.2

Mitigation: Dust and Fumes:

- As necessary, clean public roads and wet access routes using wet sweeping methods Potential dust producing activities to take place behind dust encapsulation scaffold. Ensure an adequate water supply on the site.
- Disposal of run-off water from dust suppression activities is in accordance with the appropriate legal requirements.
- The provision of clean hard standings for vehicles. Regular cleaning of hard standings using wet sweeping methods, no dry sweeping of large areas.
- Loading of material into lorries within designated bays/areas.
- All vehicles carrying loose or potentially dusty material to or from the site are fully sheeted. Sheet or otherwise enclose loaded bins and skips.
- Materials with the potential to produce dust are stored away from site boundaries where reasonably practicable. Minimize the amount of excavated material held on site.
- Sheet, seal or damp down unavoidable stockpiles of excavated material held on site, where required.

- Minimize drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- The engines of all vehicles and plant on site are not left running unnecessarily to prevent exhaust fumes. Use low emission vehicles and plant fitted with catalysts, diesel particulate filters or similar devices.
- No open fires on the site.

Mitigation: Noise Emissions during construction

- Coordinated delivery times and efficient traffic management to prevent queues of traffic accessing the site.
- Ensuring all plant has sound reduction measures (mufflers, baffles or silencers)
- Utilizing construction techniques that minimize the production of noise.
- Utilization, where possible of pre-fabricated components.
- Strict adherence to the site working hours.

Mitigation: Noise Emissions during wind farm operation

- Wind farm is designed so that the location of wind turbines has sufficient offset distance from nearby homes such that noise emissions are below a maximum of 45 dB at nearby receptors, including at the school. This level is well below that of measured background noise in the community, conforms to international standards in order to ensure peaceful sleep and undisturbed daytime activities. Maximum noise at ground level beneath the wind turbines will be 55dBA, which is well within acceptable standards for any work environment, and well below the present-day noise limits in Guyana of 75dB daytime and 60 dB night-time for residential areas, and 80dB for commercial areas. This topic is discussed at length in Chapter 12.

Mitigation: Shadow flicker during wind farm operation

- Shadow flicker is mitigated by turning off the wind turbines for the relevant periods to achieve no more than 30 minutes flicker at any residence per day, with a cumulative total of less than 30 hrs per year, as discussed at length in Chapter 11

Mitigation: Tower collapse and blade throw

- Wind farm is designed to meet minimum offset safety distance of 1.5 times the maximum height (270m) from the nearest residential dwellings, as per HSE guidance of the International Finance Corporation (IFC, 2015), resulting in risk of severe injury well below the generally accepted standard of 1 in 1 million years.
- Remote monitoring of wind farm, with sensors in place to identify early indicators of abnormalities in rotor movement and vibrations, with ability to turn off and lock the rotor remotely.
- Remote monitoring of lightning strikes of the wind turbine and nearby region. Wind turbines are designed to withstand lightning strikes, but a high amount of lightning strikes would trigger an inspection of the blades for potential damage.
- Regular planned blade inspections and inspections triggered by log of lightning strikes. Blades inspected via drone mounted camera, with follow up rope-work inspection and repair, if required.

18.2 Emergency Response Plan

18.2.1 Introduction

Although the renewable industry shares a number of characteristics with other industries, the remoteness of location and the demands of an elevated and constrained workplace has led the industry to conclude that it requires its own guidance on emergency procedures. The Emergency Response Plan (ERP) at this early stage of project development is very much preliminary and will be developed into a detailed plan before construction begins, with input from all the key contractors and emergency support services. Aspects of this draft ERP that are specific to wind turbines were informed by the SafetyON/RenewableUK 2015 publication of good practice guidelines for emergency response planning for onshore wind farms.

18.2.2 Types of Emergencies

Scenarios which require emergency planning are as follows:

- Medical emergencies
- Wind turbine rescue
- Public road transport accidents
- Security breach
- Fire or explosion
- Flooding
- Wind turbine structural failure
- Bomb threat
- Civil unrest

18.2.3 Organisational structure for emergency response

Emergency planning is required for the construction phase and the operations phase. During construction there will be a substantial amount of activity, with some 30 to 100 workers at the site or driving transport vehicles over a 10-month period, and therefore there is a much higher probability of situations which might require an emergency response. The same leadership responsible for HSE management will also be responsible for managing any emergency response during this period as shown in Figure 18-4.

During the operations phase activity, levels are much lower, with daily site presence from security personnel, weekly site presence from grounds maintenance personnel, and occasional visits by maintenance technicians. The facility will be monitored remotely during the 20-year operation phase of the project. The total personnel involved during the operation phase is some 8 to 10 persons. The organisational chart during wind farm operation is illustrated in Figure 18-5.

18.2.4 Construction Phase Emergency Response Command Structure:

The line of command and responsibilities are as follows:

Emergency Response Leadership:

At any time there will be a designated Emergency Director who is in charge of the emergency response for the project. The Project General Manager (PGM) is the

designated Emergency Director in charge for coordinating Emergency Response matters on behalf of project staff and contractors, supported by the Site Emergency Manager (the HSE / Security Manager) who will be focussed on directing activities at the site of the emergency. Should the PGM or the HSE Manager for any reason not be available to do this task at the time of an emergency, there must always be back-up alternatives who can take over their roles via a handover procedure. If an EPC contractor is in charge of all engineering and construction activities, then the EPC contractor will also have the responsibility of HSE and Security management.

The HWE Board of Directors will be informed and will fulfil a supporting role under the direction of the Emergency Director, as may be required. This supporting role will include communication with stakeholders and the media, and support for accessing any resources needed during the emergency.

Each of the main contractors will also designate a Contractor Emergency Manager who will be contacted and will coordinate their efforts via the Emergency Director.

For each type of emergency situation, and depending on the severity of the situation, there will be a plan of action, a plan for communication for any support required by emergency support services, and a communication plan with any impacted stakeholders.

If an emergency situation is serious enough to warrant reaching out for national emergency response organisations such as the Police, Fire Services, or the Guyana Civil Defence Commission, then the project emergency response leadership will follow the directives from and provide support to such national emergency organisations.

Emergency Response Support:

The emergency response leadership is further supported in the field by the Site Emergency Manager (HSE Manager) and HSE and Security Officers, and the HSE / Security managers and field staff for each of the main contractors, and also trained first aiders and fire-fighting trained personnel.

First aid and fire-fighting trained personnel are trained to act as first responders, immediately engaging to an emergency situation to the best of their abilities, and if the situation is serious, at the same time to ensure that the requisite Ambulance, Fire and Police Services are called, and informing the site supervisor and Emergency Director. Personnel will be dispatched to direct the emergency services to the emergency site.

Organisations that may be required to support or may need to be informed about the emergency include, amongst others: Ambulance and Medical Emergency Technicians and Hospitals, Fire Service, Guyana Power & Light, NDC Chairperson, NDIA Flood

control room, Meteorological Service, Local Fisherman's Representative, Local Community Representative, Environmental Protection Agency, Ministry of Security, Ministry of Works and Occupational Health and Safety Agency.

As part of the emergency plans there will be a contact list established for all emergency services and reporting requirements. This will be maintained and updated by the HSE & Security Manager.

18.2.5 Wind Farm Operating Phase Emergency Response Command Structure:

The line of command and responsibilities are as follows:

Emergency Response Leadership:

Similar to above, the Emergency Director will be the Wind Farm General Manager, who is in charge of coordinating emergency response activities and the Site Emergency Manager (the Security Supervisor) who is in charge of activities at the site of the emergency. All key roles in the emergency response structure will have back-up alternatives.

The wind turbine O&M contractor will similarly have an O&M Emergency Manager, reporting to the Emergency Director.

If an emergency situation is serious enough to warrant reaching out for national emergency response organisations such as the Police, Fire Services, or the Guyana Civil Defence Commission, then the project emergency response leadership will follow the directives from and provide support to such national emergency organisations.

Emergency Response Support:

The HWE Board of Directors will be informed and will fulfil a supporting role under the direction of the Emergency Director, as may be required. This supporting role will include communication with stakeholders and the media, and support for accessing resources needed during the emergency.

The Asset O&M Manager ensures the engineering and technician staff are ready to provide support required for safe facility shutdown and ensuring control of electrical and mechanical energies. The engineering and technician team will be in charge of any emergency response related to the substation electrical equipment or electrical line infrastructure.

The contractor for remote monitoring will support the Asset O&M Manager, and the O&M Emergency Manager and their supporting wind turbine technicians will provide support for site rescue efforts from wind turbines if required.

First aid trained and fire-fighting trained personnel (all site security and technicians) will provide first response action in case of medical or fire emergencies, and as soon as possible make the decision as to whether the Medical, Fire and/or Police emergency services should be called to site. Personnel will be dispatched to direct the emergency services to the emergency site.

Organisations that may be required to support or may need to be informed about the emergency include, amongst others: Ambulance and Medical Emergency Technicians and Hospitals, Fire Service, Guyana Power & Light, NDC Chairperson, NDIA Flood control room, Meteorological Service, Local Fisherman's Representative, Local Community Representative, Environmental Protection Agency, Ministry of Security, Ministry of Works and Occupational Health and Safety Agency.

18.2.6 Incident Response Levels 1, 2 and 3:

Level 1 Emergency: are those which are limited to the project site, involve minor injuries, minor damage to site facilities, and can be managed by the project teams on site and their respective organisations, led by the Site Emergency Manager. The Emergency Director and Emergency Response Team will be informed. The role of the responders is as follows:

- Assess the incident and respond in accordance with organisational policies, procedures and systems of work;
- Determine if the incident should be reported to the emergency services;
- Report the incident to the appointed Site Emergency Manager;
- Develop, communicate and control the specific plan of response;
- Continually evaluate the effectiveness of the response, changing circumstances, etc.;
- Record or log decisions and actions for future review and investigation; and
- Consider the escalation to a Level 2/3 response.

Level 2 Emergency: are those where the incident requires support that is beyond the onsite personnel and requires the support of the offsite Emergency Response Team, company and contractor organisations but does not require any national emergency response services. This type of emergency will not have any serious injury or fire, but may have more extensive equipment damage and disruption to worksite activities, or

requires wind turbine rescue, which will require additional organisational and contractor support. The role of the Emergency Response Team will be to:

- Review the effectiveness of the response, ensuring the additional resources are made available and provided with all required information;
- Continually assess the need to escalate to a Level 3 response; and
- Record or log decisions and actions for future review and investigation.

Level 3 Emergency: are those where the incident requires external emergency services support. For example, any serious injury or fatality, multiple injuries, fire that can potentially be out of control, accidents or injuries which impact the public or property outside of the project site boundary, security threats which requires the Police, flooding or natural disasters, or incidents in the public domain which could potentially spill over and impact the project site. If a Level 3 response is required, then a single point of contact should be identified to liaise with the emergency services to:

- Provide resources as required and/or determine limitations;
- Ensure there are clear lines of communication internally and with the emergency services;
- Consider availability of resources for out-of-hours response and relief staff;
- Where appropriate, develop a media response plan ensuring consistency with emergency services and regulatory requirements; and
- Document the incident scene events, log decisions and actions for future review and investigation.

A key principle is that it is better to overreact initially rather than under-resource the response. Assets can always be stood down if not required. Trying to regain control once time is lost is very difficult or impossible.

18.2.7 Emergency Planning and Response Drills

A key component to effective emergency response is good scenario planning, and training drills of these scenarios which also include the contractors and representatives of the emergency support services as well as stakeholders in the surrounding communities. Learnings from the training drills will then be incorporated into the emergency plans. It is key that the emergency service teams have an opportunity to do simulated drills at the site in order to familiarise themselves with the plant layout, equipment, and to provide feedback on procedures.

18.2.8 Incident Communication

Emergency planning and drills should ensure that there is effective communication between the work locations, logistic routes and any control centres/emergency call centres as well as with relevant affected stakeholders. Plans should include secondary communication methods and requirements to test communication on a regular basis.

A communication protocol must be established and practiced; attention to who and how the emergency services should be alerted and what information is to be communicated. For example, using the recognised format METHANE:

M: major incident - confirmation that such has been declared
E: exact location
T: type of incident
H: hazard present or suspected
A: access, routes that are safe to use
N: number, type, severity of casualties
E: emergency services present and those required

The level of response will be dictated by the appropriate emergency service

18.2.9 Key Emergency Support Services

Guyana Civil Defence Commission
Lt Col. Craig Kester
Tel: 226 1114
Disaster management & emergency response

Ambulance and Emergency Medical Centers:

Dr. CC. Nicholson, District Hospital
Location: Nabaclis (3 km),
Tel: 229-2965
Services: open 8am to 8pm, 1 ambulance, 4 doctors, 7 nurses

Allied Health Medical Lab and Clinic
Location: Lusignan (12 km)
Tel. 220-5888
Services: open 8am to 4pm and 5pm to 10pm, 1 doctor present. Suitable for tending to minor injuries only.

Georgetown Public Hospital

Location: Georgetown (25km)
Tel: 227 8241
Services: open 24hr, ambulances + EMT, emergency + trauma ward, 600 beds, life support units. Largest hospital in Guyana. State run.

National Emergency Medical Services (EMS) via the Guyana Fire Service (GFS)

Location: Liliendaal (22 km)
Tel: 912
Service: 24 hr ambulance, 5 vehicles, over 100 emergency medical technicians, service on East Bank only to Enmore (4km from site)

Dr. Balwant Singh's Hospital

Location Georgetown (25 km)
Tel: 226-4279
Services: 24 hr emergency, 24hr ambulance with critical care, emergency ICU, 50 beds acute care, surgery

St Joseph's Mercy Hospital Ambulance Service

Location: Georgetown (25 km)
Tel: 226-1592, 223-5447,620-8378
Services: 24hr ambulance with life support and advanced cardiac support, advanced medical equipment, emergency ward, 70 beds

Woodlands Hospital

Location Georgetown (25 km)
Tel: 225-4050
Services 24hr emergency ward, ICU, operating theatre

Ambulance service only operates in and around Georgetown, the remainder of the country has no organized ambulance service and relies on police, taxi, and civilian transport to local hospitals in an emergency. The nearest ambulance service is a single unit at Nicholson District Hospital at Nabaclis, otherwise either National EMS from Liliendaal, which services areas as far as Enmore (4km from site), or hospitals with somewhat limited ambulance support in Georgetown. This is an item that will require resolution.

Fire Emergency Services

Mahaica Fire Station

Location: Helena (5 km)
General emergency tel: 912
Station Tel: 228 2921, Officer in charge: Sub-Officer Nigel Gravesande

Services: 1 fire truck, main fire station for the area, always supported by Melanie fire services, resulting in two trucks with 12 water lines, and two pumps to draw water from local water sources. Fire truck has 10m (35ft) ladder, and station has cutting equipment and "jaws-of-life" for extracting persons from traffic wreckage or similar situations.

Melanie Fire Station

Location: Melanie (8 km)
Station Tel: 270 1456, general fire emergency Tel 912
Services: 1 fire truck, secondary support fire station for the area, capable to support Mahaica fire service, resulting in two trucks with 12 water lines, and two pumps to draw water from local water sources. Fire truck has 10m (35ft) ladder, and station has cutting equipment and "jaws-of-life" for extracting persons from traffic wreckage or similar situations.

Police:

Cove and John Police Station (Regional Headquarters)

Location: Cove and John (3km)
Tel: 229 2655
Main police station and headquarters for East Coast police services. Closest police station to the Hope Beach project site.

Mahaica Police Station

Location: Helena (5km)
Tel: 228 2422
Closest police station to the Chapman's Grove portion of project site

Medivac option - TBD

Helicopter Rescue option - TBD

18.2.10 Initial Plans for Emergency Scenarios

18.2.11 Emergency Evacuation Plan

Evacuation of the construction site or wind farm during the operation phase may be required during certain emergencies, such as a fire emergency. The evacuation plan will determine safe routes, from all locations to evacuate the project site to a central safe mustering area, where all personnel can be accounted for by Security/HR personnel. Alternative evacuation muster points will be required depending on the site of the emergency and wind direction. Evacuation could be for a number of reasons and will be sounded by an audible alarm.

The detailed plan will be completed, when the site design is completed and before site work begins. Depending on the location of the emergency at the site, the emergency evacuation may also involve evacuation of the fisherman area and Hope Canal sluice gate area. It is unlikely there will be any need to evacuate any residential areas given the safety offset distances. Evacuation procedures will be communicated to members of the public in surrounding areas who may need to be evacuated.

18.2.12 Medical Emergency Plan

In the event of a medical emergency an ambulance should be called. The onsite decision to call an ambulance will be made by the first aid responders, supported by the site HSE Officer during the construction phase. During the operation phase, all wind turbine technicians will be first aid trained, and also trained in evacuation of an injured person from the nacelle of a wind turbine. Once the ambulance has been hailed, calls with then be placed to the Project General Manager in order to initiate emergency response procedures and full organisational support.

Medical emergencies often occur with associated safety hazards, such as failed equipment, collapsed structures, fire or explosion, which will require parallel activities in order to render the area safe, and to remove injured personnel from hazardous areas. Such larger scale emergencies will also require calling in national emergency services, such as Fire Services and the Police. The emergency plans must also cater for scenarios where the injured person is trapped or pinned, and for scenarios with multiple injuries. The local Fire Services are trained in procedures to extract persons from wreckage or equipment. The project is fortunate in having two fire service locations within 5 km from the site.

During the construction and operation phases, trained first aid personnel will be on the project site at all times, to assist with stabilizing any injured person. A comprehensive construction site first aid kit will be maintained on site, including Defibrillator, Resuscitator, Oxygen and Pressure Eye baths. During the operation phase the site operator room located at the substation will have a comprehensive first aid kit, and each wind turbine nacelle will be equipped with first aid and self-rescue equipment. The first aid kits will also include a stretcher to move the injured to a safe location.

During the planning phase of the project the capabilities of the available ambulance services and hospitals will be evaluated. There is a single ambulance at the Nicholson District Hospital, at Nabaclis, some 3km from the site. The next closest, and also the largest ambulance service in the country, is based in Liliendaal, some 22km away towards Georgetown, which has 5 fully equipped ambulances with trained EMT technicians. However, the site is just outside the service support limits of the Liliendaal based service, which is defined as Enmore, some 4 km away from the site. Guyana has improved the ambulance service capabilities over the past decade, but the project will need to evaluate carefully if there is a requirement to bolster the available resources in the nearby region.

The local community medical facility at Mahaica, and the somewhat larger Nicholson District Hospital nearby at Nabaclis are not intended for managing serious medical emergencies, rather these are capable of assisting only with non-emergency medical care during daytime and early evening hours. Serious medical injuries are handled only at select hospitals based in Georgetown, some 25km from the site.

Very serious medical conditions may need helicopter evacuation, and once stabilised may also require medivac via plane to more specialised medical facilities outside of Guyana. Options for such evacuations will be assessed during the planning phase.

18.2.13 Wind Turbine Rescue Plan

There are some common rescue scenarios that can occur while working on wind towers and for which a detailed plan will be put in place. All wind turbine technicians will be trained in rescue procedures. Consideration will be given to stationing tower rescue kits at the top of each tower. In addition, the use of helicopters for tower evacuation will also be considered when safe to do so.

i) Rescue from the ladder inside the tower. During installation of the WTG ladders inside the tower provide access to the top of the tower and nacelle. Towers greater than 60m in height typically are equipped with an elevator to minimise the risk of accidents using the ladders, but such elevators are only commissioned towards the end

of the WTG installation. Ladder climbing pose a potential threat to worker safety when they must climb to great heights, usually multiple times a day. Accidents during ascent/descent of tower ladders are responsible for over 60% of the working at heights related incidents in Figure 18-3 (AWEA, 2019). Even though the climber can use the deck landings to rest, the climb still can be physically demanding, leading to cramping, fatigue, heat and cold stress, and more. Elevators are only in service once the wind turbine is fully installed.

Other hazards in this scenario include slipping on an oily or muddy ladder, as well as the constant threat from items such as radios, cell phone and hardhats which can be dropped or fall, striking workers below. Working at heights requires tethering of equipment, PPE suitable for climbing with helmets having chin-straps and fall protection, and work procedures that minimise dropped tools and objects.

Ladder rescues in this situation are challenging and must be planned from both the ground and from the nacelle. The size and portability of a complete rescue system is crucial, as it must be deployed and carried to the victim from the ground or down the ladder if it's stored in the nacelle.

ii) Rescue from the top of the nacelle roof – This scenario can occur if an emergency happens while working on top of the nacelle or if the worker slips while moving on the nacelle, possibly while trying to access the hub.

Non-entry fall protection rescue is reserved for injured workers who are suspended by fall protection, but are conscious, alert and can adequately protect themselves during a lowering operation. To perform such a rescue, the rescuer must have access to the victim's anchor point, integrated lanyard rescue D-ring or harness D-ring.

It also is possible that the victim in such a situation may be injured or unconscious on top of the nacelle. In this case, it would be necessary to lower the victim over the edge of the nacelle. In cases where victims fall over the side, there may be a need to pick them up off of their fall protection equipment.

Challenges in this rescue scenario include deploying and carrying the entire rescue system to the top of the nacelle. Normally, the rescue equipment would be stored inside the nacelle, but there's still a need to get all the equipment through the top hatch to the top of the nacelle.

iii) Rescue from inside the nacelle -This scenario may occur at any time, as the worker likely is working inside the nacelle most of the time. Workers can encounter electrical hazards, sustain injuries from working on the heavy equipment or experience medical conditions that leave them incapacitated. Nacelle work is often associated with confined entry spaces (hub and medium voltage transformer space).

This rescue may be challenging because the employee may be working under or around equipment away from the escape hatch. Further, the employee likely will be working without a fall protection harness. There also may be a need to lift the technician up from where he's working, which may be down below the equipment or on the opposite end of the nacelle from the escape hatch. Putting the victim's harness onto him is imperative to complete the rescue.

The victim also must be transported from his location, over equipment, to the escape hatch. Cross-haul techniques are best used for this to allow a single person to perform the rescue. Multiple lifting systems make this process very simple and efficient. Pulley systems should be carefully monitored while in use. If increased resistance occurs during the process, operations should cease to check the victim for a trapped body part or equipment.

iv) Rescue from inside the hub – When a worker is inside the hub, rescue may be challenging, particularly if the rescue system is stored in the nacelle as it must be deployed and carried to the victim. Anchoring to pick the victim up also may prove difficult, meaning cross-haul techniques must be used to move the victim's body up and diagonally out of the hub. Multiple lifting systems make this process feasible.

The hub is a dirty, greasy environment, so it's important to ensure that the rescue system is not significantly affected by possible contamination.

v) Self rescue in case of an emergency – Emergency scenarios can occur when a worker may need to escape the nacelle to ensure his own safety. The hazard from which a worker may need to escape affects the choice of the escape point. If there's significant heat in the nacelle, the worker may be under major duress. In this case, ensure the rescue system operates with fire-resistant rope.

Proper planning can make a real difference in successfully rescuing workers when an accident occurs. The ultimate test of any rescue plan is in the execution. Of course, repetitive training is the key to ensuring workers take the appropriate actions when a real emergency occurs. All wind turbine installers and maintenance technicians will be

trained in Wind Turbine Safety Rules (WTSR) and self-rescue techniques, such as certified training offered by the Global Wind Organisation.

The detailed emergency plan for the construction phase will be completed during the detailed design phase, in close collaboration with the wind turbine installation contractor and Operations and Maintenance contractor (Vestas).

18.2.14 Public Road Transport Accident Emergency Plan

With over 5,000 truckloads of equipment and aggregate transported to the site over the 10-month construction period, an emergency response plan for transport related incidents on the public roads is vital, as previously discussed. Most of the transportation will be the responsibility of the various transport contractors, including taking the lead on any emergency situation, supported by the Project Emergency Response organisation.

Accidents involving trucks and personnel transport vehicles, possibly also vehicles from the general public, will require the attention of the ambulance service for any injured persons, the police to assist with traffic control/diversion, and possibly the Fire Services if fire suppression and extraction of persons is required. The Emergency Response plan will support initiatives required to bring emergency services to the site, coordination of ambulance delivery to medical facilities, and to coordinate services for clearing of any damaged vehicles or debris from the roadway once the police deem this safe.

During the transport of oversize and overweight equipment special precautions including police and project escort vehicles will be in place, with most of this transport occurring during low traffic periods. Procedures for any accident will be the same as above. Should there be any damage to roadways, bridges, crossings or related infrastructure which could create traffic safety hazards or traffic congestion, then the emergency procedure plan will be to advise the Ministry of Works and traffic departments, and to support them as required with resolving such problems in a timely manner. This may require mobilizing cranes to lift heavy equipment.

18.2.15 Fire / Explosion Emergency Plan

The fire plan will detail location and type of fire-fighting equipment needed and also ensure trained personnel onsite at all times to be a first response to a fire, before the local Fire Service arrives. The local Fire Service will be given detailed plans showing the potential fire hazardous areas and exercises will be conducted with them and the Police and Bomb Disposal Squad. The Fire Services have equipment suitable for

typical residential or commercial housing type fires, and for these rely on local water sources and are also restricted with height and reach by 10m maximum height ladders. The facility design will require inclusion of the type of fire-fighting equipment required for electrical fires, such as foam fire retardant, and CO_2 extinguishers over and above the typical handheld fire extinguishers. The facility should also install water tanks and fire hydrants which the local fire engines can connect to. The design of facility installations will be in collaboration with the Fire Services to ensure compatibility of interconnecting equipment. The wind turbine nacelles are completely out of reach of any standard fire-fighting equipment. and will rely on automated and/or remotely triggered fire suppression systems.

Fire suppression during the operation phase of the wind farm will require coordination also between GPL, the plant operator, and the fire-fighting services to ensure all electrical sources are disconnected and rendered safe, and the shut-down of the wind turbines with rotors locked into place. The contact number for both the Fire Services, Police and Bomb Squad will be kept up to date at the security operations room.

18.2.16 Security Breach Emergency Plan

Security of the project site is critical. The construction site will be secured using modern technology: 24/7 remote monitoring via cameras, motion and sensors, site access control and fencing, keeping worksite personnel rosters, and 24/7 onsite security personnel.

The security team will also be trained in the correct search method for a potential IED (Improvised Explosive Device) in the open and general areas. They are responsible for the integrity of the project site.

As part of the security plan there will be a Quick Response Team created to respond to security issues with linkage to the two nearest police stations at Mahaica and Cove & John.

The police will be an integral part of the Security Plan for the project site and will be kept informed by the most senior security person during each shift. Contact details for the following will be maintained by the Security Operations Department.

18.2.17 Flooding Emergency Plan

The coastal plain of Guyana is prone to flooding. This may be caused by excessive rains and poor drainage, with more serious flooding related to a breach of the regional NDIA irrigation/drainage canal system, or a breach of the seawall. The Hope Beach site located on the relict beach ridge is slightly elevated, at 1 ft above the average high tide level, but the Chapman's Grove and access road area through the marsh lands all landward of the seawall have land elevations some 1.5m to 1.8m below mean high tide, and are thus prone to flooding. The first mitigation against flooding is to plan the facilities to be capable of operating even during serious flooding conditions, with flood levels of 1.2 to 1.8m above ground level, as experienced during the regional 2005 flood. As such, all equipment sensitive to water damage, such as the entire substation, and electrical equipment in the base of the wind turbine towers, will be elevated above such maximum flood water levels. During construction this will be developed to take into account also crane pad and critical equipment laydown area elevations. During the operation phase the entire facility will also be operated remotely via SCADA technologies.

Nevertheless, serious flooding may have implications on the ability to access the site via public roadways, strand operators and security personnel at the site, and there may be issues with operation of the GPL grid which could require shutdown of the facility.

A plan will be developed to manage issues related to flooding of some or all of the project site and surrounding region, or public and access roads to the site. It will look at mitigating measures to secure the construction work site and its equipment from flooding, and to access the site in order to evacuate any stranded workers, and also to maintain security at the site.

The detailed plan will be completed, when the site design is completed and before site work begins.

18.2.18 WTG Structural Failure Emergency Plan

Structural failure of the wind turbine resulting from a collapsed tower or blade throw is extremely unusual. Quantitative risk assessment has this as a less than 1 in 35 million year risk at distances from the wind farm which could impact residents, the flood gate

facility operator or fishermen. Nevertheless, an emergency response plan must be developed for such an unlikely scenario.

Should such structural instability due to rotor blade issues gradually develop then it is likely that vibration sensors would highlight this risk, and the wind turbine would be stopped, the area under threat from dropped blade would be cordoned off, and the problem blade would be replaced.

If the blade does break off and is thrown, or the turbine tower does collapse, without any warning, the failure would then trigger automatic alarms with immediate shut down of the wind farm and inspection of the problem wind turbine by onsite security. Both the automated alarm and reporting by on-site security would cause an immediate response by the Emergency Response Team, with communication also to the Guyana Civil Defence Commission, the Police, the Fire Services and an Ambulance Service as a precautionary measure. If the incident impacts any NDIA drainage infrastructure or is within the NDIA reserve then the NDIA must also be contacted. The Fishermen and Community stakeholders will also be contacted and kept informed.

The immediate priority by on-site personnel will be to establish the extent of the damage, confirm if there are any casualties, and to cordon off the area affected and any area in potential danger. Supporting HWE engineers and technicians would focus on wind farm facility shutdown and ensuring electrical and mechanical safety.

Should there be any casualties, the onsite first aiders will immediately attend to such persons as their top priority if the injured person's location is deemed safe to approach. Should there be more than one casualty then additional ambulances should be called. Medical Emergency Response Plan procedures will then be followed.

If the area affected is outside of the wind farm boundary, then the local authority (Police or Fire Services) shall be in charge of emergency response activities, with support as required by the HWE Emergency Response Team.

It is likely that mobile crane and transport vehicle support will be required if it is necessary to move any large pieces of wind turbine tower, nacelle or blade component.

The plan is thus to take care of any injured persons, followed by ensuring the accident site has been rendered safe, any damaged property has been cordoned off and stabilised, any impact or blockage of roadways or drainage canal facility or fishing facility is cleared up and related damages are repaired.

18.2.19 Security: Bomb Threat Emergency Plan

Bomb threat response and action will be defined as part of the detailed emergency response planning activities, under the guidance of the Guyana Civil Defence Commission, the Police and the Fire Services.

18.2.20 Security: Civil Unrest Emergency Plan

Civil unrest response and action will be defined as part of the detailed emergency response planning activity, under the guidance of the Guyana Civil Defence Commission, and the Police.

18.2.21 Ending an Emergency

Once an emergency is under control, an investigation will be conducted as soon as practical by the Site Emergency Manager. This investigation will include an assessment of damage to persons, property and the environment and recommendations of measures / procedures to prevent recurrence or minimize the effects should a similar event recur. The report on the investigation will then be forwarded to the Emergency Director for sign off. If the investigation determines that conditions leading to the emergency are alleviated, mitigated or contained, and unlikely to reoccur, the Emergency Director gives the "all clear" for operations to resume. The Emergency Director will be responsible for releasing reports to external agencies as required.

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19 CLIMATE AND CLIMATE CHANGE

19.1 Definitions

PARAMETER	SHORT NAME	DEFINITION
El-Nino Southern Oscillation	(ENSO)	El Niño–Southern Oscillation is an irregular periodic variation in winds and sea surface temperatures over the tropical eastern Pacific Ocean, affecting the climate of much of the tropics and subtropics. The warming phase of the sea temperature is known as El Niño and the cooling phase as La Niña.
Inter-tropical Convergence Zone	ITCZ	Intertropical convergence zone (ITCZ), also called the equatorial convergence zone, is a belt of converging trade winds and rising air that encircles the Earth near the Equator. The rising air produces high cloudiness, frequent thunderstorms, and heavy rainfall. The ITCZ shifts north and south seasonally with the Sun
Mean Temperature	-	Near surface air temperature (1.5 m)
Neap Tide		A tide in which the difference between high and low tide is the least. Neap tides occur twice a month when the Sun and Moon are at right angles to the Earth.
Number of cold nights	Cold Nights	Number of days with daily minimum temperature below the 10th percentile of daily minimum temperatures of the period 1961-1990
Number of cold days	Cold Days	Number of days with daily maximum temperature below the 10th percentile of daily maximum temperatures of the period 1961-1990
Number of hot nights	Hot Nights	Number of days with daily minimum temperature above the 90th percentile of daily minimum temperatures of the period 1961-1990
Number of hot days	Hot Days	Number of days with daily maximum temperature above the 90th percentile of daily maximum temperatures of the period 1961-1990

PARAMETER	SHORT NAME	DEFINITION
Spring Tide		A tide in which the difference between high and low tide is greater. Spring tides occur twice each lunar month all year long, without regard to the season.
Total Precipitation	-	Surface total precipitation.
Consecutive Dry Days	CDD	Maximum number of consecutive days with rainfall less than 1 mm
Consecutive Wet Days	CWD	Maximum number of consecutive days with rainfall greater than 1 mm
Intensity of heavy rainfall events	R95TOT Heavy Rain Intensity	95th percentile of daily precipitation amounts, but only wet days (with rainfall ≥ 1mm) are considered
Maximum 10-day precipitation sum	Max 10d Rain	Maximum rainfall that occurs in 10 consecutive days

19.2 Existing Information, Baseline Studies

Guyana has a total land area of 214,970 km^2. The coastline with the Atlantic Ocean extends some 430 km. The coast lies about 1.4 m below mean high tide. About 40% of the population of Guyana live in the coastal strip. Settlements and most of the country's agriculture are located on land below sea level. The low-lying terrain and inadequate drainage systems make the area vulnerable to flooding (TNC First Draft V&A Chapter).

Typical spring tidal range is 2.8 m and neap tidal range is just under 1m at Georgetown. Most of the coastal plain is elevated below the high tide level. Earthen embankments, masonry sea walls and sand banks protected by mangrove, act as sea defence systems along the coastline. The proposed wind farm is to be located at Hope Beach and Chapman's Grove on the coastline in Region 4 – Demerara Mahaica.

The natural resources of Guyana include some of the last standing large-scale tracts of tropical forests in the world. Approximately 18.39 million hectares of rainforest cover over 85% of the land area (NCCPAP, 2019). Coastal zone forest classes comprise marsh forests, open swamp forest in Regions 2 to 4 and mangrove forests along the coast and in the brackish waters of the major rivers (TNC First Draft V&A Chapter).

Historical deforestation rates are between -0.1 to 0.3 %. The 2019 current rate (0.05%) of deforestation remains one of the lowest rates in Latin America and the developing world. The forest resources of Guyana act as a large store of carbon and a provider of global environmental services.

19.3 Climatology

Guyana is situated at the equator. It experiences warm temperatures, cooled by Northeast trade winds blowing from the Atlantic Ocean. The country's climate is influenced by the following two features:

- The Inter-tropical Convergence Zone (ITCZ) or equatorial trough which is a cloud and rain-bearing belt of rising air where south-easterly and north-easterly trade winds converge so affecting wind direction and rainfall pattern. Its north - south movement influences the seasons. The northern and coastal zones of Guyana experience two dry seasons (February to April and August to October) and two rainy seasons (May to July and November to January) as illustrated in Figure 19-1 using rainfall data for the 1991-2015 period.

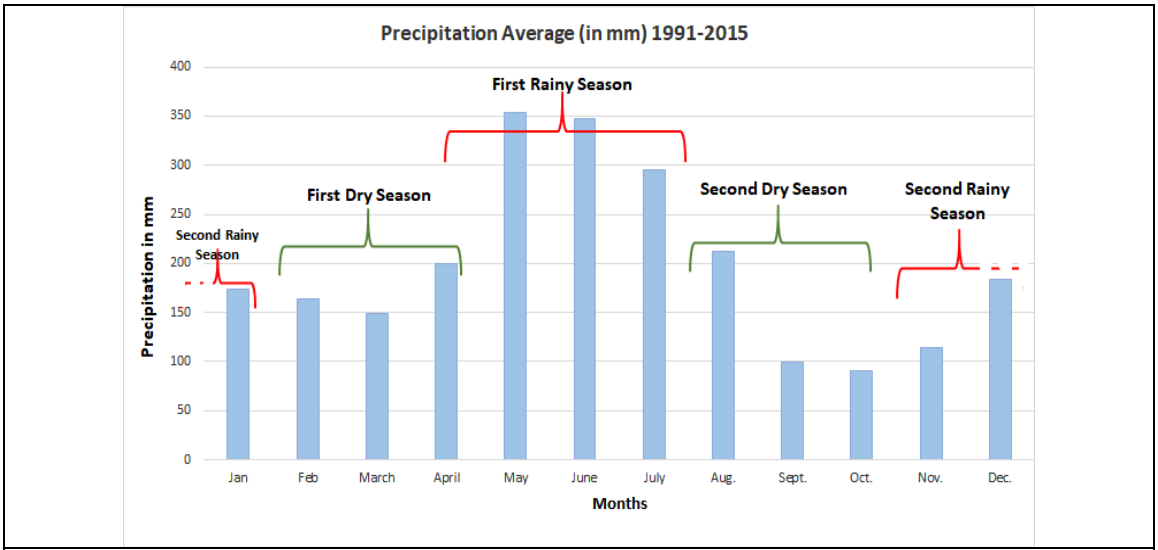


FIGURE 19-1: SEASONAL VARIATION IN RAINFALL (SOURCE: TNC FIRST DRAFT V&A CHAPTER)

- El-Nino Southern Oscillation (ENSO) which involves fluctuating sea surface temperatures in the equatorial Pacific. In El Nino there is a weakening of trade winds and a move to drier conditions. In La Nina there are stronger than average trade winds and higher precipitation levels. For coastal Guyana, El-Nino (negative Southern Oscillation Index- SOI) events are likely to result in drought conditions, whereas La-Niña (positive SOI) events result in significantly higher than normal precipitation (TNC First Draft V&A Chapter).

19.3.1 Temperature and Relative Humidity

19.3.1.1 Country Profile

The average, maximum and minimum temperatures for Guyana are shown in Table 19-1 for the periods 1951-2018 and 1986-2006.

TABLE 19-1: AVERAGE, MAXIMUM AND MINIMUM, MONTHLY AND ANNUAL TEMPERATURES (°C) FOR GUYANA (1951-2018 AND 1986-2006)

Source: TNC First Draft V&A Chapter - Table 2.

MONTHS	AVERAGE		MAXIMUM		MINIMUM	
	1951-2018	1986-2006	1951-2018	1986-2006	1951-2018	1986-2005
January	24.6	24.8	28.8	29.1	21.5	21.7
February	25.1	25.4	30.1	30.2	21.7	21.9
March	25.6	25.9	30.9	30.9	22.1	22.3
April	25.8	26.2	31.2	31.3	22.1	22.5
May	25	25.3	29.6	29.7	21.8	22
June	23.6	23.8	27	27.1	21.1	21.2
July	23.1	23.3	26.4	26.5	20.6	20.8
August	23.5	23.7	27	27.1	20.9	21.1
September	24.7	25.2	28.9	29.1	21.8	22.2
October	25.4	26	29.9	30.2	22.4	22.8
November	24.9	25.3	29.1	29.3	22	22.3
December	24.4	24.9	28.7	29	21.4	21.9
Annual	24.6	25	29	29.1	21.6	21.9

Average monthly temperatures vary seasonally and are slightly lower in the rainy seasons (23.5°C to 25.8°C during the dry season and 23.1°C to 25°C during the rainy season for the long-term period 1951 to 2018). This trend is also illustrated in Figure 19-2. The average annual temperature was 24.6°C. Average maximum and minimum temperatures were between 26.4°C and 31.2°C and 20.6°C and 22.4°C, respectively. There is no significant difference in average temperatures for the two time periods.

Figure 19-3 shows the increases in average annual, maximum and minimum temperatures trends for baseline 1951-2018 and the period 1985-2006.

The duration of sunshine averages 7 hours/day in the dry seasons, while in the rainy seasons there is an average of 5 hours sunshine/day (UNCCC SNC, 2012).

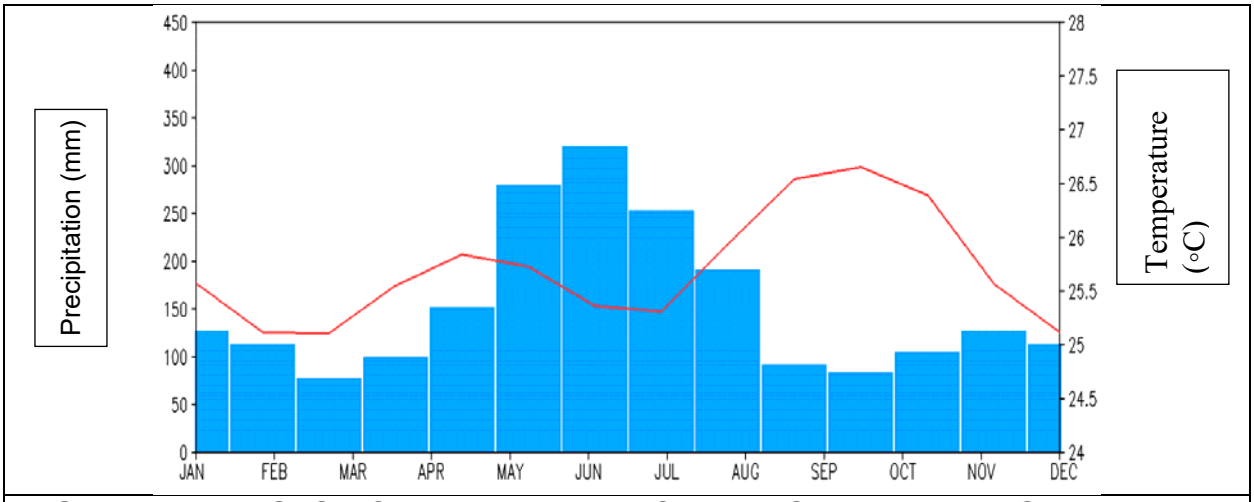


FIGURE 19-2: HISTORICAL ANNUAL PRECIPITATION (BLUE BARS) IN MM AND TEMPERATURE (RED LINE) IN ºC FOR 1951-2018 AND 1986-2006

(SOURCE: TNC FIRST DRAFT V&A CHAPTER -TABLE 4)

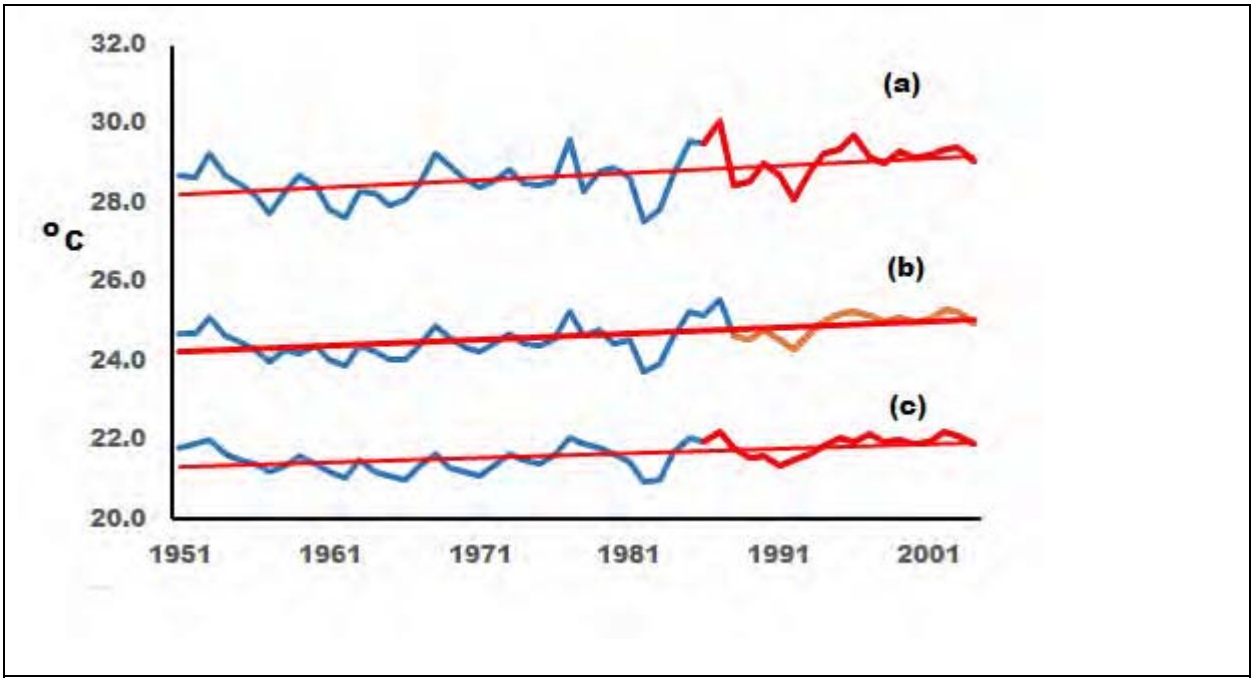


FIGURE 19-3: ANNUAL TEMPERATURE TRENDS, 1951-2018 AND 1985-2006: (a) MAXIMUM; (B) AVERAGE; (C) MINIMUM. RED LINE CORRESPONDS TO THE PERIOD 1985-2006.

Source: Guyana's TNC

19.3.1.2 Project Area

Temperature and relative humidity for the Georgetown Botanic Gardens for the period 2017 to 2019 were provided by the Hydrometeorological Office (see Table 19-2). Georgetown, like the proposed project site, lies on the coast and is within Region 4.

For this 3-year period, the monthly mean minimum temperatures were between 24°C and 25.2°C while the average maximum temperatures were between 29.4°C and 31.9°C. Monthly mean Relative Humidity (RH) was between 79% and 90%. The highest RH was recorded during June/July.

TABLE 19-2: MONTHLY MEAN MAXIMUM AND MINIMUM TEMPERATURES AND MONTHLY MEAN RELATIVE HUMIDITY FOR BOTANIC GARDENS, GEORGETOWN (2017-2019)

Source – Hydromet Service

YEAR	MONTHLY MEAN MINIMUM TEMPERATURES (°C)											
	J	F	M	A	M	J	J	A	S	O	N	D
2017	23.7	24	24.3	25.4	24.7	23.9	24.1	25.1	24.8	25.4	24.8	24.1
2018	23.6	23.5	24.7	24.4	24.6	23.9	24	24.6	24.6	25.2	24.8	24.4
2019	24.6	24.4	25.3	25.5	25.1	24.9	23.9	24.4	25.4	25.1	25.1	24.6
AVG	24	24	24.8	25.1	24.8	24.2	24	24.7	24.9	25.2	24.9	24.4
	MONTHLY MEAN MAXIMUM TEMPERATURES (°C)											
2017	29.3	29.3	29.8	30.5	30.6	30.5	31.1	32	32	31.8	30.8	29.7
2018	29.6	29.2	29.9	29.8	29.3	29.7	30.4	31	31.1	32	31	29.6
2019	29.6	29.6	30.7	31.2	30.1	30.3	30.4	30.9	31.9	31.9	31.3	30
AVG	29.5	29.4	30.1	30.5	30	30.2	30.6	31.3	31.7	31.9	31	29.8
	MONTHLY MEAN RELATIVE HUMIDITY (%)											
2017	86	83	84	79	88	91	91	85	84	83	85	85
2018	85	82	80	83	85	91	90	84	86	80	83	83
2019	83	83	77	77	87	88	90	86	81	80	86	89
AVG	84.7	82.7	80.3	79.7	86.7	90	90.3	85	83.7	81	84.7	85.7

19.3.2 Rainfall

19.3.2.1 Country Profile

Monthly and annual precipitation for Guyana for the periods 1951-2018 and 1986-2005 are shown in Table 19-3. These averages follow the general trend (shown in Figure 19-1), of lower rainfall during the two dry seasons as compared to the two rainy seasons.

Annual rainfall averaged over the long-term period 1951-2018 was higher than the more recent 20-year average for 1986-2005. June to August are the rainiest months while December to April have the lowest rainfall.

TABLE 19-3: MONTHLY AND ANNUAL PRECIPITATION FOR GUYANA (1951-2018 AND 1986-2006)

MONTHS	AVERAGE PRECIPITATION IN mm	
	1951-2018	1986-2005
January	67.3	66.1
February	47.8	41.0
March	78.0	70.8
April	82.7	75.1
May	130.3	133.0
June	211.3	215.7
July	223.3	226.4
August	209.6	212.7
September	160.4	147.9
October	123.5	109.7
November	123.5	117.0
December	88.8	86.7
Annual	1546.5	1467.2

Figure 19-4 shows the general trend of precipitation in Guyana for the baseline 1951-2018 and period 1985-2006. It shows the long-term average rainfall trend for Guyana decreasing from ~1,700mm/yr in 1951 to ~1,400mm in 2018.

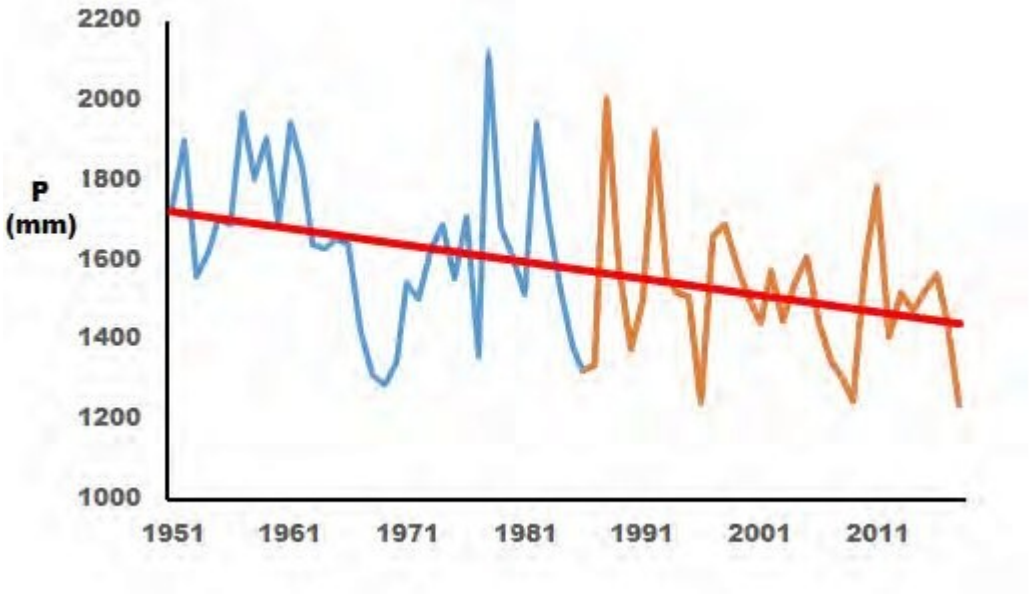


FIGURE 19-4: GENERAL TREND OF PRECIPITATION IN GUYANA. BASELINE 1951- 2018. RED LINE REPRESENTS THE PERIOD 1985-2006.

Source: Guyana's TNC.

19.3.2.2 Region 4

Table 19-4 presents the annual and seasonal (wet and dry months) cumulative precipitation (mm) for the 42-year period 1966-2008 for two locations in Region 4 within which the proposed project site is located. Georgetown which is on the coast (as is the proposed project site) recorded less rainfall in the wet months as compared to Timehri which is situated more inland. However, in the dry season, higher rainfall was recorded at coastal Georgetown as compared to the inland location.

TABLE 19-4: PRECIPITATION DISTRIBUTION FOR LOCATIONS IN REGION 4 (1966-2008)

Source: TNC First Draft V&A Chapter - Extracted from Table 4

PRECIPITATION (CUMULATIVE) IN MM			
LOCALITY	ANNUAL	WET MONTHS	DRY MONTHS
Georgetown	2338	1501	837
Timehri	2411	1630	781

Rainfall data for the period 2017-2019 was obtained for the Hydromet station at Beehive which is located approximately 2 km south east of Hope Beach and 1.7 km west of Chapman's Grove. Table 19-5 presents a seasonal analysis of that data which is illustrated in Figure 19-5.

TABLE 19-5: RAINFALL DATA FOR HYDROMET STATION AT BEEHIVE (2017-2019)

YEAR	RAINFALL (MM)												
	1ST DRY SEASON			1ST WET SEASON			2ND DRY SEASON			2ND WET SEASON			YEAR TOTAL
	F	M	A	M	J	J	A	S	O	N	D	J	
2017	8.3	4.2	4	7.2	16.3	6.2	3	5.1	3	7.2	17.1	10.6	92.2
2018	5.1	1.1	11.1	12.9	18.5	5	3.2	8.2	0.7	5.9	4.6	2.7	79
2019	6	1.2	4.5	18.4	15.3	20.4	3.7	1.8	1.4	5	4	2.7	84.4
MONTHLY AVG	6.5	2.2	6.5	12.8	16.7	10.5	3.3	5.0	1.7	6.0	8.6	5.3	
SEASONAL AVERAGE (2017-2019)	5.1			13.3			3.3			6.6			
SEASONAL TOTAL (2017)	16.5			29.7			11.1			34.9			
SEASONAL TOTAL (2018)	17.3			36.4			12.1			13.2			
SEASONAL TOTAL (2019)	11.7			54.1			6.9			11.7			

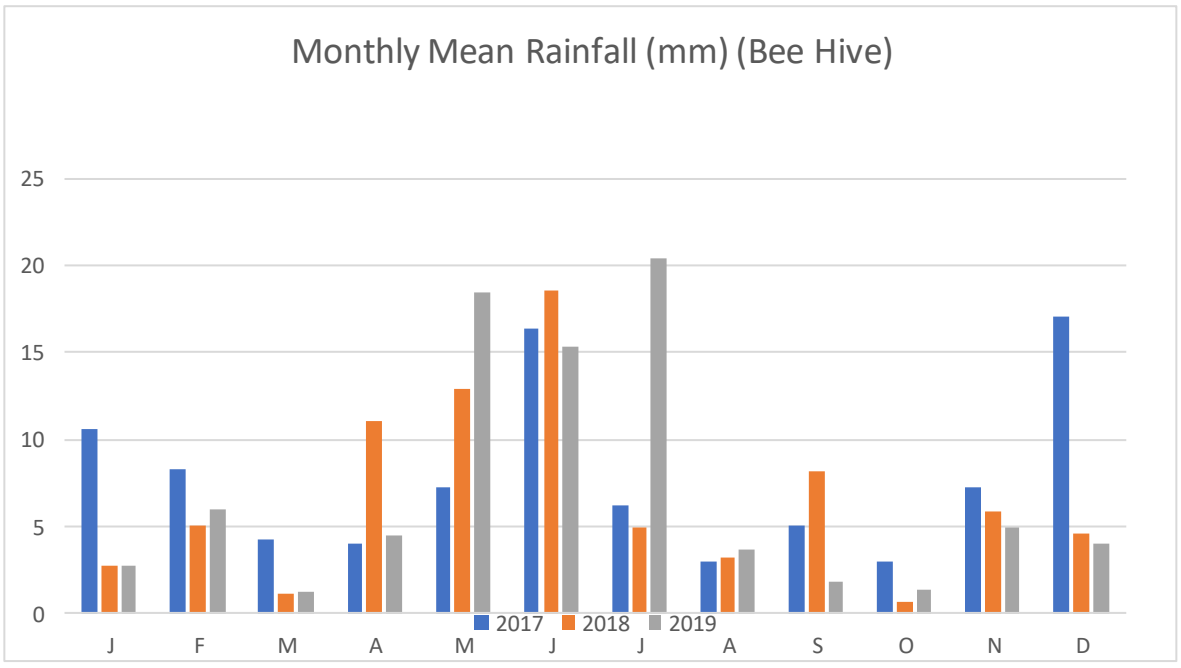


FIGURE 19-5: 2017-2019 TREND IN MONTHLY MEAN RAINFALL FOR BEEHIVE HYDROMET STATION

19.3.3 Wind Speed and Direction

19.3.3.1 General Data

The wind experienced at any given location is highly dependent on local topography and other factors. General hourly average wind speed and direction data for Georgetown was accessed from the available online sources including: https://www.worldweatheronline.com/georgetown-weather-averages/demerara-mahaica/gy.aspx and meteoblue.com

Figures 19-6 and 19-7 show the wind speed and direction data for Georgetown over the period 2010 to 2020. Wind direction is generally from the east. Average wind speeds during the period 2010 to 2020 ranged between 4 km/hr to 8 km/hr with maximum winds in excess of 12 km/hr.

19.3.3.2 Site Specific Data

3 years of wind metering at 90m height demonstrates good trade wind conditions at the project site. Finance grade data recovery was over 99% during this 3-year period. The

wind data analysis and annual energy production estimate was performed by EMD International A/S, a respected Danish wind engineering consultancy with over 30 years of industry expertise.

Average wind speeds at hub height are very persistent, with wind speed within a narrow range of 5 to 11 m/s for almost 90% of the time. There are no extreme wind speeds in Guyana. The wind speed is less than the cut-in wind speed for the wind turbine (i.e. wind turbine is stopped) for less than 5% of the time.

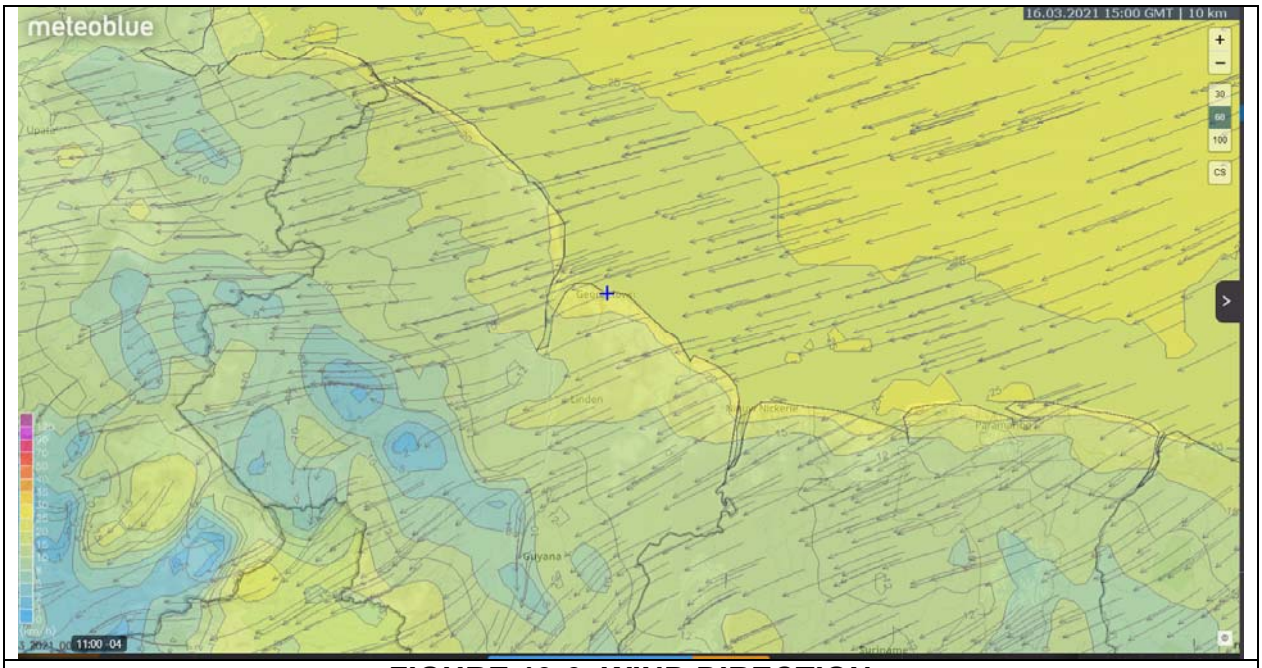


FIGURE 19-6: WIND DIRECTION

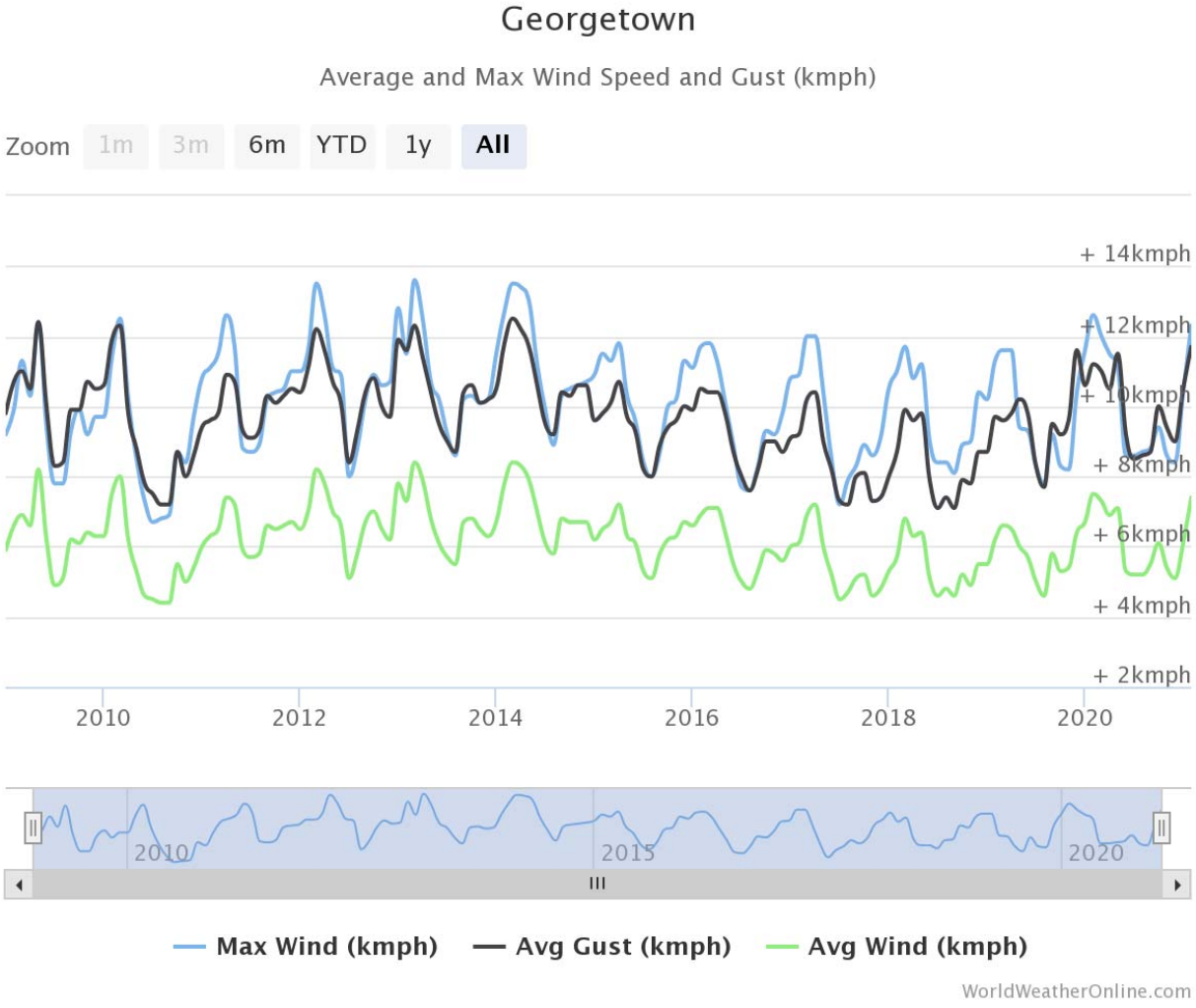


FIGURE 19-7 WIND SPEED DATA (2010-2020)

19.4 Climate Change

19.4.1 Environmental Agreements

At the UN Conference on Environment and Development (UNCED) in 1992, Guyana committed to the RIO Declaration and Agenda 21. Guyana is also Party to several other related international conventions on the environment including:

- UN Framework Convention on Climate Change (signed 1992)
- Kyoto Protocol to UN Convention on Climate Change (acceded in August 2003)
- UN Convention to Combat Desertification (Ratified in June 1997)
- 2015 Paris Agreement on Climate Change

At the international level, Guyana has played a key role in the UNFCCC negotiations on Reducing Emissions from Deforestation and Forest Degradation (REDD) as well as REDD+. The country also works along with negotiating groups such as the Coalition for Rainforest Nations and the Alliance of Small Island States (AOSIS), participates actively in the work of the United Nations (UN) Commission on Sustainable Development and is committed to acting to achieve the Sustainable Development Goals (SDGs) at the national level.

Guyana is signatory to:

- The Escazu Agreement, which is the first regional environmental treaty of Latin America and the Caribbean aiming to guarantee the full and effective implementation of the environmental access rights to information, participation and justice.
- CARICOM's frameworks to combat climate change including the Liliendaal Declaration and the Regional Framework for Achieving Development Resilient to Climate Change (2009) and its Implementation Plan (2012)
- The Hyogo Framework for Action (HFA) (2005-2015) and its successor, the Sendai Framework for Disaster Risk Reduction (2015-2030) represent the global reference framework for Disaster Risk Reduction (DRR) and present an approach to contribute to sustainable development and increased resilience of nations and communities by mainstreaming disaster risk reduction into state policies
- The SIDS (Small Island Developing States) Accelerated Modalities of Action (SAMOA) Pathway in disaster risk management.

19.4.2 Key Relevant Policy, Legislation, Guidelines and Standards

19.4.2.1 National Climate Change Policy

This Policy is formulated in response to international and national level drivers. International drivers include Guyana's commitments to the UNFCCC, Paris Agreement, Kyoto Protocol and the United Nations Sustainable Development Goals.

The Vision of Guyana's climate change policy is that it integrates the socio-economic and environmental challenges of climate change and provides strategic guidance for adaptation, mitigation and resilience to foster national sustainable development.

Policy goals include:

- Reduce climate related loss and damage
- Protect livelihoods and improve standard of living
- Strengthen community economic development and resilience
- Promote a clean and healthy environment for all
- Promote holistic development approaches
- Enhance human and institutional capacity
- Adopt new and innovative ways to face climate challenges
- Promote integrated systems approaches
- Reduce greenhouse gas emissions and enhance sinks
- Make data and information available and accessible to all

The guiding principles of the Policy are:

- Inclusive participation
- Long-term sustainability
- Strategic partnerships and collaboration
- Equity and fairness
- Best Affordable and Appropriate Technologies
- Incorporating lessons learned

A National Climate Change Policy Action Plan (NCCPAP) was developed in alignment with the achievement of Sustainable Development Goal (SDG) 13: *"Take urgent action to combat climate change and its impacts"*. Policy actions are proposed to combat and prepare for climate change impacts across multiple sectors of which the following have

been identified as potentially most at risk: agriculture, forestry, water resources, energy and transportation. One of the 9 policy directives of the Plan is to *drive technology-based mitigation solutions* and the proposed wind farm project directly satisfies one of the related objectives which is to: *increase the national renewable energy supply base*.

The NCCPAP also seeks to achieve commitments set out in the Kyoto Protocol and Paris Agreement as well as aligns with and supports the Low Carbon Development Strategy (LCDS).

19.4.2.2 Other Policies, Legislation and Plans

NCCPAP, 2019 lists the following recent policy, legislation and plans that influence Guyana's climate actions with respect to mitigation and disaster response:

- **Low Carbon Development Strategy:** This Strategy aims to transform Guyana's economy to a low carbon, sustainable development trajectory, while simultaneously combating climate change. The strategy aims to protect and maintain the forests to reduce global carbon emissions and at the same time attract payments from developed countries for the climate services that the forests provide to the world, which will be invested to foster growth and development along a low carbon emissions path, without compromising the sovereignty over the forests or affecting the development prospects of Guyanese.

- **Updated Sea and River Defence Sector Policy**.

- **Draft Guyana REDD+ Strategy (2019):** A critical component of Guyana's REDD+ Readiness Process, the Strategy aims to maintain the country's low rate of deforestation and forest degradation by continuing related policy, procedures and programmes; and by strengthening monitoring, reporting and verification systems.

- **Nationally Appropriate Mitigation Actions (2018)**: This NAMA presents a framework for the green development of towns in Guyana looking at various aspects of the energy sector in relation with other sectors, such as water, transport and waste management (to be approved)

- **National Mineral Sector Policy Framework and Actions (2019 – 2029)**: This Policy accepts that mining in Guyana has other implications and impacts: for other land uses, such as forestry, protected areas, and Indigenous and other communities; and for national sovereignty, border security, health security, law enforcement, hinterland and infrastructure development, social cohesion, internal population movement and redistribution.

- **Revised National Forest Policy Statement (2018)**: This is implemented through the National Forest Plan. This Policy reflects Guyana's movement away from valuing of forests for simply their wood and trees, and instead treats forests as part of the national patrimony, to be managed collectively.

- **Draft Guyana Energy Transition Roadmap (2017)**: Guyana's draft Energy Transition Roadmap provides a renewable energy power expansion plan inclusive of a transition strategy based on natural gas for Guyana for the period 2017 – 2035.

- **Technical Needs Assessment – Adaptation (2016); Technical Needs Assessment – Mitigation (2016):** A set of country-driven activities that identify and determine the mitigation and adaptation technology priorities of Guyana. These activities may address soft and hard technologies, such as mitigation and adaptation technologies, identify regulatory options and develop fiscal and financial incentives and capacity building.

- **Guyana National Land Use Plan (2013):** The primary objective of the National Land Use Plan (NLUP) is to provide a strategic framework to guide land development in Guyana. As such the NLUP is built upon a number of national policies and strategies that have a direct relevance for land use and land management. A main objective of the NLUP is to enable financial resources to be targeted at optimal land uses at the regional level. To this regard the NLUP has been compiled from a policy of active promotion of multiple land use.

- **Nationally Determined Contribution (2015)**: Guyana's international commitment to addressing issues on climate change is reflected in the Nationally Determined Contribution (NDC) submitted to the United Nations Framework Convention on Climate Change (UNFCCC).

- **Integrated Coastal Zone Management Policy (2015)**: reflect an integrated approach to delivering sustainable sea and river defense policies within the coastal zone of Guyana. It is the key in protecting Guyana's coastland environment, against some of the effects of climate change.

- **Climate Resilience Strategy and Action Plan (CRSAP) (Draft 2015)**: This addresses this gap and aims to provide a comprehensive and overarching framework for adapting and building resilience to climate change impacts. (this will be replaced by the National Adaptation Plan when completed)

- **Disaster Risk Management Bill (2019) & Integrated Disaster Risk Management Plan (2013-2023)**: This bill seeks to provide for the management of disasters and disaster risk through comprehensive disaster risk management, the establishment and operation of a Natural Resources and Environment Cabinet Sub-Committee (formerly the National Disaster Risk Management Commission), a National Disaster Risk Reduction Platform and a National Disaster Risk Management Fund. (currently under revision).

- **Guyana's Second National Communication to the UNFCCC (2012):** The SNC comprise of seven main components - national circumstances of the country; greenhouse gas inventory from base year 1990 to 2004; measures to facilitate adaptation to climate change; measures to mitigate climate change; research & systematic Observation Systems including a technology needs assessment; public education & capacity building; and identification of gaps & constraints related to financial, technical and capacity needs.

- **National Adaptation Strategy to Address Climate Change in The Agriculture Sector of Guyana and Action Plan**

- **Comprehensive Disaster Management (CDM) Country Work Programme (CWP) (2019-2024)**

- **Regional Disaster Risk Management Systems (RDRMS) and Community Based Disaster Risk Management Plans (CBDRMP).**

- **National Prevention, Preparedness and Relief Plan of 1982.**

- **National Flood Preparedness and Response Plan of 2010, revised in 2012.**

- **National Multi-hazard Preparedness and Response Plan (2013) which address strategic actions over the next ten years to tackle floods and droughts.**

- **National Early Warning Systems (EWS) Framework (2013).**

19.4.3 Key Institutions and Organizations

In 1993, the Cabinet created the Natural Resources and Environment Advisory Committee (NREAC) to coordinate Guyana's implementation of the Rio Conventions - the UN Framework Convention on Climate Change (UNFCCC), the UN Convention on Biological Diversity (UNCBD) and the UN Convention to Combat Desertification (UNCCD), and the overall management of the country's natural resources.

In 2007 a National Climate Unit was established within the Ministry of Agriculture to coordinate climate change activities. The Office of Climate Change (OCC) was then created within the Office of the President (now Ministry of the Presidency) in 2009 to coordinate these activities. As stated in NCCPAP, 2019 the core governance institutions for climate change in Guyana are: Ministry of the Presidency (Minister of State), Office of Climate Change and National Climate Change Committee.

19.4.3.1 Office of Climate Change (OCC)

The Office for Climate Change (OCC) is situated under the Ministry of the Presidency and is the Focal Point for the UNFCCC as well as the Secretariat to the National Designated Authority for the Green Climate Fund. It was established in 2009, and has the following functions:

- Leads in the development and implementation of national policies and actions for climate change mainstreaming.
- Coordinates efforts and implementation of actions on climate change adaptation, mitigation and resilience building across sectors and agencies at the national and regional (administrative) levels, including ministries, agencies and non-governmental organizations.
- Ensures that the Government of Guyana (GoG) fulfils its obligations as a Party to the Convention, its Protocol and Agreement.
- Leads the engagement and dialogue with multilateral agencies on behalf of the GoG, to establish partnerships and facilitate access to technical and financial support for climate change mitigation and adaptation initiatives, in furtherance of national development thrust.

- Works closely with the Ministry of Foreign Affairs on international negotiations.
- Leads regional engagement such as with the Caribbean Community Climate Change Center (5Cs). In its role of leading national efforts, the OCC

19.4.3.2 National Climate Change Committee (NCCC)

In August 2018, the government re-launched the National Climate Change Committee (NCCC) which was given the key role of optimizing the efficiency of climate governance and in advancing implementation across sectors. The Committee comprises of representatives from the Ministries of Education, Public Health, the Guyana Land and Surveys Commission, the University of Guyana, the Environmental Protection Agency, the Guyana Forestry Commission, Partners of the Americas, and other State and non-State agencies. The NCCC is responsible for:

- Mainstreaming climate change considerations into relevant policies, strategies and/or plans.
- Supporting the OCC´s operational mandate (see Section 19.4.3.2.1, above).
- Providing guidance and support to the implementation of sectoral initiatives with respect to climate change.

19.4.3.3 Other Key Agencies

The following additional agencies have key roles in managing climate change in Guyana:

- The **Department of Environment** under the Ministry of the Presidency and it is responsible for coordinating the implementation of the Green State Development Strategy: Vision 2040.
- The **Hydro-meteorological Service** observes and archives Guyana's weather and climate and provides meteorological information.
- The **National Drainage and Irrigation Authority (NDIA)** functions under the Ministry of Agriculture (MoA). It deals with all public matters pertaining to management, improvement, extension and provision of drainage, irrigation and flood control infrastructure and services in declared areas of the country. The NDIA manages and maintains the drainage and irrigation systems as well as the large inland low-level dams, mostly on the coastal areas and has been implementing the upgrading and rehabilitation plan of drainage and irrigation infrastructure in Regions 2 to 10.

- **The Sea Defence Board (SDB)**, comprises the Chief Hydraulics Officer/Chief Sea and River Defence Officer (CSRDO)] and other members appointed by the Minister of Public Works. It is responsible for the care, maintenance, improvement, management and construction of sea and river defences and also for the provision of drainage, irrigation and flood control within the eight defined Sea Defence Districts in Guyana.

- **The Civil Defence Commission (CDC)** is currently the focal agency in charge with Disaster Risk Management (DRM). the CDC has the responsibility for coordinating and monitoring disaster risk management and comprehensive disaster management.
- **The Coastal and Marine Management Committee (CMMC)** replaces the Integrated Coastal Zone Management Committee for addressing Integrated Coastal Zone Management issues. The committee coordinates the activities of the various agencies with involvement in coastal zone management; provides policy recommendations for the identification, monitoring, utilization and management of resources within the coastal zone; and advises on issues of concern to coastal zone management.

19.4.4 Climate Change

Since the early 1960s, Guyana has been observing increases in temperature, sea level as well as the frequency and intensity of extreme rainfall events. In recent years, there have been several extreme weather events that have resulted in droughts and high levels of flooding. Extreme flooding occurred in 2005, 2006, 2008, 2010, 2011, 2013, 2014, 2015 and 2017 and droughts occurred in 1997-8, 2009-2010 and 2015 (TNC First Draft V&A Chapter).

Various models and scenarios have been used to predict changes to Guyana's climate to the end of the 21st century. A summary of the climate change projections for Guyana is shown in Table 19-6 (TNC First Draft V&A Chapter). These are based on the use of models such as:

- Perturbed Physics Experiments (PPEs)
- Global Circulation Models (GCMs)
- PRECIS RCM (Regional Climate Model)

The modelling considers climate changes using two approaches:

- Emission Scenarios which examine various levels of Green House Gas Emissions (GHG): future global population growth, technological development, globalization, societal values.

- Emissions Futures which examine a range of possible emissions pathways to achieve representative concentration pathways (RCPs) and is based on the concept of radiative forcing (the balance between the amount of energy (watts/m2) that enters the earth's atmosphere and the amount that is reflected back into space compared to pre-industrial conditions).

A new approach for future modelling (post 2020-2021) will be based on pathways that examine how global society, demographics and economics might change over the next century and they are known as the "Shared Socioeconomic Pathways" (SSPs).

TABLE 19-6: PROJECTIONS OF DIFFERENT CLIMATE VARIABLES FOR GUYANA

Source (TNC First Draft V&A Chapter Table 6)

Climate Variable	2030s	2040s-2070s	2070s-2100
Average annual temperature	↑ 0.4°C to 2.0°C	↑ 0.9°C to 3.3°C	↑ 1.4°C to 5.0°C
Maximum temperature		↑ 0.5°C to 1.1°C	
Minimum temperature		↑ 0.9°C to 1.5°C	
Average annual precipitation		↓8.0 % to 9.7 %	
Sea level rise	↑0.14 m to 0.26 m	↑ 0.21 m to 0.43 m	↑ 0.25 m to 0.51 m
Storm surge	↑ 2.94 m to 5.94 m	↑ 2.89m to ↑	↑ 2.93 m to 6.19 m

19.4.4.1 Temperature Increases

The global average warming rate is approximately 0.08°C/decade (NCCPAP, 2019). Observed climate data shows mean annual temperatures for Guyana have increased by 0.3°C since the 1960s, corresponding to an average rate of temperature increase of approximately 0.07°C per decade, with the highest changes occurring in the August-September months (~ 0.10°C per decade). Guyana's rate of increase of 0.07°C per decade is therefore slightly below the global average warming rate. The average number of cold days per year has decreased by 37 (10% of days) and the frequency of cold nights has decreased at a similar rate. (NCCPAP, 2019)

According to TNC First Draft V&A:

- Annual temperatures for the country are predicted to increase by 1.8 °C to 2.4 °C (7-10%) by 2030 (to 26.4 °C – 27°C); by 2.2 °C to 2.9 °C (9-11%) by 2050 (to 26.8 °C – 27.5 °C) and by 2.3 °C to 5 °C (9-20%) by 2070 (to 26.9 °C – 29.6 °C)

relative to a 1952-2018 baseline temperature of 24.6°C. (TNC First Draft V&A - Table 9a)

- By the end of the century, maximum temperatures are predicted to increase by 1.5 °C to more than 7 °C; and minimum temperatures by 1.5 °C to 6 °C.

Table 19-7 shows seasonal and annual changes to the end of the century relative to 1961-1990 baseline temperature for four scenarios.

TABLE 19-7: RANGE OF PROJECTED SEASONAL AND ANNUAL TEMPERATURES RELATIVE TO 1961-1990 BASELINE TEMPERATURE FOR 4 SCENARIOS

Source: TNC First Draft V&A - Adapted from Table 8

SEASON	RANGE OF PROJECTED TEMPERATURE CHANGES (°C)		
	2030s	2050s	2070s
Nov-Dec-Jan	1.31 – 1.69	1.72 – 2.71	1.92 – 4.17
Feb-Mar-Apr	1.05 - 1.70	1.87 – 3.10	1.82 – 4.55
May-Jun-Jul	1.32 – 2.24	2.75 - 4.26	2.58 – 6.33
Aug-Sept-Oct	1.11 – 2.47	2.60 – 3.25	2.18 – 5.09
Annual	1.25 -1.98	2.11 – 3.28	2.14 – 4.98

For the project area which is in the coastal zone in Region 4:

- Predicted temperature changes relative to 1952-2018 baseline temperatures are 1.50 °C to 1.64 °C by 2030s; 1.93 °C to 2.89 °C by 2050s; and 1.95 °C to 4.19 °C for 2070s. (TNC First Draft V&A Chapter -Table 9a)
- Temperature changes of 3.5 °C – 4 °C by 2070 are predicted along the coastal zone and mountain region/central Guyana.

While the projected rate of warming is similar in all seasons, it is expected to be more rapid in the southern interior region of the country than in the northern, coastal areas where the proposed wind farm is located (NCCPAP, 2019).

19.4.4.2 Precipitation

Despite the large uncertainty in precipitation projections, all scenarios show that rainfall reduction could occur during the early wet season (MJJ) and to a less extent during the late wet season (ASO), where almost all the projections indicate reductions in precipitation. (TNC First Draft V&A Chapter) (see Table 19-6, above and Table 19-8, below)

TABLE 19-8: PREDICTED CHANGE IN SEASONAL AND ANNUAL PRECIPITATION (%) FOR 3 TIME PERIODS AND 4 SCENARIOS

Source: TNC First Draft V&A Chapter - Adapted from Table 10

TIME PERIOD	SEASONAL CHANGE (%)				ANNUAL CHANGE (%)
	NOV-DEC-JAN	FEB-MAR-APR	MAY-JUN-JUL	AUG-SEPT-OCT	
2030s	-7.63 TO +9.87	-14.60 TO +2.21	-13.16 TO -22.68	-1.30 TO +14.05	-2.13 TO -12.23
2050s	-23.98 to +24.63	-1.92 to -12.78	-2.1 to -40.62	-11.35 to +0.86	-5.38 to -19.45
2070s	-39.6 to 5.14	-14.60 to +0.11	-18.46 to -52.95	-12.97 to - 45.41	-5.94 to -23.84

Predictions for Region 4 in which the proposed wind farm is to be located indicate a decrease in precipitation (based on various scenarios) of -2.13 to -12.23 for 2030s; -5.38 to-19.45 for 2050s; and -5.94 to -23.84 for 2070s (TNC First Draft V&A Chapter - Table 11). These decreases are significantly greater than predictions for the entire country. NCCPAP, 2019 concludes that reductions in precipitation are projected as greater in the north in the 2030s and 2070s-2100.

19.4.4.3 Sea Level Rise / Storm Surge

Worldwide sea level rise (SLR) is 2-4 mm/year. For Guyana tide gauge records for 1951-1979 and 1979-2017 at the Georgetown Port show SLR greater than 10mm/year which is significantly higher than global increases. The higher sea-level rise along Guyana's coastal plain which is underlain by under-consolidated Demerara Clays is attributed to ground subsidence combined with global sea-level rise. The projected rise in global mean sea levels is estimated between 0.29m and 1.10m by the end of the century according to the International Panel of Climate Change (https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/). With subsidence levels averaging 2.74mm/yr between 1974 and 2010 in Georgetown (climate risk report), subsidence will likely add another 2 m of sea-level rise by the end of the century *in addition to* global sea level rise.

Satellite altimeter sea level measurements show a mean rate of rise in sea level of 3.4 ± 0.4mm/year over the last 17 years for Guyana. Sea level rise is influenced by global or

absolute sea change as well as vertical movements of the land (natural or human-induced – pumping of water, dredging).

Projections conducted for V&A for TNC (Tables 4.22 and 4.24) provide information on SLR and storm surges for three scenarios for 2050 and 2100. Sea levels are projected to increase by 0.24m to 0.84m by 2050 and by 0.5m to 3.1m by 2100. The predicted increases for 2050 can potentially affect as many as 77,000 persons (approximately 9% more than in 2019). Predicted storm surges can significantly increase the rise in sea level by 6m (2050) to 9.2m (2100), affecting 404,000 to 646,000 persons in coastal areas.

In Region 4 with an area of 2,113.01 km^2, 2.38% to 4.62% of the land can be permanently affected by 2050; and by 2100, the area that can be affected by the projected sea level rise can be between 7.26% and 30.77%. With the added effect of storm surges, it is predicted that between 41.77% and 46.56% of the Region can be affected by 2050 and 2100 respectively. (SLR and Storm Surge Projections for V&A for TNC, unpublished).

Increase in sea levels could result in accelerated coastal erosion; extreme coastal flooding; damage to coastal defence systems; raising water tables and increases in the salinity of rivers and aquifers (NCCPAP, 2019). Since most of Guyana's coast lies below the average high tide level, the proposed project site which is within the coastal zone can potentially be affected by erosion and flooding as a consequence of sea level rise and storm surges.

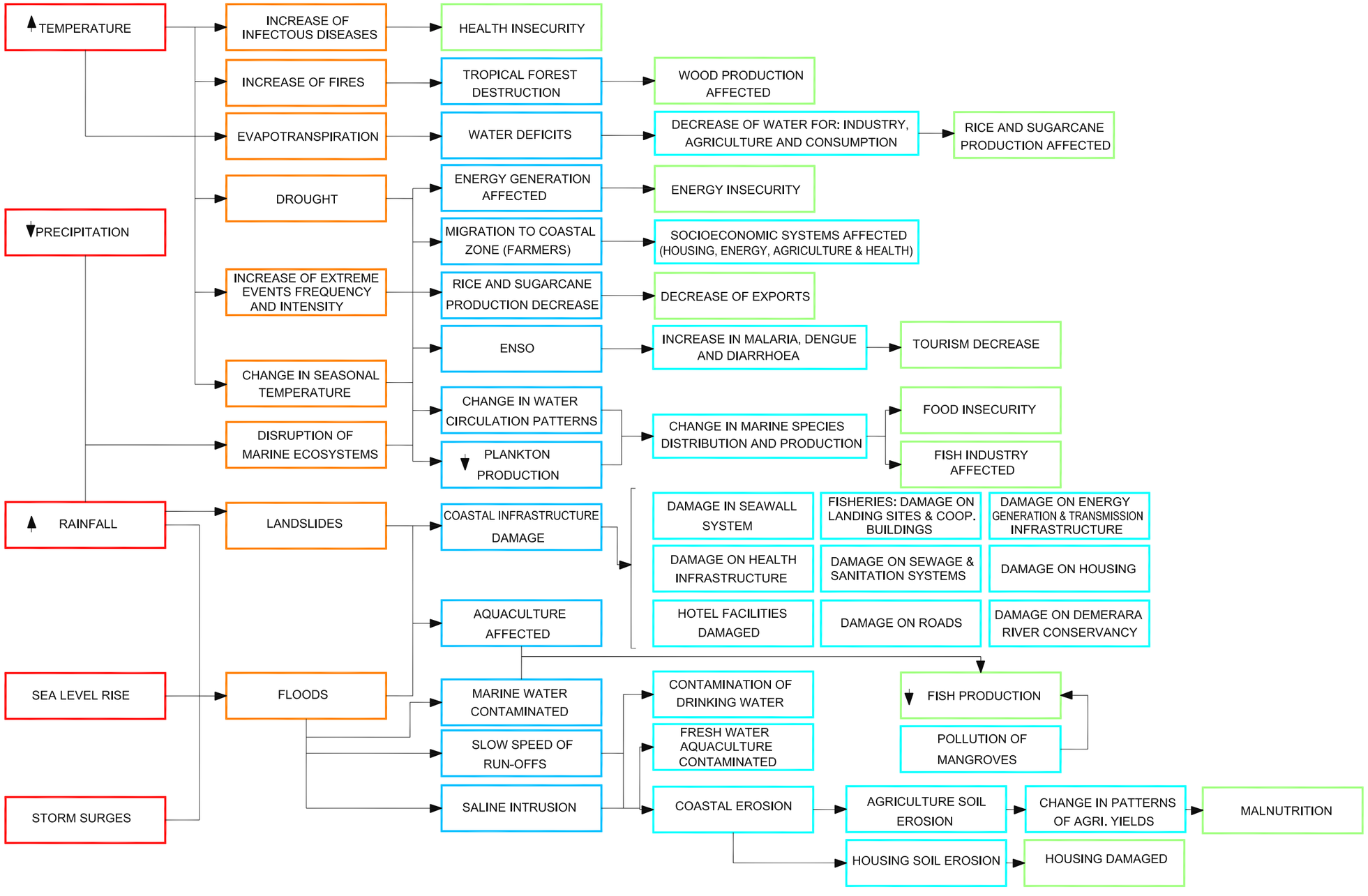
19.4.5 Potential Impacts and Mitigation Measures

19.4.5.1 General Potential Impacts

Changes in temperature, precipitation, and sea level rise as predicted to the end of this century can potentially impact agriculture, human settlements, fisheries, forestry, water resources, energy, tourism and transportation. Figure 19-8 taken from UNCCC SNC, 2019 shows some of the main as well as derived climate change threats, the primary and derived threats and the main socioeconomic activities and livelihoods affected. Some of these impacts are discussed below.

Agriculture

Guyana is a major producer of rice, sugar, livestock, fisheries, fruit and vegetables, with sugar and rice being major export crops. Agriculture is also a major source of



SOURCE: HOPE ENERGY DEVELOPMENT

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ECO REPORT NO. 10/2020

DATE: 03/12/21

CLIENT: HOPE ENERGY DEVELOPMENT INC.

PROJECT: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE CONSTRUCTION AND OPERATION OF A WIND FARM AT HOPE BEACH AND CHAPMAN'S GROVE, EAST COAST DEMERARA, GUYANA

DWG. NAME: THE CROSS-CUTTING NATURE OF CLIMATE CHANGE IN GUYANA

FIGURE NUMBER: 19-8

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employment. Much of the agriculture is practiced in Regions 2, 3, 4, 5 & 6 on the low-lying coastal plains. As such climatic impacts of extreme rainfall, flooding and drought will likely continue to affect agriculture on the coastal plain and hinterland which can also experience increased salinity. Crop yields can also be affected by changes in temperature, rainfall and solar radiation. It is projected that inundation caused by minimum storm surges of 2m to 5m may affect between 25,000 ha and over 29,000 ha of rice lands; and between 11,000 ha and 22,361 ha of residential areas for the period 2031 to 2070.

The project is not expected to result in climate change effects to agriculture in the project area.

Human Settlements

The majority of Guyana's population resides in the flat coastal zone and about 45% of the coastline is currently subject to erosion. Settlements and shoreline development in this zone can be further affected by coastal hazards such as storm surges, flooding, and erosion. It is projected that inundation caused by minimum storm surges of 2m to 5m may affect between 11,000 ha and 22,361 ha of residential areas for the period 2031 to 2070. Inundation is a threat to human lives, people's livelihoods, housing and other building infrastructure, transportation infrastructure and communications, etc.
The projected reduction in annual and seasonal rainfall, possibly leading to seasonal droughts in inland regions, could force migration to the coastal zone, which may put further pressure on existing housing, food, water, and health systems. Such migration may of course increase the population at risk to inundation which threatens the coastal zone.

Fisheries

Fish a major source of animal protein and the sector comprising marine, freshwater and aquaculture, is of high socio-economic importance. Flooding and sea level rise can affect aquaculture, landing sites, fishers and mangrove. Increased sedimentation from erosion can affect fish grounds. The projected increase in temperature and change in rainfall can disrupting ecosystem dynamics-species distribution, species abundances, and the productivity of the marine ecosystems.

Forestry

Forests act as an important carbon sink and are therefore important to climate change mitigation. About 84% (18.48 million hectares) of Guyana's total land area are covered in tropical forests. The Guyana REDD+ Monitoring Reporting and Verification System

(MRVS) Accuracy Assessment Report for the year 2017 recorded deforestation rate at 0.051%.

Forest growth can be affected by drier conditions as well as changes in ecosystems. Potential threats include fires, invasive species and pathogens which can modify structure and composition of the forest; changes in flowering times so affecting survival and growth; and biodiversity.

Mangrove forests offer protection to the country's coastal and inland areas against the effects of sea-level rise by serving as storm buffers, reducing wind and wave action in shoreline areas and breaking the force of waves thereby reducing erosion. Mangrove forests cover 290 km of Guyana's 430 km long coastline.

Mangrove forests are threatened by inundation and damage from SLR, storm surges and flooding as well as temperature changes which can affect the aerial extent and health of the trees. Mangrove loss would also reduce coastal water quality, reduce biodiversity, eliminate fish nursery habitats, and eliminate a major resource for human communities that traditionally rely on mangroves for various products and services.

Guyana continues its conservation efforts, sustainable management, and low mangrove deforestation through mechanisms such as the EU-funded Guyana Mangrove Restoration Project which was launched to implement the National Mangrove Management Action Plan of the National Agricultural Research Extension Institute; eliminate non-climate stresses to increase health, reduce vulnerability and increase resilience; manage catchment activities to control sedimentation; and mangrove rehabilitation and monitoring.

Water Resources

Guyana has the third highest renewable freshwater resource per capita in the world (315,695 m^3 as of 2014). Agriculture/irrigation, fisheries, forestry, mining, manufacturing and human settlements depend on uncontaminated water resources. Potable water is obtained from a system of 178 groundwater wells and eight surface water sources.

The availability and quality of water resources is threatened by extreme precipitation, flooding and drought. A decrease in rainfall levels along with increasing evaporation could lower water levels in rivers while persistent rain events can cause severe flooding and soil erosion which will increase sedimentation in the rivers. Salt-water intrusions due to sea-level rise and storm surges will contaminate ground water and lead to deterioration of agricultural soil.

Drainage systems may be obstructed with sea level rise as discharges to the ocean may be hampered by the reduced hydraulic head difference between water control

structures and sea outlets. Storms are likely to become more intense placing increased demands on drainage system. The EDWC dam is vulnerable to collapse with the possibility of flooding of Regions 4 & 5 with enormous economic loss in agriculture and settlements. The proposed wind farm location on the coastline in Region 4 can also potentially be impacted should this dam collapse.

Energy Impacts

Power generation is the country's largest contributor (36%) of carbon emissions as 70% of Guyana's energy consumption is derived from fossil fuels, with 25.67% from bagasse, 4.35% from rice husk, 1% from solar photovoltaic and 0.40% from fuel wood. Guyana plans to transition to nearly 100% renewable and clean energy by 2040. This would translate to the important benefit of reducing carbon emissions in the power sector.

Hydropower is a major renewable energy source that is already used to generate power. However, heavy rainfall and landslides have already caused damage to Moco Moco hydropower plant and this can be expected to remain a significant threat with the prediction for future extreme rainfall events. The future availability of water is another area of concern for hydropower generation (see Section above on Water Resources).

The proposed wind farm project is in keeping with the Government's plan to switch to energy generation with renewable sources and to diversify the production of energy. However, installations associated with the wind farm such as turbines, sub-station, etc may be subject to damage from sea level rise and other climatic impacts.

19.4.5.2 General Mitigation Measures

The Guyana National Climate Change Adaptation Policy and Implementation Plan (2020-2030 has concluded projected sea level rise (SLR) will have significant negative effects on the coastal areas of the country. As such the National Climate Change Adaptation Plan (NCCAP) has recommended measures to alleviate the potential effects on human life on the Coastal Plain of Guyana. These include:

- Integrated coastal zone management.
- Environmental impact assessments.
- Disaster contingency planning and management.
- Economic instruments.
- Building codes and standards.
- Environmental management regimes.

The proposed wind farm project at Hope Beach falls within the coastal plain and therefore can be significantly impacted by climate change, specifically projected SLR and storm surges. The wind farm will be designed, constructed and operated taking into consideration these projections and the requirements for adhering to appropriate building codes and standards and disaster preparedness planning and management. The Guyana EPA has also requested an Environmental Impact Assessment for the proposed development, in keeping with the recommendation of the NCCAP.

19.4.5.3 Project Specific Impacts and Mitigation Measures

The project specific impacts are as follows:

Reduction of GPL's CO_2 footprint

The project is expected to have a general beneficial impact to climate change since it will reduce 10% of GPL's CO_2 footprint from power generation, offsetting more than 50,000 metric tonnes of CO_2 per year, and reducing harmful pollutants associated with burning of HFO fuels at GPL's plants in and near Georgetown.

Wind energy has one of the lowest greenhouse gas and emissions impact of any power generation technology, with life cycle assessment of greenhouse gas impact less than nuclear power, less than solar photovoltaic energy, and almost as low as hydropower plants (see Figure 19-9) {NREL, G. Heath, 2016}.

Energy production from distillate fuels produces over 100 times more CO_2 emissions per unit electricity produced than a wind farm operating the V150 Vestas turbines. The wind farm CO_2 footprint is calculated from all the CO_2 emitted during the entire life of plant, including mining and production of all materials used to manufacture the wind turbines, shipping, transport, installation, maintenance and decommissioning (Razdan and Garret, 2017). The CO_2 footprint of the heavy fuel oil generation which it replaces is only accounting for the CO_2 content emitted from burning the fuel, and does not include all the emissions generated in producing, distilling and transporting the oil, manufacturing the HFO generators and constructing the power plant (see Table 19-9).

TABLE 19-9: CO_2 PAYBACK FOR HOPE WIND FARM

Distillate Fuel CO_2 content [1]	73 Kg CO_2 per MMBTU
GPL CO_2 emissions per KWh	0.66 Kg CO_2 per KWh
Vestas V150 life of plant CO_2 impact per KWh[2]	0.0061 Kg CO_2 per KWh
Hope Wind Farm avoided CO_2 emissions	53,500 Tonnes CO_2 per year 1 million Tonnes over 20 years
Hope Wind Farm CO_2 payback vs GPL generation	3.7 Months
Hope Wind Farm energy payback3	5.5 Months
Offset fuel imports	19,900 Kilo Litres per year >200m USD over 20 years

1) US Energy Information Administration (https://www.eia.gov/tools/faqs)
2) Razdan and Garret, 2017
3) The time required generate as much electrical energy as the total "cradle to grave" energy that is required to manufacture, construct, operate and decommission the wind farm

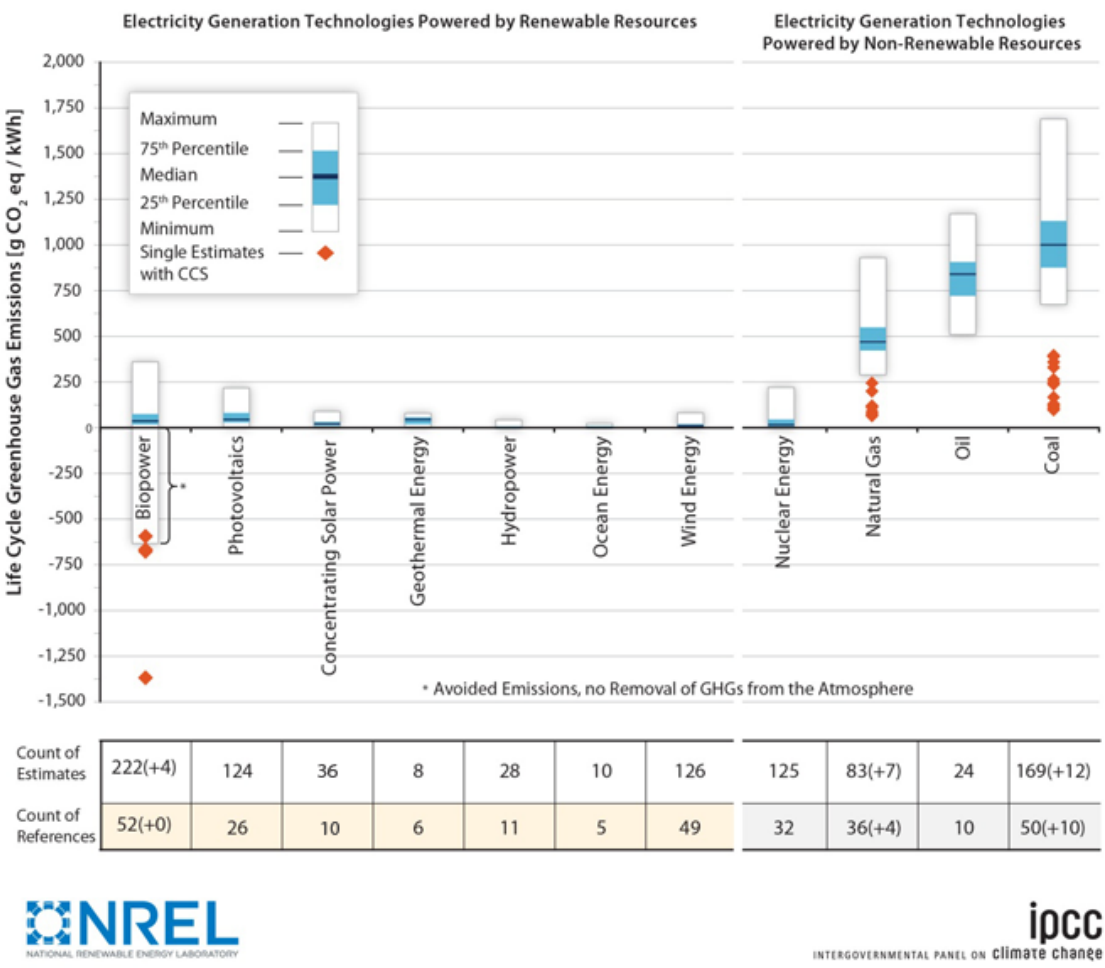

FIGURE 19-9: LIFE CYCLE ASSESSMENT OF GREENHOUSE GAS IMPACT FOR ENERGY GENERATION TYPES

Loss of Vegetation

As noted in Section 13.5.1.1, construction of the proposed wind farm will require the removal of:

1.1 ha of undisturbed vegetation (permanent)
1.0 ha of undisturbed vegetation (temporary)
1.9 ha of modified vegetation (permanent), and
0.5 ha of modified vegetation (temporary)

As shown in Figures 13-1 and 13-2, mangrove is found in proximity to both project sites. The 1.1 ha of undisturbed habitat that will be permanently removed includes original beach ridge vegetation in Hope Beach which consists of species such as *Jatropha*

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gossypiifolia (Bellyache Bush*), Fimbristalys spathacea*, *Thespesia populnea* (Wild Physic Nut) and *Ipomea biloba* along with the fruit plants *Syzygium cumunii* (Jamoon) and *Cocos nucifera* (coconut) to the west of the Hope Canal. The beach ridge east of the canal is dominated by grasses such as *Cynodon dactylon* and *Dactylis glomerata*. Coconut trees will also be cleared for the Chapman's Grove wind turbines. However, it is expected that very few mangrove trees will be removed since the design of the access roads, wind turbines, sub-station, etc. placed emphasis on avoiding encroachment into the mangrove. Since mangroves are known to sequester more carbon than other terrestrial species, the protection of this carbon sink ensures that this carbon is not released.

Sea Level Rise

While the project is not expected to contribute to sea level rise, there is the potential that sea level rise may impact the wind turbines. The coastline is already in the midst of a significant erosion cycle (see Section 9.4.2) which is impacting the mangrove forest at the Hope Beach site. The loss of mangrove trees leaves the project site susceptible to sea level rises and increased storm surges which may arise due to climate change. At present, the Government of Guyana is undertaking the construction of a new seawall at Hope Beach and also at Unity which will replace the existing seawall. This new seawall at Hope Beach will be on the coastal side of the wind turbine locations, to protect the Hope Canal flood control infrastructure, the canal outlet which serves as a fishing harbour, and the new flood control pump facility at Lowlands/Hope, and will therefore also serve to protect the wind turbine structures.

Flooding is already a risk in the coastal areas including the project sites at Hope Beach. Three likely possible causes of flooding include:

- Breach of seawall
- Breach of conservancy or Hope Canal embankment
- Heavy rains and failure of pumping stations, or clogged local drainage.

Climate change is expected to exacerbate this risk. The main project specific mitigation for flooding is that all equipment that is sensitive to water damage will be raised above any potential flood levels that could be experienced over next 30 years (~1.5m + safety margin). This includes:

- Substation and control room,
- Any equipment in the base of wind turbines.

Buried electrical lines will be designed for flooded conditions and overhead electrical lines are already above any flooding levels.

During any flood event the wind farm will still be operational, but access to the wind farm along public roads etc may be hampered. As noted in Section 18.2.17, a Flooding Emergency Plan will be developed to manage issues related to flooding of some or all of the project site and surrounding region, or public and access roads to the site for both the construction and operation phases.

20 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

This Chapter presents a summary of the mitigation and monitoring for identified adverse impacts to the natural and socio-economic environments. In this summary the actions are separated by phase as follows:

20.1 Natural Environment

20.1.1 Construction Phase

20-1	POTENTIAL IMPACT	IMPAIRED WATER QUALITY (SILTATION / SEDIMENTATION)
MITIGATION MEASURES		Mitigation measures discussed for on-site erosion (see Section 9.5.1.1) are applicable for reducing the impact associated with siltation. The following mitigation measures can also help reduce the impact of sediment migration and the entrainment of silt in water bodies (surface and marine): • Keep material stored on site to a practical minimum. Where aggregate is to be stored on site, confine using wooden cribs or cover with geotextile coverings. These should be stored at least 30m away from major watercourses and drains. • Construct bale dikes, silt fences, diversion berms or swales along the edge of the river bank to prevent loose dirt and debris from entering the watercourse. • Consider using floating or land-based silt barriers to reduce the migration of silt into the river or nearshore marine environment.
ACTION BY		▸ EPC Contractor to schedule phased construction works ▸ The Civil Engineer to develop Erosion and Sediment Management Plan and to design runoff control measures. ▸ HSE Manager to ensure effective implement of mitigation measures
TIMING		▸ Throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Silt Barriers; ▸ Wooden cribs; or ▸ Geotextile material
MONITORING / VERIFICATION		
HOW / BY		▸ EPC Contractor to confirm that design criteria are

20-1	POTENTIAL IMPACT	IMPAIRED WATER QUALITY (SILTATION / SEDIMENTATION)
WHOM/WHAT / WHERE/, FREQUENCY		conducive to soil properties. In addition, the HSE Manager and Field Managers will verify (via daily inspections) that erosion control measures are constructed according to design specifications and that they are adequately located. ▸ The Field Managers to: - oversee the extent and/or phasing of site clearing, - inspect erosion control measures for functionality and effectiveness (weekly). ▸ The HSE Manager to: - monitor exposed areas for signs of erosion on a weekly basis and/or following rainfall events. - inspect drains and channels for visible turbidity and solid deposits ▸ The HSE Manager to ensure weekly inspections of the site (or within 24 hours of significant rainfall events) to ensure that mitigation measures are being implemented. The HSE Manager to ensure inspection of the embankments and stockpiles of excavated material once per week to ensure that material is secured with crib and/or covered with geotextile material. ▸ The HSE Manager to ensure monitoring of Total Suspended Solids (TSS) in the neighbouring watercourses, drains and the nearshore area monthly during the construction phase. ▸ The HSE Manager to ensure the conduct of weekly inspections the site to ensure that mitigation measures are implemented and effective.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Inspection Checklists ▸ Sealed, sterilized sample bottles ▸ Cooler for storing samples
COMPETENCE AND TRAINING		▸ Accredited Laboratory to conduct testing
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-2	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (HYDROCARBON SPILLS AND LEAKS)
MITIGATION MEASURES		▸ Prohibit fuelling or servicing of vehicles on-site (to the extent practical) or designate a specific area for fuelling and servicing of vehicles. ▸ If necessary, fuel should be stored in bunded areas to ensure that any spills or leaks are contained and not allowed to runoff into the receiving environment. Designated storage areas should be located at least 50 m away from drainage pathways. ▸ Keep spill kits with absorbent pads on site to respond to spills, rather than "washing-down" the area. ▸ Use appropriate pumps, hoses and nozzles for refuelling and place disconnected hoses in containers after refuelling to prevent spills of residual fuel. ▸ Vehicles and construction machinery should be routinely serviced to ensure that there is no leakage from equipment. ▸ Transport collected spent lubricants off-site to a facility capable of treating and/or disposing of waste of this kind. ▸ In the event of a spill, collect contaminated soil and remove from the site to a suitable remediation facility.
ACTION BY		▸ EPC Contractor to designate area for re-fuelling. ▸ HSE Manager to implement all other mitigation measures.
TIMING		▸ Area for re-fuelling should be designated prior to the start of construction works. ▸ Other measures to be implemented throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Appropriately sized and sealed containers for the storage of spent lubricants ▸ Spill kits
MONITORING / VERIFICATION		
HOW / BY WHOM/,WHAT / WHERE/, FREQUENCY		▸ The HSE Manager to ensure conduct of weekly inspections to ensure that all mitigation measures are being implemented and that they are effective. ▸ The HSE Manager to ensure monitoring of TPH in the neighbouring watercourses, drains and in the nearshore area monthly during the construction phase. ▸ Contractor's HSE Officer to conduct daily visual inspections on vehicles and equipment for evidence of

20-2	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (HYDROCARBON SPILLS AND LEAKS)
		spills and leaks in the terrestrial and aquatic environment.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Inspection Checklists ▸ Sealed, sterilized sample bottles ▸ Cooler for storing samples
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-3	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (SPILLAGE OF PAINTS AND SOLVENTS)
MITIGATION MEASURES		▸ Bring to the site only the amount of paint required for the job. ▸ Keep all paint products and wastes away from drainage courses and highly trafficked sections of the site. Never clean brushes or rinse paint containers into drainage that leads to surface water. ▸ Use drip pans and tarp to collect any spilt paint and / or solvents. ▸ Sawdust or other such absorbent material should be added to unused paint (oil based and water based) and left to dry prior to disposal. ▸ To the extent practical, white-lining and other painting are to be conducted during dry weather conditions.
ACTION BY		▸ EPC Contractor to monitor paint volumes ▸ Field Managers to implement other mitigation measures.
TIMING		▸ Measures to be implemented throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Appropriately sized and sealed containers for the storage of waste paint and paint related waste. ▸ Sawdust or other such absorbent material.
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ The Contractor's HSE Officer to maintain a log of the disposal of waste from the site as they occur. ▸ The HSE Manager to ensure that the proper implementation of mitigation measures, monitor activities of workers and check signs of spilt or improperly disposed paint on the site and its drains (via daily inspections). ▸ The HSE Manager to inspect log book weekly.

20-3	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (SPILLAGE OF PAINTS AND SOLVENTS)
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Checklists ▸ Log book
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-4	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (CONCRETE WASHINGS)
MITIGATION MEASURES		▸ Prohibit the discharge from concrete washings into any watercourses or in surface drains. ▸ Establish a well-identified earthen pit on the site into which concrete washings will be allowed to enter. This pit should be lined with plastic to avoid groundwater contamination. After evaporation of the water, the hardened material should be regularly removed and sent for disposal at an approved landfill. ▸ All tools and equipment that came into contact with concrete or cement must also be washed such that the wash water flows into the pit, or they must be washed in a designated area where the wash water can similarly be allowed to evaporate, and the hardened material sent for disposal at an approved landfill.
ACTION BY		▸ EPC Contractor to designate an area for concrete washings to enter. ▸ Field Managers to implement other mitigation measures.
TIMING		▸ Designate and establish concrete washings pit prior to the start of construction works. ▸ Implement all other mitigation measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ The Civil Engineer to verify that the concrete wash pit is adequately located, sized and of impermeable layer. ▸ The HSE Manager to ensure the proper implementation of mitigation measures, monitor the activities of workers and check for signs of improper disposal of concrete washings (daily during concrete works).

20-4	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (CONCRETE WASHINGS)
SPECIALIZED EQUIPMENT OR MATERIAL		Checklist
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-5	POTENTIAL IMPACT	ONSITE EROSION AND SEDIMENT MIGRATION
MITIGATION MEASURES		• Identify soil properties, engineering constraints and design criteria and develop an Erosion and Sediment Management Plan to identify areas of disturbance, areas of cut and fill, slope during and after grading, existing vegetation, and measures to protect stored aggregate, slope, drainage pathways, and existing vegetation in the project area. These measures will also aid in minimizing soil loss and reducing sedimentation to protect water quality. • Undertake a phased approach to clearing and grading. • Schedule earthworks for the dry season (to the extent practical). • If scheduling earthworks for the dry season is not possible and work must be carried out during extensive wet weather conditions, consideration must be given to using gravel working pads, cross ditching, soil stabilization or synthetic geotextiles to maintain stable subgrade conditions. Monitor exposed areas for signs of erosion. • Natural vegetative cover and canopy cover should be maintained as far as practical. Areas not required for construction works should not be cleared. • Re-vegetate or otherwise cover cleared areas as early as practical. • Design runoff control features to minimize soil erosion. • Use special construction techniques in areas of steep slopes and erodible soils. • Maintain natural vegetative cover as far as practical, especially in the vicinity of watercourses, existing drains and steep slopes. Ensure that adequate measures, such as clearing on a phased basis, be undertaken so

20-5	POTENTIAL IMPACT	ONSITE EROSION AND SEDIMENT MIGRATION
		as to minimize soil disturbance. • Ensure that clearing takes place immediately prior to excavation and earthworks to minimize the length of time that soils are exposed. • Cover bare, cut slopes with geotextiles, tarpaulins or plastic. • Keep all approach roads clear of mud, debris, gravel, sediments or other materials generated from construction activities. These include the installation of a stone-stabilized pad or temporary gravel entrance/exit and a wash bay. The wash bay area shall have a gravel base, which shall be installed in such a manner so as to allow the removal of sediments by directing the water from the area to a temporary holding basin or to any temporary on-site-drain. • Incorporate and construct embankments along main drains/watercourses to contain fill as well as to prevent run-off from earthworks.
ACTION BY		▸ EPC Contractor to schedule phased construction works ▸ The Civil Engineer to develop Erosion and Sediment Management Plan and Project Engineer to design runoff control measures. ▸ Field Managers to implement other measures.
TIMING		▸ Revision of the Erosion and Sediment Management Plan and scheduling of works to be conducted prior to the start of construction. ▸ All other works to be implemented throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Geotextiles ▸ Tarpaulins or plastic ▸ Silt Fences
MONITORING / VERIFICATION		
HOW / BY WHOM/, WHAT / WHERE/, FREQUENCY		▸ EPC Contractor to confirm that design criteria are conducive to soil properties. In addition, the Field Managers will verify (via daily inspections) that erosion control measures are constructed according to design specifications and that they are adequately located. ▸ The Field Managers to: - oversee the extent and/or phasing of site clearing, - inspect erosion control measures for functionality and effectiveness (weekly).

20-5	POTENTIAL IMPACT	ONSITE EROSION AND SEDIMENT MIGRATION
		▸ The HSE Manager to ensure: - monitor exposed areas for signs of erosion on a weekly basis and/or following rainfall events. - inspect drains and channels for visible turbidity and solid deposits ▸ The HSE Manager to ensure the conduct of weekly inspections of the site (or within 24 hours of significant rainfall events) to ensure that mitigation measures are being implemented.
SPECIALIZED EQUIPMENT OR MATERIAL		Inspection Checklist
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-6	POTENTIAL IMPACT	SLOPE INSTABILITY
MITIGATION MEASURES		▸ Ensure that slopes are cut to a minimum slope angle based on the recommendations of the geotechnical investigation to minimize the potential for future slippage. ▸ Ensure that excavated areas are adequately shored including temporary shoring where necessary. ▸ Construct surface drains at the top of major cuts or along cleared slopes to facilitate run off and prevent the formation of ruts along the slope. Ensure that these are maintained until permanent growth of vegetation has been firmly established. ▸ Construct bale dikes, silt fences, diversion berms or swales along the top of the river bank to prevent loose dirt and debris from entering the watercourse. ▸ Where heavy equipment are to be used on site, ensure that the toe of the slope is secured. Do not store material or operate heavy equipment close to the edge of excavations. ▸ Vegetate cleared areas as soon as practical after construction to stabilize slopes using Vetiver, for example.
ACTION BY		Civil Engineer and HSE Manager to implement all mitigation measures.

20-6	POTENTIAL IMPACT	SLOPE INSTABILITY
TIMING		▸ Slope angle to be determined prior to the start of construction works. ▸ Surface drains at the top of cuts/along cleared slopes to be constructed as soon as slopes are cut. ▸ All other mitigation measures to be implemented throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		Geotextiles, tarpaulins and/or plastic.
MONITORING / VERIFICATION		
HOW / BY WHOM/, WHAT / WHERE/, FREQUENCY		▸ The Civil Engineer to verify that the slopes are cut at the correct angle of repose, to visually inspect slopes for signs of failure and to inspect temporary shoring structures (weekly) for functionality and effectiveness. ▸ The Civil Engineer to oversee the construction of cut drains ▸ The HSE Manager to ensure the conduct of weekly inspections of the site to ensure that mitigation measures are being implemented. ▸ The Civil Engineer and HSE Officer to inspect all cut sections after significant rainfall events
SPECIALIZED EQUIPMENT OR MATERIAL		Inspection Checklist
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-7	POTENTIAL IMPACT	IMPAIRED AIR QUALITY (DUST)
MITIGATION MEASURES		▸ Clear only the area needed for construction, leaving vegetation in other areas intact as far as practical, thereby reducing the area from which dust can be formed. ▸ Pave or vegetate cleared areas as early as practical. ▸ Keep stockpiles to a minimum and use as soon as practical, thereby reducing a source of dust. ▸ Enforce traffic speed regulations within the construction zone as speeding along roads can contribute to dust emissions. ▸ Cover smaller stockpiles or store fine aggregates in

20-7	POTENTIAL IMPACT	IMPAIRED AIR QUALITY (DUST)
		bins or silos. This prevents exposure of material to the wind. ▸ Wash truck tyres before exiting the construction site onto existing paved roads, eliminating the chance for trapped earth to become suspended in the air as dust. ▸ During earthworks implement dust control measures at source, including frequently wetting bare surfaces and access ways, thereby limiting opportunities for the formation of atmospheric dust. ▸ Cover all transport vehicles (with tarpaulins etc.) moving materials and fill to and from the site to prevent material flying up from the load into the air as dust. ▸ Erect a dust barrier (preferably natural vegetation) to shield residential communities at Hope Beach.
ACTION BY		▸ EPC Contractor to ensure civil contractors implement all of above measures
TIMING		▸ Throughout the construction phase
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Geotextile Material ▸ Tarpaulin
MONITORING / VERIFICATION		
HOW / BY WHOM/, WHAT / WHERE/, FREQUENCY		▸ The Civil QA/QC Engineer to ensure that the area to be cleared is not exceeded. ▸ HSE Manager to ensure conduct of daily inspections to ensure that all dust control measures are implemented and maintained in a complaints register. ▸ The HSE Manager to ensure monitoring of particulate air quality for TSP and PM_{10} fortnightly during the dry seasons and monthly during the wet seasons. ▸ HSE Manager to ensure weekly inspection of the site, that mitigation measures are effective and to review the complaints register.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register ▸ An air sampler with the ability to measure ambient dust concentrations and a laboratory with experience in providing the support required for the sampler.
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-8	POTENTIAL IMPACT	IMPAIRED AIR QUALITY (EXHAUST EMISSIONS FROM VEHICLES)
MITIGATION MEASURES		Properly service all vehicles and equipment to ensure that there are no visible sooty emissions. Defective vehicles should be taken out to service and should not be permitted to operate until they are repaired.
ACTION BY		▸ EPC Contractor to send vehicles and equipment for maintenance. ▸ Project Engineer and HSE Manager to implement all other measures.
TIMING		Throughout the construction phase
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/,WHAT / WHERE/, FREQUENCY		▸ Contractor's HSE Officer (in collaboration with the Project Engineer) to maintain a log book of records of vehicle and equipment maintenance. ▸ HSE Manager to maintain complaints register relating to exhaust emissions from the passage of vehicles and equipment. ▸ The HSE Manager to ensure daily inspections on the site and to note any instances of vehicles and equipment emitting abnormal quantities and quality of exhaust. The HSE Manager will also ensure the review of maintenance records for vehicles and equipment.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Log Book ▸ Inspection Checklist ▸ Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-9	POTENTIAL IMPACT	NOISE AND VIBRATION
MITIGATION MEASURES		▸ Regularly inspect and maintain construction vehicles and equipment (including mufflers on this equipment) to ensure noise emission control systems are properly functioning; ▸ Schedule noise-intense construction activities (such as pile driving) between the hours 7:00 am and 7:00

20-9	POTENTIAL IMPACT	NOISE AND VIBRATION
		pm on weekdays in order to avoid disturbance during sensitive evening and night-time periods, to the extent practical; ▸ Schedule the movements by truck between the hours of 7:00 am and 7:00 pm (in order to limit disturbance to evening and night-time activities) on weekdays, to the extent practical; ▸ Schedule pile driving at Hope Beach when school is not in session (i.e. during the vacation period), to the extent practical. ▸ Avoid night-time work to the extent that is practical. However, if night work involving noise intense activities is necessary, consultation with the EPA should be conducted first. ▸ Inform the public of noisy construction activities in the area; and ▸ Conduct condition survey of structures in close proximity to road works before construction begins.
ACTION BY		▸ Contractor's Project Director to send vehicles and equipment for maintenance. ▸ EPC Contractor to coordinate schedules. ▸ HSE Manager and Community Liaison Officers to coordinate communications with the communities.
TIMING		▸ Notify adjacent receptors of noisy works prior to the start of noise intensive activities. ▸ Implement all other mitigation measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ Project General Manager (in collaboration with EPC Contractor) to investigate claims of damage caused by vibration. ▸ HSE Manager (in collaboration with the Project Director) to maintain a log of vehicle and equipment

20-9	POTENTIAL IMPACT	NOISE AND VIBRATION
		maintenance records. ▸ HSE Manager to maintain complaints register relating to noise and vibrations during the construction phase. ▸ The HSE Manager to ensure the conduct of daily inspections and note any instances of vehicles and equipment creating excessive noise. The HSE Officer will also review the maintenance records of vehicles and equipment, as well as the complaints register. ▸ If a noise variation is required, the HSE Manager to verify that works are being conducted in accordance with the variance. ▸ HSE Manager to ensure the conduct of noise monitoring monthly during the construction phase at the fence line of the closest human receptor or otherwise and during specific noisy activities such as pile driving.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register ▸ Vehicle Log ▸ A Sound Pressure Level Meter to measure sound pressure levels
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-11	POTENTIAL IMPACT	CLEARING OF VEGETATION (LOSS OF TERRESTRIAL HABITAT)
MITIGATION MEASURES		• The routes of the proposed site roads will avoid mangrove to the extent practicable to limit the need to clear mangrove trees; • Avoid clearing vegetation in areas not required for construction works; • Burning of cleared vegetation to be prohibited; • Use of herbicides to aid in removal of vegetation to be prohibited; • All necessary permits relating to the felling of trees to be obtained; and • Re-vegetate as far as practicable and as soon as possible.

20-11	POTENTIAL IMPACT	CLEARING OF VEGETATION (LOSS OF TERRESTRIAL HABITAT)
ACTION BY		• Project General Manager to ensure final designs for access roads and other site infrastructure avoid the need to clear mangroves. • HSE Manager to implement all other mitigation measures.
TIMING		• Approve final designs for access roads and other site infrastructure prior to clearing activities. • Implement all other measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT/ WHERE/, FREQUENCY		• The EPC Contractor to ensure only areas required for construction are cleared. • Community Liaison Officers to record any complaints of removal of vegetation (outside of designated areas) and or burning.
SPECIALIZED EQUIPMENT OR MATERIAL		• Complaints Register • Permits
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-12	POTENTIAL IMPACT	FRAGMENTATION
MITIGATION MEASURES		• Design access roads to avoid the clearing of mangrove trees to the extent practicable;
ACTION BY		• Project General Manager to ensure final designs for access roads and other site infrastructure avoid the need to clear mangroves.
TIMING		• Approve final designs for access roads and other site infrastructure prior to clearing activities.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT/		• The EPC Contractor to ensure only areas required for construction are cleared.

20-12	POTENTIAL IMPACT	FRAGMENTATION
WHERE/, FREQUENCY		• Community Liaison Officers to record any complaints of removal of vegetation (outside of designated areas).
SPECIALIZED EQUIPMENT OR MATERIAL		• Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-13	POTENTIAL IMPACT	DISTURBANCE TO TERRESTRIAL SPECIES
MITIGATION MEASURES		The potential impacts on terrestrial fauna from the proposed wind farm relate to impaired noise quality. Therefore, the mitigation measures listed in Table 12-16 are also applicable here. In addition, the following additional measures can be implemented: • Limit construction works to daylight hours to the extent practical; • If night work is to occur, shield light from the vegetation and avoid use of bare and upturned bulbs; • The minimum light intensity that can be safety used should be employed for night work and for security purposes; and • Prohibit hunting or harassing of animals by workers on the construction site.
ACTION BY		• See Table 12-16 • Project Director to implement all other mitigation measures.
TIMING		• See Table 12-16 • Implement all other measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		• The EPC Contractor to schedule the construction works and verify that lights, if they are to be used, as adequately located and oriented. • HSE Manager to document any complaints of hunting

20-13	POTENTIAL IMPACT	DISTURBANCE TO TERRESTRIAL SPECIES
		within the area.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-14	POTENTIAL IMPACT	DISTURBANCE TO AQUATIC SPECIES & BENTHIC COMMUNITIES
MITIGATION MEASURES		The potential impacts on aquatic and benthic fauna from the proposed works relate to impaired water quality. Therefore, the mitigation measures listed in Tables 8-3 to 8-6 are also applicable here.
ACTION BY		See Tables 8-4, 8-5 and 8-6
TIMING		
SPECIALIZED EQUIPMENT OR MATERIAL		
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		See Tables 8-4, 8-5 and 8-6
SPECIALIZED EQUIPMENT OR MATERIAL		
RECORD KEEPING		
REPORTING		

20-15	POTENTIAL IMPACT	CONCERNS TO MIGRATORY AND RARE AND ENDANGERED SPECIES
MITIGATION MEASURES		Concerns about impacts to migratory species are related to noisy activity during construction. Therefore, the mitigation measures listed in Table 12-16 are also applicable here.
ACTION BY		See Table 12-16
TIMING		See Table 12-16

20-15	POTENTIAL IMPACT	CONCERNS TO MIGRATORY AND RARE AND ENDANGERED SPECIES
SPECIALIZED EQUIPMENT OR MATERIAL		See Table 12-16
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		See Table 12-16
SPECIALIZED EQUIPMENT OR MATERIAL		See Table 12-16
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-16	POTENTIAL IMPACT	DAMAGE TO ROADS, BRIDGES AND CULVERTS
MITIGATION MEASURES		▸ Obtain Transport Permits prior to transportation of heavy loads along public roads. ▸ Reconfirm initial load modelling of all crossings using the final transport vehicle and load configurations ▸ Undertake a final detailed route inspection before transport commences in order to confirm results of previous surveys and to account for any changes along the route. This includes visual inspection of all bridge and culvert crossings. ▸ In consultation with the Ministry of Public Infrastructure, upgrade bridges and culverts and widen roadway bends as necessary to the required load bearing capacity and transport lengths. ▸ Public notice will be given by radio, TV, newspaper media, and road signage in order to inform the public of transport restrictions and alternative route deviations, implementation of traffic plan ▸ Transport vehicles will be accompanied by both police and contractor escort vehicles to assist with traffic flow control, and to warn traffic of approaching transport vehicles ▸ Use a suitable length modular jumper bridge is used to cross those culverts that span more than three meters ▸ Ensure that transport vehicles meet the requirements

20-16	POTENTIAL IMPACT	DAMAGE TO ROADS, BRIDGES AND CULVERTS
		of the special transport permit ▸ Routinely inspect the haulage route for signs of damage to roads, bridges and culverts. ▸ Maintain a complaint register relating to damage to roads, bridges and culverts. ▸ Collaborate with the Ministry of Public Infrastructure to immediately repair damage to road infrastructure caused by the transportation of project loads
ACTION BY		Project General Manager to ensure that Transport Permits are obtained. EPC Contractor to implement all other mitigation measures
TIMING		Prior to construction phase During transportation of materials and equipment for the last three mitigation measures.
SPECIALIZED EQUIPMENT OR MATERIAL		Modular jumper bridge sections, oversize and overweight transport equipment
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		QA/QC Engineer to verify the transport permits were obtained. Civil Engineer to verify crossings structural limits QA/QC Engineer and HSE Officer to undertake visual inspections and maintain a complaints register to document any damage to roads or bridges
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-17	POTENTIAL IMPACT	OBSTRUCTION OF TRAFFIC
MITIGATION MEASURES		• Check all bends along the route for turn-radius limitations, paying specific attention to the turning radius and road widths at: two 90-degree bends at Km 20 and 20.5 (Coldingen/Non-Pareil), and the open S-bend at KM 22.5 (Bachellor's Adventure). • Upgrade any bends that may require widening to meet the turning requirements such as the 90deg right-hand bend at km 20, at Coldingen/Non-Pareil.

20-17	POTENTIAL IMPACT	OBSTRUCTION OF TRAFFIC
		• In consultation with the Police, prepare a Traffic Management Plan (TMP) that will include but not be limited to: o Notifying the travelling public in advance of the start of construction and keep them updated with respect to the movement and transportation of heavy equipment, machinery and materials as well as any special arrangements such as detours or diversions or temporarily closure of certain sections of the roadway to facilitate the passage of the load. o Schedule transport of oversize loads material and equipment for off-peak hours. During the transportation exercise HED will: • Monitor traffic flow in the area to ensure that TMP is effective. • Transport vehicles will be accompanied by both police and contractor escort vehicles to assist with traffic flow control, and to warn traffic of approaching transport vehicles • Maintain a register of complaints, accidents or incidents regarding traffic flow along the haulage route. • Avoid the use of convoys of trucks transporting material and equipment to the site. • Use Police outriders when making deliveries of long or wide loads.
ACTION BY		• EPC Contractor to prepare Traffic Management Plan and verify all bends. • HSE Manager to: o Monitor traffic flow; o Maintain register of complaints. • Civil and QA/QC Engineers to implement all other mitigation measures
TIMING		▸ Develop Traffic Management Plan and inspect and upgrade road sections prior to the start of construction. ▸ Implement all other measures throughout the construction phase.

20-17	POTENTIAL IMPACT	OBSTRUCTION OF TRAFFIC
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ Project Engineers to verify upgrades to transportation routes. ▸ HSE Officer to maintain a register of complaints, accidents or incidents regarding traffic flow within the area. HSE Officer to monitor traffic flow in the area (daily) for signs of congestion.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-18	POTENTIAL IMPACT	DAMAGE TO INFRASTRUCTURE AND UTILITIES
MITIGATION MEASURES		▸ Survey the haulage route to identify any buried or overhead utilities (water lines, telecommunication lines, electricity lines) which may be affected by the passage of project-related vehicles / equipment and map these. ▸ Consult with the relevant owners of utility lines along the haulage route to determine setbacks, restrictions and precautions to be adhered to in order to ensure that equipment / vehicles will not damage any existing utilities. ▸ Consult with the relevant utility owners to relocate affected infrastructure as necessary. During the transportation exercise HWD will: ▸ Conduct routine inspections of the haulage route for damage to infrastructure and utilities. ▸ Electrical and telecommunication lines crossing roadways which are marginal obstacles to tall oversize loads will be temporarily raised by accompanying technicians, if required, in order to allow oversize transports to pass

20-18	POTENTIAL IMPACT	DAMAGE TO INFRASTRUCTURE AND UTILITIES
		▸ Maintain a complaint register relating to damage to infrastructure and utilities.
ACTION BY		EPC Contractor to implement the first three mitigation measures. Civil and QA/QC engineers to conduct routine inspections along haulage route. HSE Manager to maintain complaints register.
TIMING		▸ Survey routes, identify utility lines and consult with utility companies prior to the start of construction works. ▸ Adhere to guidelines throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		Project Engineers to verify consultations with utilities. Civil Engineer and Project Manager to review inspection reports. HSE Officer to maintain complaints register.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-19	POTENTIAL IMPACT	ROAD SAFETY
MITIGATION MEASURES		• Develop a Traffic Management Plan for the construction works, in consultation with the Police Service in the affected areas. • Train drivers of project-related vehicles, including haulage vehicles, in Defensive Driving techniques • Provide signage clearly indicating the construction zone and marking the entrance to the project site from the roadway. This signage should be properly positioned and lit so that it can clearly be seen by oncoming traffic. • Public notice will be given by radio, TV, newspaper media, and road signage in order to inform the public of transport

20-19	POTENTIAL IMPACT	ROAD SAFETY
		restrictions and alternative route deviations, implementation of traffic plan During the transportation exercise, HWD will: • Ensure that drivers comply with the Motor Vehicle and Road Traffic Act. • Ensure that project-related vehicles including haulage vehicles are routinely maintained in accordance with manufacturer's specifications. • Monitor traffic flow in the area to ensure that TMP is effective. • Oversize/overweight transport vehicles will be accompanied by both police and contractor escort vehicles to assist with traffic flow control, and to warn traffic of approaching transport vehicles • Maintain a register of complaints, accidents or incidents regarding traffic flow within the area.
ACTION BY		• EPC Contractor to prepare Traffic Management Plan. • HSE officer to: o Train drivers; o Provide signage; o Maintain registers.
TIMING		▸ Develop Traffic Management Plan, train drivers and provide signage prior to the start of construction. ▸ Implement all other measures throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ HSE Officer to maintain a register of complaints, accidents or incidents regarding traffic flow within the area.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints Register
RECORD KEEPING		See Section 7.3.3

20-19	POTENTIAL IMPACT	ROAD SAFETY
REPORTING		See Section 7.3.4

20-20	POTENTIAL IMPACT	IMPROPER SOLID WASTE DISPOSAL
MITIGATION MEASURES		▸ Require that the Contractor develop a comprehensive Waste Management Plan utilizing the re-use, reduce and recycle approach. It is recommended that as far as practicable, scrap metal, glass and paper be recycled. ▸ Prohibit the burning of waste on site (packaging material, construction scraps or felled vegetation), as burning will produce unacceptable air emissions and also poses the danger of bush and forest fires. ▸ Encourage the sorting of recyclable material (such as glass and plastics containers) for later collection and disposal by an approved recycling company. ▸ Encourage the composting of biodegradable material (e.g. felled vegetation) on site. Suitable areas can be set aside for composting. ▸ Secure excavated material well away from roadside drains, adjacent watercourses and nearshore areas, so as to minimize the possibility of siltation or blockage. ▸ Collect all domestic garbage in secure receptacles for disposal at an approved landfill. No garbage will be left open or accessible to animals or allowed to litter the ground or drains. ▸ Require that all spills be cleaned with appropriate absorbent materials and disposed of at an appropriate waste management facility. ▸ Collect spent lubricants and fluids and send to an approved waste facility for disposal.

20-20	POTENTIAL IMPACT	IMPROPER SOLID WASTE DISPOSAL
ACTION BY		▸ Project Engineer and HSE Manager to prepare the Waste Management Plan. ▸ Project Engineer and HSE Manager to implement all other measures.
TIMING		▸ Develop the Waste Management Plan prior to the start of construction works. ▸ Implement all other mitigation measures (including the Waste Management Plan) throughout the construction phase.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ HSE Manager to verify that the Waste Management Plan has been approved by the EPA ▸ HSE Officer (in collaboration with the Project Engineer) to maintain a log book of all disposal certificates. ▸ HSE Officer to maintain complaints register relating to the improper disposal of wastes. ▸ The HSE Officer to undertake daily inspections on the site, note any instances of improper waste disposal and review disposal certificates and complaints register.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register ▸ Log Book
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-21	POTENTIAL IMPACT	IMPACTS TO LANDSCAPE AND AESTHETICS
MITIGATION MEASURES		• Clearing only areas needed for the construction; • Plan construction works so that it is finished within the allotted time; • Limit the amount of time that equipment is left on site.
ACTION BY		Project Engineer to implement all other measures.
TIMING		▸ Clear areas and plan construction works prior to construction. ▸ Monitor equipment schedules during construction.

20-21	POTENTIAL IMPACT	IMPACTS TO LANDSCAPE AND AESTHETICS
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ Project Engineer to verify the project progress against the schedule. ▸ HSE Manager to maintain complaints register.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register ▸ Log Book
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20.1.2 Operation Phase

20-22	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (HYDROCARBON SPILLS AND LEAKS)
MITIGATION MEASURES		▸ See Table 8-4
ACTION BY		
TIMING		▸ Area for re-fuelling should be designated prior to the start of operation. ▸ Other measures to be implemented throughout the operation phase.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Appropriately sized and sealed containers for the storage of spent lubricants ▸ Spill kits
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ The HSE Manager to ensure conduct of weekly inspections to ensure that all mitigation measures are being implemented and that they are effective. ▸ The HSE Manager to ensure monitoring of TPH in the neighbouring watercourses, drains and in the nearshore area monthly during the operation phase. ▸ Contractor's HSE Officer to conduct daily visual inspections on vehicles and equipment for evidence of spills and leaks.
SPECIALIZED		▸ Inspection Checklists

20-22	POTENTIAL IMPACT	IMPAIRED SURFACE WATER (HYDROCARBON SPILLS AND LEAKS)
EQUIPMENT OR MATERIAL		▸ Sealed, sterilized sample bottles ▸ Cooler for storing samples
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-23	POTENTIAL IMPACT	SHADOW FLICKER
MITIGATION MEASURES		Temporary shutdown the turbines whose cumulative shadow flicker results in exceedence of the guideline values.
ACTION BY		▸ Asset Manager Engineer
TIMING		▸ Throughout the operation phase
SPECIALIZED EQUIPMENT OR MATERIAL		None required
MONITORING / VERIFICATION		
HOW / BY WHOM/, WHAT / WHERE/, FREQUENCY		▸ The Wind Farm General Manager to verify the curtailment schedule. ▸ The Community Liaison Officers to record any complaints regarding shadow flicker concerns.
SPECIALIZED EQUIPMENT OR MATERIAL		▸ Complaints Register
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-24	POTENTIAL IMPACT	NOISE
MITIGATION MEASURES		• The wind farm will be configured to meet the maximum noise limits both daytime (50 dBA) and night-time (45 dBA) at all the nearest residential receptors. This will be achieved by operating all but one wind turbine in standard noise emissions configuration, and downgrading turbine No. 4 to a lower noise emission (and production) configuration. • The design also ensures that the maximum outdoor noise limit of 50 dBA daytime is satisfied at the Hope Secondary School, which is below the WHO

20-24	POTENTIAL IMPACT	NOISE
		recommended school outdoor limit of 55 dBA. Indoor noise levels at the school are impacted by existing outdoor background noise levels, which are reduced indoors by an uncertain amount via passage through louvered windows. Maximum wind farm noise levels at the school is 42.6 dBA, and average noise levels is 39.6 dBA, which are substantially below daytime background noise levels measured at the school such that the wind farm contribution to background noise outdoors (and consequently indoors) is less than 1 dBA and thus unlikely to be noticed.
ACTION BY		Wind Farm General Manager
TIMING		Prior to construction
SPECIALIZED EQUIPMENT OR MATERIAL		
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		▸ The Wind Farm General Manager to ensure that wind farm design and configuration meet the criteria for the noise standards. ▸ Community Liaison Offers to register complaints from community and the school.
SPECIALIZED EQUIPMENT OR MATERIAL		Complaints log
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20-25	POTENTIAL IMPACT	CONCERNS FOR AVIFAUNA AND BATS
MITIGATION MEASURES		Undertake Post Construction Mortality studies in accordance with U.S. Fish and Wildlife Service: Land Based Wind Energy Guidelines (2012). No later than 3 months after start-up of the wind farm.
ACTION BY		HSE Manager
TIMING		Throughout the operation phase
SPECIALIZED EQUIPMENT OR MATERIAL		None required

20-25	POTENTIAL IMPACT	CONCERNS FOR AVIFAUNA AND BATS
COMPETENCE AND TRAINING		Specialist Ecologist to design the study Trainees to undertake the actual surveys
MONITORING / VERIFICATION		
HOW / BY WHOM/WHAT / WHERE/, FREQUENCY		Review of the study protocols prior to start of monitoring; Weekly review of data.
SPECIALIZED EQUIPMENT OR MATERIAL		None required
COMPETENCE AND TRAINING		Specialist Ecologist
RECORD KEEPING		See Section 7.3.3
REPORTING		See Section 7.3.4

20.2 Social Management Plan

POTENTIAL ADVERSE IMPACTS			
PROPOSED IMPACTS		MITIGATION	MONITORING
Population	**Construction Phase** • Presence of migrant/ mobile workers	<u>Presence of migrant/ mobile workers:</u> - Ensure local contracting as far as possible. - Provide training for local community members where possible. - Provide adequate information to workers on expected social behaviour when in and interacting with the community (esp. in relation to fisher folk).	- Frequent community consultations to verify experienced nuisance; with frequency such as weekly, during peak construction periods and fortnightly afterwards. - Contractor agreements to spell out all required mitigations, and adherence monitored and confirmed
Social infrastructure	**Construction Phase**	<u>Increase of traffic:</u> - Transportation through	- Set up a Community

POTENTIAL ADVERSE IMPACTS			
PROPOSED IMPACTS		**MITIGATION**	**MONITORING**
	• Increased road traffic, • Damage to road infrastructure, utilities • Noise emission • Loss of work after construction is completed • Loss of access (residents, fishermen) • Reduced emergency response time • Dust emission	community areas shall be avoided as much as possible. - Planned transport routes for construction material shall strictly be followed. - Communicate the transportation of critical components early to allow the public to make required arrangements. - High noise transportation activities shall not be carried out at night as far as possible. <u>Damage to road infrastructure, utilities:</u> - All vehicles engaged for transportation shall be verified as suitable for the roads to be accessed and loads transported. - Training of drivers in defensive driving techniques, specifically targeting project area. <u>Noise emission:</u> - Utilizing construction techniques (especially noise intensive activities like pile driving) that minimize the production of noise. - Avoid night-time work to the extent that is practical - Strict adherence to site working hours. - Communicate scheduled	Grievance Redress (CGR) mechanism enabling residents to communicate their grievances to the developer via appointed liaisons officers within the community. - Regularly address complaints received through CGR officers in the different communities; set frequency such as weekly during peak construction periods and fortnightly afterwards. - Contractor agreements to spell out all required mitigations, and adherence monitored and confirmed - Set boundaries to construction area with clear directions

POTENTIAL ADVERSE IMPACTS			
PROPOSED IMPACTS		**MITIGATION**	**MONITORING**
		noise intensive activities to communities. <u>Loss of work at completion of construction:</u> - Explicitly inform workers about duration of work. - Clearly inform workers about the expected schedule and completion of each activity. - Where possible provide training of workers to transition from construction to operation phase employment. <u>Loss of access to project area:</u> - Clearly outline the area to be accessed during construction - Schedule construction activities to maintain access as far as possible. - Provide alternative access options <u>Reduced emergency response time:</u> - Schedule construction activities to maintain road access as far as possible. - Prepare and implement a Traffic Management Plan in conjunction with Police. <u>Dust emission:</u> - Enforce traffic speed regulations within the construction zone to	

POTENTIAL ADVERSE IMPACTS			
PROPOSED IMPACTS		**MITIGATION**	**MONITORING**
		reduce dust emissions due to speeding along roads. - Frequent wetting of bare surfaces and access ways, thereby limiting opportunities for the formation of atmospheric dust. - Cover all transport vehicles to prevent dust flying up from the materials into the air. **See applicable recommended measures in Chapter 10.*	
	Operation Phase • Shadow flicker • Noise emissions	<u>Shadow flicker:</u> - Turning off the wind turbines when appropriate to minimize flicker at any residences within acceptable limits <u>Noise emission:</u> - Location of wind turbines with sufficient offset distance from nearby homes such that maximum noise-emissions are below a maximum of 45 dB at nearby receptors at night, and 50 dBA during the day, including at the school.	- complete community survey at residential homes in flicker affected areas
Health & Safety	**Construction Phase** • Occupational hazards • Health concerns related to noise & air emissions • Extra pressure on local Health	<u>Occupational hazards:</u> - Ensure that workers are well trained - Provide on-site first aid facilities. - Ensure provision and use of Personal Protection Equipment. **Measures listed in*	- Ongoing daily inspections to ensure strictly following of standard operation procedures. - Monitor traffic flow in the area to ensure that Traffic

POTENTIAL ADVERSE IMPACTS			
PROPOSED IMPACTS		**MITIGATION**	**MONITORING**
	facility • Public safety	*Chapter 18: Risk Assessment, are also applicable here.* <u>Health concerns related to noise & air emissions:</u> - Utilizing construction techniques that minimize the production of noise. - Avoid working between 7.00PM and 7.00AM to avoid / minimize interruption of residents' night sleep. <u>Pressure on local health facility:</u> - Engage health authorities to provide in a dedicated ambulance service in collaboration with the local health clinic. **See chapter 18 for Emergency Response Plan* <u>Public safety:</u> - Develop a Traffic Management Plan (TMP) for construction workers - Provide clear signage for construction zone **Also see chapter 14 for mitigation on road safety*	Management Plan is effective
	Operation Phase • Noise emissions	<u>Noise emission:</u> - Operate wind turbine 4 in noise reduction mode at night	- Address complaints on noise emission received through CGR officers in the different communities.

POTENTIAL ADVERSE IMPACTS			
PROPOSED IMPACTS		**MITIGATION**	**MONITORING**
Fishing community	**Construction Phase** • Improper disposal of waste • Loss of Access • Potential for loss of earnings (fishermen)	<u>Waste generation:</u> - All waste generated shall be collected and disposed of at designated disposal site - Develop and use Waste management plan <u>Interruption of road access:</u> - Provide an alternative route to reach canal <u>Loss of earnings:</u> - Minimize impediment of fishers as much as possible	- Frequent consultations with fisher folk to assess any experienced nuisance (see comments on grievance redress above - Frequent site inspections to note any waste disposal issues.
Hope Secondary School	**Construction Phase** • Health Concerns (air and noise emissions) • Loss of Access • Increased Road Traffic (students and teachers late arrival to school)	<u>Health Concerns:</u> - Utilizing construction techniques that minimize the production of noise. - Frequent wetting of bare surfaces and access ways, thereby limiting opportunities for the formation of atmospheric dust surrounding the schoolyard - Provide extra cleaning service for dusty classrooms - Provide mouth and nose masks for use at school in case of excessive dust <u>Loss of Access:</u> - Minimize impediment of schoolchildren and teachers entering the schoolyard as much as possible - Adjust work schedule as	- Assign liaisons officers from the Community Grievance Redress (CGR) mechanism with specific duties for school grievances.

POTENTIAL ADVERSE IMPACTS			
PROPOSED IMPACTS		**MITIGATION**	**MONITORING**
		much as possible with school times (e.g. after school hours and vacations) <u>Increased Road Traffic:</u> - Adjust work schedule as much as possible with school times (e.g. avoid drop-off and pick-up periods)	
	Operation Phase • Shadow flicker • Noise emissions	<u>Shadow flicker:</u> - Shadow flicker impact is not expected to occur during school hours. <u>Noise emissions:</u> - Turbines designed to meet international and local noise standards with negligible impact at the school	

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