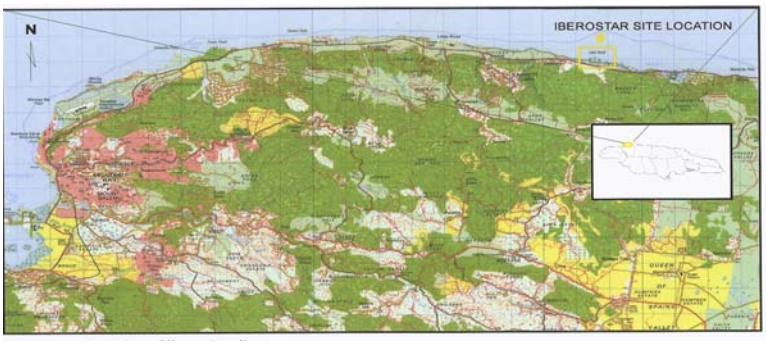
IBEROSTAR ROSE HALL RESORT AND SPA



ENVIRONMENTAL IMPACT ASSESSMENT

Prepared on behalf of:

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A member of

THE IBEROSTAR GROUP (GROUPO IBEROSTAR)

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JULY 2004

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– ROSE HALL UTILITY COMPANY

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EXECUTIVE SUMMARY

THE PROJECT

Branch Developments Ltd submitted an application to the National Environment and Planning Agency (NEPA) for a permit to construct a five storey 350 room hotel near Lilliput on the north coast of Jamaica in the vicinity of the Rose Hall Beach Club. The site lies at the eastern end of the historic Rose Hall Estate, Greater Montego Bay, St James.

The development will be known as **Iberostar Resort and Spa,** and will be located on a 16 hectare (39.52 acre) property purchased from the Rose Hall group of companies. Branch Developments Ltd, is a company of the Iberostar Group (Grupo Iberostar), and marks the first investment of Grupo Iberostar in Jamaica, and indeed in the English-speaking Caribbean. The Group is headquartered in Spain.

An Environmental Impact Assessment report was required by NEPA as part of the permitting process, and Environmental Solutions Ltd was contracted to undertake the study and prepare the report. A summary of the investigation and findings is presented in this Executive Summary.

THE STUDY

The EIA was prepared in accordance with the guidelines set out in the NRCA's Guidelines for conducting Environmental Assessments, and with the Terms of Reference approved by NEPA. The existing environment was described in the context of the proposed footprint of the development, and

the legislative and regulatory context of the project was pesented. Potential impacts were identified and suitable mitigation measures recommended as required. Specific attention was paid to the following issues: Land use management, drainage and run-off, terrestrial ecology, coastal and marine environment, traffic patterns, entrance, exits and connection to the North Coast Highway, physical carrying capacity of the proposed infrastructure and services, utilities and social amenities, buffer zones and recreational areas, sewage treatment and solid waste management.

Analysis of Alternatives to the proposed project and Environmental Quality Objectives have been included.

EXISTING ENVIRONMENT

PHYSICAL

The proposed hotel site is located on an extensive low-lying coastal strip along the northwestern coastline of Jamaica. The site is divided by the old coastal road. The area north of the old road consists of a narrow triangular coastal strip that is flat, sand covered, and close to sea level. The beach is convex in shape with a very gently sloping foreshore that narrows and tapers off in an easterly direction.

The area south of the road comprises an east-west oriented uniform slope with the toe of the slope defined by the old coastal road. The slope extends southwards to the present main road where the land surface flattens out at about 25 meters above mean sea level. This slope is generally steepest and more uniform towards the western end, where

it is close to 45 degrees, getting less steep and more irregular in form towards the eastern end.

There are no natural drainage lines on the proposed site. Runoff from the surrounding hills to the south of the present main road is diverted to the west and east of the site by a topographic divide.

The site is underlain by Montpelier limestone, which is highly permeable with abundant fractures and occasional clay partings. Soils are a light reddish brown gravely clay, and are 6 to 12 inches deep on slopes.

There is a well-developed beach with a gently sloping foreshore, which extends offshore to create a shallow lagoon between the shore and the fringing reef.

The coastal zone is highly susceptible to the effects of storm surge associated with hurricanes. Low lying areas along the coast are susceptible to inundation and accelerated erosion from increased wave action. Estimates of storm surge along this section of the north coast suggest an elevated water height of between 1.5 and 2.5 meters above mean sea level. Intense rainfall associated with other tropical weather systems can also cause flooding of low-lying areas in the coastal zone.

With respect to coastal water quality, total suspended solids, oil and grease, nitrate, and biochemical oxygen demand levels were elevated. In contrast, faecal bacterial levels were low and dissolved oxygen levels show fair levels of oxygenation. This suggests that the organic pollution recorded at this site is likely due to indirect seepage from non-point sources rather than direct discharge.

BIOLOGICAL

The flora on the property consists of coastal vegetation and disturbed dry limestone forest. The coastal plants are located in a narrow belt all along the beach. Large areas of the shore down to the high tide mark are covered by pioneer plants. Trees are generally less than 10 m tall. Saplings and small diameter trees dominate, and the canopy is open in many places. Some of these larger trees were approximately 40 cm in diameter, while the smaller trees averaged 15 cm in diameter.

The bird fauna on the property is fairly rich, with 24 species identified within 3 hours. At least nine species of bird feeding trees are present on the property, and these encourage birds to populate this area. The density of the vegetation, particularly the scrubby interior of some areas of the site, provides a good habitat for more secretive birds such as the Jamaican lizard cuckoo.

Eight endemic birds presently utilize the site, as well as the White-crowned pigeon, which has become threatened throughout its range as a result of habitat destruction and hunting. This site is therefore a significant bird area. However, the bird species found on the property are all common in Jamaica.

Turtle nesting is known to occur on the beach along the Iberostar property, particularly in the vicinity of the Rose Hall Beach Club. The Hawksbill turtle (*Eretmochelys imbricata*) is the main species seen, but occasional reports of Leatherback turtle (*Dermochelys coriacea*) sightings have also been made. The Hawksbill turtle is an endangered species due to commercial exploitation, hunting and egg

harvesting, and is listed under CITES. It is known that in Jamaica these turtles are sometimes taken for food, but egg harvesting is the more common activity.

Hawksbill turtles return to the same beach each time to lay their eggs. The clutch is usually laid above the high tide mark, often under vegetation. On the Iberostar beach, they are known to lay eggs under *Coccoloba uvifera* trees (sea grapes), and may even go into the vegetated or forested area close to shore.

The sediment on the shore and in the lagoon is mainly fine-grained buff-coloured sand. However, towards the eastern end of the lagoon, close to the shore, the sand becomes very fine and unconsolidated, taking on a mud-like texture.

The lagoon is almost entirely covered in seagrass, with few patches of bare sand and small algal beds. Turtle grass (*Thalassia testudinum*) is the dominant seagrass in the lagoon, but fair amounts of manatee grass (*Syringodium filiforme*) also occur in the middle and eastern parts of the lagoon, closer to the shore. These seagrasses, particularly *Thalassia sp.* form large mats of dead material that accumulate on the shore all along the property. The *Thalassia sp.* plants that carpeted most of the lagoon grew in fairly dense meadows with blade lengths averaging approximately 15 cm. Epibiotic cover on the blades was fairly high, at approximately 30 to 40%, indicating possible nutrient pollution in this area. Sediments also coated large areas of the blades.

Live Queen Conchs were occasionally seen amongst the sea grass in the deeper parts of the lagoon, while crabs were frequent in the shallow areas near the shoreline. Corals

were rare amongst the sea grass. Fish were quite rare over the sea grass beds, which is unusual for this typical nursery habitat

A fringing reef lies far offshore and the system is rather broad. On the **back reef** live hard coral cover is on average higher than that typically found on Jamaican reefs, at approximately 15% cover, reaching up to 20% cover in some areas. Coral colonies were of medium size, averaging 30 cm in diameter. Occasional large colonies (>1.5 m) were also observed.

The fish community is relatively rich, with 36 species identified, although size was generally less than 20 cm in length. Some commercially and ecologically important fish were commonly observed, such as Yellow tail snappers, Goatfish, Doctor fish, Spanish hogfish, Bar jacks, Schoolmasters and French Angelfish.

The **fore reef** is separated from the back reef by a shallow reef crest, which scarcely, if at all breaks the water's surface. The reef crest is covered mainly by brown algae, particularly *Sargassum sp.* and *Turbinaria sp.* large pieces of *Acropora palmata* rubble are found near the crest. The wave action and surge in this area is quite strong.

The fore reef area close to the reef crest is also dominated by brown algae, with very few benthic invertebrates. Coral cover is low, at 1 to 2%, and colonies are generally small. Fish were also few, with only a small number of immature parrotfish seen.

This area is fairly deep at approximately 6 m. The reef slopes quite sharply down from the reef crest and onto the

fore reef. Further north the reef once more gives way to *Thalassia testudinum* meadows.

It is unusual that the fore reef would be in a more degraded condition than the back reef.

SOCIAL

The Iberostar Hotel site sits toward the eastern end of the Rose Hall estate and a long stretch of coastal flatlands lie to the west of Rose Hall Beach Club extending to Sea Castles condominium and Success Beach, the eastern boundary of the Rose Hall Master Plan site. Settlement within the project area is dominated by Lilliput, a major settlement which has spread over the years on the hills south of the main road. Barrett Hall located southeast of the project boundary is a smaller area, and is connected to the coastal area alongside the project site. In addition, there are fishing clusters along the beach, such as Success Beach (centred on Barrett Town) to the west, Grange Beach//"Wagon Wheel beach", (centred on Lilliput) and Long Bay (centred on Barrett Hall and Greenwood). The combined population of Lilliput, Barrett Town and Barrett Hall totals approximately 8,342 persons.

Livelihoods are mainly derived from construction labour, domestic services to tourism, and craft. Under- employment or outright unemployment is evident.

Water supply is tapped from the 24 inch NWC main on the coast road, which brings water from the Martha Brae treatment plant. Residents interviewed reported that water supply is good.

Absorption pits (30%) and pit latrines (70%) are the main sanitary conveniences used. Given the limestone bedrock, sewage disposal is important not only to the health of the community but also coastal water quality. The direct consequences for the hospitality sector and fisheries are stark. Garbage disposal & collection is undertaken by Western Parks and Markets (WPM), but littering was evident throughout the site and in surrounding communities. Investigations of water quality and coastal conditions suggest a direct link between these practices and water quality and aesthetic observations in the coastal waters.

Sewage from the Iberostar development will be treated through a new facility to be established by the Rose Hall Utility Company. The treated effluent from the wastewater treatment facility would be pumped into an irrigation distribution system for beneficial reuse and sale to customers as irrigation water.

It is anticipated that power supply will be adequate to meet the needs of the development. Energy efficient operations should be integrated into the development plans for all major energy users of the resort. The Chiller system proposed for air conditioning is an energy efficient system.

Regarding traffic flow and transportation on the main road, NCHIP is scheduled to begin work in the area by the end of 2004. Consultation will need to be undertaken with the Project Managers to facilitate effective synergy between construction requirements of the many developments within the area. The design of the main entrance to the project must provide a smooth interchange between the project and the main road traffic.

The Rose Hall Estate and environs have a rich archaeological and cultural heritage that has been somewhat tapped as part of the tourism product. However, there is considerable potential yet to be developed and one such opportunity for the project is the Greenwood Great House, already an attraction, but which is in close proximity to the project through Barrett Hall. This Barrett Browning Great House at Greenwood is likely to become an important attraction for the project, given its ease of access.

Mount Zion, southwest of the project in the Rose Hall Development area, was a free village. Its imposing Church and graveyard were established in the year of emancipation. The church bell is inscribed with the text preached on Emancipation Day.

POTENTIAL IMPACTS

Findings of the assessment are presented according to site preparation, construction and operation phases. A generic impact matrix identifies the inter-relationships between the project activities and the physical, biological and social environmental factors. However, the Generic Impact Matrix does not take account of the full interrelationship between the environment and the project, in that the relationships identified in the matrix are unidirectional – impact of the project on the environment only. This is especially significant to the Iberostar Resort in that developers must pay particular attention to natural hazard vulnerability and social setting as significant considerations with respect to the operations of the project.

A summary of the impacts relate to the following:

DRAINAGE AND RUN-OFF

Particular attention must be paid to the cumulative impact of increased storm water runoff from the site, given the proximity of the development site to coastal/marine environment and reefs.

TERRESTRIAL ECOLOGY

Large diameter trees, especially bird feeding trees need to be retained and incorporated as far as possible into the landscape design so as to minimise loss of habitat for numerous birds and other fauna. Some species of coastal vegetation help to build dunes and prevent beach erosion – these should be maintained.

To reduce the negative impacts on turtle nesting relevant coastal vegetation should be retained, and other mitigation measures have been suggested. Proper management of the nesting beach by the hotel may actually increase the survival chances of the turtles by protecting turtle nests from poachers.

COASTAL AND MARINE ENVIRONMENT

The back reef area is quite shallow, with numerous protruding patch reefs. These are very close to the water's surface and may be hazardous to water sports activities. The area must be properly marked before these activities are offered.

Threats to the Project will also arise from the lack of adequate sewage and garbage disposal in the hill communities behind the project region.

COMMUNITY RELATIONS

The Project can be expected to bring employment and income benefits, to the community, and in exchange benefit from construction labour skills, and existing or trainable domestic occupational skills. However, the proximity to the project of this large-scale squatter community raises several social issues that must be addressed.

The project in turn, will aggravate the social pressures on the community, to the extent that new low skill employment generation, perceived and real, will likely increase the residential squatting demand unless affordable staff housing is provided. The relevant government agencies, or the private real estate development sector, with incentives if necessary, should be mobilized to do this

TRAFFIC MANAGEMENT

The project will empty on to the main north coast artery from Montego Bay to Ocho Rios. Dialogue with the National Works Agency (NWA) and the project managers of NCHIP Segment 2, is required.

PHYSICAL CARRYING CAPACITY

Total water management, including potable supply, sewage disposal and storm water drainage, energy, and internal pathways are the major considerations. Carrying capacity appears to be adequate given the proposed Rose Hall Utility Co sewage treatment facility and the Montego Bay water supply infrastructure. Drainage infrastructure will be designed to take account of the projected storm water flows.

UTILITIES AND SOCIAL AMENITIES

Social amenities within the project setting are very limited. The Resort will provide its own amenities and the surrounding communities have limited facilities. There will be limited impact of the project on the surrounding areas' utilities or social amenities.

BUFFER ZONES AND RECREATIONAL AREAS

This does not apply to the project. In order to improve aesthetics, and to reduce the impact of noise and dust on the project it has been recommended that a tree buffer be planted on the southern boundary (main road) of the project.

SEWAGE TREATMENT

The proposed Sewage treatment as discussed above is expected to improve coastal water quality, provided systems are improved upstream of the project.

SOLID WASTE MANAGEMENT

The resort will be part of the waste shed of Western Parks and Markets, and Retirement is the official waste disposal (landfill) site. Construction spoils and site clearance material will need to be carefully bundled for collection and disposal at the approved site.

During the operational phase the project should seek to employ waste reduction initiatives, e.g. composting of organics, recycling/reuse, minimise packaging etc., so as to reduce the volume of waste to be collected and transported to the landfill. Cost savings can be realised and coastal water quality must be protected from solid waste disposal.

ENVIRONMENTAL QUALITY OBJECTIVES (EQO)

EQOs have been identified for:

- **Storm water Control**
- **Energy Efficiency**
- **Minimization Of Pollution**
- **Protection Of Turtle Nesting**
- **Habitat Protection**
- **Aesthetic Appeal**

CHAPTER 1: INTRODUCTION

1.1 PURPOSE

This document presents the findings of the Environmental Impact Assessment (EIA) conducted for development of the proposed **Iberostar Rose Hall Resort And Spa.** The **Iberostar Resort** will be built near Lilliput on the north coast of Jamaica in the vicinity of the Rose Hall Beach Club to the eastern end of the historic Rose Hall Estate, Greater Montego Bay, St James.

The EIA report will form part of the documentary evidence in support of a permit application for a five storey 350 room hotel submitted by the developers, **Branch Developments Ltd,** to the National Environment and Planning Agency **(NEPA**) which is the environmental regulatory authority of the Government of Jamaica.

1.2 BACKGROUND

Branch Developments Ltd, a company of the Iberostar Group (Grupo Iberostar) purchased a 16 hectare (39.52 acre) property from Rose Hall Developments Ltd and proposes to develop over time and in phases, an all-inclusive resort consisting of three blocks. This investment marks the first of Grupo Iberostar in Jamaica and indeed in the English-speaking Caribbean. The Group is headquartered in Spain.

Rose Hall Developments Ltd has been engaged in phased development of the coastal and landward component of the

historic Rose Hall Estate since the 1960s, in keeping with an agreement with the Government of Jamaica.

This development has included sale of land to other developers, as well as specific development by Rose Hall including Spring Farm (housing) Estate, Holiday Inn Hotel, restoration of the Rose Hall Great House, The Palms (condominium), Wyndham Hotel and the Wyndham Golf Course, Rose Hall Beach Club, The Highlands (housing) Estate, Ritz Carlton Rose Hall Hotel and the eighteen hole White Witch international golf course. Figure 1.1.

The Iberostar development will occupy lands adjacent to the Rose Hall Beach Club and ultimately the site of the Beach Club itself. The development will include three blocks of development (FIGURE 1.2) with the following major components:

Three major hotel blocks accommodating 950 rooms

- Block I 350 rooms
- Block II 300 rooms

  Convention Centre

  Spa
- Block III 250 rooms

  Restaurant and Bars

  Resort Infrastructure.

The development will be linked to a proposed central sewage treatment facility that will be built, owned and operated by Rose Hall Utility company, a subsidiary of Rose Hall Developments Ltd, and designed to serve resort facilities in the Rose Hall area.

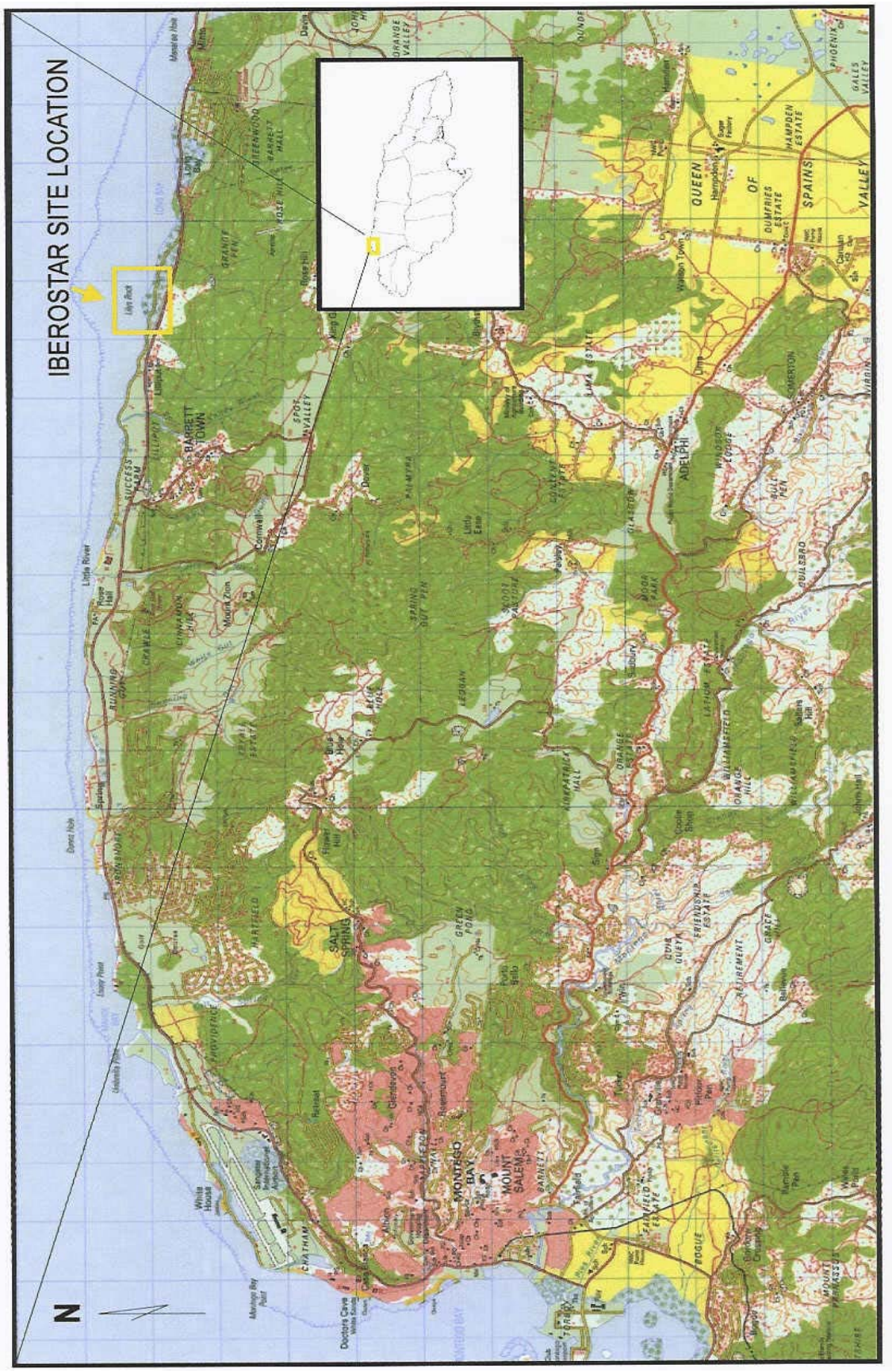

Figure 1.1 Location of Iberostar Site

1.3 DESCRIPTION OF THE PROJECT

The first phase of the development will involve the construction of Block 1 at the eastern end of the site as shown in Figure 1.3. Phase one is the subject of this report. The 350 room five storey hotel has been designed in accordance with the sloping topography of the site and entrance will be at third floor level. Swimming pools, a solarium, gardens and bars will dominate the first floor and the property will accommodate three restaurants, bars, public entertainment areas, conferencing facilities and other resort infrastructure.

No beach development proposals have been submitted at this time. It is proposed that hotel guests will utilize the existing beach on the property, which now serves the Rose Hall Beach Club. The building consists of five floors with the ground floor close to sea level. Access to the building will be from the south from the adjacent slope.

The founding of the building will involve making a cut into the slope to the south. A retaining wall will be constructed to stabilize the resulting cut slope. Access roads and paths will be constructed south of the building footprint and the remainder of the southern slopes will be landscaped.

Sewage generated by the hotel will be treated by the new treatment plant to be constructed on the Rose Hall property. Potable water and electricity will be supplied by the Jamaica Public Service and the National Water Commission respectively.

Figure 1.2 Layout of Proposed Development

Figure 1.3 Configuration of Block 1

The developer proposes to use an energy efficient, easily maintained ***Fluid Cooled Chiller system*** for air conditioning facilities. This system involves use of underground salt water, which will be used to cool the refrigerant from the condenser of the chiller through a heat exchange process. A 12" well is needed in order to abstract the salt water, and this well will be drilled to a depth of 25 meters.

The abstracted salt water (Temp. 27 ºC) will go through a titanium heat exchanger and once the heat exchange process is completed the water will be discharged/deposited into two 8" wells. The disposed salt water will have an increased temperature of 32.3 ºC.

The condenser has a closed system with a refrigerant which will also be run through the titanium heat exchanger, but in an opposite direction to the saltwater. There will be no contact between the refrigerant and the saltwater.

The distance between the abstraction well and the disposal well is at least 100 meters, so as not to abstract disposed water, and the distance between each disposal well has to be at least 25 meters. These distances are essential for the smooth operation of the system.

1.4 TERMS OF REFERENCE

The EIA will document the existing environmental conditions at the proposed site and its environs including physical, biological and socio-economic aspects. The TOR has been prepared following the guidelines set out in the NRCA's Guidelines for Conducting Environmental Assessments.

The terms of reference for conducting the Environmental Impact Assessment are as follows:

1. **Introduction** – Describe the resort development project to be assessed and outline the need for the project.

2. **Background Information** - Briefly describe the major components of the proposed project, the implementing agent, along with a brief history of the project.

3. Study Area – Describe the location and setting of the project site and indicate the boundaries of the study area.

4. Scope of Work - The EIA will include but not necessarily be limited to the following tasks:

Task 1. Description of the Proposed Project

Provide a full description of the project and its existing setting, using plans, maps and graphic aids at appropriate scales. This is to include: location, general layout (size, capacity, etc.); areas slated for pre-construction and construction activities, operation and maintenance activities.

It will also include: The overall schedule of project implementation, plans for providing utilities, waste disposal and other necessary services, and the physical, ecological, demographic, socio-cultural and institutional settings of the project. Reference will be made to current development plans for Montego Bay and other major projects in the area.

Task 2. Description of the Environment

Assemble, evaluate and present baseline data on the study area, including the following:

a) Physical environment: Describe the physical setting of the development site including climate, topography, geology, soils and natural drainage of the site. Evaluate erosion potential. Determine the ambient air quality and marine water quality conditions. Describe the marine physical

setting including shoreline configuration and beach processes. Summarise the nearshore current and wave regime.

b) Biological environment: Describe the existing terrestrial flora, and fauna on the development site and in the marine environment and assess any rare or endangered species, sensitive habitats, species of commercial importance, and species with potential to become vectors or nuisances. In particular quantify the and quantity of vegetation that will be removed and the effect on existing fauna. Determine the effect the development will have on existing habitats especially on turtles and migratory birds.

c) Socio-economic environment: Present and projected populations, community structures, land use, current development plans, recreation and public health, public and community perceptions and attitudes on the proposed project, and any historical importance of the area. In particular evaluate the effect of the project on current recreation use by the surrounding communities.

Task 3. Legislative and Regulatory Considerations: Outline the pertinent policies, regulations and standards governing project location, land use, environmental quality, and public health and safety.

Task 4. Determination of Potential Impacts:

Identify the major issues of environmental concern and indicate their relative importance to the design of the project. Distinguish construction and post-construction phase impacts, significant positive and negative impacts, and direct and indirect impacts. Identify impacts that are cumulative, unavoidable or irreversible. Area of focus will include:

- Land use management
- Drainage and run-off
- Terrestrial ecology
- Coastal and marine environment
- Traffic patterns, entrance and exits and connection to the North Coast Highway
- Physical carrying capacity of proposed infrastructure and services
- Utilities and social amenities
- Buffer zones and recreational areas
- Sewage treatment
- Solid waste management

Reference should be made to the extent and quality of the available data and any information deficiencies, and uncertainties associated with the prediction of impacts should be clearly identified.

Task 5. Analysis of Alternatives:

Indicate project alternatives including the option of no action.

Task 6. Mitigation and Management of Negative Impacts:

Summarise the potential environmental impacts (air quality, water and land) of the project. Develop any required mitigation measures and identify any residual impacts that may exist after mitigation.

Task 7. Development of a Monitoring Plan:

Prepare a plan for monitoring the implementation of mitigating measures and the impacts of the project during construction and post-operation phases. The plan should include a waste management plan, schedules of monitoring reports and should identify the persons responsible fro implementing the plan.

1.5 REPORT

The environmental assessment report will be concise and limited to significant environmental issues. The main text will focus on findings, conclusions and recommended actions supported by summaries of the data collected. The environmental assessment report will be organized according to the outline below.

- Executive Summary
- Policy, Legal and Administrative Framework
- Description of Proposed Project
- Description of the Environment
- Significant Environmental Impacts
- Analysis of Project Alternatives
- Impact Mitigation Management Plan
- Environmental Monitoring Plan

1.6 THE CONSULTANTS

In keeping with the requirements of a well-executed Environmental Impact Assessment, a multi-disciplinary core team will be assembled to carry out the work. The main team members were:

Eleanor Jones, MSc. – Environment and Development Specialist, Principal Consultant.

Dr. Margaret Jones Williams, PhD – Ecologist, EIA Specialist and Team Leader.

Aedan Earle, Mphil. - Environmental Geologist and GIS Specialist.

Sharonmae Shirley, Mphil. – Environmental Chemist and Occupational Health Specialist.

Andrea Lanigan, MPhil (pending) - Marine ecologist.

CHAPTER 2: POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 PERMITTING

Under the Natural Resources Conservation Authority Act (1991), the Natural Resources Conservation Authority (NRCA now the National Environment and Planning Agency, NEPA) is authorized to issue, suspend and revoke permits and licences. The Permit and Licence System was established in 1997 to ensure compliance with Sections 9 & 12 of the NRCA Act, which gives the NRCA the right to issue permits for new developments and request EIA studies where necessary.

Prescribed categories of projects requiring a permit have been listed by the NRCA/NEPA and these include Development Projects. A Project Information Form (PIF) and a Permit Application (PA) must be completed and submitted to NRCA/NEPA with the requisite application fee. NRCA/NEPA will then determine if an EIA is required and request submission of the Terms of Reference for conducting the EIA. An EIA is usually required for resort developments.

ESL was contracted by Branch Developments Limited to develop the Terms of Reference for the EIA and to undertake the study, both for submission to NEPA. The Terms of Reference were submitted and approved by NEPA and this document constitutes the report of the EIA.

2.2 NATIONAL LEGISLATIVE AND REGULATORY CONSIDERATIONS - NATURAL ENVIRONMENT

2.2.1 Natural Resources Conservation Act (1991)

The Natural Resources Conservation Act was passed in the Jamaican Parliament in 1991 and provided the basis for the establishment of the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development in Jamaica through the protection and management of Jamaica's natural resources and control of pollution. Sections 9 and 10 of the NRCA Act stipulate that an Environmental Impact Assessment (EIA) is required for new projects and existing projects undergoing expansion.

2.2.2 Wildlife Protection Act (1945)

The Wildlife Protection Act of 1945 prohibits removal, sale or possession of protected animals, use of dynamite, poisons or other noxious material to kill or injure fish, prohibits discharge of trade effluent or industrial waste into harbours, lagoons, estuaries and streams, and Authorizes the establishment of Game Sanctuaries and Reserves. Protected under the Wildlife Protection Act are six species of sea turtle, one land mammal, one butterfly, three reptiles and several species of birds including rare and endangered species and game birds.

2.2.3 The Endangered Species (Protection, Conservation And Regulation Of Trade) Act (1999)

This Act deals with restriction on trade in endangered species, regulation of trade in species specified in the schedule, suspension and revocation of permits or certificates, offences and penalties, and enforcement. Many species of reptile, amphibian and birds that are endemic to

Jamaica but not previously listed under national protective legislation, or under international legislation, are listed in the Appendices of this Act.

2.2.4 The Natural Resources (Prescribed Areas) (Prohibition Of Categories Of Enterprise, Construction And Development) Order (1996)

The island of Jamaica and the Territorial Sea of Jamaica has been declared as a Prescribed Area. No person can undertake any enterprise, construction or development of a prescribed description of category except under and in accordance with a permit. The Natural Resources Conservation (Permits and Licenses) Regulations (1996) gives effect to the provisions of the Prescribed Areas Order.

2.2.5 Water Resources Act (1995)

The Water Resources Act of 1995 established the Water Resources Authority (WRA). This Authority is authorized to regulate, allocate, conserve and manage the water resources of the island. The Authority is also responsible for water quality control and is required under Section 4 of the Act to provide upon request to any department or agency of Government, technical assistance for any projects, programmes or activities relating to development, conservation and the use of water resources.

It is the responsibility of the WRA as outlined in Section 16 to prepare, for the approval of the Minister, a draft National Water Resources Master Plan for Jamaica. Areas to be covered in this Draft Master Plan of 1990 included objectives for the development, conservation and use of water resources in Jamaica with consideration being given to the protection and encouragement of economic activity, and the

protection of the environment and the enhancement of environmental values.

Section 25 advises that the proposed user will still have to obtain planning permission, if this is a requirement, under the Town and Country Planning Act. In addition, Section 21 of the Act stipulates that if the water to be used will result in the discharge of effluents, an application for a license to discharge effluents will have to be made to the Natural Resources Conservation Authority or any other relevant body as indicated by the Minister.

With regard to underground water, Section 37 states that it is unlawful to allow this water to go to waste. However, if the underground water "interferes or threatens to interfere with the execution or operation of any underground works", it will not be unlawful to allow the water to go to waste in order to carry out the required works provided that there is no other reasonable method of disposing of the water. The Authority also has the power to determine the safe yield of aquifers. (Section 38).

2.2.6 The Beach Control Authority (Licensing) Regulations (1956)

The Beach Control Authority (Licensing) Regulations (1956) stipulates that a license is required for the modification of any beach/coastline and sets out requirements for the posting of public notices.

2.2.7 Country Fires Act (1942)

Section 4 of the Country Fires Act of 1942 prohibits the setting of fire to trash without prior notice being given to the nearest police station and the occupiers of all adjoining lands. In addition, a space of at least fifteen feet in width

must be cleared around all trash to be burnt and all inflammable material removed from the area. Section 6 of the Act empowers the Minister to prohibit, as may be necessary, the setting of fire to trash without a permit.

Offences against this Act include:

- Setting fire to trash between the hours of 6.00 p.m. and 6.00 a.m. (Section 5a);
- Leaving open-air fires unattended before they have been completely extinguished (Section 5b);
- Setting fires without a permit and contrary to the provisions outlined in Section 6 (Section 8);
- Negligent use or management of a fire which could result in damage to property (Section 13a);
- Smoking a pipe, cigar or cigarette on the grounds of a plantation which could result in damage to property (Section 13b).

2.2.8 Quarries Control Act (1983)

The Quarries Control Act of 1983 established the Quarries Advisory Committee, which advises the Minister on general policy relating to quarries as well as on applications for licenses. The Act provides for the establishment of quarry zones, and controls licensing and operations of all quarries. The Minister may on the recommendation of the Quarries Advisory Committee declare as a specified area any area, in which quarry zones are to be established and establish quarry zones within any such specified area.

Section 5 of the Act states that a licence is required for establishing or operating a quarry though this requirement may be waived by the Minister if the mineral to be extracted

is less than 100 cubic metres. Application procedures are outlined in Section 8. The prescribed form is to be filed with the Minister along with the prescribed fee and relevant particulars. The applicant is also required to place a notice in a prominent place at the proposed site for a period of at least 21 days starting from the date on which it was filed.

No quarry zones are proposed for the project areas, but developers' guidelines should stipulate requirements for the use of material from licensed quarries and ensure the use of certified contractors.

2.2.9 The Pesticides (Amendment) Act (1996)

The Pesticides (Amendment) Act of 1996 amended sections of the principal act, which came into effect in 1975 and established the Pesticides Control Authority. This Act gives the Authority the responsibility of controlling the importation, manufacture, packaging, sale, use and disposal of pesticides. Section 11 states that the Authority is required to keep a register or record of all relevant information such as registered pesticides, restricted pesticides, pest control operators and persons licensed to import or manufacture pesticides. Under Section 16 of the Act, the Authority may also, with the approval of the Minister, make regulations which relate to areas such as:

- Aerial application of pesticides;
- Supervision required for the use of pesticides, the prescribed protective clothing to be worn and other precautionary measures;
- The permissible levels of pesticides to be used;

- The periods during which particular pesticides may or may not be used on certain agricultural crops;
- The disposal of pesticides and packages.

2.2.10 Air Quality Standards

The Federal Clean Air Acts which came into force in the United States in 1990 established air quality standards for six pollutants: ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), respirable particulate matter (PM10) and lead (Pb). An allowable level for each of these pollutants has been set by the United States Environmental Protection Agency (US EPA) whose objective is to protect the public from exposure to dangerous levels.

National standards, known as the National Ambient Air Quality Standards (NAAQS), were established and they were categorized into two groups. In one group, there are the primary standards, designed to protect human health and in the other, there are the secondary standards designed to protect the environment and limit property damage.

2.2.11 Noise Standards

To date, Jamaica has no National legislation for noise, but World Bank guidelines are often used for benchmarking purposes. The NRCA is currently preparing a draft document for national Noise Standards.

2.2.12 Water Quality - NRCA Act (1990)

The NRCA has primary responsibility for control of pollution in Jamaica's environment, including pollution of water. National Standards exist for industrial and sewage discharge into rivers and streams. WHO Standards for drinking water

are used and these are regulated by the National Water Commission. There are no national standards for ambient water quality of riverine systems.

2.2.13 The Beach Control Authority (Licensing) Regulations (1956)

The Beach Control Regulations require a permit for any works on the beach, coastline or foreshore. Application must be made to the Applications Secretariat at the National Environment and Planning Agency (NEPA). Requirements include a Notice of Application to be posted on the landward and seaward sides of the property and said Notice should be served on adjoining neighbours.

2.3 NATIONAL LEGISLATIVE AND REGULATORY CONSIDERATIONS – HUMAN, CULTURAL AND SOCIAL ENVIRONMENT

2.3.1 Town And Country Planning Act (1958)

Section 5 of the Town and Country Planning Act authorizes the Town and Country Planning Authority to prepare, after consultation with any local authority, the provisional development orders required for any land in the urban or rural areas, so as to control the development of land in the prescribed area. In this manner, the Authority will be able to coordinate the development of roads and public services and conserve and develop the resources in the area.

Any person may, under Section 6 of the Act, object to any development order on the grounds that it is:

- impractical and unnecessary;
- against the interests of the economic welfare of the locality.

However, if the Minister is satisfied that the implementation of the provisional development order is likely to be in the public interest, he may, under Section 7 (2) of the Act, confirm it with or without modification by publishing a notice in the Gazette. Section 8 of the Act also gives the Minister the authority to amend a confirmed development order.

Section 10 of the Act states that a development order must include:

- clearly defined details of the area to be developed;
- regulations regarding the development of the land in the area specified;
- formal granting of permission for the development of land in the area.

If the provisions of section 9A of the Natural Resources Conservation Authority (NRCA) Act apply to the development, the application can only be approved by the Planning Authority after the NRCA has granted a permit for the development. (Section 11 (1A). The Authority may impose a "tree preservation order" under Section 25 of the Act if it considers it important to make provision for the preservation of trees and woodlands in the area of the development. This order may:

- prohibit the cutting down, topping, lopping or wilful destruction of trees;
- secure the replanting of any Sector of the woodland area in which trees were felled during the forestry operations permitted under the order.

The tree preservation order is not applicable to the cutting down of trees which were already dead, dying or had

become dangerous and the order can take effect only after it has been confirmed by the Minister.

The Minister can, under Section 26 of the Act, make regulations to restrict and regulate the display of advertisements in any area to be developed if he considers this to be in the interest of public safety. Section 28 of the Act empowers the local authority to require the owner or occupier of land in the development area to take the steps necessary to ensure its proper maintenance.

2.3.2 Land Development and Utilization Act (1966)

Under Section 3 of the of the Land Development and Utilization Act (1966), the Land Development and Utilization Commission is authorized to designate as agricultural land, any land which because of its "situation, character and other relevant circumstances" should be brought into use for agriculture. However, this order is not applicable to land, which has been approved under the Town and Country Planning Act for development purposes other than that of agriculture. Among the duties of the Commission outlined in Section 14 of the Act is its responsibility to ensure that agricultural land is "as far as possible, properly developed and utilized".

2.3.3 The National Solid Waste Management Authority Act (2001)

The National Solid Waste Management Authority Act (2001) is “an act to provide for the regulation and management of solid waste; to establish a body to be called the National Solid Waste Management Authority and for matters connected therewith or incidental thereto”.

The Solid Waste Management Authority (SWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste.

The SWMA also has responsibility for the promotion of public awareness of the importance of efficient solid waste management, to advise the Minister on matters of general policy and to perform other functions pertaining to solid waste management.

2.4 INTERNATIONAL LEGISLATIVE AND REGULATORY CONSIDERATIONS

2.4.1 Cartagena Convention (Convention for the Protection And Development of the Marine Environment of the Wider Caribbean Region) (1983)

Adopted in March 1983 in Cartagena, Colombia, the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, also known as the Cartagena Convention, is the only legally binding environmental treaty for the Wider Caribbean. The Convention came into force in October 1996 as a legal instrument for the implementation of the Caribbean Action Plan and represents a commitment by the participating governments to protect, develop and manage their common waters individually and jointly.

Ratified by twenty countries, the Cartagena Convention is a framework agreement, which sets out the political and legal foundations for actions to be developed. The operational Protocols, which direct these actions, are designed to

address special issues and to initiate concrete actions. The Convention is currently supported by three Protocols. These are:

- The Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region (The Oil Spills Protocol), which was adopted and entered into force at the same time as the Cartagena Convention;
- The Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region (The SPAW Protocol), which was adopted in two stages, the text in January, 1990 and its Annexes in June, 1991. The Protocol entered into force in 2000;
- The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region (LBS Protocol), which was adopted in October, 1999.

2.4.2 Biodiversity Convention

The objectives of the Convention on Biological Diversity are "the conservation of biological diversity, sustainable use of its components and the fair equitable sharing of the benefits arising out of the utilization of genetic resources". This is the first global, comprehensive agreement which has as its focus all aspects of biological diversity: genetic resources, species and ecosystems. The Convention acknowledges that the "conservation of biological diversity is a common concern of humankind and an integral part of the development process". In order to achieve its goals, the signatories are required to:

- Develop plans for protecting habitat and species.
- Provide funds and technology to help developing countries provide protection.

- Ensure commercial access to biological resources for development.
- Share revenues fairly among source countries and developers.
- Establish safe regulations and liability for risks associated with biotechnology development.

Jamaica's Green Paper Number 3/01, entitled Towards a National Strategy and Action Plan on Biological Diversity in Jamaica, speaks to Jamaica's continuing commitment to its obligations as a signatory to the Convention.

CHAPTER 3 METHODOLOGY AND APPROACH

3.1 GENERAL APPROACH

A multi-disciplinary team of experienced scientists and environmental professionals was assembled to carry out the required resource assessment, generation of baseline data, determination of potential impacts and recommendation of mitigation measures. An iterative approach among the environmental team members and other project professionals was adopted.

The team utilized the Charette-style approach to data gathering, analysis, and presentation whereby team members conducted the reconnaissance investigations together to determine the critical elements for analysis and the issues to be highlighted for the design and planning process. Team meetings were held to discuss the progress of investigations and analyses and facilitate integration of data toward an understanding of the systems at work in both the natural and built environment.

Baseline data for the study area was collected using a combination of:

- Site Reconnaissance
- Aerial Survey
- Analysis of Maps and Plans
- Review of Reports and background documents
- Field Studies and Laboratory Analyses

- Charette Style Consultations
- Public Consultations

3.2 PHYSICAL ENVIRONMENT

Information was gathered on the existing physical environment, particularly as related to geology, topography, soils, drainage, water quality, air quality and noise.

3.2.1 Geology, Topography, Soils

Information on the climate, geology, topography, soils, was obtained by compiling data from existing reports, and source agencies. Aerial photos, satellite imagery and other published maps were also examined.

Field work was carried out to augment and verify existing information relating to geology and soils and to obtain first hand knowledge of the topography.

3.2.2 Hydrology and Drainage

Surface and ground water characteristics and flows were assessed using field investigation as well as maps, aerial photographs and data from previous reports.

3.2.3 Air Quality

Particulate measurements (PM 10 - non settleable dust smaller than 10 microns in diameter) were taken at two stations for one day. Sensidyne BDX 530^{CFT} personal high flow portable vacuum pumps were used to collect the respirable particulates. These pumps were calibrated to a suction rate of approximately 2.5 litres/minute using Sensidyne EZ Cal 1 Primary Flow Calibrator.

The calibrated pumps were attached to pre-weighed filters fitted to cyclones. The cyclones separate the respirable from the non- respirable particulate by centrifugal forces. Air drawn into the cyclone is accelerated by a circular motion allowing the lighter particles to separate from the heavier ones, which are then collected unto the filters.

The pumps with the cyclones were placed at the respiratory height of pedestrians for approximately six hours running time after which the pumps were turned off, the filters removed, stabilized and re-weighed to determine a Time Weighted Average (TWA) value for the particulates. Respiratory height is the approximate height at which someone conducting his normal daily activity breathes. Weighing of the filters was done at the Jamaica Bureau of Standards, Kingston.

3.2.4 Noise

Noise level readings, wind direction and any unusual local noise sources were recorded. Measurements were taken using Quest Electronics sound level meters, which conform to ANSI S1.4 - 1983, TYPE 2 and IEC 651 - 1979, TYPE 2 standards. The meter was calibrated before and after each set of readings.

3.2.5 Water Quality

The objective of the baseline water quality programme was to determine pre-construction water quality conditions in the coastal environment at an average depth of 0.5m. All samples collected were stored in pre-cleaned 2 L polyethylene and 250/500 ml glass bottles (transparent and opaque). Bacterial samples were collected at the water surface in sterilized 100 ml glass bottles. Dissolved oxygen

and conductivity measurements were taken *in situ* at all sampling stations. Laboratory Analyses were performed at the Environmental Solutions Laboratory Division using certified methodology from Standard Methods for Water and Wastewater Analyses (Eaton *et al*, 1995).

3.3 BIOLOGICAL ENVIRONMENT

The status of the flora and fauna of the study area was determined by a review of literature relevant to the area and field investigations for both the terrestrial and marine environments.

3.3.1 Flora

The vegetative communities were identified using the method of Grossman *et al* (1991) and classified into community types. Identification was carried out of dominant tree species, assessment of stage of growth (mature or sapling) and assessment of canopy cover. The vegetation was identified and described for the property.

3.3.2 Fauna

Information on avifauna was gathered from existing literature on reported species as well as observations in the field. Avifauna was surveyed by fifteen (15) minute point counts. Birds were identified by both sight and call.

3.3.3 Marine Environment

The marine environment was investigated by SCUBA diving and snorkelling along the coastline , in the offshore lagoon, in the back reef area and in the fore reef zone. A qualitative assessment of area was conducted to provide a species list and an abundance (DAFOR) rating for each species.

The DAFOR is a subjective rating which provides an indication of whether an organism is Dominant, Abundant, Frequent, Occasional or Rare in the environment. Quantitative data on coral cover and size were collected along 10 m long transects. Data on macroalgal cover and coral recruit densities were collected using 0.25 cm^2 quadrats.

3.4 SOCIO-ECONOMIC ENVIRONMENT

Rapid field appraisal techniques in conjunction with desk research were employed to investigations of the socio economic considerations within the project area, viz:

- population and settlement characteristics
- land uses and livelihoods
- developments underway
- water supply and other utilities
- waste management practices
- recreational activities

CHAPTER 4 DESCRIPTION OF EXISTING ENVIRONMENT

4.1 PHYSICAL ENVIRONMENT

4.1.1 Climate

The climate of the Lilliput area is tropical maritime typical of Jamaicas' general climactic conditions. The long term mean rainfall for the area is in the order of 150 cm with average annual rainfall recorded in the nearby Rose Hall area in the order of 100 cm.. The two months of maximum rainfall are October and May during which about 20 percent of the annual rainfall occurs.

The Montego Bay Rose Hall area receives high-intensity short duration rainfall associated mainly with cold fronts that approach Jamaica from North America as well rainfall generated by tropical weather systems. Rainfall intensity estimated at stations at the Sangster International Airport and the Rose Hall property as shown in Table 4.1 indicates the Maximum 24 Hour Rainfall with four return periods of 2, 5, 10 and 25 years.

	Maximum 24 hour rainfall (mm)			
Return Period	T2	T5	T10	T25
Rose Hall Station	104	136	166	204
Sangster International Airport	84	147	188	239

Table 4.1: maximum 24 Hour Rainfall for selected return periods
(Source: Estimates of Maximum 24 hour rainfall for selected Return Period and for 343 Rain gauge Locations Jamaica.)

The Water Resources Authority estimates that short term rainfall intensity of 85 mm in 30 minutes is possible at the

Sangster International Airport. Humidity ranges between 66% and 87% with a significant diurnal variation resulting in high morning humidity dropping off significantly in the afternoon.

Temperatures vary from a monthly daily mean of 23^{o}C in January to about 28^{o}C in July. Winds approach the area primarily from the east and north east. Annual averages of evaporation from free water surfaces is in the order of 183 cm with the highest rates occurring in May and October. Humidity ranges from 66% and 87% with a significant diurnal variation resulting in high morning humidity dropping off significantly in the afternoon.

4.1.2 Topography, Drainage & Geology

4.1.2.1 Topography

The proposed hotel site extends southwards from the coastline to the present main road that is oriented east-west and is located on an extensive low-lying coastal strip that extends along the north-western coastline of Jamaica, Figure 4.1.

The site can be divided into two distinct topographic areas that is well defined by the old coastal road Figure 4.2. The area north of the old road consists of a narrow triangular coastal strip that is flat sand covered area close to sea level. The beach is convex in shape with a very gently sloping foreshore that narrows and tapers off in an easterly direction. Photo 4.1

Figure 4. 1 Topography of the Site

Photo 4.1: View of beach looking westward.

The area south of the road consists of east-west oriented uniform slope with the toe of the slope defined by the old coastal road. The slope extends southwards to the present road where the land surface flattens out at about 25 meters above mean sea level. This slope is generally steepest and more uniform towards the western end, where it is close to 45 degrees, getting less steep and more irregular in form towards the eastern end.

4.1.2.2 Drainage

There are no natural drainage lines on the proposed site with runoff from the hills to the south of the present main road being diverted to the west and east by a topographic divide, Figure 4.2. Most of the surface water accumulating on the southern slope of the site will percolate down through the underlying rocks. During periods of intense or prolonged rainfall surface water will flow overland as sheet flow and as concentrated rivulets. The location of the site so close to the

Figure 4.2 Regional Topography and Drainage

coastline indicates that the water table is very close to sea level.

4.1.2.3 Geology

The main rock type exposed on the site consists of limestone that is classified as the Montpelier Limestone. It consists of well bedded to massive hard and chalky limestone that contains numerous fossils. The limestone is referred to as bioclastic because the limestone consist s mainly of calcium carbonate shell fragments. This limestone is exposed on the slopes on the southern part of the site. Photo 4.2 shows the typical characteristics of the more massive rubbly variety of this limestone.

Photo 4.2: Road cut along present main road alignment showing typical characteristics of the main rock type on the site.

The lithological characteristics of the limestone is highly variable with significant changes over short distances. In

general the limestone is highly permeable with abundant fractures and occasional clay partings.

Soils overlying the limestone are and consists of a light reddish brown gravely clay. The soil is typically 6 to 12 inches deep on slopes but tends to be deeper in depressions where it can exceed five feet. There is a sharp contact between the underlying limestone and the soil cover which usually includes abundant limestone gravel, Photo 4.3.

Photo 4.2: Showing typical nature of soil overlying the Montpelier Limestone found on the site.

4.1.3 Coastal Features

There is a well-developed beach along the coastline that is convex in plan extending the full length of the site. The width of the beach narrows from west to east. The foreshore of the beach is very gently sloping and extends offshore to create a shallow lagoon between the shore and the fringe reef.

The reef reduces the energy of approaching waves and there is a net deposition of fine-grained carbonate sand along this section of the shoreline. Figure 4.3 shows the

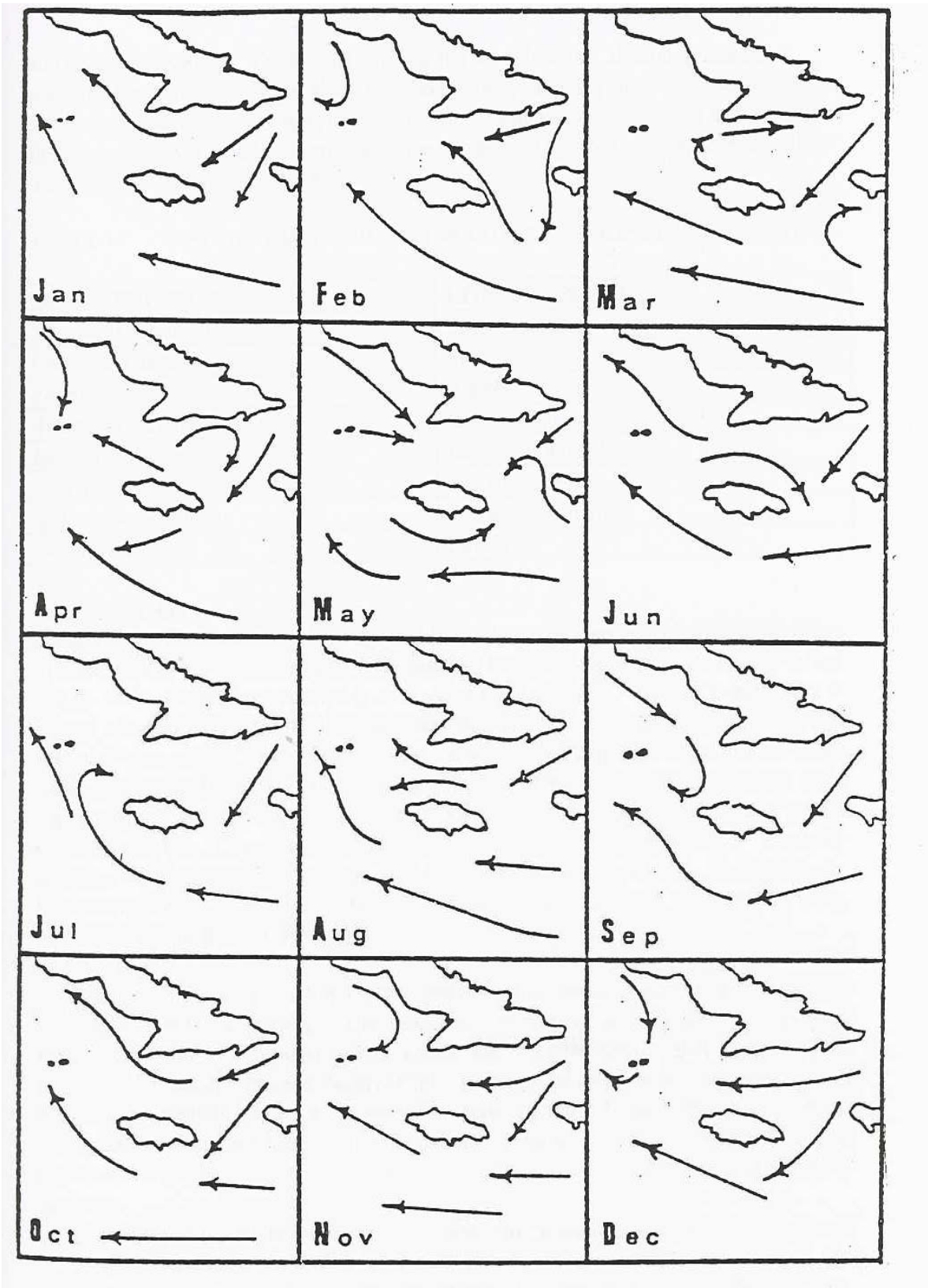

Figure 4.3 Monthly Variation in Offshore Currents around Jamaica

monthly variation in the dominant currents around the island indicating that a westerly direction of offshore currents for most of the year. The near shore configuration causes the higher energy waves to approach the shoreline from the northwest.

4.1.4 Natural hazard vulnerability

The location of the project area within Jamaica and the Caribbean basin makes it susceptible to a range of natural hazards including the effects of hurricanes and other tropical systems, earthquakes and to a lesser extent slope instability. Jamaica lies in the path of hurricanes and other tropical weather systems that typically develop and move through the Caribbean basin between June and November.

4.1.4.1 Storm Surge

The location of the project area along the northern coastline of Jamaica makes the coastal zone highly susceptible to the effects of storm surge associated with hurricanes. Low lying areas along the coast are susceptible to inundation and accelerated erosion from increased wave action. Estimates of storm surge along this section of the northern coastline of Jamaica suggest an elevated water height of between 1.5 and 2.5 meters above mean sea level. Intense rainfall associated with these weather systems can cause flooding of low lying areas in the coastal zone.

4.1.4.2 Hurricane Winds

High velocity winds generated by hurricanes have the capacity to cause significant damage. No significant acceleration of wind velocity is expected over the low lying hills of the project site although structures located on ridges and spurs are susceptible to higher wind speeds.

4.1.4.3 Seismicity

The study area experienced a magnitude 6.5 earthquake in 1957 with an epicentre 20 kilometers north west off Montego Bay. Analysis of historic seismic events and the tectonic setting of Jamaica by Pereira (1987) has produced a seismic zonation map. These maps (Figure 4.4) indicates that the project area is located in a zone that is more susceptible to low magnitude earthquakes. These low magnitude earthquakes do have the potential to cause significant damage especially where buildings are founded on alluvium and poorly consolidated sediment along the coastal zone.

4.1.4.4 Slope Stability

The stability of natural slopes in the project area is good with no evidence of substantial earth movement. High angle to vertical cuts in the underlying limestone for road placement appear to be stable up to heights of up to 15 feet. Where cuts are made into the well-bedded form of the Montpellier Limestone a greater degree of instability can be expected along steep cuts where beds slope downwards into the cut.

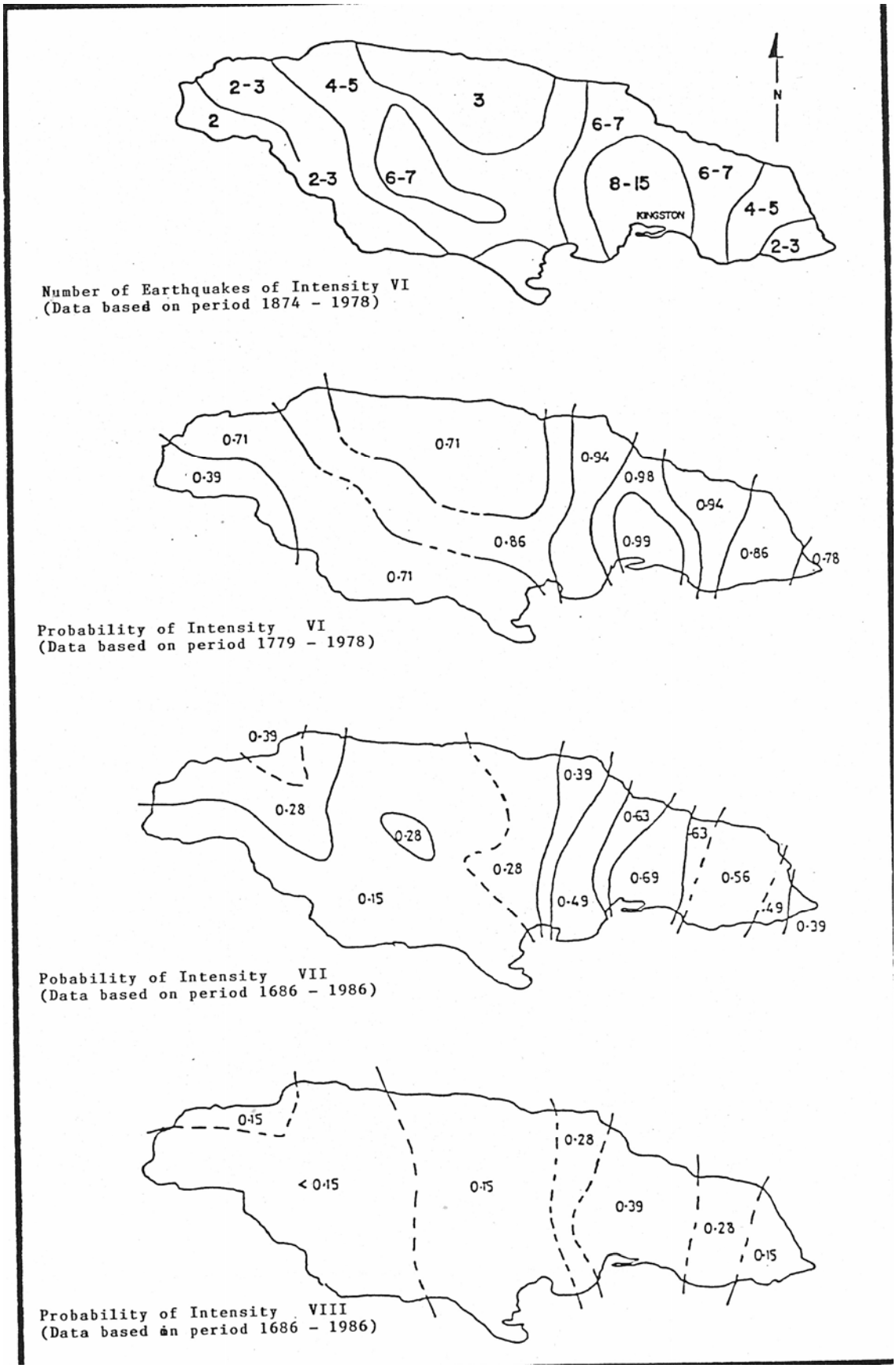

Figure 4.4: Seismic Zonation Map of Jamaica (Pereira, 1987)

4.1.5 Ambient Air & Water Quality

The air quality at the site was assessed by establishing two stations that sampled the air over a six hour period using two Sensidyne BDX 530 vacuum pump air samplers. The samplers collected Particulate matter less than 10 microns that typically remain suspended in the air mass. Results from analysis of the samples indicated that both were well within the national standard of 150ug/m^3.

In order to define the existing water quality status of the coastal zone bordering the project site a water quality survey was conducted at two sites, inshore and offshore. The data provide a quantitative indication of the existing water quality condition at the site. It should be noted that the sample was a 'one-off' grab sample. The results can therefore only be used to provide an indication of the water quality conditions on that sampling trip as they may not be the typical water quality site profile.

The samples were collected using a boat at an average depth of 0.5m. After collection they were placed on ice and transported to the ESL Laboratory at 20 West Kings House Road, Kingston 10. The following parameters were analysed:

pH

Conductivity/salinity

Temperature

Dissolved Oxygen

Total Suspended Solids

Nitrate

Phosphate

BOD

Oil and grease

Total and Faecal Coliform

Conductivity/salinity, temperature, and dissolved oxygen were measured *in situ* at the sampling stations. The analytical methods used are based on established procedures in Standard Methods for Water and Wastewater Analysis.

Results indicate that the station beyond the reef has a better water quality than the one located along the coast. This preliminary data suggest that the coastal station may be impacted by land-based activities.

Total suspended solids, oil and grease, nitrate, and biochemical oxygen demand levels were elevated. In contrast faecal bacterial levels were low and dissolved oxygen levels show fair levels of oxygenation. This suggests that the organic pollution recorded at this site is likely indirect seepage from non-point source rather than direct discharge.

PARAMETERS	NEPA Ambient Interim Water Standards	STATIONS	
		Outside Reef	Coastline
pH	6.5-8.5	7.8	7.7
Dissolved Oxygen (mg/L)	>4	6.2	6.6
Salinity (ppt)	-	35.2	35.3
Temperature (^{0}C)	-	27.6	27.7
BOD (mg/L)	2	8	10
TSS (mg/L)	10	15	40
Nitrate (as nitrogen) (mg/L)	0.001 – 0.081	6.2	5.7
Phosphate (mg/L)	0.001 -0.055	0.02	0.13
Total Coliform (MPN/100ml)	<500	<3	<3
Feacal Coliform (MPN/100ml)	<100	<3	<3
Oil & Grease (mg/L)	10	1.40	7.20

Table 4.2 Results for the Iberostar Water Quality Survey, May 11, 2004

4.2 BIOLOGICAL ENVIRONMENT

4.2.1 Terrestrial flora

The vegetation on the property may be categorized into two types: coastal vegetation and disturbed dry limestone forest. The coastal plants are located in a narrow belt all along the beach. This belt is less than 5 m wide, and where the beach is narrow it is even less. The remainder of the property is vegetated by disturbed dry limestone forest, with cleared areas found at intervals throughout the site.

Large areas of the shore down to the high tide mark are covered by pioneer plants. These are generally herbaceous creeping plants, and are quite numerous along the shore, particularly east of the Rose Hall Beach Club (see plates 11T and 12T in Appendix 3). *Sesuvium portulacastrum* is commonly seen in this area, as well as salt-tolerant grasses.

Moving landward, these runners are replaced by short erect plants and trees. These are generally less than 4 m tall. They include *Acacia sp.*, *Coccoloba uvifera, Terminalia catappa, Avicennia germinans* and *Conocarpus erectus.* These trees grade into the disturbed dry limestone forest type. The substrate in this transition zone is sandy, and covered with dry leaf litter (see plate 8 in Appendix 2).

The disturbed dry limestone forest covers the remainder of the property, extending from the old main road to the southern border of the property. The substrate is mainly limestone with a thin layer of soil in some areas (see plate 6 in Appendix 2). Trees are generally less than 10 m tall. Saplings and small diameter trees dominate, and the canopy is open in many places. In some areas, such as the western side of the property, the understorey layer is quite open, while in others, as on the southern side, the undercanopy layers are thick, mainly composed of dense *Acacia sp*. and other shrubs.

The trees found in the forest are listed in Appendix 3 with Red birch, *Acacia sp*., Poinciana, Guango and Sweetwoods being the most commonly seen. On the landward side of the forest, many trees bearing pods, fruits and berries were seen, and birds were observed feeding on them. Some of

these larger trees were approximately 40 cm in diameter, while the smaller trees averaged 15 cm in diameter.

Solid waste is plentiful throughout the property from the shore to the southern boundary. Dumping of garbage by members of the surrounding community was observed while at the site.

4.2.2 Terrestrial fauna

4.2.2.1 Birds

The bird fauna on the property is fairly rich, with 24 species identified within 3 hours. 197 individual birds were counted (see Appendix iii). The most common birds on the property include Loggerhead and Gray kingbirds, Cattle egrets, Northern mockingbirds, Green-rumped parrotlets, Doves and Grassquits.

A number of birds were seen foraging in the ocean. These include the Magnificent frigatebird, Brown pelican, Little blue heron and Great egret. The remainder of birds was distributed throughout the site, with Kingbirds, Grassquits, Common ground doves, Kestrels and Saffron finches found in the more open areas.

At least nine species of bird feeding trees are present on the property, which encourage birds to populate this area. The density of the vegetation, particularly the scrubby interior of some areas of the site, provides a good habitat for more secretive birds such as the Jamaican lizard cuckoo.

Eight endemic birds presently utilize the site, as well as the White-crowned pigeon which has become threatened throughout its range as a result of habitat destruction and

hunting. This site is therefore a significant bird area. However, the bird species found on the property are all common in Jamaica.

4.2.2.2 Turtles

Turtle nesting is known to occur on the beach along the Iberostar property, particularly in the vicinity of the Rose Hall Beach Club. The Hawksbill turtle (*Eretmochelys imbricata*) is the main species seen, but occasional reports of Leatherback turtle (*Dermochelys coriacea*) sightings have also been made. The Hawksbill turtle is an endangered species due to commercial exploitation, hunting and egg harvesting, and is listed under CITES. It is known that in Jamaica these turtles are sometimes taken for food, but egg harvesting is the more common activity.

Hawksbill turtles return to the same beach each time to lay their eggs. The clutch is usually laid above the high tide mark, often under vegetation. On the Iberostar beach, they are known to lay eggs under *Coccoloba uvifera* trees (sea grapes), and may even go into the vegetated or forested area close to shore. Each female may only nest once every 2 to 3 years, but may lay up to 6 clutches per nesting season containing an average of 130 eggs each. The nesting season is anytime from April to November, with an incubation time of approximately two months. Hatchlings leave the beach immediately for the ocean, attracted by the reflection of the moon on the water.

4.2.3 Other Fauna

Small crabs were abundant all along the shore in the littoral region, and hermit crabs were found throughout the property. In the forested areas, large holes belonging to land crabs

were also observed. In the forest, large green lizards and termite nests were seen. Snails, particularly littorinids, were common on the shore.

4.2.4 Marine Ecosystem

4.2.4.1 Lagoon

The lagoon occupies a large area, extending from the shore to the fringing reef, which is quite far from land. Near to the shore the lagoon is quite shallow, and gently slopes downward to depths of approximately 4.5 m closer to the reef. The back reef area then becomes shallower, with depths ranging from 1.5 to 6 m.

The sediment on the shore and in the lagoon is mainly fine-grained buff-coloured sand. However, towards the eastern end of the lagoon, close to the shore, the sand becomes very fine and unconsolidated, taking on a mud-like texture.

The lagoon is almost entirely covered in seagrass, with few patches of bare sand and small algal beds. Turtle grass (*Thalassia testudinum*) is the dominant seagrass in the lagoon, but fair amounts of manatee grass (*Syringodium filiforme*) also occur in the middle and eastern parts of the lagoon, closer to the shore. These seagrasses, particularly *Thalassia sp.* form large mats of dead material which accumulate on the shore all along the property. Dead *Syringodium sp.* was only observed on the shore adjacent to the Rose Hall Beach Club.

The *Thalassia sp.* plants which carpeted most of the lagoon grew in fairly dense meadows, with blade lengths averaging approximately 15 cm. Epibiotic cover on the blades was fairly high, at approximately 30 to 40%, indicating possible

nutrient pollution in this area. Sediments also coated large areas of the blades.

Algae found in the lagoon include *Schizothrix calcicola, Penicillus dumetosus and Acetabularia calyculus* in the shallower areas close to the shore, and *Avrainvillea longicaulis* and *Udotea sp.* closer to the reef. *Halimeda sp.* are found throughout the lagoon and back reef areas. Along the shoreline in very shallow water, clumps of *Chaetomorpha linum* were frequently seen.

Enteromorpha flexuosa was found in small patches at the water's edge at the eastern side of the shore. *Enteromorpha sp.* is often found in brackish water, and may indicate freshwater inflows at these points. It was noted that trickles and tiny streams of possibly fresh or brackish water coursed down the eastern shore throughout the day, often appearing to spring from the mats of dead seagrass.

Fauna in the lagoon was composed mainly of echinoderms. The urchins and sea cucumber specified in Appendix 3 were common in the area. The West Indian sea egg and variegated urchin were the most commonly seen, often camouflaged by bits of shell, seagrass and other debris. These urchins were common from the shore to the reef, at densities of approximately 4 m^{-2}.

Live Queen Conchs were occasionally seen amongst the seagrass in the deeper parts of the lagoon, while crabs were frequent in the shallow areas near the shoreline. Corals were rare amongst the seagrass, with only occasional small colonies seen. *Siderastrea radians* were the most commonly observed coral in the seagrass beds.

Fish were quite rare over the seagrass beds, which is unusual for this typical nursery habitat. A few juvenile parrotfish were observed, as well as single large individuals of Porcupine fish and Trunk fish. A school of silversides was present in the shallow water in front of the Beach Club, and small schools of an unidentified small (< 6 cm) white fish were distributed throughout the area close to the shore.

4.2.4.2 Back Reef

A fringing reef lies offshore and is composed mainly of large mounds and patch reefs in the back reef area. Relief in this area is generally low at approximately 1.5 m, and depth ranges from 1.5 to 5 m. The sandy areas between the patch reefs and coral heads are mostly covered by *Thalassia sp.* These seagrass blades also carry a fairly high epiphyte load.

Live hard coral cover is on average higher than that typically found on Jamaican reefs, at approximately 15% cover, reaching up to 20% cover in some areas. Coral colonies were of medium size, averaging 30 cm in diameter. Occasional large colonies (>1.5 m) were also observed. The more frequently occurring corals include *Montastraea annularis*, *Agaricia agaricites, Siderastrea siderea, Porites porites, Porites astreoides* and *Millepora sp.* Coral recruits (colonies <2 cm in diameter) were quite common on the back reef where macroalgal cover was low, indicating the potential for growth of the reef.

Macroalgal cover on the reef is approximately 53%, with 25% composed of fleshy algae and 28% calcareous algae. Crustose coralline algae are quite common at 22% cover, and reached up to 50% cover in some areas. Reefs with a low macroalgae: crustose coralline algae ratio is considered

to be healthier reefs than those with a high ratio, suggesting that this reef is in fairly good condition.

Macroalgal heights averaged 6.5 and 2.5 cm for fleshy and calcareous algae respectively. This is relatively high growth of fleshy algae, but quite low for calcareous algae. High fleshy algal biomass is generally indicative of a degraded reef. By these standards, the reef is somewhat degraded, but it is in better condition than many north coast reef systems.

Gorgonians were generally not very common throughout the site, with sea fans, corky sea fingers and black sea rods observed around the area. Sponges were uncommon at this location.

The fish community is relatively rich, with 36 species identified. At least 3 unidentified species were also observed. A number of species were observed in fairly large numbers, including French grunts, various parrotfish and squirrelfish. The fish were generally less than 20 cm in length. Other commercially and ecologically important fish were commonly observed, such as Yellow tail snappers, Goatfish, Doctorfish, Spanish hogfish, Bar jacks, Schoolmasters and French Angelfish.

4.2.4.3 Fore Reef

The fore reef is separated from the back reef by a shallow reef crest, which scarcely, if at all breaks the water's surface. The reef crest is covered mainly by brown algae, particularly *Sargassum sp.* and *Turbinaria sp.* Large pieces of *Acropora palmata* rubble are found near the crest. The wave action and surge in this area is quite strong.

The fore reef area close to the reef crest is also dominated by brown algae, with very few benthic invertebrates. *Dictyota sp., Stypopodium sp.* and *Lobophora sp.* in addition to those mentioned on the reef crest are abundant in this area. Fleshy macroalgae occupy approximately 70% of the substrate, and average 10 cm in height. Calcareous macroalgae cover a further 20% of the reef.

Coral cover is low, at 1 to 2%, and colonies are generally small. Corals identified include *Acropora palmata, Montastraea annularis* and *Porites astreoides*. Gorgonians, sponges and other benthic invertebrates were sparse in this area. Fish were also few, with only a small number of immature parrotfish seen.

This area is fairly deep at approximately 6 m. The reef slopes quite sharply down from the reef crest and onto the fore reef. Further north the reef once more gives way to *Thalassia testudinum* meadows. It is unusual that the fore reef would be in a more degraded condition than the back reef. The reef system at this location is far from the shore and is rather broad.

It is possible that the fore reef proper is located even further north than the furthest point of the study site, and the degraded area was simply an extended reef crest. The distance from the shore and time constraints precluded further investigations of the fore reef, but it will probably not be affected greatly by the development due to the distance from the land.

4.3 SOCIO ECONOMIC ENVIRONMENT

4.3.1 The Site

The western one-third of the Iberostar development site is currently occupied by the Rose Hall Beach Club which was owned and is still currently operated by Rose Hall Developments Ltd. A club house, parking area and well-maintained extensive beach occur in this segment. The eastern two-thirds of the site is unoccupied and undeveloped, as description of the Biological environment indicates in Section 4.2. The socioeconomic characteristics of the site therefore lie in the regional setting and characteristics of the surrounding communities.

4.3.2 Regional Setting

The Iberostar Hotel site sits toward the eastern end of the Rose Hall estate as indicated in Section 1.2 above. A long stretch of coastal flatlands lie to the west of Rose Hall Beach Club extending to Sea Castles condominium and Success Beach, the eastern boundary of the Rose Hall Master Plan site. East of the project site is Grange Pen/"Wagon Wheel beach", Long Bay and Barrett Hall. On the landward side – across the main road lies the sprawling community of Lilliput and Barrett Hall further east. Barrett town lies inland from Success, and could be considered part of the sphere of influence of the project. (See Figure 1.1 above)

The project is located within the larger regional setting of Rose Hall Developments and the Greater Montego Bay Area. Rose Hall Developments has been described above in Chapter 1, and it is important to reiterate that the development sits amidst significant tourism development

extending from Montego Bay through Falmouth and ultimately Ocho Rios. As indicated in Section 1.2 of this report conversion of the estate lands to urban/resort/residential uses has been occurring since the late 1960s when the Rose Hall Great House was restored as a major tourism attraction.

The estate forms part of the Greater Montego Bay Area (GMBA) for which a development plan to the year 2014 was drafted and eventually promulgated by the Grater Montego Bay Redevelopment Co. (GMRC) in 1997. The GMBA is the residential and economic core of St. James and covers an area of 52,168 acres extending over a radius of 19 kilometers from Montego Bay to include 38 residential districts in 42 planning areas. The 2001 Census of Jamaica refers to the Montego Bay **"Special Area",** which essentially incorporates the GMBA. The area has been zoned for **mixed resort commercial /residential use.**

Tourism is posited as the growth industry and economic mainstay of the GMBA. Key development plans within GMBA relate to construction and expansion of the hotel, resort and attraction infrastructure, expansion of the Donald Sangster International Airport (SIA), now operated by MBJ Airports Ltd, expansion of shipping and the Freeport, and business expansion within the Freezone.

The economy of Montego Bay and the GMBA has changed over the last fifty years from being a trading post serving the western end of the island as a largely agricultural town to being a tourism resort economy. The area has about fifty percent of Jamaica's tourism accommodation and accounts for about 35% of the national tourism earnings. Currently

the GMBA has about 4,200 tourist rooms with a mix of hotels, guesthouses, cottages and apartments. About 50% of available rooms are found in hotels with 200 or more rooms that represent about 13% of all accommodation types. The economy of the GMBA represents about 6% of national GDP.

Figures provided by the Jamaica Tourist Board, indicate that Montego Bay accounts for 30.9% of visitor arrivals to Jamaica, and that the four main hotel properties lying within the Project area account for 37.4% of visitors to Montego Bay.

The Project must therefore be regarded as significantly positioned, in relation to Montego Bay's tourism product.

4.3.2 Population

The 2001 Census indicated a population of 174,120 for the parish of St James, and 55% (or 95,940 persons) is located in Montego Bay and its immediate environs (referred to collectively as the Montego Bay Special Area). The population of the GMBA was estimated at 98,000 in 1995 with an annual growth rate of 2.5%. About 80,000 workers are estimated to commute and work within the GMBA on a daily basis, and population numbers rise with the introduction of cruise ship and stopover visitors. Unemployment rates in the GMBA are estimated at 17% with 65% of current economic activity consisting of family type businesses.

In the Montego Bay Special Area, persons between the ages of 0-39 years account for 73% of the population, and those in the 15-39 age cohort account for 40%. STATIN data and community-based interviews, confirm that this age

distribution is also representative of that found in the communities within the project area. The Project will therefore be located within and impact, a predominately young population.

The Dependency Ratio is a STATIN indicator of the degree of dependency on the 15-64 age group by the rest of the population. This ratio for the Montego Bay Special Area is 61.23, which means that for every 100 persons within these communities, 61 are assumed dependent on the rest. It is very likely that the Dependency Ratio for the poorer communities neighbouring the Project area, have this same value.

Of additional consideration is the level of education within the project region. Educational attainment figures are at present available only for the parish (2001

Census), but as Montego Bay is the major centre these data could be considered somewhat representative. The Census reports educational attainment for the population 15 and over as 25% Primary, 56% Secondary, 3% University and 9% Other Tertiary.

The hospitality sector currently absorbs skills across the educational spectrum. However entry requirements for employment in the type of upper scale properties found within the Project area are increasing. Typically, candidates applying for entry-level supervisory and managerial positions to these hotels, can offer tertiary, including postgraduate qualifications. Similarly, it appears that the demand for most domestic staff, could, if required, be met by applicants having completed some secondary education. Educational levels in the surrounding communities could not be

ascertained, but observation seems to indicate lower levels of achievement and therefore marginal skill offerings.

Employment possibilities within the project area, and in associated developments are a vexed issue, as some persons seem to feel “outside” the resort developments. The implications for community relations suggest the need for involvement of the relevant government agencies and tourism interests in facilitating opportunities for improved synergies.

One such initiative could be some form of collaboration between such stakeholders as, the Montego Bay Chamber of Commerce, The Urban Development Corporation, The Jamaica Tourist Board and Rose Hall Development Ltd. to plan and initiate community tourism projects, that can link, innate, community based entrepreneurial skills, to the Project. Currently the Rose Hall Development Ltd, has a school feeding program, which supports several schools in the neighbouring communities to the value of about J$900,000 annually. Other individual properties within the Project area also have out reach programs. A coordinated approach, which places greater focus on creating income earning potential, may be what is required into the future. The objective would be to begin bridging the major socio-economic gap, separating the Project from its poorer neighbours.

4.3.3 Settlements

Settlement within the project area is dominated by Lilliput, a major settlement which has spread over the years on the hills south of the main road. Barrett Hall located southeast of the project boundary is a smaller area, and is connected to

the coastal area alongside the project site. In addition, there are fishing clusters along the beach, such as Success Beach (centered on Barrett Town) to the west, Grange Beach (centered on Lilliput) and Long Bay (centered on Barrett Hall and Greenwood).The combined population of Lilliput, Barrett Town and Barrett Hall totals approximately 8,342 persons.

Communities	Population	% of Total
Lilliput	4,865	58.32
Barrett Town	1,441	17.27
Barrett Hall	1,100	13.19
Spot Valley	531	6.36
Cornwall	405	4.85
TOTAL	**8,342**	**100**

Table 4.3: Population of Surrounding Communities

4.3.3.1 LILLIPUT

Lilliput is a low and low middle income, residential squatter community. The community is served by some basic schools, but has neither a public health clinic, nor police post. Social infrastructure includes a community playing field and churches. The size and proximity of this settlement to the project requires planning for effective community relations.

Population & Demography

The population of Lilliput in 2001 was 4,865 or about 30% of the Montego Bay Special Area (STATIN). The population has exploded over the last 10 years, increasing from

approximately 1,087 in 1991 to its present figure, or by some 347%. This explosion is probably attributable to two main factors. Firstly the overall net migration into St. James over the period, which it can be reasoned has been focused on the Montego Bay Special Area. Secondly, diminishing coastal residential land space and increasing land values, have acted as engines of growth for this “100% squatters community”. Increased tourism activity, better transportation and the eastward economic expansion of Montego Bay, have created both real and perceived employment opportunities, to which internal migration has responded. The population is evenly split with respect to gender (50% each).

The largest segment of the population is in the age group 0-39 years accounting for over 77% of the population. The population is therefore significantly young, this ratio being higher than that for the Montego Bay Special Area (73%). Assuming that the population exhibits the same characteristics as the Montego Bay Special Area, the dependency ratio is likely to exceed 61%, meaning that 6.1 persons out of every 10 are dependent on the remaining population. The official ratio of female-headed households is not available, but based on limited interviews, it is reported to be as low as 30% of all households. If correct this either points to atypical stability in family relationships, or a high proportion of adult male households.

Land Use and Livelihood

The main land use is residential. Small-scale trading activities are carried out mainly in food, retail, and household services. In common with squatter communities elsewhere,

main occupations seem to be based on hustling occupations, and domestic and artisan skills supplying services both within and outside of the community. Livelihoods are mainly derived from construction labour, domestic services to tourism, and craft. Under- employment or outright unemployment is evident. There is no visual evidence of a serious tourism product being offered or developed within the community.

Water Supply

Water supply is partially metered and is sourced from the Martha Brae water supply system. It is tapped from the 24 inch NWC main on the coast road, which brings water from the Martha Brae treatment plant. Residents interviewed reported that water supply is good.

Public Health & Safety

Absorption pits (30%) and pit latrines (70%) are the main sanitary conveniences used. Given the limestone bedrock, sewage disposal is important not only to health of the community but also coastal water quality. The direct consequences for the hospitality sector and fisheries are stark. Garbage disposal & collection is undertaken by Western Parks and Markets (WPM). However, littering is much in evidence, throughout the community. The likely consequence of this is that solid waste, during rain events, is being carried into the sea. Investigations of water quality and coastal conditions described above (Sections 4.1 and 4.2) suggest a direct link between these practices and water quality and aesthetic observations in the coastal waters.

Transportation & Traffic

The main mode of public transportation for community members is by route taxis. The project will therefore impact the community, in that it can be expected to add to the growing traffic congestion on the main road into Montego Bay. Lilliput itself has three entrances off of the main road into the community.

Developments Underway

Other than the UDC's primary school currently under construction at the coastal road entrance to closer to Wyndham Rose Hall, no other major development plans are associated with the community.

4.3.3.3 BARRETT HALL

Barrett Hall is a comparatively young community having mainly sprung up within the last 20 years. Located to the southeast of the project site, the area evolved as space became less available in the Lilliput area, and a Housing project was undertaken by the Government of Jamaica.

Population & Demography

The population of Barrett Hall in 1991 was approximately 562 persons (STATIN). The population has doubled over the10 year period ending 2001 to 1,065, due mainly to the commencement of an NHDC PRIDE Project. Currently, according to PRIDE there are some 1,891 Greenfield lots, and 1,100 Brownfield lots are about 70% developed. From previous socio economic data developed by the consultants, it can be projected that, upon completion, the population of Barrett Hall will approximate 11,000 given the then average household size of 5, somewhat higher than the national

average. Barrett Hall therefore has the potential of becoming a significant population centre.

Its population is also relatively young with over a third being below the age of 17 years and less than 5% being over the age of 60yrs. Typically, however, the proportion of males to females is evenly split. Up to the year 2000, just over half of the population originated from outside of the parish, with only 11% coming from within the community's postal zone.

Land Use and Livelihood

The main land use is residential. During the 1970's as land space became increasingly scarce in Lilliput the Barrett Hall settlement became more established. Squatters increased with a shift in profile from residents of St. James and itinerant vendors from Montego Bay, to land seeking residents of parishes as far away as St. Elizabeth, Manchester and Kingston. The intervention of PRIDE, has stabilized, what may have easily become another Lilliput, and currently, the community is served by almost full infrastructural requirements.

Barrett Hall has from the outset, been an above average PRIDE project as regards to average income earned by households. Employment is found outside of the community, across a range of occupations both in Montego Bay and in Falmouth. Construction occupations have been an important mainstay, while development has been taking place. Employment in tourism related occupations are reported as important. Several shops and small restaurants exist within the community, and a small subset of the population engages in fisheries.

Infrastructure

In keeping with its status as an almost completed Pride Project, the infrastructure, so deficient in Lilliput, is mainly present in Barrett Hall. A central sewage system is in place, as well as a garbage collection system, full electricity supply and metered water. Social infrastructure includes basic schools, and churches, and a health centre major community sports centre are planned for. Although as yet incomplete, the main road system as designed, is thought to be adequate.

Water supply is also sourced from the Martha Brae water supply system. It is tapped from the 24 inch NWC main on the coast road, which brings water from the Martha Brae treatment plant.

Archaeological & Cultural Heritage

The community borders on the famous Barrett Browning Great House at Greenwood.

This is likely to become an important attraction for the project, given its ease of access.

Other estate related, archaeological & cultural heritage elements exist that add to the general attractiveness of the area for tourism. This promises positive spin off's for the community.

While Barrett Hall itself, does not have any known exploitable heritage elements, this section of the coast can be assumed to be rich in such unrevealed and therefore unrecovered, archaeological and heritage elements. Such elements should be surveyed and preserved and with the help of both the Project and the National Heritage Trust, be

made available to deepen Barrett Hall's potential for inclusion in the benefits of the Project.

Transportation & Traffic

As with Lilliput, the main mode of public transportation for community members is by route taxis. Barrett Hall has one main entrance onto the main road and a two much smaller ones to the eastern and western boundaries respectively.

4.3.3.4 GRANGE PEN FISHING BEACH

This fishing beach is located opposite to the entrance to the Barrett Hall Pride Project, about two miles West of Greenwood. According to fishermen interviewed, the beach has existed for over 100 years. Unlike Success Beach, the beach is reported to have been growing steadily, and has doubled in size in recent years. It is a licensed beach with 20 boats; 16 were actually counted. The beach provides a livelihood for about 40 fishermen. About half of these are unlicensed and this group comprises several youth who engage in fishing part time. The fishers estimate that about 1000 people, including family members and vendors depend on the beach for part or all of their livelihoods.

The main means of fishing is by setting pots, which like Success Beach is done between the shoreline and the inshore reef. However, an important fishing ground is referred to as Long Bank, lying about 2 miles out.

The main complaints voiced by the fishers, are similar to those raised at Success Beach and again, have nothing to do with the Project. However they also blame a "drastic" fall off in fish catch to the chemical contamination and destruction of the marine ecology arising from the

construction of the Ritz Carlton Hotel and the surface water run off from its golf courses. These problems are said to have aggravated the decline, set in motion by Hurricane Gilbert in 1988. They see the problems experienced with the Ritz Carlton Hotel reoccurring with the Project. They see such an outcome as forcing fishermen to either come out of fishing, or to move into Cuban waters. Interestingly, the fishers feel that the Government should now begin to negotiate for such access.

The beach is resisting relocation to Success Beach. The reasons put forward are reproduced below. They illustrate the difficulty in attempting the rationalization of fisheries along the coast. Whether to provide upgraded and shared facilities, or to make way for resort development.

- Grange Pen has better yields than Success Beach.
- The inshore grounds are much larger since the reef is set back further.
- The difficulty in navigating the very narrow reef channel at Success when the sea is running will mean a loss of about 50% of trips.
- The Barrett Hall market would be lost due to distance.
- Their homes would no longer be within walking distance.

Solid waste and sewage disposal both pose health problems on the beach. Ironically, even while criticizing the dumping of construction material along the coast, a large mound of concrete debris has been introduced by the fishers to stop flooding from a shallow, shrub hidden, drainage outfall bordering the beach.

4.3.3.5 LONG BAY FISHING BEACH

This small fishing beach is located at Long Bay in Greenwood, and is marked by a couple of vending stalls that have traditionally sold conch shells. It is not a licensed beach, but the few fishermen using it, claim to be licensed. The beach provides a livelihood for about 12 fishermen, and berths 6 boats, all of which were on the beach at the time of the survey. Unlike Success Beach and Grange Pen, there are no structures on the beach. The fishers estimate that only 5 business places and a small number of residents provide regular patronage. The stalls that sell conch shells and curios are not connected to the beach. The shells are imported from Savannah-La-Mar.

It is evident, and the fishermen confirm, that the beach has been in decline for many years. About 70l pounds of fish per fisherman is landed per week. This is less than a quarter it is claimed, of what would have been landed in the 1980's.

Long Bay is of interest, because it marks the point, east of the Rose Hall Development area at which the fishers do not associate the fall off in fish catch with the construction of the Ritz Carlton. Instead they blame over fishing the area, and the use of half-inch seine nets, and spear guns, by irresponsible fishers as the main reasons.

The fishermen regard the tourism development project positively and take pride in the evident growth and importance of Montego Bay as a tourist destination. They are uncertain as to the potential impacts on Long Bay of the Project, but this is not a threatening issue to them.

Unlike the other beaches, because of the absence of dwellings, and the close proximity to supporting community

infrastructure, the issues of waste management and sewage disposal on the beach, is minimal. However a nearby, failed marina at the western end of the bay, shows evidence of being used as a community dump. The fishing beach poses no threat to the Project, but could benefit from any increased community employment that the Project provides.

4.3.4 INFRASTRUCTURE

4.3.4.1 Water Supply

Potable water is supplied to the GMBA from the Great River and Queen of Spain's Valley water treatment plants with a combined output capacity of 32 million gallons per day supplying current demand of an estimated 24 million gallons per day. It is expected that water supply will be adequate to meet the demand of approximately 1.2 million litres per day required for the hotel operation.

Basins	Currently Supplying	Projected Demand 2015	Reliable Yield.
Great River	21.96	32.91	381.20
Martha Brae	1.17	3.34	89.0
Totals	**23.13**	**36.25**	**470.20**

Table 4. 4 Water Resources Available to St. James (Millions of Cubic Meters per Year (MCM/Year)

4.3.4.2 Sewage

Sewage from the Iberostar development will be treated through a new facility to be established by the Rose Hall Utility Company. The treated effluent from the wastewater

treatment facility would be pumped into an irrigation distribution system for beneficial reuse and sale to customers as irrigation water. It is estimated that the daily average flow from the existing hotels, resorts, and commercial establishments would be 350,000 gallons per day with a potential future flow of 1,000,000 gallons per day.

The wastewater treatment facility would be an extended aeration system which has benefits of ease of operation and maintenance, more capable handling of spikes in flow and contents and less generation of solids. The company would build operate and maintain a wastewater collection force-main which would extend along the eight mile stretch of coastal highway. Details of the collection system, irrigation system and wastewater treatment system are given in Appendix 4.

4.3.4.4 Solid Waste Disposal

The Retirement Waste Disposal site, which is the official solid waste disposal site for Montego Bay is currently being upgraded to function as a landfill site. The site receives about 80 tonnes of solid waste per day and serves the parishes of St. James and Hanover. Iberostar will need be serviced by Western Parks and Markets and the official municipal system.

4.3.4.5 Electricity and Telecommunications

The Jamaica Public Service Company supplies electricity to the GMBA, and recent improvements at the Bogue plant has greatly enhanced power supply to the GMBA. It is anticipated that power supply will be adequate to meet the needs of the development. Energy efficient operations should be integrated into the development plans for all major

energy users of the resort. The Chiller system proposed for air conditioning is an energy efficient system.

The telecommunications services are provided to the GMBA by all the service providers in Jamaica, and data transfer services are provided by the Montego Bay Digiport facility. Conferencing facilities will require efficient telecommunications.

4.3.4.6 Transportation

Montego Bay is the major transportation node for western Jamaica. Ground transportation for commuting non-resident population, local residents and tourists is largely by privately owned taxis and mini buses. Larger minibuses and tour buses transport passengers out of the city. The North Coast Highway Improvement Project (NCHIP) includes as Segment II upgrading of the link between Montego Bay and Ocho Rios. This improvement includes development links that bypass the towns of Falmouth, Duncans and Rio Bueno, and will function as an improved transportation corridor.

NCHIP is scheduled to begin work in the area by the end of 2004, and therefore consultation with the Project Managers is crucial to enable effective synergy between construction requirements of the many developments within the area. The design of the main entrance to the project, must provide a smooth interchange between the project and the main road traffic.

Recent road improvements within the GMBA has improved traffic flow and eased traffic congestion, and NCHIP is expected to further improve traffic movement after completion of road works. .

The Donald Sangster International Airport serves as the hub of the national airline, Air Jamaica, and is the larger of two international airports serving the island, transporting most of the Jamaica's tourists to the island. The airport was recently privatised under a development agreement and an expansion and development plan is underway. Development plans are underway for the Montego Bay Freeport, which is a major transhipment container port, with cruise berths. The Freeport is associated with the Montego Bay Freezone, which is also expected to increase business enterprise. Road traffic east of Montego Bay associated with these operations is therefore expected to increase.

4.3.5 Archaeological & Cultural Heritage

The Rose Hall Estate and environs have a rich archaeological and cultural heritage that has been somewhat tapped as part of the tourism product. However, there is considerable potential yet to be developed and one such opportunity for the project is the Greenwood Great House, already an attraction, but which is in close proximity to the project through Barrett Hall. This Barrett Browning Great House at Greenwood is likely to become an important attraction for the project, given its ease of access.

Mount Zion, southwest of the project in the Rose Hall Development area, was a free village. Its imposing Church and graveyard were established in the year of emancipation. The church bell is inscribed with the text preached on Emancipation Day.

Other estate related, archaeological & cultural heritage elements exist and add to the general attractiveness of the area for tourism. Such elements should be surveyed and

preserved and with the help of both the Project and the National Heritage Trust, be made available to deepen the potential for inclusion of the surrounding communities in the benefits of the Project.

5.0 POTENTIAL IMPACTS AND MITIGATION MEASURES

5.1 IMPACT DISCUSSION

This section identifies the potential impacts, and suggested mitigation measures, as related to the proposed developments. Findings of the assessment are presented according to site preparation, construction and operation phases (Table 5.2). The impacts have been determined as significant positive or negative, direct or indirect, long term or short term. The Impact Matrix presented in Table 5. 1 identifies the inter-relationships between the project activities and the physical, biological and social environmental factors.

Of significance is the fact that the Generic Impact Matrix does not take account of the full interrelationship between the environment and the project, in that the relationships identified in the matrix are unidirectional – impact of the project on the environment only. This is especially significant to the Iberostar Resort in that developers must pay particular attention to natural hazard vulnerability and social setting as significant considerations with respect to the operations of the project.

Based on written communication from the National Environment and Planning Agency (NEPA) (Appendix I), particular attention has been given to the following aspects.

Land use management

The site is currently undeveloped so clearing of vegetation will be the major aspect of land use management prior to operations. The impact mitigation Table outlines the suggested activities to minimize impact of vegetation clearance and paved surfaces on runoff and siltation during the construction and operational phases of the project respectively.

Drainage and run-off

Erosion mitigation with respect to proximity of the development site to coastal/marine environment and reefs is the major consideration. Consideration must be given to drainage of the site through percolation, overland flow, and existing natural drainage channels paying particular attention to the cumulative impact of increased storm water runoff from the site.

Terrestrial ecology

Removal of the dry limestone forest and coastal vegetation will result in loss of habitat for numerous birds and other fauna. Large diameter trees, especially bird feeding trees identified in the species list (Appendix III) need to be retained and incorporated as far as possible into the landscape design. Some species of coastal vegetation help to build dunes and prevent beach erosion – these should be maintained.

Turtle nesting is a major concern. The Iberostar beach, particularly the western side, is a significant Hawksbill turtle-nesting site and it is desirable that this be maintained. The construction and increased traffic on the beach could drive

away nesting turtles. To reduce the negative impacts on the turtles, as much of the coastal vegetation as possible should be maintained, especially low-growing *Coccoloba uvifera* trees under which eggs are often laid. Motor vehicles should not traverse the beach, particularly along the vegetation line, so as not to crush nests. Hotel and beach lighting should be properly planned, as artificial lights are known to cause disorientation of adult turtles as well as hatchlings. Nesting turtles typically avoid bright lights, while hatchlings are attracted to light, so excessive beach lighting may drive away adults, or lure hatchlings away from the sea, increasing their chances for injury or death.

A major threat to turtle survival is egg harvesting. Proper management of the nesting beach by the hotel may actually increase the survival chances of the turtles by protecting the nests from poachers.

Coastal and marine environment

The back reef area is quite shallow, with numerous protruding patch reefs. These are very close to the water's surface and may be hazardous to water sports activities. The area must be properly marked before these activities are offered.

Threats to the Project will also arise from the lack of adequate sewage and garbage disposal in the hill communities behind the project region. Considerable garbage was found on the site indicating that some dumping takes place. That, together with leaching and throughflow of wastewater, raises concerns for coastal water quality, as evidenced by high nutrient loading and algal growth on the extensive and dense seagrass meadows.

Community Relations

Exclusion from employment opportunities on projects that have already taken place within the Project area, is a complaint that fuels tension between community residents and project development within the Greater rose Hall area. The perception is that very few jobs are directed towards these communities, either during hotel construction or post construction. While complaining that the tourism sector does not absorb sufficient workers from the communities, these communities still acknowledge the sector as being their most important source of employment. Therefore, domestic services, construction and hustling occupations are very important.

The Project can be expected to bring employment and income benefits, to the community, and in exchange benefit from construction labour skills, and existing or trainable domestic occupational skills. However, the proximity to the project of this large-scale squatter community raises several social issues that must be addressed.

Urban decay and substandard housing and health conditions in Lilliput create an enclave of social challenges. The community is known for harbouring criminal elements, whose ranks are swollen by temporary migrations of criminals into the area as policing activity elsewhere dictates. In the minds of informants in other communities, hard drugs, and domestic, criminal and gang violence are associated with the community. Lilliput therefore presents a potential threat to the Project in terms of these urban low-income issues. Serious physical upgrading and social reengineering need to be undertaken by the relevant authorities to stem the potential for further deterioration.

The project in turn, will aggravate the social pressures on the community, to the extent that new low skill employment generation, perceived and real, will likely increase the residential squatting demand unless affordable staff housing is provided. The relevant government agencies, or the private real estate development sector, with incentives if necessary, should be mobilized to do this

Traffic patterns, entrance and exits and connection to the North Coast Highway

The project will empty on to the main north coast artery from Montego Bay to Ocho Rios. Traffic management will require dialogue with the National Works Agency (NWA) and the project managers of NCHIP Segment 2, to facilitate safe intersection and merging of traffic in the vicinity of the project. In addition active communities on the southern side of the project area require careful traffic planning.

Physical carrying capacity of proposed infrastructure and services

Total water management, including potable supply, sewage disposal and storm water drainage, energy, and internal pathways are the major considerations. Carrying capacity appears to be adequate given the proposed Rose Hall Utility Co sewage treatment facility and the Montego Bay water supply infrastructure. Drainage infrastructure will be designed to take account of the projected storm water flows.

Utilities and social amenities

Social amenities within the project setting are very limited. The Resort will provide its own amenities and the surrounding communities have limited facilities. There will

be limited impact of the project on the surrounding areas' utilities or social amenities.

Buffer zones and recreational areas

This does not apply to the project. In order to improve aesthetics, and to reduce the impact of noise and dust on the project it has been recommended that a tree buffer be planted on the southern boundary (main road) of the project.

Sewage treatment

The proposed Sewage treatment as discussed above is expected to improve coastal water quality, provided systems are improved upstream of the project.

Solid waste management

Solid waste is abundant throughout the site. And must be disposed of properly particularly when vegetation is cleared. The resort will be part of the waste shed of Western Parks and Markets and Retirement is the official waste disposal (landfill) site. Construction spoils and site clearance material will need to be carefully bundled for collection and disposal at the approved site.

During the operational phase the project should seek to employ waste reduction initiatives, e.g. composting of organics, recycling/reuse, minimise packaging etc., so as to reduce the volume of waste to be collected and transported to the landfill. Cost savings can be realised and coastal water quality must be protected from solid waste disposal.

TABLE 5.1: IMPACT MATRIX

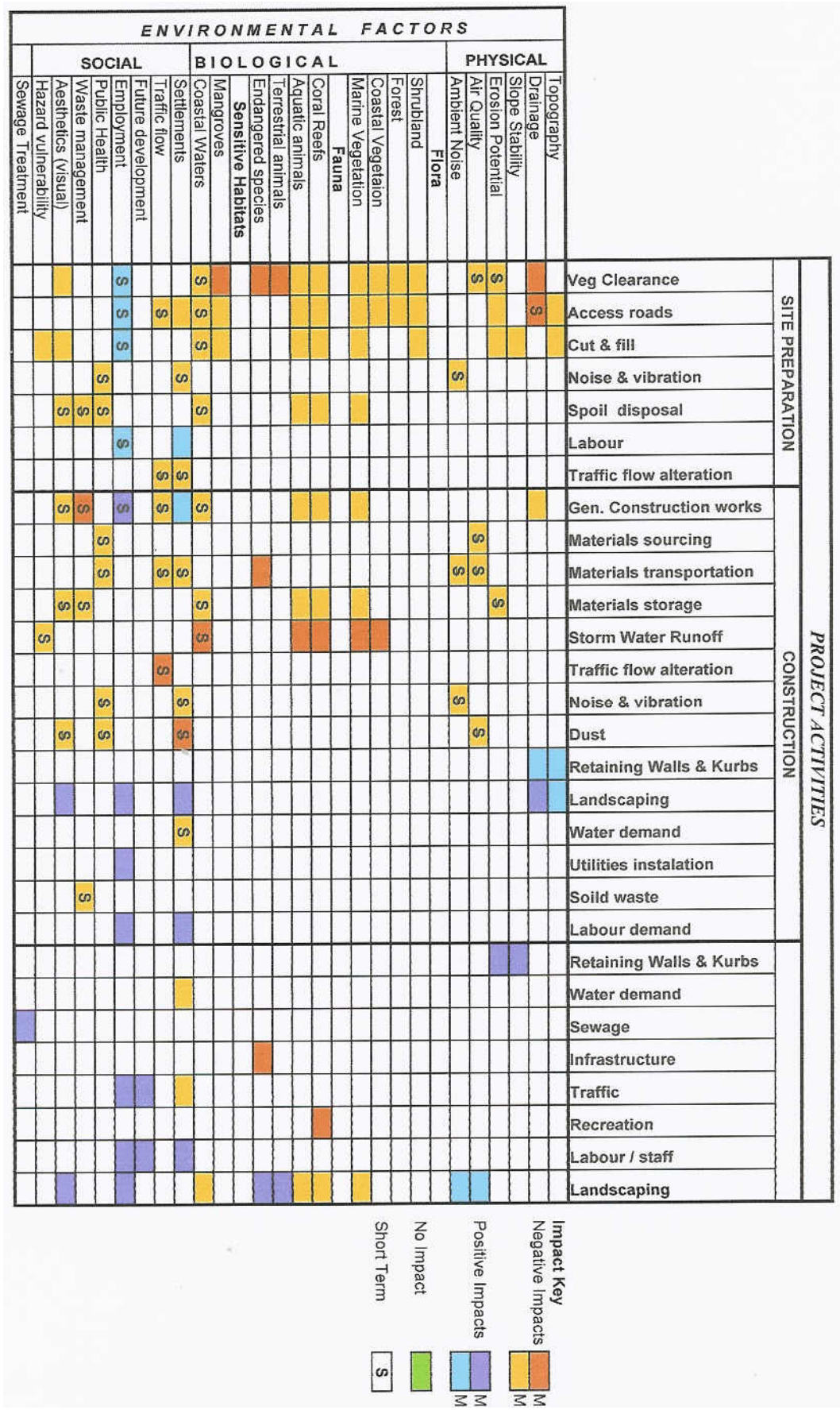
ENVIRONMENTAL FACTORS
PHYSICAL
BIOLOGICAL
SOCIAL
Topography
Drainage
Slope Stability
Erosion Potential
Air Quality
Ambient Noise
Flora
Shrubland
Forest
Coastal Vegetaion
Marine Vegetation
Fauna
Coral Reefs
Aquatic animals
Terrestrial animals
Endangered species
Sensitive Habitats
Mangroves
Coastal Waters
Settlements
Traffic flow
Future development
Employment
Public Health
Waste management
Aesthetics (visual)
Hazard vulnerability
Sewage Treatment
PROJECT ACTIVITIES
SITE PREPARATION
Veg Clearance
Access roads
Cut & fill
Noise & vibration
Spoil disposal
Labour
Traffic flow alteration
CONSTRUCTION
Gen. Construction works
Materials sourcing
Materials transportation
Materials storage
Storm Water Runoff
Traffic flow alteration
Noise & vibration
Dust
Retaining Walls & Kurbs
Landscaping
Water demand
Utilities instalation
Soild waste
Labour demand
Retaining Walls & Kurbs
Water demand
Sewage
Infrastructure
Traffic
Recreation
Labour / staff
Landscaping
Impact Key
Negative Impacts
Positive Impacts
No Impact
Short Term
M
M
M
M
S

Table 5.2: Natural Environment – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
Hydrology and Drainage	**Design and Construction Phase** Impacts on drainage are both direct and indirect. They relate to all phases of the development and to high volume events (major drainage) as well as to drainage requirements for run-off from more frequent events (minor drainage).	1. The engineering design for the development should use the NWA design criterion for drainage structures, to accommodate site runoff from flash floods and catastrophic events. 2. Storm water runoff (more frequent events) should be handled by kerbs, channels, catch basin inlets, storm sewers, minor swales and roadside ditches. These must be designed to prevent ponding and unchecked runoff to the coastal zone. 3. Siltation control measures are required for run-off. **These mitigation measures are the responsibility of the developer.** 4. Design must ensure that there is no blockage of the existing channels from the main road. **This is the responsibility of the developer in collaboration with the National Works Agency (NWA).**

		Operation Phase During the operation phase the mitigation measures incorporated in the engineering design should prevent problems of ponding, and rapid surface run-off. Scheduled inspections and maintenance of drainage channels is critical. **This is the responsibility of the developer**

Hazard Vulnerability	**Design and Construction Phase** The coastal zone is vulnerable to Storm surge and swells from northers Impacts during site preparation or construction relate to the effect of flood events and storm water run-off in the project area. Flooding is a major natural hazard to be considered and the major impact is derived from the effect of extreme runoff on the site and the topographical features. With respect to man-made/technological hazards, accidents can occur as a result of construction activities directly on-site and as a result of activities off-site, such as transportation of equipment and materials. Health and safety aspects must be considered during both the Construction and	1. Adequate setbacks and elevation of lower levels should be so designed as to reduce the impact of coastal flooding. 2. Shoreline protection must be appropriately engineered for the development 3. Site preparation and construction schedules should take account of the traditional rainy season between May and October and of the hurricane season from June to November, during which tropical systems sometimes cause flood rains. Extraordinary tropical systems have also caused problems of supersaturated soils, so that schedules should factor this eventuality. 4. A safety management plan including traffic handling and equipment management procedures should be developed as part of the construction scheduling. **These mitigation measures are the responsibility of the developer.**

	the Operation Phases with respect to workers, residents in neighbouring communities, and the motoring public.	**Operation Phase** During the operation phase the mitigation measures incorporated in the engineering design should prevent problems associated with hazards.

Air Quality	**Site Preparation and Construction Phase** Movement of trucks and heavy-duty equipment to and from the project area, as well as construction work and stockpiling of earth material, will contribute to dust emissions. Construction activities will involve removal of vegetation that will expose and loosen soil, which can become airborne with medium to strong winds. This would add fugitive dust to the area. The transport of aggregate for construction will also contribute to the fugitive dust levels. Construction vehicles will emit air contaminants such as nitrogen and sulphur oxides as well as particulates. Road improvement works for NCHIP will add fugitive dust to the area.	1. Watering of un-vegetated areas and stripped road surfaces along which construction vehicles and trucks travel will control dust emissions by up to 70%. A full-time watering truck should be maintained on site for watering road surfaces as needed to minimize fugitive dust emissions. Over-saturated conditions, which would cause outgoing trucks to track mud onto public streets, should be avoided. Watering would not be necessary on days when rainfall exceeds 2.5 mm (0.01 inch). 2. Stock piling of earth materials for construction should be carried out within temporarily constructed enclosures to limit fugitive dust. Vehicles transporting earth materials should be covered en route. Mixing equipment should be sealed properly and vibrating equipment should be equipped with dust removing devices. Stockpiles of fines should be covered on windy days. 3. A monitoring program for dust is recommended to assess

	Operation Phase The main air impacts during the operational phase will be from vehicular emissions. There are currently no vehicular emissions standards for Jamaica. However, vegetative buffers, which are proposed for the development, will help to reduce negative impacts of vehicular emissions on the development.	the effectiveness of control measures in meeting ambient air quality standards. 4. Provide dust masks to operators in order to protect them from dust impacts. 5. Take account of prevailing wind direction and plant tall leafy and dense vegetation between road and resort to filter pollutants. **The above mitigation measures are the ultimate responsibility of the developer, working with contractors and subcontractors.**
Noise	**Site Preparation and Construction Phase** The noise level is expected to increase during site preparation and construction with the use of heavy machinery and earth moving equipment.	1. Although not expected to create a significant negative impact, noise impacting on nearby communities from construction activities can be minimized by limiting noisy construction activities to the hours between 7 am and 6 pm, where construction is in close proximity to residential areas. Construction machinery and vehicles should be serviced at regular intervals in order to keep

		noise to a minimum. ***Operation Phase*** 2. The use of vegetative barriers, defined as a series of narrow and dense trees and shrubs planted near the roadside can significantly reduce roadside noise. Vegetative barriers have been shown to reduce noise by 1-3 dB. **Responsibility of the developer as determined.**

Marine Water Quality and Reefs	**Construction Phase** The marine survey indicates a degraded reef system. The major water quality impacts likely during construction work are listed below: • Increased suspended solid loading (sediments and garbage) to the coastal waters (from earth moving activities and terrestrial run-off) • Increased bacterial levels due to indiscriminate disposal of human waste (particularly construction camp activities). • Oil and grease from heavy equipment and trucks.	1. Measures to control or limit sedimentation to the coastal zone during the construction phase will include storage of earth materials within containment berms 2. Deployment of sediment traps as needed. 3. The engineering design must incorporate measures for slope stabilization and reinforcement. 4. The proper removal and disposal of construction spoil so as not to send waste material to the coastal zone. 5. Take all necessary measures to prevent refuse (solid waste) and wastewater produced in construction camps from entering drains and coastal zone **Provision of portable chemical toilets at work sites, with appropriate sanitary arrangements for disposal of the contents.** Oil and grease, which may be generated from construction

	Operation Phase The most important impacts relate to increased nutrient loading in the coastal environment from the use of fertilisers, solid waste, and contaminated storm drainage. Assessment of the reef indicates a partially degraded reef structure resulting from high nutrient loading, possibly from surface run-off, and reduction of grazers, possibly due to over-fishing Landscaping will involve an increase in the use of fertilizers, which could increase the nutrient loading to the coastal environment. The increase in number of snorkelers and recreational SCUBA divers may lead to physical damage of the reef due to trampling, breaking corals or removal of organisms for souvenirs.	equipment, should not be allowed to run into the sea and should be properly stored and disposed of, off site, to prevent washdown in terrestrial run-off during rainfall events. **The above mitigation measures are the ultimate responsibility of the developer, working with contractors and subcontractors.** *1. Install appropriate waste collection receptacles and removal system* *2. The services of a reliable certified contractor must be engaged for the timely and efficient removal of solid waste to the approved landfill site.* **These mitigation measures are the responsibility of the management entity for the development.** Investigations should be conducted into the use of alternative fertilisation methods to reduce the nutrient loading on the coastal environment.

		Monitoring of the coastal environment should be conducted against baseline data as part of management of the environmental asset of the development. Establish regulations and promote environmental awareness amongst visitors and residents e.g. using posters or signs, giving talks in hotels/communities. **Water quality monitoring may be the responsibility of the developer if speciefied by NEPA in any permit issued.** **Other mitigation measures are the responsibility of the developer.**

Vegetation	**Site Preparation and Construction Phase** Site preparation and construction activities will remove several acres of vegetation, removing the airshed purification function and habitat for birds. Removal of coastal vegetation will disrupt turtle nesting and have impacts on beach and dune stability leading to beach erosion. Loss of terrestrial vegetation will also increase surface run-off and sheet flow after heavy rainfall events. Percolation into the limestone can also be increased providing indirect paths to the coast.	1. Clearing of the vegetative stands should be carried out on a phased basis to reduce the amount of exposed top soil that can be washed down in rainfall events. 2. Clearance of vegetation should be done in accordance with the Terms and Conditions specified in any permit from NEPA 3. Feeding trees for birds, particularly sweetwoods, should be maintained. 4. Trees to be retained should be 'red-flagged' to alert contractors. 5. Maintain as much of pioneer coastal vegetation as possible to prevent erosion of sand dunes. Dune plants such as *Sesuvium portulacastrum should be maintained.* 6. Construction monitoring is recommended. 7. Replant trees and shrubs wherever possible to provide air shed functions of purification. 8. Tree planting should also

		be carried out to form buffers for dust and noise from the main road, erosion control and for aesthetic appeal, as appropriate. 9. Selection of plants for landscaping should consider habitat suitability, feeding trees, trees of national interest, flowering trees and shrubs. 10. Vegetation planted for landscaping buffers and for aesthetic appeal should be maintained, through a scheduled maintenance programme The requirement for construction monitoring and the establishment of Permit Conditions are **the responsibility of NEPA.** Other mitigation measures are ultimately **the responsibility of the developer** and any **contractors** or **subcontractors.**

Birds	**Site Preparation and Construction** Vegetation clearance will result in loss of habitat for both endemic and migratory bird species. Fragmentation of the forest can result in fragmentation of the habitat, a decrease in the numbers and abundance of the forest bird species, and can impede feeding for birds reluctant to cross open areas. Birds that prefer open spaces will increase provided feeding trees remain.	1. Landscaping and vegetation buffers will result in the replacement of some habitat for selected species. 2. Selective vegetation clearance should be exercised to ensure that feeding, nesting and roosting sites are maintained in suitable numbers. These mitigation measures are the **responsibility of the developer and the design engineers.**
Sea Turtles	Turtle nesting has been reported in the sandy areas along the shore. Sea turtles are protected by both national and international legislation and are an endangered species.	1. Design of shoreline facilities should utilise turtle-sensitive lighting so as to minimise disorientation of turtles, disruption of nesting activities and to facilitate safe emergence of hatchlings. 2. Maintain as much of coastal vegetation as possible - especially low growing C*occoloba uvifera* trees under which eggs often laid.

		3. No motor vehicles should traverse the beach area. 4. Strategies to facilitate turtle nesting on the sandy beaches should be integrated within any management plan. 5. NEPA has specific guidelines for the management of turtle nesting sites these will need to be incorporated into the management plan to be outlined by NEPA on the issuing of the beach licence. These mitigation measures are the **responsibility of the developer.**

Table 5.3: Social Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures

Environmental Aspect	Potential Impacts	Mitigation Measures
Traffic, Transportation and Access Roads	**Site Preparation and Construction Phase** Site preparation and construction activities will see an increase in the movement of heavy vehicles and construction equipment. ***Operation Phase*** Disruption to traffic is not anticipated during the operation phase. However, consideration should be given to the creation of underpasses for pedestrian traffic. Exit ramps from the main road to access the property should be considered.	Scheduling of construction work should seek to minimise disruption to traffic flow along the main north coast artery and allow for the movement of material and heavy equipment. Arrangements for parking and storage of material should be made on-site as is feasible for efficient operations. Discussions should be held early with the National Works Agency regarding the current work on the Northern Coastal Highway

		Improvement Project to determine the construction schedule through the Rose Hall area. Discussion should be had with the National Works Agency regarding the provision of underpasses and exit ramps. Properly trained flag persons and roadside signs should be used where the movement of heavy machinery and construction equipment may cross the main road. These mitigation measures are the **responsibility of the developer and the contracters in consultation with the National Works Agency, as required.**
Community Relations	**Construction Phase** Movement of construction vehicles will generate – dust, noise, traffic disruption	Vehicles should be covered and major movement should take place outside of peak

	which can prove to be nuisance to the communities around. Increased residential squatting in area because of perceived employment opportunities Tensions if few jobs	hours as much as possible. A community liason/relations officer(s) will assist in communication between the project and adjacent communities. Regular meetings to provide information on the project schedule etc. will assist mutual understanding. Avoid high decibel activity at night.
Employment	Site Preparation and Construction Phase Employment opportunities will be created during the site preparation and construction phases. This will mostly be unskilled labour for the duration of the construction activities. Additionally, economic opportunities will	1. Casual labour will find employment and this is expected to be a positive impact for the surrounding communities. 2. Workers should be briefed on traffic management, solid and liquid waste disposal, dust management, parking, idling of equipment and oil spill control. 3. The “politicisation” of employment opportunities often poses

	involve the sourcing of construction material and linkages created with local and regional suppliers and industries.	some challenge to contractors, and the need for security and relevant dialogue have to be factored into construction planning. These mitigation measures are the **responsibility of the developer.**
Social Infrastructure	**Operational Phase** Housing, Schools, Health Centres and other institutions are generally inadequate in the areas around. Population pressure on housing demand is likely to increase the squatter population and the requirement for sanitation as well as housing and other infrastructure	Housing development planned for Barrett Hall should help to ease the pressure if units are affordable and if they are brought on stream in tandem with the developments in the rose Hall area. The developers and Rose Hall Ltd should enter into dialogue with the Montego Bay Chamber of Commerce and Industry and the St James Parish Council to seek support in encouraging the relevant government agencies to accelerate the provision of housing and sanitation in the surrounding areas. **Improvement of social**

		infrastructure is the responsibility of the relevant agencies of the Government of Jamaica.
Solid Waste Management	**Site Preparation and Construction Phase** Solid waste generated from the site preparation and construction activities will include construction debris, vegetation, and solid waste from the site.	Construction sites generate considerable waste and provision must be made for suitable separation and storage of waste in designated and labelled areas throughout the site. Collection of waste by certified contractors and disposal at the approved site for St James. Any hazardous waste should be separated and stored in areas clearly designated and labelled, for future entombing and disposal as directed by the National Solid Waste Management Authority. Worker training should include instructions on how to dispose of food and drink containers

		emphasizing the need to protect the coastal environment. Portable chemical toilets must be provided, maintained and removed by a certified contractor. These mitigation measures are the responsibility of the developer.
Proposed Developments	Major developments are proposed for the Rose Hall Estate to the west of the project site through the provision of the Master Plan - "Residences of Rose Hall" project, Conference Centre, Resort Residential Development. Within the GMBA other developments are planned including the expansion of major infrastructure – airport, port, roads. Further Resort developments are proposed for the	These developments are expected to further enhance the contribution of the Iberostar Resort development. Cumulative impacts related to traffic management may occur if construction schedules overlap. The mitigation measures as described under traffic management would need to be applied by other developers.

	coastal strip toward the east including the proposed signature Harmonisation Resort at Harmony Hall, Trelawny.	
Public Health and Safety	**Site Preparation and Construction Phase** Site preparation and construction will involve transportation and storage of significant volumes of construction material, and proper disposal of construction spoil and any hazardous waste. Increased levels of fugitive dust and construction noise are also public health issues.	***Mitigation Measures*** 1. To minimise risk to the public the construction activities which will directly affect the movement of traffic and pedestrians, should be properly scheduled and standard construction techniques for sign–posting and flagging should be adhered to. 2. Dust control by wetting is essential. 3. Unnecessary idling of construction related vehicles should be discouraged. 4. Proper sign posting of speed limits and

		entrances and exits. **These mitigation measures are the responsibility of the developer.**
Zoning	Some types of recreational water sports are incompatible, such as snorkelling and jet skiing. Some areas of the reef are in shallow water, and accidents could occur.	1. Zoning of areas for swimming/ snorkelling and for other sports such as jet skiing. 2. Placing markers to identify shallow parts of reef which may be hazardous to jet skiers. These mitigation measures are the **responsibility of the developer.**
Archaeological and Cultural Heritage	**Site Preparation and Construction Phase** Rose Hall is a listed site under the Jamaica National Heritage Trust Act. The Rose Hall Great House has been renovated by Rose Hall Developments Ltd. and is a major tourist	

	attraction. The adjacent Greenwood Great House at Barrett Hall is also a restored heritage site. Site preparation and construction could result in the unearthing and discovery of artefacts.	
	Operation Phase Damage to artefacts and heritage sites can occur if open access is maintained.	1. Any sites discovered should be properly secured to reduce public access and interference. 2. Heritage sites should be demarcated with interpretive signs. These mitigation measures are the **responsibility of the developer in association with the JNHT.**
Sewage Treatment	**Operation Phase** Sewage generation at	Details of the Rose Hall

	the Iberostar Resort will be the standard output of resorts based on occupancy levels/room nights and the associated support infrastructure. Sewage will be collected and treated at a central facility operated by rose Hall Utility co. and the treated effluent will be discharged through an irrigation system for golf courses in the area. No effluent will be released on the site of the resort.	Utility Company collection, and treatment and irrigation system are given in Appendix IV. A Public Hearing for this facility as requested by NEPA, was held as part of the permitting process. Pre-treatment of the effluent on the site of the Resort will be essential prior to collection. This is to ensure prevention of unsuitable substances entering the system. A monitoring system will need to be implemented to ensure the effluent is being handled according to the required specifications of the rose Hall Utility system. This measure is the **responsibility of the developer on approval by NEPA.**

5.2 POSITIVE IMPACTS

The mandate of Iberostar Resort and Spa (Grupo Iberostar) is to develop the project area with luxury accommodation, and supporting recreational and resort infrastructure. Several positive impacts are anticipated from the fulfilment of these objectives.

Physical Environment

The engineering of drains, kerbs and channels, should channel storm water run-off to reduce potential ponding and sheet wash. Sedimentation control devices should reduce the levels of siltation in nearby coastal waters.

The proposed sewage treatment plant to be built and operated by Rose Hall Utility company will constitute a major facility in the area and it is expected that wastewater management throughout that section of the north coast will be greatly enhanced, thus reducing the potential pollution to the coastal waters. It is expected that nutrient loading and the effects of eutrophication in coastal waters will be minimized.

Biological Environment

Engineering for storm water run-off can have beneficial impacts on the coral reefs through the reduction of siltation. Additionally, where engineering and landscaping include retention ponds the impacts associated with high nutrients in run-off should be minimized.

The maintenance of large diameter bird feeding trees will help to maintain habitat for avifauna, which are currently numerous on the site.

A major threat to turtle survival is egg harvesting. Proper management of the nesting beach by the hotel may actually increase the survival chances of the turtles by protecting the nests from poachers.

Socioeconomic Environment

The Iberostar development will make a significant contribution to the tourism product in Jamaica in terms of investment opportunity for resort style accommodation, recreational facilities and support services. The evidence of squatting/informal settlements in the surrounding areas is a major cause for concern with respect to environmental integrity of some of Jamaica's major natural and built assets. Controlled and well-designed development with the attendant infrastructure to facilitate positive environmental impact is a positive impact of this proposed development.

During design, site preparation and construction, employment will be generated for several categories of workers including engineers, casual labourers, skilled and unskilled workers, as well as suppliers of goods and services. During the operation phase supplies of goods and services will be required.

An energy efficient chiller system has been proposed for the resort's air conditioning needs. The system will require well-extracted seawater, and passage through as described in Appendix II. No negative impacts are indicated and the benefit will be energy efficiency in a major energy-using component of the development (air conditioning).

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6.0: CONSIDERATION OF ALTERNATIVES

The land purchased by Grupo Iberostar – Branch Developments Ltd from Rose Hall Developments Ltd. was earmarked for high-end tourism development as part of the mandate of the agreement between the Government of Jamaica and Rose Hall Ltd.

The alternatives for the site include:

1. No action – site remains as currently obtains
2. Development with alternate design
3. Alternate use of the site

No Action

The site with no development would mean retention of the vegetation cover and the habitat for terrestrial flora and fauna as identified. However, such action is likely to perpetuate degradation in terms of solid waste dumping and polluted runoff to the coastal zone. Management of the site is critical to environmental quality.

The economic value to be added to the site is part of the mandate for Rose Hall Estate lands. An environmentally sound development that takes account of the physical, ecological and social quality objectives can be a positive contribution.

Alternative Design

The hotel represents the first of three proposed structures for the complete holding at the current Rose Hall Beach Club area. Alternatives in layout and design have been considered, and the design as presented takes account of

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the even gentle slopes and utilised multi-storied graded design to reduce the visual impact from the road in terms of high rise and to make maximum use of the site. The developers have indicated that the design is cost effective, and utilises methods employed successfully elsewhere internationally by the Group.

Alternative Use

The site is earmarked for resort residential development. Currently a Beach Club with a well-developed beach lies on the western side of the property. Club facilities could be expanded on the property, but again the value added would be minimal. Management of the site is critical to environmental quality.

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7.0 ENVIRONMENTAL QUALITY OBJECTIVES

Environmental Quality Objectives have been identified for the proposed development to highlight the following aspects:

STORMWATER CONTROL

Storm water run-off to the coast must be controlled so as to prevent polluted discharge to the coastal waters. Runoff has the potential to carry volumes of sediment and agricultural chemicals (particularly fertilizers) to the coastal waters. Recommendations have been made for the effective management of storm water run-off through engineering.

ENERGY EFFICIENCY

Energy efficiency is essential to sustainable development and to operating cost management. The integration of energy efficient systems should be part of all aspects of the development. Developers should install energy efficient equipment, including fluorescent bulbs, timers and energy efficient appliances. A Chiller system for air conditioning has been proposed.

MINIMIZATION OF POLLUTION

Pollution of the coastal environment may be exacerbated by poor solid waste management practices and sewage treatment and disposal which can result in the wash down of material during rainfall events. Proper solid waste management practices are to be incorporated in the development including the provision and installation of trash

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receptacles, collection and removal of trash by a certified contractor for disposal at an approved site.

Appropriate and effective sewage treatment and disposal is essential to the quality of the coastal environment. Connection to the rose Hall Utility facility will assist compliance with this objective. Meeting the specifications of the utility company will be a requirement.

PROTECTION OF TURTLE NESTING

Turtles are an endangered and protected species under national and international laws. Management of turtle nesting sites must be integrated into management plan for the resort. Retention and propagation of selected species is important to this process.

HABITAT PROTECTION

Recommendations have been made for the retention of selected tree species as bird feeders and for aesthetic purposes. Retention of low bushes on the coast will assist turtle laying and hatching. Habitat compatibility for introduced landscape vegetation has also been recommended.

AESTHETIC APPEAL

Tree buffers along the road and within the property will help to create the sense of "lush tropical environment". The use of grassy verges should be incorporated into the design to enhance this effect. These measures will enhance aesthetic appeal by ensuring maximum green areas, but will also help to protect the habitat of species of birds, and reptiles.

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APPENDICES

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APPENDIX I:NEPA CORRESPONDENCE

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Ref: 2004-08017-EP00095

Javier Bethencourt
Project Manager
Branch Development Ltd
21 East Street
Kingston

July 1, 2004

Dear Mr. Bethencourt

Re: Permit Application for Development of Iberostar Rose Hall Resort Complex

Following a review of the application for the captioned development the National Environment and Planning Agency has determined that an Environmental Impact Assessment is required for the project. Your specific proposed Terms of Reference must be submitted to this office for approval prior to commencement of the EIA. Please note that **no** EIA will be accepted without a **prior approved** Terms of Reference.

The TOR for the Environmental Assessment shall address but not be restricted to the following areas:

1. A survey with respect to existing vegetation, anticipated vegetation loss and hence loss of habitat for the fauna in the area.

2. A determination of the effect the proposed activity will have on the species present with special emphasis on, sea turtles and migratory bird species. Nesting activity by Leatherback turtles have been reported at this project site.

3. A description of the existing physical and biological environment at the project site.

4. The impact that this project present to beach users of the site and the residents of the surrounding community.

5. A socio-economic survey to gauge public perception/support for the project.

6. Erosion mitigation with respect to proximity to a coastal/marine environment and reefs.

7. The impact of the project on the sea, wetlands and the surrounding area especially as it relates to the cumulative impact of this project.

8. Drainage, especially with respect to existing natural drainage channels.

9. The proposed method, level and location of any sewage treatment options and the impact of its disposal on the environment.

10. The document shall include a construction site waste management plan for the project.

11. The EIA document must identify the parties to be responsible for the implementation of the mitigation plan, environmental monitoring and management plan aspects of the project.

12. The timelines and schedules for the proposed construction phases inclusive of the proposed periodicity at which monitoring reports are to be submitted.

Additionally, please be guided by the NRCA's Guidelines for Conducting Environmental Impact Assessment which can be found at the website indicated below:

http://www.nrca.org/business/guidelines/general/GuidelinesforConductEIA.pdf

Yours sincerely

.....
Krishna Desai
for Chief Executive Officer.

cc Aeden Earle – Environmental Solutions Ltd

National Environment & Planning Agency
10 & 11 Caledonia Avenue, Kingston 5, Jamaica W.I.
Tel: (876) 754-7540 Fax: (876) 754-7595-6 toll free help-line: 1-888-991-5005
E-mail: ceo@nepa.gov.jm, Web Site: http://www.nepa.gov.jm

Ref: 2004-08017-EP00095

July 12, 2004

Javier Bethencourt
Project Manager
Branch Development Ltd
c/o Myers Fletcher & Gordon
21 East Street
Kingston

Dear Mr. Bethencourt:

Re: Permit Application for Development of Iberostar Rose Hall Resort Complex

The National Environment and Planning Agency has reviewed the draft Terms of Reference (TOR) for an Environmental Impact Assessment (EIA) for the above-mentioned project. The Agency has approved the TOR on condition that the following issues are addressed in EIA document when submitted.

Task 2: Description of the Environment

c) Socio-economic environment

- Considerations should be made for the availability of schooling for the children of workers; adequate security (police presence in the area); housing for the workers; transportation.

Task 4: Determination of Potential Impacts

- The impact of motor vehicle emissions as well as fugitive dust emissions should be examined in this section.
- Impacts on the ambient air quality need to be considered also.
- The vulnerability of the area to natural hazards needs to be included.
- The report should also include disposal of waste grease from the facility,
- Storage of fuel at the facility during construction and operational phases should be included.

Task 5: Analysis of Alternatives

- This section should analyse the rationale for (a) site selection, (b) size of the project and (c) project layout and design
- The costs or approximate costs of the possible alternatives should be included in the preparation of this section where possible.

Be advised that 10 hard copies and a digital copy of the EIA (inclusive of any appendices) report should be submitted, and as relevant, any subsequent addenda and monitoring reports should also be forwarded with copies in digital format. This is being done so as to facilitate as broad as possible review of the relevant information

Yours sincerely

for Krishna Desai
for Chief Executive Officer

cc Aeden Earle-Environmental Solutions Ltd

APPENDIX II:THE CHILLER SYSTEM

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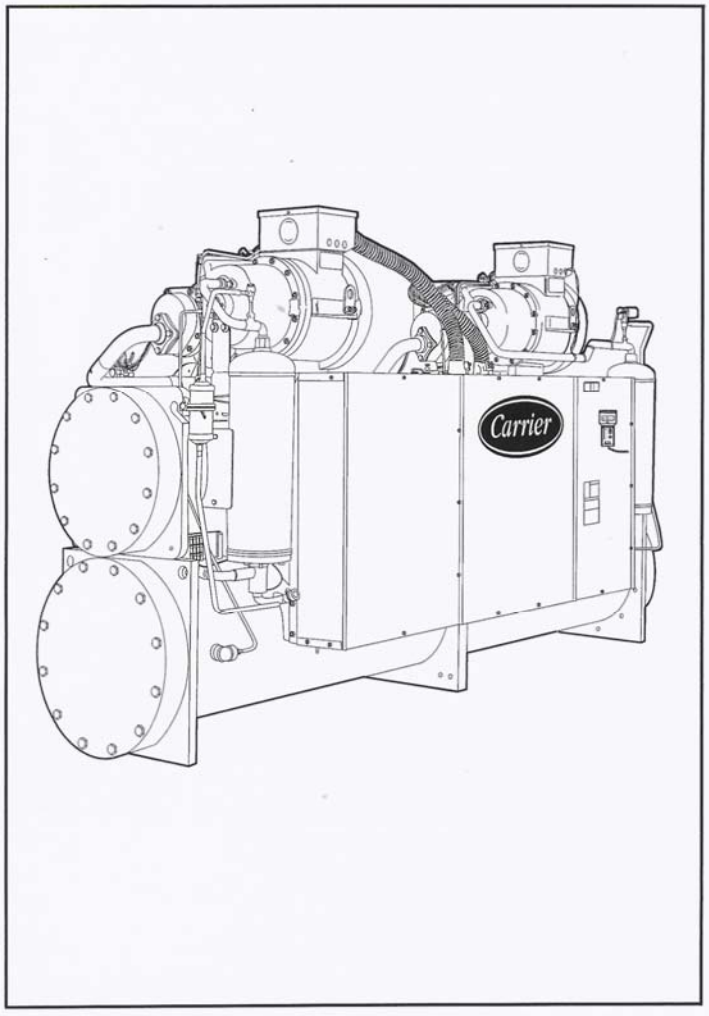
Carrier

Product Data

30HXA076-271
30HXC076-271
Condenserless and Fluid-Cooled Chillers
50/60 Hz

75 to 265 Tons (264 to 931 kW)

ComfortLink™



Fluid-cooled and condenserless chillers designed from the ground up to meet the needs of today and tomorrow, including:

- Fits through a standard door with no disassembly required
- Chlorine-free HFC-134a refrigerant
- Dual circuit independent refrigerant
- Smooth compression using twin screw compressors
- ARI certified efficiencies to .53 kW/ton

Features/Benefits

Quality design and construction make the 30HXC (Fluid Cooled) and the 30HXA (Condenserless) units the preferred choice

Easy installation

The 30HX chiller has a compact design that fits through a standard door opening and requires minimal indoor space. The 30HX chiller is delivered as a complete package for easy installation. There are no extra controls, clocks, starters, or other items to install.

The 30HX unit also provides a single location electrical power entrance (using the accessory field-installed control transformer) and quick, easy piping using either welded or accessory victaulic-type clamp-on couplings for the cooler.

The 30HX 208/230-v, 230-v, 460-v and 575-v units are designed in accordance with UL (Underwriters' Laboratory, U.S.A.) and CSA (Canadian Standards Association) standards to minimize electrical inspection time.

Form 30HX-6PD

A quick start-up is assured once installation is complete, since each 30HX unit is manufactured at an ISO 9002-listed manufacturing facility to guarantee quality. In addition, all 30HXC units are tested under load at the factory to provide reliable start-up.

Easy operation

The 30HX units have a quiet, low-vibration design featuring screw compressors.

Efficiency levels of the 30HX units exceed minimums established by ASHRAE (American Society of Heating and Refrigeration Engineers) and CSA for both full- and part-load operation, thus saving on operating costs through lower electrical costs. All 30HX units are also rated in accordance with ARI (Air Conditioning and Refrigeration Institute, U.S.A.) standards. The 60 Hz 30HXC units are ARI certified.

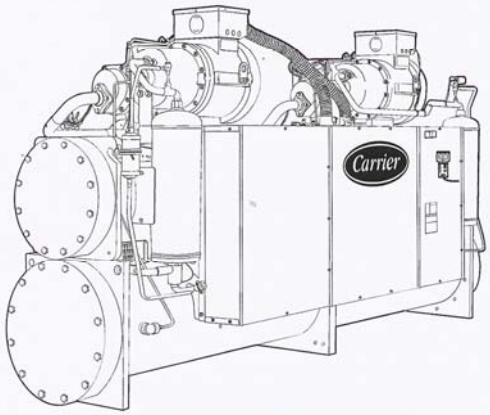
The 30HX controls are fully automatic. The leaving-fluid temperature is directly controlled, and the entering-fluid temperature is continuously monitored to detect load and flow changes controlling to within .5° F (.3° C).

Dual, independent refrigerant circuits provide reliable, dependable cooling, and the 30HX units use medium-pressure HFC-134a refrigerant to minimize stress on the compressors and ensure a long life.

From a service standpoint, the 30HX units offer the following features:

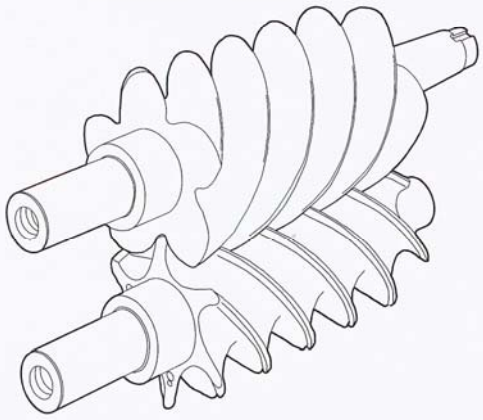
- Use of HFC-134a refrigerant, which has no planned phase-out in its future
- Mechanically-cleanable cooler and condenser (30HXC units)
- Twin-screw compressors, which require no routine service or maintenance
- Easily accessed service information includes suction and discharge pressure and temperature using standard Navigator™ display module

DUAL INDEPENDENT REFRIGERANT CIRCUITS

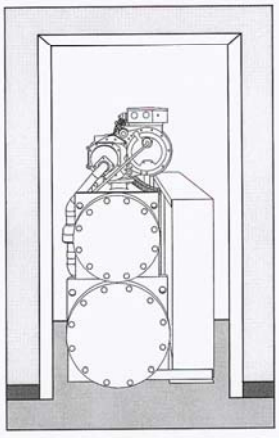


NAVIGATOR IN DISPLAY MODE

TWIN-SCREW COMPRESSOR DESIGN



FITS THROUGH STANDARD DOORWAY



Application data

Unit location

Unit should be level to assure (particularly in its major lengthwise dimension) proper oil return.

The unit should be located indoors in an area of temperature greater than 50 F (10 C).

Good acoustic design practice should be followed, i.e., unit should not be located adjacent to sound sensitive areas unless appropriate consideration has been made.

Cooler fluid temperature

1. *Maximum* leaving chilled-fluid temperature (LCWT) is 60 F (21 C). Unit can start and pull down with up to 95 F (35 C) entering-fluid temperature due to MOP (maximum operating pressure) feature of the expansion valve. For sustained operation, it is recommended that entering fluid temperature not exceed 70 F (21.1 C).
2. *Minimum* LCWT is 40 F (4 C) for standard units. Special-order brine units are required for operation with leaving fluid temperatures in the range of 39 to 12 F (4 to –9 C). For ratings below 40 F (4 C) LCWT, contact your local Carrier representative.
3. *Minimum* entering chilled-fluid temperature (ECWT) is 45 F (7.2 C). *Maximum* ECWT is 70 F (21.1 C).

Leaving-fluid temperature reset

The accessory reset sensor can be applied to the chiller to provide reset of LCWT in constant fluid flow systems. Reset reduces compressor power usage at part load when design LCWT is not necessary. Humidity control should be considered, since higher coil temperatures resulting from reset will reduce latent heat capacity. Three reset applications are offered:

From return-fluid temperature — Increases LCWT set point as return (or entering) fluid temperature decreases (indicating load decrease). Reset from return fluid may be used in any application where return fluid provides accurate load indication. Limitation of return-fluid reset is that the LCWT may only be reset to value of design return-fluid temperature. No additional hardware is required.

From outdoor-air temperature — Increases LCWT as outdoor ambient temperature decreases (indicating load decrease). This reset should be applied only where outdoor ambient temperature is an accurate indication of load. A field-supplied thermistor is required.

From occupied space temperature — Increases LCWT as space temperature decreases (indicating load decrease). This reset should be applied only where space temperature is an accurate indication of load. A field-supplied thermistor is required.

Condenser fluid temperature

1. *Maximum* leaving condenser fluid temperature is 105 F (40.5 C) on all 30HXC units.
2. *Standard* 30HXC units will start at entering condenser fluid temperatures above 55 F (12.8 C). In general, however, continuous machine operation with entering condenser fluid temperatures below 70 F (21.1 C) is not recommended. When the entering condenser fluid temperature is expected to drop below 70 F (21.1 C), it is recommended that some form of condenser flow control be used to optimize performance. Tower pump, bypass valves, or flow regulating valves may be controlled by a 4 to 20 mA output from the 30HXC control (60-second open to close time recommended for actuator).

Cooler and fluid-cooled condenser temperature rise

Ratings and performance data in this publication are for a cooling temperature rise of 10° F (5.6° C). Units may be operated at a different temperature rise, provided flow limits are not exceeded and corrections to capacity, etc., are made. For minimum flow rates, see the Minimum Flow Rates table. High flow rate is limited by pressure drop that can be tolerated.

Minimum cooler flow — Flow (maximum cooler temperature rise) is shown in the Minimum Flow Rates table. Minimum flow rate must be maintained to prevent fouling. When gpm (L/s) required is lower (or rise is higher), follow recommendations below:

1. Multiple smaller chillers can be applied in series, each providing a portion of the design temperature rise.
2. Chilled fluid can be recirculated to raise flow rate. However, mixed temperature entering cooler must be maintained at a minimum of at least 5° F (2.8° C) above the leaving chilled fluid temperature.
3. Special plus one-pass cooler can be used. Contact your Carrier representative for further information.

Maximum cooler flow (> 5 gpm/ton or < 5° F rise [> 0.09 L/s · kW or < 2.7° C rise]) — Maximum flow results in practical maximum pressure drop through cooler. Special minus-one-pass cooler can be used to reduce pressure drop. Contact your Carrier representative.

Return fluid can bypass the cooler to keep pressure drop through cooler within acceptable limits. This permits a higher ΔT with lower fluid flow through cooler and mixing after the cooler. Contact your Carrier representative if pressure drop appears excessive.

Variable cooler flow rates — These variable rates may be applied to standard 30HX series chillers. However, the unit will attempt to maintain a constant leaving chilled-fluid temperature. In such cases, minimum fluid loop volume must be in excess of 3 gpm per ton (3.2 L per kW) and flow rate must change in steps of less than 10% per minute. Apply 6 gal per ton (6.5 L per kW) fluid loop volume minimum if flow rate changes more rapidly.

Minimum fluid-cooled condenser flow — This value (maximum rise) is shown in Minimum Flow Rates table. Ensure leaving-fluid temperature does not exceed 105 F (40.5 C).

Application data (cont)

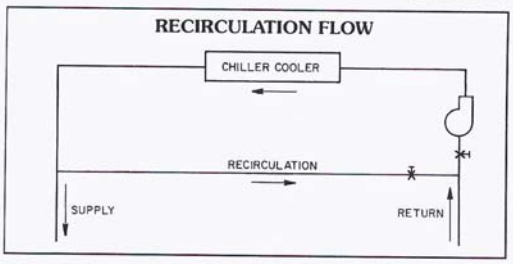
Carrier

MINIMUM FLOW RATES

DEVICE	UNIT SIZE	COOLER # of Passes	COOLER Type	MIN. FLOW RATE* GPM	MIN. FLOW RATE* L/s	COOLER TEMP DIFFERENCE F	COOLER TEMP DIFFERENCE C
COOLER	076	2	Minus 1	136.0	8.6	13	7.4
		3	Standard	90.0	5.7	20	11.1
		4	Plus 1	68.0	4.3	27	14.8
	086	2	Minus 1	149.0	9.4	13	7.4
		3	Standard	100.0	6.3	20	11.1
		4	Plus 1	75.0	4.7	27	14.8
	096	2	Minus 1	169.0	10.7	13	7.4
		3	Standard	113.0	7.1	20	11.1
		4	Plus 1	85.0	5.3	27	14.8
	106	2	Minus 1	188.0	11.8	13	7.4
		3	Standard	125.0	7.9	20	11.1
		4	Plus 1	94.0	5.9	27	14.8
	116	1	Minus 1	272.0	17.2	10	5.6
		2	Standard	136.0	8.6	20	11.1
		3	Plus 1	91.0	5.7	30	16.7
	126	1	Minus 1	295.0	18.6	10	5.6
		2	Standard	147.0	9.3	20	11.1
		3	Plus 1	98.0	6.2	30	16.7
	136	1	Minus 1	327.0	20.7	10	5.6
		2	Standard	164.0	10.3	20	11.1
		3	Plus 1	109.0	6.9	30	16.7
	146	1	Minus 1	350.0	22.1	10	5.6
		2	Standard	175.0	11.0	20	11.1
		3	Plus 1	117.0	7.4	30	16.7
	161	1	Minus 1	376.0	23.7	10	5.6
		2	Standard	188.0	11.9	20	11.1
		3	Plus 1	125.0	7.9	30	16.7
	171	1	Minus 1	399.0	25.2	10	5.6
		2	Standard	199.0	12.6	20	11.1
		3	Plus 1	133.0	8.4	30	16.7
	186	1	Minus 1	426.0	26.9	10	5.6
		2	Standard	213.0	13.4	20	11.1
		3	Plus 1	142.0	9.0	30	16.7
	206	1	Minus 1	508.0	32.1	10	5.6
		2	Standard	254.0	16.0	20	11.1
		3	Plus 1	169.0	10.7	30	16.7
	246	1	Minus 1	597.0	37.7	10	5.6
		2	Standard	309.0	18.8	20	11.1
		3	Plus 1	199.0	12.6	30	16.7
	261	1	Minus 1	618.0	39.0	10	5.6
		2	Standard	309.0	19.5	20	11.1
		3	Plus 1	206.0	13.0	30	16.7
	276	1	Minus 1	642.0	40.5	10	5.6
		2	Standard	321.0	20.3	20	11.1
		3	Plus 1	214.0	13.5	30	16.7
CONDENSER	076,086	2	—	105	6.6	—	—
	096,106	2	—	135	8.5	—	—
	116,126	2	—	170	10.7	—	—
	136,146	2	—	195	12.3	—	—
	161	2	—	235	14.8	—	—
	171,186	2	—	255	16.1	—	—
	206	2	—	273	17.2	—	—
	246	2	—	333	21.0	—	—
	261	2	—	333	21.0	—	—
	271	2	—	333	21.0	—	—

*Based on 20 F temperature difference at ARI conditions.

NOTES:
1. The 30HX units will start with loop temperatures up to 95 F (35 C).
2. Minimum flow rate shown is based on ARI Ratings and is for reference only. **20 F (11.1 C) is the maximum cooler temperature differential that will determine actual minimum flow rate.**
3. To obtain proper temperature control, loop fluid volume must be at least 3 gal/ton (3.23 L/kW) of chiller nominal capacity for air conditioning and at least 6 gal/ton (6.5 L/kW) for process applications.



Oversizing chillers

Oversizing chillers by more than 15% at design conditions must be avoided as the system operating efficiency will be adversely affected (resulting in greater and/or excessive electrical demand and cycling of compressors). When future expansion of equipment is anticipated, install a single chiller to meet present load requirements, and install a second chiller to meet the additional load demand.

It is also recommended that the installation of 2 smaller chillers be considered where operation at minimum load is critical. The operation of 2 small chillers at higher loading is preferred to operating a single chiller at or near its minimum recommended value.

The minimum load control accessory should not be used as a means to allow oversizing chillers. Minimum load control should be given consideration where substantial operating time is anticipated below the minimum unloading step.

Parallel chillers

Where chiller capacities greater than can be supplied by a single 30HX chiller are required, or where stand-by capability is desired, chillers may be installed in parallel. Units may be of the same or different sizes. However, cooler and condenser flow rates must be balanced to ensure proper flow to each chiller. The standard 30HX ComfortLink™ control can be configured to provide lead/lag control for two chillers. The accessory Chillervisor™ System Manager III control may be used for proper leaving chilled fluid temperature control and to ensure proper staging sequence of up to 8 chillers. Refer to the accessory Chillervisor System Manager III installation instructions for further details.

Series chillers

Chillers in series may be used for capacities greater than those supplied by a single 30HX chiller. Using the Minus-One-Pass Cooler Head option, fluid pressure drop across the cooler can be held to reasonable levels. The leaving fluid temperature sensors need not be relocated. However, the cooler minimum entering fluid temperature limitations should be considered for the chillers located downstream of other chillers. The standard 30HX control can control two 30HX chillers in series. Condensers should be piped in parallel to maximize capacity and efficiency. This should also minimize condenser pressure drop and saturated condensing temperatures. However, if condensers are piped in series, ensure that the leaving water temperature does not exceed 105 F (40.5 C).

Energy management

Demand limiting and load shedding are popular techniques used to reduce peak electric demands typically experienced during hot summer days when air conditioning loads are highest. When utility electricity demands exceed a certain level, electrical loads are turned off to keep the peak demands below a prescribed maximum limit. Compressor unloading reduces electrical demand while allowing the chiller to operate under part-load capacity and to maintain partial chilled fluid cooling.

Electrical demand can be limited through demand limit input to chiller control which unloads the chiller to a predetermined percentage of the load. One stage of unloading can be initiated by a remote signal to significantly reduce the chiller power consumption. This power reduction applies to the full load power at nominal conditions. The demand limit control should not be cycled less than 10 minutes on and 5 minutes off.

Duty cycling

Duty cycling will cycle an electrical load at regular intervals, regardless of electrical demand. This reduces the electrical demand by "fooling" demand measuring devices. Duty cycling of the entire compressor is **NOT** recommended since motor windings and bearings will be damaged by constant cycling.

Wye-delta start

Wye-delta start is standard on 30HX 208/230 v 60 Hz units and 230 v 50 Hz units and optional on all other 30HX units. This feature is not always required on 30HX units due to the use of multiple compressors that allow small electrical load increments, but is available if required. Maximum instantaneous current flow (see ICF in Electrical Data tables on pages 58-61 should be used in determining need.

Vibration isolation

External vibration isolators are available as field-installed accessories.

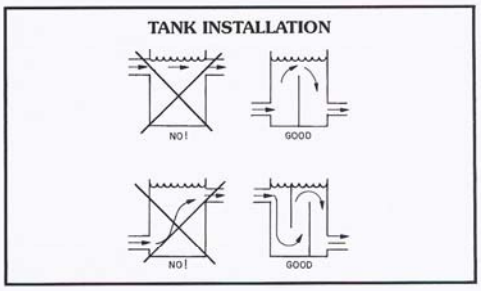
Strainers

A strainer with a minimum screen size of 20 mesh should be installed in both the cooler and condenser fluid lines, just ahead of the cooler and condenser, and as close to the cooler and condenser as possible. For 30HXA units, this recommendation applies only to the cooler.

Chilled fluid loop volume

The chilled fluid loop volume in circulation must equal or exceed 2 gal per nominal ton of cooling (2 L per kW) for temperature stability and accuracy in normal air conditioning applications. For example, a 30HXC096 with a nominal capacity of 93.4 tons would require 186.8 gal (707 L) in circulation in the system loop.

For process jobs where accuracy is vital, or for operation at ambient temperatures below 32 F (0° C) with low unit loading conditions, there should be from 6 to 10 gal per ton (6.5 to 10.8 L per kW). To achieve this volume, it is often necessary to install a tank in the loop. Tank should be baffled to ensure there is no stratification, and that water (or brine) entering tank is adequately mixed with liquid in the tank. See below.



Fouling factor

The factor used to calculate tabulated ratings for the cooler is 0.00010 $ft^2 \cdot hr \cdot F/Btu$ (0.000018 $m^2 \cdot K/W$), and for the condenser is 0.00025 $ft^2 \cdot hr \cdot F/Btu$ (.000044 $m^2 \cdot K/W$). As fouling factor is increased, unit capacity decreases and compressor power increases. To determine selections at other fouling factors, use the chiller program in the electronic catalog.

Cooler and fluid-cooled condenser freeze protection

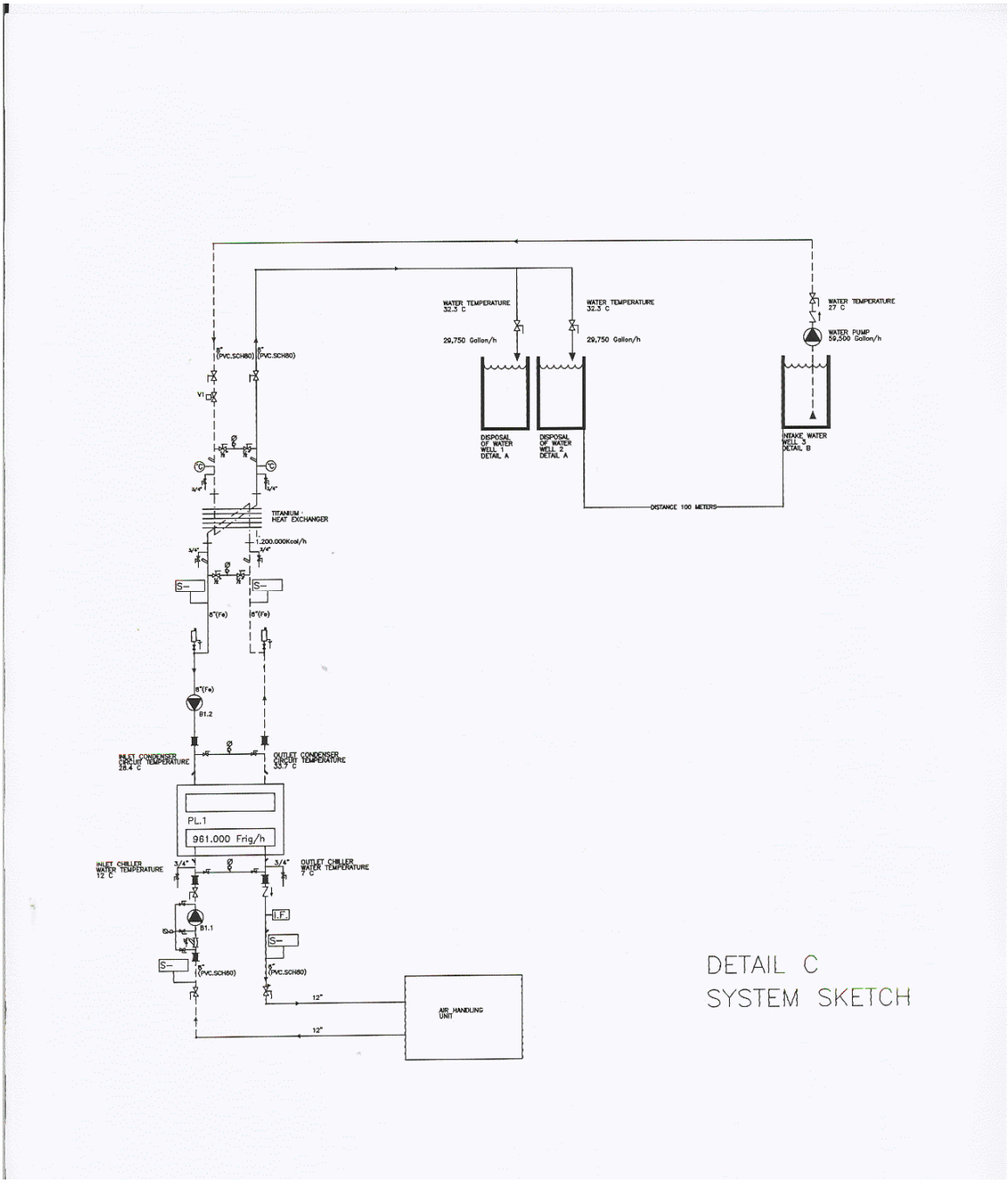
If chiller refrigerant or fluid lines are in an area where ambient conditions fall below 32 F (0° C), it is recommended that an antifreeze solution be added to protect the unit and fluid piping to a temperature 12° F (–11.1° C) below the lowest anticipated temperature. For corrections to performance, refer to the chiller program in the electronic catalog.

Use only antifreeze solutions approved for heat exchanger duty. Use of automotive antifreezes is not recommended because of the fouling that can occur once their relatively short-lived inhibitors break down.

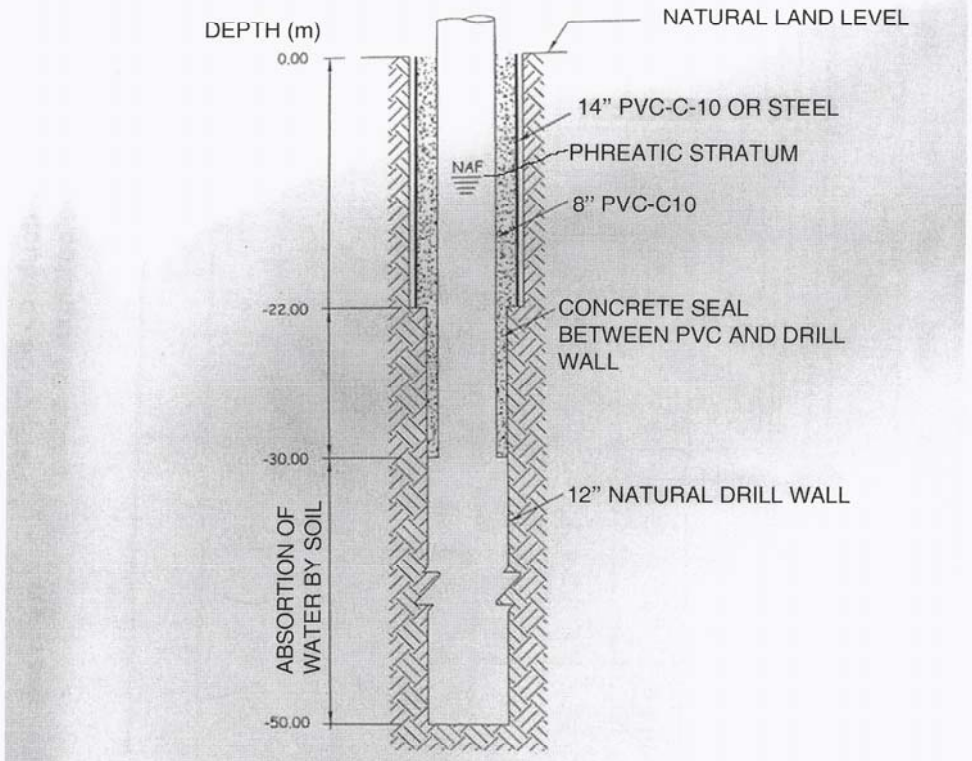
If not protected with an antifreeze solution, draining cooler and outdoor piping is recommended if system will not be used during freezing weather conditions.

30HXA remote condenser requirements

1. Do not manifold independent refrigerant circuits into a single condenser.
2. Ensure each refrigerant circuit has its own head pressure control.
3. Condensing pressure control must be provided on condensers used with 30HXA to maintain a minimum 75 F (24 C) saturated discharge temperature at light loads.
4. Condenser must provide 15° F (–8.3° C) subcooling, a maximum of 40° F (22.2° C) difference between saturated condensing temperature and outdoor ambient temperature (to prevent overload at high ambient temperatures), and a minimum of 20° F (–11.1° C) difference (to assure subcooling).


WATER TEMPERATURE
32.5 C
29,750 Gallon/h
WATER TEMPERATURE
32.5 C
29,750 Gallon/h
WATER TEMPERATURE
27 C
WATER PUMP
59,500 Gallon/h
DISPOSAL OF WATER WELL 1 DETAIL A
DISPOSAL OF WATER WELL 2 DETAIL A
INTAKE WATER WELL 3 DETAIL B
DISTANCE 100 METERS
8" (PVC.SCH80)
8" (PVC.SCH80)
V1
TITANIUM - HEAT EXCHANGER
1.200.000Kcal/h
8"(Fe)
8"(Fe)
8"(Fe)
B1.2
INLET CONDENSER CIRCUIT TEMPERATURE 28.4 C
OUTLET CONDENSER CIRCUIT TEMPERATURE 35.7 C
PL.1
961.000 Frig/h
INLET CHILLER WATER TEMPERATURE 12 C
OUTLET CHILLER WATER TEMPERATURE 7 C
B1.1
LF
8" (PVC.SCH80)
8" (PVC.SCH80)
12"
12"
AIR HANDLING UNIT
DETAIL C
SYSTEM SKETCH

.



DETAIL A

WELL FOR DISPOSAL OF WATER .
WATER PRODUCT OF THE HEAT EXCHANGE.
WATER COOL CHILLER

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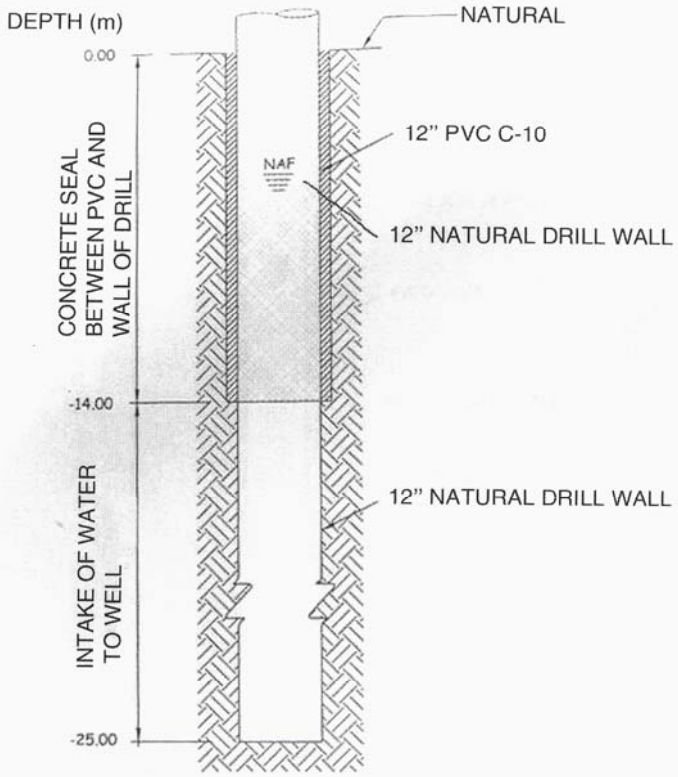

NOTES:

Intake depth of pump must not exceed seal leghth

Measurements in meters

DETAIL B

INTAKE WELL
FOR HEAT EXCHANGE
WATER COOL CHILLER

.

APPENDIX III:BIOLOGICAL DATA

(i) VEGETATION

(ii) AVIFLAUNA

(iii) REEF LIST

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Appendix III
Biology Data and Plates

Table 1: List of vegetation identified on the Iberostar property (*Bird feeding trees). (Hargreaves and Hargreaves 1965; Downer and Sutton 1990).

Common name	Species
Acacia	*Acacia sp.*
Almond	*Terminalia catappa*
*Black mangrove	*Avicennia germinans*
Bougainvillea	*Bougainvillea sp.*
*Bullet	*Bumelia spp.*
*Button mangrove	*Conocarpus erectus*
*Cactus	
Calabash	*Crescentia cujete*
Sisal	
Guango	*Samanea saman*
Guinep	*Melicoccus bijucatus*
Love bush	
Mango	*Mangifera indica*
*Naseberry	*Manilkara zapota*
Oil nut	*Ricinus communis*
*Pimento	*Pimenta dioica*
Poinciana	*Delonix regia*
*Red birch	*Bursera simaruba*
Santa Maria	*Calophyllum calaba*
Sea grape	*Coccoloba uvifera*
Seaside mahoe	*Thespesia populnea*
Seymour grass	*Bothriochloa pertusa*
Shoreline seapurslane	*Sesuvium portulacastrum*

.

*Sweetwoods	*Nectandra spp.*
*Tamarind	*Tamarindus indica*
Wild tamarind	*Leucaena glauca*
Total	**26 species**

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Table 2: Bird species occurring on the Iberostar property.

(Raffaele et al. 1998; Downer and Sutton 1990).

Common name	Scientific name	Number present	Notes
Magnificent frigatebird	*Fregata magnificens*	4	
Brown pelican	*Pelecanus occidentalis*	2	
Little blue heron	*Egretta caerulea*	1	
Great egret	*Casmerodius albus*	1	
Cattle egret	*Bubulcus ibis*	24	
Loggerhead kingbird	*Tyrannus caudifasciatus*	15	Endemic subspecies
Gray kingbird	*Tyrannus dominicensis*	10	
Northern mockingbird	*Mimus polyglottos*	12	
Greater antillean grackle	*Quiscalus niger*	4	
Smooth-billed ani	*Crotophaga ani*	2	
Jamaican lizard cuckoo	*Saurothera vetula*	1	Endemic species
Zenaida dove	*Zenaida aurita*	6	
White-winged dove	*Zenaida asiatica*	11	
White-crowned pigeon	*Columba leucocephala*	14	Threatened species
Caribbean dove	*Leptotila jamaicensis*	1	Endemic subspecies
Common ground dove	*Columbina passerina*	17	Endemic subspecies
American kestrel	*Falco sparverius*	2	
Red-billed streamertail	*Trochilus polytmus*	1	Endemic genus
Green-rumped parrotlet	*Forpus passerinus*	39	
Olive-throated parakeet	*Aratinga nana*	3	Endemic subspecies
Saffron finch	*Sicalis flaveola*	6	
Jamaican euphonia	*Euphonia jamaica*	1	Endemic species
Yellow-faced grassquit	*Tiaris olivacea*	13	
Bananaquit	*Coereba flaveola*	7	Endemic subspecies

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Total species : 24 **Endemic species : 8** **Threatened species : 1**	**197 individuals recorded.**	

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Table 3. Species list of organisms found at the reef and lagoon sites.

Common name	**Scientific name**	**DAFOR**
Fish		**36 species**
Blue tang	*Acanthurus coeruleus*	F
Doctorfish	*Acanthurus chirurgus*	F
Bar jack	*Caranx ruber*	F
French grunt	*Haemulon flavolineatum*	F
White grunt	*Haemulon plumierii*	O
Stoplight parrotfish	*Sparisoma viride*	F
Striped parrotfish	*Scarus iserti*	F
Redband parrotfish	*Sparisoma aurofrenatum*	O
Redtail parrotfish	*Sparisoma chrysopterum*	O
Greenblotch parrotfish	*Sparisoma atomarium*	O
Princess parrotfish	*Scarus taeniopterus*	O
Blue parrotfish	*Scarus coeruleus*	O
Spanish hogfish	*Bodianus rufus*	O
Spotted goatfish	*Pseudupeneus maculatus*	O
Yellow goatfish	*Mulloidichthys martinicus*	O
Yellowtail snapper	*Ocyurus chrysurus*	F
Schoolmaster	*Lutjanus apodus*	O
Slippery dick	*Halichoeres bivittatus*	O
Yellowhead wrasse	*Halichoeres garnoti*	F
Bluehead	*Thalassoma bifasciatum*	F
Squirrelfish	*Holocentrus adscensionis*	F

.

Blackbar soldierfish	*Myripristis jacobus*	O
Harlequin bass	*Serranus tigrinus*	O
Fairy basslet	*Gramma loreto*	O
French angelfish	*Pomacanthus paru*	R
Dusky damselfish	*Stegastes adustus*	F
Threespot damselfish	*Stegastes planifrons*	F
Bicolor damselfish	*Stegastes partitus*	O
Cocoa damselfish	*Stegastes variabilis*	F
Yellowtail damselfish	*Microspathodon chrysurus*	F
Sergeant major	*Abudefduf saxatilis*	F
Sand diver	*Synodus intermedius*	R
Porcupinefish	*Diodon hystrix*	R
Trunkfish	*Lactophrys trigonus*	R
Trumpetfish	*Aulostomus maculatus*	R
Silversides	Family Atherinidae	F
Echinoderms		**7 species**
Long-spined urchin	*Diadema antillarum*	F
West Indian sea egg	*Tripneustes ventricosus*	A
Reef urchin	*Echinometra viridis*	O
Variegated urchin	*Lytechinus variegatus*	A
Red heart urchin	*Meoma ventricosa*	O
Donkey dung sea cucumber	*Holothuria mexicana*	F
Cushion sea star	*Oreaster reticulatus*	O
Cnidarians		**3 species**
Giant anemone	*Condylactis gigantea*	F
White encrusting zoanthid	*Palythoa caribaeorum*	O

.

Thread hydroid	*Halopteris carinata*	O
Gorgonians		**5 species**
Corky sea finger	*Briareum asbestinum*	F
Black sea rod	*Plexaura homomalla*	F
Orange spiny sea rod	*Muricea elongata*	O
Swollen-knob candelabrum	*Eunicea mammosa*	O
Common sea fan	*Gorgonia ventalina*	F
Scleractinian corals		**19 species**
Branching fire coral	*Millepora alcicornis*	F
Blade fire coral	*Millepora complanata*	F
Staghorn coral	*Acropora cervicornis*	O
Elkhorn coral	*Acropora palmata*	O
Finger coral	*Porites porites*	F
Mustard hill coral	*Porites astreoides*	F
Pillar coral	*Dendrogyra cylindrus*	R
Yellow pencil coral	*Madracis mirabilis*	R
Lobed star coral	*Montastraea annularis*	F
Mountainous star coral	*Montastraea faveolata*	O
Great star coral	*Montastraea cavernosa*	O
Boulder star coral	*Montastraea franksi*	O
Massive starlet coral	*Siderastrea siderea*	F
Lesser starlet coral	*Siderastrea radians*	F
Symmetrical brain coral	*Diploria strigosa*	F
Knobby brain coral	*Diploria clivosa*	O
Grooved brain coral	*Diploria labyrinthiformis*	F
Lettuce coral	*Agaricia agaricites*	F

.

Smooth flower coral	*Eusmilia fastigiata*	O
Seagrass		**2 species**
Turtle grass	*Thalassia testudinum*	D
Manatee grass	*Syringodium filiforme*	O
Algae		**24 species**
Paddle blade alga	*Avrainvillea longicaulis*	F
Bristle ball brush	*Penicillus dumetosus*	F
Green mermaid's wine glass	*Acetabularia calyculus*	O
Stalked lettuce leaf alga	*Halimeda tuna*	F
Green jointed-stalk alga	*Halimeda monile*	O
Watercress alga	*Halimeda opuntia*	F
Three finger leaf alga	*Halimeda incrassata*	O
Network alga	*Microdictyon marinum*	O
Mermaid's fans	*Udotea sp.*	F
Chaetomorpha	*Chaetomorpha linum*	O
Enteromorpha	*Enteromorpha flexuosa*	O
Y branched algae	*Dictyota cervicornis*	F
Leafy flat-blade alga	*Stypopodium zonale*	F
White scroll alga	*Padina jamaicensis*	F
Encrusting fan-leaf alga	*Lobophora variegata*	F
Sargassum	*Sargassum sp.*	F
Saucer leaf alga	*Turbinaria tricostata*	F
Blistered saucer leaf alga	*Turbinaria turbinata*	O
Tubular thicket algae	*Galaxaura oblongata*	F
Pink segmented alga	*Jania adherens*	F
Y-twig alga	*Amphiroa rigida*	F

.

Reef cement	*Porolithon pachydermum*	F
Burgundy crust algae	*Peyssonnelia sp.*	O
Schizothrix	*Schizothrix calcicola*	O
Other		**8 species**
Southern lugworm	*Arenicola cristata*	F
Caribbean reef squid	*Sepioteuthis sepioidea*	O
Social feather duster	*Bispira brunnea*	O
Sea walnut	*Mnemiopsis mccradyi*	A
Queen conch	*Strombus gigas*	O
Hermit crab	*Paguristes sp.*	F
Blue crab	*Callinectes sp.*	F
Cymothoid isopod		O
Total		**104 species**

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QUANTITATIVE DATA

Table 4. Quantitative description of algae in the back reef area.

Quadrat	Fleshy		Calcareous		Crustose coralline	Other
	% cover	Height/cm	% cover	Height/cm		
1	30	5	20	4	25	25
2	5	5	30	1	25	40
3	25	8	50	2	10	15
4	50	8	15	3	5	30
5	10		15		50	25
6	30		40		15	15
Average	**25**	**6.5**	**28**	**2.5**	**22**	**25**

Table 5. Coral size data collected by transect in the back reef area.

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Species	Diameter/cm	Height/cm
Siderastrea siderea	110	80
Porites porites	20	10
Porites porites	10	5
Porites porites	10	5
Porites porites	10	5
Montastraea annularis	20	10

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PLATES: PHOTOGRAPHS OF MARINE ASPECTS

Plate 1M. View of the shore from the back reef site.

Plate 2M. School of immature bar jacks close to the reef crest.

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Plate 3M. Back reef area showing arrangement of patch reefs and mounds. Note seagrass growing between the mounds, and shallowness of the water.

Plate 4M. Colony of *Porites porites* in the back reef area. Note low algal growth in the background.

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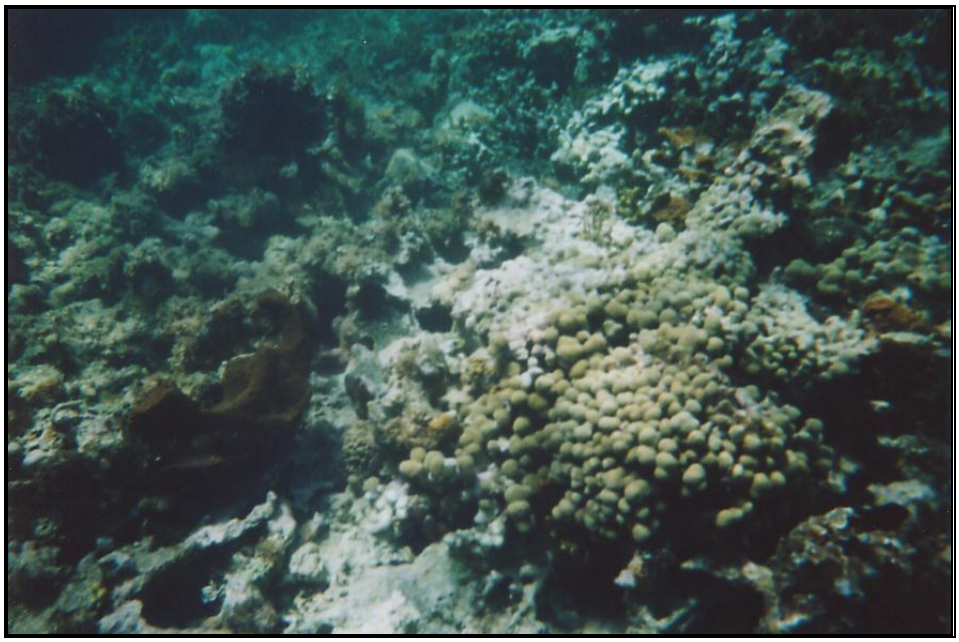

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Plate 5M. Area of fairly high coral cover.
Note crustose coralline algae (pink to white in colour).

Plate 6M. View of the back reef.
Note that the water's surface is visible at the top of the picture.

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Plate 7M. Transect and quadrat laid in the back reef.

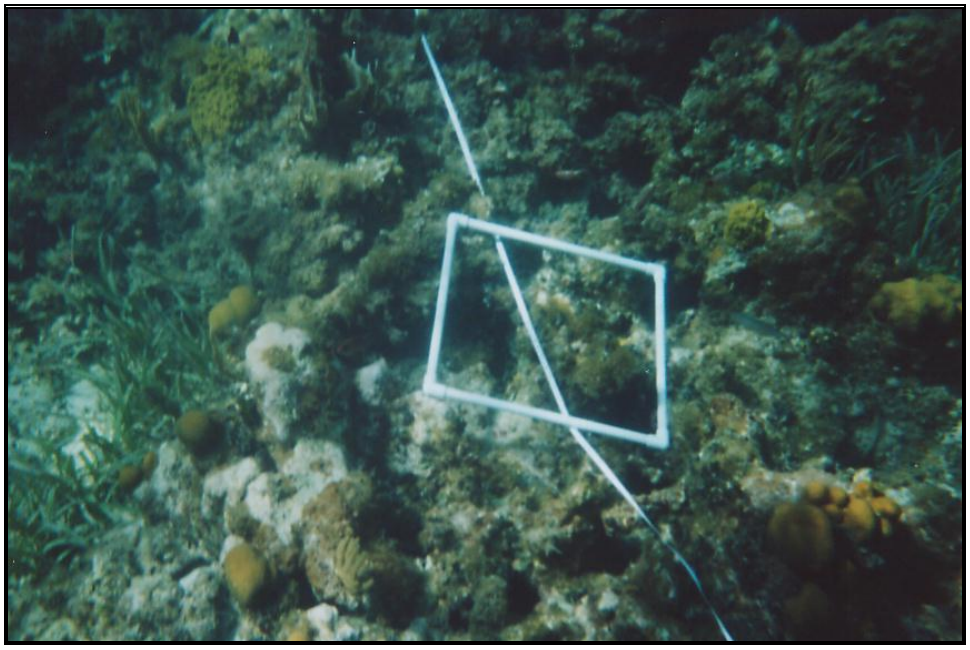

Plate 8M. Urchins attached to patch reef. Note surrounding seagrass.

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Plate 9M. Area of relatively high coral cover. Visible are *Porites porites, Montastraea franksi, Montastraea annularis, Acropora cervicornis* and *Millepora complanata*.

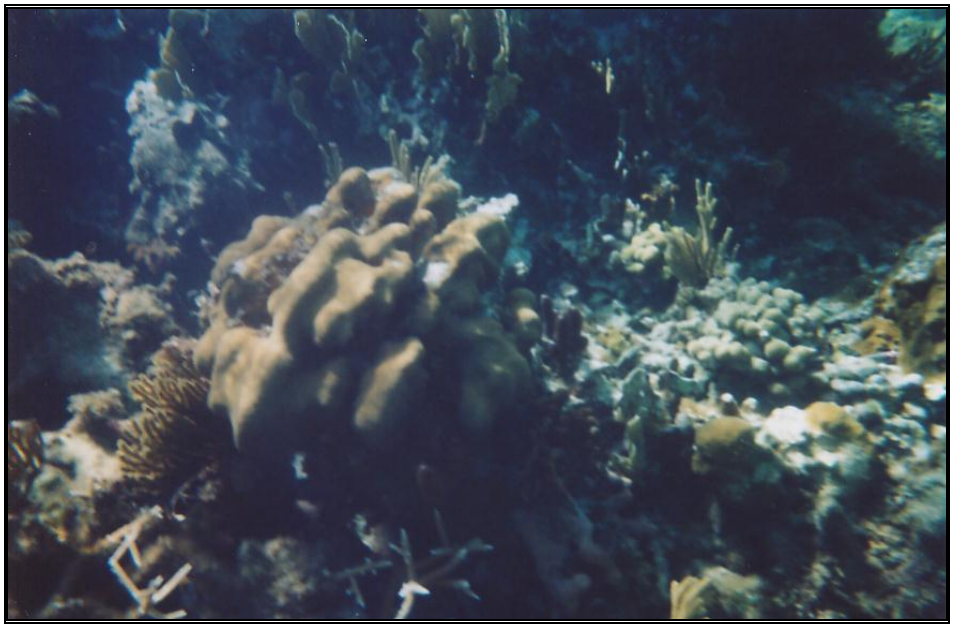

Plate 10M. *Siderastrea siderea* colony amongst *Thalassia* blades.

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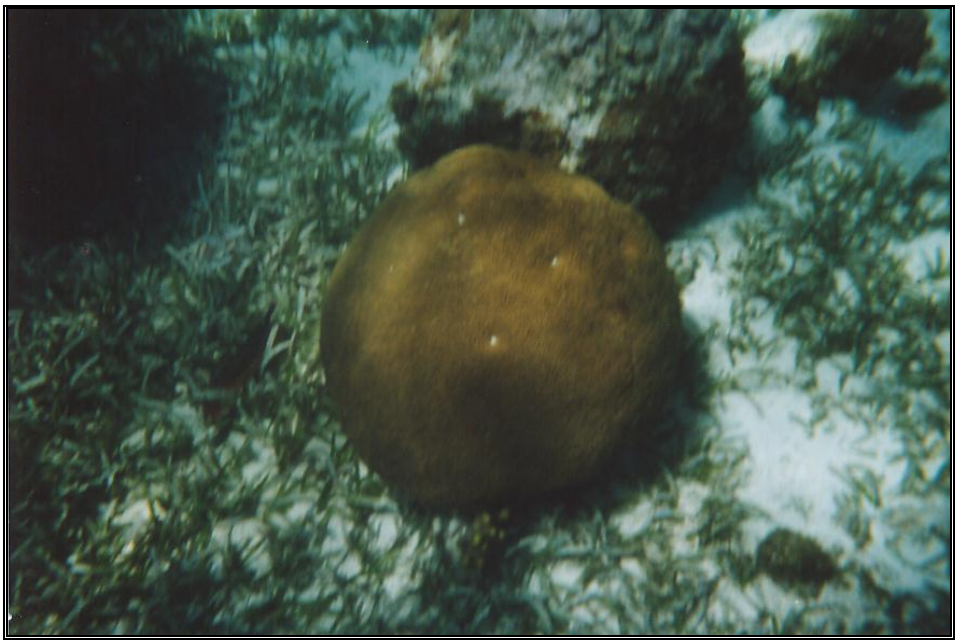

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Plate 11M. Dense turtle grass meadow in the back reef and lagoon areas.

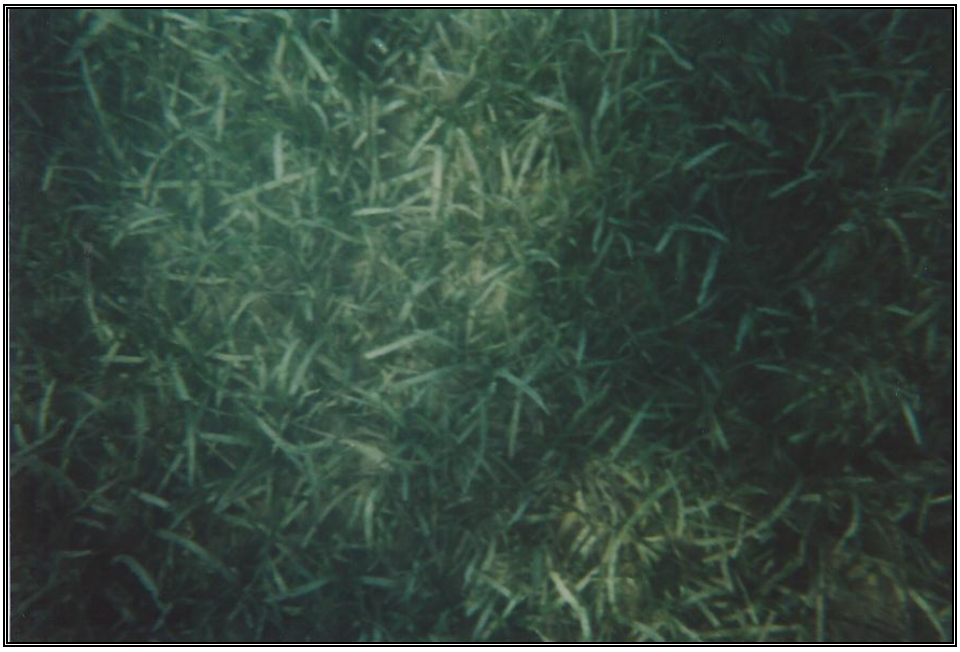

Plate 12M. Seagrass (*Thalassia sp*.) to the right and Giant anemones at upper left.

Note epiphytic cover on seagrass blades (grey in colour).

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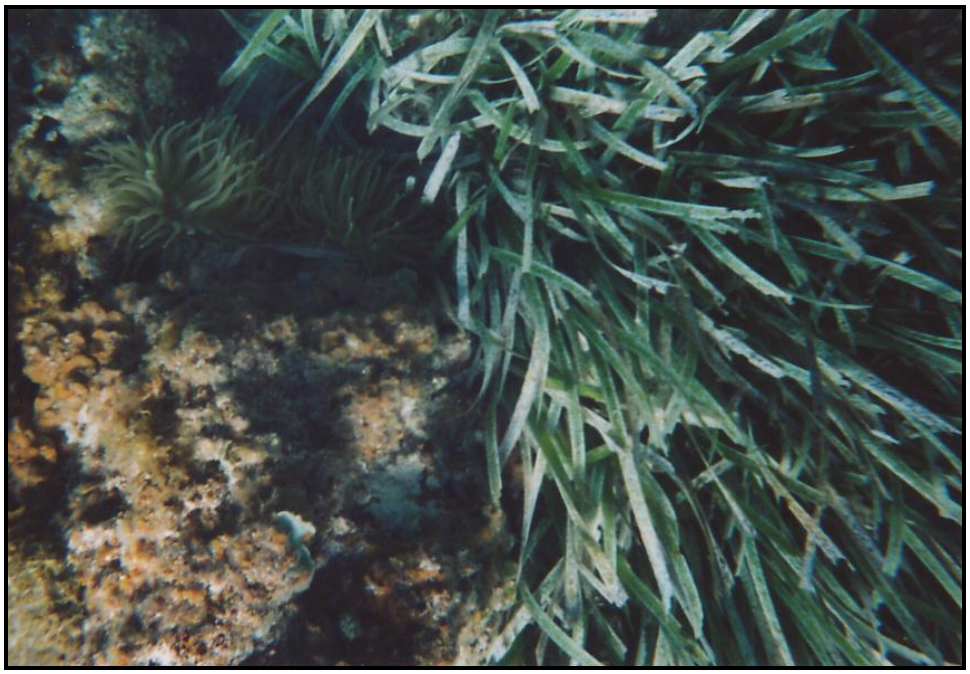

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Plate 13M. Algal bed in the back reef area.

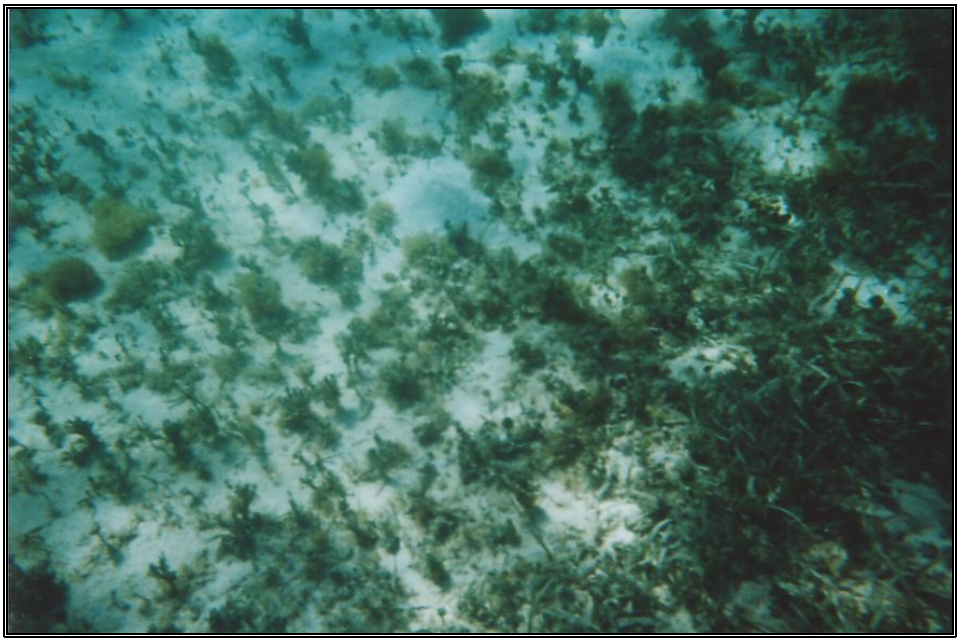

Plate 14M. Elkhorn coral colony on the fore reef.
Note algal overgrowth and paucity of benthic invertebrates in the background.

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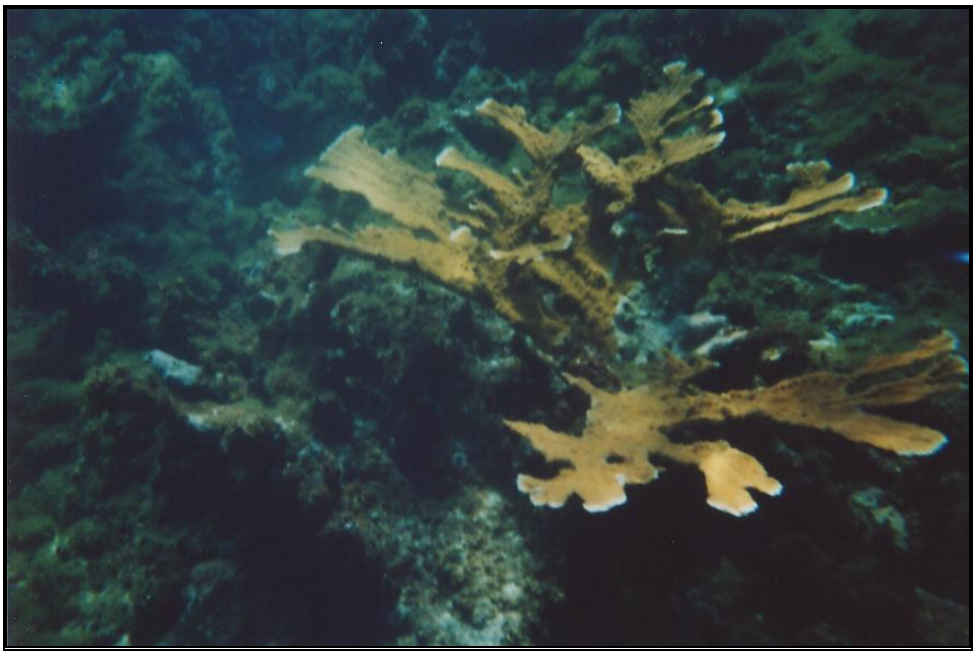

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PLATES: PHOTOGRAPHS OF TERESTRIAL ASPECTS

Plate 1T. Disturbed dry limestone forest. Note open canopy and small diameter of trees.

Plate 2T. Wooden structure in forest near western side of property.

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Plate 3T. Small sewage plant for Rose Hall Beach Club.

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Plate 4T. Cleared area off the main road.

The sewage plant is concealed in the vegetation at the left side of the picture.

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Plate 5T. One of the solid waste heaps dumped on the property.

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Plate 6T. View of the rocky substrate with little topsoil and saplings in the disturbed dry limestone forest on the property.

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Plate 7T. View of the sandy substrate in the forested area between the beach and the old main road.

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Plate 8T. Interior of the forest viewed from the beach.
Note the large quantity of dry leaf litter on the substrate.

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18/06/2004

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Plate 9T. Larger diameter trees north of the old main road.

Plate 10T. Road and vegetation at the southern side of the property.

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Plate 11T. Coastal vegetation along the beach. Note the old main road in the background.

Plate 12T. Coastal vegetation, mainly composed of *Coccoloba uvifera*. Note coastal pioneer plants in the foreground.

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18/06/2004

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Plate 13T. View of the eastern end of the property.
Wagon wheel fishing beach is visible at the far left.

Plate 14T. Shallow water close to the shore.
Note the short blades of seagrass and the turbidity of the disturbed areas.

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Plate 15T. View of the eastern shore of the property. Note the narrowness of the beach and the carpet of dead seagrass (*Thalassia sp*.) on the shore.

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Plate 16T. Shore adjacent to Rose Hall Beach Club.
Note extensive seagrass beds starting close to the shore.

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Plate 17T. Dead seagrass (*Syringodium sp*.) on the western side of the shore. Note also the fine-grained white sand and numerous pebbles and shells.

Plate 18T. One of the many crab holes observed on the shore.

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18/06/2004

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Plate 19T. View of the shore adjacent to the Rose Hall Beach Club. Note the large size of the beach, although most of it is vegetated by pioneer plants.

Plate 20T. Large beach space adjacent to the Rose Hall Beach Club.

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18/06/2004

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APPENDIX IV:SEWAGE PLANT

➢ROSE HALL UTILITY COMPANY

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PRELIMINARY ENGINEERING REPORT

ROLLINS JAMAICA, LTD
WASTEWATER COLLECTION, TREATMENT & IRRIGATION DISTRIBUTION SYSTEMS
ROSE HALL, JAMAICA

INTRODUCTION

Rollins Jamaica, LTD is looking to construct and operate a wastewater collection, treatment & irrigation distribution system in Rose Hall, Jamaica (Figure 1). The following report gives a basic outline description of the three major components to the total system. Each of the three sections will contain estimated construction costs, operation and maintenance costs. A final section will provide an analysis of the costs versus the potential revenue from the collection and treatment of the wastewater and distribution of beneficial reuse water for irrigation.

The Rose Hall Plantation is located on the north coast of Jamaica between Montego Bay and Falmouth. Rose Hall includes an eight-mile stretch of beachfront on the Caribbean Sea along the Coastal Highway and rises into the adjacent hills. Currently, several hotels and resorts are located on the shore including the Ritz Carlton, Holiday Inn, Half Moon Hotel, Wyndham Hotel, and Sea Castle. The Wyndham Golf Course, Ritz Carlton Golf Courses and the Half Moon Golf course are located within Rose Hall. The community of Lillipun lies in the eastern end of the eight-mile stretch. The beachfront has a number of developable sites for future hotels, resorts, and commercial property.

Many of the existing hotel and resort properties have individual package wastewater treatment systems. These systems are in need of repair and/or expansion.

Rollins Jamaica, LTD has developed a water supply and distribution utility from various wells located in the hills above the coast. The water from the wells is stored in storage tanks and reservoirs also built by Rollins Jamaica, LTD.

As an additional utility to the water utility, Rollins Jamaica, LTD plans on building a wastewater collection, treatment, and irrigation distribution system. The treated effluent from the wastewater treatment facility would be pumped into an irrigation distribution system for beneficial reuse and sale to customers as irrigation water. It is estimated that the daily average flow from the existing hotels, resorts, and commercial establishments would be 350,000 gallons per day with a potential future flow of 1,000,000 gallons per day. The Rollins Jamaica, LTD would build, operate, and maintain a wastewater collection forcemain. The forcemain would extend along the eight-mile stretch of Coastal Highway. The wastewater customers would pump wastewater from a pump station that would be owned and operated by the customer into the forcemain to the

proposed wastewater treatment facility. The wastewater treatment facility would be located near the middle of the development, along the Coastal Highway, across from existing wastewater treatment lagoons.

The wastewater treatment facility would be an extended aeration system. The benefits of an extended aeration system include: ease of operation and maintenance, more capable in handling spikes in flow and contents without upsetting the biological treatment process than other types of treatment systems, and less solids generated that require disposal.

The effluent from the treatment facility would be collected in a basin where it would be pumped into a pressure distribution system for beneficial reuse as irrigation water. Rollins Jamaica, LTD would sell the effluent to the various hotels, resorts, and commercial properties along the Coastal Highway. The excess irrigation water not consumed would be stored in a reservoir located on the adjacent hillside. The stored water would be repumped into the system during peak usage.

COLLECTION SYSTEM

Wastewater flows will be pumped into a pressurized force main. These flows will be monitored through the use of Mag Meter devices at each customer's discharge point. The wastewater collection system has been designed such that it is capable of handling flow simultaneously from all discharge points. The pump rate peaking factor will be based upon the size of each customer's wet well and its capacity to equalize flow. For the calculations, a peaking factor of 1.5 has been assumed. Discharge points will be from pumping stations, which will be later specified by Rollins Jamaica, LTD, and shall be purchased and maintained by each wastewater customer. These stations shall be submersible or suction lift package stations capable of operating within a hydraulic head range of 4.5 to 43 feet. The stations shall be duplex stations outfitted with level sensing alarms and incorporate an odor control system. The majority of each station shall be below ground with the exception of any necessary above ground appurtances. It is recommended that these stations be supplied with an appropriate source of backup power in the event of a power loss. A typical layout of these stations can be viewed in Figure A.1 in Appendix A.

The collection system will consist of approximately 42,240 liner feet of 4-inch, 6-inch, and 8-inch PVC pipe. Construction costs assume that all road crossings will be bored with casing installed. All roads/driveways that are open cut shall be backfilled entirely with stone and returned to their previous state. Stream crossing are assumed to incorporate Best Management Practices (BMP) in order to minimize the effects of storm water runoff into streams. All installation shall be performed in accordance with local utility construction standards.

The table below outlines the estimated costs for construction of the collection system. All costs include materials and labor necessary for installation as well as all miscellaneous appurtances. A more detailed cost summary can be viewed in the Table A.2 in Appendix A.

TABLE 1

ITEM	COST
4-inch PVC	$130,459
6-inch PVC	$540,446
8-inch PVC	$305,250
TOTAL COST	$976,155

All costs in US Dollars

IRRIGATION SYSTEM

Due to the high quality of treatment at the wastewater treatment facility, the treated effluent from the plant will be made available to surrounding facilities to provide irrigation. This will provide a beneficial system for the reuse of the water as well as an additional source of revenue for Rollins Jamaica, LTD.

The primary design of the irrigation system is to utilize the effluent discharge from the plant for irrigation. A 90 horsepower booster station located at the wastewater treatment facility will pump the effluent into the system. Effluent from the wastewater treatment facility, not immediately consumed for irrigation will be discharged and stored in two reservoirs, Stable Lake and Nursery Lake. During times of peak irrigation demand any necessary additional irrigation water will be supplied from a booster station located near Stable Lake or supplied by gravity from Nursery Lake.

Stable Lake is a man-made reservoir located approximately 3,000 feet south of the Coastal Highway. The lake is situated at an approximate elevation of 165 feet MSL and has a storage capacity of 25 million gallons. Water will be pumped to the top of an earthen dam and drawn off the bottom through a 10 horsepower booster station.

Nursery Lake is a man-made reservoir located approximately 5,500 feet south of the Coastal Highway. The lake is situated at an approximate elevation of 455 feet MSL and has a storage capacity of 33 million gallons. Water will be pumped into the lake and then supplied to the system through gravity feed.

The booster stations located at the Stable Lake and the wastewater treatment facility, as well as the hydraulic head produced at Nursery Lake, will be capable of maintaining an average minimum static pressure in the system of 45 psi. Construction of the waterline will consist of approximately 53,240 linear feet of 6-inch and 12-inch diameter PVC pipe as well as all necessary appurtances. Rollins Jamaica, LTD will provide the necessary taps to the irrigation main and set the necessary meters. It will be the responsibility of the irrigation customer to connect to the meter.

Construction costs assume that all road crossings will be bored with casing installed. All roads/driveways that are open cut shall be backfilled entirely with stone and returned to there previous state. Stream crossings are assumed to be done with Best Management Practices (BMP) in use to minimize the effects of storm water runoff into streams. All installation shall be performed in accordance with local utility construction standards.

The table below outlines the estimated costs for construction of the collection system. All costs include materials and labor necessary for installation as well as all miscellaneous appurtances. A more detailed cost summary can be viewed in the Table A.2 in Appendix A.

TABLE 2

ITEM	COST
6-inch PVC	$677,180
12-inch PVC	$780,487
90hp Duplex Booster Station w/ backup generator	$214,000
10hp Duplex Booster Station w/ backup generator	$53,500
TOTAL COST	$1,725,167

All costs in US Dollars

WASTEWATER TREATMENT SYSTEM

The Plant is 1.0 million gallon per day (mgd) Extended Aeration Wastewater Treatment Plant. The proposed location of the Plant is south of the current wastewater lagoons located on the Coastal Highway (Figure 2). A Site Plan of the Plant is shown on Figure 2.

The Basis of Design for the Plant is based on the following criteria:

Influent Characteristics

Average Design Plant Flow	-	1.0 mgd
Peak Flow	-	2.5 mgd
Influent BOD_5	-	280 mg/l
Influent TSS	-	250 mg/l
Influent NH_3-N	-	20 mg/l
Influent Phosphorus	-	8 mg/l
Wastewater Temperature	-	20°C
Altitude	-	100 feet
Alpha Coefficient	-	0.85
Beta Coefficient	-	1.0

Number of Reactors	-	2
Reactor Dissolved Oxygen	-	2.0 mg/l

Effluent Requirements

BOD_5	-	30 mg/l
TSS	-	30 mg/l
NH_3-N	-	1 mg/l
Phosphorus	-	1 mg/l

Jamaica National Sewage Effluent Standards

BOD_5	-	20mg/l
TSS	-	30 mg/l
Nitrates (as Nitrogen)	-	30 mg/l
Phosphates	-	10 mg/l
COD	-	100 mg/l
PH	-	6-9
Fecal Coliform	-	1000 MPN/100 ml
Residual Chlorine	-	1.5 mg/l

The eight major components of the Plant are described below:

1) Micro Strainer Screen – Untreated waste enters the Plant at the Micro Strainer Screen (Screen) where plastic, rags, paper, and other nuisance items are separated from the waste stream by the Screen (see Figure 2, #1). The Screen contains a screw conveyer that removes the nuisance solids from the wastewater to a separate discharge point for removal and disposal. The Screen has 1/4 –inch openings with a head loss of 6 inches at peak flow. The Screen is equipped with an emergency bypass.

2) Anaerobic Reactor – The wastewater enters the Anaerobic Reactor (Reactor) where phosphorus is removed. The phosphorus removed from the wastewater is incorporated into the sludge mass (see Figure 2, #2). Submersible mixers within the Reactor keep the wastewater mixed while maximizing anaerobic conditions. The reactor is divided into 3 chambers allowing for greater flexibility in series or parallel operation. The waste stream leaves the Reactor through slide gates and flows into the Oxidation Ditches. The Reactor has a hydraulic detention time of 1.5 hours at 1.0 mgd. The total volume of the Reactor is 62,000 gallons.

3) Oxidation Ditches – The waste stream enters the two-Oxidation Ditches (Ditches) where oxygen is added to the wastewater (see Figure 2, #3). Each Ditch contains two large rotors, which oxygenate the wastewater in each ditch, resulting in denitrification. Denitrification removes nitrogen from the wastewater. The Oxygen Ditches can be operated in parallel or series depending on the flow conditions.

A loading rate of 14.0 lbs of BOD_5/1,000 cubic feet at average design conditions was utilized to provide a hydraulic detention time of approximately 21.3 hours in each of the two Ditches. The average loading of 200 mg/l BOD_5 and 20 mg/l NH_3-N was selected for the design. To meet oxygen conditions requirements for a standard oxygen requirement of 103.2 lbs of oxygen per hour was selected for each reactor. This is based upon a BOD_5 removal of 1.5 lbs of O_2/lb BOD_5 and oxygen requirement for nitrification of 4.6 lb O_2/lbNH_3-N. The actual oxygen requirement was then converted to standard conditions. The total daily oxygen requirement is 4,955 lbs/day. Volume of each Ditch is 444,298 gallons.

4) Clarifiers – The waste stream enters the clarifiers where the solids are segregated and removed from clarified effluent (see Figure 2, #4). The decanted effluent leaves the Clarifiers and enters Pump Station #1. The decanted effluent is then pumped to the wet well adjacent to Pump Station #1. The pump station pumps the decanted effluent into the irrigation system for beneficial reuse. The volume of each Clarifier is 166,500 gallons.

5) Return Activated Sludge Pumps - The Return Activated Sludge (RAS) is pumped by the RAS pumps back into the Oxygen Ditches to ensure a viable biomass is maintained in each ditch (see Figure 2, #5). The Waster Activated Sludge (WAS) is sent to the Aerobic Digester.

6) Aerobic Digester – The WAS is pumped to Aerobic Digester (Digester) that provides sludge stabilization by aerobically treating the remaining degradable organic components of the wastewater (see Figure 2, #6). The Digester will also provide additional sludge thickening and allow for decanted water to be returned to the headworks of the Plant. After digestion, the sludge will go to the Sludge Drying Beds. The Digester has a volume of 64,575 gallons.

7) Sludge Drying Beds – The Sludge Drying Beds (Beds) allow the sludge from the Digester to be dried (see Figure 2, #7). The Beds contain an under drain, which captures water from the sludge and returns it to the headworks of the Plant. A concrete-retaining wall surrounds the Beds. Upon drying, the sludge will be land applied on Rose Hall Jamaica, LTD's land for agricultural beneficial reuse. After drying, the sludge is expected to meet US EPA's Class B for land application. The proposed sludge drying beds are 20 feet by 100 feet in area. There will be eight drying beds based on the volume of sludge generated each day from the Digester.

8) Ultraviolet Light Disinfection – The decanted effluent flows from the Clarifiers and goes through Ultraviolet (UV) lamps that disinfect the effluent prior to being pumped into the irrigation system. The UV lamps transfer electromagnetic energy from its arc lamps to an organism's genetic material (DNA and RNA). When UV light penetrates the cell wall of an organism, it destroys the cell's ability to reproduce. The design criteria for the UV systems are as follows: TSS –

REFERENCES

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REFERENCES

Downer, A. and R. Sutton. 1990. Birds of Jamaica. A photographic field guide. Cambridge University Press, Cambridge. 152 pp.

Hargreaves, D. and B. Hargreaves. 1965. Tropical trees found in the Caribbean, South America, Central America, Florida, Mexico. Ross-Hargreaves, Hawaii. 64 pp.

Humann, P., N. Deloach. 2002. Reef coral identification: Florida, Caribbean, Bahamas. New World Publications, Inc. Jacksonville, FL, USA. pp 272.

Humann, P., N. Deloach. 2002. Reef creature identification: Florida, Caribbean, Bahamas. New World Publications, Inc. Jacksonville, FL, USA. pp 448.

Humann, P., N. Deloach. 2002. Reef fish identification: Florida, Caribbean, Bahamas. New World Publications, Inc. Jacksonville, FL, USA. pp 512.

Raffaele, H., J. Wiley, O. Garrido, A. Keith, J. Raffaele. 1998. A guide to the birds of the West Indies. Princeton University Press, New Jersey. 511 pp.

Scullion Littler, D., M. Littler, K. Bucher, J.N. Norris. 1989. Marine plants of the Caribbean: A field guide from Florida to Brazil. Smithsonian Institution Press. Washington DC, USA. pp 263.

http://northflorida.fws.gov/SeaTurtles/Turtle%20factsheets/hawksbill-sea-turtle.htm

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