SUNSET BEACH RESORT HOTEL EXPANSION
MONTEGO BAY, JAMAICA

ENVIRONMENTAL IMPACT ASSESSMENT

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1. INTRODUCTION

1.1 PURPOSE AND BACKGROUND

Sunset Beach Resort & Spa Hotel Ltd. intend to expand their hotel at Freeport, Montego Bay, by adding a new 176-room block on 4.8 ha (12 acres) of land immediately north of the present hotel (Figure 1.1). This document sets out the findings and recommendations of an environmental impact assessment (EIA) of the project that has been prepared to meet the requirements of the funding agency as well as those of the National Environment and Planning Agency (NEPA). In the case of the latter, projects involving the construction of hotel/resort complexes of more than 12 rooms may be required to submit an EIA as part of the permitting and licencing process.

The proposed development site is located next to the existing Sunset Beach Hotel. This and the adjacent residential complexes are built on Seawind Island, which is part of land reclaimed in the 1960s (using sea-bottom material) during the dredging and the construction of Montego Harbour.

Final design details and drawings for the hotel's layout, drainage and sewering systems are expected to incorporate recommendations made by ESL in an initial site assessment report prepared in June 2003. The latter document presented an environmental characterization of the proposed site, identified key environmental matters relevant to the proposed development, and provided environmental guidelines for final project design. It outlined the key environmental considerations relevant to the construction phase of the proposed development and provided environmental guidelines for planners, architects, engineers and contractors involved with the physical development of the site.

Detailed layout, drainage and sewering plans for the proposed expansion works are still being adjusted and finalised by the project engineers and were unavailable for detailed review during the preparation of this EIA report. However, this should not compromise the relevance of the EIA report.

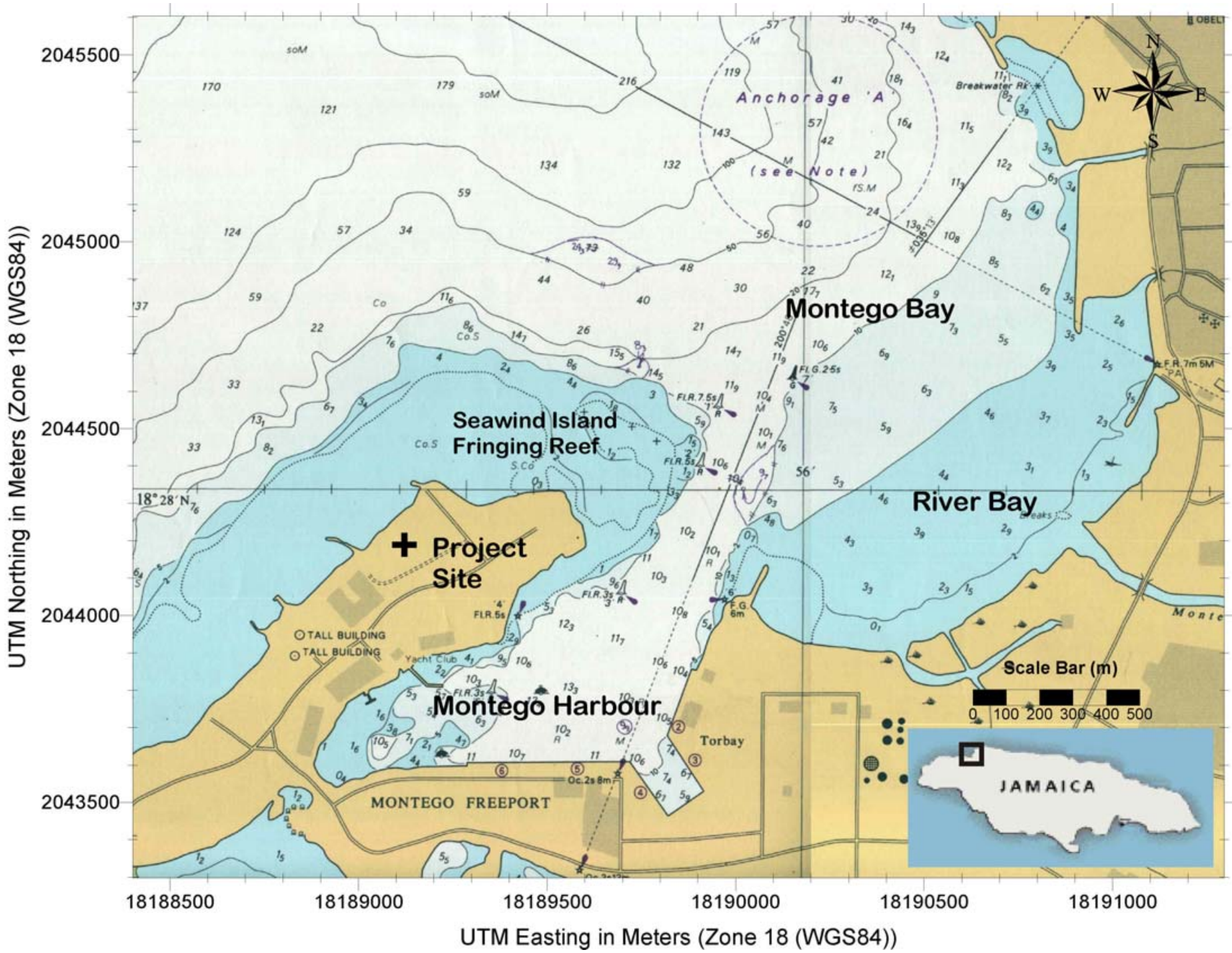

Figure 1.1 Sunset Beach Hotel expansion EIA – Study area and site location map.

1.2 TERMS OF REFERENCE

The following TORs for the Sunset Beach Hotel expansion project were adapted from World Bank and NEPA guidelines.

1. *Introduction – Identify the development project to be assessed and explain the executing arrangements for the environmental assessment.*

2. *Background Information – Briefly describe the major components of the proposed project, the implementing agents, along with a brief history of the project and its current status.*

3. *Study Area – Specify the boundaries of the study area for the assessment as well as any adjacent or remote areas within the area of influence of the project.*

4. *Scope of Work – The following tasks will be undertaken:*

   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 reclamation, pre-construction and construction activities, operation and maintenance activities, project life span, 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 the current development plans for Montego Bay.

   Task 2. Description of the Environment – Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area, including the following:

   a) *Physical environment: coastal features, geology, topography, soils, climate, hydrology, drainage and storm water runoff, and marine water quality. Existing sources of pollution, and the extent of contamination relevant to the project area, will be identified.*
   b) *Biological environment: flora, fauna, rare or endangered species, sensitive habitats, species of commercial importance, and species with potential to become vectors or nuisances.*
   c) *Socio-cultural 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.

Task 3. Legislative and Regulatory Considerations – Describe the pertinent regulations and standards governing siting and land use control, environmental quality, health and safety, protection of sensitive areas, protection of endangered species, and tourism.

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. Special attention should be paid to:

- *Vegetation clearance and habitat destruction related to construction activities.*
- *Existing flora, fauna and coastal resources, tree protection, replanting and landscaping.*
- *Modification of existing drainage patterns and surface runoff during construction and post-construction phases.*
- *Water supply and demand.*
- *Waste water treatment, use and management.*
- *Solid waste management during construction and post-construction phases.*
- *Construction impacts including materials sourcing, transport and storage, building construction methods, site management, noise, fugitive dust, traffic obstruction, and employment.*
- *Resort operations and maintenance; use of energy saving and resource conservation technology, vehicular traffic generation, and employment.*
- *Socioeconomic conditions, effects on existing users of the coastal areas, infringement on rights of stakeholders, community involvement and public perceptions of the project.*
- *Potential impacts of the development on adjacent property owners.*
- *Impacts on the Montego Bay Marine Park.*

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.

<u>Task 5. Mitigation and Management of Negative Impacts</u> – Recommend feasible and cost effective measures to prevent or reduce the significant negative impacts to acceptable levels and present an environmental management plan for the construction phase.

<u>Task 6. Development of a Monitoring Plan</u> – Prepare a plan for monitoring the implementation of mitigating measures and the impacts of the project during construction.

<u>Task 7. Assist in Inter-Agency Coordination and Public/NGO Participation</u> – Assist in co-ordinating the environmental assessment with the government agencies and in obtaining the views of local NGO's and affected groups. Manage and coordinate the public hearing on the EIA findings as required by the NEPA permit approval process.

5. <u>Report</u> – 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 and citations for any references used in interpreting those data. 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*
- *Impact Mitigation and Environmental Management Plan*
- *Environmental Monitoring Plan*
- *Inter-Agency and Public/NGO Involvement*
- *List of References*

1.3 STUDY TEAM

Environmental Solutions Ltd. carried out this EIA, in association with Smith Warner International Ltd. The multidisciplinary team included local expertise in environmental impact assessment, marine and coastal ecology, coastal engineering, environmental chemistry, socio-economics and tourism planning. The team members were:

Environmental Solutions Limited

- Mr. Peter Reeson, M.Sc. - EIA Specialist
- Mr. David Narinesingh, M.Sc. – Ecologist
- Mrs. Eleanor Jones, M.Sc. – Social Ecologist and Planner
- Mrs. Sharonmae Shirley – Environmental Chemist

Smith Warner International Limited

- Mr. Philip Warner, M.Sc., P. Eng. – Coastal Engineer

1.4 METHODOLOGY

1.4.1 Terrestrial Survey

A simple 'walk through' survey of the terrestrial flora and fauna was conducted on 13 May 2003. Tree species were identified, the presence of rare and endemic plants was determined, and an indication of biodiversity at the site was obtained.

1.4.2 Marine Survey

Information on the marine environments of a) Montego Bay Harbour, b) River Bay, c) Montego Bay, and d) offshore of the proposed hotel expansion site were obtained from detailed seagrass bed and coral reef surveys recently conducted by ESL for the Montego Bay Freeport dredging project (ESL, 2002a). Seagrass meadows and the coral reefs were assessed by a combination of boat patrolling and exploratory grab sampling. The Seawind Island fringing reef (Figure 1.1), part of which is found immediately offshore of the proposed Sunset Beach Hotel expansion site, was assessed by SCUBA diving on 8 May 2002. The information and descriptions obtained from these surveys are summarized and presented in Section 3.5.3 of this EIA report.

1.4.3 Water Quality Survey

Six marine stations were also occupied on the morning of 8 May 2002 during the above study to measure background levels of water quality parameters (ESL, 2002a). The parameters measured were: salinity, pH, temperature, total suspended solids (TSS), turbidity (Secchi disc), dissolved oxygen (DO), biological oxygen demand (BOD_5), nitrates, phosphates, total and faecal coliform bacteria. The locations of these stations are shown on Figure 1.2.

Samples were collected at a depth of 0.5 m using a small boat. All samples were collected in pre-cleaned 2 litre polyethylene sample bottles and placed on ice. Bacterial samples are collected at the water surface in sterilized 100 ml glass bottles.

Salinity, temperature, and dissolved oxygen were measured *in situ* at all sampling stations using a YSI Model 57 Salinity/Conductivity/Temperature (SCT) meter and a YSI Model 33 Oxygen meter, respectively. Measurements were taken at the surface (0.5 m depth) of the water column.

Environmental Solutions Limited Laboratory performed or supervised the analysis of all parameters. Laboratory analyses used certified methodology, primarily from the text *'Standard Methods for Examining Water and Wastewater'*. The results of the water quality survey are summarized and presented in Section 3.6 below.

Supplemental information on water turbidity, offshore of the proposed Sunset Beach Hotel expansion site, was obtained for a station which was surveyed three times per day between 6 – 10 August, 2002 during the environmental monitoring of PAJ's dredging operations (ESL, 2002b). The location of this station - T7 - is also shown on Figure 1.2.

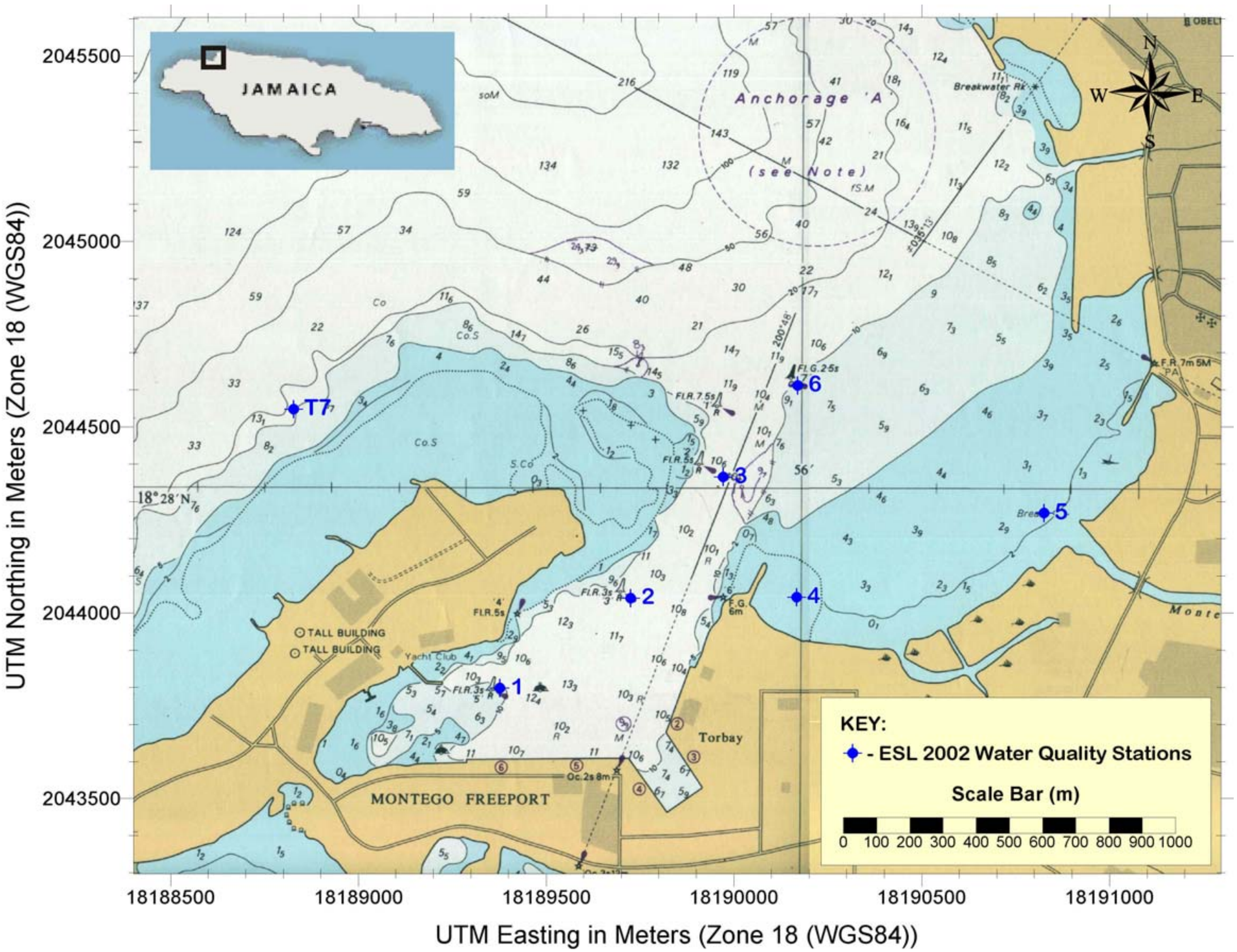

Figure 1.2 PAJ Montego Freeport Dredging project - Locations of water quality sampling stations.

2. ENVIRONMENTAL POLICY, LEGISLATION AND REGULATORY FRAMEWORK

The environmental laws and regulations of Jamaica that are relevant to the proposed Sunset Beach Hotel expansion project are listed and commented upon below.

2.1 LEGISLATION AND REGULATIONS

Natural Resources Conservation Authority Act (1991)

This is the main environmental legislation that relates to the proposed project. This Act establishes the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development through the protection and management of the country's natural resources and the control of pollution. This is done mainly through an environmental permit and licence system.

The Act gives the Authority power to:

- issue permits to the person responsible for undertaking any enterprise, construction or development of a prescribed category in a prescribed area [Section 9]. This section, the Prescribed Area Order, designates all of Jamaica as being within the prescribed area;
- issue licences for discharge of trade or sewage effluent or for construction or modification of any works for such discharge [Section 12 (1) (a) and (b)];
- request information or documents as the Authority thinks fit [Section 10 (1) (a)];
- request an environmental impact assessment containing such information as may be prescribed [Section 10 (1) (b)];
- request information on pollution control facilities [Section 17];
- revoke or suspend permits.

The Act also incorporates the earlier Beach Control Act, Wildlife Protection Act and Watersheds Act.

◊ Beach Control Law (1955) and Beach Control Act (1978) (subsequently re-authorized under the NRCA Act and currently under review)

The regulations of 1978 relate to hotels, commercial and public recreational beaches, regulated beach activities, care of beaches and rights of license. The Beach Control Act extends only to the foreshore; while it provides for the designation of protected areas, it does not address the basis for such designation, nor does it deal with the management of coastal resources landward or seaward of the foreshore. The Beach Control Law requires that an application be made for the modification of any beach/coastline and sets out requirements for the posting of public notices.

◊ Wild Life Protection Act (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. It authorizes the establishment of Game Sanctuaries and Reserves. Protected under the Wildlife Protection Act are six species of sea turtles.

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.

Natural Resources Conservation (Permits and Licenses) Regulations (1996)

These regulations give effect to the provisions of the Prescribed Areas Order. Hotel/resort complexes of more than 12 rooms, as well as sewage treatment facilities, are included on the prescribed list.

Natural Resources Conservation (Sewage Effluent) Regulations (Draft)

These regulations, when brought into effect, will cover the discharge of sewage effluent, the operations, monitoring and reporting mechanism of sewage treatment facilities.

Natural Resources Conservation (Montego Bay Marine Park) (Declaration) Order (1992)

The Montego Bay Marine Park was established in 1992. The Order describes the area and includes a map with boundaries. This order bans dredging, excavating, discharge of pollutants, littering, use of explosives and poisons and fishing except under permit, and also allows research and collection for educational and research purposes under permit.

Fishing Industry (Fish Sanctuaries) Order (1979)

The Fishing Industry Act of 1975 is related to the regulation of the fishing industry and serves to conserve and manage the fisheries resources by addressing such issues as licensing. Under the 1979 Order fish sanctuaries may be declared by the Minister in which no fishing is allowed. The Bogue Islands Lagoon has been declared as a Fish Sanctuary and this is now incorporated within the boundaries of the Montego Bay Marine Park.

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 effluent discharges to rivers and streams.

Town and Country Planning Act (1958)

Established the Town and Country Planning Authority with responsibility for Development Orders to control both rural and urban land development, ensure proper sanitary conveniences, co-ordinate building of roads and other public services. Planning approvals for the project will have to be obtained from the Town Planning Authority at NEPA.

Quarries Control Act (1983)

This Act repeals the Quarries Act of 1958 and makes provisions for quarry zones and licenses, quarry tax, enforcement and safety. The proposed project should ensure that any earth materials used for the proposed expansion of the Sunset Beach Hotel are obtained only from licenced quarries.

2.2 POLICIES AND REGULATIONS

National Policy for the Conservation of Seagrasses (1996)

This policy guides the issuing of licenses, or permits for activities such as dredging, disposal of dredged material, beach development and effluent disposal, which directly or indirectly affect seagrass communities. Seagrass meadows occur in the bay beyond the Montego Freeport harbour and along the shoreline offshore of the Sunset Beach Hotel site. Note is taken of the proposal to remove seagrasses from in front of the beach at the development site.

Policy for Jamaica's System of Protected Areas (1997)

The System of Protected Areas is an expression Jamaica's commitment to protect the environment and its resources through the protection of parks and protected areas. The policy lists six goals, which include, economic development, environmental conservation, sustainable use of resources, recreation and public education, public participation and financial sustainability. The proposed project is located within the boundaries of the Montego Bay Marine Park.

Mangrove and Coastal Wetlands Protection - Draft Policy and Regulations (April 1996)

A review of the issues affecting wetlands in Jamaica as well as Government's role and responsibility. Five main goals are outlined which include guidelines for wetlands development, cessation of destructive activities, maintenance of natural diversity, maintenance of wetland function and values and integration of wetland functions in planning and development. There are no mangrove or coastal wetlands onsite or within the immediate vicinity of the Sunset Beach Hotel site. Extensive mangrove ecosystems are, however, associated with the Bogue Lagoon, approximately 2 km southeast of the project site.

Coral Reef Protection and Preservation Policy and Regulation (Draft - 1996)

This document reviews the ecological and socio-economic functions of coral reefs, issues affecting coral reefs and Government's role and responsibility. Five main goals are outlined which include reduction of pollutants, reduction of over-harvesting of reef fish, reduction of physical damage from recreational activities, improving the response capability to oil spills, and control of coastal zone developments. The proposed hotel expansion project must endeavour to ensure that its onsite and shoreline reclamation activities do not threaten or harm the coral reefs around Montego Bay and Seawind Island.

3. DESCRIPTION OF PROJECT AREA

3.1 PHYSIOGRAPHY

The proposed development site is located next to the existing Sunset Beach Hotel. This and the neighbouring residential complexes are built on Seawind Island, part of the land reclaimed in the 1960s using sea-bottom material dredged during the construction of Montego Harbour. During this process, several of the original mangrove-covered Bogue Islands were linked and connected to the mainland. The whole area is now referred to as Montego Freeport. Land filling and the destruction of mangrove forests caused considerable ecological perturbation to the marine environment at Bogue and radically changed the pattern of water flow around the islands. Further ecological damage was done during dredging of the channel to Montego Harbour in the early 1990s when coral reefs at the NE end of Seawind Island were removed. Maintenance dredging of the harbour was carried out later in 2002, apparently without any significant impact to the environment.

The proposed site for expansion of Sunset Beach Hotel is flat with mean elevations of approximately 1.5 m (not exceeding 2 m) above sea level (Plates 1 & 2). The site is fronted by a white sand beach (Plates 3 & 4) with a length of approximately 244 m (800 ft). Groynes at either end anchor the sand and the beach is currently reserved for nudists. Shallow waters, less than 3 m (10 ft) deep, extend seaward for about 20 m and the sea floor is covered with dense meadows of turtle grass *(Thalassia testudinu*m) with bare sand patches found close to the shoreline. A fringing reef runs parallel to the shore.

Generally, the site is fairly well protected from the prevailing NE Trades but is very exposed to storm events and annual "cold fronts" coming from the N or NW during the winter season. The hotel operators report a continuing problem of sand erosion from the beach.

3.2 GEOLOGY AND LITHOLOGY

The coastal area of Montego Bay (inclusive of Montego Bay City) is situated on a coastal limestone platform which forms part of the Pleistocene raised reefal limestone formations generally found exposed along large sections of the north coast of Jamaica. Thin layers of marine calcareous sand and silty sand deposits, less than 35 cm (14 in.) in depth, tend to overlie this coastal limestone platform.

As noted before, the site itself is made up of dredged marine sediments, which are carbonate-rich. The soil is sandy/coralline in texture with little clay/loam content. It is therefore very pervious and has a low erosion potential.

3.3 METEOROLOGY

Montego Bay has a subtropical to tropical climate with temperatures ranging between 20°C to 27°C, in the winter, and 30°C to 32°C, in the summer. Mean annual rainfall is in the order of 1371.6 mm with two distinct rainy seasons between May - June and September – November. Mean monthly rainfall varies from 45 mm in March to 184.4 mm in October. Relative humidity values range between 66% and 87%.

Winds impacting Montego Bay are predominantly from the E and ENE throughout the greater part of the year. Some seasonal changes occur within this pattern as a result of the relative position of the sun and the earth's surface. In general, these seasonal changes in the annual wind regime may be described as follows:

- December to February: winds are primarily from the NE to ENE.
- March to May: winds are mainly from the East.
- June to August: winds are primarily from the E to ESE.
- September to November: winds are mainly from the E to SE.

Mean wind speed at Donald Sangster International Airport is typically 9 m/s (17 knots) and maximum sustained winds speeds are generally between 5 m/s (10 knots) and 12 m/s (25 knots) (ESL, 2002a).

3.4 HYDROLOGY

There is no standing water and no defined surface water drainage features on the site. Most of the rainfall that falls on the site percolates through the pervious soils.

3.5 ECOLOGY

3.5.1 Terrestrial Vegetation

The undeveloped sections of Montego Freeport/Seawind Island are covered by opportunistic plants in the form of various types of trees and shrubs that are tolerant of the marine air environment and poor soils.

The vegetation community at the site is best described as ruinate grassland. Approximately 85% - 90% of the site was covered by grasses or bare ground (see Plates 1 & 2). The remaining 10% - 15% of the site was covered by Willow (*Casuarina equisetifolia*) and Almond (*Terminalia cattapa*) trees. The canopy was open and the grassy undergrowth was dominated by *Sporobolus indicus*.

3.5.2 Terrestrial Fauna

Given the very disturbed and open nature of the existing vegetation and terrestrial habitat on the site, there is very little fauna of any ecological significance to be seen. No birds were noted during the brief site visit.

3.5.3 Marine Ecology

Turtle grass (*T. testudinum*) meadows are found along the northwestern and western (windward) sides of Seawind Island, i.e. along the shoreline of the proposed Sunset Beach Hotel expansion site (Sullivan and Chiappone, 1994) and Donovan Rose & Associates, 1991). The presence of these seagrass beds was confirmed during the present site visit although it was noted that the area of turtle grass does not appreciably extend in a SW direction beyond this area.

A shallow protective fringing reef is located along the northern, northwestern and western shorelines of Seawind Island, along the shoreline of the Sunset Beach Hotel (refer to Figure 1.1). This fringing reef is the closest coral reef to the project site and the reef ecosystem most at risk to poor water quality caused by poorly mitigated activities associated with the proposed hotel expansion works, particularly activities which could generate turbidity in the water column.

Substrate composition on the reef is summarised at Table 3.5.1, and the algal species, observed during the earlier SCUBA survey, are listed in Table 3.5.2. Coral, fish and invertebrate species, observed on the Seawind Island fringing reef are listed respectively in Tables 3.5.3, 3.5.4, & 3.5.5.

Massive Starlet Coral (*Siderastrea siderea*), Lettuce Coral (*Agaricia agaricites*), Yellow Pencil Coral (*Madracis mirabilis*) and Symmetrical Brain Coral (*Diplora strigosa*) were the dominant stony coral species in the fore reef environment; while colonies of Blade Fire Coral (*Millepora complanata*) and Corky Sea Finger (*Briareum asbestinum*) were the frequent and dominant soft coral species on the reef. Turf and macrophytic algae accounted for 60% of substrate cover. Elkhorn coral (*Acropora palmata*) were conspicuously absent, although one or two individuals of Staghorn coral (*Acropora cervicornis*) were observed during the dive. Overall, the fringing reef is presently dominated by algal growth, under stress and is in poor to moderate condition. It is, however, showing some signs of recovery and every effort should therefore be made to promote its recovery and mitigate against worsening its condition by means of further eutrophication, siltation and generally declined water quality (ESL, 2002a).

Table 3.5.1 Summary of substrate composition on the Seawind Island fringing reef.

COVER/SUBSTRATE TYPE*	% COMPOSITION
Seagrass	0
Algae	60
Coral (living)	15
Macro fauna	3
Sponges	2

COVER/SUBSTRATE TYPE CODE*:

SEAGRASS	-	‘r’ species or climax communities
ALGAE	-	turf or macrophytic
CORAL	-	branching, boulder or encrusting
MACRO FAUNA	-	other cnidarians,e.g.gorgonians,anemones or zoanthids
SPONGE	-	fleshy, boring or encrusting
BASE SUBSTRATE	-	bare rock, rubble, sand or mud

Table 3.5.2 Marine algal species observed on the Seawind Island fringing reef.

CLASSIFICATION/SPECIES		
Green Algae (Chlorophyta)	Brown Algae (Phaeophyta)	Red Algae(Rhodophyta)
Ventricaria ventricosa *Penicillus dumetosus* *Halimeda tuna*	*Dictyota divaricata*	*Amphiroa rigida* *Amphiroa tribulus*

Table 3.5.3 List of the stony and soft coral species observed on the Seawind Island fringing reef.

FAMILY	SCIENTIFIC NAME	COMMON NAME	HABITAT & BEHAVIOR	DAFOR
Stony Coral			**Size:** Colony usually 1 ft. - 8 ft.	

Acroporidae	*Acropora cervicornis*	Staghorn Coral	**Depth:** 1 - 160 ft. Most common between 10 - 60 ft. Prefer shallow to intermediate depths in clear, calm water. Most common on reefs, but colonies may grow separately on open clean sand areas. Rapidly growing coral, under optimum conditions can grow five to six inches per year.	R
Agariciidae	*Agaricia agaricites*	Lettuce Coral	**Size:** Colony usually 4 in. - 3 ft. **Depth:** Usually 3 - 240 ft Inhabit most marine environments from mangroves and back ref areas to outer reefs and walls.	A,F
Faviidae	*Diplora strigosa*	Symmetrical Brain Coral	**Size:** Colony usually 6 in. - 6ft. **Depth:** 3 - 130ft. Most common between 2 - 40 ft. Inhabit many marine environments.	O,F
Pocilloporidae	*Madracis mirabilis*	Yellow Pencil Coral	**Size:** Colony usually 5 in. - 4 ft. **Depth:** Usually 3 - 190 ft Generally inhabit deeper, clear water, outer reefs. Occasionally in shallower water with some sedimentation and water movement.	F
Poritidae	*Porites astreoides*	Mustard Hill Coral	**Size:** Colony usually 6 in. - 2 ft. **Depth:** Usually 3 - 160 ft. Most common between 15 - 80 ft. Inhabit all reef environments.	O
Siderastreidae	*Siderastrea radians*	Lesser Starlet Coral	**Size:** Colony usually 4 in. - 12 in. **Depth:** Usually 0 - 90 ft (rarely below 30 ft) Inhabit flat rocky/sandy substrates, most common from low tide line to 20 ft. Can tolerate surge sandy & silty conditions.	O
Siderastreidae	*Siderastrea sidereal*	Massive Starlet Coral	**Size:** Colony usually 1 ft. - 6 ft. **Depth:** Usually 2 - 220 ft Tend to inhabit shallow to moderate reefs between 25-45 ft. Prefer clear water. Usually deeper than similar Lesser Starlet Coral.	F
<u>Fire Corals – Hydrocorals</u>				
Milleporina	*Millepora complanata*	Blade Fire Coral	**Size:** Colony usually 1 in. - 18 in. **Depth:** Usually 0 - 45 ft Inhabit shallow water reef tops. Usually in areas with some water movement; most common in areas with constant surge.	O
<u>Gorgonians – Octocorals</u>				
Briareidae	*Briareum asbestinum*	Corky Sea Finger	**Size:** Colony height [illegible] - 24 in. **Depth:** Usually 3 - 100 ft Inhabit most reef environments, especially shallow fringing, patch and back reef areas. Abundant to common in	O

			the Caribbean.	
Gorgoniidae	*Gorgonia flabellum*	Venus Sea Fan	**Size:** Colony height 2 - 3 ▯ ft. **Depth:** Usually 3 - 100 ft Prefer clear water with some movement. Commonly inhabit the seaward side of shallow reef slopes and patch reefs. Only occasionally on reefs and along the lips of drop-offs deeper than 35 ft. In the Caribbean often inhabit shallow back reef areas.	R

Table 3.5.4 List of the fish species observed on the Seawind Island fringing reef.

FAMILY	SCIENTIFIC NAME	COMMON NAME	HABITAT & BEHAVIOR	ABUND-ANCE
Acanthuridae	Acanthurus bahianus	Ocean Surgeonfish	**Size:** 6 - 12 in ., max. 15 in. **Depth:** Usually 15 - 80 ft Inhabit reefs. May swim in loose aggregations that can include Blue Tangs and look-alike Doctorfish.	F
Chaetodontidae	*Chaetodon capistratus*	Foureye Butterflyfish	**Size:** 3 - 4 in ., max. 6 in. **Depth:** Usually 10 - 60 ft Flit about reef tops; often in pairs. Common to occasional in the Caribbean.	F
Holocentridae	*Holocentrus rufus*	Longspine Squirrelfish	**Size:**5 - 10 in ., max. 12□ in. **Depth:** Usually 4 - 100 ft During the day, drift inconspicuously in shaded areas near bottom.	F
Labridae	*Thalassoma bifasciatum*	Bluehead Wrasse	**Size:** 4 - 5 in ., max. 6 in. **Depth:** Usually 6 - 80 ft Usually inhabits most reefs environments. May act as cleaners, removing parasites and debris from larger fish. Often swims in schools.	F
Pomacentridae	*Abudefduf saxatilis*	Sergeant Major	**Size:** 4 - 6 in ., max. 7 in. **Depth:** 1 - 40 ft Swim in all habitats, most often in midwater. Usually in loose aggregations.	F
Pomacentridae	*Chromis cyanea*	Blue Chromis	**Size:** 3 - 4 in ., max. 5 in. **Depth:** 35 - 80 ft Swim in midwater above reefs, feeding on plankton	F
Pomacentridae	*Stegastes fuscus*	Dusky Damsel	**Size:** 3 - 5 in ., max. 6 in. **Depth:** 5 - 40 ft Inhabit rocky areas. Territorial; pugnaciously chasing away intruders	F
Serranidae	*Hypoplectrus indigo*	Indigo Hamlet	**Size:** 3 - 4□ in., max. 5□ in. **Depth:** Usually 30 - 130 ft Swim about reefs, near bottom. Rare to occasional in the Caribbean.	F
Serranidae	*Hypoplectrus puella*	Barred Hamlet	**Size:** 3□ - 4□ in., max. 6 in. **Depth:** Usually 10 - 50 ft Swim about reefs, near bottom. Common in the Caribbean.	F

ABUNDANCE CODE:

S	-	Single	-	One (1) sighting
F	-	Few	-	Two (2) to ten (10) sightings
M	-	Many	-	Eleven (11) to one hundred (100) sightings
A	-	Abundant	-	Over one hundred (100) sightings

Table 3.5.5 List of the invertebrate species on the Seawind Island fringing reef.

SCIENTIFIC NAME	COMMON NAME	HABITAT & BEHAVIOR	ABUND-ANCE
<u>Anemones</u>			
Condylactis gigantean	Giant Anemone	**Size:** 6 -12 in. across tentacles & body **Depth:** 15 - 100 ft Inhabit reef and lagoonal areas	S
<u>Crustaceans</u>			
Panulirus argus	Spiny Lobster	**Size:** 6 - 10 in. Max. 2 ft. **Depth:** 15 - 60 ft Inhabit reefs.	S
<u>Feather Duster Worms</u>			
Bispira brunnea	Social Feather Duster	**Size:** Crown □ - 1□ in. **Depth:** 15 - 60 ft Inhabit reefs. Prefer areas with some water movement.	F
<u>Porifera- Demospongiae</u>			
Cinachyra sp.	Orange Ball Sponge	**Size:** 4□ - 6□ in. **Depth:** Usually 15 - 100 ft Inhabit protected areas of coral reef. Common in the Caribbean.	F
<u>Zoanthids</u>			
Zoanthus pulchellus	Mat Zoanthid	**Size:** Disc □ - □ in. **Depth:** 20 - 60 ft Inhabit reef tops.	F

ABUNDANCE CODE:

S	-	Single	-	One (1) sighting
F	-	Few	-	Two (2) to ten (10) sightings
M	-	Many	-	Eleven (11) to one hundred (100) sightings
A	-	Abundant	-	Over one hundred (100) sightings

<u>3.5.4 Protected Areas – The Montego Bay Marine Park and Bogue Lagoon Fish Sanctuary</u>

The new and expanded MBMP (formerly the Cornwall Beach Marine Park of the early 1970s) was established in 1989 under the Protected Areas Resource Conservation (PARC) Project, and was officially opened on 23 July 1992. It covers an approximate area of 15.3 km^2, which extends from the shoreline mean high tide mark to the 100 m depth contour, and encompasses 9 km of coastline extending from the Donald Sangster International Airport to just east of Great River. Montego Bay, Montego Bay Harbour and Seawind Island all lie within the boundaries of the MBMP (see Figure 3.1).

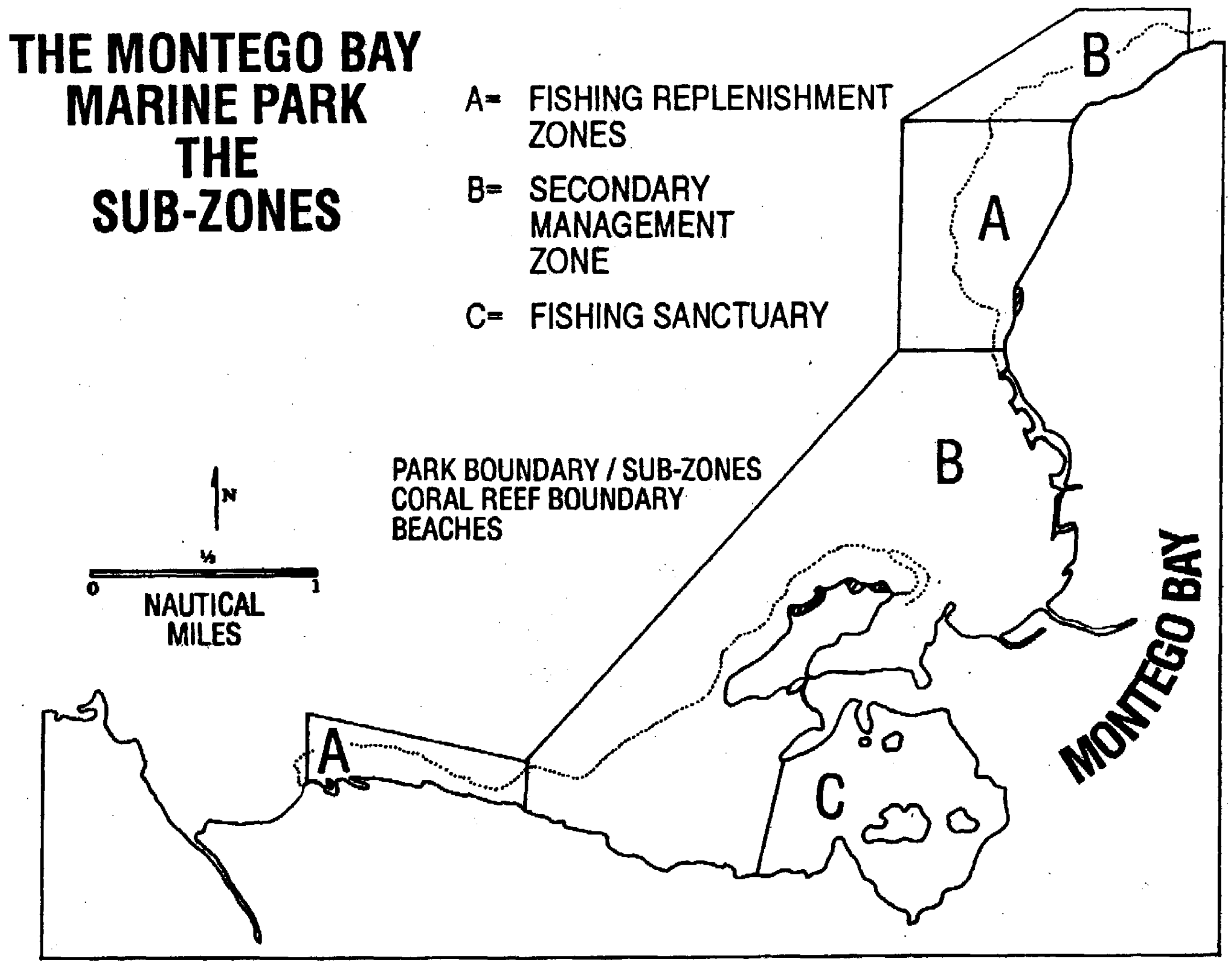

Figure 3.1 Map showing MBMP boundaries and sub-zones.

The Bogue Lagoon, situated adjacent to and south of Montego Freeport, is also a declared protection area. It is currently zoned as a fish sanctuary (under the MBMP legislation), because of its extensive mangrove ecosystem, which functions as a fish nursery and feeding ground.

3.6 MARINE WATER QUALITY

The results of the ESL (2002a) water quality sampling exercise are presented in Table 3.6.1. The water quality at all the stations sampled, with the exception of Station 5, appeared to be quite good and typical of Jamaican coastal waters.

Table 3.6.1 Marine surface water quality measurements taken at Montego Bay on 8 May 2002.

Parameters	Stations						NEPA Standard
	1	2	3	4	5	6	
PH	8.0	8.1	8.1	8.1	8.0	8.1	7.0-8.4
Temperature (^{o}C)	28.3	28.0	28.0	28.2	28.8	28.1	<32
Transparency* (m)	2.70	1.85	4.84	3.10	1.29 (Bottom)	8.51	N/A
Salinity (ppt)	35.3	35.4	35.3	35.1	30.9	35.3	N/A
DO (mg/l)	6.31	6.24	6.36	6.48	6.63	6.46	4.5-6.8
BOD (mg/l)	1	1	0	1	4	0	0,57-1.16
TSS (mg/l)	1.83	1.81	1.16	1.97	2.14	1.02	10
Nitrate (mg/l)	0.105	0.062	0.031	0.143	0.464	0.186	0.001-0.081
Phosphate (mg/l)	0.03	0.01	0.01	0.01	0.16	0.00	0.001-0.055
Total coliform (MPN/100ml)	3	<3	<3	<3	1100	<3	48-256
Faecal coliform (MPN/100ml)	<3	<3	<3	<3	240	<3	<2-13

* Secchi disk diameter = 33cm

The water was well oxygenated with acceptable BOD levels. Nitrate levels slightly exceeded NEPA standards at Stations 1 & 6 but phosphates were within standard. The levels of total and faecal coliform bacteria were also acceptable (ESL, 2002a). Water samples were not collected outside Montego Harbour, Montego Bay or River Bay during the ESL (2002a) water quality survey. Water quality offshore of Seawind Island and the proposed Sunset Beach Hotel expansion site, however, is likely to be similar to Station 6 of the ESL (2002a); if not better.

The lowered salinity value at Station 5 suggests that this area is affected by freshwater outflow from the Montego River. Bacterial, BOD, phosphate and nitrate levels were also elevated, suggesting that (a) this station is being negatively impacted by contaminated river waters, and (b) outflows from the Montego

River could be having a very deleterious effect on water quality in the bay during periods of heavy rainfall (ESL, 2002a).

During environmental monitoring of the 2002 dredging works, turbidity values at Station T7 (i.e. offshore of the proposed hotel expansion site) ranged between 0.46 NTU and 3.36 NTU. A post-dredge survey conducted one week after the cessation of dredging indicated that water turbidity at T7 was typically 0.40 NTU (ESL, 2002b).

In summary, the findings of recent (ESL 2002a, ESL 2002b) water quality surveys suggest that the marine water quality offshore of the proposed Sunset Beach Hotel expansion site is good in regards to total suspended solids (TSS), turbidity, dissolved oxygen (DO), biological oxygen demand (BOD_5), nitrates, phosphates, total and faecal coliform bacteria.

3.7 NATURAL HAZARD VULNERABILITY

Montego Bay is prone to hurricane force winds, storm surges, earthquakes and flooding from storm events of varying intensity. A hindcast analysis of storm waves was carried out, using the program HURWave, in order to explore design criteria and storm surge conditions at Montego Bay. Design criteria are presented in Appendix 1.

For hurricane and storm surge analyses a deep-water location was selected (>200m water depth) with coordinates 18°30' latitude and 77°57' longitude. For this point, the storm tracks that passed within a 400 km radius were extracted from the National Oceanic and Atmospheric Administration (NOAA) historical database of tropical cyclones. The full database of tropical cyclones extending back to 1900 was utilized for this investigation.

For the 103-year period investigated, 126 storms have come within 400 km of Montego Bay. Of this number, 52 were classified as hurricanes. The categories are divided according to the Saffir-Simpson Scale, given in Table 3.7.1 following. Almost half of these storms were Category 1 hurricanes and six were Category 4's. One storm, Allen in 1980, was a Category 5, the highest category.

Table 3.7.1 Categorization of Tropical storms and hurricanes passing within 400 km of Montego Bay. (Using the Saffir-Simpson Intensity Scale. 1 minute maximum sustained near surface wind speed)

Units	Storm Category					
	Tropical Storm	Hurricane Categories				
		1	2	3	4	5
Knots	<64	64-83	84-95	96-113	114-135	>135
Km/hr	<119	119-154	155-178	179-210	211-250	>250
m/s	<33	33-43	44-49	50-58	59-70	>70
Number within 400 km of Montego Bay	74	24	10	11	6	1

Figure 3.2 below shows the distribution of storm intensities over the past 103 years for tropical storms and hurricanes passing within 400 km of Montego Bay.

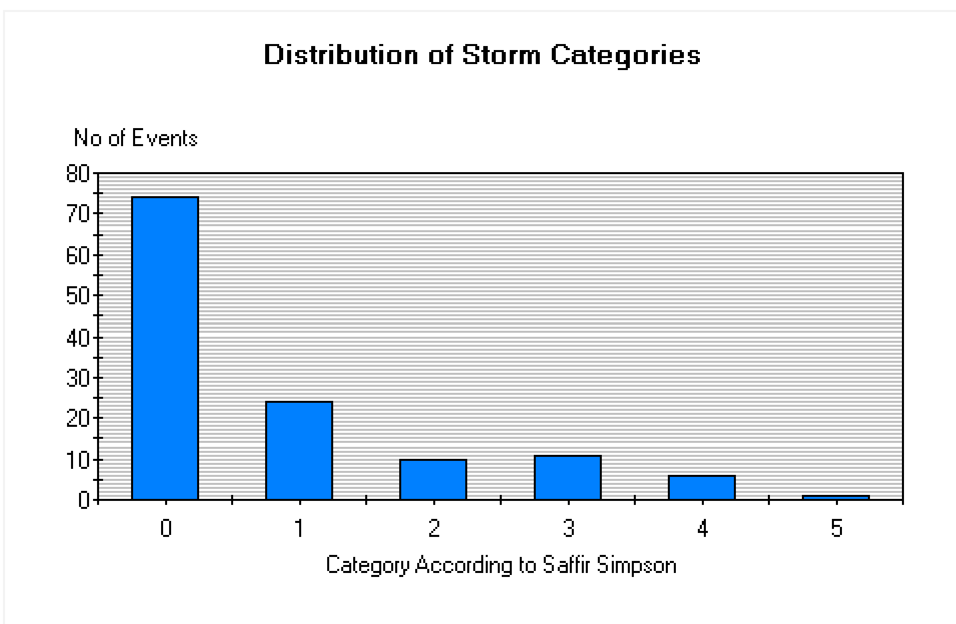

Figure 3.2 Distribution of Tropical Storms (Category 0) and Hurricanes (Category 1-5) passing within 400km of Montego Bay over the period 1900-2002.

Figure 3.3 following, shows the tracks of those storms classified as Category 3 or greater that passed within this 400 km radius between 1900 and 2002.

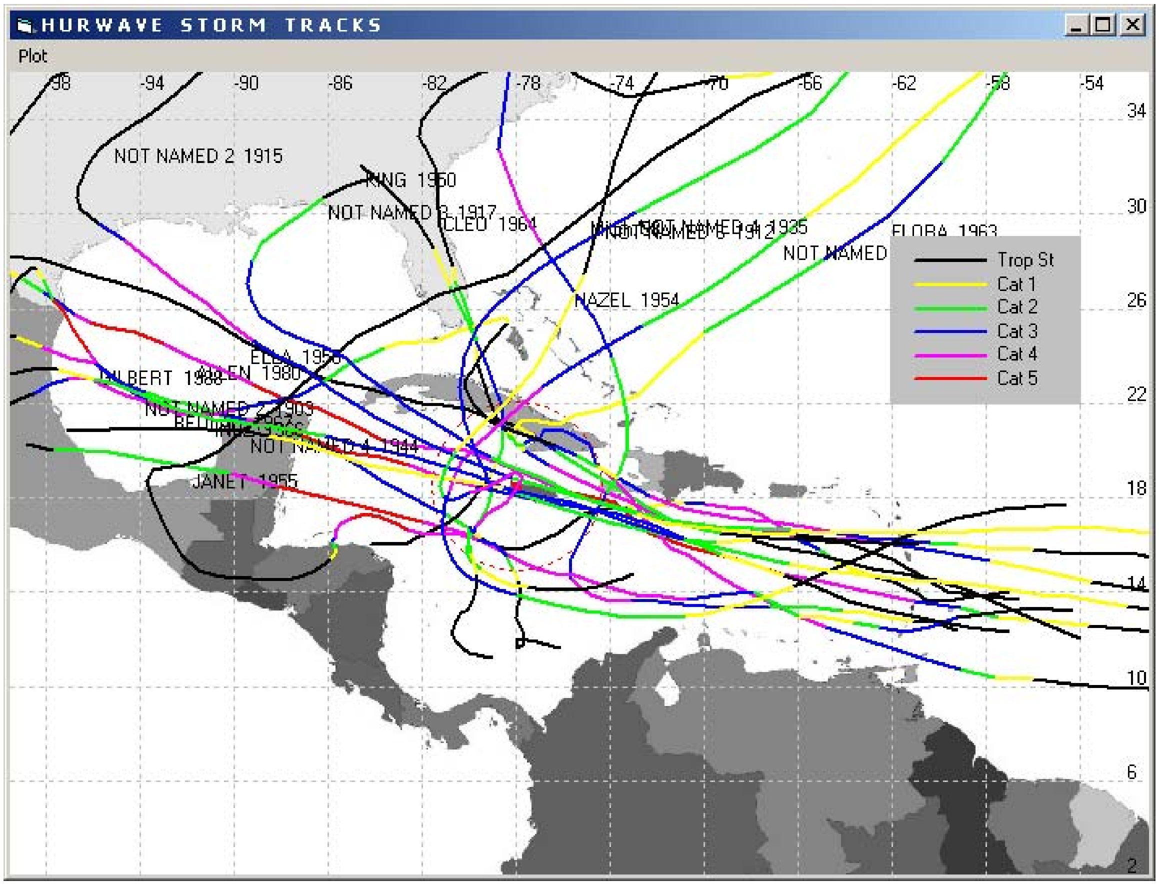

Figure 3.3 **Tracks of Intense Hurricanes (Categories 3-5) to have Passed within 400km of Montego Bay.**

These storm tracks show the typical west to northwesterly tracks of Atlantic storms, although many of the storms have slow looping tracks in the vicinity of Jamaica.

Storm surge consists of the anticipated sea level rise due to the passage of tropical storms and hurricanes, but must also consider the effects of normal tidal variations and any long-term sea level changes. Tides in Montego Bay were not measured as part of this assignment. However, as part of an on-going R&D project tide, current and wave measurements are being made at Montego Bay. The tide measurements made earlier in 2003 are shown in the following figure and indicate a maximum range of 0.50 metres, with an average range of 0.30 metres. The range above MSL would therefore be half of this, or 0.15 metres.

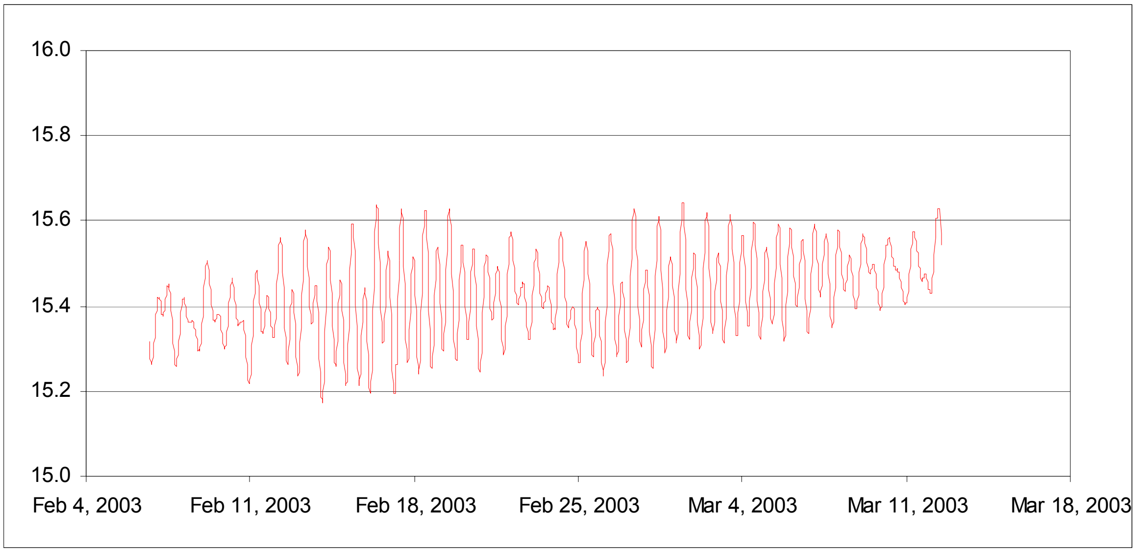

Figure 3.4 Tidal Measurements in Montego Bay.

Long-term sea level rise should also be considered in the assessment of storm surge risk. In the absence of local, site-specific data, a recommended value of 5mm per year has been proposed by UNEP. For infrastructure works such as a hotel development, a 50-year design horizon should be considered, resulting in an increase in the water level of 0.25 metres.

When defining storm surge, it is usual to select a datum from which to present the results. Existing topographic data for this site is referenced to Mean Sea Level (MSL) datum as is the bathymetric data. The storm surge elevations that have been computed are referenced to the mean sea level. There can be discrepancies between the MSL datum and the actual mean sea level due to a variety of factors, including the effects of global warming.

Storm surge resulting from the passage of a tropical storm consists of several components that are detailed in Table 3.7.2 following.

Table 3.7.2 Storm Surge components.

Component	*Definition*	*Time scale*
Inverse barometric rise	The low pressure in the "eye" of the hurricane compared with surrounding pressure elevates the water level within the hurricane.	1 – 4 hours
Wind set-up	As the wind pushes water onshore, the water surface becomes tilted to balance the wind stress.	1 – 4 hours
Wave set-up	As waves break nearshore, the forward motion of wave energy halts and is balanced by an increase in the mean sea level.	Duration of high seas
Wave Run-up (not part of the quasi-static storm surge)	As waves reach the shoreline the remaining wave energy runs up the shore.	10-15 seconds

Inverse barometric rise and the hurricane wave conditions for different wave periods have been computed by the program HURWave.

An analysis of the occurrence of inverse barometric rise was also conducted using HurWAVE. Following a similar procedure to wave heights, the storm surge component caused by the lower atmospheric pressure within the eye of a tropical storm was evaluated on a historical - statistical basis. The following plot (Figure 3.5) shows the statistical fit, and Table 3.7.3 shows the resulting IBR values for different return periods.

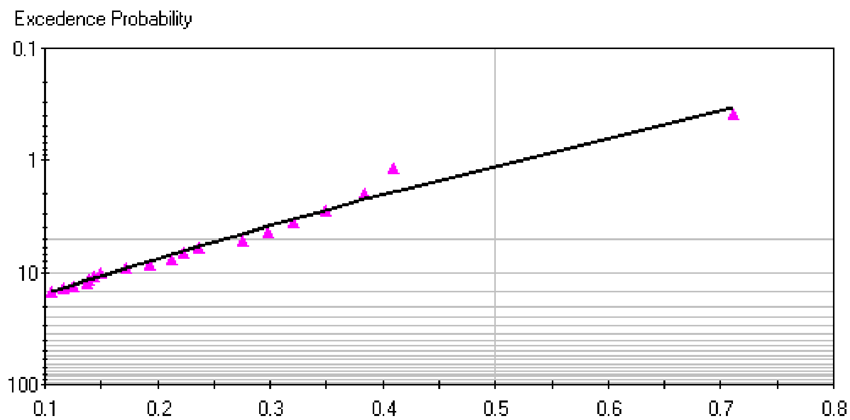

Figure 3.5 Statistical Fit of Maximum IBR for Tropical Storms passing with 400 km of Montego Bay, Jamaica.

Table 3.7.3 Inverse Barometric Rise

Return Period (years)	*IBR (m)*	*Standard Deviation (m)*	*IBR (95th %)*	*Encounter Probability (%) in 50 years*
2	0.00	0.04	0.04	100.0
5	0.09	0.07	0.15	100.0
10	0.19	0.11	0.24	99.5
20	0.29	0.14	0.34	92.3
25	0.32	0.16	0.37	87.0
50	0.43	0.20	0.49	63.6
100	0.55	0.24	0.60	39.5
Correlation = 0.989 for Weibull Distribution; K=0.75				

The above wave conditions were then combined with the existing seabed information to determine the variation of wave heights from deep water to the shoreline. The complex process of wave shoaling, refraction and breaking requires a computer model. In this case, the most appropriate computer model was found to be sBEACH. The following plot (Figure 3.6) is a typical output from sBEACH and shows the seabed profile and the reduction in wave height as well as the increase in mean water level.

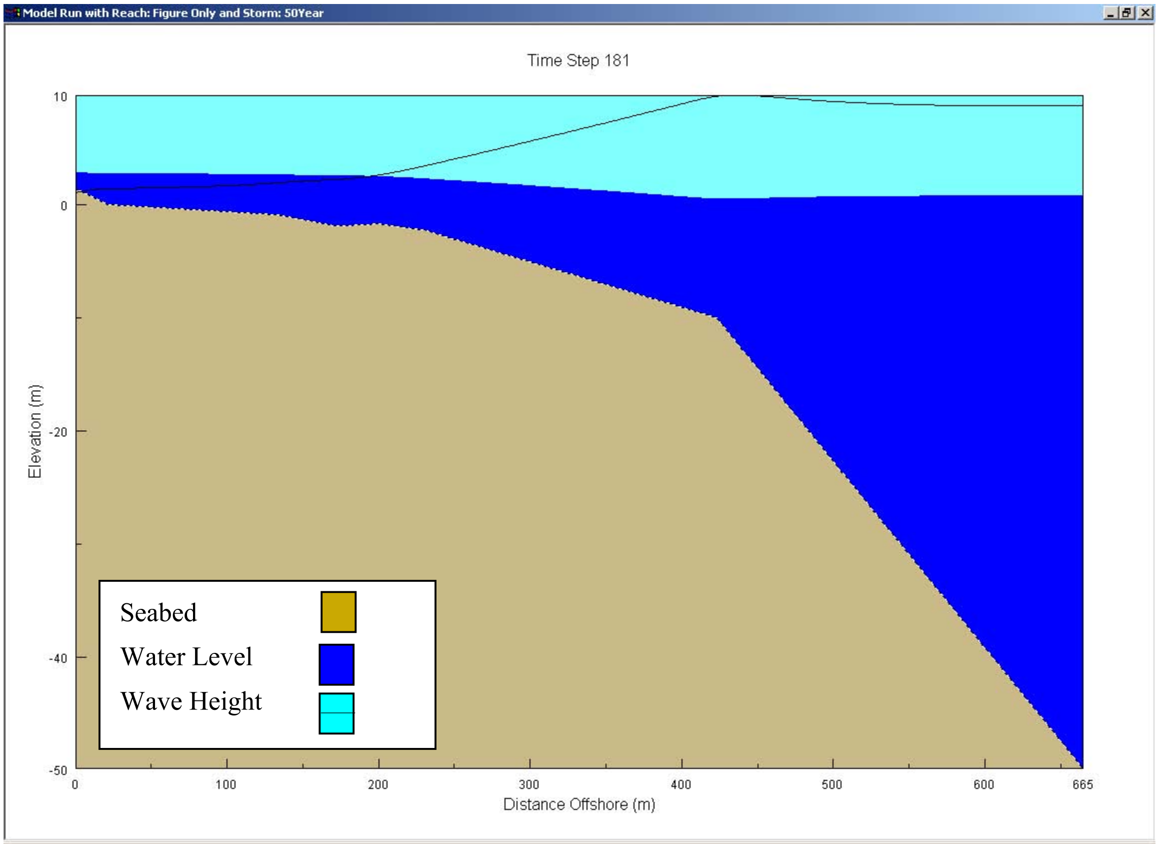

Figure 3.6 Typical output from sBEACH.

Table 3.7.4 below outlines the results from this wave transformation procedure and provides the design storm surge levels.

Table 3.7.4 Storm Surge Levels (relative to MSL), Excluding Wave Run-up.

Storm Surge Component	*Return Period (Years)*		
	25	50	100
High tide	0.15	0.15	0.15
Global Sea level rise	0.25	0.25	0.25
Inverse Barometric	0.32	0.43	0.55
Wind and wave set-up	1.67	2.00	2.33
Total	2.39	2.83	3.28

The values quoted in the above table do not consider wave run-up. This is normally dependant on the characteristics of the surface that is exposed to wave run-up. For example, a gentle sloping beach would have a different run-up height than a sloped revetment. In addition, it may not be practical to site infrastructure away from the highest run-up, but it may be feasible to design facilities to withstand the run-up forces. For this reason, the following Table 3.7.5 outlines the maximum wave run-up height and the wave forces that would be expected if no run-up were allowed.

Table 3.7.5 Wave run-up heights (m) and forces (kg/m).

Storm Surge Component	*Return Period (Years)*		
	25	50	100
Nearshore Wave (m)	0.76	1.05	1.30
Run-up height (m) above storm surge height			
Wave Forces (kg/m) with no run-up.			

3.8 SOCIO-ECONOMIC ENVIRONMENT

3.8.1 Demographics and Livelihoods

The Greater Montego Bay Area (GMBA) continues to be a rapidly growing urban center which has a current population conservatively estimated at 140,000. It is estimated that the 2% annual growth rate experienced during the 1981-1991 inter-censal period has continued, if not accelerated. The fast growing informal communities, which characterize the city, perhaps accommodate more persons than was reflected in the census. It is noteworthy that population increased by more than 100% during the inter-censal period in settlements such as *inter alia* Bogue, Montego River, Rose Mount, Tucker, and Fairfield. Some inner city communities and peripheral areas experienced decline, but significant population movement took place within the GMBA, especially into the informal communities.

The age structure of the GMBA indicates large 0-19 and 19-30 cohorts which means a relatively large and growing labour force, but also a high demand for social support systems – educational institutions, recreational facilities, day care centers and housing. The labour force is estimated to be 65,000, based on an estimated 47% labour force to population ratio (GMRC, 1997). The male/female ratio for the Montego Bay area is 0.92. This compares with 0.959 for the entire parish of St. James and 0.958 for Jamaica.

An interesting analysis of weekday population in the Central Business District (CBD) of Montego Bay revealed a total of 214,000 persons with commuter inflow accounting for approximately 28%, residents 65% and tourists 7%. It has been suggested that by the year 2014, the weekday population of Montego Bay will be approximately 10% the population of Jamaica, up from 4.5% in 1991 (GMRC, 1997). The Freeport Area accommodates approximately 500 residents and a commuting population of approximately 5,000. The implications for the proposed project relate to the need for minimum disruption to transportation and traffic flow between the Freeport and GMBA. Traffic is a major constraint to mobility within the GMBA, as the roads quickly become choked particularly during peak hours.

3.8.2 Transportation

As a regional center and major tourist destination, the city of Montego Bay has a number of transportation modes:

1. The public transit system is characterized by both a formal and informal system of ‘taxis’. These taxis range from registered minibuses and cars to unregistered cars. Buses and minibuses commute between outlying districts within the city as well as between parishes. The public transport system is inadequate and the problem is exacerbated by the need to meet the significant demand of work force commuters who travel within the GMBA as well as from the neighbouring parishes.
2. A primary and secondary road network facilitates movement of private and commercial vehicular traffic throughout the city and from surrounding settlements.

The Freeport is well connected by road to the city of Montego Bay. Howard Cooke Boulevard and Alice Eldemire Drive are the main roads connecting to the north and west respectively, and work to dualize both these arteries is now underway. Construction will further hamper free movement of traffic, but the completed project is not expected to add to the problem. A proposal for a bypass road is also under active consideration and it is anticipated that the current traffic gridlocks will be alleviated by the on-going and proposed road improvements. The road network within the Freeport is well developed, but some road surfaces need to be upgraded.

3.8.3 Land Use

The Sunset Beach Hotel site is part of an area zoned for resort/residential development.

The Montego Freeport Area is the single most significant economic enclave in the city of Montego Bay. It is unique in that it houses a commercial shipping port and a 95-acre free zone industrial estate, along with a cruise ship port. Significant residential/resort complexes, the Montego Bay Yacht Club, and fuel farms add to the diversity of land use.

The area was created to provide expanded port facilities for the city of Montego Bay, and to accommodate export industry, a hotel, townhouses and apartments, as well as commercial and service enterprise. *Sunset Beach Resort*, with 420 rooms, is the main tourism facility and the clusters of apartments/condominiums include *The Lagoons* (105 units), *Ocean Pines* (40-60 units), *Seawind on the Bay* (104 units), *Anchorage* (12 3-bedroom units) and *Bay Pointe* (53 units).

Tourism is the economic base of Montego Bay, which has been described as an urban resort. Urban services and employment augment the tourism base, and light manufacturing and export industry now occur in the Bogue/Reading and Montego Freeport Area respectively. At Montego Freeport there are currently five factories as well as hotel suppliers, commercial and service enterprises, offices, warehousing, a rice mill and petroleum storage facilities. Recent closures in garment manufacturing plants in the Freeport Area have added to the pool of unemployed and the economic fallout being experienced in the city, but commerce and wholesale activities along with port services have increased.

3.8.4 Shipping

Shipping and port facilities constitute the major land use within the Freeport Area. Montego Bay receives 250 – 350 ships calls per year, including two regularly scheduled cargo vessels per week and one hundred and fifty cruise vessels per year.

3.8.5 Recreation and Marina

The quality of coastal waters and beaches is significant to the resort based economy of Montego Bay. Diving and recreational boating are major activities. The Montego Yacht Club operates a small marina in the Freeport harbour and accommodates about 60 boats including four residential units, pleasure yachts and a catamaran. The bay facilitates small boat anchoring and serves as an important hurricane refuge (safe haven) for boats from along the north coast.

4. PROJECT DESCRIPTION

4.1 INTRODUCTION

Final design details and drawings for the hotel's layout, drainage and sewering systems are not yet completed but are expected to incorporate recommendations made in the initial site assessment report (ESL, 2003). The latter document presented an environmental characterization of the proposed site, identified key environmental matters relevant to the proposed development, and provided environmental guidelines for final project design. It outlined the key environmental considerations relevant to the construction phase of the proposed development and provided environmental guidelines for use by planners, architects, engineers and contractors involved with the physical development of the site.

This section therefore describes in outline the main infrastructural features of the development, and assumes that the final plans will eventually be submitted to the relevant government agencies, for review and approval, as they become available.

4.2 PROJECT BRIEF

Sunset Beach Resort & Spa Hotel Ltd. intend to expand its hotel at Freeport, Montego Bay, by adding a new 176-room complex on 4.8 ha (12 acres) of land immediately north of the present hotel. The proposed development site is located next to the existing Sunset Beach Hotel. A site layout plan is provided in the pocket inside the back cover. This development is part of a larger upgrading and refurbishment project being carried out at the property, which is not considered in this EIA. The project is estimated to be completed by February 2005. A detailed construction schedule is not available.

The most critical environmental issues and recommendations have been identified and conveyed to the project management team. These were related to site drainage, construction works management, landscaping, marine resources protection and employee housing. With the incorporation and implementation of the recommendations and mitigative measures detailed in the site assessment report, together with those detailed within this EIA report, the proposed project is not expected to have any long-term adverse negative impacts on the infrastructure and the ecological and social environments of Montego Freeport and Montego Bay.

Construction of the hotel will result in the loss of some, if not most, of the existing trees on the site. However, landscaping of the site (after building completion) can restore a wooded appearance to the site and can be expected to enhance its visual and ecological qualities through the introduction of local, non-invasive, low maintenance, coastal tree and vegetation species which attract birds. Building height will vary between 2 to 5 stories. The irrigation system for the grounds at the hotel is expected to use recycled water.

Sewage generated by the hotel will be discharged to the National Water Commission's (NWC's) sewage mains running along the road in front of the site and will be treated at the STP at Bogue. There will therefore be no on-site disposal of sewage and complete connectivity to the NWC sewage collection and treatment system will be ensured. Issues related to sewage discharges to coastal waters at the site therefore do not arise.

It is estimated that the incremental demand for water induced by the development will be approximately 300 m^3/day (80,000 gpd). Water will be supplied from existing NWC mains along Southern Cross Boulevard and the additional demand should be well within the capacity of the current NWC system. This will be confirmed in writing by NWC.

The proposed onsite drainage system for the expanded hotel will ensure that surface freshwater runoff does not cross over the beach or enter the marine environment offshore of the hotel site. The project engineers are investigating the option of maximising rainfall storage on land and reusing it for grounds irrigation. If and where sea discharge of runoff is necessary, it would be done away from coral reef areas to minimize any adverse effects on the marine biota.

The hotel is expected to continue with its present contracted waste collection arrangements and final disposal of solid waste will therefore be at the Retirement dump. It is expected that garbage management and good housekeeping will be practiced on the site.

Electricity for the hotel will be supplied by the Jamaica Public Service Company (JPSCo.) Ltd. from the existing electrical mains along Southern Cross Boulevard and the additional demand should be well within the capacity of the current system. This will be confirmed in writing by JPSCo. A standby generator is being considered for use during power cuts.

The present hotel operators report a continuing problem of sand erosion from the beach to the south of the expansion site, which is not entirely surprising given the fact that the beach is artificial and was created after the filling of the original mangrove island (see Section 3.1). Mitigative measures for controlling this erosion would be the subject of a separate study. There are currently no plans to attempt any enhancement of the bathing beach fronting the expansion site.

5. ENVIRONMENTAL IMPACTS AND MITIGATION

Potential positive and adverse environmental impacts, associated with the hotel expansion project, could arise during the construction and the operation phases. These impacts are discussed below under those two major categories of project activities. For ease of discussion and presentation, the corresponding impact mitigation measures are presented after the discussion of each impact. A summary of the impacts is given in Table 5.3.1.

5.1 SITING AND CONSTRUCTION PHASE IMPACTS

5.1.1 Loss of Vegetation and Wildlife Habitat

Construction of the hotel will essentially entail the removal and loss of some, if not most, of the existing trees and underlying grassland at the project site, and the permanent erection of block and steel concrete structures associated with the hotel's new infrastructure. This would constitute a loss of alternative land use, an irreversible commitment of land resources, and thus a direct long-term impact.

The site was not extensively or heavily vegetated prior to construction and did not support any significant ecological habitats or fauna. Therefore, the impacts from erecting the new buildings are considered to be not significant in terms of habitat loss. Impact mitigation is not required during the construction phase.

Landscaping of the site, after building completion (see Section 5.1.8), will see the introduction of plants and trees that should offset any negative impacts associated with the removal and loss of existing trees at the project site. The numbers and types of vegetation to be introduced during the landscaping exercise are expected to be greater and more diverse than presently obtains and these are expected to play a greater role in terms adding ecological value and attracting birds and other terrestrial fauna during the operational phase of the project, apart from being more pleasing aesthetically.

Mitigation:
N/A

5.1.2 Modification of Drainage Pattern

The overall flat topography of the project site will be dramatically changed by the erection of 2 to 5 storey buildings and this will significantly change the existing pattern of surface drainage. Mainly, the impact will arise from the creation of impermeable surfaces (roofs, pavements, etc.) and the corresponding reduction in the amount percolation in the soil and capacity of the site to absorb rainfall.

As a normal part of the EIA review process, plans of the proposed onsite drainage system must be submitted to NEPA for review and approval. These were unavailable for review at the time of preparation of the EIA report. They should demonstrate the adequacy of the proposed drainage system to effectively contain surface runoff, prevent local flooding, and facilitate discharge to the ground. The drainage design should also seek to avoid discharge of surface runoff directly across the face of the beach. For the time being it is assumed that there will be no adverse impacts related to modification of site surface drainage.

Mitigation:

N/A

Recommended that**:**

- *Rainfall storage be maximized and the water used for grounds irrigation.*
- *If and where sea discharge of runoff is necessary, it should be done away from coral reef areas where reduced salinities may have adverse negative effects on the biota.*

5.1.3 Erosion of Cleared Areas

Vegetation clearance and excavation works related to construction of the hotel will expose soils in the affected areas which could leave them vulnerable to erosion by surface run-off and create the threat of water turbidity and sediment deposition in drains, coastal waters and nearshore coral reefs. The flat topography of the site and the pervious nature of the soils would help to reduce erosive surface flows and the potential situation should exist only for the duration of the construction works (approx. 15 months) before landscaping and drainage works reduce the susceptibility to soil erosion. There are no other significant surface features such as gullies, streams or rivers in close proximity to the site that could be affected by soil erosion.

Mitigation:

- *Where possible, phase the site clearance exercise so as to reduce the amount of exposed soil at any given time.*
- *Deliberately re-cover exposed soils with grass and other appropriate species as soon as possible.*
- *Temporarily bund exposed soil and redirect flows from heavy runoff areas that threaten to erode or result in substantial surface runoff to adjacent marine waters.*
- *Monitor areas of exposed soil during periods of heavy rainfall throughout the construction phase of the project*

5.1.4 Earth Material Sourcing

Earth materials needed for construction (e.g. marl, sand) are normally obtained from quarry and mining operations. Conscious or unwitting purchases of these materials from illegal operations indirectly supports, encourages and promotes environmental degradation at the illegal quarry sites across the island causing medium- to long-term negative impacts at source.

Mitigation:

- *Earth materials must be obtained from officially licenced and approved quarries and copies of the relevant licences made available for inspection at the site.*

5.1.5 Materials transportation

The various materials required for construction and building (e.g. steel, blocks, lumber, marl, asphalt, etc.) will be obtained from sources elsewhere and transported to the site. Transportation of these materials, typically in over-laden and sometimes uncovered trucks, usually results in undue road wear-and-tear. In the case of fine earth materials, dusting and spillages occur on the roadways between source and site. Dusting degrades local air quality and material spillages worsen road driving conditions and increase the risk of road accidents. These occurrences represent indirect, short-term, reversible, negative impacts on public health and safety related to the project.

Of some concern are the existing levels of traffic on the Howard Cooke Boulevard and the Alice Eldemire Drive. Heavily-laden and slow-moving construction vehicles, in transit to and from the project site, may cause traffic hold-ups, resulting in commuter frustration and, possibly, in traffic accidents.

Mitigation:

- *Earth materials must be obtained from officially licenced and approved quarries and copies of the relevant licences made available for inspection at the site.*
- *All fine earth materials must be covered during transportation to the site to prevent spillage and dusting. Trucks used for that purpose on the project should be fitted with tailgates that close properly and with tarpaulins to cover the materials. The cleanup of spilled earth and construction material on the main roads should be the responsibility of the contractor and should be done in a timely manner (say within 4 hours) so as not to inconvenience or endanger other road users. These requirements should be included as clauses within contracts made with relevant sub-contractors.*
- *The transportation of lubricants and fuel to the site should only be done in the appropriate vehicles and containers, i.e. fuel tankers and sealed drums.*
- *As far as possible, transport of construction materials should be scheduled for off-peak traffic hours.This will reduce the risk of traffic congestion and of road accidents on the access roads to the site.*

5.1.6 Materials Storage

The improper siting and storage of sand, gravel, cement, etc., at the project site could lead to fine materials being washed away into the adjacent marine environment during heavy rainfall events. This would not only represent a waste of materials but would also contribute to turbidity and sedimentation with negative impacts on inshore marine water quality and the ecology of shallow marine environments.

Hazardous and flammable materials (e.g. paints, thinner, solvents, lubricants, fuels, etc.), improperly stored and handled onsite, are potential health hazards for construction workers. Improper storage and handling of fuel and oil would inevitably result in spillage during equipment refueling and maintenance exercises. Spilt petrochemicals would have the potential to contaminate soil and inhibit plant growth on the site.

Mitigation:

- *The stockpiling of construction materials should be properly managed and controlled. Fine-grained materials (sand, marl, etc.) should be stockpiled away from surface drainage channels and features.*
- *Low berms should be placed around the piles and/or tarpaulin used to cover open piles of stored materiasl to prevent them from being washed away during rainfall.*
- *Safe storage areas should be identified and retaining structures constructed prior to the arrival of material.*
- *Hazardous chemicals (e.g. fuels) should be properly stored in appropriate containers and these should be safely locked away. Conspicuous warning signs (e.g. 'No Smoking') should also be posted around hazardous waste storage and handling facilities.*
- *Refueling and maintenance of heavy construction vehicles at the site, should be done at specified areas or makeshift "depots" where measures are in place to deal with spillages and temporary storage of oily wastes. Preferably these depots should be located in an area that would ultimately be permanently paved (e.g. parking lots) thereby covering any contaminated soil. The ground at the depot site should be covered with a thick layer of marl to absorb any spillages. Subsequently, this marl layer should be removed for proper disposal. In the event of a large spill, the latter must be cleaned up immediately by excavating the contaminated soil and removing it in a secure vehicle to an approved disposal site.*
- *In order to reduce ground contamination, an impervious sump or container should also be placed under the spigots of fuel drums to collect drippings.*

5.1.7 Air contamination

It can be anticipated that a certain amount of air borne particulate matter (dust) will be generated by the movement of heavy equipment and by earth moving activities, particularly if marl is imported to the site for land filling purposes, etc. This situation will be worse during the dry season and during the afternoons when the winds are most prevalent. Air borne particulates may pose a hazard to persons in the vicinity of the construction site that suffer from upper respiratory tract problems. Otherwise it may of nuisance. The impact of dusting is short-term, lasting for the duration of the construction works, but it may be severe if it causes significant health problems, a matter of particular concern given the nature of the hospitality industry.

Mitigation:

- *Access roads and exposed ground should be regularly wetted in a manner that effectively keeps down the dust.*
- *Stockpiles of fine materials (e.g. marl) should be wetted or covered with tarp during windy conditions.*
- *The dispersal of dust beyond the construction site will be reduced somewhat if a fence is erected around the site.*
- *Workers on the site should be issued with dust masks during dry and windy conditions.*

5.1.8 Noise

The use of heavy equipment during site preparation and construction works, particularly for the piling of foundations, will inevitably generate noise, which may cause a nuisance to hotel guests and nearby residents. Albeit annoying, this negative impact will be short-term (limited to the construction phase of the project) and is not considered to be a significant threat to the health or well being of guests at the adjacent hotel blocks.

Mitigation:

- *Construction activities that will generate disturbing sounds should be restricted to normal working hours.*
- *Local residents and hotel guests should be given notice of intended noisy activities so as to reduce annoyances.*
- *Workers operating equipment that generates noise should be equipped with noise protection gear. Workers operating equipment generating noise levels greater than 80 dBA continuously for 8 hours or more should use ear muffs. Workers experiencing prolonged noise levels of 70 - 80 dBA should wear earplugs.*

5.1.9 Site sewage and litter management

Inadequate provision of toilets for use by workers can lead to ad hoc defaecation in secluded areas on the site, thus creating of unsanitary conditions and sources of fly infestation. Improper disposal of food cartons and other domestic forms of construction camp garbage could lead to littering of the site and pollution of adjacent coastal waters.

Mitigation:

- *Proper solid waste receptacles and storage containers should be provided, particularly for the disposal of lunch and drink boxes so as to prevent littering of the site.*
- *Arrangements should be made for the regular collection of litter and for its disposal only at the Retirement dump site.*

5.1.10 Construction Waste Disposal

Solid waste generated during site preparation and construction work would include cut vegetation and typical construction waste (e.g. wasted concrete, steel, wooden scaffolding and forms, bags, waste earth materials, etc.). This waste would negatively impact the site and surrounding environment if not properly managed and ultimately disposed of at an approved dumpsite. Cleared vegetation, if burnt onsite, would generate smoke, negatively impacting ambient air quality (with reciprocal negative impacts upon human health). Vegetation and solid waste, if allowed to accumulate in sensitive areas, may cause localised ponding and flooding. Furthermore, the ponding of water would create conditions conducive to the breeding of nuisance and health-threatening pests such as mosquitos.

Mitigation:

- *A site waste management plan should be prepared prior to project commencement. This should include designation of appropriate waste storage areas, collection and removal schedule, identification of approved disposal site, and system for supervision and monitoring. Preparation and implementation of the plan must be made the responsibility of the building contractor with the system being monitored independently.*
- *Special attention should be given to minimizing and reducing the quantities of solid waste produced during site preparation and construction. To reduce organic waste, softer vegetation may be composted onsite and used for soil amendment during landscaping.*
- *Vegetation and combustible waste must not be burned on the site.*
- *Reusable inorganic waste (e.g. excavated sand) should be stockpiled away from drainage features and used for in-filling where necessary.*
- *Unusable construction waste, such as damaged pipes, formwork and other construction material, must be disposed of at an approved dumpsite.*

5.1.11 Replanting and landscaping

In addition to enhancing the aesthetic appeal of the project site, landscaping provides the means for partially restoring the site's natural elements and ecological habitats. It is therefore a significant mitigation activity with a positive impact.

The landscaping plan should seek to avoid the use of non-native and potentially invasive species. It should include low-maintenance, salt-tolerant coastal species and the types of trees and shrubs used for feeding by local bird species. The landscape design should seek to encourage bird life, maximize shade and windbreak effect, as well as to hide the roofline of the hotel.

It is recommended that most, if not all, of the Willow/Australian Pine (*Casuarina equisetifolia)* trees be removed from the site. Despite their nitrogen fixing properties, their heavy leaf fall inhibits undergrowth. A few individuals may be retained along the shoreline as their leaves make a pleasant whistling sound when the wind blows.

Mitigation:

N/A

5.1.12 Employment/Income Generation

It is estimated that 350 workers will be employed on the site during the construction phase. The expansion project is expected to augment current employment levels by about 100 persons. These levels of short-term and long-term employment will have a positive impact on the local economy and on regional unemployment.

Mitigation:

N/A

5.1.13 Worker Housing

Tourism resort development in Montego Bay, as is the case elsewhere in Jamaica, has not been matched by the corresponding development and construction of housing and the social infrastructure to meet the demand from resort facility workers, etc. Therefore, squatting and informal settlements despoil the city and suburbs and worsen social tensions. This is viewed as an indirect, cumulative, long-term, reversible negative impact. The present project may add to this settlement problem.

Mitigation:

- *Sunset Beach Resorts must seek, in some appropriate manner, to alleviate the problems of housing shortage for the increased workforce induced by the expansion project.*

5.1.14 Seagrass Removal and Beach Enhancement

Potential negative impacts associated with the project's proposed beach and bathing area enhancement works could result from the removal of portions of the nearshore seagrass beds. Removal of seagrasses would mean a corresponding loss in their sediment retention capacity and possible shoreline erosion over the long term. Short term impacts would be associated with the suspension of sediments and turbidity resulting from the dredging of mud/silt along the foreshore of the site and the dumping and spreading of coarse replacement fill material. This could lead to the smothering of corals and seagrass bed ecosystems if adequate measures are not put in place to contain turbidity.

As is the case with the earth materials required for the construction of the hotel, sourcing/purchase of the sand required for beach nourishment must be done from approved sites and in a manner approved by NEPA.

Positive impacts associated with the beach enhancement works would include the improvement to the beach and overall appeal of the site, and the generation of temporary employment.

Mitigation:

- *Determine and implement the minimum amount of seagrass removal required to maintain beach stability and satisfy bathing needs.*
- *Replant seagrasses removed from shorefront to approved location/s in manner approved by NEPA.*
- *Use silt screens/turbidity barriers to contain sediment plumes generated during (i) the seagrass bed and sand excavation/dredging exercise, and (ii) the filling/beach nourishment exercise.*
- *Use vacuum suction dredges for dredging and sand excavation works so as to minimise turbidity at dredging and filling sites.*

- *Conduct the dredging works during periods/seasons of low wave activity and halt works whenever wave and current conditions make it difficult to contain the sediment plumes.*

5.2 OPERATIONAL IMPACTS

5.2.1 Sewage Disposal

Sewage generated by the hotel will be discharged to the sewage mains at the main road for treatment at the NWC plant at Bogue. Issues related to discharges to coastal waters at the site should therefore not arise. The project engineers should, however, ensure complete connectivity to the NWC sewage collection and treatment system and should ensure there is no on-site disposal of sewage. Evidence of this should be shown by the sewerage design plans supplied to NEPA for review and approval. (As mentioned under Section 4, these plans, drawings and information were not available during the EIA report preparation process.)

Mitigation:

N/A

5.2.2 Water Supply

It is estimated that the incremental demand for water induced by the development will be approximately 300 gal/room/day or a total of 52,800 gpd (211 m^3/day). Water will be supplied from the existing mains along Southern Cross Boulevard and the additional demand should be well within the capacity of the current NWC system. This will be confirmed in writing by NWC and will be made available to NEPA upon request.

Mitigation:

N/A

Recommended that:

- *Aerators/flow restrictors are installed.*
- *Low flush toilets are installed.*
- *Water meters are installed at key usage points to monitor and manage water usage.*
- *Grey-water be separated from sewage and reused for irrigation.*
- *Rainwater be collected from roofs for landscape irrigation.*

- *Use options other than chlorination for disinfecting pools.*

5.2.3 Solid waste disposal

Poor solid waste disposal practices should not arise if the hotel continues with its contracted waste collection arrangements and with final disposal of wastes at the Retirement dump. It is expected that garbage management and good housekeeping will be practiced on the site.

Mitigation:

N/A

Recommended that:

- *A waste compactor be installed and operated at the hotel to reduce the volume of generated solid waste.*

5.2.4 Energy Usage

Electricity for the hotel will be supplied by the JPSCo. Ltd. from the existing mains along Southern Cross Boulevard. The additional demand should be well within the capacity of the current system. This will be confirmed in writing by JPSCo. and the letter will be made available to NEPA.

In the event of power failure, a standby generator is being considered. Negative impacts could include spillages of fuel oil, waste gas emissions, the production of noise and, to a certain extent, vibration in the vicinity of the machine.

Mitigation:

- *The standby electricity generator should be located downwind of guestrooms and insulated against noise.*
- *Contingency plans should be formulated to deal with the containment of spills of stored fuel oil.*
- *The fuel storage tank should be placed within a bund that can contain the contents of the tank in the event of leakage or spillage.*
- *Sub-meters and real-time energy monitoring equipment, timers, photoelectric cells, thermostats, etc. should be installed at the hotel.*

- *Translucent shades, phosphorescent lighting and key/card switches be installed and used in guest rooms.*
- *Pipe insulation, tank lagging (not asbestos!) and heat recovery systems be installed in the hotel's laundry and throughout the hotel, wherever it is practical to do so.*
- *Renewable energy should be used throughout the hotel, wherever it is possible and practical to do so.*

5.3 SUMMARY OF IMPACTS

The impacts and environmental issues discussed above are summarised in Table 5.3.1.

Table 5.3.1 Environmental Impact Matrix.

ENVIRONMENTAL IMPACT	IMPACT TYPE: Positive		IMPACT TYPE: Negative						MITIGATION			
	Significant	Not significant	Significant	Not significant	Short Term	Long Term	Irreversible	Cumulative	Mitigation Not Required	Major Mitigation Required	Minor Mitigation Required	Reference to Mitigation Section
SITING AND CONSTRUCTION PHASE												
Loss of vegetation & wildlife habitat				×	×				×			
Modification of drainage patterns			×			×	×	×	×			
Erosion of cleared areas				×	×						×	5.1.3
Earth material sourcing												5.1.4
Materials transportation				×	×						×	5.1.5
Material storage				×	×						×	5.1.6
Air contamination												5.1.7
Noise				×	×						×	5.1.8
Site sewage and litter management				×	×						×	5.1.9
Construction waste disposal												5.1.10
Replanting landscaping	×					×			×			
Employment/income generation		×				×			×			
Worker housing			×			×		×		×		5.1.13
Seagrass bed removal/beach enhancement			×			×	×			×		5.1.14
OPERATIONAL PHASE												
Sewage disposal				×		×			×			
Water supply				×		×			×			
Solid waste disposal				×		×			×			
Energy usage				×		×					×	5.2.4

6. OUTLINE ENVIRONMENTAL MONITORING PLAN

Prior to site clearance activities, the site layout plan (labour camp, material storage areas, etc.), the waste management plan, and the landscape plan should be prepared and reviewed by the environmental monitoring entity. Any existing trees earmarked for protection should be inspected and marked.

The major elements of the proposed environmental impact monitoring programme that should be monitored during the construction phase of the project are set out below:

- Site clearance to ensure that trees marked for preservation are left untouched and that large sections of soil are not left exposed and uncovered for extended periods of time.
- Site drainage and surface runoff, especially during and shortly after major rainfall events, to ensure there is no flooding, ponding and runoff of surface water across the beach.
- Compliance of construction works with site management and landscape plans.
- Inspection of quarry licences to ensure earth materials are obtained only from licensed operators.
- The transportation and storage of construction material. The location of hard standings should be monitored bi-monthly to ensure that they are placed away from drainage features on the site and do not end up in the marine environment.
- Earth materials transport to ensure that trucks are properly covered to prevent spillage and the generation of dust.
- The contractor must immediately and completely clean up spills of materials in public areas.
- Solid waste disposal practices to ensure appropriate on-site management and final disposal at approved dump.
- The labour camp to ensure installation of VIP toilets and the proper disposal of sewage and labour camp solid waste.
- Marine water quality, on a monthly basis throughout construction phase, to ensure that the construction works are not negatively impacting coastal water quality. The parameters that should be monitored are salinity, dissolved oxygen, nitrates, phosphates, turbidity, faecal and total coliforms.
- Seagrass bed removal, dredging and beach nourishment exercises, associated with any beach and bathing area works proposed by the project's coastal engineers.

7. SUMMARY AND CONCLUSIONS

The EIA of the proposed Sunset Beach Hotel expansion project has not identified any major negative impacts that cannot be successfully mitigated. The critical environmental issues identified by the EIA were related to site drainage, construction works management, landscaping, marine resources protection, beach enhancement and worker housing. Residual negative impacts are anticipated to be negligible, provided that the mitigative measures recommended are properly implemented and monitored.

The positive impacts of implementing the proposed project would include:

- expansion of capacity to generate foreign exchange,
- generation of employment in the region;
- improvement to the general aesthetics of Seawind Island.

9. REFERENCES

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9. APPENDICES

1. UPDATED DEEP WATER WAVE CLIMATE

In the evaluation of the environmental impact of any coastal or shoreline development, it is necessary to describe the wave conditions. This is necessary for two main reasons:

1. To allow for an assessment of the impacts that any coastal works may have on the environment, including adjacent beaches, coral reefs and other sensitive marine habitats.
2. To determine the exposure of the development to natural hazards, such as storm surge and beach erosion.

Normally, the wave conditions are determined in two ways. The first looks at day-to-day waves, and the second at extreme waves generated by storms and hurricanes. It is often necessary to make separate assessments of these two different wave conditions. Techniques that are appropriate for day-to-day waves often exclude hurricanes, and vice-versa.

1.1 Operational Wave Climate

Two different sources have been examined to determine the day-to-day wave conditions. The first drew on a recent data collection programme that was being undertaken as internal research and development by Smith Warner International Ltd. This project involved the deployment of a combined wave and current meter at Montego Bay, adjacent to the airport. Unfortunately, this project only began in 2003, and was interrupted when the wave recorder was required elsewhere. The second source of wave data came from the UK Meteorological Office (UKMO) global wave model.

The approach that has been used to determine extreme wave conditions is to examine a long-term database of hurricane storm tracks and to mathematically recreate the wave conditions during each storm. This has been done on several occasions for Montego Bay, which was once used as a case study for the development of a Policy Framework and Guidelines for the Computation of Storm Surge (CDMP, 1999).

The global wave model is run by the UK Met Office on a six-hour interval using a grid spacing of approximately $3/4^{o}$. The following table outlines the results of three years of this model output for a location along the north coast of Jamaica. It shows that the wave climate is dominated by Trade-Wind generated waves, with an average wave height of 1.23 metres and a wave period of approximately 4.5 seconds, mostly coming from the east to northeast.

The shoreline orientation at Sunset Beach naturally shelters the beach from virtually all of these waves. The UKMO model also computes swell wave conditions, which have also been examined, and are presented in the following figure. This database shows longer wave periods, and smaller average and maximum wave heights.

This swell wave database has been screened to examine only those waves coming from the northwest sector (270^{o} to 360^{o}). The results are presented in the lower half of the figure. The number of occurrences is much smaller from this direction (representing approximately 2.5% of the time). These NW swell wave heights have a higher average wave height and longer periods. Comparing the larger wave heights (circled in red), it is apparent that the largest swell waves are coming from the NW sector, which confirms many observations regarding the occurrence of swells along the north coast.

The shoreline orientation at Sunset Beach is fully exposed to these NW swell waves, and it is these conditions that cause changes to the shoreline, including erosion and alongshore sediment transport.

Table 1.1 UKMO Deep Water Wave Data.

UKMO Deep Water Wave Data

Global Wave Model Results (Jan 2000 to June 2003)

Bivariate Table

Wave Height (m)	Wave Periods (s) < 3.0	3.0 - 4.0	4.0 - 5.0	5.0 - 6.0	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	10.0 - 11.0	11.0 - 12.0	TOTALS
0.0 - 0.5		8	17								**25**
0.5 -1.0		234	2280	118	1						**2633**
1.0 - 1.5			995	369	1						**1365**
1.5 - 2.0			30	194	20						**244**
2.0 - 2.5				34	10						**44**
2.5 - 3.0				1	5	1					**7**
3.0 - 3.5					1	3					**4**
3.5 - 4.0					1	1					**2**
4.0 - 4.5											
4.5 - 5.0											
TOTALS		**242**	**3322**	**716**	**39**	**5**					**4324**

Average Wave Height 1.23 m
Average Wave Period 4.63 s

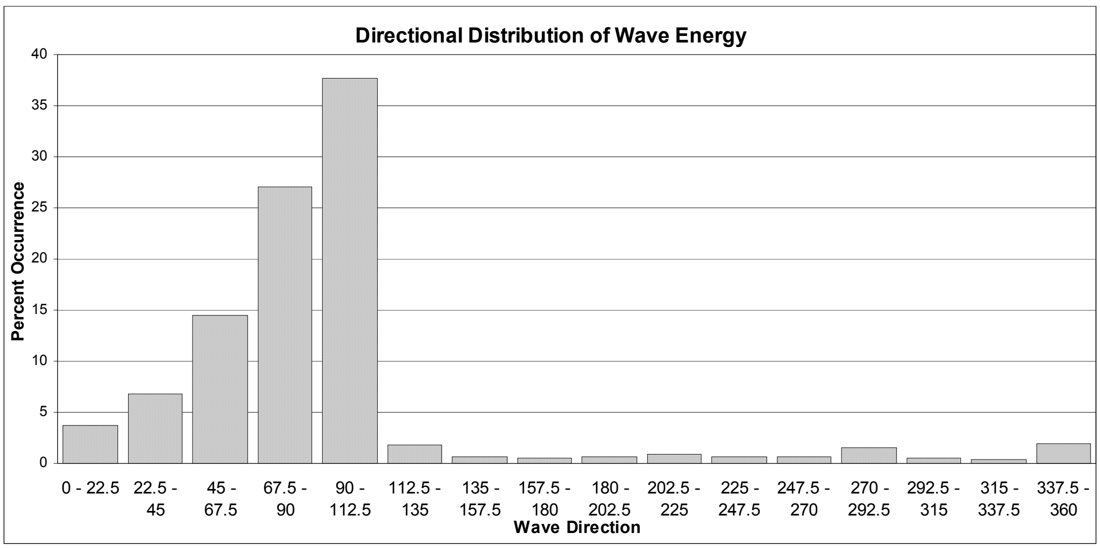

Table 1.2 UKMO Deep Water Wave Data Swell Only.

UKMO Deep Water Wave Data Swell Only

Global Wave Model Results (Jan 2000 to June 2003)

Bivariate Table

Wave Height (m)	Wave Periods (s) 4.0 - 5.0	5.0 - 6.0	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	10.0 - 11.0	11.0 - 12.0	12.0 - 14.0	14.0 - 16.0	TOTALS
0.0 - 0.5	59	175	192	243	104	38	18	1			**830**
0.5 -1.0	181	1246	1059	390	107	45	12		1		**3041**
1.0 - 1.5	2	45	165	90	56	22	2				**382**
1.5 - 2.0			8	15	4	1	2				**30**
2.0 - 2.5				2		1	1	2			**6**
2.5 - 3.0					1	1	1				**3**
3.0 - 3.5											
3.5 - 4.0											
4.0 - 4.5											
4.5 - 5.0											
TOTALS	**242**	**1466**	**1424**	**740**	**272**	**108**	**36**	**3**	**1**		**4292**

Average Wave Height 0.96 m
Average Wave Period 6.20 s

UKMO Deep Water Wave Data NW Swell Only

Bivariate Table

Wave Height (m)	Wave Periods (s) 4.0 - 5.0	5.0 - 6.0	6.0 - 7.0	7.0 - 8.0	8.0 - 9.0	9.0 - 10.0	10.0 - 11.0	11.0 - 12.0	12.0 - 14.0	14.0 - 16.0	TOTALS
0.0 - 0.5		2	2	7	7	5	2	1			**26**
0.5 -1.0	5	23	15	8	9		1				**61**
1.0 - 1.5		4	3	2	1						**10**
1.5 - 2.0			1	2							**3**
2.0 - 2.5				1			1	1			**3**
2.5 - 3.0					1	1	1				**3**
3.0 - 3.5											
3.5 - 4.0											
4.0 - 4.5											
4.5 - 5.0											
TOTALS	**5**	**29**	**21**	**20**	**18**	**6**	**5**	**2**			**106**

Average Wave Height 1.05 m
Average Wave Period 6.90 s

The programme of wave measurements in Montego Bay resulted in a short time-series during the months of February and March 2003, as shown in Figure 1.1 following. A comparison has been made using the measured wave data and refracted UKMO data. The wave refraction process accounts for the changes to the wave height and direction as it moves from deep water, where the UKMO model computes to shallow water, where the wave recorder was located.

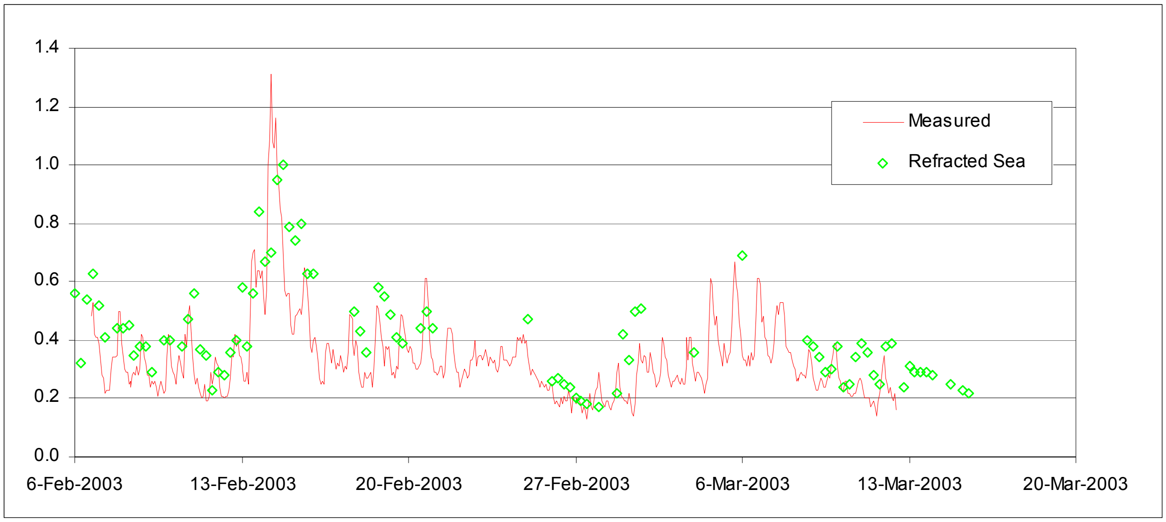

Figure 1.1 Comparisson of SWI Wave Measurements and UKMO data.

1.2 Design Wave Climate

Several investigations have already been undertaken for Montego Bay to determine design wave conditions. In order to determine the accuracy of these, a separate analysis was undertaken using an in-house model called HURWave.

Table 1.3 following outlines the results of previous investigations that have determined extreme wave heights in the vicinity of Montego Bay. Those investigations utilized a database extending from 1950 to 2002.

Table 1.3 Deep Water Extreme Wave Heights (m).

Source	***Return Period (years)***		
	25	**50**	**100**
Sunset Beach – Preliminary Engineering (SWIL, 1999)	6.5	7.6	8.6
Howard Cooke Highway (SWIL, 2001)	6.8	7.7	8.4

10. PLATES

Plate 1.

Plate 2.

Plate 3

Plate 4