ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT

PELLEW ISLAND, PORTLAND

Prepared by:
CARIBBEAN ECOSYSTEMS LTD.

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Executive Summary

The Pellew Island development located in the parish of Portland intends to develop the island by building two (2) villas. Pellew Island, also known as Monkey Island, is approximately eight kilometres (8 km) from the parish capital of Port Antonio. It is located on the seaward edge of the 1.12 km long lagoon that runs west-north-west to east-south-east between The Blue Lagoon, which is located at the south-eastern extreme of the lagoon and Alligator Head, which is located at the north western extreme of the lagoon.

The proposed development plans indicate the construction of two (2) villas; one 7-bedroom and one 4-bedroom. The design concept envisages an old Jamaica/Balinese style of architecture with clinker board exteriors, thatched covered copper alloy roofs, high ceilings, wrap around verandas, demerara windows and poured coloured concrete and wooden floors in the appropriate areas. The two villas will be on the north-east and north-west of the island both will be entered from a central internal common area, with circulation paths radiating from this area, wrapping around the villas to the shoreline of the island. All of the existing trees will be retained in the proposed landscaping design.

The island will be accessed by boat, an electric powered glass bottom boat or bamboo raft, from the reception area located directly south of the Island on land alongside the main road at 43 San San Main Road west of the Blue Lagoon villas. A jetty and a small four (4) vehicle parking lot will be constructed at the reception area. Each villa will have its own pier for individual access to each villa.

This EIA report presents the assessment criteria, the methodologies for the assessments, the identification of the possible impacts of the project, the analysis of project alternatives, recommended mitigation measures for all negative impacts identified, and outlines an environmental monitoring plan for the development as stipulated by the approved TOR issued by NEPA .

The objectives of this EIA are as follows:

- To describe the proposed development project;
- To describe the legislative and regulatory considerations associated with the project;
- To describe the present status of the environment on the project site;
- To describe the present status of the socio-economic attributes of the project site;
- To identify and predict any potential positive, negative, reversible, irreversible short and long term impacts, as well as any cumulative and synergistic environmental and socio-economic impacts that may arise from the project;
- To assess the hazards associated with the development;
- To facilitate mitigation of possible negative impacts caused by the proposed development;
- To recommend measures to enhance any positive impacts identified;
- To outline possible alternatives to the project; and
- To outline a suitable environmental management and monitoring plan for the duration of the project.

This report is divided into twelve (12) sections including the introductory chapter. ***Section 2*** of the report provides a description of the project including location and description of activities to be carried out throughout the duration of the project. This is followed by ***Section 3,*** which presents an overview of all the pertinent laws and regulations that must be considered for this type of development activity. ***Sections 4*** and ***5*** provide a description of the current Biophysical and Socio-Economic baseline of the study area, respectively. The analysis of alternatives to the project is presented in ***Section 6***. In ***Section 7, 8*** and ***9*** the environmental, socio-economic and hazard impacts are analysed and mitigation measures presented. A draft monitoring plan for the development is presented in ***Section 10.*** This is followed by the Bibliography in ***Section 11*** and the Appendices in ***Section 12***.

All the major social and environmental impacts have been identified and described along with mitigative measures for negative impacts. All identified negative impacts can be mitigated. Issues identified and discussed include: biodiversity loss, sewage treatment, land clearance, air quality, water quality, aesthetics, noise, solid waste generation, storm water run-off, storage, transportation and use of construction materials, operation of the villas, dock construction, traffic, natural hazards, fire, landscaping, chemical handling, utilities, job creation, income generation, economic benefits, health and emergency services.

The project has come under public scrutiny even before all of the studies and plans were complete. To this end an electronic petition site was launched. This report includes an analysis of the petition site and has considered all of the reasons put forward by the petitioners.

1.0 INTRODUCTION

The Pellew Island development located in the parish of Portland intends to develop the island by building two (2) villas *inter alia*. An environmental permit application was submitted to the National Environment and Planning Agency (NEPA) for consideration, and based on the screening of this application; an Environmental Impact Assessment (EIA) was requested for the villa development by the Agency. The approved Terms of Reference (TOR) for the conduct of this EIA is shown in ***Appendix 1***.

This EIA report presents the assessment criteria, the methodologies for the assessments, the identification of the possible impacts of the project, the analysis of project alternatives, recommended mitigation measures for all negative impacts identified, and outlines an environmental monitoring plan for the development as stipulated by the approved TOR issued by NEPA .

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- To outline a suitable environmental management and monitoring plan for the duration of the project.

1.1 STRUCTURE OF THE REPORT

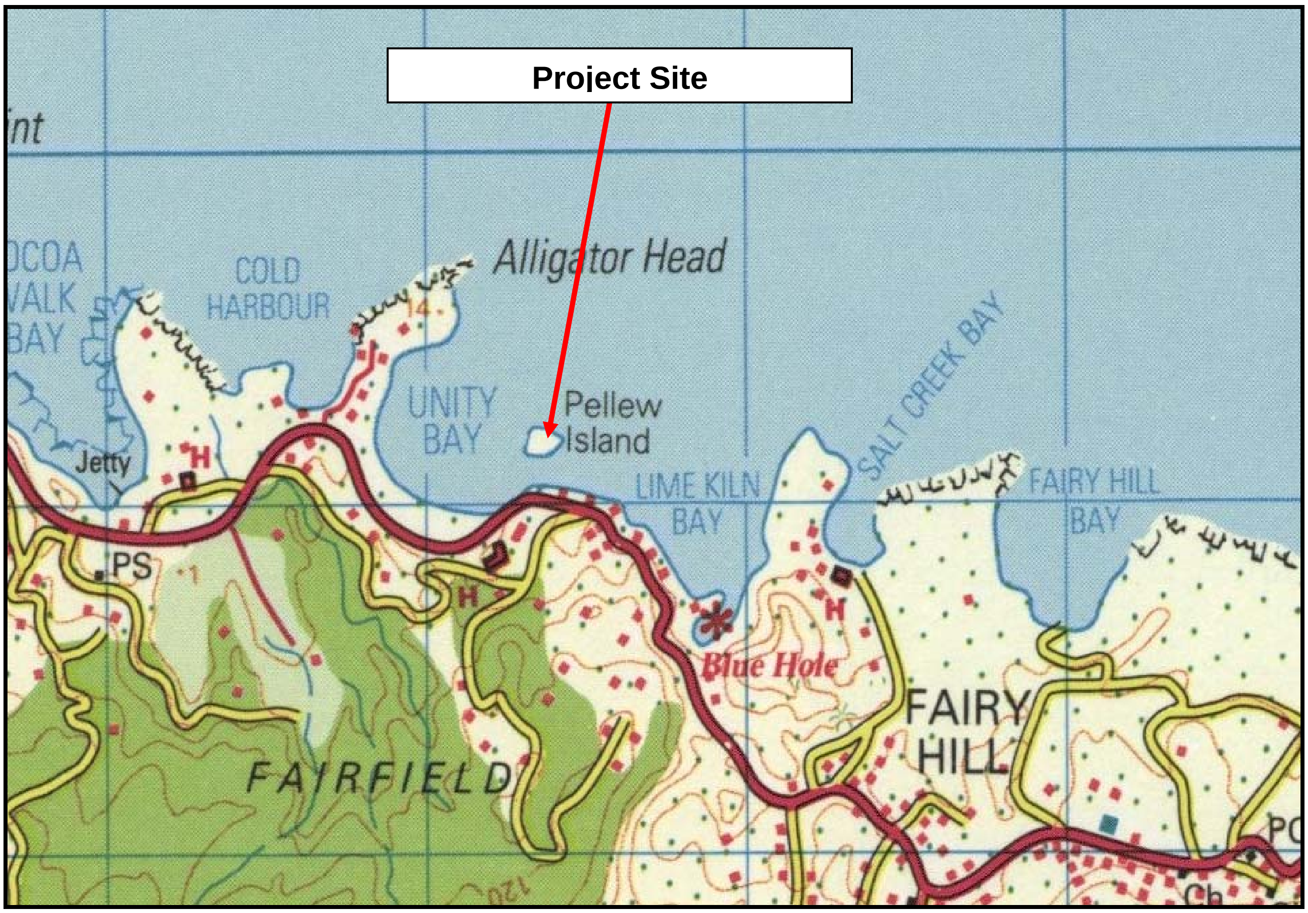
This report is divided into twelve (12) sections including the introductory chapter. ***Section 2*** of the report provides a description of the project including location and description of activities to be carried out throughout the duration of the project. This is followed by ***Section 3***, which presents an overview of all the pertinent laws and regulations that must be considered for this type of development activity. ***Sections 4*** and ***5*** provide a description of the current Biophysical and Socio-Economic baseline of the study area, respectively. The analysis of alternatives to the project is presented in ***Section 6***. In ***Section 7, 8*** and ***9*** the environmental, socio-economic and hazard impacts are analysed and mitigation measures presented. A draft monitoring plan for the development is presented in ***Section 10.*** This is followed by the Bibliography in ***Section 11*** and the Appendices in ***Section 12***.

2.0 PROJECT DESCRIPTION

2.1 PROJECT LOCATION

Pellew Island, also known as Monkey Island, is found in the parish of Portland, approximately eight kilometres (8 km) from the parish capital of Port Antonio. It is located on the seaward edge of the 1.12 km long lagoon that runs west-north-west to east-south-east between The Blue Lagoon, which is located at the south-eastern extreme of the lagoon and Alligator Head, which is located at the north western extreme of the lagoon. This is shown in ***Map 1*** below.

Map 1: Project Location Map of Pellew Island



2.2 DESCRIPTION OF THE AREA TO BE DEVELOPED AND CURRENT LAND USE

Pellew Island is approximately 0.65 hectares (~1.6 acres) in size. It consists mostly of rock faces around the perimeter of the island with a semi-flat plateau on top. The island is currently undeveloped and consists of a few large trees and other vegetation typical of coastal areas. Currently the island is used mostly for recreational purposes. A small beach area is located to the southern section of the island which is the part that is often used by visitors for picnics and small weddings. The waters offshore are used for swimming and snorkelling. The island is also renowned for its “Monkey Rock”, which is reported to be used by visitors to treat skin ailments such as liver spots and acne[1].

The land-use in the surrounding area is typically resort type activities. Approximately 0.6 km of coastline from the Blue Lagoon to a point opposite Pellew Island is occupied by thirteen (13)[2] up-market villas. These villas have been constructed on the original shore line, and are situated directly on the water’s edge. San San Beach, a private beach club, is located on the south western shore of the lagoon. The Dragon Bay Hotel is located on the peninsula that defines the south eastern boundary of the lagoon, while the Goblin Hill Hotel is located on the promontory due south and over-looking Pellew Island and the lagoon.

[1] **Verbal communication with visitors to the island**
[2] **Source: www.bluelagoonvillas.com**

Figure 1: Figure showing the aerial image of Pellew Island

Source: Google Earth (2007)

Figure 2: Pictures showing some of the Blue Lagoon Villas.

2.3 PROPOSED PROJECT DESIGN & IMPLEMENTATION

2.3.1 DESCRIPTION OF THE PROJECT

The proposed development plans indicate the construction of two (2) villas; one 7-bedroom and one 4-bedroom. The design concept envisages an old Jamaica/Balinese style of architecture with clinker board exteriors, thatched covered copper alloy roofs, high ceilings, wrap around verandas, demerara windows and poured coloured concrete and wooden floors in the appropriate areas. The two villas will be on the north-east and north-west of the island both will be entered from a central internal common area, with circulation paths radiating from this area, wrapping around the villas to the shoreline of the island. All of the existing trees will be retained in the proposed landscaping design.

The common amenities will include a sun/moon deck (an exposed wooden deck with bar area) erected at the highest point, to provide a visual feast of the elements and windward ocean views. A security post will be located at the south-west corner. Two (2) plunge pools, one (1) for each villa, have also been proposed for the island. (See ***Appendix 2*** for layout plans).

The island will be accessed by boat, an electric powered glass bottom boat or bamboo raft, from the reception area located directly south of the Island on land alongside the main road at 43 San San Main Road west of the Blue Lagoon villas. A jetty and a small four (4) vehicle parking lot will be constructed at the reception area. Each villa will have its own pier for individual access to each villa. (See ***Appendix 2*** for layout plans)

2.3.2 KEY CONSTRUCTION ACTIVITIES

The key construction activities in the construction of the villas will include:

- partial clearing of vegetation to facilitate surveying
- establishment of a dock facility to receive construction materials

- routing of electrical and water conduits across the channel to support and facilitate construction activities and will be used eventually for the operations of the villas.
- the establishment of the construction site inclusive of portable chemical toilets.
- the transportation by boat, unloading and storage of construction materials on Pellew Island.

2.3.3 PERSONS EMPLOYED IN CONSTRUCTION AND OPERATION PHASES

It is expected that an average of sixty (60) persons will be employed during the construction of the villas. During the operation phase it is expected that a maximum of twelve (12) persons will be employed.

2.3.4 WATER REQUIREMENTS

A. Construction Phase

Water for use in the construction and operation phases will be provided by the National Water Commission (NWC) main supplying the area.

Approximately sixty (60) persons will be employed during the construction phase. The estimated daily water consumption for workers is 55 litres per day for each worker (EHU, 2005). The total water consumption during the construction phase is therefore estimated to be 3,300 litres (3.3 m^3) per day. It is estimated that up to 2,700 litres per day will be needed for general construction activities particularly during cement and concrete pours. Therefore, a maximum total of 6,000 litres per day is the projected water consumption during construction.

B. Operation Phase

During the operation phase a maximum of twelve (12) persons will be employed to the resort. The estimated daily consumption for these employees is 55 litres per day each

(EHU, 2005) totalling an average of 660 litres (0.6 m^3) per day. At its maximum capacity the resort can accommodate twenty-two (22) guests. The estimated water consumption for each guest varies between 150 - 190 litres per day (EHU, 2005). Therefore at its maximum occupancy, the water consumption for the operation phase will be about 4,840 litres per day for guests and workers.

2.3.5 SEWAGE TREATMENT

Each villa will have its own tertiary sewage treatment plant which will comprise of a Cromoglass™ Model CA15DF Wastewater Treatment Module, one Cromoglass™ Chlorine Contact Tank , one 83785 Cromoglass™ Coagulation Tank and one Sanitron S50-B Ultra Violet Disinfection Unit and one Sludge Processing Tank (***Appendix 3***). Sewage will be treated by a sequencing batch reactor (SBR). The comparison of the sewage effluent parameters from this system is compared to the NEPA effluent limit in ***Table 1*** below.

Table 1: Comparison of effluent parameters from the proposed Chromoglass system with the NRCA Effluent Standards.

Parameter	Chromoglass System	NEPA Effluent limit
BOD_5	< 10 mg/L	20 mg/l
TSS	<10 mg/L	20 mg/l
Total Nitrogen	< 10 mg/L	10 mg/l
Phosphates	< 4 mg/L	4 mg/l
COD		100 mg/l
pH		6-9
Faecal Coliform	<100/1000 mL	200 MPN/100 ML
Residual Chlorine		1.5 mg/l

(Further specifications on this sewage treatment methodology are shown in ***Appendix 3***). Assuming a 100% water consumption conversion to effluent, the amount of sewage to be generated daily at maximum occupancy on the island (including guests and employees) will be 4,840 litres per day. This is shown in ***Table 2*** below.

Table 2: Table showing the estimated sewage production during the operation phase

Source	Maximum Capacity	Estimated Sewage Generation
Villas (guests)	22 persons	4,180
Resort Workers	10 persons	550
Reception Area/Office	2 persons	110
Total		4,840

2.4 PROJECT IMPLEMENTATION

It is anticipated that the project will be implemented over a one (1) year period.

3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1 JAMAICAN LAWS AND REGULATIONS

There are over seventy different laws in Jamaica that deal with environmental management. The administration of the major environmental laws is the responsibility of the Natural Resources Conservation Authority (NRCA) now subsumed within the National Environment and Planning Agency (NEPA). The functions of the Authority are:

- To take such steps as necessary for the effective management of the physical environment of Jamaica to ensure the conservation, protection, and proper use of its natural resources.
- To promote public awareness of the ecological systems of Jamaica and their importance to the social and economic life of the Island.
- To manage such national parks, marine parks, protected areas, and public recreational facilities as may be prescribed.
- To advise the Minister on matters of general policy relating to the management, development, conservation, and care of the environment.
- To perform such other functions pertaining to the natural resources of Jamaica as may be assigned to it by the Minister under the Act or any other enactment.

The NRCA, through the 1991 Act may:

- Develop, implement, and monitor plans and programmes relating to the management of the environment and the conservation and protection of natural resources.
- Construct and maintain buildings and other facilities for public recreational purposes.

- In relation to prescribed national parks, marine parks, protected areas, and public recreational facilities:
    - Carry out or cause to be carried out such improvements as it thinks fit.
    - Provide for the zoning thereof for specified purposes and for the licensing of persons carrying on any trade or business therein.
- Formulate standards and codes of practice to be observed for the improvement and maintenance of the quality of the environment generally, including the release of substances into the environment in connection with any works, activity, or undertaking.
- Investigate the effect on the environment of any activity that causes or might cause pollution or that involves or might involve waste management or disposal, and take such action as it thinks appropriate.
- Undertake studies in relation to the environment and encourage and promote research into the use of techniques for the management of pollution and the conservation of natural resources.
- Conduct seminars and training programmes and gather and disseminate information relating to environmental matters.
- Do anything or enter into any arrangement which, in the opinion of the Authority, is necessary to ensure the proper performance of its functions.

The major environmental laws that are relevant are as follows:

3.1.1 Natural Resources Conservation Authority (NRCA Act) 1991

This Act confers on the NRCA the power to take the necessary steps for the effective management of the physical environment in Jamaica so as to ensure conservation, protection and proper use of its natural resources (Part 1 Section 1). The Authority has been given commensurate powers with which to enforce compliance with its requirements. The sections of the Act which are of relevance to this project are:

***Section 9*:** *No construction or development can take place without permission from the Authority according to Section 9 of the Act. If there is likely to be a discharge, a permit for this is needed (as prescribed in section 12). A permit will not be granted if any activity is likely to be injurious to public health or natural resources. If the Authority does not grant a licence, the reasons shall be stated in writing and the applicant can appeal against the decision under section 35 of the Act.*

***Section 12*:** *Subject to the provision of this section no person shall discharge or cause or permit the entry into waters, on or into the ground, any sewage or trade effluent or any poisons, noxious or polluting matter, nor construct, reconstruct or alter any works for the discharge of such matter except under and in accordance with a license to do so.*

***Section 15*:** *Where it appears to the NRCA that any waters have been or are likely to be polluted in consequence of an act or omission which the Authority may, in consultation with the Minister responsible, serve on the occupier of the land where the act or omission took place, a notice requesting him to stop or prevent acts or omissions of that kind.*

***Section 17*:** *The Authority may by notice in writing require the owner or operator of any sewage treatment plant, industrial waste treatment facility or any facility for the disposal of solid waste or any other facility for controlling pollution, to submit to the Authority at such intervals as the Authority may specify in the notice, information relating to all or any of the following:*

(a) The performance of the facility
(b) The quantity and condition of the effluent discharged
(c) The area affected by the discharge of effluents, and such owner or operator as aforesaid shall comply with the requirements of the notice.

***Section 18*:** *This section empowers the Authority to serve an `enforcement notice', where it appears to the Authority that the activities of an undertaking in any area are such as to pose a threat to the natural resources or to public health, on the person(s) who appear(s) to have carried out or to be carrying out the activity. The enforcement order can specify, where appropriate, the cessation of the offending activity or restoration of the natural resources to their condition before the activity took place.*

The NRCA is also authorised to formulate standards and codes of practice to be observed for the improvement and maintenance of the quality of the environment, generally. This includes the release of substances into the environment in connection with any works, activity and undertaking, and the investigation of any activity which may affect the environment or may cause pollution, waste management or disposal problems. The NRCA may take appropriate corrective action as it deems necessary.

In this regard, the NRCA established trade effluent standards in January 1997. Further to this they have requested that industry submit information on their current waste management practices.

The NRCA is also drafting regulations, which would allow them to levy a cess on companies that discharge effluent not in compliance with their standards. The justification for such a levy would be to provide funds to further treat the effluent or apply mitigative measures. It is expected that these regulations will be in force shortly.

3.1.2 The Clean Air Act

This Act is enforced by the Ministry of Health. The relevant section of the Act is as follows:

Section 5: *This section stipulates that an Inspector on production of his authority may enter any premises on which there are industrial works, the operation of which is likely to result in discharge of smoke, fumes, gases or dust into the air, for the purpose of inspection and examination of any substance as he considers necessary for the performance of his duties. The owner or his agents shall afford all necessary facilities and information for this inspector.*

3.1.3 The Jamaica Public Health Act (1974)

This Act is the enabling legislation under which the Public Health (Air, Soil and Water Pollution) Regulations (1976) were enacted. Based on the appropriate Water Pollution Control Regulations, the NRCA has issued the following:

- o Definitions of receiving water classifications;
- o For each classification, the regulations define quality standards. A scale of I to VII is used to classify water.

3.1.4 Water Resources Authority Act

This Act established the Water Resources Authority, a corporate body, to promote conservation and the proper use of water resources in Jamaica. The Act replaces the Water Act and the Underground Water Act. This Authority monitors the health of our water resources.

The Act authorizes the Authority to regulate, allocate, conserve, and manage the water resources of the Island. It prohibits the abstraction and use of water without a license from the Authority. Where the use of water involves the discharge of effluents application for use of the water must be accompanied with a copy of application made to NRCA for permit for effluent discharge. It allows for the declaration of emergency areas on the account of drought or any other condition that renders the supply of water inadequate in terms of quantity and/or unsuitable in terms of quality to satisfy requirements of licenses granted. The Act confers power on the Authority to grant licenses for the drilling of wells and regulating the safe yield of any aquifer. It allows for the protection of the quality of water resources by declaring Water Quality Control areas and preparing plans for such areas.

3.1.5 Town and Country Planning Act

This Act established the Town and Country Planning Authority which has responsibility for ratifying Development Orders containing broad based land use plans and regulations. The Authority is now subsumed under the National Environment and Planning Agency. These development Orders are prepared by the Town Planning Department to control the development of land in both rural and urban areas, secure proper sanitary conditions and conveniences, co-ordinate the building of roads and public services, protect and extend amenities, and conserve and develop resources.

3.1.6 Land Acquisition Act (1947)

The Land Acquisition Act of 1947 is administered by the ministry responsible for the management of Crown Lands. *Section 3* of the Act empowers any officer authorised by the Minister to enter and survey land in any area that is deemed to be required for public purpose. This officer may dig or bore the soil, cut any standing crops, bush or woodland and remover any fences and carry out any other activities, which may be necessary to determine the suitability of the land.

Section 5 of this Act authorises the Minister to publicly declare that an area is required for public purpose. The Minister will then instruct the Commissioner of Lands to take proceedings to acquire the land, which will include negotiations for purchase of the land.

If no agreement can be reached within a reasonable time the Commissioner will invite all interested parties to present in writing their interests in the land and the amount and particulars of their claims to compensation.

On the day specified, the Commissioner will enquire into the value of land and the interests of persons claiming compensation and will make an award as to the true area of the land, the compensation for the land and the apportionment of the compensation to the persons interested. If the party is still dissatisfied with the compensation presented the matter may be brought before the Supreme Court.

3.1.7 Wildlife Protection Act (1945)

Under the Wildlife Protection Act (1945), it is illegal to remove, sell or have in ones possession a protected animal, use dynamite or other poisonous or noxious material to kill or injure fish, discharge or empty waste or industrial effluent into harbours, lagoons, estuaries, and streams.

This Act is administered by the National Environment and Planning Agency (NEPA) and authorises the establishment of Game Sanctuaries and Reserves.

3.1.8 Endangered Species (Protection, Conservation and Regulation of Trade Act (2000)

The Endangered Species Act of 2000 provides for the conservation, protection and regulation of trade of endangered species. The primary purpose of this Act is to control the domestic trade of endangered species. Contained in this Act are four (4) Schedules. This Act seeks to monitor and control the following:

- The exportation of specimens that are derived from indigenous Jamaican animals or plants;
- The exportation and importation of specimens that are derived from animals or plants which:
  - are threatened with extinction and are or may be affected by trade;
  - may become so threatened if international trade in specimens of such
  - species is not subject to strict regulation; and
  - require or are likely to require protection or the cooperation of other States in order to prevent or restrict exploitation.
- The importation of animals or plants, the introduction of which has or is likely to have an adverse effect on the habitats and species of indigenous Jamaican animals or plants; and
- The exportation or importation of specimens that are difficult to distinguish from specimens referred to in the bullet points above.

3.1.9 Country Fires Act (1942)

The land for the development will have to be cleared and therefore the developer may use fire as a means of clearing the land. The Ministry of Agriculture administers the Country Fires of Act of 1942. Under this Act it is an offence to:

- Set fire to trash without serving an officer of the nearest police station with notice or clearing open space around trash.
- Set fire to trash between 6 p.m. and 6 a.m.
- Leave open – air fire unattended.
- Failure by occupier of land to take responsible steps to extinguish fire on his land.
- Set a fire contrary to the order or permit.

3.1.10 Solid Waste Management Authority Act (2001)

The Solid Waste Management Authority Act was enacted in 2001 and gives the National Solid Waste Management Authority (NSWMA) jurisdiction over the disposal of solid waste in Jamaica. Under this Act it is illegal to:

- Dispose of solid waste in an unauthorised way or manner.
- Operate a solid waste disposal facility or to collect, transfer/manage solid waste without a licence/certificate.
- Throw or deposit litter in a public place.
- Throw or deposit litter on another's premises without consent.

3.1.11 Public Health Nuisance Regulations (1995)

The Public Health Nuisance regulations are administered by the Ministry of Health in Jamaica and were brought into force in 1995. Under these regulations it is an offence if a person fails to abate a nuisance or perform such an act to prevent the reoccurrence of a nuisance. A nuisance under the regulations is defined as:

- A building or structure which is or likely to become a health hazard due to structural defects or unsanitary conditions;
- Premises or other places where unsanitary conditions are present or are likely to become a health hazard;
- Accumulation or deposit of solid waste, human or animal excreta;
- Dust, smoke, fumes, gases or effluvia emitting from any manufacturing process or caused from trade or business;
- Lack of water or water supply system;
- Water supply that is not maintained in a sanitary condition; and
- Discharge of sewage, industrial waste or any other noxious matter into the sea or any watercourse or unto any land.

3.1.12 Public Health Act (Air, Soil and Water Regulations (1976)

The Public Health Act (Air, Soil and Water Regulations) of 1976 is responsible for regulating the construction, repair or alteration of sewage treatment facilities and is administrated by the Environmental Health Unit of the Ministry of Health.

3.1.13 Beach Control Act (1956)

The Beach Control Act of 1956 is administered by the National Environment and Planning Agency (NEPA). Under this Act, no person shall be deemed to have any rights in or over the foreshore of the island or the floor of the see and all rights over the foreshore of the island and floor of the sea are declared to be vested in the Crown. No person shall encroach on or use, or permit any encroachment on or use of the foreshore or the floor of the sea for any public purpose or for in connection with any trade or business or commercial enterprise without a licence granted under this Act.

3.1.14 Tourist Board Act (1985)

This Act is governed by the Tourist Board of Jamaica. Under this Act it is an offence to operate or maintain any tourism enterprise without a licence issued by the Board.

3.2 INTERNATIONAL CONVENTIONS AND REGULATIONS

3.2.1 Convention on Biological Diversity (CBD) (1993)

The Convention on Biological Diversity (CBD) was negotiated under the auspices of the United Nations Environment Programme and entered into force in 1993. The three goals of the CBD are to (CBD, 2006):

- Promote the conservation of biodiversity.
- Sustainable use of its components.
- The fair and equitable sharing of benefits arising out of the utilization of genetic resources.

To date over one hundred and seventy (170) countries have signed the agreement. Jamaica became signatory in 1995. As a signatory to the CBD Jamaica is obliged to:

- Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, *inter alia*, the measures set out in this Convention relevant to the Contracting Party concerned; and
- Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

3.3 RELEVANT JAMAICAN POLICIES

3.3.1 National Policy for the Conservation of Seagrasses (1996)

The National Policy for the Conservation of Seagrasses in Jamaica was developed in 1996. The aim of this policy it to guide the issuing of licenses or permits for activities such as dredging, disposal of dredged material, beach development, and effluent disposal.

3.3.2 Coral Reef Protection and Preservation – Draft Policy and Regulations (1996)

Similarly, a Draft Policy was drafted for coral reef protection and preservation in 1996. This policy reviews the factors which affect coral reefs island-wide and outlines the Government of Jamaica's roles and responsibility in seeking to protect these habitats.

4.0 DESCRIPTION OF THE ENVIRONMENTAL SETTING

This section of the report provides an overall description of the various elements including the biophysical characteristics of the environment. It also outlines the methodologies employed in conducting the baseline research and presents the results and observations from these assessments.

4.1 THE PHYSICAL ENVIRONMENT

4.1.1 CLIMATE

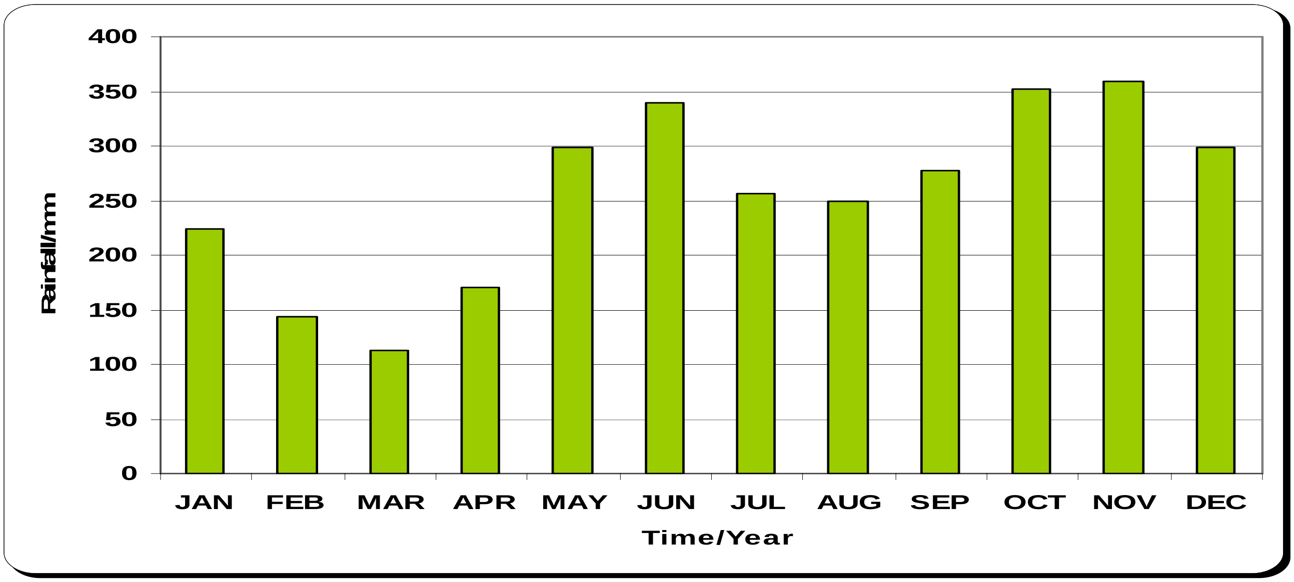
METHODOLOGY

The data presented in this section was collected by secondary research. The National Meteorological Service of Jamaica has collected a plethora of climate data for the island and the information presented below is data that has been generated from the meteorological station in Port Antonio, Portland, located approximately eight (8) kilometres from the development site.

A. RAINFALL

The 30-year mean for rainfall data collected at the meteorological station in Port Antonio, Portland is shown in ***Figure 3*** below. The data shows that the average rainfall in the area ranges from a low of 113 mm in March to a high of 359 mm in November.

Figure 3: Graph showing the 30 Year Mean (1951-1980) Rainfall for Port Antonio, Portland

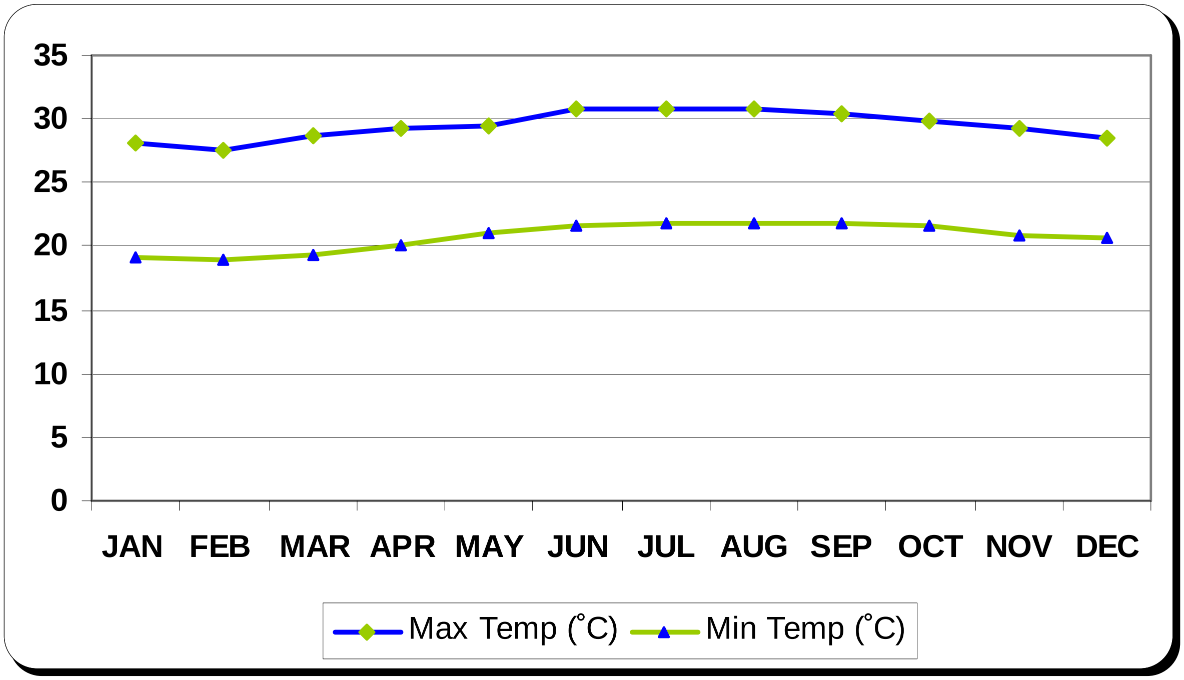


Source: National Meteorological Service, Jamaica (2007)

B. TEMPERATURE

The temperature recorded for Port Antonio shows that temperatures range from a maximum of 30.7ºC in July/August to a minimum of 18.9ºC in January. This is shown in ***Figure 4*** below.

Figure 4**:** Graph Showing the Average Temperature Ranges for Port Antonio, Portland



Source: National Meteorological Service, Jamaica (2007)

C. WIND

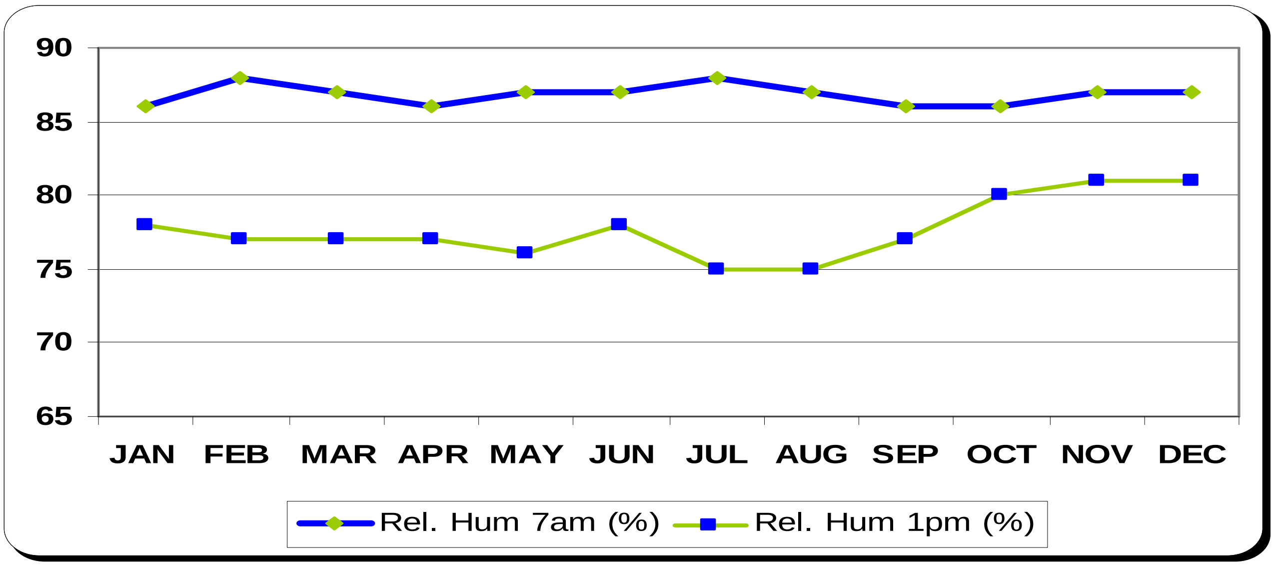
The North Coast daily wind pattern is dominated by the Northeast Trade Winds. During the daytime these Trades combine with the breeze from the sea to give an East-North-Easterly wind, at an average speed of 27 kilometres per hour (15 knots). At night the wind generally has a southerly component at an average speed of 10 kilometres per hour (5 knots). These trades are lowest between January to March, when the wind is composed of Trades, sea breeze and northerly winds associated with cold fronts and high pressure areas. The period between June and July has the highest daytime wind speeds of up to 42 kilometres per hour (23 knots).

Being directly on the coast, the island is affected by high wind speeds, the northern section being mostly affected. The southern section of the island which faces the lagoon experiences some sea breeze, but the levels are markedly reduced as compared to the wind conditions on the northern section.

D. RELATIVE HUMIDITY

Data from the National Meteorological Service of Jamaica shows that the relative humidity in coastal areas averages 86 % - 88 % during the morning; this however falls to 75 % to 81 % during the afternoon. This is shown in ***Figure 5*** below.

Figure 5: Graph Showing the Relative Humidity Ranges for Port Antonio, Portland



Source: National Meteorological Service, Jamaica (2007)

4.1.2 AIR QUALITY

Due to the location of the site and the land-use activities surrounding the area it was determined that that air quality monitoring was not necessary and it was therefore assumed that that the present air quality levels are within the stipulated air quality levels as outlined by the Natural Resources Conservation Authority's Air Quality Guidelines as shown in ***Table 4*** below.

Table 4: The Natural Resources Conservation Authority's Air Quality Guidelines for PM_{10}, SO_2 and NO_2

Pollutant	Averaging Time	Standard (maximum concentration in g/m^3)
PM_{10}	Annual 24-hour	50 150
Sulphur Dioxide (SO_2)	Annual 24-hour 1-hour	80 365 700
Nitrogen Dioxide (NO_2)	Annual	100

Source: NAAQS (2002)

4.1.3 WATER QUALITY

A. METHODOLOGY

Water samples were collected from three (3) sample points in the vicinity of the island (See ***Figure 6*** below). Samples were collected over a two (2) day period between December 1 and 2, 2007. These samples were kept in cold storage (<4^{o}C) until delivery to the laboratory for analysis. These methods of analysis are shown in ***Table 5*** below.

Table 5: Table showing the methods of analysis of Water Samples

Parameter	Test Method	Detection Limit	Range
BOD_5, mg/L	Dilution HACH Method 8043 (a modified form)		
COD, mg/L	Reactor Digestion, HACH Method 8000		0 to 150 and 0 to 1500 ranges
	Colorimetric Determination > > >		0 to 150 mg/L 0 to 1,500 and 0 to 15,000 mg/L COD
Faecal & Total Coliform MPN/100 mL	SMEW * Method 9221		
Dissolved Oxygen, mg/L	DO Meter		0 to 20 mg/L
Nitrate, mg/L	Cadmium Reduction, HACH Method 8171		0 to 4.5 mg/L NO_3^--N
Orthophosphate, mg/L	PhosVer 3 (Ascorbic Acid) Method, HACH Method 8048	0.02 mg/L	0 to 2.50 mg/L PO_4^{3-}
TSS, mg/L	Filtration / Gravimetric Method		

No marine water quality standards have been developed for Jamaica, as such international standards such as the World Health Organisations (WHO) and the United States Environmental Protection Agency (EPA) water quality standards were used for comparison.

Figure 6: Aerial image showing water quality sampling sites

Source: Google Earth (2007)

B. RESULTS

The results of the water quality analyses are shown in ***Table 6*** below.

Table 6 Table showing the results of the Marine Water Quality Analysis

PARAMETER	RESULTS						*EPA Standards	**NRCA Standards
	DAY 1			DAY 2				
	S1	S2	S3	S4	S5	S6		
BOD (mg/L)	7.31	6.45	6.64	7.39	7.24	7.28	**1.18 mg/L**	
COD (mg/L)	125	3,660	2,710	129	145	168		
Faecal Coliform (MPN/100ml)	3	300	308	105	< 3	150		
Total Coliform (MPN/100ml)	3	303	311	108	< 3	153		
DO (mg/L) @ 20^{o}C	10.60	10.10	10.30	9.65	10.40	10.00	**4.8 mg/L**	
Nitrate (mg/L)	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	**0.081 mg/L**	
O-Phosphate (mg/L)	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	**0.055 mg/L**	
TSS (mg/L)	103.45	55.62	86.28	84.87	90.85	73.43		**< 10 mg/L**

***** United States Environmental Protection Agency's Marine Water Quality Standards
** Draft Natural Resources Conservation Authority's Coral Reef Policy (1996) Proposed Coral Reef Criteria Value

i. Biochemical Oxygen Demand (BOD)

BOD at all marine sampling sites was high (an average of 7 mg/L for all sites) as compared to the United States of America's Environmental Protection Agency's (EPA) standard which is 1.18 mg/L. This indicates that there is some organic loading already present in the water.

ii. Total and Faecal Coliform

All the sites are compliant with the WHO standard for bathing and recreational waters (1,000 mg/l). However, sites within the lagoon area 2, 3, 4 and 6 show that there is input of Faecal Coliform in this area. The most probable source is the Blue Lagoon

Villas, as it is suspected that these villas do not have adequate sewage treatment facilities.

iii. Dissolved Oxygen (DO)

Dissolved Oxygen levels at all sites are well above the EPA's threshold value of 4.8 mg/L for marine waters. This indicates adequate oxygen levels in the daytime for the lagoon.

iv. Nitrate

Nitrate levels at all of the sample sites exceeded the EPA standard of 0.081 mg/L. This may be attributed to the influence from land-based activities which take place offshore the island. The critical levels of nitrogen below which reefs remain healthy without being overgrown by sea weed and algae are suggested to be 0.014 mg/l N (0.040 mg/l NO^3)[3]. The nitrate levels at all sites were approximately 0.76 mg/l. This means that at current nitrate levels algal growth will be encouraged. Again, the most probable source for the nutrient would be the Blue Lagoon Villas.

v. Phosphate

Phosphate levels at all sites were below the EPA standard of 0.055 mg/L. It is suggested that phosphate levels should be below 0.0007 mg/l for reefs to remain healthy and not impacted by algal growth[3]. This means that at current phosphate levels algal growth will be encouraged. Again, the most probable source for the nutrient would be the Blue Lagoon Villas.

vi. Total Suspended Solids (TSS)

TSS at all sites was very high, being five to ten times above the standard across all sampling sites, as compared to the Draft Natural Resources Conservation Authority's Coral Reef Policy (1996) Proposed Coral Reef Criteria Value of < 10 mg/L. This may be attributed to the land-based activities currently being undertaken offshore the island.

[3] **Modification of Benthic Community Structure by Natural Eutrophication: The Belize Barrier Reef. Lapointe, B., Littler, M. and Littler, D. Proceedings 7th International Symposium on Coral Reefs, 317-328, 1993.**

The construction of more villas and renovations along the shore at the Blue Lagoon Villas would be the most likely source of suspended solids. Observation of construction activities there shows no effort in controlling run-off from those sites into the lagoon.

4.1.4 SOILS & GEOLOGY

4.1.4.1 GEOLOGY

A. METHODOLOGY

A geological assessment of the proposed development site was done. Traverses of the terrain were done and the rock and soil types present were recorded. An assessment of geological hazards was made.

B. RESULTS

The proposed development site rests on limestone units belonging to the Coastal Group of Jamaica. The bedrock is exposed along the margins of the islet as well as in sections of its interior. Samples can be described as a relatively soft chalky limestone that is cream in colour. Macrofossils were not evident in the samples. The unit is massively bedded and well jointed. The chalky intervals alternate with harder limestone intervals of a similar description. The Coastal Group, as the name implies, is found exclusively along the coastal margins of Jamaica. The formations within this group represent one of the latest stages of limestone development on the island.

4.1.4.2 SOILS

A dark brown clay soil is present on the site. The soil samples are heavily infiltrated by roots. Given the variable topography on the site, soil development and accumulation is also variable. The restricted nature of the site has limited the natural supply of new soil material such as sand and silt from accumulating.

4.1.5 NOISE

Noise pollution can be defined as any unwanted sound, usually of anthropogenic origin. The impact can range from minor irritation to disruption of concentration, disruption of social regimes to changes in physiology resulting in health impacts such as hearing loss.

The location of Pellew Island and the land–use surrounding the project site does not classify Pellew Island as a noise sensitive area. Visits to the island showed that the noise heard on Pellew Island is limited to the noise from the ocean, wind and birds.

4.1.6 LANDSCAPE AND AESTHETICS

METHODOLOGY

A walk through of the area was carried out to determine the landscape and aesthetic value of the site. The site was also viewed from various vantage points.

4.1.7.1 PRESENT STATUS

Pellew Island, also known as Monkey Island, has been described as an "icon of Port Antonio". It can be seen while traversing along the San San main Road and also from the properties that overlook the lagoon. The island can be described as one that is aesthetically pleasing and offers a sense of tranquillity from all vantage points. It has also been described as one of the most scenic places in Jamaica.

4.2 BIOLOGICAL ENVIRONMENT

4.2.1 TERRESTRIAL ENVIRONMENT

This section outlines the description of the biological environment, the methodologies involved and the results of the assessment. It is divided into two parts; the first outlines the results of the Floral Assessment and the second outlines the results of the Assessment of the Fauna observed in the area.

4.2.1.1 ASSESSMENT OF FLORA

A. METHODOLOGY

The assessment of the vegetation in the area was carried out in two (2) phases, a *Phase 1* Assessment and a *Phase 2* Assessment respectively. The *Phase 1* Assessment included a review of aerial images of the project area. This was followed by a site visit to formulate a general image of the area, as well as to identify the particular habitats and vegetation types.

A *Phase 2* Assessment was then conducted during a site visit which included the laying of line transects across the study area. Due to the difficulty of the terrain in some areas where transects could not be used; direct observation along an imaginary line was used to identify the plant species in these areas.

All species observed during the assessment were identified in the field where possible, and photographs and samples were taken of all unknown species for later identification. Species that were of ecological and commercial value were also recorded during this exercise. A Semi-Quantitative Abundance Rating method was used to determine the abundance of all the species identified as shown in ***Table 7*** below.

Table 7: Table showing the Semi-Quantitative Abundance Rating Method

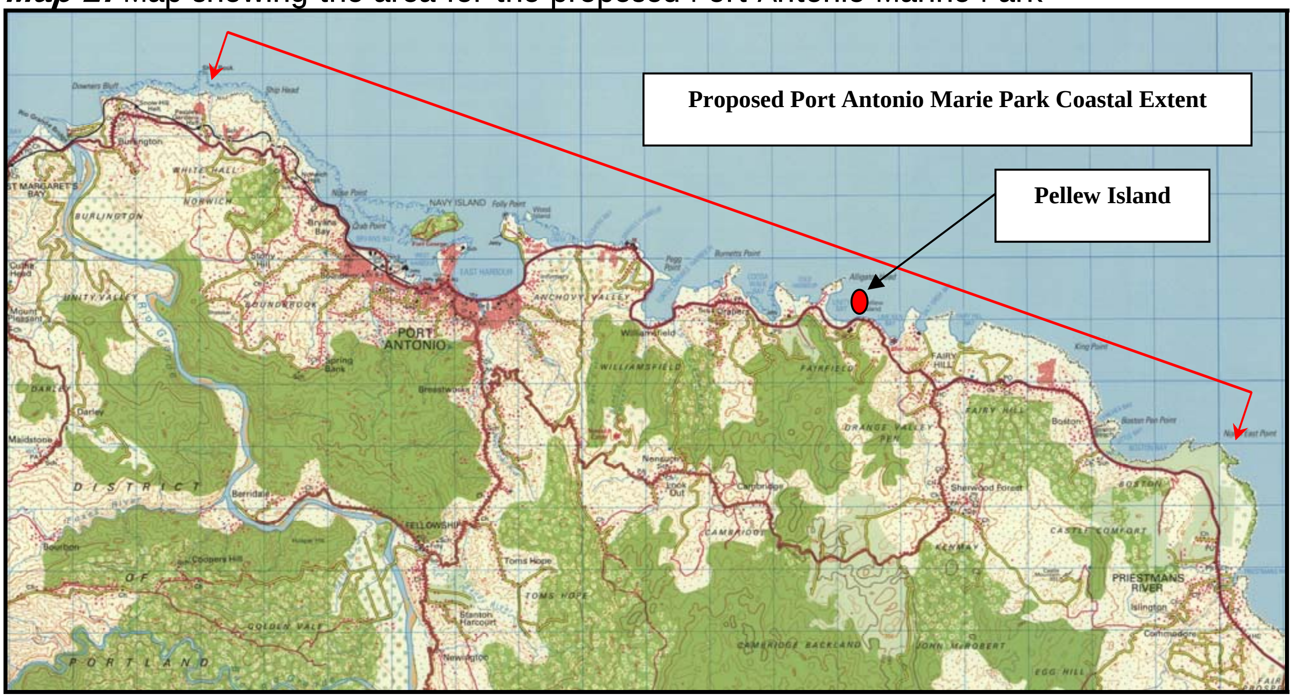
RATING	SYMBOL
Dominant	**D**
Abundant	**A**
Frequent	**F**
Occasional	**O**
Rare	**R**

B. PRESENT STATUS

i. Conservation Status of the Area

The analysis of aerial photographs of the site and the Protected Area Map of Jamaica (NEPA, 2005) shows that the project site is not located within a protected or conservation area. The area however falls within the proposed Port Antonio Marine Park (See ***Map 2*** below) which has been under consideration for more than ten (10) years[4], but has not been legally declared.

Map 2: Map showing the area for the proposed Port Antonio Marine Park



ii. Description of the Flora

Pellew Island is not densely vegetated. It is an island that consists of moderate floral diversity consisting of large trees with minimal under storey. Vegetation is concentrated in areas where there is sufficient soil cover for survival. Where an under storey was observed it consisted of homogenous patches of a single species namely

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4 Jamaica's Commitment to the Conservation and Management of Natural Resources: Ten Years in Retrospect. NEPA, March 2002.

ferns (*Polypodium vulgaris)* and in one area a stand of Vervine *(Stachytarpheta jamaicencis)* was observed. Where no under storey was observed, the ground was covered with leaf litter. The spatial distribution of the dominant species in this area is typified by a clumped distribution pattern, which has the characteristics of the presence of one plant of a species means there is a high probability of finding another of the same species close by (Barbour *et. al*, 1987).

Trees on the island range from 20 – 30 m in height with diameter at breast height (dbh) of over 6 m. Most of species observed on the island are those that are typically found in coastal areas and are those that can tolerate the effects of sea spray and saline conditions. Commonly observed species, included Sea Grape (*Cocoloba uvilera*), Wild Grape (*Cocoloba diversifolia),* Noni (*Morinda citrifolia*), and Almond (*Terminalia catappa)*. Although some of these species were observed on the semi-flat plateau, these were concentrated closer to the waters edge. Among the species mentioned earlier, other species that were commonly observed on the semi flat plateau (the area where the construction activities will be focused) consisted of a number of coconut trees (*Cocus nucifera*), Swamp Cabbage (*Roystonea principes*) and a large stand of Bamboo (*Bambusa vulgaris)* that is concentrated to the centre of the island. Uncommon species observed include Guinep (*Melicoccus bijugatus),* Weeping Willow *(Casuarina equisetifolia),* Flame of the Forest *(Spathodea campanulata)* and Poincina *(Poinciana coriaria).*

Twenty–three (23) plant species were observed during the assessment, four (4) of which are endemic to Jamaica. This includes *Hylocereus triangularis, Stachytarpheta jamaicencis, Cionosicyos pomiformis,* and *Roystonea principes (*Adams, 1972*)*. The remaining species observed are either introduced or native and can be observed in similar habitats island-wide. No rare, threatened or endangered species were observed during the assessment. One (1) invasive alien species, *Bambusa vulgaris* was observed (JACHM, 2007). The complete list of plant species observed during the Floral Assessment is shown in ***Appendix 4***.

Based on the assessment, it can be concluded that the vegetation on the island has been established for many years, as indicated by the height of the canopy and the diameter at breast height (dbh) of the trees that were observed. These plants are likely to have populated the island through seeds being carried from the mainland by wind, water and animals such as birds. The vegetation has also been largely influenced by climatic conditions. Wind has especially played an important factor in the distribution of vegetation on the island. The southern section and those areas more inland have a higher level of diversity and the greater concentration of the large trees. Whereas the more exposed areas, that is to the northern section of the island, shows evidence of impact of high wind gusts on the growth pattern of trees. Alteration of the bark of trees is evident in this area. There is also evidence of the impact that hurricanes have had on the island through numerous broken limbs and fallen trees. The island experienced the effect of Hurricane Dean some four (4) months prior to the time of this assessment and the vegetation is beginning to regenerate. A number of seedlings of plants such as Santa Maria (*Callophyllum jacquinii)* were observed, although no mature plant species were observed on the island, which shows that new species have begun to colonise the area.

The diversity in the floral species observed on the island can be explained by two factors which include the distance of the island from the mainland and the size of the island. The island being so close to the mainland has allowed plant species to be easily dispersed either through wind, water or carried by animals. The footprint available for colonization of plant species is however limited, if perhaps the island were larger and in the same proximity to the mainland then the species diversity would also be significantly larger than what was observed on Pellew.

4.2.1.2 ASSESSMENT OF FAUNA

This section of the report is divided into two (2) parts as follows:

- Assessment of Avifauna
- Assessment of Macro Fauna including other Insects, Reptiles, Gastropods and other Vertebrates

The Class Aves (Birds) was assessed separately because of the importance of these species as indicator species, and the high level of endemism present on the island.

A. AVIFAUNA

Islands are often characterised by a very rich biodiversity, and Jamaica is no exception. The bird life in particular, is not only rich in the number of species present but also in the number of species unique (endemic) only to the island of Jamaica. Of all the Caribbean islands, Jamaica has the most endemic species of birds with 30 species being recorded; although 2 of which are believed to be extinct.

i. Methodology

A point count sampling method was employed to assess the avifauna. In this method the observer stood at one point and counted all the birds seen and heard within six (6) minutes within an estimated fixed radius of 50 meters. In total four (4) points were counted, each approximately 150 meters apart. In addition, notes were made of the birds observed while travelling between the points. Point counts were conducted on May 4 and 5 2007 starting at 6:30 am and 6:00 am respectively.

The abundance for the birds identified during the assessment was determined by the scale as shown in ***Table 8*** below.

Table 8: Table showing the abundance ratings for the Avifauna identified

ABUNDANCE	RATING
Common	Seen or heard in >50% of observation points in suitable habitat
Locally common	Detected in >50% of observation points but habitat type restricted in area
Fairly common	Seen or heard in 25% - 50% of observation points in suitable habitat
Uncommon	Seen or heard in <25% of observation points in suitable habitat
Rare	Not likely to be seen on every observation trip
Vagrant	A migrant that occurs less frequently than once every 10 years

ii. Present Status

Islands are often characterised by a very rich biodiversity, and Jamaica is no exception. The bird life in particular, is not only rich in the number of species present but also in the number of species unique (endemic) only to the island of Jamaica. Pellew Island, however, is too small to accommodate a large population of birds. Nevertheless, being only 82 metres from the Jamaican mainland, a few species may find its isolation ideal for nesting. This was evident from the observation of the nest of a Bananaquit (*Coereba flaveola*). A possible nest hole of a Jamaican Woodpecker (*Melanerpes radiolatus*) was noticed in a dead tree, but this could not be verified. The presence of rats on the island however, may also limit the number of nests and types of birds that occupy the island.

Only fourteen (14) species of birds were identified on or in the vicinity of the island. This low number is most likely attributed to the small size of the island. This made it difficult to discern abundance ratings based on the DAFOR scale. As a result, their ratings were partly based on the knowledge of their abundances on the mainland in the immediate vicinity.

The Bananaquit was the most abundant bird observed on Pellew Island, and it also exhibited nesting activities. Therefore, this bird was rated as being dominant and all other birds scaled from it. While only single individuals of most other species were observed, no species was ranked as rare since they were all at least frequent on the mainland and the frequency in which they visit the island is unknown.

Only two (2) endemic species were observed; the Jamaican Woodpecker and the Black-billed Streamertail (*Trochilus scutinus*). Both species are believed to make use of feeding opportunities on the island. They are not believed however, to be the only endemic or resident species that make the trip to the island to feed. The avifauna of the neighbouring mainland is rich in species and abundance.

Five (5) species that were observed are associated with the coast and feed by fishing in the shallow lagoon around the island. These species include the Magnificent Frigatebird *(Fregata magnificens*), the Belted Kingfisher (*Ceryle alcyon*), the Osprey (*Pandion haliaetus*) and the herons.

No rare, threatened or endangered species were observed during the assessment. It is important to note, however, that all bird species observed are protected under the Wild Life Protection Act (1945). The list of bird species observed is shown in ***Appendix 4***.

B. OTHER MACRO-FAUNA

i. Methodology

The assessment of the macrofauna, excluding avifauna and butterflies, were conducted simultaneously with the assessment of the flora. Animals were divided into four (4) categories as follows:

- Reptiles
- Insects
- Crustaceans
- Nuisance Species

ii. Present Status: Reptiles

The Anoles lizard is one of the most common vertebrates in Jamaica and is widely distributed from highly disturbed urban areas to forests. Only a very few lizard species were observed during the assessment, however. This is due to the small area of the island as well as the isolation of the area from the mainland.

iii. Present Status: Insects

Apart from the presence of a few ants, the diversity of insects observed is practically non-existent. This can be attributed to the isolation of the island from the mainland, as well as the strong wind conditions that affect the island especially to the northern side.

iv. Present Status: Crustaceans

The site being coastal in nature, a number of crabs were observed. These were all hermit crabs (*Coenobite clypeatus*). These crabs were mostly observed on the beach area to the south of the island.

v. Present Status: Nuisance Species

A few rats (*Rattus rattus*) were observed during the assessment. Being excellent swimmers and the island only being about 100m from the shoreline, these rats have possibly colonised the island from the mainland and reside there feeding on the fruit trees present.

4.2.2 BIOLOGICAL ENVIRONMENT: MARINE ENVIRONMENT

METHODOLOGY

Literature relevant to the characterization of the benthic communities in the study area was reviewed in conjunction with satellite imagery of the area. A detailed visual assessment of the project area was conducted with the aid of underwater video and still cameras to ground truth the benthic features identified on satellite images, and to characterize the benthic communities on the fore reef and in the foot-print of the docks proposed for Pellew Island and the mainland.

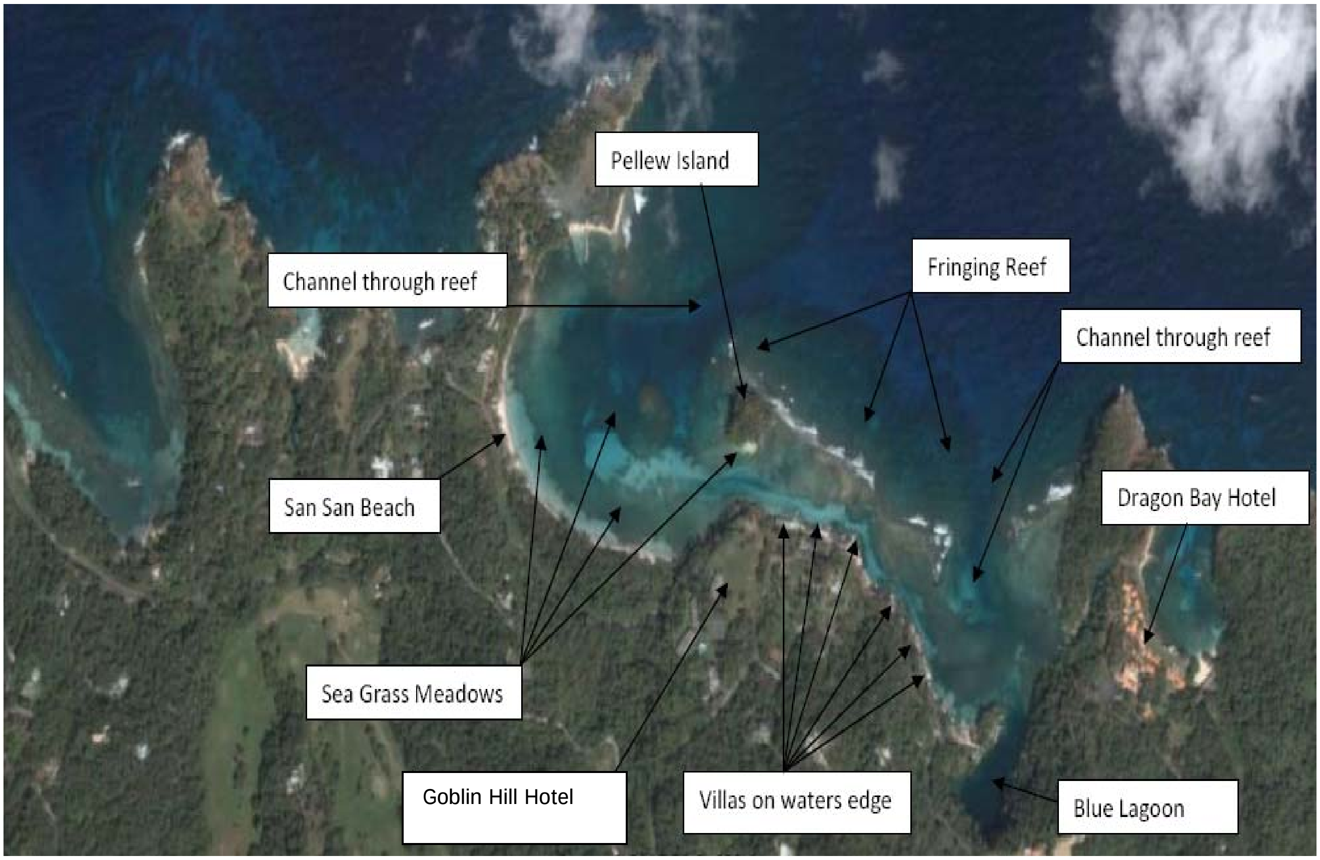
Standard techniques were used to analyze the video footage of the coral reef communities on the fore reef[5].

4.2.2.1 DESCRIPTION OF THE GENERAL AREA

Pellew Island is located on the seaward edge of the 1.12 km long lagoon that runs west-north-west to east-south-east. This lagoon is protected by a central reef formation approximately 500m in length running north-west to south-east. The reef formation comprises of a fore reef, reef crest and back reef. Pellew Island is located at the north-western end of the reef formation, immediately behind the reef crest. The island and the reef formation serve as a natural breakwater, protecting the lagoon from the direct force of the sea. Immediately to the east and west of the reef formation are channels that provide access to the lagoon for small vessels. The lagoon varies in width. At its widest, in the vicinity of San San Beach, it is approximately 460m wide. At its narrowest, the distance between Pellew Island and the mainland, is approximately 100 m. In the south-east of the lagoon the distance between the existing villas on the waters edge and the reef crest varies between approximately 100m in the vicinity of Pellew Island to approximately 250m in the vicinity of the Blue Lagoon. This is shown in ***Figure 7*** below.

[5] **www.nova.edu/ocean/cpce**

Figure 7: Figure showing Pellew Lagoon



Source: Google Earth (2007)

The shore of the mainland and the area behind or landward of the reef crest and Pellew Island is fringed by sea-grass (*Thalassia Testudinum*) meadows. The sea-grass meadows fringing the mainland are separated from those that fringe Pellew Island and the reef crest by a sandy channel.

The currents in the lagoon run east to west as is expected for the north coast of the country. However, waves overtopping the reef crest to the east and west of Pellew Island drive water in the lagoon from north to south. That is, currents formed by the pressure of water overtopping the reef crest travel westward along the channel past Pellew Island towards San San Beach. During periods of heavy wave action, currents in the lagoon near the reef crest can reach three meters per second.

A: THE PRESENT STATUS: THE LAGOON

The substrate in the lagoon varied with proximity to the reef crest and exposure to wave action. The areas immediately east and west of Pellew Island are exposed to strong wave-induced currents. The substrate was characterised by a mixture of irregular coral pavement, coral rubble, and sand patches. To the west of Pellew Island, additional relief was provided by the eroded remnants of massive coral colonies. These areas were characterised by highly diverse assemblages of seagrass, algae, fish, corals, and other invertebrates (See ***Appendix 4*** for the full list of species that were observed*)*.

In the comparatively protected areas immediately to the landward side of the Pellew Island and the shallow waters bordering the mainland, the substrate tended to be sandy. The dominant plant-cover in these areas was provided by the seagrass *Thalassia testudinum*. The plant and animal assemblages in these areas tended to be less diverse than in the high-energy areas to the east and west of Pellew Island.

The substrate to the seaward of the mangroves located south of San San Beach was varied between sand and fine muddy sediment. The substrate was populated by dense *Thalassia* meadows*. Tripneustes ventricosus* were patchily distributed in the seagrass meadows. The maximum localised density observed during reconnaissance was six (6) individuals per square meter.

The floor of the channel that runs the length of the lagoon was predominantly sandy with occasional fields of scattered coral rubble, or isolated relic coral colonies. The channel floor tended to be devoid of algae and seagrass. High densities of *Diadema antillarum* were associated with large relic coral heads.

The development plan includes the construction of two docks on the island. The area for the location of the docks was assessed and the results outlined below.

i. Dock 1

The most common coral species observed in the area in the footprint of ***Dock 1*** on the eastern side of Pellew Island (Shore: N18, 10’ 25.0” / W076, 23’ 24.1”; End of Dock: N18, 10’ 28.8” / W076, 23’ 24.2”) were *Siderastrea radians,* and *Porites sp*. (See ***Appendix 4*** for complete list of species).

The algal community was dominated by the coralline algae *Halimeda opuntia*, *Penicillus* sp., and the fleshy algae *Dictyota* sp. and *Padina jamaicensis.* Less abundant algal species observed included *Galaxaura* sp., *Turbinaria* sp., *Udotea* sp., and *Ventricaria ventricosa*.

The common invertebrate species observed included *Stichodactyla helianthus*, *Condylactis gigantea*, and the brown encrusting sponge.

ii. Dock 2

The substrate in the area proposed for ***Dock 2*** to the west of the island consisted of coral pavement and sand with coral rubble and large, eroded, relic coral colonies. The three-dimensional relief created by the relic coral colonies and live coral colonies was greater, on average, than that observed at the proposed location for ***Docks 1*.** The coral, non-coral invertebrates, and algal, species observed in the area were similar to those observed in the area proposed for ***Docks 1****.* However, the number of fish and other species were observed to be higher than at the proposed location for ***Dock 1***. This may have been due to the high levels of relief and three-dimensional complexity created by the large relic coral colonies, irregular coral pavement, and large coral rubble fragments.

B. THE PRESENT STATUS: THE FRINGING REEF

The fringing reef runs roughly parallel to the mainland shoreline and is separated from the mainland by the reef crest, and the shallow lagoon. The spur and groove structure of the fringing reef is very pronounced with steep sided sand channels separated by heterogeneous stony coral buttresses. The fringing reef is approximately 500m long (running north-west to south-east) and is 100m to 250m in width (running south-west to north-east) see ***Figure 8*** below.

The fringing reef seaward of Pellew Island was surveyed by the University of the West Indies Centre for Marine Sciences (CMS) in 2000 as part of the Caribbean Planning for Adaptation to Climate Change (CPACC) Project's activities to assess the impacts of global climate change in the Caribbean. Pellew Island, or Monkey Island as it is referred to in the monitoring reports, was selected as one of three monitoring sites because it was considered to be minimally affected by anthropogenic factors. The monitoring site extended from due north of Pellew Island eastwards to the Blue Hole area following the 7 – 13 m depth contour (Chavannes-Creary 2006).

The National Environment and Planning Agency, (NEPA) continued field monitoring at the same site using the same survey methodology for the period 2001 – 2003 as part of their regular work programme (Chavannes-Creary 2006). Coral reef monitoring by NEPA was not carried out in 2004 or 2005, but was resumed in 2007.

The surveys conducted by the CMS and NEPA involved the use of underwater video cameras to record the state of the benthic community along 20m transects located randomly on the fore reef parallel to the 7 to 13 m depth contour. Data were collected using the CPACC Video Monitoring Protocol.

Figure 8: Aerial photograph showing the location of the monitoring site at Pellew (Monkey) Island, Portland. (Chevannes-Creary, 2006).

The survey results for the period 2001 to 2003 at Monkey Island, Portland showed that the algae and dead coral colonised by algae dominated the benthic community representing a combined percentage cover of approximately 60% for all three years. The coralline algae were the next highest contributor to the benthic substrate cover representing 13.47% in 2001, 23.66% in 2002 and 5.15% in 2003. Live coral cover fluctuated between 11.24% in 2001, down to 6.23% in 2002 and up again to 11.80% in 2003 (Chevannes-Creary, 2006).

The results of the monitoring programme for the three-year period 2001 to 2003 were similar to those obtained in the study carried out in 2000 with hard coral cover appearing to fluctuate from year to year, but not rising above 12% (Chevannes-Creary, 2006).

An analysis of the footage from transects surveyed in March 2007 suggested that the relative coverage of the components of the fringing reef community seaward of Pellew Island had not undergone significant change since the 2003 survey (See ***Table 9*** below).

Table 9: Table showing the summary of mean percentage cover for the substrate categories found at Pellew (Monkey) Island, Portland for the period 2001 to 2003 (Chevannes-Creary, 2006) and 2007

SUBSTRATE CATEGORY	2001	2002	2003	2007
Hard coral	11.24	6.23	11.80	10.90
Gorgonians	1.41	0.13	0.19	0.27
Sponges	1.46	0.23	0.13	1.78
Zonanthids	0.00	0.00	0.01	0.00
Macroalgae	26.92	55.02	55.85	63.61
Other live	0.74	1.36	1.38	0.69
Dead coral with algae	33.95	3.94	5.29	8.68
Coralline algae	13.47	23.66	5.14	3.02
Diseased coral	0.14	0.00	0.00	0.00
Recently dead corals	0.38	0.04	0.04	0.14
Sand rubble, rock boulder	10.26	7.53	17.70	8.44
Unknown	0.03	1.86	2.46	2.47

The status of the reef along Pellew Harbour is not unique. The increasing abundance and diversity of algae species suggests eutrophication, which has become a general phenomenon island-wide. It also indicates that the reefs do have anthropogenic influence; the most probable source being the Blue Lagoon Villas.

Along the North Coast of Jamaica between 1977 and 1993 average coral cover dropped from 52% to 3% while the abundance of seaweed increased from 4 to 92%[6]. This has been attributed to the effects of hurricane damage, surface water drainage, over fishing, disease and predation, sewage effluent discharge, climate change and direct human contact. Each of these causes of reef degradation has been suggested as the cause of the island wide deterioration of reefs and the Port Antonio area has not been exempt, as eutrophication has been reported to be visible in all the populated bays, but generally absent off un-populated shores.

[6] **Hughes, T. P. Science 265, 1994.**

The critical levels of nitrogen and phosphorous below which reefs remain healthy without being overgrown by weed and algae are suggested to be 0.014 mg/l N (0.040 mg/l NO^3) and 0.003 mg/l P (0.007 mg/l PO_4) respectively[7]. Port Antonio is, relative to other areas, little populated, but a survey of nitrate levels conducted in all major freshwater sources along the proposed Port Antonio Marine Park shoreline in 1994 showed even these would need to be diluted between 2 to 45 times to meet these requirements. Port Antonio's freshwater discharge is therefore not 'coral-friendly'.

More recently, there may have been some degree of recovery rather than, as previously assumed, continual decline[8], with areas showing an increased population of the sea urchin *Diadema antillarum* recording less algal cover and more juvenile coral. This emphasizes the importance of algae-feeding organisms in the maintenance of healthy reefs. It also supports one school of thought that the key to controlling the abundance of algae is to increase sea urchin, fish and other herbivore populations rather than control nutrients. With the exception of rare epidemics it is easier to control the decline in fish and other beneficial species through the enforcement of existing fishing regulations, than significantly reduce the input of nutrients, many of which originate well way from the coast.

C. THE PRESENT STATUS: SEA TURTLES

Information gleaned from local fishermen indicated that sea turtles were often seen in the lagoon. They, however, could not identify which species of turtle observed. While no species of turtles were observed during this assessment, the turtles that are inhabitants in the coastal waters of Jamaica are the Loggerhead, Hawksbill, Leather back and the Green Sea Turtle. Due to the limited sandy areas on the site, it was not perceived that Pellew Island was used by these species as a nesting site. Areas suitable

[7] ***Modification of Benthic Community Structure by Natural Eutrophication: The Belize Barrier Reef.*** **Lapointe, B., Littler, M. and Littler, D. Proceedings 7th International Symposium on Coral Reefs, 317-328, 1993.**

[8] ***Recovery of*** **Diadema antillarum** ***reduces Macroalgal Cover and Increases Abundance of Juvenile Corals on a Caribbean Reef.*** **Edmunds, P. J. & Carpenter, R. C. Proc. Natl. Acad. Sci. 98, 2001**

for nesting are possibly the sandy shores to the north west of the area in the vicinity of Alligator Head.

D. THE PRESENT STATUS: MANATEES

During the socio-economic survey, respondents attested to the presence of manatees that sometimes visit the lagoon. This would not be unusual given the extensive seagrass meadows on which they would forage. No manatees were observed during the time of the assessment.

5.0 DESCRIPTION OF THE SOCIO-ECONOMIC SETTING

The socio-economic conditions of the area will be discussed in this section. The conditions looked at will be examined in terms of micro (local) and macro (national) levels.

METHODOLOGY

The assessment of the socio-economic setting of the study area involved the collection of primary and secondary data and the review of socio-economic data presented in past reports.

For the purpose of this evaluation, local conditions focused on the communities within a 2 km radius from the site while those on a national level focused on the island-wide conditions. Discussions were also held with residents in these communities during the months of November and December 2007. Since the evaluation the numbers of villas to be constructed has been halved. It is assumed that the responses to the survey would still be relevant given that the project description is greater than that now envisaged.

The gathering of quantitative and qualitative data are equally important when gauging the perceptions of stakeholders ranging from the existing conditions of their communities to what the impacts they believe any development may have on their quality of life. One of the primary research tools used to glean information on the public perception of the project from the existing residents within the communities was a questionnaire or structured interview (See ***Appendix 5)***. At the beginning of all interviews, interviewees were briefed about the proposed development and a site layout plan (See ***Appendix 2***) shown.

The questionnaire used had a mixed format of closed and open questions. Where necessary the answers were limited to facilitate easier answers on the part of participants. Some questions were structured to allow the respondents to expand on their previous answers or to give more personal input to the answers. In cases where the expressed opinion of the participant was most appropriate the question posed tended to be open allowing full expression. A total of forty–three (43) questionnaires were administered within the study area.

5.1 SOCIAL STRUCTURE

5.1.1 COMMUNITY STRUCTURE

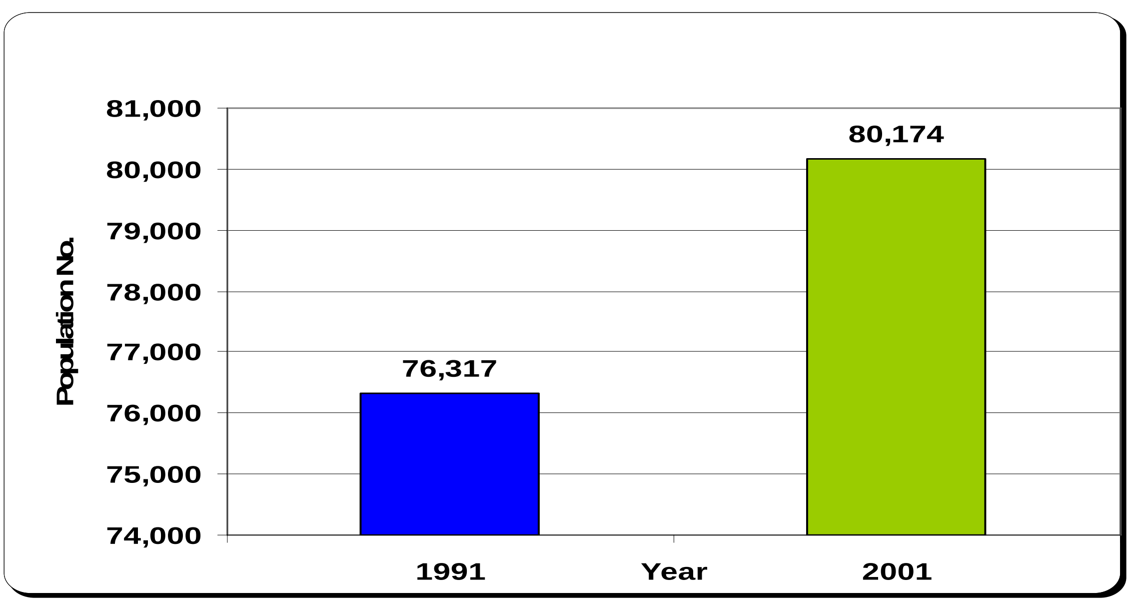
Several residential communities are within 2 km of the development site. These include the communities of Blue Lagoon, Zion Hill, Pompey and San San. The major township of Port Antonio is located approximately 8 km from the development site.

5.1.2 DEMOGRAPHY

A. Population

Census data from the 2001 Census shows that the population in the parish of Portland is approximately 80,174 showing a population growth of 4.8 % over the ten (10) year period since the population census in 1991. See ***Figure 9*** below.

Figure 9: Graph showing the population numbers for 1991 and 2001 for the parish of Portland



Source: STATIN (2001)

B. Gender Ratio

The total female population of the parish of Portland is 40,223 and the total male population is 39,951 which is an average of approximately a 1:1 ratio of males compared to females.

C. AGE VARIANCE

The 2001 census data from the Statistical Institute of Jamaica (STATIN) show that approximately 32% of the population of Portland is under 15 years of age, 59.9% 16-64 and 8.1% older than 65.

5.2 ECONOMIC STRUCTURE

5.2.1 EMPLOYMENT AND INCOME GENERATION

A variety of professionals were polled during the survey, these ranged from property owners, to fishermen to craft vendors and construction workers *inter alia*. During the survey persons attested to the need for more job opportunities for young people in the area. The shortage of jobs was however not evident in the survey, as the unemployment rate among those persons who participated was low and only accounted for about two percent 2 (%) of the census body.

Of those persons that were surveyed, approximately fifteen percent (15 %) obtained a direct income from the island. These persons were mostly boatmen or fishermen who made their living by transporting tourists to the island for daily excursions. The average cost of these trips is currently about J$1,000 per round trip and this group said that they could make an average of three (3) trips per week. Persons also said that they made indirect income from the island from craft vending, in the vicinity of the Blue Lagoon. Property owners also said that the island attracted their guest to their properties and that the visit to the island was popular among tourists. Persons have also travelled from abroad to utilise the beach area for small wedding ceremonies.

5.3 INFRASTRUCTURE

5.3.1 TRANSPORTATION NETWORK AND TRAFFIC

Pellew Island can be accessed by boat from the San San main road about 8 km from the town of Port Antonio. The access to this section of the island from other communities is at best difficult, at present. The roads between Port Antonio and Ocho Rios and Port Antonio and Kingston are narrow, winding and generally in poor condition with frequent pot holes, although a new section of the North Coast Highway is under construction. Traffic is however not an issue in this area.

5.3.2 UTILITIES

A. Electricity

The adjacent main land areas immediately south of Pellew Island have access to electricity. There is currently no electricity supply on the island, but is available on the main land immediately south of the island.

B. Water Availability

Data provided by the Statistical Institute of Jamaica (STATIN) shows that within the Port Antonio area 70.9% of households have access to public piped water supply, 13.1% to a public standpipe, while 3.1% use river and/or spring sources, 11.6% depend on rainwater harvesting, and 1.3% have private wells. Overall accessibility to 'safe' water is 84%. The National Water Commission (NWC) is however in the process of overhauling the supply of potable water to the town of Port Antonio. There is no access to potable water on the Pellew Island at present, but it is available on adjacent main land areas immediately south of Pellew Island.

C. Telecommunication Services

Fixed line services provided by Cable and Wireless Jamaica Ltd. are available in the communities within the study area. Most residents in the area said they relied on cellular service (Digicel, Cable and Wireless and Miphone) for their means of telephone communication. No fixed line services are available on the island, presently; however, cellular service was available and reliable on Pellew Island during the time of this assessment.

5.4 WASTE MANAGEMENT

5.4.1 SOLID WASTE

Data from the National Solid Waste Management Authority's (NSWMA) Garbage Collection Schedule (2007) shows that garbage is collected in the area by the North Eastern Parks and Market at least once per week. This is disposed of at the solid waste disposal site located close to the border of the parishes of Portland and St. Mary.

5.4.2 SEWAGE DISPOSAL

Most of the residents interviewed had indoor plumbing suitable for piped water in their homes with toilet facilities. This sewage is disposed of in individual absorption pits. The sewage system that is utilised by the villas within the lagoon is reported to consist of a sealed septic tank which is emptied once it has reached its maximum holding capacity[9].

5.5 SOCIAL SERVICES

5.5.1 HEALTH SERVICES

The major hospital in Portland is the Port Antonio Hospital which is located approximately 8 km from the proposed development site. The closest other hospital is about 30 km from the project site and is located in the township of Buff Bay. A Health Centre is also located in the town of Portland, as well as a number of private doctor practices.

[9] **Verbal communication with villa workers and construction workers at the Blue Lagoon Villas**

5.5.2 EMERGENCY SERVICES

A. Fire Services

The closest Fire Station to the study area is the Port Antonio Fire Station, which is located approximately 8 km from the project site. A second fire station serves the parish and is located in the township of Buff Bay approximately 30 km from the project site.

B. Police Stations

The closest police station to the project site is the Port Antonio police station which is located about 8 km from the project site.

5.5.3 TRANSPORTATION

Bus and route taxi services are available but are inevitably slow because of the poor road conditions in the parish. The closest airport to the site is the Ken Jones Aerodrome which is located approximately 15 km from the site, but this airport has been closed for some time. In early 2008, the Government of Jamaica announced development plans for the construction of an airport equipped with customs and immigration which is proposed to be built in Duckenfield, St. Thomas which is located about 35 km from the project site. This construction would significantly improve the means of accessing Portland, which has been hampered by poor road conditions in the past.

Access to Pellew Island is via boat or bamboo raft, which are operated by the fishermen from the Blue Lagoon fishing beach. Due to the narrow channel between the land and the island some persons access the island by swimming.

5.6 AREAS OF HISTORICAL AND CULTURAL SIGNIFICANCE

Pellew Island is located approximately 8 km from the historical town of Port Antonio, which is reputed to be surrounded by one of the most beautiful harbours in the Caribbean. Also located in the town are buildings which boast Georgian type architecture such as the courthouse, neo-Romanesque Anglican Church built in 1840, the gingerbread Demontevin Lodge built in 1881 and several dozen other houses on the Titchfield Peninsular, and Fort George. Just outside the town on a prominent headland lies the ruin of Folly which was built in 1905, a 60-room mansion constructed from concrete in pseudo-Grecian style, and the Folly Point Lighthouse built in 1888. Navy Island, just off the twin harbours, was once owned by actor Errol Flynn. Pellew island has also been described as one of the ‘icons’ of the parish and it came into public light when Princess Nina Khan received the island as a romantic wedding gift from her husband.

5.7 COMMUNITY’S PERCEPTION & KNOWLEDGE OF THE PROJECT

Forty–three (43) persons were interviewed during the Socio-Economic Assessment to garner the local community’s perception of the proposed project. The participants in these interviews ranged from fishermen, local environmental non-government organisations in the area, construction workers, tourists, villa owners (Blue Lagoon Villas, San San villas and other villas within the 2 km radius), hotel operators, craft vendors resort employees.

5.7.1. COMMUNITY’S AWARENESS OF THE PROJECT

Of all the persons surveyed 39 % were aware that they were development plans for the island. Some of these persons said they had seen the proposed development on the internet, other persons said that they only knew that some development was to be undertaken at the site, but they were not sure what exactly was going to be built there.

5.7.2 USE OF THE DEVELOPMENT AREA BY THE COMMUNITY

Interviewees were asked if they used the island in any way. Approximately thirty-seven percent (37 %) of those interviewed said they utilised the property. Use ranged from fishing, swimming and snorkelling around the island, others utilised the beach for recreational purposes, a significant number of persons said they gained income from the transportation of guests to the island and one person reported that they often visit the island to reap coconuts.

5.7.3 GENERAL PERCEPTION OF THE DEVELOPMENT

The majority of the persons surveyed thought that the development would be good for the area (approximately 44 % of the persons surveyed). The basis of these positive responses was due to the anticipation of primary and secondary income generation activities that would arise from the development. Most of the persons polled were excited that new jobs would be created through direct employment during the construction and operation phases. Indirect income earnings were expected from the provision of goods and services such as craft items and an increase in demand from fishing activities.

It was also thought that the development of the island would encourage more tourist type development in the area. Although some of these persons said that the development would have a positive impact, some also had concerns about the economic impact that the development would have to residents in surrounding communities and hoped they that these persons would directly benefit from the jobs that would be created in the construction and operation phases of the development. Of those persons who thought it would be positive and currently use the island, hoped that they would still have unrestricted access to the beach area. Concerns were also raised about how the development would affect the aesthetics of the island, and some of these persons hoped that if the development occurred that it would be done in such away to offer that serene effect that the island now gives.

Thirty–two percent (32 %) of the respondents however thought that the development would have a negative impact. Reasons that were put forward included the loss of the aesthetics that island offers from all vantage points. Many persons responded to say that they thought the island in its natural state was beautiful to look at and offered them a sense of place. Fishermen especially thought that the development would affect the reef, which they said had only begun to regenerate since the passing of hurricane Dean in August 2007, and this would therefore affect their fishing catch. A number of persons said that the development would prevent them from using the beach and the waters around the island that were used for swimming, snorkelling and fishing. Most persons were however concerned about the environmental impacts that might arise from the development, through improper sewage disposal, solid waste disposal and run-off from the development into the surrounding waters. Concerns were raised especially by villa owners of privacy issues and it was hoped that if the development took place then villas would not face each other.

About seven percent (7 %) of the respondents said they did not care if it would be good or bad for the community. These persons however raised concerns about waste management (solid and sewage).

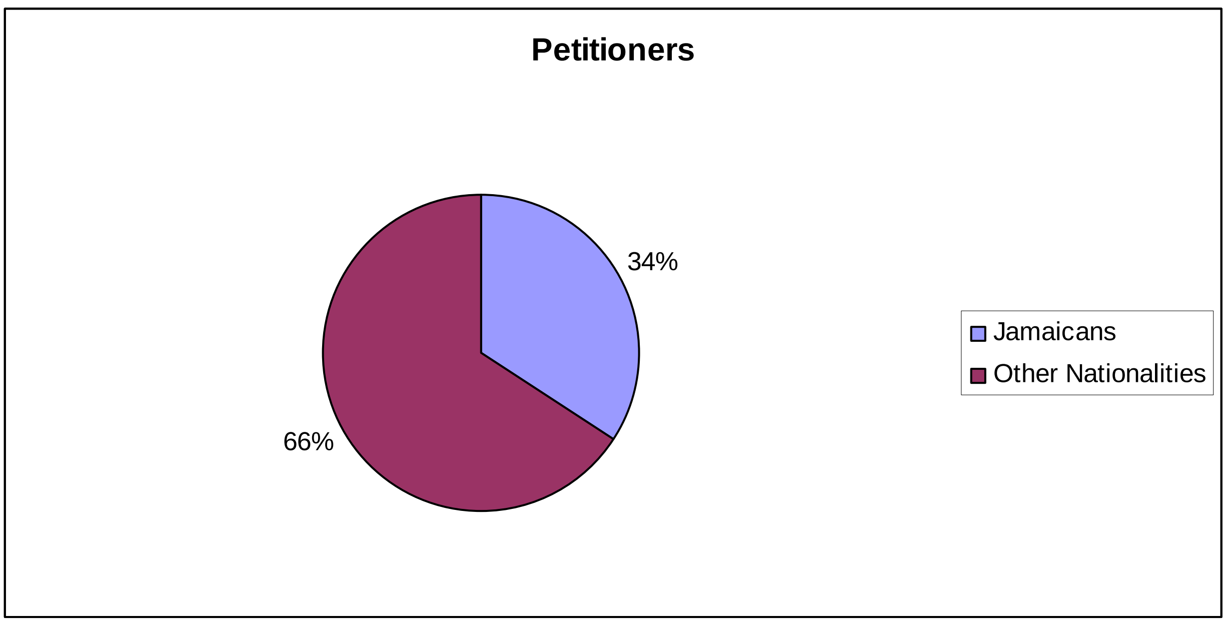
Seventeen percent (17 %) of the respondents said they were not sure whether the development would be good or bad for the community, but also raised concerns about the impacts to the environment from the various aspects of the development.

The Jamaica Environmental Advocacy Network (JEAN) has also vehemently opposed the development. An electronic petition has been circulated nationally and internationally for persons who wish to oppose the planned development (http://www.thepetitionsite.com/petition/846734890). JEAN also convened a meeting with villa owners from within the Port Antonio and San San area on Tuesday January 29, 2008. Excerpts from these minutes are shown in ***Appendix 5***.

The petition refereed to above, has also been circulated by the Jamaica Environment Trust (JET) to its members. This email encourages persons to sign the petition and indicates that there is likely to be significant environmental impact, loss of beach access and loss of scenic vistas, no basis for the assertions are presented in the preamble to the petition for the opposition to the development. There is also only a minimal project description and no project drawings.

The petition site was launched on January 30, 2008 and as of April 18, 2008 had 1,944 petitions recorded. The petition was closed at the end of July 2008 and had a total of 2,025 petitions. Of the 2025 petitioners only 699 (34%) claimed that they were Jamaicans the others were mainly from the USA, Europe and the Caribbean (Fig. 10). Two Hundred and Eighty Two (14%) of the petitioners chose to remain anonymous.

Figure 10: Petitioners



The comments of the 2,025 petitioners were grouped into reasons for objection to the project and the data are presented in the Table below.

Reason for Objection	Number of petitioners	Comment
No Comment	1,040	
Beauty compromised, unspoilt place	416	Developer intends to preserve the natural beauty of the island.
Environmental impact, loss of biodiversity and wildlife	171	See Chapters 7, 8 and 9 for impact assessment and mitigation.
Too much development, anti-development	177	
ICON lost/nostalgia	107	
Marine Park	42	Not located in a declared protected area
Greed of developers	31	No covenants on the Title against development
Access to the island lost	31	Private property
Call for EIA/reasoned thinking/balanced view	5	
Stop foreign owners	4	Owners are not foreigners
Unique species present	1	No unique species are present on the island
TOTAL	2,025	

All of the reasons put forward by the petitioners have been consider by this report.

5.7.4 PROPOSED ALTERNATIVE LAND USE

During the survey respondents were also asked to identify alternative land-use activities that they believed would be more suitable for the island as opposed to the development of villas as proposed. Seventeen percent (17 %) of the respondents said they thought that the island should be left in its natural state. Another seventeen percent (17%) said they were unsure. The remainder of persons offered the following suggestions:

- The island should be declared a national monument and used as an eco-tourism attraction;
- Restaurant and Bar;
- Natural spa/Sea Spa – aqua-therapy;
- Casino; and
- Build a private house.

6.0 ANALYSIS OF ALTERNATIVES

The alternatives with respect to the project from the Environmental and Socio-Economic perspectives are discussed in this section. This includes a discussion on the project activity alternatives and the project design alternatives.

6.1 PROJECT ACTIVITY ALTERNATIVES

6.1.1 THE 'NO ACTION' ALTERNATIVE

Without the proposed development, Pellew Island will remain a relatively undisturbed area providing an aesthetically pleasing area from all vantage points. The habitats on and around the island will also continue to be impacted by anthropogenic and natural factors that do occur.

From a socio-economic perspective fishermen and boat men will continue to reap, however small, the economic benefits through the transportation of visitors to the island, and locals will still enjoy the use of the island for recreation purposes; which is a land-use that is difficult to put a dollar value on.

Pellew Island is privately owned. The Title for Pellew Island allows the building of a private dwelling house, guest house or hotel. To not permit a development that was sound and took into account all planning, building, environmental, and socio-economic issues would be to trespass on the legal rights of the owner.

It should be noted that access to the island could still be withdrawn from the public even if there is no development undertaken.

6.1.2 THE PROPOSED PROJECT ALTERNATIVE

With the construction of the villas, the island will see some alterations to the environmental attributes (physical and biological) of the area. Ecologically there will be removal of plant species that will also affect the fauna of the area but the species diversity as described in ***Section 4*** above is low and hence this impact would not be significant. The impacts of clearing of vegetation may have a major secondary impact through the impacts associated with soil quality and water quality in the marine environment surrounding the island. Improper sewage and solid waste disposal may also have major negative impacts on the marine environment. The number of villas to be constructed limits however the maximum visitors that the development can accommodate at any time that limits the severity of these impacts. Mitigation measures must include the proper handling of sewage treatment and solid waste management.

From a socio-economic perspective, the development would contribute to a partial national, regional and local income generation. Some earning potential by fishermen may be lost as with the proposed development will mean that they will now be unable to transport guests to the island. The developer may want to leave the beach area as an unrestricted area for guests, but this may have implied security issues.

The economic benefits that the development may bring have more observable positive impacts than the economic losses that the development may pose, as several jobs would be created by the development either directly or indirectly. The development would also, when combined with the other developments slated for the parish, contribute to community growth and development.

6.1.3 NATIONAL MONUMENT/ECOTOURISM ATTRACTION

The declaration of the island as a national monument and eco-tourism attraction may have its own implied impacts. Currently the island is a popular destination among tourists to area, however many local persons have never visited the island although they live within a 2 km radius from the island. The added publicity that a declaration would bring may increase the amount of visitors, which may in turn have a negative impact on the ecology and environment of the island. In order to minimise any negative impact some amount of infrastructure would have to put in place including restroom facilities for visitors, docks and pathways; some of the very same infrastructure that the development now proposes. This alternative would however perhaps maintain the aesthetic appeal that the island offers as it is presumed that little vegetation would be removed and no major structures would be constructed.

From a socio-economic perspective this alternative may not be a feasible, as the attraction that the island presents is limited. There are no unique environmental attributes of the project area that is not found in nearby coastal areas. The project area is used as a popular snorkelling destination but the reefs are beginning to show signs of deterioration due to anthropogenic influences from the developments that now exist. The increase in snorkelling activities may further exacerbate these impacts. Indeed, whether Pellew Island is developed or not there is a need to address the environmental impacts now associated with the villas that already exist.

Given the delays in declaring the proposed Port Antonio Marine Park it is not expected that the Government will move swiftly to acquire and protect Pellew Island for the common good. It is understood that many years ago a suggestion was made to the San San Association by the owners to have the Association purchase the island and place it in Trust, but that this was declined.

6.1.4. RESTAURANT AND BAR

The construction of a restaurant and bar would require the same amount of construction activities and will have similar impacts as the proposed villa development. Depending on the popularity of the bar more sewage and solid wastes may be generated by the restaurant and bar than the proposed villas.

From a socio-economic perspective, this alternative may not provide the level of economic benefits that the villa development may provide.

6.1.5. NATURAL SPA

The construction of a natural spa would also require significant construction of infrastructure and other amenities, which will have similar negative environmental impacts as the proposed development.

From a socio-economic perspective the development of the island as a natural spa may not have the same level of economic benefits as compared to the proposed villa development.

6.1.6. CASINO

The casino alternative was proposed by some of the neighbouring residents polled. This alternative would pose similar negative environmental impacts to the proposed villa development, as infrastructure works would have to be undertaken to facilitate this type of development. Further, depending on the success of the casino environmental impacts may be more significant in line with the negative impacts associated with the creation of a restaurant and bar which was discussed above. More vegetation would have to be cleared to accommodate the construction of such a casino.

Casinos have been known to provide a wealth of economic benefits, the size of the island however limits the footprint that may be necessary for the construction of an economically feasible casino. There are studies that indicate that casinos are disruptive to community structure and have an overall negative influence on the surrounding populace.

6.2 THE CHOSEN ALTERNATIVE

Based on the analysis of all the alternatives presented above, the villa development from an environmental and socio-economic stand-point may be the best alternative.

This development proposal presents an opportunity for a development that takes into account environmental issues and with the proper implementation of mitigative measures and environmental management will result in a project that provides ample economic benefits locally and nationally while protecting the environmental attributes of Pellew Island.

7.0 ENVIRONMENTAL IMPACT ASSESSMENT

This section outlines the methodology used for predicting the environmental impacts of the project and the identification of subsequent mitigation measures recommended for each negative impact identified.

METHODOLOGY

An environmental impact identification matrix was developed which covered the main potential impacts (positive, negative, major, minor, long and short term and any cumulative or synergistic impacts) of the project. The matrix lists impact types under broad headings with more detailed project specific impact categories (***Appendix 6***). These impacts are divided into the Site Preparation and Construction Phases and Operation Phase of the development.

7.1 PHYSICAL IMPACTS

7.1.1 CLIMATE

A. SITE PREPARATION AND CONSTRUCTION PHASES

Only a small footprint of vegetation needs to be cleared for the implementation of the project, and all the trees will be preserved. Therefore, these phases of the development will have minimal, if any, impact on the climate of the area. The removal of vegetation may marginally increase the wind speeds that affect the mainland due to the small size of the island.

Mitigation Measures:

- Maintain all mature trees (trees greater than 25cm dbh) throughout the development;
- Retain a 2 - 3 m vegetation buffer area around the perimeter of the island
- Remove only vegetation that is absolutely necessary for the construction of the villas and other amenities;

- All raw materials must be sourced as close as possible to the construction site thus reducing the emissions from vehicular traffic;
- Utilise just-in-time construction techniques that will minimise the need for storage of large quantities of building materials.
- Recruit staff from the surrounding communities to decrease the travelling distance thus reducing emissions from vehicular traffic;
- Ensure that all vehicles involved in the transport of construction material and staff, and machinery involved in the construction is properly maintained and serviced; and
- Machines must not be left idling for unnecessary periods of time; this will save fuel and reduce emissions.

B. OPERATION PHASE

This phase of the development will have no impact on the climate of the area. Landscaping activities will more than adequately replace the biomass of vegetation lost during the construction phase of the project.

7.1.2 AIR QUALITY

NO_2 and SO_2 produced in significant quantities may cause adverse health effects, via both acute and chronic exposure. Chronic exposure may result in increased incidences of respiratory illnesses in the exposed population. It is not expected that the construction of the project would produce significant quantities of pollutant gases, and therefore the air quality will not be significantly impacted by project development.

A. SITE PREPARATION AND CONSTRUCTION PHASES

Vegetation clearing for site preparation, storage of raw materials and spoilage are all expected to liberate dust and other forms of particulate matter. While most of the dust generated is likely to settle a short distance from these sources, smaller particles may be transported across a wider area. The magnitude of dispersion will be influenced by the local meteorological conditions, being on the coast, it is expected that the level of dispersion will be greater than as compared to inland areas, as wind speeds tend to be higher in these areas. The fugitive dust has the impact of being a nuisance. Fine particulates (<10μm measured as PM_{10}) in large quantities may cause respiratory distress or illness (asthma, bronchitis). Due to the small footprint of the development and the type of development that is planned, the level of dust liberated is expected to be minimal and therefore this phase of the development will have minimal, if any, impact on the air quality of the area.

Mitigation Measures:

- Ensure that all material (sand and aggregate) stockpiled on the site to be used in construction activities are covered with tarpaulins and regularly wet with water to reduce the effects of the wind and decrease the chances of producing fugitive dust.
- Ensure that all trucks and boats carrying construction material to the site are covered during delivery to the site.
- Care must be taken in the unloading construction materials to prevent spillage. If a spill occurs, this should be cleaned up as soon as possible thereafter.
- All staff employed at the construction site must be provided with dust masks and be asked to use them.
- All raw materials must be sourced as close as possible to the construction site thus reducing the emissions from vehicular traffic.
- A traffic system should be implemented that involves the use of appropriate signals and signs to ensure the smooth flow of traffic. This will reduce the idling time of vehicles and therefore reduce the emissions in the delivery area.
- All construction waste must be transported off-site to a Parish Council approved facility. They may not be burnt or stored for any longer than is absolutely necessary.

- o Staff should be recruited from the surrounding communities to decrease the travelling distance thus reducing emissions from vehicular traffic.
- o Ensure that all vehicles involved in the transport of construction material and staff, and machinery involved in the construction are properly maintained and serviced which will reduce air emissions and the likelihood of oil or fuel spills.
- o Machines must not be left idling for unnecessary periods of time; this will save fuel and reduce emissions.

B. OPERATION PHASE

The operation of the resort will see a minimal, if any, increase in vehicular traffic to the area but this will be negligible when compared to background levels. Therefore, this phase of the development will have no impact on the air quality of the area.

7.1.3 WATER QUALITY

A. SITE PREPARATION AND CONSTRUCTION PHASES

The activities involved in these phases of the development may possibly cause a major irreversible negative short-term impact on the water quality in the area. This will be as a result of many of the activities which are slated to take place in these phases which includes the possible storage of hazardous substances on the site such as diesel and motor oil for the operation of machinery and stand-by generators, and the storage of raw material for the construction of buildings.

The clearing of the vegetation within the development area may also have a synergistic negative long term impact on the water quality in the area as well. The removal of vegetation may increase the runoff from the site and therefore increase the level of sedimentation in the marine environment. The mitigation of this occurrence is particularly important, as the levels of Total Suspended Solids (TSS) at all water quality sample sites were considered above acceptable levels. This will also have a cumulative impact on the water quality within the lagoon as TSS values are currently at some sampling points ten (10) times above the required water quality standard.

Inappropriate disposal of sewage during this phase of the development may also have a major negative impact on the marine water quality in an area that currently shows elevated Nitrates (NO_3) levels.

Mitigation Measures:

- Land clearance for construction must be done on a phased basis to minimise the exposure of substrate, organic material, or top-soil;
- Clearance of vegetation must be avoided in periods of heavy rainfall (between May to June and October to November) to reduce the impact of runoff;
- Older trees and shrubs should not be removed to maintain vegetative cover;
- Minimise the disturbance to vegetation during the construction phase. Removal of vegetation should be kept to only the absolutely necessary.
- Maintain a fully vegetated buffer zone 2 meters in width around the perimeter of the island in order to manage sediment contained in the run-off from the site;
- Employ mitigative landscaping to control drainage patterns and to intercept and sediment laden surface run-off;
    - Deploying sandbags to contain loose excavated material and aggregate during the construction phase;
    - All building roofs must be guttered to reduce run-off;
    - Install siltation traps within the drainage design to collect silt and sediments ensuring that they do not end up in adjacent aquatic areas.
    - Employ engineering measures to reduce run-off and prevent it from reaching existing natural drainage courses and the sea;
    - Store all raw materials away from the vicinity of water bodies located on the property and away from sea to avoid contamination;

- Special consideration should be given to the storage of fuel, oil, cleaning agents, solvents, and paints. Avoid as much as possible storing these items on the island. If these materials are to be stored on site, ensure that they are properly contained in a bunded area (110% of stored capacity) with an impervious base. This area must be situated away from all water bodies and signs indicating the storage of these substances erected;
- Leaking or empty oil drums must be temporarily sealed or contained and removed from the site immediately and disposed of via a licensed waste disposal contractor. Washings from concrete mixers, paint or paint utensils should not be allowed to flow onto the ground or into any drain or watercourse;
- A comprehensive materials management plan should be developed to manage the movement of personnel, equipment, materials and supplies, and to identify the points in the transportation-chain or in usage that present risks for inadvertent pollution or contamination of the construction site and or marine environment. All spills should be immediately cleaned up. The development and implementation of the materials management plan should be made a contractual responsibility of the building contractor.
- A comprehensive waste management plan should be developed for the Pellew Island development site. The development and effective execution of the waste management plan should be made the contractual responsibility of the building contractor. The responsibilities should include, but not be limited to:
  - The designation of appropriate waste storage areas on the site for solid, liquid, and toxic or combustible waste materials. General refuse generated during these phases of the development must be stockpiled in one central area of the site, away from existing water bodies and collected, transported and disposed of appropriately at the designated disposal site;
  - The periodic removal of waste materials to the appropriate approved disposal facility by a certified contractor.

  - The institution of the necessary measures to prevent the inadvertent or intentional dispersal or loss of waste materials during storage, transportation, or disposal.
- Provide workers at the development site with chemical toilets during this phase of the development. One toilet should be provided for every eight (8) workers on the site. The chemical toilets should be removed regularly from the site and sewage disposed of by an approved contractor.
- Store all raw materials away from the vicinity of water bodies located on the property and away from the sea to avoid contamination in these areas.
- Conduct periodical water quality monitoring for areas around the island to ensure that stipulated standards are maintained.

B. OPERATION PHASE

This phase of the development may possibly have a major irreversible negative long term impact on the water quality in the marine environment especially from the operation of sewage treatment plants, solid waste generated from the facility and run-off. Sewage effluent may cause increased nutrient loading to the marine environment which already shows elevated organic matter and nutrient levels. This increased nutrient loading may affect parameters such as BOD, nitrates and phosphates which may have a negative impact on aquatic life. This nutrient loading may also lead to the enhanced algal growth in these areas, a process referred to as eutrophication. This surge in plant life can increase turbidity and hence light attenuation in water and also exacerbates the deoxygenation of these areas. It is thought that anoxic conditions may lead to the release of phosphate from bottom sediments and hence allow the eutrophication to become self perpetuating, regardless of future inputs into these water bodies (Morris and Therivel, 2000).

The activities involved in the operation of the villas may also possibly have an effect on the water quality in the area such as an increase in the level of run-off that may contain heavy metals, faecal bacteria, organic and inorganic chemicals, household cleaning residues and grease and oils. Oils and grease, for example, deoxygenate water as they are broken down, and can blanket the surface of the water inhibiting oxygen diffusion and it may also coat aquatic plants and animals causing injury or even death.

Mitigation Measures:

- Ensure that all sewage treatment plants are regularly maintained and that effluent is monitored to determine if the required Natural Resources Conservation Authority (NRCA) standards are being met.
- Effluent from the tertiary sewage treatment plant will be used to irrigate the project site during operation of the facility.
- An 8,000 litre storage tank for treated effluent should be installed to contain 2 days maximum production from the sewage treatment plant. This is so in the event of prolonged rainy weather that precludes irrigation that there is adequate storage. Also, this will provide a fail-safe in case of brief periods of plant malfunction. In both these cases the storage tank should be pumped dry into a portable tank that can be taken to the mainland and disposed at an approved sewage treatment facility.
- General refuse generated must be stockpiled in one central area of the development site, away from existing water bodies and collected, transported and disposed of appropriately at the designated disposal site.
- All chemicals to be used in the maintenance and operation of the villas and other amenities of the resort must be stored in a bunded area (110% storage capacity) with an impervious floor. This area must be situated as far away from all water bodies and signs indicating the storage of these substances erected.
- Run-off from the site must be contained.
- A comprehensive waste management plan should be developed for the Pellew Island development site for the operation phase of the development.

7.1.4 SOILS AND GEOLOGY

A. SITE PREPARATION AND CONSTRUCTION PHASES

The activities involved in the site preparation and construction phases of the development may, if done improperly, have a major negative long-term impact on soil profile of the project site. These phases of the development will see the removal of vegetation which will leave areas of soil exposed to the elements, which may result in soil erosion. This is a particular area of concern since the restricted nature of the island has also restricted the rate of soil accumulation that can take place as compared to mainland areas.

Diesel and other chemicals may be stored on the construction site and also at the storage site on the mainland. If spills occur, these may contaminate the soil in the area.

Mitigation Measures:

- Vegetation should be removed on a phased basis. This should be avoided in heavy periods of rainfall which is between May to June and October to November;
- Only remove vegetation that is absolutely necessary;
- Ensure that all open or exposed areas are replanted and landscaped as soon as possible;
- Install appropriate drainage systems to direct water away from slopes;
- Areas storing hazardous substances such as diesel must be properly contained in a bunded area (110% storage capacity) lined with impervious material. This area must be situated away from project activities and signs indicating the storage of these substances are to be erected. Care must be taken when handling these chemicals and substances to avoid spills.
- Constructing board-walks or paths of permeable-paving to minimise erosion due to daily foot-traffic and the movement of construction materials and equipment;

- In the event of a spill, the spill should be immediately contained and cleaned up and any contaminated soil must be removed and disposed of at a parish council approved disposal site.
- Ensure that general refuse is collected regularly and is transported and disposed of appropriately at the designated disposal site.

B. OPERATION PHASE

The operation phase of the development could have a minor negative impact on the soils and geology of the area. This may be through the impact of uncontrolled run-off from the roofs of buildings and general run-off from the site that may increase the level of soil erosion on the island.

Mitigation Measures:

- The villas must be guttered to control the runoff from roofs which if uncontrolled may cause accelerated soil erosion around the margins of buildings. The water collected can be recycled to be used for irrigating landscaped areas ;
- Ensure that all chemicals to be used in the maintenance of the villas, namely the chlorine to be used in the maintenance of the plunge pools, are properly stored in a specific location. All chemicals stored in this area must be properly labelled. The area where chemicals will be stored and handled must be constructed with an impermeable surface. This area should also be bunded with 110% storage capacity;
- Ensure that all vegetated areas on the island are maintained.

7.1.6 NOISE

A. SITE PREPARATION AND CONSTRUCTION PHASES

The activities to be carried out in this phase of the development may likely have the most significant negative short-term impact on the ambient noise in the development area. This will be from the movement of heavy goods vehicles that will be delivering supplies to the area and the loading and unloading of materials onto boats for transport to the island. The construction activities however will be concentrated on the island. Being a considerable distance from the mainland the actual construction activities will not significantly affect the ambient noise levels in the surrounding area. It is however important that the developer is conscious of implementing mitigation measures that will reduce the level of noise impact that may be associated with this phase of the development since the area is one that is used and zoned for tourist activities.

Mitigation Measures:

- Where possible silenced machinery and instruments should be employed to reduce the impact of noise on the existing residents and workers.
- Workers, especially those working with machinery, vehicles and instruments that emit high levels of noise should be supplied with ear plugs and ear muffs to reduce the risk of hearing impairment. Prolonged exposure to this impact should be reduced where possible.
- Maintain a 2 m vegetation buffer around the perimeter of the island this will act as a natural acoustic screen which will reduce the impact of noise during these phases;
- Construction hours should be limited to the hours between 8:00 a.m. and 6:00 p.m. daily.
- The delivery of raw materials must be limited to the hours between 8:00 a.m. and 6:00 p.m. daily.
- Ensure that there is proper traffic signage and signals where necessary or appropriate to effect the free and safe movement of traffic along the main road and therefore reduce the noise caused by traffic build-up.

B. OPERATION PHASE

The Operation Phase of the villa should have no impact on the ambient noise levels of surrounding areas due to the distance of the resort from the mainland.

7.1.7 LANDSCAPE AND AESTHETICS

A. SITE PREPARATION AND CONSTRUCTION PHASES

Pellew Island in its current undeveloped state offers attractive scenery for viewers from all vantage points. The removal of vegetation from the island that is involved in these phases of the development may negatively alter the aesthetics in the area if not done with sensitivity. Construction camps and storage sites which will be located on the mainland may also have a major negative short–term impact in the area that has been described as one of the most scenic coastlines on the island.

Mitigation Measures:

- Remove as little vegetation throughout the site as possible;
- Clearance of vegetation must be done on a phased basis;
- Retain a 2 m vegetation buffer around the perimeter of the island to reduce the visual effects of this stage of the development;
- Ensure that barriers are constructed around the land based construction camp and storage site to reduce the visual impact from this area;
- Ensure that local building materials are utilised in the construction process and that muted colours are used during the construction process to reduce the visual impacts of the development;
- Landscaping using natural vegetation is encouraged to hide or blend the development in with the local environment;

B. OPERATION PHASE

Once completed the villa development with proper landscaping may complement the aesthetics of the area which may have a major long-term positive impact.

Mitigation Measure:

- Ensure that the villas and other infrastructure are regularly maintained.
- Develop and maintain landscaping

7.2 BIOLOGICAL IMPACTS: TERRESTRIAL ENVIRONMENT

7.2.1 FLORA

A. SITE PREPARATION AND CONSTRUCTION PHASES

Pellew Island is not considered to be of high ecological value in terms of its floral composition. Twenty-three (23) species of plants were identified during the floral assessment, three (3) of which are endemic to Jamaica, but which are commonly observed island-wide. No rare, threatened, or endangered species were observed during the assessment which further indicates that the area is not one of significant ecological value.

This phase of the development will see the removal of some amount of vegetation. It is important to note that where the construction activity will be concentrated the vegetation is dominated by bamboo (an invasive alien species), and that proposed construction plans have been so designed that all mature trees will be preserved for use in the development. While the impact of the loss of vegetation may not be very significant, the removal of this vegetation may have cumulative impacts. These impacts could include an increase in the level of soil erosion due to the removal of vegetation, which is particularly important since the rate of soil accumulation on the island is thought to be low. The removal of this vegetation may also significantly affect the water quality in the marine environment surrounding the island through the increase in sediment loading to this area via run-off.

Mitigation Measures:

- Vegetation must be cleared on a phased basis;
- Retain all mature trees during this phase of the development;
- Retain a 2 m fully vegetated buffer area around the perimeter of the island
- Incorporate existing vegetation into the landscaping activities of the development. Where a tree or shrub will have to be removed during these phases of the development, these can be kept in nurseries and transplanted during the landscaping exercise.
- Ensure that native species are incorporated in the landscape design and that plants used are not listed as Invasive Alien Species as these plants have the tendency to out compete native species for resources which can result in the loss of native species.

B. OPERATION PHASE

Once construction is completed the development will be landscaped. This phase of the development will however have no impact on the flora of the island. It is however important to maintain the vegetation that will be incorporated on the island.

7.2.2 FAUNA

i. AVIFAUNA

A. Site Preparation and Construction Phases

Pellew Island is not believed to be an important habitat for wildlife. This is evident from its small size and by the low numbers of bird species observed, with often only a single individual of a species represented. The presence of rats on the island may also limit the number of type of other animals that can inhabit it. Furthermore, a large portion of the island is overgrown with bamboo, an introduced species often referred to as ecologically sterile. This is due to the inability of most native species to utilize bamboo for feeding or as a habitat.

In light of these observations, it is not believed that the loss of vegetation during construction would adversely affect any bird or other animal populations.

Mitigation Measures:

- Maintain all mature trees (trees > 25 cm dbh) within the development;
- Only remove vegetation that is necessary for the construction of the villas;
- Incorporate as many local plants found within the area into the final landscaping of the development ;
- Birds tend to be most active during the early morning and late evening. Construction activities must therefore be limited to the hours between 8:00 a.m. and 6:00 p.m.
- The developer may encourage birds to the island by installing nest boxes, feeders and birdhouses
- The developer should remove portions of the bamboo and incorporate trees that are used by bird species for foraging to attract bird species to the island.

ii. OTHER MACROFAUNA

A. SITE PREPARATION AND CONSTRUCTION PHASES

The diversity among other faunal species is low. Therefore this phase of the development should have only a minor temporary negative impact on the species that area present.

Mitigation Measures:

- Introduce site clearing on a phased basis to allow species the opportunity to relocate to suitable nearby habitats and to reduce the shock to the various habitats that may be disturbed.

- During site preparation and construction phases, the spoilage and waste should be removed, relocated or stored in a manner that does not allow for the disturbance of surrounding habitats or the species that remain.

B. OPERATION PHASE

The operation of the resort will not have an impact on the fauna observed. Lizards are very ubiquitous species and the vegetation that remains will be able to maintain the population on the island.

This phase of the development may encourage the proliferation of rat species on the island due to the increase in food sources for this species. The increase in rat population may have a negative impact on human health as these species are known carriers of various diseases.

Mitigation Measures:

- The maintenance of the mature trees and the 2- m buffer zone around the perimeter of the island may be used for “passive” habitat creation. These areas may encourage the colonisation of other animal species.
- Pest control measures should be used to exterminate or, at a minimum, control the rat population.

7.3 BIOLOGICAL IMPACTS: MARINE ENVIRONMENT

A. SITE PREPARATION AND CONSTRUCTION PHASES

The site preparation and construction phases of the development, if done improperly, may have a long-term irreversible major negative impact on the marine environment. An immediate adverse impact to the benthic marine community will occur as a result of the construction of the two docks proposed on the shore of Pellew Island. The processes of dock construction will involve the direct disturbance of benthic habitat and communities during the processes of sinking the wooden posts (piles) that will support the jetty. Although the footprint of the individual posts (piles) will be small, a larger, more substantial area will be disturbed in the processes of positioning and fixing the piles in the substrate. During the dock construction processes the degree of disturbance to the benthic environment will be greater in shallow water, less than 1 m in depth, where construction activity may require workers to stand on the substrate in order to manipulate tools and materials to construct the dock platform and footings.

In order to provide water and electricity to Pellew Island to facilitate construction and sanitation, water and electricity will have to be supplied from the mainland. This will involve conducting water and electricity through an underwater pipe and cables from the mainland to Pellew Island. The conduit carrying the water-pipe and electrical cable will cross the lagoon and will be buried on the shallower sections of its path for protection from wave action and human disturbance. The excavation of the substrate to burry the conduit will disturb benthic communities in the shallow waters adjacent to the mainland and adjacent to Pellew Island. T he choice of substrate through which the conduit is routed will have implications for the severity of the impact to the benthic community. The shortest route for running the conduit will be from the mainland dock to the southern shore of the island. This will require disturbance to the seagrass in between the channel and Pellew Island. It is expected that the seagrass will recover after the construction period ends.

The partial removal of vegetative cover on Pellew Island and the subsequent excavation activities required for infrastructure installation will influence the quantity and quality of surface run-off from the island. The removal of vegetation will increase the risk for the loss of top-soil, excavated material, and partially decomposed organic matter especially during rainfall events. The potential for turbid run-off will increase during the construction phase when excavation, the storage of aggregate, and the movement of personnel and equipment across the development site are at their highest levels.

Sediment laden surface run-off will pose a direct threat to the marine organisms in the shallow benthic communities around Pellew Island.

Also during the construction phase at least one dock will have to be constructed on Pellew Island to facilitate the delivery of construction materials, construction equipment, tools and the personnel involved in the construction of the villas and supporting infrastructure, and landscaping. The transportation and delivery of building supplies and materials, fuels, lubricants, sanitary and cleaning agents in a marine environment presents the risk of the direct negative impact to surrounding areas from dust, spillage, and emissions.

Given the elevation and steep topography of Pellew Island and its location in the marine environment it can be expected that the island will be exposed to regular sea breezes and periodic high winds. The improper storage of building materials such as sand, cement in the construction site could lead to the wind-borne dispersal during dry periods, or the dispersal in surface run-off during heavy rains. This could have a negative impact on the benthic communities around Pellew Island.

In addition, the delivery of construction materials, construction equipment, tools and the personnel involved in the construction of the villas and supporting infrastructure, and landscaping will require the daily operation of small vessels in shallow waters of Pellew Island. Frequent operation of vessels in the shallow waters surrounding Pellew Island will create the risk of direct damage to the benthic communities from groundings, anchor damage, the beaching of vessels, and the spillage of construction materials, fuels, lubricants, cleaning agents, paints, and solvents. Construction materials requiring disposal may include, but not be limited to; cut vegetation from the clearing of land for the development, wood scraps, saw-dust, excavated material, waste aggregate, cement, and concrete; packaging, plastics, scraps of PVC conduit and electrical wiring, discarded fastenings (nails, screws, straps), paints, primers, solvents, cleaning materials, lubricants and fuels.

During the construction phase the entire island will effectively become a construction site. This construction site will be situated in a marine coastal environment with little or no buffer zone between the construction site and the marine environment. In the absence of a comprehensive waste management plan being developed and implemented there is a high risk of contaminating the marine environment with waste materials and for contaminating the soil with solvents, fuels, paint residues, sealants, cleaning agents, or fuels.

The provision of inadequate facilities or numbers of portable toilets (port-a-potties or dry-toilets) and dumpsters will lead to unsanitary conditions. This impact will be cumulative, posing an increasing danger to human health and the environment with the length of time that adequate sewage and garbage disposal provisions are withheld.

Mitigation Measures:

- During the dock construction process the degree of disturbance to the benthic environment will be greater in shallow water (less than 1 m in depth) where construction activity will require workers to stand on the substrate in order to manipulate tools and materials to construct the dock platform and footings. The construction zone for each dock should be clearly marked to identify the area of benthic substrate in one meter or less of water that can be accessed on foot for construction purposes. This will limit the area of benthic substrate subject to disturbance by trampling. It is expected that disturbed areas will recover with time.
- Dock construction will be done by a special craft to be used by the Contractor, Tank Weld Special Projects, made for working in shallow water while providing for the least disturbance. We are informed that this craft has been used successfully in constructing other similar docking facilities.
- In areas where the Sea Grass *Thelassia testudinum is* disturbed, the disturbance should be monitored. If the disturbed Seagrass is killed or does not show signs of recovery within one month of disturbance, the damaged areas of seagrass

should be replanted. This measure is necessary to conserve and restore damaged habitat, and to prevent further loss of seagrass habitat as a result of the erosion and under-cutting of the exposed sandy substrate and the subsequent creation of blow-outs.

- As a priority, the first development activity undertaken on the Pellew Island site should be the construction of the dock that will serve as the construction phase receiving point for supplies. This will limit the risk of damage to the benthic marine environment from boat groundings and anchoring during the delivery of construction equipment, supplies, materials and personnel, and the removal of waste.
- During the construction phase the delivery of construction materials, equipment, and personnel, and the removal of construction waste and garbage should be confined to one dock to limit the impact to one area.
- Once established the deliberate grounding of vessels for the purpose of delivery or removal of equipment, materials, supplies, personnel, waste or garbage should be prohibited. The waters to the north of the channel and adjacent to Pellew Island should be designated a no-anchoring zone.
- All stipulations and restrictions regarding the operation of vessels in support of the development of Pellew Island should be included in the terms of reference of the contractor and the vessel operators contracted to the development project.

B. OPERATION PHASE

The activities involved in the operation phase of the development may also have a major negative impact on the marine flora and fauna. This may be as a result of any improper sewage treatment and disposal practices, improper solid waste management practices, and the run-off from the development.

Mitigation Measures:

- The manager of the villas should consider the development of an environmental management plan to conserve the environmental integrity of the island and the surrounding waters and hence the ambiance and value of the development. This is particularly important since ambient water quality levels in the area are above the stipulated standards for marine environments. This effort should include the participation of the managers of the Blue Lagoon Villas.
- Anchoring in the shallow areas around Pellew Island should be prohibited. The central area between Docks 2 and 3 should be designated a swimming area to restrict boat activity and hence damage to the sea grass.
- The removal of sea grass to enhance or enlarge swimming areas should be prohibited.
- Install a storage tank to confine treated effluent from the sewage plant on rainy days. This storage tank also provides a fail-safe for brief periods of sub-optimal operation of the sewage treatment plant where partially treated or untreated sewage may be released.
- In the event that there is the release of partially treated or untreated sewage arrangements should be made to empty the contents of the storage tank into a portable holding tank and the contents transported to the municipal sewage treatment plant.
- If it becomes necessary to empty swimming pools or plunge pools the water should be used for irrigation purposes rather than being directly discharged to the marine environment.

8.0 SOCIO-ECONOMIC IMPACT ASSESSMENT

This section outlines the methodology used for predicting the socio-economic impacts of the project and the identification of subsequent mitigation measures recommended for each negative impact identified.

METHODOLOGY

A socio-economic impact identification matrix was developed which covered the main potential impacts (positive, negative, major, minor, long and short term and any cumulative or synergistic impacts) of the project. The matrix lists impact types under broad headings with more detailed project specific impact categories. These impacts are divided into the Site Preparation and Construction and Operation phases of the project.

8.1 SOCIAL STRUCTURE

8.1.1 DEMOGRAPHY

A. SITE PREPARATION AND CONSTRUCTION PHASES

The inflow of workers who choose to reside in the community during these phases of the development may not have any impact on the demography of the area. The numbers of workers anticipated to be employed in these phases is estimated at sixty (60) workers who will be directly employed in these phases. This number of workers will not necessarily have an impact on demography on the community which currently shows no evidence of overcrowding. To ensure that this does not become a problem the developer should employ the mitigation measure outlined below.

Mitigation Measure:

- As far as possible employ persons from the surrounding communities during this phase of the development to reduce the numbers of persons that will migrate to the area seeking employment.

B. OPERATION PHASE

The changes in the demography of the area is not likely to increase due to the operation phase of the resort as it is anticipated that this phase of the development will employ approximately twelve (12) persons. There is currently no evidence of overcrowding in and around the development area and therefore there will be minimal variations in demography.

Mitigation Measures:

- As far as possible employ persons from the surrounding communities during this phase of the development to reduce the numbers of persons that will migrate to the area seeking employment.

8.2 ECONOMIC STRUCTURE

8.2.1 EMPLOYMENT AND INCOME GENERATION

A. SITE PREPARATION AND CONSTRUCTION PHASES

Based on the results of the socio-economic assessment, the unemployment rates in the area are very low. The residents polled in the area are however excited about the increase in job availability that the development of the island will bring. Any available jobs will be provide an immediate positive impact on the employment and income situation at the level of the project area as well as at the parish and national levels. This phase of the development will provide the most benefits in terms of employment and increase in income. Initially the site preparation and construction phases will employ a number of skilled and unskilled workers. Knock-on income generating effects will also be evident, such as vendors and the various shops in the area supplying the workers with meals and refreshments. This phase of the development will therefore have a short-term major positive impact on the employment and income at the local community level.

Mitigation Measures:

- As much as is possible it is recommended that persons from the nearby communities be employed to work on the construction site.
- As far as possible, supplies to be used in the construction of the villas should be purchased from local suppliers.

B. OPERATION PHASE

This phase of the development will also have a minor positive impact on the employment and income generating opportunities both locally and nationally over the long-term. The operation of the resort will mean that jobs will be available for villa type workers. There will also be an increase in the demand for good and supplies to be used in the operation of the resort.

Mitigation Measures:

- As much as is possible it is recommended that persons from the nearby communities be employed to work during the operation of the resort. This will avoid any feelings of resentment and will ensure that the community derives the most benefits from the development.
- As far as possible purchase goods and supplies for the operation of the villas from suppliers within the area to ensure that the community reaps the maximum benefit from the development.

8.3 INFRASTRUCTURE

8.3.1 ROAD NETWORK & TRAFFIC

A. SITE PREPARATION AND CONSTRUCTION PHASES

These phases of the development may have a negative impact on the present road network in the study area. The roads in their current states may not be able to handle the increase in heavy-duty equipment traffic. It is expected, however, that the general road conditions in the parish will be improved with the implementation of other major developments that have been planned for Portland.

Traffic is currently not a major problem in the area. The combination of the increase in the heavy goods vehicles for the delivery of construction material, the marginal increase in transportation of workers with the site and poor road conditions may have a short-term negative impact on the traffic in the area.

Mitigation Measure:

- A traffic system that involves appropriate signals and signs to ensure the smooth flow of traffic must be implemented.

B. OPERATION PHASE

This phase of the development will have no significant impact on the road network or the traffic in the area.

8.3.3 UTILITIES

i. ELECTRICITY

A. SITE PREPARATION AND CONSTRUCTION PHASES

These phases of the development will not have an impact on the electricity supplying the area.

B. OPERATION PHASE

This phase of the development will not have any impact on the electricity consumption in the area as the operation is not an energy intensive one. The developer should however implement the mitigation measures outlined below to reduce the energy consumption of the resort.

Mitigation Measures:

- Install energy saving lights throughout the resort;
- Utilise solar panels for equipment such as water heaters and lighting on the island;
- Lights that are not operated by solar power should be fixed with light sensors to regulate the duration of on-time for these lights; and
- Train employees in the benefits of energy conservation.

ii. WATER AVAILABILITY

A. SITE PREPARATION AND CONSTRUCTION PHASES

Water is not a scare commodity within the study area. These phases of the development will have no impact on the water availability in the area as demand will be on such a small scale.

B. OPERATION PHASE

The operation phase of the resort will not have any impact on the water availability in the area as the water consumption is estimated to be 4,180 litres per day at its maximum capacity. The villa operators should however implement measures as outlined below to conserve water consumption at the resort.

Mitigation Measures:

- Water consumption can be reduced with the installation of water conservation fixtures in bathrooms and kitchens; and
- Treated effluent and runoff from villa roofs can be collected to be used in the irrigation of the landscaped areas. This will also reduce the amount of run-off to the marine environment.

iii. TELECOMMUNICATIONS

A. SITE PREPARATION AND CONSTRUCTION PHASES

These phases of the development will not have an impact on the telecommunication services in the area.

B. OPERATION PHASE

This phase of the development will have no impact on the telecommunications services available in the area.

8.4 WASTE MANAGEMENT

8.4.1 SOLID WASTE

A. SITE PREPARATION AND CONSTRUCTION PHASES

Solid waste will be generated in this phase through the clearing of vegetation for construction and general refuse from construction activities. This will therefore have a major negative short-term impact on solid waste collection in the area as currently the collection is limited to a once per week schedule. This current schedule will not be able to adequately handle the removal of the solid waste from the construction site. Solid waste may also have an impact on the marine environment which has already been discussed in ***Section 7.3***.

Mitigation Measures:

- The developer should seek to hire a private licensed solid waste collection company to mitigate the impact on the local collections services;
- All the refuse generated from this phase of the development should be properly transported and disposed of at the nearest parish council approved solid waste facility.

  - Ensure that vending during these phases of the development is localised and limited to the mainland.
  - Provide adequate garbage receptacles around the project site.
  - Ensure that all debris and garbage generated during this stage of the development is placed in a central place on the project site, moved regularly to the mainland, and collected by a licensed garbage disposal company who will deposit at the parish council approved disposal site.
- A comprehensive waste management plan should be developed for the Pellew Island development site for both phases of the development. The design and effective implementation of the waste management plan should be made the contractual responsibility of the building contractor. The responsibilities should include, but not be limited to:
  - The designation of appropriate waste storage areas on the project site for solid, liquid, and toxic or combustible waste materials.
  - The periodic removal of waste materials to the parish council approved disposal facility.
  - The institution of the necessary measures to prevent the dispersal or loss of waste materials during storage, transportation, or disposal.

B. OPERATION PHASE

The operation phase of the development will have a minor long-term negative impact on the solid waste collection in the area. The accumulation of solid waste can cause the proliferation of domestic pests such as rats (*Rattus norvegicus* and *Rattus rattus*) which are vectors many diseases such as leptospirosis. Rats have been observed on the island. The current collection schedule in the area is once per week which may not be enough to handle the solid waste generated, especially when the resort is operating at its maximum capacity.

Mitigation Measures:

- The villa operator should seek to hire a private licensed solid waste collection company, who will collect solid waste at least twice (2) times per week to mitigate the impact on the local collections services;
- All solid waste must be properly contained and transported to the shore;
- All refuse and debris generated from this phase of the development should be properly transported and disposed of at the nearest licensed solid waste facility.
- Wherever possible steps should be taken to reduce, reuse and recycle solid waste.

8.4.2 SEWAGE DISPOSAL

A. SITE PREPARATION AND CONSTRUCTION PHASES

A number of persons will be employed throughout these phases of the development and hence there will be generation of sewage. If not properly disposed of and treated the sewage may have a short-term, major negative impact on the marine quality in the area, as well as affecting general human health of workers.

Mitigation Measures:

- Ensure that chemical toilets are provided for use by employees during these phases of the development. One (1) chemical toilet should be provided for every eight (8) workers on the project site.

B. OPERATION PHASE

It is estimated that a maximum of 4,840 litres of sewage will be generated daily when the resort is operating at its maximum capacity. Sewage that is not properly treated or disposed may pose a major threat to the surrounding marine environment. Nutrients such as Nitrogen and Phosphorus are pre-cursors for the process of eutrophication. In some instances these algal blooms can harm or even kill fish, shell fish and other animals by using up the Dissolved Oxygen (DO) in the water that these species rely on. Excessive algal growth may also cloud the water, effectively blocking sunlight from reaching submerged aquatic vegetation (SAV), such as seagrasses which provides prime nursery and spawning habitat for juvenile finfish and shellfish. In addition, untreated sewage that is not disposed of appropriately may also have a major impact on human health.

Mitigation Measure:

- A tertiary sewage treatment plant, a sequencing batch reactor, will be provided to adequately treat the sewage generated by the villas.
- Treated effluent will be used for irrigation and a storage tank of 2 days capacity will be used to store effluent on rainy days when irrigation is not possible.
- The developer should ensure that all sewage treatment plants are maintained regularly and that all effluent released is in compliance with the sewage effluent standards as stipulated by the Natural Resources Conservation Authority (NRCA). See ***Section 11*** for Effluent Standards.

8.5 SOCIAL SERVICES

8.5.1 HEALTH SERVICES

A. SITE PREPARATION AND CONSTRUCTION PHASES

These phases of the development will have no impact on the health services in the area. The developer must however put in place mitigation measures below to deal with injuries which can be quite common on construction sites.

Mitigation Measures:

- Provide a First Aid Kit on site for any minor injuries that may occur on site.
- Provide Personal Protective Equipment for workers on site including, hard hats, reflective vests, dust masks, and safety shoes.

- Inform and make arrangements with the nearest Health Clinic to accommodate any major injuries that may occur in these phases of the project.

B. OPERATION PHASE

The Post Construction phase of the project will have no significant impact on the health services in the area because of the small numbers of guests and staff at the resort.

Mitigation Measures:

- Provide a First Aid Kit on site for any minor injuries that may occur;
- The villa operators should have a boat that is available 24 hours per day, seven days per week to transport guests or workers to and from the island;
- Villa operators should make arrangements with local medical professionals who will be available 24 hours per day, seven days per week to attend to any medical emergencies that may arise.

8.5.2 EMERGENCY SERVICES

i. FIRE SERVICES

This will be addressed in ***Section 9.1*** below.

ii. POLICE SERVICES

A. SITE PREPARATION AND CONSTRUCTION PHASES

The parish of Portland has a relatively low crime rate. However, violence at construction sites is a common problem in Jamaica. These phases of the development may therefore have a minor negative, short term effect on the police services in the area.

Mitigation Measures:

- As much as is possible it is recommended that persons from the nearby communities be employed to work on the construction site. This will avoid any feelings of resentment that may be felt from locals and may reduce the level of crime and violence during these phases of the development.
- It is recommended that there be adequate security present at the construction site at all times.

B. OPERATION PHASE

Crime and violence does not seem to be a major issue in the area. Due to the isolation of the island from the mainland and the numerous access points to the villas, adequate security for guest and villa workers has to be implemented.

Mitigation Measure:

- A security post will be established on the island and staff will be present at all times.

8.5.3 TRANSPORTATION

A. SITE PREPARATION AND CONSTRUCTION PHASES

Access to public transportation is currently not a problem within the development area as numerous taxis traverse the route along the San San main road. This phase of the development will therefore have no impact on the transportation network in the area.

B. OPERATION PHASE

This phase of the development will have no impact on the transportation network in the area, because of the small numbers of guests and staff at the resort.

9.0 HAZARD IMPACT ASSESSMENT

A Hazard Impact Assessment (HIA) was undertaken to analyse the probability and magnitude of hazards directly associated with the Site Preparation, Construction and Operation phases of the development. It also includes an analysis of the vulnerability of the development to naturally occurring hazards and estimates the magnitude of these hazards. This process also includes an appraisal or evaluation of the hazards identified and the identification of recommendations on how to mitigate the effect of these hazards.

This section outlines the methodology used for the identification of the hazards and their magnitude associated with the project. Recommendations have been made to mitigate the effects of each of the hazards identified.

Methodology

A hazard analysis matrix was developed which included the main potential hazards associated with project activities as well as those caused by forces of nature. The results of this were used to differentiate between the hazards, which posed a high and moderate risk to the project. The matrix lists hazard types under broad headings with more detailed project specific categories. This can be seen in ***Appendix 7.***

9.1 TECHNOLOGICAL HAZARDS

Fire and explosions are technological hazards which can cause serious injury to humans or result in loss of life and damage to vegetation.

A. SITE PREPARATION AND CONSTRUCTION PHASES

Flammable substances including diesel and motor oil may be stored or used on the project site for equipment. These substances may potentially cause fires and explosions, which may range from small incipient to larger fires of great intensity, which generates heat causing damage to property, injuries or loss of human life.

Mitigation Measures:

- Provide all employees with safety and protective gear including hard hats, safety goggles, dust masks, gloves and safety shoes. Employees will be required to wear these at all times on the project site.
- Adequate numbers and types of fire extinguishers should be available at the project site.
- Designate the roles and responsibilities of employees, which will enable a clear chain of command during a fire or explosion and allows persons to be aware of their responsibilities in the event of such occurrences.
- Ensure that all machinery used on the site is properly maintained and inspected before use.
- Place a fully equipped first aid kit on the project site.
- Place conspicuous warning signs where hazardous or flammable substances will be stored.
- Where flammable substances will be stored, this should be done in a bunded area which is able to contain 110% of the substances that are stored on site.
- Place information signs around the project site, which list the numbers of the person responsible for handling emergencies on the site, the Port Antonio Fire Department, and the Port Antonio hospital.
- Keep an emergency log to document any occurrences of fires and explosions as well as to record any damage to the property and human injuries. This log must also contain emergency contact information for all employees.

B. OPERATION PHASE

The use of electric appliances and the use of flammable substances (cooking gas, gasoline, etc.) may lead to the occurrence of a fire or explosion in the area.

Mitigation Measures:

- Designate the roles and responsibilities of employees, which will enable a clear chain of command during a fire or explosion and allows persons to be aware of their responsibilities in the event of such occurrences.
- Install several suitable, approved fire extinguishers at accessible, conspicuous and unobstructed points throughout the villas and the office area.
- A pump will be used on a pressurised line which will use water from the sea will be installed and used to combat large fires.
- Install fire blankets in all the kitchens in the villas
- Place conspicuous warning signs where hazardous or flammable substances will be stored.
- Place information signs around the project site, which list the numbers of the person responsible for handling emergencies on the site, the Port Antonio Fire Department, and the Port Antonio hospital.
- Keep an emergency log to document any occurrences of fires and explosions as well as to record any damage to the property and human injuries. This log must also contain emergency contact information for all employees and guests.

9.3 NATURAL HAZARDS

Because of Jamaica's location, geology and geography the island is prone to a range of natural hazards including those of a meteorological and geological nature. The major threats include hurricanes, tropical storms, floods, land slippage and earthquakes. These hazards can cause damage to property, injuries of varying severities and loss of human life.

9.3.1 METEOROLOGICAL HAZARDS

The meteorological hazards that mostly affect Jamaica include hurricanes, tropical storms and to a lesser extent storm surges. Jamaica is located within the North Atlantic

Hurricane Belt and has had a long history of tropical storms and hurricanes which has caused a significant amount of damage over the years. The official Hurricane Season lasts from 1st June to 30th November each year, but tropical weather systems can occur from April to December. Winds of approximately 98 kilometres per hour or more were recorded 35 times in the 135 years to 2005 for the island as a whole and 26 times in Port Antonio with average frequencies of once every 3.86 years for the island and once every 5.19 years for Port Antonio. Jamaica as a whole is directly hit[10] on average once every 27 years and Port Antonio every 10.4 years. Notable past tropical storms and hurricanes affecting Port Antonio is shown in ***Table 10*** below. ***Figure 11*** below shows the hurricane tracks that have affected island between 1888 and 1988 and ***Figure 12*** shows the hurricane tracks that have affected the island between 2000 and 2006.

Table 10: Table showing the hurricanes and tropical storms that have affected Port Antonio (1874- 2005)

YEAR	WIND SPEED	LEVEL OF DAMAGE
1874	145 km/hr	
1880	129 km/hr	Over 20 persons killed
1912	242 km/hr	Massive Storm surge over 100 persons killed island wide
1917		Very high storm surge
1944		Heavy damage with thousands left homeless island wide
1951	137 km/hr	
1980		Moderate damage
1988		Moderate damage
2004	250 km/hr	Moderate damage
2005	177 km/hr	Severe damage locally from wind and heavy rain

[10] **A 'direct hit' is defined as the centre passing within 40 miles.**

Figure 11: Figure showing the hurricane tracks for Jamaica between 1888 and 1988

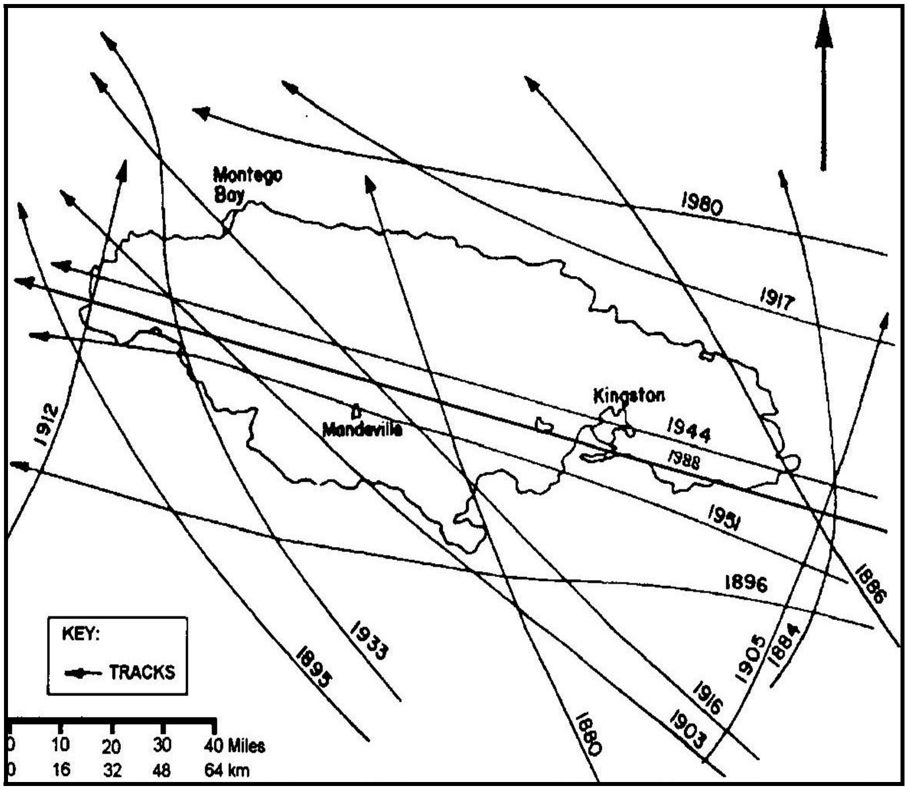
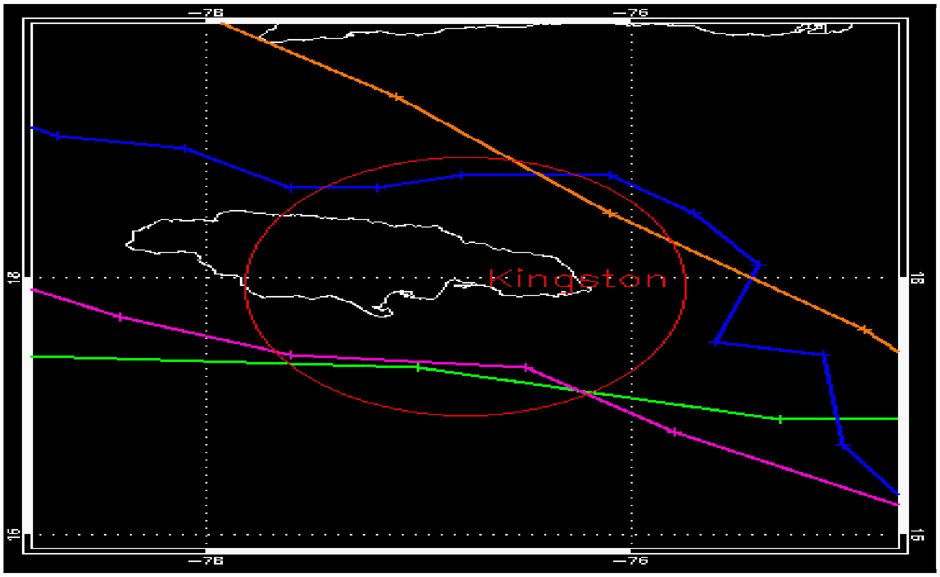


Figure 12: Figure showing the hurricanes that have affected the island between 2000 and 2005



KEY	Name of Hurricane/Tropical Storm	CATEGORY	DATE
(green line)	**Hurricane Iris**	**1**	**October 7, 2001**
(magenta line)	**Hurricane Ivan**	**5**	**September 11, 2004**
(orange line)	**Hurricane Dennis**	**3**	**July 7, 2005**
(blue line)	**Tropical Storm Lilly**		**September 29, 2002**

A. SITE PREPARATION AND CONSTRUCTION PHASES

The location of Pellew Island makes it very susceptible to the effects of hurricane, tropical storms and storm surges. The island is also said to serve as a wind break which reduces the effects of these hazards on the existing villas located along the shore of the mainland. The construction activity is however limited to the highest point on the island is about 20 m above mean sea level. Precautionary measures have to be implemented to mitigate the effects of these meteorological hazards.

Mitigation Measures:

- Ensure that construction activities as far as possible are not at its peak during the hurricane season (Between June 1st and November 30th);
- Maintain a fully vegetated buffer zone 2 m in width around the edge of Pellew Island;
- Relocate all mobile machinery and equipment to suitable storage facilities on the mainland on approach of a tropical storm or hurricane.
- Keep a logbook and record all damage that may have occurred after the hurricane.
- Do not use electrical or mechanical machinery after the hurricane without proper inspection.
- Remove all stockpiled material and move to proper storage facilities on the mainland within 48 hours of an approaching hurricane or tropical storm.
- Evacuate all project personnel from the site 24 hours prior to the projected arrival of the hurricane or tropical storm.

B. OPERATION PHASE

The clearing of the vegetation for the construction of the villas may exacerbate the effect of a hurricane or tropical storm during the operation of the resort. Mitigation measures have been therefore identified to reduce the effects of these hazards during this phased of the development.

Mitigation Measures:

- Prepare a disaster preparedness plan for the resort that includes hurricanes, earthquakes, and fires.
- Evacuate all guests and workers from the island 24 hours prior to the arrival of a hurricane or tropical storm;

- Relocate all mobile machinery and equipment to suitable storage facilities;
- Ensure that any loose roofing material, all windows and doors are securely fastened prior to a hurricane;
- Keep a logbook and record all damage that may have occurred after the hurricane.

9.2.2 SEISMIC RISK AND HAZARDS

Jamaica lies in an active earthquake zone. Earthquakes can cause loss of human life and injuries as well as causing damage to infrastructure. As there is a limited soil or alluvial profile on the site and because much of the site is supported by relatively hard bedrock, ground shaking would not be amplified relative to sites that have deep seated bedrock. Potential hazards would also include small scale tsunami events which are known to have occurred on the north coast of the island and perhaps have distal origins. Such an event would have a relatively low probability of occurrence due to the strike slip nature of the fault system to the north of Jamaica. Wooden constructions, as that proposed for the villas, are typically subject to less structural damage than are concrete ones.

Mitigation Measures:

- Ensure that employees are aware of the precautions to take during an earthquake.
- Ensure that staff at the construction site is aware of the measures to be implemented during an earthquake.
- Designate the roles and responsibilities of employees, which will enable a clear chain of command in the event of an accident and allows persons to be aware of their responsibilities in the event of such occurrences.
- Place a fully equipped first aid kit on the project site

- Place information signs around the project site, which list the numbers of the person responsible for handling emergencies on the site, the Port Antonio Fire Department, and the Port Antonio hospital.

9.2.3 LANDSLIDES

Landslide potential is considered relatively low due to both the abundance of relatively hard bedrock and the presence of a relatively shallow soil profile. Care must be however taken to reduce the impact of sediment run-off from the site to the marine environment.

Mitigation Measure:

- Maintaining a fully vegetated buffer zone 2 m in width around the edge of Pellew Island this will assist in maintaining the current slope stability, and lessen the potential for erosion at the project site.

10.0 DRAFT MONITORING AND ENVIRONMENTAL MANAGEMENT PLAN

This section of the report presents a Draft Monitoring Plan for the villa development. This monitoring plan has been developed to ensure that the environmental and socio-economic mitigation measures that have been recommended are implemented and are effective, as well as to identify any unanticipated impacts that might arise as a result of the project.

10.1 ENVIRONMENTAL PARAMETERS

10.1.1 AIR QUALITY

The development may have a negative impact on the air quality in the area during the Site preparation and Construction phases of the development. The main impacts to air quality during the Site preparation and Construction phases will be due to the increase in dust and the increase in the vehicular traffic. It is therefore necessary to monitor the PM_{10}, levels in the area at different intervals during these phases to ensure that the levels of these pollutants remain within the Natural Resources Conservation Authority's (NRCA) National Ambient Air Quality Standards (2002) as outlined in ***Table 11*** below. Although Jamaica has its own standards values recorded can also be compared with the World Health Organisation's (WHO) air quality standards as well, shown in ***Table 12*** below. Although the Operation Phase is not expected to have a major impact on air quality, it will be necessary to intermittently monitor the air quality of the area to ensure that the levels of pollutants in the area are within the air quality standards.

Table 11: Table showing the Jamaica National Ambient Air Quality Standards

POLLUTANTS	STANDARDS $\mu g/m^3$					
	Annual		24 hr		1 hr	
	1^0	2^0	1^0	2^0	1^0	2^0
PM_{10}	50		150			

Source: NAAQS (2002)

Table 12: Table showing the World Health Organisation's (WHO) Air Quality Guidelines

POLLUTANT	Averaging Time	Standard (g/m^3)
PM_{10}	Annual	20
	24-hour	50

Source: World Health Organisation (2007)

10.1.2 NOISE AND VIBRATION

Noise levels will have to be monitored especially during the construction phase to ensure that the standard ambient noise levels are not exceeded. No noise standards have been developed for Jamaica; The World Health Organization (WHO) has however developed guidelines for community noise. The WHO recommends that the noise limits should not exceed 50dB LA_{eq} for outdoor living areas, although it suggests that this value can be up to 55dB LA_{eq} in some circumstances. The standards which may be used in the monitoring activities are shown in the ***Table 13*** below.

Table 13: Noise standards and Guidelines from The United States Environmental Protection Agency (EPA), the World Health Organisation (WHO) and the European Commission (EC)

ORGANIZATION	INDUSTRIAL AREA	COMMERCIAL AREA	RESIDENTIAL AREA	SILENCE ZONE
	Day / Night	Day / Night	Day / Night	Day / Night
U.S.(E.P.A.)	70	60	55	45
W.H.O. & E.C.	65	55	55 / 45	45 / 35

10.1.3 WATER QUALITY

The development in both the construction and operation phase may have a major long-term negative impact on the marine water quality. No Jamaican standards have been developed for marine water quality; therefore the United States Environmental Protection Agency's (EPA) standards may be used for comparison. It is critical that the water quality in all these areas be monitored consistently to ensure that they are in keeping with these required standards. These are shown in ***Table 14*** below.

Table 14: Marine Water Quality Standards

PARAMETER	*EPA STANDARDS	**NRCA STANDARDS
BOD (mg/L)	1.18 mg/L	
DO (mg/L)	4.8 mg/L	
Nitrate (mg/L)	0.081 mg/L	
O-Phosphate (mg/L)	0.055 mg/L	
TSS (mg/L)		< 10 mg/L

10.1.4 SOILS AND GEOLOGY

The soil quality of the project site has to be visually monitored, especially during the construction phase of the development, to determine the levels of soil erosion and the change in soil quality due to the project's activities.

10.1.5 ECOLOGY

It will be important to ensure that the all mature trees, where possible are retained during the site clearance and construction phase of the development and that the 2 m vegetation buffer zone that has been recommended is maintained. The bird population should be monitored to ensure that the population is maintained or is being enhanced.

10.2 SOCIO - ECONOMIC PARAMETERS

The socio-economic parameters pertaining to the project will also have to be monitored to ensure that the mitigation measures recommended are offsetting any negative impacts identified or enhancing positive impacts. Of particular note, is the implementation of the project in a way that benefits the local community through employment and the supply of goods and services in all phases of the development. Traffic control measures also need to be monitored during the construction phase to ensure that the movement of heavy goods vehicles does not adversely interrupt the flow of traffic in the area.

10.3 RISKS AND HAZARDS

The implementation of mitigation measures that have been identified to offset the hazards associated with the development should be monitored to reduce the impact of these hazards throughout all phases of the development.

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12. APPENDICES

APPENDIX 1:

A. TERMS OF REFERENCE FOR THE CONDUCT OF AN ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR A VILLA DEVELOPMENT ON PELLEW ISLAND, PORTLAND

INTRODUCTION

Mr. Jeremy Millingen, Architect, for a villa development planned for Pellew Island in Port Antonio, has requested that Caribbean Ecosystems Limited submit a proposal for the conduct of an Environmental Impact Assessment for the development. The Client has secured Outline Approval from the Portland Parish Council, have had some environmental studies already commissioned and has applied for an environmental permit for the construction of the villas. We are also requested to assess the status of the application process and take steps to complete the process.

The development intends to construct 4 villas (one 4-bedroom, one 3-bedroom, and two 2-bedroom) on Pellew Island. Each villa will have its own pier. The villas will have a plunge pool and a sun/moon deck. The buildings will be thatched roof, constructed on stilts and will feature water and energy conservation devices and will be serviced by a tertiary sewage treatment plant. Pellew Island is approximately 1.6 acres in size. The project will also construct a 4 vehicle parking lot and reception building and jetty directly south of the Island on land alongside the main road (43 San San Main Road).

TERMS OF REFERENCE

The Terms of Reference for the conduct of the Environmental Impact Assessment are as follows.

1. Project Description

Prepare a detailed description of the project. This section will provide information on the proposed project. This information should include:

- Details of project components complete will topographic maps of the site and site layout/ schematic plan.

- Details on infrastructure development including design plans for sewage disposal system, drainage features , roads and utility requirements

2. Existing Environment

A natural resources survey of the proposed development site will be conducted. This information will form the basis upon which impacts of the project will be assessed. The following aspects will be described in this section:

- o Physical Environment - Topography, soils, climate, drainage, geology, coastal features and hazard vulnerability including potential impacts on current and wave regimes in the area.

- o Biological Environment – Description of terrestrial habitats, existing vegetation, flora and fauna surveys inclusive of a species list; Description of marine habitats and communities; Commentary on the ecological health, threats and conservation significance of terrestrial and marine habitats.

  This would include:
  - A detailed qualitative and quantitative assessment of terrestrial habitats in and around the proposed project sites and the areas of impact. This must also include flora and fauna surveys, including species lists.
  - A detailed qualitative and quantitative assessment of marine habitats and communities in and around the proposed project sites and the possible areas of impact. This must include but not be limited to seagrass, coral reefs and their associated biota.

  The field data collected will include, but not be limited to:
  - Percentage coral cover
  - Vegetation profile
  - Seagrass
  - Other benthic features of the proposed development areas as well as the areas of potential impact.
  - Species lists must be provided for each community,
  - A habitat map of the area
  - Information on fish data must also be included.

- o Social Environment—Demography, regional setting, location assessment and current and potential land–use patterns of neighbouring properties; Description of existing infrastructure such as transportation, electricity, water and telecommunications; Socio-economic survey determining public perception of the project, this should include potential impacts on social, aesthetic and other values.

3. Legislation and Regulatory Considerations

All applicable government policies, regulations and legislation will be highlighted. This will include local parish council plans and policies.

4. Analysis of Alternatives

This will include the no action alternative and project design alternatives. These will be assessed according to the physical, ecological and socio-economic parameters of the site. A rationale for the selection of any project alternative will be provided.

5. Impact Identification

A detailed analysis of the project components will be done in order to identify the potential environmental impacts, both negative and positive, of the project. Cumulative impacts will also be evaluated. The identified impacts will be profiled to assess the magnitude of the impacts. Each impact will then be ranked as major, moderate and minor and presented in a matrix for all the phases of the project (i.e. preconstruction, construction and occupation).

The impacts to be assessed will include but not be limited to the following:

- Design and engineering- siting, geotechnical investigation
- Visual/aesthetics and noise
- Construction - site clearance, earthworks, access, transportation and spoil disposal
- Operation and maintenance - waste disposal, site drainage, sewage, and air quality
  Empirical data will be provided to show that the sewage treatment facility has the capacity to remove the nutrients to meet the National Sewage Effluent Standards.
- Ecological impacts- terrestrial and marine habitats and their effect(s) on species present with special emphasis on any rare, endangered, or endemic species found on site.
- Social impacts – changes in public access, change in beach/recreational use, public perception
- Beneficial impacts – national economy, development of local communities
- Cumulative impacts – synergies between existing or proposed and potential activities

6. Impact Mitigation

Mitigation and abatement measures will be developed for each potential negative impact identified. This will also include recommendations for the enhancement of beneficial impacts.

7. Environmental Monitoring and Management

An environmental monitoring and management plan will be developed which will detail the requirements for construction and operational phases of the project. This will include recommendations to ensure the implementation of mitigation measures and long term minimization of negative impacts.

8. Public Participation

A public meeting to present the findings of the EIA will be held at the request of the National Environment and Planning Agency (NEPA). The consultant will be responsible for this presentation. All EIA documents will be made available to the public as required.

Stakeholder meetings will also be held to inform the public of the proposed development and the possible impacts, and will also gauge the feeling/response of the public toward the development.

9. Permit Application

The development will require an environmental permit, licence, and beach control act license issued by NEPA. We will facilitate the permit application process with the Client.

ACTIVITIES

In order to effectively and efficiently conduct the Environmental Impact Assessment it will be necessary to carry out various activities which include:

I. Documentation Review

All documentation pertaining to the development will need to be reviewed. These should include, but not be limited to, the project profile, site plan, drainage plan, applications made for financing or planning approval, and any technical and engineering studies that have been done.

Legislation and regulations pertaining to the project will also be reviewed. This will include the local parish council plans and policies as well as regional and international laws and Conventions where applicable.

II. Resource Inventory

An assessment of the present status of the proposed project site will be conducted. This will facilitate the identification of the possible impacts that will be generated from the development as well as aiding in the analysis of the possible alternatives to the development. This assessment will include the following:

a. Preparation of a Project Description

The consultant will undertake a survey of the project site and relative documentation to provide a detailed description of the proposed project. This description will include:

- Details of project components complete with topographic maps of the site and site layout/schematic plan.

- Details on infrastructure development including design plans for sewage, disposal system, drainage features, road and utility requirements.

b. Physical Environment

A study will be conducted to determine the physical nature of the project site including the following:

- Topography
- Seismic features
- Soils
- Climate
- Drainage
- Geology
- Coastal features
- Hazard Vulnerability

Several databases and GIS systems will be accessed at UWI, WRA, Meteorological Office, and NEPA along with published materials and technical reports. Site visits to confirm, collect, and validate the data will be done.

c. Biological Environment

The consultant will make site visits to inventory the biological environment (marine and terrestrial). Any available existing data and reports on the site will be accessed and reviewed. This assessment will include:

- Description of terrestrial habitats, flora and fauna surveys inclusive of a species list indicating endangered and endemic species.

- Description of marine habitats and communities including water quality measurement. The marine assessment already done will have to be expanded in scope and range.

- Analysis of the ecological stability indicating the nature, location and cause of any stresses to the habitats identified.

- Indication of the conservation significance of the terrestrial and marine habitats.

Line transects will be used for vegetation and marine studies. Spot counts and some line transects will be used for avifaunal studies. Databases at NEPA and the Institute of Jamaica will be accessed and the information used in conjunction with the data collected during site visits. Statements will be made as to the ecological functioning of the terrestrial and marine ecosystems found on site. Maps will be produced using satellite photographs of expected locations of benthic habitats, structures, flora/fauna. Photographic records will be made of the significant marine features and a fish and invertebrate assessment will also be done.

d. Social Environment

The consultant will investigate the current socio-economic status of the area by assessing the following:

- Demography
- Regional setting
- Location assessment
- Current and potential land-use patterns
- An assessment of public perception of the project
- Description of existing infrastructure (transportation, electricity, water and telecommunication).

Data collection will be done via interviews and field visits to surrounding communities. Questionnaires may be used to collect data to cross check findings of the previous reports. This will afford the opportunity to present the project to the stakeholders.

III. Analysis of Alternatives

Alternatives to the site location, project design and operation conditions will be analysed including the "no-action" alternative. These alternatives will be assessed based on the physical, ecological and socio-economic parameters of the site identified. The consultant will provide justification for the selection of the chosen alternative(s). The physical, biological and sociological settings will provide the framework in which to assess the different project alternatives.

IV. Impact Assessment

The consultant will carry out a detailed impact assessment of the project components (pre-construction, construction and operation stages) in order to identify the potential impacts (positive, negative and cumulative impacts) that will be associated with the project. The significance and magnitude (major, moderate and minor) of the impacts identified will also be evaluated through the use of a weighted matrix.

The impacts to be assessed will include but not limited to the following:

- Effects of project design and engineering
- Effects on visual aesthetics and landscape
- Effect of noise and vibration
- Effects of construction activities such as site clearance, earthworks, access routes, transportation networks and spoil disposal
- Effects of operation and maintenance activities such as waste disposal, traffic management, site drainage, sediment, sewage, public access and air quality.
- Effects on ecology including effect on terrestrial and marine habitats. Emphasis will be placed on any rare, endangered, and endemic species found.
- Effects on socio-economic status such as changes to public access, recreational use existing and potential agricultural activities, contribution of development to national economy and development of surrounding communities.

The physical, biological and sociological status will provide the framework in which to assess the impacts of the proposed project.

V. Identification of Mitigation Measures

Mitigation measures will be developed in order to eliminate or reduce the potential negative impacts that are identified. Recommendations will be made as to how the potential positive impacts identified can be enhanced.

VI. Report Preparation and Generation

The EIA will be written by integrating existing reports, reference to the baseline data mentioned above, and having discussions with the client. We presume that we will have access to the site and to all materials and reports that will aid in the completion of a quality EIA.

VII. Development of an Environmental Monitoring and Management Plan

A monitoring and environmental management plan will be developed covering construction and operation activities of the project. This plan should protect the integrity of the environment allowing for future studies, which will help to manage the development. It should also identify any anomalies that may arise after the study has been conducted. Due to the short time frame envisioned for the conduct of the EIA temporal variations may not be assessed to the fullest extent. The EMMP will address the long term assessment of these variations.

VIII. Public Participation Activities

Stakeholders surrounding the project site will be subject to a public perception survey in which the details of the project will be presented and feedback solicited.

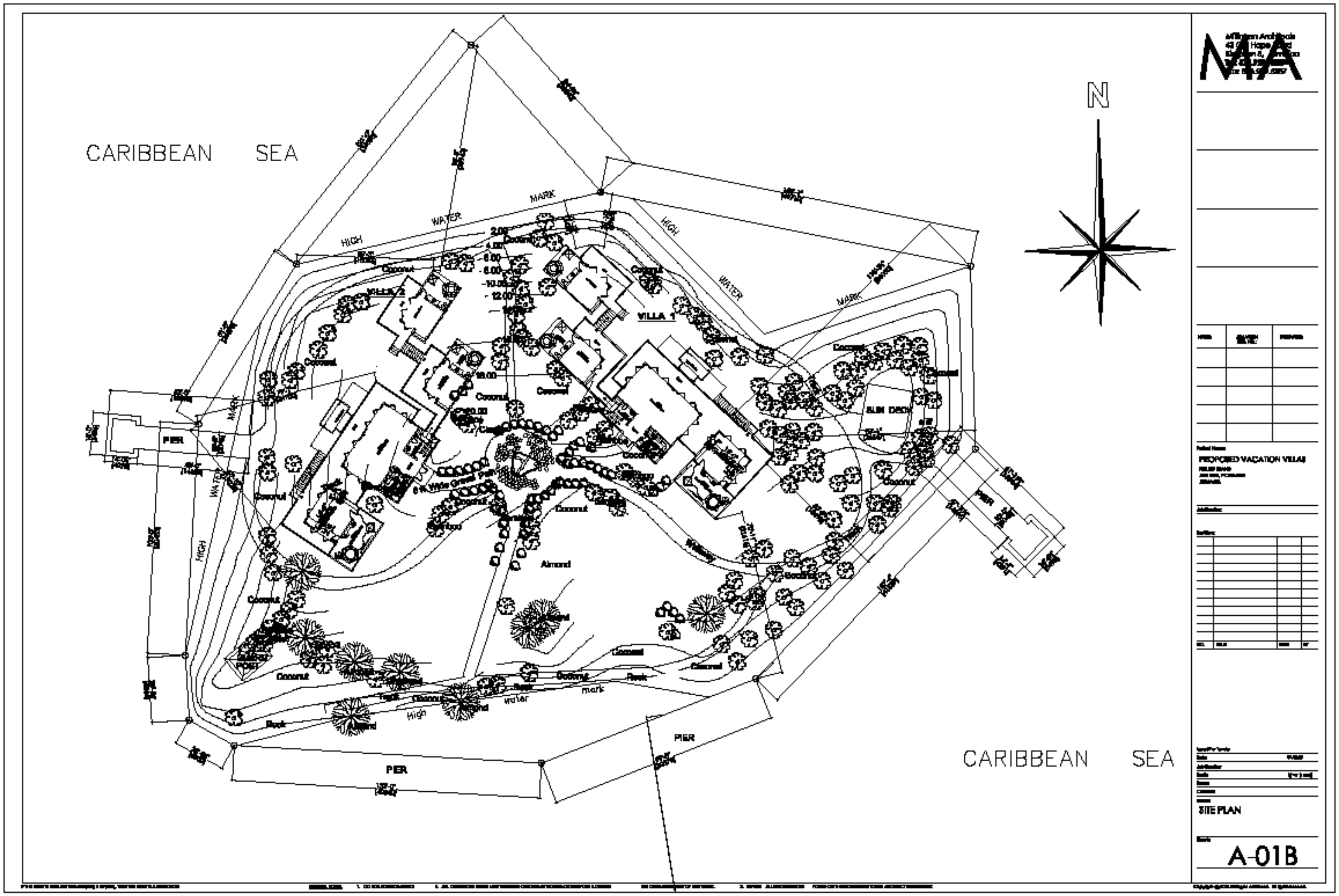
It is expected that NEPA will request that a Public Presentation to members of the surrounding communities. The consultant will present the findings of the EIA in Port Antonio. This will be done to inform and sensitise the public about the activities of the project and the significant steps being planned to address key environmental issues. A report on the Public Presentation will be sent in to NEPA as an addendum to the EIA.

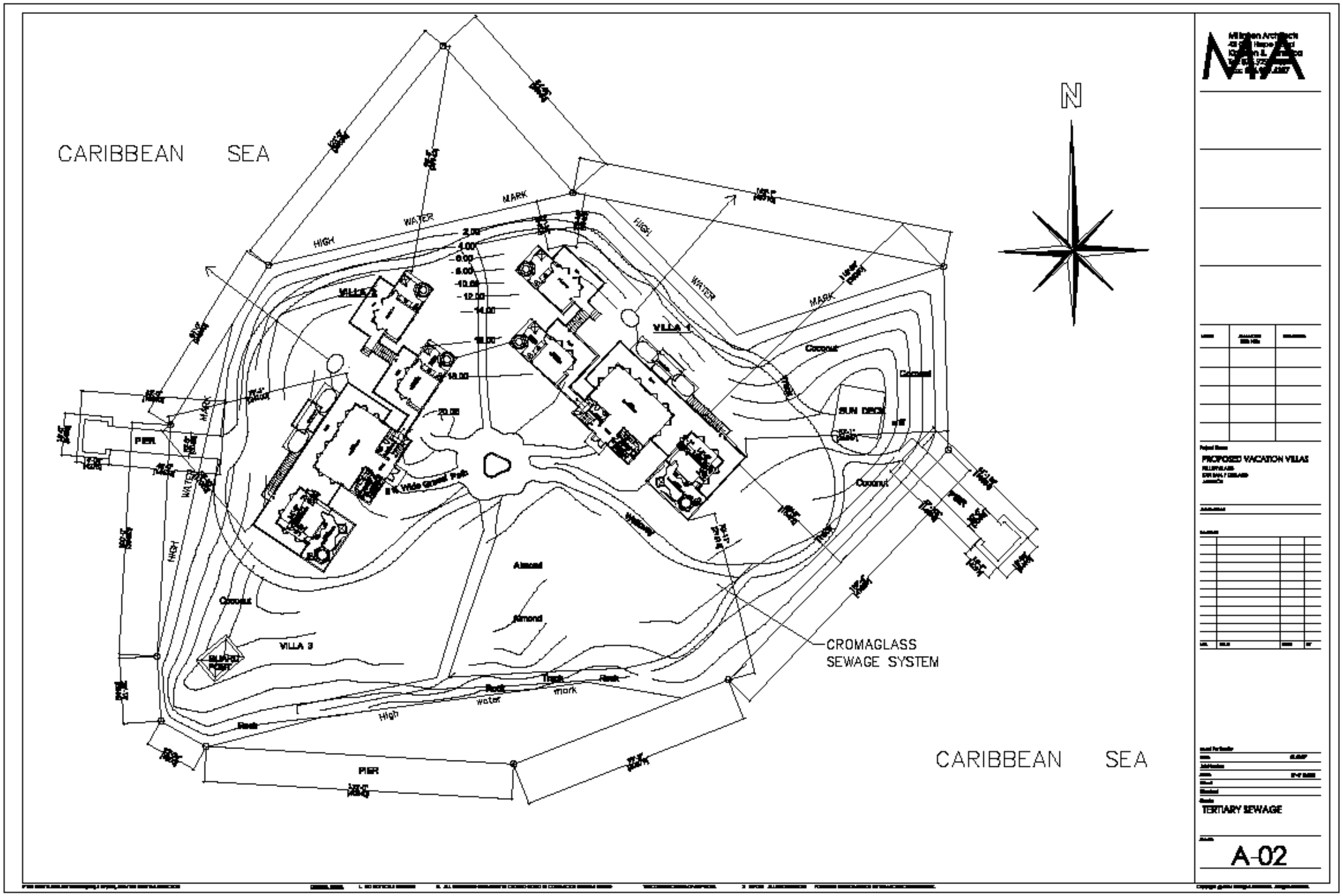
IX. Permit Applications

The Consultant will facilitate the permit application process by having the relevant meetings, drafting of the permit and license application forms for signature by the client and respond to any queries or comments made by NEPA.

APPENDIX 2:

SITE LAYOUT PLAN OF THE PROPOSED DEVELOPMENT


CARIBBEAN SEA
CARIBBEAN SEA
N
HIGH WATER MARK
VILLA 1
VILLA 2
PIER
PIER
PIER
PIER
SUN DECK
Coconut
Almond
Rock
High water mark
PROPOSED VACATION VILLAS
SITE PLAN
A-01B


CARIBBEAN SEA
VILLA 2
VILLA 1
VILLA 3
PIER
SUN DECK
Coconut
Almond
GUARD POST
CROMAGLASS
SEWAGE SYSTEM
HIGH WATER MARK
CARIBBEAN SEA
N
PROPOSED VACATION VILLAS
TERTIARY SEWAGE
A-02

1 A-09 REAR ELEVATION (7-BED RM. UNIT)
SCALE 1:75

1 A-09 FRONT ELEVATION (7-BED RM. UNIT)
SCALE 1:75

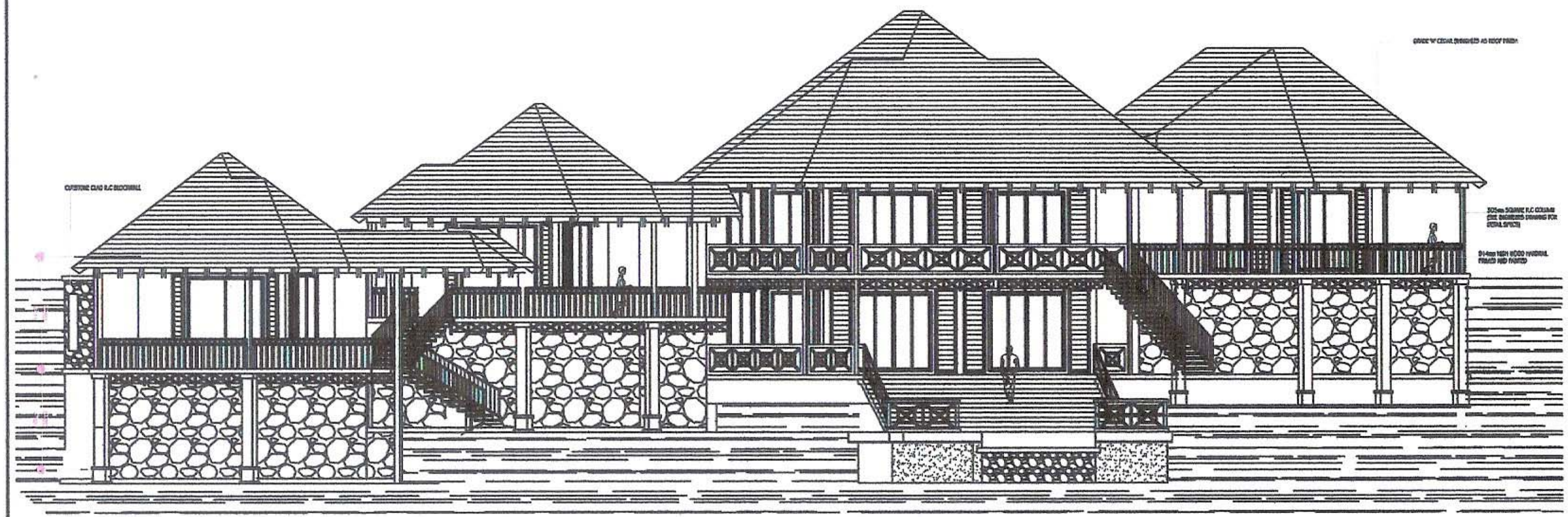
MA
Milngen Architects
Old Hope Road
Kingston 6, Jamaica
Tel. 876.[illegible]9230
Fax 876.929.[illegible]357

PROPOSED VACATION VILLAS

ELEVATIONS
7 BED RM. UNIT

Scale: AS SHOWN

A-09



1
A-07
REAR ELEVATION (4-BED RM. UNIT)
SCALE 1:75

1
A-07
FRONT ELEVATION (4-BED RM. UNIT)
SCALE 1:75

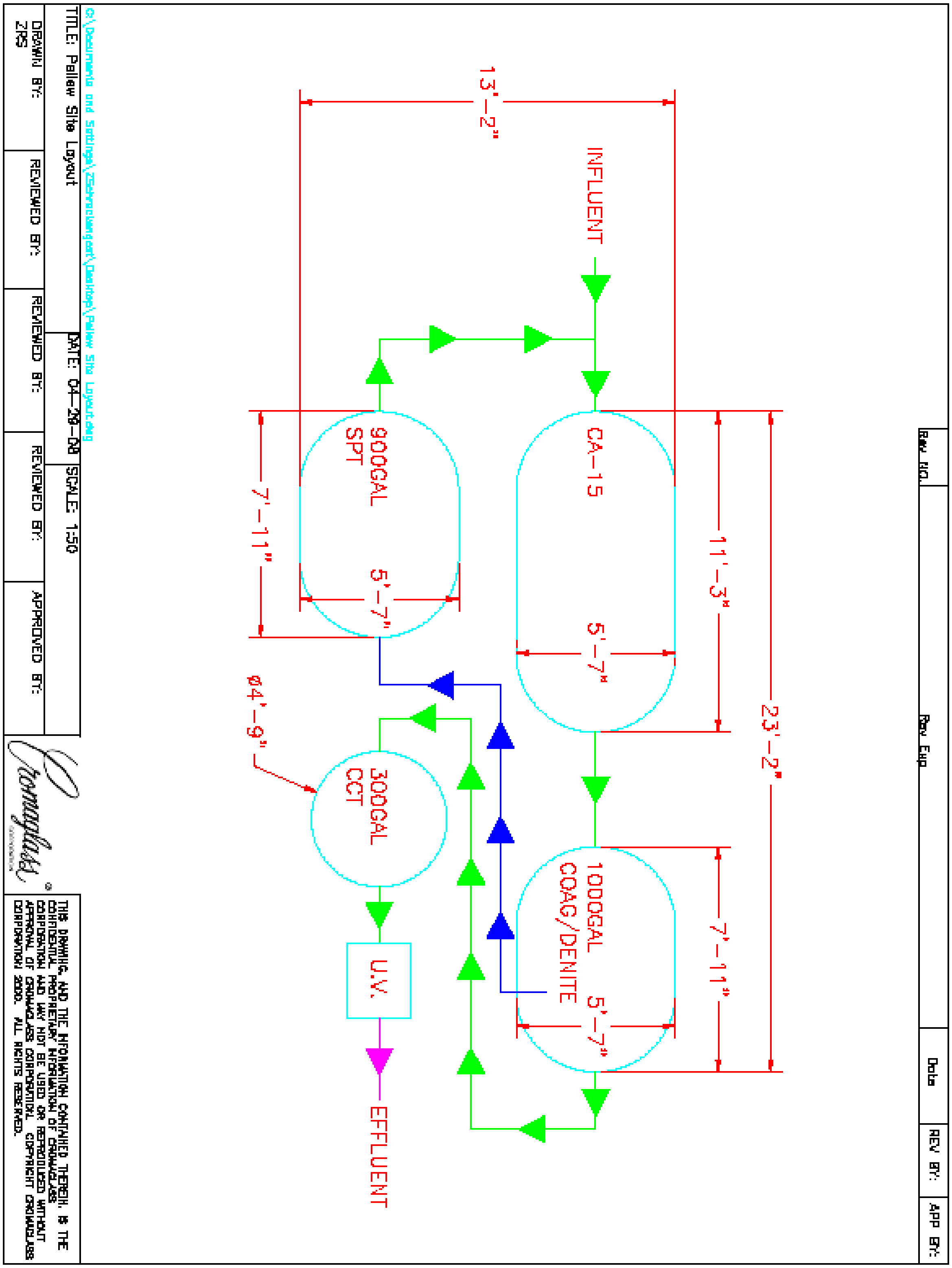
PROPOSED VACATION VILLAS

JAMAICA

ELEVATIONS
4 BED RM. UNIT

A-07

APPENDIX 3:
SPECIFICATIONS OF THE SEWAGE TREATMENT SYSTEM



INFLUENT
13'-2"
CA-15
5'-7"
11'-3"
23'-2"
900GAL SPT
5'-7"
7'-11"
Ø4'-9"
300GAL CCT
1000GAL COAG/DENITE
5'-7"
7'-11"
U.V.
EFFLUENT
TITLE: Pellew Site Layout
DATE: 04-29-08
SCALE: 1:50
DRAWN BY: ZRS
REVIEWED BY:
REVIEWED BY:
REVIEWED BY:
APPROVED BY:
Cromaglass
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Date
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APP BY:

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WASTEWATER TREATMENT SYSTEMS

EMAIL MEMORANDUM

TO: Bobby Miller
COMPANY: BIO-GT Sanitation Solutions, LTD
EMAIL: biogtsol@yahoo.com
FROM: Henry R. Holcomb
DATE: May 28, 2008
 # OF PAGES INCLUDING COVER: Five (5)
RE: Pellew Island, Port Antonio, Jamaica (update IV)

Dear Bobby:

Recommendations and calculations for your project are as follows:

DESIGN DATA

Parameters

Design Flow: 1,210 GPD
Run-off period: 16 hrs

Wastewater Characteristics

Influent		Effluent
220 mg/L	BOD_5	15 mg/L
220 mg/L	TSS	15 mg/L
45 mg/L	TN	N/A mg/L
	Giarda Cyst	<1/ 100ml
	Fecal Coliform	<12 MPN/100ml
	Residual Chlorine	0.5 mg/L

DESIGN COMMENTS:

- Flow, influent, and effluent criteria and type of use are as provided by BIO-GT Sanitation Solutions, LTD in a phone conversation on April 27, 2008.
- Engineer of Record must approve all calculations prior to manufacturing and sale of system. These calculations will be invalid if any criteria changes; ***any change will require a resubmission*.**
- Maximum daily organic load is not to exceed 2.5 lbs. BOD_5 per day.

ADDITIONAL COMMENTS:

- A fixed film media system consisting of 4 cylinders (4” diameter) will be installed in the CA-15F to enhance the growth of nitrifying bacteria. By enhancing the growth of organotrophic and nitrifying bacteria a decrease in effluent BOD occurs.
- The ultraviolet disinfection system and chlorine contact tank are required to provide proper disinfection before surface discharge
- The Sludge Processing Tank is recommended to provide the operator with an effective means of controlling the Activated Sludge Process.
- Expansion of the treatment equipment should be considered when the actual average hydraulic and/or organic loading meets or exceeds 80% of the design capacity.
- Please contact us if you have any questions or comments.

Proposed Equipment

A. ***One (1) Cromaglass Model CA-15F Wastewater Treatment Module***
Comprising a single system
B. ***One (1) 900 gal. Cromaglass Aerated Sludge Processing Tank***
C. ***One (1) 300 gal. Cromaglass Chlorine Contact Tank***
D. ***One (1) Dechlorination interface for storage unit.***
E. ***One (1) Ultraviolet Water Purifier (By Others)***

Design Specifications & Calculations

A. ***One (1) Cromaglass Model CA-15F Wastewater Treatment Module***. The Model CA-15F shall be complete with fiberglass tank, internal parts, fixed film media, schedule 40 and or schedule 80 PVC piping, One (1) Goulds WS0529B 1/2hp submersible aeration pump, one (1) Goulds WE0329H 1/3hp submersible discharge pump, one (1) Goulds WS0329B 1/3hp submersible sludge return pump, and controls. Electrical service to each control panel shall be 220 volt, 50 Hz, 40 amp, single phase.
B. ***One (1) 900 gal. Cromaglass Aerated Sludge Processing Tank*** shall be complete with fiberglass tank, internal parts, schedule 40 PVC piping, one (1) Goulds WS0329B 1/2hp submersible aeration pump, one (1) Goulds WS0329B 1/3 submersible decant pump, and controls. Electrical service to each control panel shall be 230 volt, 50 Hz, 20 amp, single phase.

C. ***One (1) 300 gal. Cromaglass Chlorine Contact Tank*** shall be complete with fiberglass tank, internal parts, schedule 40 PVC piping, and erosion style chlorinator.

D. ***One (1) Dechlorination interface for storage unit.*** Shall include internal parts, schedule 40 PVC piping, and erosion style dechlorinator.
E. ***One (1) Ultraviolet Water Purifier (By Others)***

Design Specifications

	EQ Tank	Treat. Unit	Total
Rated Treatment Capacity (combined)			1,210 GPD
Total Tank Volume (combined)		1,358	1,358 gals
Aeration Volume (combined)		950	950 gals
Clarifier Volume (combined)		408	408 gals
Surge Volume (combined)		500	500 gals
Standard Aerator Efficiency (SAE)		0.81	lbs. O_2/hp-hr
Oxygen Transfer Rate (OTR)		0.40	lbs. O_2/hr
Oxygen Supplied (combined)		6.7	6.7 lbs. O_2/day
Minimum Design Dissolved Oxygen*			2.0 mg/L
Design MLVSS			2,000 mg/L
F/M Ratio			0.13

***During aeration at ≤Design MLVSS**

Design Calculations

1. **Organic Loading:** not to exceed 30 lb. $BOD_5/1000\ ft^3$ aeration volume

$$= \frac{220 \times 0.0012 \times 8.34 \times 7.48 \times 1000}{950}$$

$$= 17.3 \text{ lbs. } BOD_5/1000\ ft^3$$

2. **Food to Microorganism Ratio:** (F/M Ratio); normal operating range = 0.05-0.30

$$= \frac{220 \times 8.34 \times 0.0012}{2000 \times 8.34 \times 0.00095}$$

$$= 0.13$$

3. **Retention Time:** (Volume/Flow) (24 hrs.); normal operating range = 12-50 hrs.

$$= (950/\ 1{,}210) \times 24$$

$$= 18.9 \text{ hrs}$$

4. **Oxygen Requirements:** must exceed 100%

Carbonaceous	$= 220 \times 8.34 \times 0.0012 \times 1.8$
	$= 4$ lbs. O_2/day
Nitrogenous	$= 45 \times 8.34 \times 0.0012 \times 4.6$
	$= 2.1$ lbs. O_2/day
Total required	$= 6.1$ lbs. O_2/day
Oxygen Supplied	$= 6.7$ lbs. O_2/day
Ratio	= 109.8 %

5. **Sludge Yield:** Waste Activated Sludge @ 10,000 mg/L MLSS, ρ=1.02, 50% decant vol.

$WAS_{lbs.}$	= 0.65 lb. WAS/lb. BOD_5 oxidized
	$= 0.0012 \times (220 - 20) \times 8.34 \times 0.65$
	= 1.3 lbs./day
$WAS_{vol.}$	$= \dfrac{1.3 \times 10^6 \times 0.5}{1.02 \times 10{,}000 \times 8.34}$
	= 7.6 GPD x 30 days = 228 gal./ month

DESIGN CRITERIA

Definitions of Variables & Constants

BOD	= Influent $CBOD_5$ concentration	mg/L
Q	= Hydraulic flow rate	GPD or MGD
V_{aer}	= Aeration Volume	gal.
MLVSS	= Mixed Liquor Volatile Suspended Solids (based on engineering judgement)	mg/L
COD	= Carbonaceous Oxygen Demand	lb. O_2/day
NOD	= Nitrogenous Oxygen Demand	lb. O_2/day
TOD	= Total Oxygen Demand	lb. O_2/day
TKN	= Total Kjeldahl Nitrogen	mg/L
RAS	= Return Activated Sludge	gal.
WAS	= Waste Activated Sludge	gal.
1000 ft^3	= Multiplier to obtain reactor organic loading in	$\frac{\text{lb. BOD}}{1000\ ft^3 \text{ aeration volume}}$
7.48	= Multiplier to convert gal to ft^3	
8.34	= Multiplier to convert mg/l to lb./million gal.	
1.5	= Multiplier (empirical)	$\frac{\text{lb. } O_2 \text{ required}}{\text{lb. BOD oxidized}}$
4.6	= Multiplier (empirical)	$\frac{\text{lb. } O_2 \text{ required}}{\text{lb. TKN oxidized}}$

CALCULATIONS

Organic Loading (lb. BOD/1000 ft^3): $\frac{(BOD)(8.34)(Q\ mgd)(7.48)(1000)}{(V_{aer}\ gpd)}$

Note: not to exceed 30 lb. BOD/1000 ft^3

F/M Ratio: $\frac{(BOD)(8.34)(Q\ mgd)}{(MLVSS)(8.34)(V_{aer}\ mgd)}$

Retention Time (hr): $\frac{V\ gal}{Q\ gpd} \times 24$ hr/day

Oxygen Demand (lb./day): COD = (BOD)(8.34)(Q mgd)(1.8)
NOD = (TKN)(8.34)(Q mgd)(4.6)

Total Oxygen Demand (lb./day): TOD = COD + NOD

Ratio (%): $\frac{O_2 \text{ Supplied}}{TOD} \times 100$ (must exceed 100%)

APPENDIX 4: **ECOLOGY**

A. TERRESTRIAL: FLORA

Table showing the List of Plant Species Observed within the Project Area

COMMON NAME	SCIENTIFIC NAME	VEGETATION TYPE	ECOLOGICAL IMPORTANCE	ABUNDANCE RATING
Prickle Withe	*Hylocereus triangularis*	Epiphyte	Endemic	F
Almond	*Terminalia catappa*	Tree		A
Cabbage Palm	*Sabal jamaicensis*	Tree		O
Dog Wood	*Piscidia piscipula*	Tree		O
Guinep	*Melicoccus bijugatus*	Tree		R
Maiden Plum	*Comocladia pinatifalia*	Tree		R
Noni	*Morinda citrifolia*	Tree		O
Sea Grape	*Cocoloba uvilera*	Tree		A
Bamboo	*Bambusa vulgaris*		Invasive	A
Seaside Mahoe	*Thespesia populnea*	Tree		
Trumpet Tree	*Cecropia peltata*	Tree		O
Weeping Willow	*Casuarina equisetifolia*	Tree		R
Coconut	*Cocus nucifera*	Tree		A
Vervine	*Stachytarpheta jamaicencis*	Shrub	Endemic	O
Duppy Pumpkin/Wild Melon	*Cionosicyos pomiformis*	Vine	Endemic	O
Wild Grape	*Cocoloba diversifolia*	Tree		A
Flame of the Forest	*Spathodea campanulata*	Tree		R
Poinciana	*Poinciana coriaria*	Tree		O
Crabwood	*Ateramnus lucidus*	Tree		R
Santa Maria	*Callophyllum jacquinii*	Tree		F
Swamp Cabbage	*Roystonea principes*	Palm	Endemic	O
Philodendron	*Phliodedron lacerum*	Vine		A
	Poypodium vulgaris	Fern		A

B. TERRESTRIAL: FAUNA

Table showing the List of Bird Species Observed within the Project Area

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
Fregatidae	**Frigatebirds**		
Fregata magnificens	Magnificent Frigatebird	R	F
Ardeidae	**Herons, Egrets and Bitterns**		
Ardea herodias	Great Blue Heron	NBR	O
Bubulcus ibis	Cattle Egret	R	F
Cathartidae	**New World Vultures**		
Cathartes aura	Turkey Vulture	R	F
Pandionidae	**Ospreys**		
Pandion haliaetus	Osprey	NBR	O
Falconidae	**Falcons and Caracaras**		
Falco peregrinus	Peregrine Falcon	NBR	O
Columbidae	**Pigeons and Doves**		
Patagioenas leucocephala	White-crowned Pigeon	R	A
Alcedinidae	**Kingfishers**		
Ceryle alcyon	Belted Kingfisher	NBR	F
Trochilidae	**Hummingbirds**		
Trochilus scutinus	Black-billed Streamertail	E	A
Picidae	**Woodpeckers**		
Melanerpes radiolatus	Jamaican Woodpecker	E	F
Emberizidae	**Emberizids**		
Dendroica caerulescens	Black-throated Blue Warbler	NBR	F
Setophaga ruticilla	American Redstart	NBR	F
Mniotilta varia	Black-and-white Warbler	NBR	F
Coereba flaveola	Bananaquit	R	D

Table showing the List of Other Macrofauna Observed within the Project Area

COMMON NAME	SCIENTIFIC NAME/ORDER	ECOLOGICAL IMPORTANCE
REPTILES		
	Anolis sps.	Endemic
INSECTS		
Ants,	Order Hymeoptera	
CRUSTACEANS		
Hermit Crabs	*Coenobite clypeatus*	

C. MARINE ENVIRONMENT

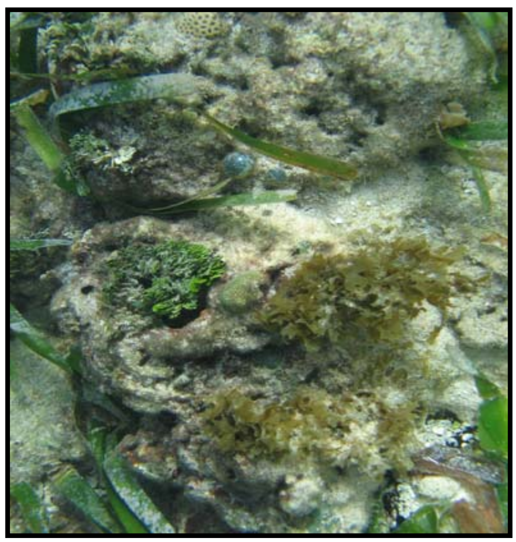
Commonly observed organisms located in the footprint and immediate environs of the proposed Docks

Corals	
Common Name	**Species Name**
Massive Starlet Coral	*Siderastrea siderea*
Lesser Starlet Coral	*Siderastrea radians*
-	*Madracis sp.*
Blue Crust Coral	*Porites branneri*
Finger Coral	*P. porites*
Mustard Hill Coral	*P. astreoides*
Sunray lettuce Coral	*Leptoseris cucullata*
Sponges & Cnidarians	
Brown encrusting sponge	-
Giant Anemone	*Condylactis gigantea*
Sun Anemone	*Stichodactyla helianthus*
Echinoderms	
Long Spined Urchin	*Diadema antillarum*
Reef Urchin	*Echinometra viridis*
West Indian Sea Egg	*Tripneustes ventricosus*
Macro-Algae	
Bristle Brush Algae	*Penicillus sp.*
Y-branched algae	*Dictyota sp.*
Bristle Ball Brush	*Penicillus dumetosus*
Se PEARL	*Ventricaria ventricosa*
White scroll Algae	*Padina jamaicensis*
Saucer Leaf Algae	*Turbinaria Sp.*
Watercress Alga	*Halimeda opuntia*
Green Feather Alga	*Caulerpa sertularioides*
Mermaid's Fan	*Udotea Sp.*
Fish	
Blue Tang	*Acanthurus coeruleus*
Bluehead Wrasse	*Thalassoma bifasciatum*
Clown Wrasse	*Halichoeres maculipinna*
Bicolour Damselfish	*Stegastes partitus*
Dusky Damselfish	*Stegastes fuscus*
Three Spot Damselfish	*Stegastes planifrans*
Slippery Dick	*Halichoeres bivittatus*
Indigo Hamlet	*Hypoplectus indigo*

The benthic environment in the vicinity of the proposed location for Dock 1 at the eastern end of Pellew Island

Brown Ecrusting Sponge

Halimeda opuntia, Dictyota sp., Siderastrea radians, Ventricaria ventricosa, Padina jamaicensis, Galaxaura sp.

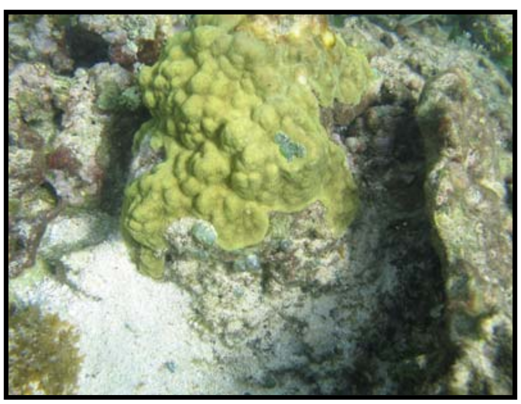


Padina jamaicensis, Galaxaura sp., Dictyota sp., Turbinaria sp., Neospongodes sp., Thalassia testudinum.

Condylactis gigantea.

Stichodactyla helianthus

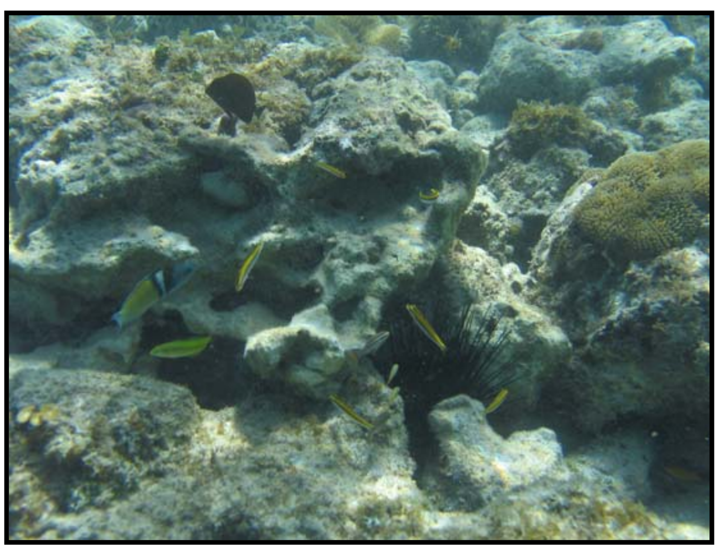
Porites astreoides



The benthic environment in the vicinity of the proposed location for Dock 2 at the western end of Pellew Island

Relic coral colony encrusted in coralline (*Halimeda* sp., *Penicillus dumetosus*) and fleshy (*Dictyota* sp., *Padina jamaicensis*) algae sits on sandy substrate populated by *Thelassia Testudinum* and Bluehead Wrasse (*Thalassoma bifasciatum*) terminal and juvenile stages, swim around relic coral colony.

The area in which it is proposed that Dock 2 will be located is characterised by high levels of relief and three-dimensional special complexity. The irregular substrate provides shelter and habitat for fish such as the Dusky Damselfish, (*Stegastes fuscus*); Bluehead Wrasse (*Thalassoma bifasciatum*) terminal and juvenile stages, the intermediate juvenile stages of the Slippery Dick (*Halichoeres bivittatus*), and the juvenile Clown Wrasse (*Halichoeres maculipinna*) and the Long-spined Urchin (*Diadema antillarum*).

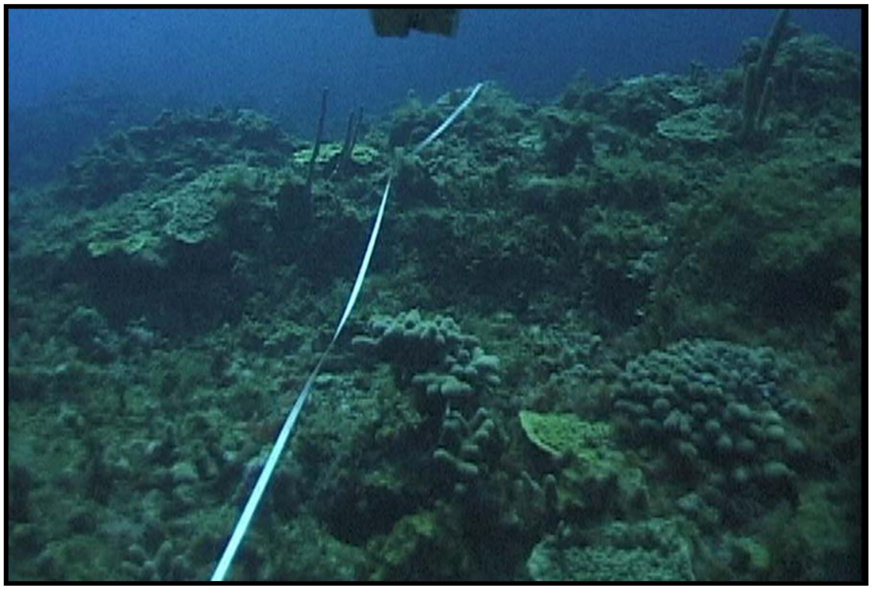


Porites porites and Brown Encrusting Sponge on irregular substrate among *Thelassia* shoots.

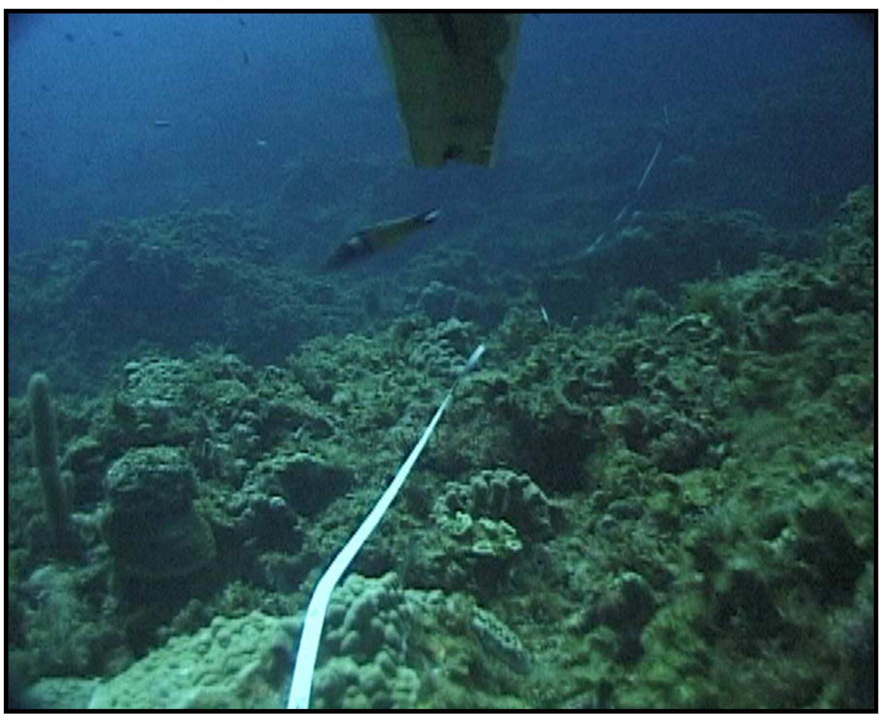
Coral boulders are colonised by the Brown Encrusting Sponge, the Sun Anemone (Stichodactyla helianthus), the coralline alga *Halimeda opuntia*, the Finger Coral *Porites porites*, and the Mustard Hill Coral *Porites astreoides* the Lesser Starlet Coral *Siderastrea radians. Thelassia* Testudinum shoots grow from the sand in the spaces between the coral boulders.

The Benthic Environment on the Fringing Reef Seaward of Pellew Island

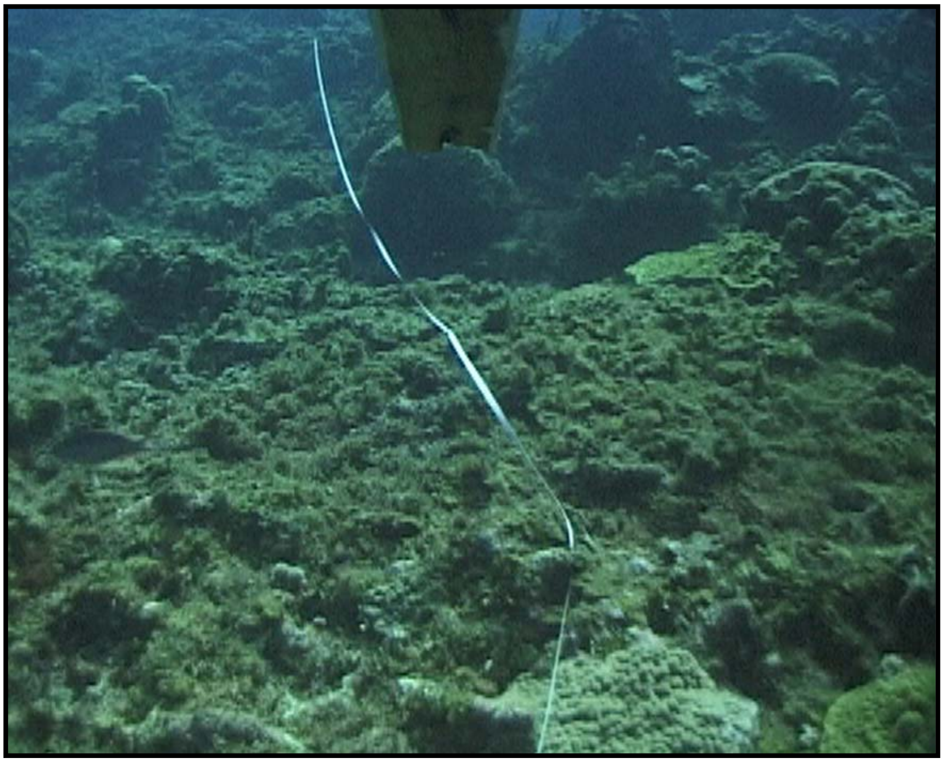
Fringing reef with *Porites porites* and *Porites astreoides* in the lower right fore ground to the right of the tape measure marking the transect line.



View across a section of the fore reef showing transect line marked by tape measure. A *Porites astreoides* colony lies under the measuring tape at the bottom of the photograph. A colony of *Eusmilia fastigiated* lies above the *Porites* colony and to the right of the measuring tape.



Section of fringing reef showing heavy algal cover on dead coral substrate



APPENDIX 5:
SOCIO-ECONOMIC

A. SOCIO –ECONOMIC SURVEY FORM: PELLEW ISLAND

1. DATE:
____

2. COMMUNITY:
____

3. OCCUPATION: ____

4. How long have you been a resident/fisherman/ operated your business in the area?

☐ within the last five years ☐ within the last 10 years ☐ within the last twenty years ☐ over twenty years ago

5. Are you aware of the development that has been planned for Pellew Island? ☐ Y ☐ N (If no show development plan)

If yes what do you know about the development?

____
_____

6 Do you now use Pellew Island in any way? ☐ Y ☐ N

If yes how do you use the property?

____

7 Do you think this development will affect the area in a good or bad way?

☐ Good ☐ Bad

How do you think it will affect the community Good/Bad?

____

____

8. Is there any other land-use that you would have like to seen the property used for?

9. Any other comments?

B: Electronic Petition

Excerpt from meeting with San San Association members

"There was unanimous opposition to the development and all the 37 participants, representing 27 properties, gave their support to re establishing a San San Association. Another 17 properties which were not represented at the meeting, have also opposed the development".

Electronic petition of JEAN from JET

"Next Steps:

Sign the electronic petition and pass it on: there are many, many folks who love Pellew (Monkey) Island - http://www.thepetitionsite.com/petition/846734890"

"Dear JET members,
We have become aware that there is a plan to put villas on Pellew Island off the coast of San San in Portland. There is an on line peitition at the link below - if you do not agree with this plan, please go to the link and sign the petition. It's really easy and there is an option for an anonymous comment.

http://www.thepetitionsite.com/petition/846734890

Thanks,
Diana"