ENVIRONMENTAL AUDIT

For the existing Powerhouse and Desalination Plant

at

Palm Beach Resort & Spa

(Madhiriguraidhoo, Lhaviyani Atoll)

Proposed by:

Sun Sporting Holidays Pvt. Ltd.

Prepared by:

CDE Pvt. Ltd.

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Non Technical Summary

The purpose of this Environmental Audit report is to fulfill the requirements of Maldives Energy Authority and Maldives Water and Sanitation Authority guidelines to get necessary environmental clearance from the Environmental Protection Agency to carry out the registration of both facilities.

The project involves the existing powerhouse and the desalination plant in Palm Beach Resort and Spa. The power generation system involves a powerhouse building that houses five diesel fired generator sets with total capacity of 2,900kVA and a fuel storage facility with total capacity of 169,911 litres. Desalination system involves three plants with a total capacity of 300 tonnes per day and two water storage tanks with a capacity of 220,000 litres. These facilities have been in operation since 1999.

The main environmental impacts associated with this project include, increased noise levels and other emissions, potential risk for ground water and soil contamination due to fuel spills and leaks, damages to vegetation due to heat and smoke generated from the power house, potential impact on the marine environment due to brine discharge from the desalination process.

Visual observation identifies no notable damage to existing vegetation around the powerhouse building and no indication of any fuel spills around the powerhouse area. Noise measurements taken during the field visit conforms to international standards while marine water quality tests identify no significant contamination. Groundwater quality tests conducted shows that the groundwater at the location is not suitable for drinking due to its physical appearance and turbidity levels for which the method of sampling may have contributed to.

Mitigation measures that are in place to reduce the environmental impacts associated with the operation of the two facilities include installation of sound attenuators to reduce the noise levels from the generator sets, a chimney at the powerhouse to reduce the emission by accumulating particulate matters in the smoke within the chimney. In order to protect the environment from potential fuel spills, fuel storage facilities are bunded to contain any spills and proper pipelines are established for safe fuel transfers.

A monitoring plan is proposed to observe any changes taking place due to the operation of powerhouse and desalination plant. In the event that monitoring indicates that any environmental quality is deteriorating to unacceptable levels, the proponent will correct operation procedures that are contributing to the problem and/or undertake necessary engineering installations.

1 Introduction

1.1 Purpose

The Ministry of Transport, Housing and Environment requires that desalination and power plants in the Maldives are registered. In order to carry out the registration process, environmental clearance from the Environmental Protection Agency (EPA) is required, which is a decision statement regarding the environmental impact assessment of the powerhouse and the desalination plant. In order to provide such a clearance, the EPA requires that an Environmental Audit be done for existing facilities. Since the powerhouse and the desalination plant at Palm Beach Resort & Spa are existing facilities, this environmental audit is done for the purpose of registering the existing desalination plant and the powerhouse facility at Palm Beach Resort & Spa.

This report is developed for Sun Sporting Holidays Pvt. Ltd. by CDE Pvt. Ltd.

1.2 Terms of Reference of the Audit

This audit has been prepared to the requirements established by the Term of Reference (ToR) issued for this project on 24 March 2010 (See Appendix 2 for the ToR).

1.3 Assessment Methodology

The process followed in the preparation of this EIA report consists of five parts. These are:

- scoping consultations;
- literature review;
- field surveys;
- analysis of results; and
- compilation of the assessment in the form of a report.

The first step of the process covered consultations with client and government agencies to determine the scope of the audit. The environmental assessment needs was determined based on the EIA Regulations 2007 and the issues brought forward by the Environmental Protection Agency in the scoping meeting.

During the second stage, a literature review was conducted to acquire background information on the site and its environment as well as to identify possible environmental impacts of similar developments in island settings. In this context, the EIA Regulations 2007, best practices from similar development activities, scientific studies undertaken in similar settings around Maldives and previous documents/historical publications was considered.

The third stage involved field assessment on the island and areas covered by the EIA scope. Conditions of the existing environment were analysed using established scientific methods. Field surveys were undertaken from 14 –15 October 2009 and 1 - 2 February 2010.

The fourth stage involved analysis using scientific analysis methods. These methods will be explained in detail in later sections.

The final stage involved compilation of individual consultants' findings.

1.4 Report Outline

This audit report is organised into nine sections. They are:

Chapter	Brief Description
Chapter 1	Introduction
Chapter 2	A description of the project including the project location, information on the proponent, detailed description of project components including site conditions and site plans.
Chapter 3	A summary of the policy, planning and legal framework applicable to the audit and a demonstration of how the existing facilities comply with the existing environmental policies and regulations.
Chapter 4	Detailed description of the existing baseline environmental conditions.
Chapter 5	Information on the operational impacts and mitigation measures of the project.
Chapter 6	Details of the environmental monitoring program
Chapter 7	Information regarding the potential gaps in existing data and limitations in the assessment

1.5 Audit Team Members

The project team members and their areas of contributions are listed in Table 1.1 below. Their CV's of are attached in Appendix 3.

Table 1.1: Audit team and their areas of contribution

Consultant	Areas of Contribution
Dr. Simad Saeed	Team Leader, Social Scientist and Environmental Management and Planning
Dr. Ahmed Shaig	Terrestrial Environment
Hafeeza Abdulla	Environmental Management
Ali Moosa Didi	Surveyor
Mohamed Shinaz Saeed	Marine Specialist

2 Project Description

2.1 The Proponent

The proponent of this project is Sun Sporting Holidays Pvt. Ltd, which manages Palm Beach Resort and Spa.

2.2 Project Location

Palm Beach resort is developed on the island of Madhiriguraidhoo in Lhaviyani Atoll, Maldives. It is one of the biggest islands in Maldives, measuring almost 2 kilometers (km) in length and 400 meters in width. Madhiriguriaidhoo is located at coordinates 73°33’44 E and 5°28’40N on the north eastern peripheral reef of Lhaviyani Atoll.

Figure 2.1: Location of Palm Beach (Madhiriguraidhoo) in Lhaviyani Atoll

Figure 2.2: Aerial view of Palm Beach (Madhiriguraidhoo)

The shape of the island is elongated triangle. The island has mature vegetation which consists mainly of coconut palms, *Kashikeyo* and *Nika*. Madhiriguraidhoo can be reached by seaplane in 40 minutes.

Palm Beach Resort and Spa started its operation in 1999 with 118 rooms.

2.3 Project Objectives

The powerhouse system was developed to provide reliable electricity supply which is required for the operation of the resort. Similarly, the main objective of the desalination plant is to provide freshwater to the resort operation and also to conserve the groundwater aquifer of the island.

2.4 The Project

2.4.1 Powerhouse

The project involves the existing powerhouse and the desalination plant in Palm Beach Resort and Spa. The existing powerhouse building houses five diesel fired generator sets with total capacity of 2,900kVA (2x375kVA, 2x450kVA and 1x1, 250kVA). Mounted radiators are used to cool the engines.

Figure 2.3: Powerhouse and desalination plant building from outside

The powerhouse building has been adequately sound and vibration proofed to achieve the allowable limits of 70-75 dB (A) at 3 meters radius.

The powerhouse has no emission control measures except a 15 feet high chimney.

2.4.2 Fuel storage

Fuel is stored in appropriately bunded storage tanks on site about 300 feet from the power house. There are two storage tanks with total capacity of 169,911 litres. The bunding will hold 150% of the total capacity of the fuel tanks. The fuel storage tanks are in good condition (see Figure 2.4 below).

Figure 2.4: Fuel Storage Tank with bund

2.4.3 Fuel Handling Method

The fuel used for power generation and desalination is transported from Male' to Palm Beach by fuel suppliers via fuel barges. The fuel handling system in Palm Beach includes properly established pipelines from the harbour to the main storage tanks, from the storage tanks to the fuel day tanks, and fuel day tanks to engines. Fuel is transferred to the main storage tanks via the pipelines and then to the fuel day tank and to the engines as required.

Waste oil from the powerhouse is transported weekly to Thilafushi for proper disposal.

2.4.4 Desalination System

Desalination involves three plants with a total capacity of 300 tonnes per day (3x100 tonnes per day). The seawater intake pipelines for desalination is located on the on the eastern side. Brine discharge is also located on the eastern side but away from the intake pipeline as shown on the site plan (Figure 2.7). The desalination plant building is adjacent to the powerhouse building which is located within the staff facilities. Layout of the power plant and the desalinated plant is given in Appendix 1.

Figure 2.5: Desalination Plant

There are two large steel water storage tanks with a capacity of 220,000 litres to store desalinated water on site. Desalinated water is used for all purposes including, drinking, cooking and cleaning on Palm Beach. No rainwater is harvested on the island.

Figure 2.6: Desalinated water Storage Tanks

No additional developments are proposed within this project, and hence no construction activities will be involved in this project.

2.4.5 Fire safety

Fire extinguishing equipments are readily available on site and employees have been trained to use the equipments. In general, water-based portable fire extinguishers are used.

Figure 2.7: Site Plan showing the boundary of the project

3 Policy and Legal Framework

This Chapter will provide a summary of the legal instruments applicable to the project and demonstrate how the project conforms to these aspects.

3.1 Relevant Legislations

3.1.1 Environment Protection and Preservation Act (Act no. 4/93)

- Environment Protection and Preservation Act of Maldives (4/93) is the framework law on environmental management in the Maldives. Articles 2, 4, 5, 6, 7, and 8 of the law are relevant to this project.

- Article 2 states that the concerned government authorities shall provide the necessary guidelines and advise on environmental protection in accordance with the prevailing conditions and needs of the country. All concerned parties shall take due considerations of the guidelines provided by the government authorities. The project proponent shall abide by any guidelines or advice given by the concerned Government authorities for the project. The concerned Government authorities are identified in this Chapter.

- Article 4 states that the Ministry of Housing, Transport and Environment shall be responsible for identifying protected areas and natural reserves and for drawing up the necessary rules and regulations for their protections and preservation. There are no protected areas located in the close vicinity of the project.

- According to Article 5 (a) of the Act, an Environmental Impact Assessment study shall be submitted to the Ministry of Housing, Transport and Environment (MHTE) before implementing any activity that may have an impact on the environment. This environmental audit has been prepared for an existing facility.

- According to Article 6, the Ministry of Housing, Transport and Environment has the authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation.

- Article 7 of the Environment Protection Act (4/93) prohibits the disposal of wastes, oil and gases in a manner that will damage the environment. Wastes, oil and gases has to be disposed off in areas designated by the Government. Waste oil generated from the powerhouse is taken to Thilafushi waste disposal site for disposal.

- Article 8 of the Environment Protection Act (4/93) prohibits the disposal of hazardous wastes**.** Any hazardous wastes that may be generated from the project shall be transferred to the designated Regional Waste Collection and Management Center for disposal according to Government regulations and standards.

3.1.2 National Energy Policy

The national energy policy is of particular relevance to this project. The objectives of the energy policy are:

- Ensure a continuous and economically viable diversity of energy supplies to sustain socioeconomic development, without compromising the environment, health and safety.
- Guarantee accessibility of affordable and reliable energy services to all people.
- Enhance national energy security by promoting indigenously available renewable sources of energy while creating new jobs and strengthening the economy.
- Protect the environment and health of the people by ensuring environmentally sound energy supply and usage.
- Promote energy conservation and energy efficiency to achieve optimum economic use of renewable and non-renewable sources of energy and reduce consumption without lowering the quality of service rendered.
- Ensure transparency of energy sector planning and operations to attract both national and international investors where appropriate.

3.1.3 Policy on water

As addressed in the Health Master Plan 1996 – 2005, the key elements of the policy on water are:

- Preserve water resources and protect the aquifer and marine environment from contamination; and
- Provide access to safe potable and non-potable water.

The key objectives of the policy on water are to:

- Reduce infant and child mortality rate due to diarrhoea and other waterborne diseases.
- Provide universal access to 10L of water/person/day for drinking and cooking and 40L/person/day on islands with groundwater contamination;
- Minimise groundwater contamination from septic tanks;
- Promote the protection and conservation of water resources and facilitate the use of rainwater;
- Protect the groundwater aquifers;
- Expand water supply technology to the islands;
- Identify alternative technologies for water supply;
- Ensure 50 per cent of households have access to water conservation materials;
- Ensure 50 per cent of islands have trained and equipped water supply system operators;
- Develop policies, procedures, approaches and long-term strategies for water supply; and
- Ensure that 50 per cent of the community and school water tanks are well-maintained and regularly chlorinated.

The policy on water is particularly relevant to this project since groundwater of the island is completely conserved as desalination provides fresh water required for resort operation.

3.2 Relevant Regulations and Guidelines

3.2.1 Environmental Impact Assessment Regulations 2007

- Environmental Impact Assessment Regulations were issued by Environment Ministry on 1st May 2007. The first step in environmental assessment process involves screening of the project to be classified as one that requires an EIA or not. Based on this decision, the Ministry then decides the scope of the EIA which is discussed with the proponent and the EIA consultants in a "scoping meeting". The consultants then undertake the EIA starting with baseline studies, impact prediction and finally reporting the findings with impact mitigation and monitoring plan. This report follows the principles and procedures for EIA outlined in the EIA regulations.

- The EIA report is reviewed by the Environment Protection Agency under MHTE following which an EIA Decision Note is given to the proponent who will have to implement the Decision Note accordingly. As a condition of approval, appropriate environmental monitoring may be required and the proponent shall have to report monitoring data at required intervals to the MHTE. The project proponent is committed to implement all impact mitigation measures that are specified in this EIA report. Furthermore, the proponent is committed to environmental monitoring and shall fulfil environmental monitoring requirements that may be specified in the EIA decision note as a condition for project approval.

- The process stated in the Environmental Impact Assessment Regulation was followed in preparing this Environmental Audit.

3.2.2 Regulation on the Registration of Desalination

- Desalination System regulation requires the registration of desalination systems that will be operated for use by a population exceeding 200 or for large-scale agricultural or tourism activities or for the purpose of implementing project(s) that involves economic or industrial operations. Prior to the establishment of desalination system, an EIA must be carried out in accordance with regulations issued by MHTE. Since no EIA has been undertaken for the existing desalination plant in Palm Beach, this audit is required for the registration of the plant in accordance with the regulation.

- The Desalination Regulation of the Maldives does not have specific requirements for brine discharge except if the brine is discharged into a public sewer. Also, there are no policies, guidelines or regulations relating to the disposal of brine into the marine environment.

3.2.3 Regulation on providing electricity services

- Under this regulation, construction of the powerhouse and, handling and storage of fuel must be according to standards issued by former Ministry of Construction and Public Infrastructure and Ministry of Environment, Energy and Water (MEEW) respectively. This regulation is particularly relevant to this project, specifically for the fuel storage and handling.

3.3 Environmental Permits Required for the Project

3.3.1 Environmental Impact Assessment (EIA) Decision Note

- The most important environmental permit required to register both facilities is a decision (referred to as the Decision Note) regarding this EIA. This environment audit report assists decision makers in understanding the impacts of the project. Therefore, the Decision Note may only be given to the Proponent after a review of this document following which the Ministry may request for further information or provide a decision if further information is not required. In some cases, where there are no major environmental impacts associated with the project, the Ministry may provide the Decision Note while at the same time requesting for further information.

3.4 Responsible Institutions

The appropriate authority jurisdiction that will specifically apply to the project is the Maldives Energy Authority (MEA).

3.5 International Conventions

3.5.1 Vienna Convention and Montreal Protocol

- The Montreal Protocol made it illegal for member countries to use CFC containing refrigerators and air conditioners. The Montreal Protocol also prohibits the use of halon containing fire extinguishers. The proponent complies with the provisions of the Montreal protocol and Vienna Convention by using CFC and halon free fire extinguishers in the powerhouse and the desalination plant building.

3.5.2 UNFCCC and Kyoto Protocol

- The Maldives is a party to the United Nations Framework Convention on Climate Change and the Kyoto Protocol to the UNFCCC. The objective of the Convention is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

- The IPCC defines mitigation “as an anthropogenic intervention to reduce the sources or enhance the sinks of green house gases.” The greenhouse gas inventory of the Maldives forms an integral part of the First National Communication of the Maldives to the UNFCCC. In March 2009, the President of the Maldives has announced the target to make Maldives carbon neutral by 2020. Hence, careful attention needs to be given to ensure energy efficiency and reduce fuel consumption.

4 Existing Environment

This section covers the existing environmental conditions of Palm Beach, specifically those areas which may be impacted by the existing power house and the desalination plant.

4.1 Study Methodologies

Baseline environment of the study area were analysed by using standard scientific methods. The environmental components of the study area were divided into marine and terrestrial environment. The marine environment covered the lagoon habitats including coral patches, reef flora and fauna and marine water quality. Terrestrial environment covered the existing vegetation and ground water quality of the site. Field surveys were undertaken from 14 – 15 October 2009 and 1-2 February 2010.

4.1.1 Marine Environment

Lagoon benthos and patch reefs within the lagoon were surveyed using visual observations during snorkelling to establish the general characteristics of the lagoon system. Tidal data was taken from previous research.

To assess the marine water quality of the site, samples were collected at the desalination water intake pipe, brine outfall pipe and at the sewage outfall. Water samples were collected in clean 1500ml PET bottles after washing them with water to be sampled. Parameters tested were turbidity, salinity, Suspended Solids (SS), pH, nitrate, reactive phosphorus, Chemical Oxygen Demand (COD), Total dissolved solids, Iron, Electrical conductivity, Total Chlorine, temperature and physical appearance. All parameters were analysed at the National Health Laboratory.

4.1.2 Coastal Environment

Coastal environment was not surveyed in detail as the project is predominantly terrestrial environment based.

4.1.3 Terrestrial Environment

The terrestrial environment of the site was surveyed by visual observations and testing ground water. One of the main environmental components that would have been affected by the existing powerhouse and the desalination plant would be the aquatic resources and water quality. Groundwater quality of the site was assessed by taking two sets of samples from a borehole located outside the powerhouse building (Figure 4.1). Samples were collected in clean 1500ml PET bottles after washing them with water to be sampled. Parameters tested were physical appearance, electrical conductivity, pH, Total Dissolved Solids (TSD), Sulphate, turbidity and Total hardness. All parameters were analysed at the National Health Laboratory.

4.1.4 Study Area and Survey locations

The boundary of the study area and survey locations is shown in Figure 4.1 below.

Figure 4.1: Study Area and Survey Locations

*Red stars indicate project components; green circles indicate survey locations.

4.2 Physical Environment

4.2.1 Climatic Setting

The Maldives, in general, has a warm and humid tropical climate with average temperatures ranging between 25°C to 30°C (MHAHE, 2001) and relative humidity ranging from 73 per cent to 85 per cent. The country receives an annual average rainfall of 1,948.4mm. There is considerable variation of climate between northern and southern atolls. Table 4.1 provides a summary of key meteorological findings for Maldives. General studies on climatic conditions of Maldives were taken into account during study as local level time-series data are limited for longer periods at the nearest meteorological station in Hulhule'.

Table 4.1: Key Meteorological Information

Parameter	Data
Average Rainfall	9.1mm/day in May, November 1.1mm/day in February
Maximum Rainfall	184.5 mm/day in October 1994
Average air temperature	30.0 C in November 1973 31.7 C in April
Extreme Air Temperature	34.1 C in April 1973 17.2 C in April 1978
Average wind speed	3.7 m/s in March 5.7 m/s in January, June
Maximum wind speed	W 31.9 m/s in November 1978
Average air pressure	1012 mb in December 1010 mb in April

4.2.2 Monsoons

Monsoons of Indian Ocean govern the climatology of the Maldives. Monsoon wind reversal plays a significant role in weather patterns. Two monsoon seasons are observed: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. Monsoons can be best characterized by wind and rainfall patterns. The southwest monsoon is the rainy season which lasts from May to September and the northeast monsoon is the dry season that occurs from December to February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.

4.2.3 Rainfall

Annual average rainfall in Maldives is about 1900mm. There is a marked variation in rainfall across Maldives with an increasing trend towards south. The annual average rainfall in north is 1977mm and for south is 2470mm.

The southwest monsoon is known as the wet season with monthly average rainfall ranging from 125-250mm. The northeast monsoon is known as the dry season with average monthly rainfall of 50-75mm.

Long term data for Madhiriguraidhoo area are not available. Medium term records in Male' International Airport indicate an average annual rainfall of 1977mm. The possibility of lack of rainfall during drought periods may be a concern for aquifer recharge and terrestrial environment in general.

4.2.4 Temperature

Daily temperatures of Maldives vary little throughout the year with a mean annual temperature of 28°C. The annual mean maximum temperature recorded for Male' during the period 1967-1995 was 30.4°C and the annual mean minimum temperature for the same period was 25.7°C. The highest recorded temperature for Male' was 34.1°C on 16th and 28th of April 1973. The hottest month recorded was April 1975 with a maximum monthly average temperature of 32.7°C, the next highest being 32.6°C in April 1998. The lowest minimum average temperature of 23.7°C was recorded in July 1992.

Average daily temperatures for the Meteorological Station at Hulhule' vary between 26°C and 31°C and hence Palm Beach is expected to have a similar variation.

4.2.5 Wind

Winds affect sedimentation process both during the formation and development of islands. Winds help regenerate waves that are weakened by travelling over reefs and also cause locally generated waves over lagoons. Figure 4.2 shows the wind direction pattern for Malé International Airport from National Meteorological Centre. Winds from the north-east and the east-north-east are predominant during December to February. During March to April the direction varies with the general direction being westerly. Strong winds are associated with the southwest monsoon season. Gales are uncommon, and cyclones very rare in the Maldives. The stormiest months are typically May, June and July. Storms and squalls producing wind gusts of 50-60 knots have been recorded at Malé.

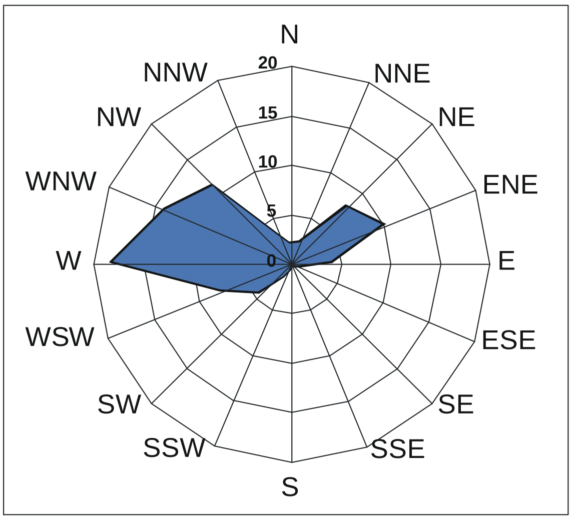


Figure 4.2: General wind rose diagram for the Maldives (source MEEW 2005).

4.3 Oceanography

4.3.1 Waves

Two major types of waves have been reported on the coasts of the Maldives namely; wave generated by local monsoon wind and swells generated by distance storms. The local monsoon predominantly generates wind waves which are typically strongest during April-July in the south-west monsoon period. During this season, swells generated north of the equator with heights of 2-3 m with periods of 18-20 seconds have been reported in the region. Local wave periods are generally in the range 2-4 seconds and are easily distinguished from the swell waves.

Distant cyclones and low pressure systems originating from the intense South Indian Ocean storms are reported to generate long distance swells that occasionally cause flooding in Maldives (Goda, 1988). The swell waves that reached Malé and Hulhule in 1987, thought to have originated from a low pressure system of west coast of Australia, had significant wave heights in the order of 3 metres. Palm Beach could experience the effects of such waves reaching Maldives.

In addition, Maldives was subject to an earthquake generated tsunami reaching heights of 4.0m in December 2004. Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than one occasion, most notable being the 1883 tsunami resulting from the volcanic explosion of Karakatoa (Choi et al., 2003).

4.3.2 Tides

Tides experienced in the Maldives are mixed semi-diurnal and diurnal with a strong diurnal inequality. A tide station at Male International Airport has continuous records of tide for over the past 30 years. The maximum tidal range recorded at this tide station is 1.20m. The highest astronomical tide level is +0.64m (MSL) and the lowest astronomical tide level are -0.56m (MSL) (Table 4.2). No tide records have been made at the project site therefore it has been assumed that the tidal range and patterns at the project site will be same as that at the nearest tide station at Male' International Airport.

Table 4.2: Summary of tide levels at Male' International Airport, Male Atoll

Tide levels	Water level referred to Mean Sea Level (MSL)
Highest Astronomical Tide (HAT)	0.64
Mean Higher High Water (MHHW)	0.34
Mean Lower High Water (MLHW)	0.14
Mean Sea Level	0
Mean Higher Low Water (MHLW)	- 0.16
Mean Lower Low Water (MLLW)	- 0.36
Lowest Astronomical Tide (LAT)	- 0.56

Tides affect wave conditions, wave-generated and other reef-top currents. Tide levels are believed to be significant in controlling amount of wave energy reaching an island, as no wave energy crosses the edge of the reef at low tide under normal conditions. In the Maldives the tidal range is small (1m) and tides have significantly important influence on the formation, development, and sediment movement process around the island. Tides also may play an important role in lagoon flushing, water circulation within the reef and water residence time within an enclosed reef highly depends on tidal fluctuations.

4.3.3 Currents

Studies on current flow within a reef flat in Male' Atoll suggests that wave over wash and tides generate currents across the reef platforms, which are also capable of transporting sediments (Binnie Black & Veatch, 2000). However, available information suggests that tidal currents are not strong due to small tidal range.

Generally current flow through the Maldives is driven by the dominating two-monsoon season winds. Westwardly flowing currents are dominated from January to March and eastwardly from May to November. The change in currents flow pattern occurs in April and December. In April the westward currents flow are weak and eastward currents flow will slowly take place. Similarly in December eastward currents flows are weak and westward currents will take over slowly. Data on current speed and direction around Palm Beach was not measured.

4.4 Marine Environment

This section will look at the marine environment of the island with specific emphasis on areas where outfall pipes and salt water intake pipes are located. Marine environment is defined as the environment from the shore line to the reef line. Marine environment of Palm Beach consists of the shallow lagoon, reef flat and reef slope.

4.4.1 Methodology

The area was assessed through general observations by means of snorkelling. However water conditions were rough and prevented the assessor from making a detailed observation.

4.4.2 Location

The area that was assessed was approximately 25m off the sewage outfall pipe location.

4.4.3 General Observations

Water conditions were shallow and visibility was poor, which in addition to the rough water conditions complicated the assessment procedures. The sewage outfall, brine outfall and desalination intake were all on one side of the island and very close together.

4.4.4 Coral Communities

The area was dominant with *Heliopora coerula* corals, which formed in massive colonies. There were few solitary colonies of *Porites Sp.* However, large areas of dead coral, sand and rubble were eventually more dominant in the area. Approximately 55% of the coral community could be judged as live and 18% of new growths which mainly consists of budding *Acropora* corallites.

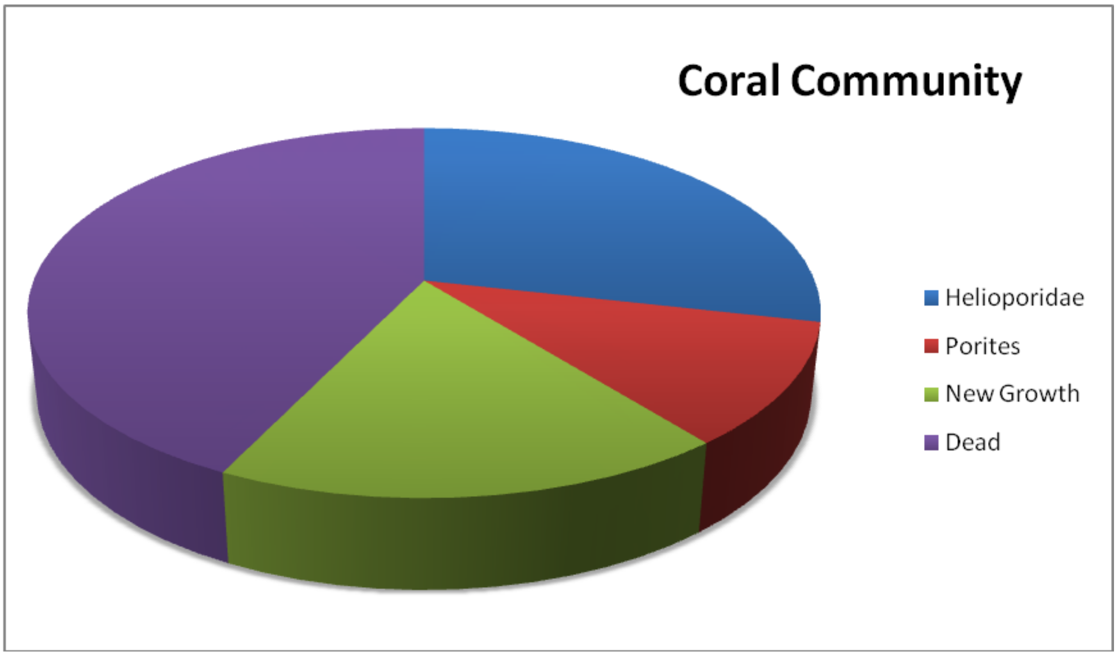


Figure 4.3: Description of coral community found in the area

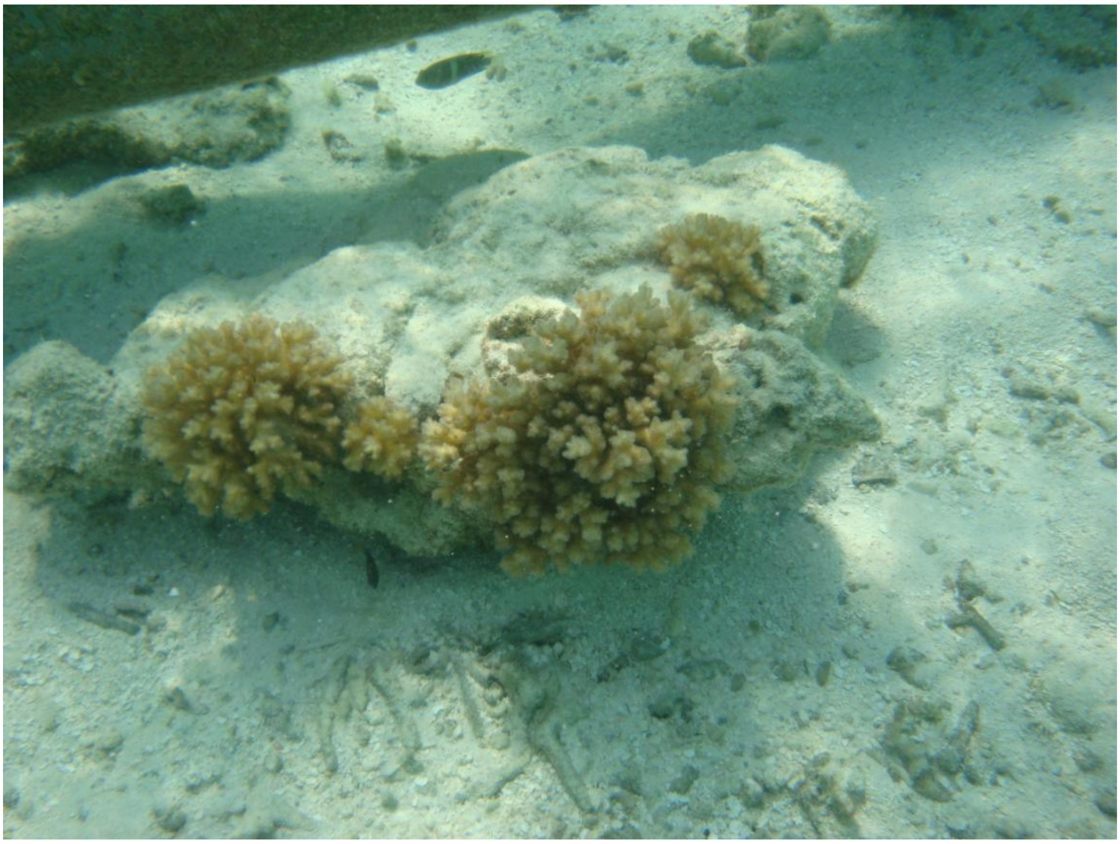


Figure 4.4: Photo showing signs of new growth

Figure 4.5: Photo showing the dominant coral in the area - Heliopora Coerula

4.4.5 Fish Communities

Fish life was generally healthy and mostly evident among the coral colonies. The following tables describes the quantification of the fish communities by using the **DAFOR** scale.

Table 4.3: Quantification of fish communities found in the area

Fish	Quantity
Blue Striped Snapper	Frequent
Silver Sprat	Abundant
Fine-lined Bristle Tooth	Occasional
Six-barred Wrasse	Occasional
Blue-green Puller	Abundant
Bird Wrasse	Rare
Brown Tang	Rare

4.4.6 Marine Water Quality

The marine water quality at the outfalls and intake area was assessed by taking samples from these locations. Samples were assessed from the National Health Laboratory. Table 4.4 below gives the results of the tests. There are no previous water quality surveys to compare these results with. The results show that water quality in the area is generally good.

Parameter Tested	Brine Outfall	Salt Water Intake	Sewage Outfall
Physical Appearance	Clear	Clear	Clear
Chlorine Total (mg/l)	0	0	0
Electrical Conductivity (µs/cm)	47400	47200	47600
Iron (Total) (mg/l)	0	0	0
Nitrate (mg/l)	-	-	0
Chemical Oxygen Demand - COD (mg/l)	1660	1280	1668
BOD*			
pH	8.3	8.3	8.4
Salinity (mg/l)	29100	29100	-
Suspended solids (mg/l)	0	1	0
Temperature (°C)	25.2	25.3	-
Total Dissolved Solids (mg/l)	28400	28400	28600
Phosphorus, Reactive (mg/l)	-	-	0.41
Turbidity (NTU)	0	0	-

Table 4.4: Results of the Seawater Quality Assessment

* Test unable to perform from National Health lab

All parameters identified in the TOR were tested except BOD. BOD was not able to test as the samples could not be delivered to the National Health Laboratory on the same day of sampling due to transportation limitations.

4.5 Terrestrial Environment

4.5.1 Vegetation

The vegetation types and frequency of their occurrence around the powerhouse were assessed through observation. The project area was mainly dominated by Dhivehi Ruh (Cocos nucifera) and Boakashikeyo (Pandanus tectorus). Dhun'buri (Ochrosia borbonica) and Uni (Guettarda speciosa) were found in abundance while frequent occurrence of Dhiggaa (Hibiscus tiliaceus), Hirun'dhu (Thespesia populnea) and Kan'dhu (Hermandia peltata) were found.

Figure 4.6: Photos showing vegetation around the powerhouse area

Table 4.5 below provides a list of the types of vegetation and the frequency of their occurrence found around the powerhouse and desalinated plant building.

Table 4.5: Results of the vegetation assessment

Local Name	Common Name	Scientific Name	Family Name	Occurrence
Boa-kashikeyo	Wild screw pine	*Pandanus tectorus*	Pandanaceae	Dominant
Dhivehi Ruh	Coconut Palm	*Cocos nucifera*	Arecaceae/Palmae	Dominant
Dhun'buri	Corkwood	*Ochrosia borbonica*	Apocynaceae	Abundant
Dhiggaa	Sea/beach hibiscus	*Hibiscus tiliaceus*	Malvaceae	Frequent
Hirun'dhu	Tulip tree	*Thespesia populnea*	Malvaceae	Frequent
Kan'dhu/ Mas Kan'dhu	Jack in the box	*Hernandia peltata*	Hernandiaceae	Frequent
Kaani/Kauni	Sea trumpet	*Cordia subcordata*	Ehretiaceae	Frequent
Midhili/madhu	Country almond	*Terminalia catappa*	Combretaceae	Frequent
Nika/Kiri gas	Banyan tree	*Ficus benghalensis*	Moraceae	Occasional
Uni	Nit pitcha (s)	*Guettarda speciosa*	Rubiaceae	Occasional

4.5.2 Groundwater Quality

Groundwater quality at the impact area was assessed by taking two samples from approximately 5 metres away from the existing powerhouse. Two samples were taken to ensure accuracy and average results of the two samples are presented. Geographical coordinates of the location was recorded using a differential GPS and is presented in Figure 4.1. Samples were tested from the National Health Laboratory and results are presented in Table 4.6. Groundwater assessment was conducted to assess the ambient conditions of groundwater.

Table 4.6: Results of the groundwater Quality Assessment

Parameter Tested	Ground Water (average)	WHO drinking water standard
Physical Appearance	Grey With Suspended Particles	Clear & Colourless
pH	7.7	6.5-8.5
Total Dissolved Solids (mg/l)	546.6	<1000mg/L
Electrical Conductivity (µs/cm)	911	<1500
Sulfate (mg/l)	65.25	
Turbidity (NTU)	23.5	
Hardness, Total (mg/l)	176.9	

As illustrated from the above table, the analysis of groundwater revealed that the groundwater of Palm Beach is in good order apart from the physical appearance and turbidity. Turbidity greater than 30 NTU's indicate poor water quality. The method of sampling may have contributed to the nature of these two results. Samples were taken from a borehole which was dug at the time of sampling and sample was collected before the suspended particles were settled properly.

Oil and grease were not able to test from the National Food and Drug Authority at the time, hence it was not able to determine whether the groundwater at the location of the powerhouse is contaminated with fuel.

No groundwater is used for any purpose in the resort.

4.5.3 Noise

Noise levels around the powerhouse building at a radius of 30 metres (m) and 60 metres (m) were recorded using a handheld sound level meter of 0.1dB resolution. The average noise level around the powerhouse within 30m and 60 m are 55.15dBA and 50.10dBA respectively. Both values are within the range of residential area. During day time, average noise levels inside the desalination plant house was recorded as 89.6dBA and inside the generators room was recorded as 110dBA. Noise level outside the powerhouse and desalination plant building was recorded as 78.7dBA.

Table 4.7: Average noise level around the powerhouse area

Location	Spot Reading/ dB(A)
5°28´03N, 73°33´40E	53
5°28´04N, 73°33´40E	53.8
5°28´04N, 73°33´41E	61.2
5°28´04N, 73°33´40E	65

Outside powerhouse	72.4
Powerhouse – inside generator room	100.5
Powerhouse – inside control room	70.8
Desalination plant room	89.4
5°28´03N, 73°33´42E	55.2
5°28´06N, 73°33´43E	47.5
5°28´07N, 73°33´43E	50.1
5°28´06N, 73°33´42E	50.7
5°28´06N, 73°33´41E	65.4
5°28´07N, 73°33´41E	51.1
5°28´07N, 73°33´40E	48.7
5°28´08N, 73°33´39E	44.7

Figure 4.7: Average noise level around the powerhouse area

4.5.4 Air Quality

General local air quality in Palm Beach was observed to be in pristine condition. Air quality of the Maldives is generally considered to be good and in pristine state. As the islands of the Maldives are small, sea breezes flush the air masses over the islands and refresh air over the islands. Sources of local air pollution are insignificant in Maldives. Smoke and other emissions from the powerhouse are emitted to the atmosphere through a 15 feet high chimney with no additional emission reduction measures.

5 Environmental Impacts and mitigation measures

As noted earlier, there is no baseline assessment of the site since there was no formal EIA undertaken for the development of the resort. This study therefore looks into existing impacts from operations on the powerhouse and desalination plant and mitigation measures that are already in place and which can be used to reduce or manage the negative impacts on the environment.

Impacts can generally be distinguished as direct, indirect or cumulative in nature. However, due to the developments being on the site for the past 10 years, it is only possible, at this stage, to identify the cumulative impacts on the site. Accordingly, this Chapter will describe the cumulative impacts from the existing operations on the site.

5.1 Noise Pollution

The operation of the powerhouse and the desalination plant generate noise that may cause nuisance to those living on the site. Further, continuous exposure to noise levels exceeding 85dBA for more than 8 hours a day is considered hazardous and it is recommended that workers should not be exposed at any time to sound levels exceeding 115dBA, without the use of hearing protectors.

Readings taken from outside the Powerhouse and inside the control room are within the range of industrial zone noise levels. These are the only areas where workers will be exposed to high noise levels for longer periods. At Palm Beach, employees who are working in the powerhouse and desalination plant are provided with ear muffs.

Figure 5.1: Average noise level around the powerhouse area

Sound proofing attenuators (Figure 5.1) have been installed at the powerhouse to reduce the noise level generated by the engines. However, the desalination plant building has not been sound proofed or air-conditioned. There are no boundary walls around the powerhouse building. Boundary walls can significantly reduce the noise level outside the powerhouse building.

There are no baselines standards imposed by either EPA or MEA with regard to power generating equipment especially with regard to emissions such as sound, noise or particulate matter. In the absence of such locally applied standards, international stands have been used to compare the result of the noise measurements taken from Palm Beach. The noise level outside the powerhouse building at the door was recorded as 72.4dBA, which is within the industrial zone noise levels. The average noise level around the building within a radius of 30m conforms to international standards for residential area noise levels.

Table 5.1: Standard noise levels for different zone

Category of Area	Limits in dB (A)	
	Day Time (6 am – 9pm)	**Night Times (9 pm – 6am)**
Industrial area	75	**70**
Commercial area	65	**55**
Mixed residential areas (with industry)	60	**45**
Residential area	55	**45**
Silence Zone	**50**	**40**

Additional mitigation measures that can be taken to further reduce the noise level include, installing silencers and enclosing the powerhouse and desalination building with a boundary wall.

5.2 Impact on Air Quality

Emissions from operation of the powerhouse have the potential to degrade the air quality of the site. The generator sets used at the Palm Beach are fuelled by diesel. The generator sets are properly tuned and maintained. In addition, a 15 feet high chimney installed at the powerhouse reduces the emissions by accumulating particulate matters in the smoke within the chimney. Hence, it can be considered that the impact on air quality due to emissions from the powerhouse is insignificant.

5.3 Impact on Vegetation

The vegetation types and frequency of their occurrence around the powerhouse area are given in section 4.4.1 of this report. *Dhivehi Ruh* and boa *kashikeyo* are the two dominant species in the area. Impact of the powerhouse in terms of heat and emission on the vegetation around the powerhouse building was assessed by visual observation. There was no indication to suggest that the vegetation has been affected by the heat or smoke generated by the power house or the desalination plant.

5.4 Impact on Soil and Water Quality

Potential exists to impact soil and ground water quality due to spillage of fuel. No signs of fuel spill on the ground were observed during the filed visit. The resort currently has significant measures in place to avoid fuel spills during fuel handling. These measures include, having bund walls around the fuel storage tanks and having proper pipelines installed to transfer fuel from the tanker to the storage tanks and subsequently to the fuel day tanks and then to engines.

As radiator cooling systems are used to cool the generator sets, no thermal water is discharged into the marine environment avoiding any impact on the marine environment from thermal pollution. Similarly, the brine discharge from the desalination plant is free from chemicals and other pollutants and does not indicate increased salinity that will affect the quality of the receiving water.

5.5 Uncertainties

Environmental impact prediction or measurement involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. Additionally, uncertainties in impact prediction or measurement also arise due to the lack of long term data, and lack of standard procedures to collect data leading to inconsistent methodologies used by the various EIA consultants.

No EIA has been undertaken during the development of Palm Beach. Accordingly, the uncertainties associated with measuring impacts for this particular audit are due to limited amount and type of baseline data available for comparing the accumulated impacts measured in the study. However, it is unlikely that the limitations would have significant impacts on the outcomes of the findings.

6 Environmental Monitoring

Environmental monitoring would include regular monitoring according to the monitoring schedule given in this report. This monitoring programme for the project includes at least annual monitoring of the following environmental components which will be monitored using scientific methods.

- Annual inspections of the condition of the seawater intake pipe, fuel storage facility, water storage facility, and fuel handling system.
- Waste oil handling and disposal system
- Marine water quality around the brine discharge location. Parameters to be monitored include temperature, salinity, pH, dissolved oxygen, total suspended solids, turbidity and biochemical oxygen demand.
- Ecological aspects related to coral and lagoon benthos: Percent live coral cover and overall health of the reef and lagoon benthos at the intake and outfall locations.
- Groundwater quality at the impacted area – pH, Salinity, oil and grease
- Noise level inside and around the powerhouse and the desalination plant
- Inspection of vegetation around the powerhouse and desalination plant

It is important that information and experience gained through the monitoring activities are fed back into the EIA evaluation and analysis system to improve the quality of future assessment studies.

6.1 Monitoring Programme

This monitoring programme for the proposed project includes at least annual monitoring and covers terrestrial environment as well as marine environment. The following table shows the frequency at which the different parameters may be monitored.

Table 6.1: Proposed Monitoring Time table

Type	Frequency of monitoring	Main Concerns to address	What to monitor
Vegetation	Six monthly	Damage to existing vegetation due to heat or other emissions generated by the power plant or desalination plant.	Loss or damage to the existing vegetation due to heat, smoke or particulate matter.
Soil	Six monthly	Ensure that the power house and desalination	Evidence of soil contamination in high risk

		plant operation activities do not contaminate the soil and land, especially as a result of fuel and chemical storage, transportation handling and use.	locations such as outside the fuel storage area, near the power house building.
Groundwater	Annually	Ensure that the fuel handling activities do not contaminate groundwater aquifer.	Evidence of grease or oil in groundwater at the location where groundwater quality has been tested for this study.
Air and noise	Three monthly	Changes in noise levels and air quality.	Noise and air quality measurements in standard units, from the locations where noise level has been measured for this study.
Waste oil handling	Three monthly	Waste oil generated in the operation are properly handled and disposed of.	Procedure followed in handling and disposing waste oil generated from the operations. Quantify the volume of waste oil generated and disposed on monthly basis.
Marine Ecology	Annually	Ensure that brine discharged into the lagoon does not affect water quality and the ecology of the marine environment.	Percent live coral cover and overall health of the reef and lagoon benthos at the intake and brine outfall locations. Also seawater quality at the same locations.
Structural integrity	Six monthly	Ensure that the fuel storage tanks, oil handling system pipes and pumps, seawater intake and brine outfall pipes are in good condition.	Check the pipelines and the tanks for any leaks or damages.

6.1.1 Commitment

The Proponent is committed to undertake the monitoring according to the monitoring programme given here. In the event that monitoring indicates that any environmental quality is deteriorating to unacceptable levels, the proponent will correct operation procedures that are contributing to the problem and/or undertake necessary engineering installations.

6.2 Monitoring report

A detailed environmental monitoring report is required to be compiled and submitted to the Ministry of Transport, Housing and Environment annually based on the data collected for the monitoring the parameters included in the monitoring plan. This report may be submitted to the relevant Government agencies in order to demonstrate compliance.

The report will include details of the site, strategy of data collection and analysis, quality control measures, sampling frequency and monitoring analysis and details of methodologies and protocols followed.

6.3 Cost of Monitoring

The proponent has fully committed to perform a highest level of commitment for proper management of the project. Environmental aspects of the monitoring work will be subcontracted to competent local consultants. The costs of annual monitoring for the first year are given in Table 6.2.

Table 6.2: Estimated cost breakdown for monitoring the work

No	Details	Unit Cost (USD)	Total cost (USD)
1	Annual Monitoring Fees – assuming three months	750	3,000
2	Transportation, logistics, management and administration		4,000
3	Miscellaneous		500
	Total		**7,500**

7 References

Binnie Black & Veatch, 2000. Enviromental / Technical Study for Dredging / Reclamation Works under Hulhumale' Project - Final Report. Ministry of Construction and Public Works, Male'.

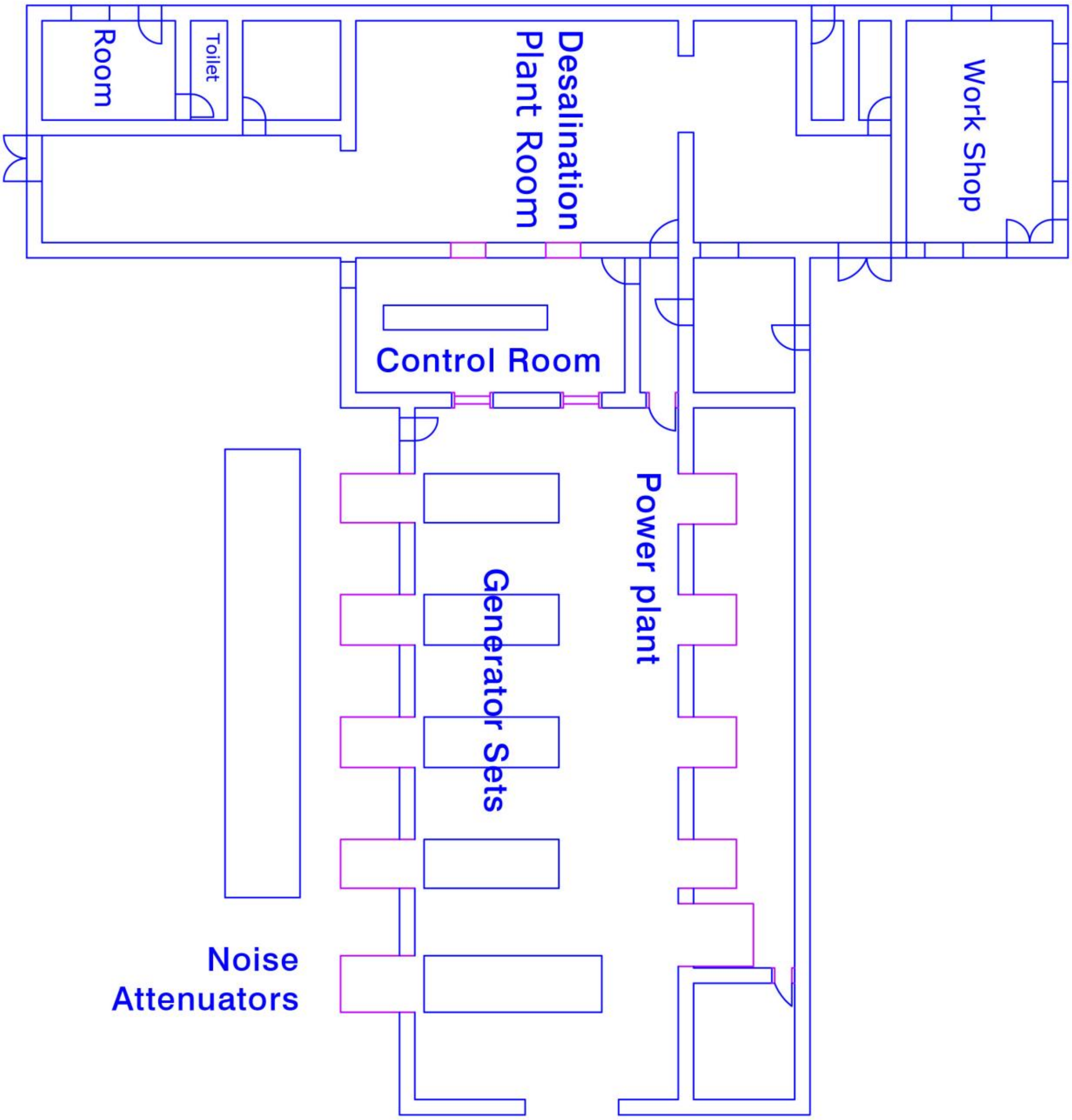
Choi, B. H., Pelinovsky, E., Kim, K. O. & Lee, J. S., 2003. 'Simulation of the Trans-Oceanic Tsunami Propagation Due to the 1883 Krakatau Volcanic Eruption'. Natural Hazards and Earth System Sciences, 3, 321-332.

Goda, Y., 1988. Causes of High Waves at Male' in April 1987. Department of Public Works and Labour, Male, Maldives.

MHAHE, 2001. Maldives State of the Environment 2001, Ministry of Home Affairs, Housing and Environment, Male'.

MEEW, 2005, State of the Environment Report 2004: Male', Ministry of Environment, Energy and Water.

8 Appendix 1 – Layout of the powerhouse and desalination plant



9 Appendix 2 – Terms Of Reference

Environmental Protection Agency

EPA

Environmental Protection Agency

Male', Republic of Maldives

Terms of Reference for the Environmental Impact Assessment on Existing Desalination Plant and Powerhouse and related infrastructure in Palm Beach Resort & Spa, Lhaviyani atoll, Maldives.

The following TOR is based on the points discussed in the scoping meeting held on the 13th December 2009, for undertaking the Environmental Impact Statement report for the existing desalination plant and powerhouse and related infrastructure in Palm Beach Resort & Spa, Lhaviyani atoll, Maldives.

This document is a legally binding document prepared after consultation with all relevant stakeholders and the EIA report must strictly follow the activities under this ToR.

1. <u>Introduction</u> – The Ministry of Transport, Housing and Environment requires that desalination and power plants in the Maldives are registered. In order to carry out the registration process, environmental clearance is required from the EPA, i.e. a Decision Statement regarding the environmental impact assessment of the power and water infrastructure. In order to provide such clearance the EPA requires that an Environmental Impact Assessment be done for proposed new or upgrading projects and an Environmental Audit be done for existing facilities. Since there are no upgrading or additional components to the desalination and power infrastructure in Palm Beach, it was decided that an Environmental Audit will be done for the purpose of registering the desalination and power infrastructure in Palm Beach.

2. <u>Study Area</u> – The study will be focused on the power and desalination infrastructure existing on the island of Palm Beach, Lh. Atoll. The specific areas include powerhouse with stacks and immediate vicinity affected by noise and emissions and oil handling areas, the desalination plant including the seawater intake, plant housing, storage facilities and brine discharge locations.

3. <u>Scope of Work</u> - The following tasks will be performed:

<u>Task 1. Description of the Project</u> - Provide a brief description of the proponent, full description of the relevant parts of the project, using clearly labeled maps, scaled site plan including location of existing powerhouse, desalination plant, outfalls and saltwater intake.

For the powerhouse provide details of the area of powerhouse, number of and capacity of generator sets, height of smokestack, method of generator sets cooling, power plant cooling water discharge outfall if any, emissions control measures, location and capacity of fuel tanks, condition of fuel tanks and fuel handling methods.

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For the desalination plant provide details of area of the plant room, number of and capacity of desalination plants, method of saltwater intake and, location and length of brine discharge outfall.

Provide a brief description of the existing safety measures in place in case of an emergency.

Task 2. Description of the Environment - Where baseline data is to be collected, careful consideration must be given to the design of the methodology and sampling programme. Data collection must focus on key issues needing to be examined for the EIA. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that the data collected is suitable for use as a baseline to monitoring impacts.

Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area (and disposal sites).

a) Physical environment: meteorology (rainfall, wind, waves and tides), sea currents, surface hydrology, climatic and oceanographic conditions in the discharge area. Brief description of groundwater quality at the powerhouse and desalination plant location. Marine water quality at the location of intake and brine discharge locations. Marine water quality parameters shall include dissolved oxygen, COD, BOD, E-Conductivity/salinity and pH. Groundwater quality shall include dissolved oxygen, TDS or E-Conductivity, THC, COD, BOD, nitrate and phosphate. Quality of the product water from desalination plant shall also be assessed, especially for pH, E-Conductivity and coliform bacteria (E-coli and Total coliforms). Describe of the general status of the groundwater in terms of the size and quality of the water lens

b) Biological environment: Assessment of coral cover along the pipe if the brine discharge or intake pipe or part of the pipe runs on reef areas where live corals can be found. Describe the terrestrial vegetation in the audit area.

c) Human environment: Identify the noise levels in the vicinity and how they affect recreational quality and public and occupational health. Also identify if the existing power house emissions have any negative impact on the living, recreational and working environment.

Characterize the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts. All available data from previous studies of the island, if available should be presented. Geographical coordinates of all sampling locations should be provided. All water samples shall be taken at a depth of 1m from the mean sea level or mid water depth for shallow areas. The report should outline the detailed methodology of data collection utilized to describe the existing environment. Baseline conditions should be presented for the marine environment

An average of at least 5 measurements must be given for each parameter tested and analyzed from a certified laboratory. Provide details of calibration for any onsite data analysis.

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Task 3. Legislative and Regulatory Considerations - - *Describe the pertinent national legislation, regulations and standards, and environmental policies that are relevant and applicable to the audit, and identify the appropriate authority jurisdictions that will specifically apply to the audit. Determine how well the existing infrastructure complies with existing environmental policies and regulations.*

Task 4. Determine the Environmental Performance and Compliance of the Project –*Identify operational impacts of the powerhouse and desalination plant facilities. Identify if the brine is discharged in appropriate location and if exhaust emissions are appropriately discharged. Discuss the short term as well as long term effects of any emissions or discharges on the environment, especially the health of the staff. Identify any information gaps and evaluate their importance for decision-making. Distinguish between significant impacts that are positive and negative, direct and indirect, and short and long term. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making.*

Task 5. Mitigation and Management of Negative Impacts – *Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to intake system, brine disposal, emission and noise control and operation and maintenance issues. Cost the mitigation measures, equipment and resources required to implement those measures. A commitment regarding the mitigation measures should be submitted by the responsible person.*

Task 6. Monitoring Plan – *Identify the critical issues requiring monitoring to ensure compliance to energy management and water quality regulations and standards. All requirements for reporting shall be identified and a comprehensive monitoring plan with the cost and commitment of the Proponent to conduct the monitoring programme shall be provided. A detailed reporting time table and ways and means of undertaking the monitoring programme must be provided.*

Task 7. Methodology Explain clearly the methodologies used for data collections, making predictions and data gaps and also the information on the uncertainties and assumptions involved in interpreting the data.

Presentation - *The environmental impact assessment report, to be presented in print and digital format, will be concise and focus on significant environmental issues. It will contain the 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, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2007.*

Timeframe for submitting the EIA report - *The developer must submit the completed EIA report within 3 months from the date of this Term of Reference.*

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16 March 2010

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10 Appendix 3 – CVs of Consultants