ENVIRONMENTAL IMPACT ASSESSMENT

For the proposed redevelopment of Island Hideaway at Dhonakulhi Island Resort, Haa Alif Atoll, Maldives

Proposed by

Turquoise pvt Limited

Prepared by

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For Water Solutions Pvt. Ltd., Maldives

March 2011

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2 Declaration of the consultants

This EIA has been prepared according to the EIA Regulations 2007, issued by the Ministry of Environment, Energy and Water. The EIA was carried out by a multidisciplinary consulting team representing Water Solutions Private Ltd. In preparing this report, no data has been manipulated. All data has been collected by field visits.

We certify that the statements in this Environmental Impact Assessment study are true, complete and correct.

Name: Abdul Aleem (EIA 09/07)

Signature:

Name: Ahmed Jameel (EIA 07/07)

Signature:

3 Non Technical Summary

This report discusses the findings of an environmental impact study undertaken by Water Solutions Pvt. Ltd. for the proposed redevelopment of Island Hideaway resort at Dhonakulhi Island in Haa Alif Atoll.

Dhonakulhi is formed on its own reef system. The island is located at about latitude of 6°50'40.54"N and longitude of 73° 3'4.15"E. The island is formed on an isolated coral reef system, almost round in shape and east of another triangular shaped reef called Mathifaru. The reef is on the northern rim of Haa Alif Atoll. The house reef on south eastern side is approximately 200 m from the island's southern side and varies between 30 to 60 meters on the western side. On the west of the island's house reef is a narrow channel approximately 100 meters wide and with an average depth of 20 meters at the deepest part. This narrow channel separates Mathifaru and the reef of Dhonakulhi and is well known to have very strong currents.

The proposed redevelopment consists of two major components, namely over water development and development on land. Over water development consists of constructing a new set of water villas (different categories), over water restaurants, and a presidential suit, while the redevelopment activities on land includes new developments on the island. Following are the major components of this development:

- Development of 74 new water villas with an access jetty (over water).
- Development of the pool bar (on land).
- Construction of new junior staff quarters (on land).
- Upgrading and extension of theatre bar and disco (on land).
- Construction of new senior staff bungalows (on land).
- New Japanese / Thai restaurant (over water).
- New Arabic restaurant (over water).
- New presidential suit (over water).
- New owners villa (on land)
- New conference hall (on land)

Environmental impacts of the proposed redevelopment works have been examined through a number of processes. The report has identified that the impacts of the redevelopment process will mainly be felt on the marine and coastal environment. Impacts on the marine environment will be felt through sedimentation and siltation caused by the construction activities on the lagoon during this period. Impacts on the coastal environment will be felt as a result of developing new structures on the lagoon resulting in alteration of the sediment and long shore patterns. Fortunately, the lagoon where new water villas will be developed does not contain much live corals. On the

overall, the redevelopment process will have the greatest impacts during the construction period. Terrestrial impacts are not going to be significant, but there will be vegetation clearance to some extent to make way for new land structures. The resort's redevelopment plan have been designed and developed to increase the number of guest rooms without disrupting the existing guest rooms on the island. The guest rooms on Dhonakulhi have been developed with lot of space and privacy for each room, which is the defining characteristic of the resort. Large rooms, with complimentary services and facilities like private decks, pools, living space and bar per each guest room requires lot of space which cannot be compromised. Such compromises will affect the special requirements for the existing guest villas on the island. Therefore the goal of the developers is to create additional room without disturbing this balance in the island. Hence, all new guest rooms will be developed over water.

A significant impact will also be felt with the increasing demand for water and energy production. With the additional facilities and services offered, there will be a higher demand for energy. Production of increased amounts of water will also require more energy and thus there will be an overall increase in the emission of green house gases.

Several mitigation measures have been identified including working in low tide hours, proper supervision. In addition, limiting construction to the minimum time period possible and a management and monitoring plan has also been identified as mitigation measures. These measures are proposed in order to mitigate the impacts on the coral reef and generally the marine environment.

Finally, the report provides a conclusion which outlines the alternatives, the mitigation measures and the environmental monitoring that will be undertaken in Dhonakulhi Resort.

4 Introduction

This Environmental Impact Assessment report (EIA) has been prepared to fulfil the requirements of the Environmental Protection and Preservation Act, law no. 4/93 for the proposed redevelopment of the Island Hideaway Resort at Dhonakulhi island, located in south Ari Atoll. The island of Dhonakulhi is a luxury island resort hotel well known for its luxurious, spacious private rooms and the first yacht marina in Maldives. The island is also popular as one of the most naturally beautiful islands in the north region of Maldives.

4.1 Structure of the EIA

The report has been structured to meet the requirements of the EIA regulations 2007 issued by the Ministry of Environment, Energy and Water. Hence, the report will provide an executive summary at the beginning. The report will then have a project description in detail, existing environmental conditions, justifications given by the proponent for undertaking the proposed project components and alternatives. Alternatives to proposed components or activities in terms of location, construction methods and technologies, design and environmental considerations would be suggested. A mitigation plan and monitoring programme before, during and after the works will be outlined at the end.

The major findings of this report are based on qualitative and quantitative assessments undertaken during site visit in January 2012. However, due to unavailability of long term site-specific data, the impact assessment methodology has been restricted to field data collected, consultations, experience and professional judgment and field data taken on site. In addition, satellite photos have also been used to study the geography and environmental changes.

4.2 Aims and Objectives of the EIA

The objective of the report is to:

- Assist in mitigating impacts caused due to the construction of additional over water structures as well as other modifications in the island without undertaking EIA by the previous owner.
- Promote informed and environmentally sound decision making.
- To demonstrate the commitment by the proponent on the importance of environmental protection and preservation.
- To fulfill the obligations of the proponent to undertake an EIA under Clause 5 of the Environmental Protection and Preservation Act of the Maldives and requirements of the Tourism Regulations.

- Undertake the project work with minimum damage to the environment.

4.3 EIA Implementation

This EIA has been prepared by a local environmental consulting firm, Water Solutions. Water Solutions have been chosen by the proponent as the environmental consultants for this project. The team members were:

- Abdul Aleem, BSc, MPH – Mapping and GIS (EIA-09/07)
- Ahmed Jameel, B. Eng (Environmental), MSc – Environmental (EIA-07/07)
- Faruhath Jameel, BSc, - Surveying science
- Hamdhulla Shakeeb, - Assistant Surveyor.

4.4 Terms of Reference

Terms of Reference for the this assessment has been included in the Appendix of this report

5 Project Setting

This section outlines the relevant environmental legislation pertaining to this project.

5.1 Applicable Policies, Laws and Regulations

5.1.1 Environmental Protection and Preservation Act

The Articles of the Environmental Protection and Preservation Act (Law No. 4/93) addresses the following aspects of environmental management:

- Guidelines and advice on environmental protection shall be provided by the concerned government authorities.
- Formulating policies, rules and regulations for protection and conservation of the environment in areas that do not already have a designated government authority already carrying out such functions shall be carried out by MEEW.
- Identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation.
- An EIA shall be submitted to MEEW before implementing any developing project that may have a potential impact on the environment.
- Projects that have any undesirable impact on the environment can be terminated without compensation.
- Disposal of waste, oil, poisonous substances and other harmful substances within the territory of the Maldives is prohibited. Waste shall be disposed only in the areas designated for the purpose by the government.
- Hazardous / Toxic or Nuclear Wastes shall not be disposed anywhere within the territory of the country. Permission should be obtained for any trans-boundary movement of such wastes through the territory of Maldives.
- The Penalty for Breaking the Law and Damaging the Environment are specified.
- The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment.

The proposed redevelopment project will fully abide to the Environmental Preservation and Protection Act. Disposal of oil, chemicals and other hazardous materials will be strictly controlled and managed. Such materials will not be disposed in to the local or the regional environment, but will be transported to designated waste disposal site, such as Thilafushi.

5.1.2 Second National Environnent Action Plan (1999)

The aim of NEAP II is to protect and preserve the environment of the Maldives and to sustainably manage its resources for the collective benefit and enjoyment of present and future generations.

Main strategies of the NEAP II are:

- Continuous assessment of the state of the environment in the Maldives, including impacts of human activities on land, atmosphere, freshwater, lagoons, reefs and the ocean; and the effects of these activities on human well-being.
- Development and implementation of management methods suitable for the natural and social environment of the Maldives, and maintain or enhance environmental quality and protect human health, while at the same time using resources on a sustainable basis.
- Consultation and collaboration with all relevant sectors of society to ensure stakeholder participation in the decision making process.
- Preparation and implementation of comprehensive national environmental legislation in order to provide for responsible and effective management of the environment.
- Adhering to international and regional environmental conventions and agreements and implementation of commitments embodied in such conventions.

NEAP II specifies priority actions in the following areas.

- Climate change and sea level rise; coastal zone management;
- biological diversity conservation; integrated reef resources management;
- integrated water resources management;
- management of solid waste and sewerage;
- Pollution control and management of hazardous waste;
- sustainable tourism development;
- land resources management and sustainable agriculture
- Human settlement and urbanization.

NEAP II contains environmental policies and guidelines that should be adhered to in the implementation of the proposed project activities.

The redevelopment of Dhonakulhi island will also be in accordance with the main strategies of the NEAP II. The monitoring programme proposed in this report outlines the environmental management strategy and plan. This EIA has also been

prepared in consultation with all the key stakeholders. Therefore, these measures address the key strategies outlined in the NEAP II.

5.1.3 National Biodiversity Strategy and Action Plan

The goals of the National Biodiversity Strategy and Action Plan are:

- Conserve biological diversity and sustainably utilize biological resources.
- Build capacity for biodiversity conservation through a strong governance framework, and improved knowledge and understanding.
- Foster community participation, ownership and support for biodiversity conservation.

In implementing the proposed project activities due to care has to be given to ensure that the national biodiversity strategies are adhered to. The proponent has committed fully on conservation and protection of the environment while undertaking this proposed project. More specifically, the coral reef and generally the marine environment have been assessed in detail in order to assess baseline values. Quantitative and qualitative surveys were undertaken to assess the biological diversity of the coral reef, especially in close proximity to the proposed development area. Hence, development of the water villas will take in to account the conservation of biological diversity. Practical mitigation measures and solutions have been identified to conserve and protect the biodiversity.

5.1.4 Protected Areas and Sensitive Areas

Under Article 4 of the Environment Protection and Preservation Act, the Ministry of Environment is vested with the responsibility of identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation. At present there are no rules and regulations made available to the public on designation and protection of habitats and heritage areas.

The redevelopment is proposed in the island of Dhonakulhi. There are no protected sites or resources such as protected birds and trees in the island environment. However, the island is known as a breeding and nesting ground for turtles. At present, the resort management has a policy of maintaining these nesting areas as tourist attractions and staff and guest are given information and education about the protection of these sites on a day to day basis. These measures will be followed during the redevelopment phase also as this is an important component of the resort concept.

5.1.5 Waste management policy

The Ministry of Environment, Energy and Water has developed the framework for a national waste management policy. The key elements of the policy include:

- Ensure safe disposal of solid waste and encourage recycling and reduction in waste generated.
- Develop guidelines on waste management and disposal and advocate enforcing these guidelines through inter-sectoral collaboration.
- Ensure safe disposal of chemical, industrial and hazardous waste.

The key objective of the waste management policy would be the formulation and implementation of guidelines and means for solid waste management to maintain a healthy environment.

Waste management for the proposed project has been considered during the construction and operational stage. Since the island is being redeveloped, measures are already in place to manage the waste during operational period, such as incineration and regular transfer of waste to Thilafushi. There is already an established waste management mechanism in the island. Similarly, during the redevelopment process, waste management strategies have been developed, details of which are outlined in the report. Therefore, this project will also confirm to this policy. During the construction stage, all green waste will be transported to the island of Theefaridhoo in Haa Dhaalu Atoll, approximately 10 kms south of Dhonakulhi island. This island is an agricultural island operated by the parent company that operates and manages Dhonakulhi. Hence, the green waste will be used for the various agricultural activities in this island. All other construction waste will be transported to Thilafushi.

5.1.6 Regulation on sand and aggregate mining

This regulation addresses sand mining from uninhabited islands that have been leased; sand mining from the coastal zone of other uninhabited islands; and aggregate mining from uninhabited islands that have been leased and from the coastal zone of other uninhabited islands.

Neither sand nor aggregate will be mined for this project. This regulation would not have any implication on the proposed project.

5.1.7 Ban on coral mining

Coral mining from the house reef and the atoll rim has been banned through a directive from the President's Office dated 26th September 1990. According to these policies,

- coral mining is not to be carried out on island house reefs;
- coral mining cannot be carried out on atoll rim reefs and common bait fishing reefs;
- coral or sand mining is only allowed from designated sites, and approval from the concerned Atoll Office is required prior to the commencement of any mining operation.
- requests for coral or sand mining from residents of inhabited islands are required to be submitted to the Atoll Office through their respective island office
- the island office is required to estimate the quantity of corals required for the applied construction work and hence this ensures that permission is granted to mine just the required amount;
- Every island is required to keep a log book of the amount of corals mined.
- sand mining is not allowed on the beaches of inhabited islands, islands leased for industrial developments and tourist resorts and within the lagoons adjoining these islands.

Coral and sand would not be mined in any stage of the project.

5.1.8 Tourism Act (Law no. 2/99)

This Act provides for the determination of zones and islands for the development of tourism in the Maldives:

- the leasing of islands for development as tourist resorts,
- the leasing of land for development as tourist hotels and tourist guesthouses,
- the leasing of places for development as marinas,
- the management of all such facilities; and
- the operation of tourist vessels, diving centres and travel agencies, and
- the regulation of persons providing such services.

5.1.9 Ministry of Tourism Regulations and Circulars

The Tourism Regulations in the Maldives ensure that carrying capacity of the island and atoll ecosystems are well within limits and the negative effects of the development are minimal. The Ministry also issues circulars on several occasions and

when necessary to discourage activities such as sand and coral mining, developing on the coastal environment and waste disposal which may cause harm or damage to the natural environment, which is the main tourism product.

Tourism regulations strictly discourage modifications to the natural movement of sand around the islands. Therefore, Tourism Regulations require that special permission from the Ministry of Tourism and Civil Aviation be sought before commencing any coastal modification works on any tourist resort. It is also stated that hard engineering solutions are not encouraged and construction of solid jetties and groynes be controlled and shall only be undertaken after conducting an Environment Impact Assessment study. Similarly, design of boat piers, jetties and other such structures are required to be in such a way that these shall not obstruct current and sediment circulation patterns of the island.

The Ministry also issues circulars on several occasions and when necessary to discourage activities such as sand and coral mining, developing on the coastal environment and waste disposal which may cause harm or damage to the natural environment, which is the main tourism product.

All over water structures proposed to be developed in Dhonakulhi island will conform to this regulation. The conceptual plan and drawings have been approved by the Tourism Ministry.

5.2 Framework for Environmental Assessment

The enforcement of EIA regulation in the country began with the formulation of the Environmental Protection and Preservation Act (Law 4/93) in April 1993 in order to protect, preserve and safeguard the fragile environment of the country. The Environmental Act gives very high prominence towards safeguarding the environment with regard to all the development activities and is currently being implemented by the Environment Protection Agency of the Ministry of Housing and Environment. The Ministry was formed few years ago and its mandate includes:

- organizing, developing and managing systems for environmental monitoring, including periodically evaluating the actual state of the environment, and forecasting environmental changes;
- evaluating environmental impact assessment reports of new projects and monitoring reports for existing facilities;
- issuing and revoking certificates based on compliance with environmental standards;

According to article 5 (a) of the Act, an Environmental Impact Assessment shall be submitted to the Ministry of Environment, Energy and Water according to guidelines formulated by the Ministry before implementing any activity that may have an adverse impact on the environment. The Ministry shall determine projects that need such assessment. This umbrella law gives the Ministry the right to terminate projects that have undesirable impacts or claim compensation for damages caused by activities that are detrimental to the environment.

This project fully complies with this law as all necessary permits have been undertaken and this report is submitted in order to obtain the necessary EIA Decision Note.

5.2.1 Environmental Impact Assessment Regulation 2007

The Ministry of Environment, Energy and Water has issued new EIA regulation on May 2007, which guides the process of undertaking the Environmental Impact Assessment in the Republic of Maldives – This guideline also provides a comprehensive outline of the EIA process, including the roles and responsibilities of the consultants and the proponents. This regulation outlines every step of the IEE/EIA process beginning from application to undertake an EIA, details on the contents, minimum requirements for consultants undertaking the EIA, format of the EIA/IEE report and many more.

The guidance provided in this Regulation was followed in the preparation of this EIA report. The EIA has also been prepared by registered consultants.

5.2.2 Post EIA Monitoring, Auditing and Evaluation

The environmental monitoring programme given in EIA reports is an important aspect of the EIA process. The monitoring programme outlines the objectives of the monitoring; the specific information to be collected; the data collection program, and managing the monitoring program. Managing the monitoring programme requires assigning institutional responsibility, reporting requirements, enforcement capability, and ensuring that adequate resources are provided in terms of funds, skilled staff, etc.

The monitoring programme outlined in this report will comply with the EIA Regulations 2007.

5.3 Relevant International conventions, treaties and protocols

5.3.1 The Montreal Protocol on Substances that Deplete the Ozone Layer

The Montreal Protocol on Substances That Deplete the Ozone Layer is a landmark international agreement designed to protect the stratospheric ozone layer. The treaty was originally signed in 1987 and substantially amended in 1990 and 1992. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere; chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform--are to be phased out by 2000 (2005 for methyl chloroform). Scientific theory and evidence suggest that, once emitted to the atmosphere, these compounds could significantly deplete the stratospheric ozone layer that shields the planet from damaging UV-B radiation.

Redevelopment of Dhonakulhi island will not involve use and consumption of any substances banned in this convention. Even during the operational stage of the resort, compounds or substances that contain ozone depletion will not be imported.

6 Project Description

6.1 Project Proponent

The project is presented by Turquoise Pvt Ltd. The company is a Maldivian registered company that aims to operate and manage luxury resort properties in Maldives. The goal of the company is to create, develop, showcase and sustain high quality resorts within the luxury segment of the Maldives, offering the discerning traveller a unique Maldivian experience and continue to sustain the reputation of creating unique and special concepts & philosophies, which will cater to specific market segments worldwide. The company's mission is to:

- Continue to explore market gaps in key source markets and bridge this gap with fine exclusive products , so as to capture this specific market segment
- Continue to give emphasis on the market positioning of the individual resort and ensure that all is done to sustain this positioning
- Sustain the quality and service delivery of the unique concepts created , by constantly focusing, developing and upgrading the product, the personnel profile and the service delivery
- Ensure at all times, that there is no duplication of product concepts and make sure that the individual resorts cater to specific market segments and do not compete against each other
- Invest in the right personnel with the right experience and attitude, to take forward the philosophies and ensure that the local resort management never strays away from the core vision and the final product is always at par with the original philosophy

At present, the company owns and operates Lily Beach Resort in Alif Dhaal Atoll and Dhonakulhi island in Haa Alif Atoll.

6.2 Project Location and Study Area

The project takes place in the island of Dhonakulhi located on the northern periphery of Haa Alif Atoll. Dhonakulhi island is approximately 250 miles North from Malé International Airport.

6.3 Geography

Dhonakulhi is a physically large crescent-shaped island with a beach length of approximately 1.4 kilometres on each side and with a width of 500 metres. The island is a typical Maldivian island, with lush vegetation and variety of introduced species. The island generally has less coconut trees that are mostly concentrated on the central areas. In addition to coconut trees, banana trees and lush vegetation, the hotel Island is

covered by uniquely rich dense bushy vegetation, which has been one of the defining features of the resort. The Island is unique in its reef formation. The reef system sits on having a natural channel splitting it in two distinct parts, and thereby forming a natural harbour for a marina on the western side. On the west of the channel is Mathifaru, a large reef west of the narrow channel which protects the western side of the island during most part of the north-west monsoon. This reef is the main reason for the calm conditions prevailing for the resort's marina..

Dhonakulhi is formed on its own reef system. The island is located at about latitude of 6°50'40.54"N and longitude of 73° 3'4.15"E. The island is formed on an isolated coral reef system, almost round in shape and east of another triangular shaped reef called Mathifaru. The reef is on the northern rim of Haa Alif Atoll. The house reef on south eastern side is approximately 200 m from the island's southern side and varies between 30 to 60 meters on the western side. On the west of the island's house reef is a narrow channel approximately 100 meters wide and with an average depth of 20 meters at the deepest part. This narrow channel separates Mathifaru and the reef of Dhonakulhi and is well known to have very strong currents.

The closest island to Dhonakulhi is Mulidhoo, an uninhabited island, which is roughly 3.8 km west of Dhonakulhi. The closest resort island is Alidhoo which is located approximately 11 km east. The island is approximately 8.3 km west of Dhiddhoo, Atoll capital of Haa Alif Atoll. Dhonakulhi has a beautiful and easily accessible house reef.

6.4 Need and Justification to redevelop the island

Tourism in the Maldives is rapidly expanding with tourist arrivals increasing at about 60% between 1990 and 1995 and about 50% from 1995 to 2000. However, the tsunami of December 2004 has left the industry crippled requiring additional infrastructure and investments. Therefore, there was the need to create added capacity to cater for the growing tourism industry in the Maldives. In 2011, the government introduced the tax system for tourist resorts based on the land area. Dhonakulhi island was initially developed with limited guest villas in the island, the goal was to keep them large spacious in order to provide the unique luxury and privacy. At the time, the rents were based on number of rooms. However, with the introduction of the tax based on land area, it is economically not feasibly for the owners to operate the resort at the present level of limited rooms. Hence, in order to offset the increase in rent due to the large land area, the owners decided to develop additional guest rooms that would not compromise the existing guest rooms on the island. Hence, the only

practical option for this was to develop over water villas which would not affect the existing guest villas on the island.

Hence, the strategy that would be used for the redevelopment is to create additional over water guest rooms (water villas / bungalows), upgrading of some of the existing infrastructure, create new staff and back of house facilities, develop new restaurants and increase the capacity of the Junior and senior Staff Accommodation and to increase and upgrade the existing services. In order to be competitive in the market, diversifying the services available in the island is urgently required that will come with the expansion. Therefore, the present sewage treatment plant will be further upgraded and staff quarters and facilities will be upgraded in addition to other improvements. Having additional beds in the resort will be economically feasible to invest for upgrading the property to be competitive in the market. In addition, Maldives Tourism Industry will be benefited in terms of bed capacity and its income.

6.5 Project duration and boundary

A proposed project schedule is attached as an annex. For the redevelopment, the resort operation will be closed.

6.6 Existing Facilities in the Resort

The site plan attached with the report has a detail description and illustration of all the existing facilities on the island as well as all the new infrastructure that will be developed as part of the redevelopment process.

6.7 Overview of the overall re-development

The proposed redevelopment consists of two major components, namely over water development and development on land.

Over water development consists of constructing a new set of water villas (different categories), over water restaurants, and a presidential suit, while the redevelopment activities on land include new buildings and modification of some structures. Following are the details of these:

- Development of 74 new water villas with an access jetty (over water).
- Development of the pool bar (on land).
- Construction of new junior staff quarters (on land).
- Upgrading and extension of theatre bar and disco (on land).
- Construction of new senior staff bungalows (on land).
- New Japanese / Thai restaurant (over water).
- New Arabic restaurant (over water).

- New presidential suit (over water).
- New owners villa (on land)
- New conference hall (on land)

6.8 Redevelopment concept and Built Environment

The philosophy of the proposed resort re-development is to preserve and protect the unique natural assets of Dhonakulhi and develop a nature based ultimate retreat on the island for the luxury traveller by integrating the island's breathtaking environment for rejuvenation and rediscovery. In this process, the existing island environment will be modified minimally.

The basic design concept is to protect the environment of the island and it's surrounding through the introduction of innovation and co-evolvement. The design concept of the proposed resort re-development on the island is to:

- Create the ultimate luxury eco retreat for the rich and famous on an island of unrivalled beauty with different categories of accommodation available, both on land and on water.
- Protect and preserve the island's environment and to create a nature reserve on part of the island. Hence, no additional rooms will be developed on the island.
- Minimise the impact on the environment by integrating the development into the island's environment and develop an environmental management system specifically for the island.
- Promote and practice the government policy of sustainable tourism and making as strong marketing tool.
- Strive for resource conservation, encourage the use and delivery of environment-friendly goods and services, and adopt a green procurement policy.
- Optimise the efficient use of resources such as water and reduce waste in order to minimise the negative impacts on the environment and environmentally conscious high end holiday seekers
- Apply the environmental best practice whenever and wherever possible.

6.8.1 Land clearance

All new buildings on the island have been planned and located so as to minimize disruption to the natural environment of the island. The concept adopted in the site planning is to have 'minimal de-landscaping' for construction of new buildings and to maintain the mature vegetation rather than artificial landscaping. During the clearing of areas for new buildings, all the existing mature trees, most

importantly coconut trees will be retained and will only be relocated if it is absolutely necessary. Under this activity vegetation will be cleared and all trees available in the area will be cut and removed. It is intended to preserve some trees, where possible on the plots and relocate trees to other areas on the island, most importantly large coconut trees. While during clearing and site setting, buildings will also be adjusted slightly if large coconut trees can be avoided without cutting them. Therefore the total number of trees to be cut down will be less the estimated maximum amount. However this will be quantified during the project.

6.8.1.1 Methods of clearance and vegetation waste disposal

The trees (both large and small) will be cut using chain saws aided by excavators and other tools. The trees will be then be chopped into smaller parts by using chain saws and will be stockpiled on site. The green waste, tree parts and green waste will then be transported to the island of Theefaridhoo for disposal.

All waste generated from vegetation clearing will be green waste from trees and tree parts. The green waste will be managed by disposing them to another island. Theefaridhoo is an agricultural island in Haa Dhaal Atoll managed by the parent company that operates Dhonakulhi. Hence, the green waste will be used in their agricultural activities, such as enrich the soil and use of timber parts for various uses among others. Since green waste is organic no major environmental problems are anticipated from disposing this waste. A no objection letter indicating the owners consent to dispose green waste to Theefaridhoo island is attached as an annex.

6.8.2 Construction of New Water Villa

Seventy four (74) new water villas will be constructed on the south east side of the island.

6.8.2.1 Methods of construction and machinery

Water villas will be constructed on pine poles with concrete footings. The poles with the concrete footings will be transported to the location with the aid of a high neck excavator during low tide. Surveyors will mark the location and each pine pole will be located at their respective location. Construction of the villas will then be done once the poles are connected using truss and the decking. Water villas will be constructed using prefabricated material, that is wooden structures.

6.9 Environmental Infrastructures

6.9.1 Energy Generation

Power will be generated by diesel generators installed at the island. The diesel generators installed under the redevelopment will be the type that are commonly used in the Maldives and have low emission and high thermal efficiency. Hence Diesel will be the main source of energy at the island.

Electricity for the proposed resort will be generated via KVA generator sets.

Fuel storage tanks of the resort will be constructed with appropriate bunding wall to contain the fuel in case of spill and oil recovery trenches at the power house floors. The bunding will hold 110% of the total capacity of the fuel tank.

The existing power generation capacity at the resort is as follows. There are 4 generators in the resort.

1- One generator with a capacity of 1 MW

2- Two generators with a capacity of 500 KV

3- One generator with a capacity of 400 KV

The generators are placed at the back of house (refer to the site plan) and the fuel is periodically transported from the supply jetty to the storage tanks. At present the generators are not used all at once, leaving one generator always as a backup plan in case of emergency. The villas and other areas utilize low energy consuming bulbs in places where appropriate including the bar and the restuarnts.

The diesel storage is located close to the power plant and has an allowance of 3 weeks of generator operation at 75% load. The enclosure of the storage tanks has the capacity to retain 110% of the total volume of the tanks. The floor has a slope towards a collecting point and a drain valve is installed on the external side of the enclosure.

As part of the upgrading three additional generators will be purchased.

1- One generator of 1250 KVa

2- Two generator with a capacity of 1000 KVa

6.9.2 Sewage and waste water

A sewage treatment plant, is already installed at the resort which will be enough to cater for the additional loads as the system has not reached its capacity. The purpose of this STP is to provide treatment of all sewage generated during the

construction and operation phase. The sewage treatment plant as designed according to the following assumptions.

Characteristics of the influent	
Parameter	Control Limits
COD	700 ppm
BOD5	350 ppm
PH	6.5 – 7
Nitrates as N	15 ppm
TDS	650 ppm
Chlorides	80 mg/L
Sulphates	20 mg/L
Colour	2000 Pt.Co
Oil in Water	80 mg/L
Expected characteristics of the effluent	
Suspended Solids	30 ppm
COD	120 ppm
BOD5	40 ppm
PH	5-9
Nitrates as N	15 ppm
TDS	2000 ppm
Chlorides	250 ppm
Sulphates	500 ppm
Chromate chromium	Nil
Colour	20 Pt.Co
Oil in Water	10 mg/L
Phosphrous	2 mg/L
Ammoniacal N	15 mg/L

Table 1: Characteristics of sewage

6.9.3 Disposal of the effluent

The effluent of the STP will be discharged via the sea outfall indicated in the illustrations provided in the marine environment section.

6.9.4 Water Production

At present, the island has three RO plants with the following water generation capacity.

1- Two units of RO plant with 150 tons per day capacity

2- One unit of RO plant with 300 tons per day capacity

With the redevelopment, the new capacity of water production would increase by an additional 225 tons per day.

The new system will be housed in the same building as the existing systems and the product water will be integrated in to the existing system.

Emergency water supply plan

The water storage will be constituted of one tank. The total volume of the water storage will be equivalent to 3 days of the estimated total consumption.

6.9.5 Solid Waste Management

It is common practice in the Maldives that all wastes be dumped to a known location for incineration. A specific boat will be needed for the transportation of wastes to Thilafushi island and the number of trips will depend on the waste volume produced by the hotel. During the construction stage, all demolition and construction waste will be regularly transported to Thilafushi on cargo dhoni's. During the operational stage, the following will be used to treat other wastes on the island: Incinerator, Glass Crusher, Shredder – for organic disposal, Composter and Compactor.

6.10 Construction Schedule, Process and Methodology

Construction is expected to begin in March / April 2012 upon receipt of the building permit and EIA approval. As soon as the EIA is approved and a decision statement is issued, the project activities will initiate, including finalizing contractors and other issues. Mobilization of the workforce will begin from then onwards (transporting materials and arranging other logistics). Materials such as concrete, timber and other building construction materials will be transported to the island. They will not be stored on the beach. They will be stored on land and protected from rain. All the empty space available in the island will be utilized such as the soccer field to store materials. Refer to the site set up plan attached as an annex of this report.

6.10.1 Construction Strategy

The construction will be undertaken in the planned time period to reduce cost and also reduce the environmental damage. Construction of over water structures will be undertaken starting from close to the island and moving away.

6.10.2 Work Methods for Over Water Structures

All new water villas, and their corresponding walkway will be constructed on pine poles with concrete footings. This method involves fixing the poles encased with a concrete footing. The footings will then be placed on their fixed locations and connected by the supporting horizontal truss. Once these horizontal trusses are in

place, then construction of the water villa structure will be undertaken. Afterwards, plumbing, electrical and fire networking lines will be laid.

6.10.3 Work Methods for Activities in the Island

The redevelopment includes vegetation clearing, construction of new structures and modification of existing structures. Modification is proposed mainly to disco bar which will be expanded. No land clearing is expected for this component.

6.10.4 Management of Waste

The executive arrangements in place for managing construction stage waste is simply by stockpiling the waste for the shortest duration possible in the island and then transport periodically to Thilafushi. This operation is not expected to be disrupted and the management of the waste will not be a significant issue. Waste will be transferred to Thilafushi once a month. Method of disposal of green waste has been described earlier in the

6.10.5 Expected Environmental Conditions during the Project Implementation Period

The project activities will take place mainly in south-west (SW) monsoonand hence, environmental conditions are expected to be both favourable and unfavourable during the construction period. However due to unpredictable weather conditions associated with global warming and climate change, there may be an event of a storm or bad weather during the construction period. As the water villa construction will be on the south east side, the lagoon is expected to be mostly calm during SW monsoon as this side will be protected by the island during most part of SW monsoon.

However, despite this, the strategy would be to complete the water villa columns as soon as possible and to avoid most part of their construction before regular rains begins. This would give more window for construction workers to undertake other works rather than causing delays due to bad weather. The most difficult part of the construction would be placing the water villa footings for over water structures, especially in bad weather.

6.10.6 Risks Associated with the Project

There are few risk factors associated with this project that could possibly have both financial and environmental implications. The most significant risk associated is not completing the work on time and causing delay in reopening the island.

There is also the risk of project delays caused by bad weather. The construction period falls towards the beginning of the south-west monsoon which is the wet season, unpredictable rainfall and storms are expected. This risk can be minimized if the footings of the water villas and the jetty could be completed within the minimum period. However, it is unlikely that this could be completed by the end of June/July 2012 and hence, does not provide a reasonable safe working window. This risk will also be minimized by awarding the contract to only experienced contractors with experience in working in similar situations. Therefore, work delays will be least impacted.

The most important risk associated with this project is the possible damage to the marine environment as a result of not only construction of over water structures, but due to the overall construction process. Although the water villas are proposed in south east lagoon, the mobilization of equipment, movement of labour in and out of the island and use of lagoon for various other purposes will definitely be a risk. There is also the risk of environmental abuse by unskilled workers during the construction period. Such activities in other resorts under construction in Maldives have been well documented and associated with foreign and local labour force, mainly unskilled. Some of these activities and risks include, walking on the reef, fishing, feeding fish and marine life etc. These risks can be minimized by awarding the contract to experienced contractors and for those who can manage the labour force and control these activities and provide environmental protection plans and adhere to them.

In Dhonakulhi island, the lagoon where water water villas are proposed is clear lagoon and has very limited or less live corals. Therefore, this it is not possible cause any damages which is a huge advantage in this island. However, sedimentation of the lagoon will be a risk and will impact the coral reef indirectly.

6.11 Project Inputs and Outputs

6.11.1 Project Inputs

The types of resources that will go into the project and from where and how these will be obtained are given in table 1 & 2.

Input resource(s)	Source/Type	How to obtain resources
Construction workers 200	Maldivians and foreigners	Open bidding by advertising in local papers/other sources
Water supply (construction period)	100 m3/day desalination plant	Existing capacity is 600m³/day desalinization unit
Electricity/Energy (construction period)	1000 KVA generator capacity in the island	Existing Diesel generators in the island
Construction machinery	Floating barge, concrete mixer, excavators, dump trucks and general	Local suppliers

	construction tool	
Telecommunications	Island's Phone Systems, Fax Machines, E-mail and internet facilities	Already these services are available in the island
Transport (sea)	Sea transport by dhoni and speed boats. Materials to be transported in cargo vessels/dhoni or large barges. All construction debris will be transported to Thilafushi via cargo vessels/dhoni	Already established.
Food and Beverage during construction period	Mainly imported sources except a few locally available.	From the resort
Fuel, Kerosene and LPG	Light Diesel, LPG Gas, Petrol, Lubricants	Local suppliers and from the resort

Table 2: Matrix of Major Inputs during Construction Period

6.11.2 Project Outputs

The type of outputs (products and waste streams) and what is expected to happen to the outputs are given in the Table below.

Products and waste materials	**Anticipated quantities**	**Method of disposal / Control**
Sewage and wastewater	Estimated to be at 150 litres/person/day	Utilize the existing disposal system in the resort and also the STP installed during the construction stage.
Grey water/laundry wastewater	Estimated to be at 50 litres/person/week	Existing wastewater system.
Construction waste from construction activities, mainly timber and other building materials.	6000 cubic meters of debris in total and general construction waste.	Debris once a month sent to landfill in Thilafushi. All green waste to be disposed to Theefaridhoo island. Green waste to be transported to Theefaridhoo island.
Waste oil and grease	50 to 75 litres per month	Stockpiled and sent to landfill in Thilafushi.
Noise	Localised to the island environment	Fencing the construction area and barricading the boundary.
Air pollution	Limited quantities of dust	Mainly arising as a result of dust emission from the construction work such as cement mixing, carpentry work, vehicle movement etc and other processes. Only localised to the island environment only.

Table 3: Matrix of major outputs of environmental significance during construction stage

7 Methodology

This section outlines the methodologies used in this environmental assessment. The following table outlines a matrix of methodologies used in this project. Details of these methodologies and their descriptions are attached as an annex.

Methodology type	**Area / environmental aspect**	**Used in this project (yes/no)**
General methodologies of data collection	Generally covering the broader Environment	Yes
Mapping and location identification	Coastal, terrestrial and marine environment.	Yes
Marine Environmental survey	**Marine environment**	
50 m Line Intercept transect (LIT)	Marine environment	Yes
50 m photo quadrate analysis	Marine environment	No
Qualitative assessment of the reef	Marine environment	Yes
Permanent photo quadrate	Marine environment	No
Ref fish visual census	Marine environment	Yes
Marine Water Quality	Marine environment	Yes
Coastal Environment	Coastal Environment	Yes
Shoreline and vegetation line mapping	Coastal Environment	Yes
Coastal structures mapping	Coastal Environment	Yes
Erosion and accretion areas mapping	Coastal Environment	Yes
Beach profiles	Coastal Environment	Yes
Drogues and current	Coastal Environment	Yes
Terrestrial Environment	**Terrestrial environment**	
Terrestrial floral survey	Terrestrial environment	Yes
Terrestrial faunal survey	Terrestrial environment	No
Groundwater assessment	Terrestrial environment	Yes
Bathymetry	Marine / Coastal Environment	Yes
Aerial Photos	Generally covering the broader Environment	Yes
Long term weather data	Generally covering the broader Environment	Yes

8 Existing General Environment of Maldives

This section outlines the general environmental conditions in Maldives, including the climatic settings, tides, wind and wave. As there are no specific such data for individual islands, these data will form the basis for describing the conditions for the islands of the Maldives. The data collection on climate, tide and waves are undertaken from weather stations based strategically throughout the Maldives, including Male' international airport, Gan International airport, Kaadehdhoo Airport and Hanimaadhoo airport.

8.1 Meteorological Conditions

Meteorology at Maldives is monitored by the Maldives Meteorological Service (MMS) through three stations as detailed below. The stations monitor rainfall, temperature, wind and tide levels at the islands. The secondary data presented in this section has been sourced from recordings of MMS monitoring stations.

Location	Latitude	Longitude	Tide gauge
National Meteorological Centre, Malé	04.19°N	73.53°E	Yes
Haa Dhaal Hanimaadhoo Meteorological Office	06.75°N	73.17°E	Yes
Laamu Kadhdhoo Meteorological Office	01.86°N	72.10°E	No

Table 4: Geographical Coordinates of the Meteorological Centres in Maldives (Source: Maldives Meteorological Service)

Hourly meteorological data was also collected for Hulhule (MIA) for the period 1990-2009. The data includes parameters such as atmospheric pressure, temperature, humidity, wind speed and direction and precipitation which is provided in the subsequent section

8.2 Climatic Setting

Maldives is located at the equator and experiences monsoonal climate. Maldives has two distinct seasons; dry season (northeast monsoon) and wet season (southwest monsoon). In these two seasons the temperature remains more or less the same. . Northeast monsoon extends from January to March. Since Maldives consists of small islands and are surrounded by sea, hot days are often tempered by cooling sea breezes and evening temperatures drops. Throughout the year, temperature remains almost same in the Maldives. However, daily temperature ranges from around 31^{o}C in daytime to 23^{o}C in night-time. The mean daily maximum temperature for Central parts (Hulhule) of the Maldives is 30.5^{o}C and minimum temperature is 25.7 ^{o}C. On the other hand, mean daily maximum and minimum temperature for South (Gan) is 30.9^{o}C and 24.5 ^{o}C, respectively.

The wet season- southwest monsoon runs from mid-May to November. In this season Maldives experiences torrential rain. Central, Southern and Northern parts of the Maldives receive annual average rainfall of 1924.7mm, 2277.8mm, and 1786.4mm, respectively. The highest rainfall ever recorded in the Maldives with in 24 hour period was on 9th July 2002 at Kaadedhdhoo Meteorological Office and amounts to 219.8mm of rainfall. Maldives being located at the equator, receives plentiful of sunshine throughout the year. On average Southern atolls (Gan) of the Maldives receives 2704.07 hours of sunshine each year. Furthermore, on average central (Hulhule) parts of the country receives 2784.51 hours of sunshine per year. The relative humidity in Maldives ranges from 73% to 85%.The monthly average sunshine and rainfall is presented in the figure below:

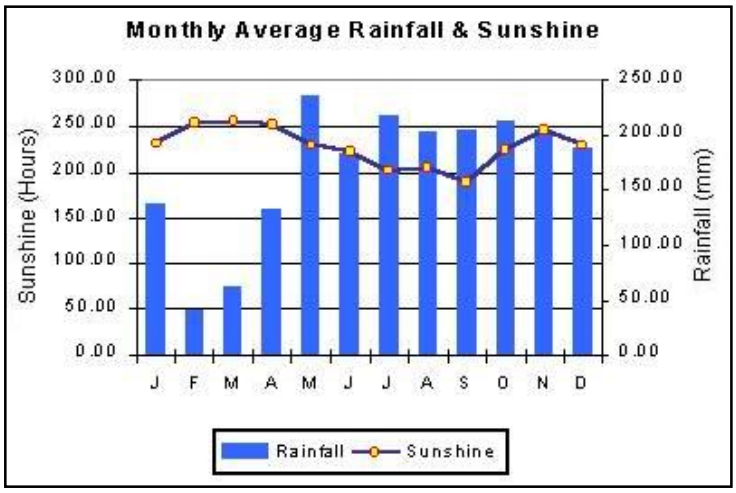


Table 5: Monthly Average Rainfall and Sunshine(Source: Maldives Meteorological Service)

The month wise rainfall data for Maldives recorded for the month of 2009 is as provided below:

Locality	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Male'	2,201	85.2	12.8	36.8	86.6	175.1	213.3	275.9	416.4	193.3	107.5	409.2	189.4
Hanimaadhoo	1,635	2.6	7.6	31.5	55.5	145.4	156.6	218.7	234.8	177.3	83.9	234.4	286.9
L.Kadhdhoo	2,158	58.3	193.1	30.9	149	244.5	187.7	42	295.3	165.4	203.8	336.1	252.5
Kaadedhdhoo	2,023	242.7	50	60.5	124.3	307.3	32.5	83.2	318.1	180.8	188	155.2	280.6
S.Gan	2,307	247.3	23.6	54.1	134.6	253.7	105.1	252.8	165.2	224.9	322	261.3	263.1
Source: Maldives Meteorological Service													

Table 6: Month-wise Rainfall Data for Maldives, 2009

8.3 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.

Locality	Yearly Avg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AVERAGE OF DAILY MAXIMUM TEMPERATURE (oC)													
Male'	31.1	30.5	31.0	31.9	31.7	31.7	31.2	31.2	30.3	30.7	31.6	30.6	30.6
HDh.Hanimaadhoo	31.3	30.7	31.5	32.4	32.1	32.1	31.1	30.9	30.6	30.8	31.6	31.0	31.1
L.Kadhdhoo	31.3	30.6	30.7	32.1	32.3	32.2	31.3	31.4	30.6	31.3	31.4	30.8	30.9
GDh.Kaadedhdhoo	31.1	30.8	31.0	31.8	31.6	31.6	31.1	31.1	30.4	31.1	30.9	30.2	30.9
S.Gan	31.1	30.7	31.1	31.7	31.5	31.2	31.1	30.9	30.6	31.2	31.1	30.5	31.3
AVERAGE OF DAILY MINIMUM TEMPERATURE (oC)													
Male'	26.3	25.8	26.1	27.1	26.9	26.7	26.6	26.2	25.2	26.1	26.7	25.8	26.0
HDh.Hanimaadhoo	25.5	24.6	24.2	25.5	26.3	27.3	26.0	25.4	25.5	25.8	25.3	25.2	24.7
L.Kadhdhoo	25.7	25.8	24.6	26.0	26.6	26.7	26.1	26.1	25.0	26.1	25.6	25.1	24.7
GDh.Kaadedhdhoo	24.6	24.6	24.5	24.6	25.4	25.1	25.2	24.4	23.8	24.6	24.2	24.4	24.6
S.Gan	25.4	25.2	25.5	25.9	25.8	26.0	25.8	24.9	24.7	25.6	25.0	24.9	25.2
Source: Maldives Meteorological Service													

Table 7: Details of the average daily maximum and minimum temperature of Maldives for 2009.

8.4 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.

8.5 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.

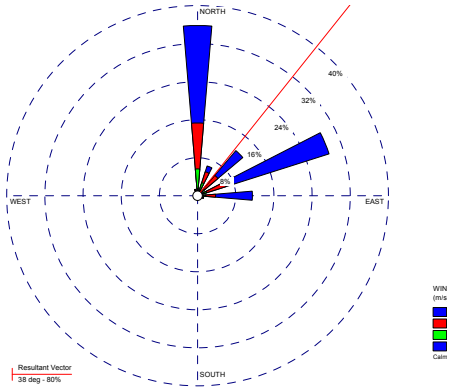
Rainfall records indicate an average annual rainfall of 2500mm. The intensity of rainfall is a concern in the Maldives since intensity is high with low frequency. Excessive rainfall is not a concern for Ziyaaraifushi since the island does cup towards the middle.

8.6 Wind Conditions

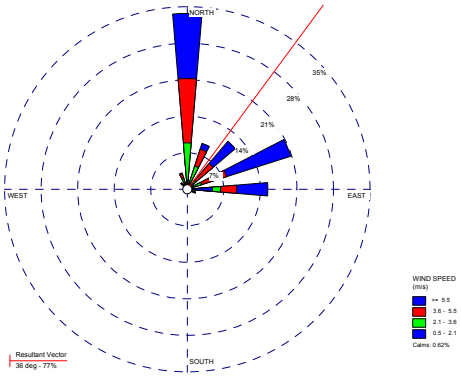
The National Meteorological Center for Maldives provides data for wind speed as recorded at Hulhulé meteorological station, for the period 1990-2010. The month wise windrose for the period of 20years

Table 8: Monthly Wind Rose Diagrams for Hulhulé Station, 1990-2010

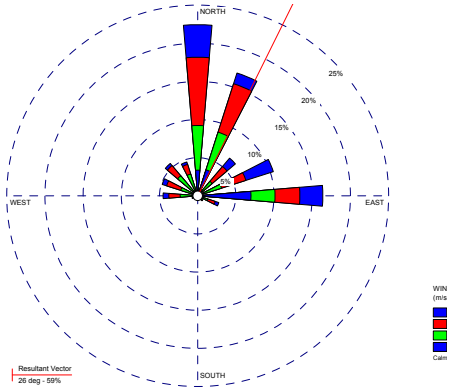
January



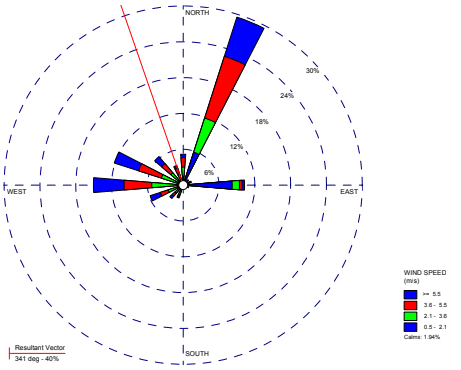
February



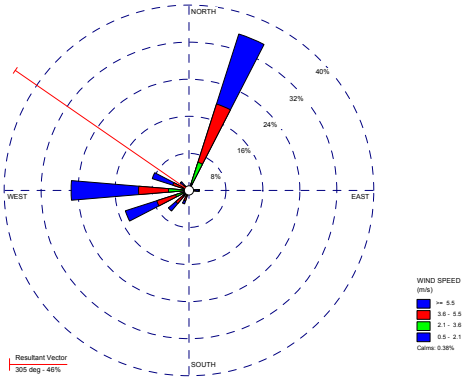
March



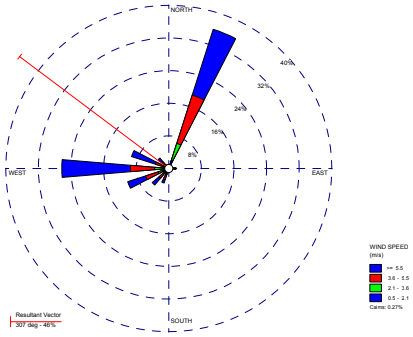
April



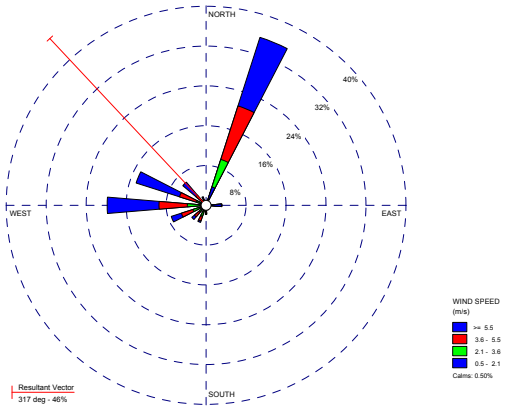
May



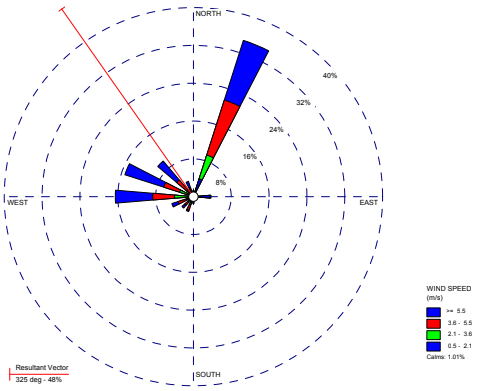
June



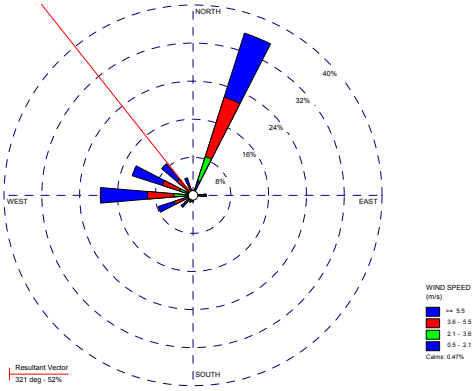
July



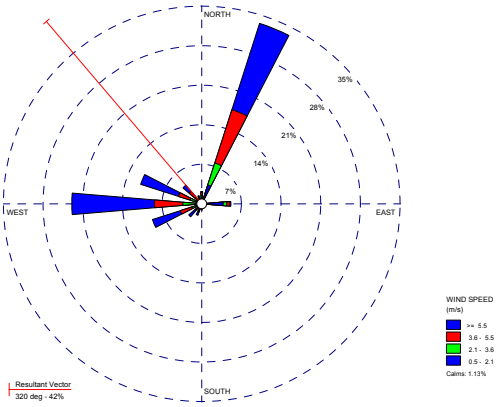
August



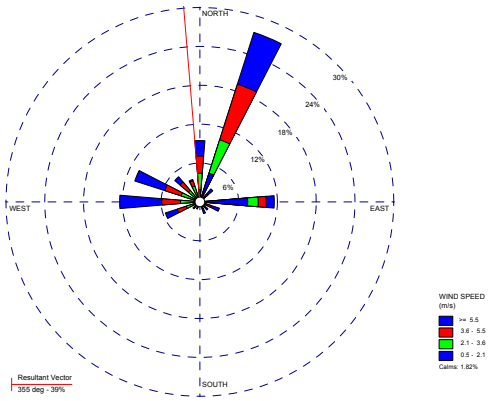
September



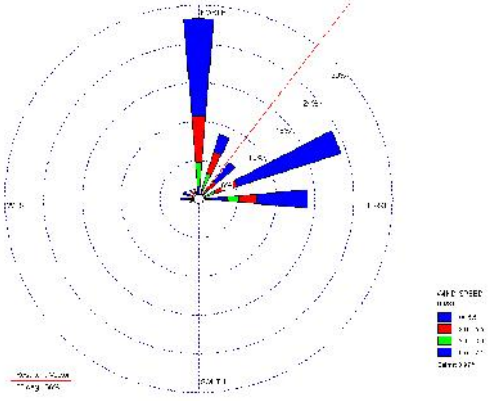
October



November



December



Source: National Meteorological Center, Maldives

The figure below illustrate the wind rose for Kaadhehdhoo from 1980 to 2006.

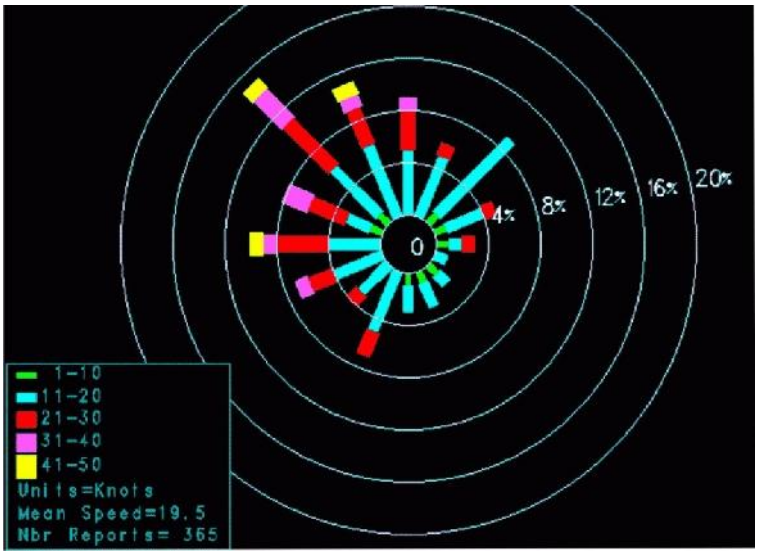
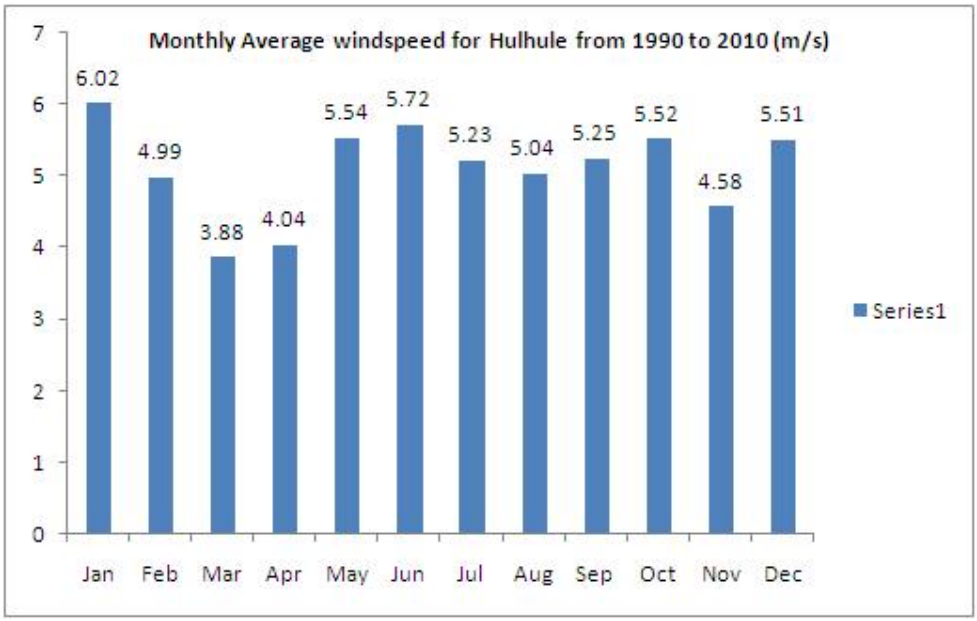


Table 9: Percentage of average wind direction for Kaadhedhoo (1980-2006)

8.7 Wind Speed

The average monthly wind speed over last 10 years at Hulhulé has been derived from the above windrose diagrams and presented in table below. The maximum average wind speed has been observed in the month of January and lowest in March.

Table 10: Average Monthly Wind Speed of Hulhulé (1990-2010)



8.8 Wind Direction

The predominant wind direction throughout the year is from North and North-East. The calm periods are low at less than 2% throughout the year. The month wise breakup of the wind direction and the resultant vector for Hulhule is provided in the following table.

Month	Predominant Directions	Calm Percentage	Resultant Vector
January	North (36%) Followed by East North East	0.27%	North East (35°)
February	North (34%) Followed by East North East	0.62%	North East (36°)
March	North (22%) Followed by North North East	1.95%	North North East (26°)
April	North North East (29%) Followed by West	1.94%	North North West (341°)
May	North North East (36%) Followed by West	0.38%	North West (305°)
June	North North East (36%) Followed by West	0.27%	North West (307°)
July	North North East (36%) Followed by West	0.50%	North West (317°)
August	North North East (36%) Followed by West	1.01%	North West (325°)
September	North North East (36%) Followed by West	0.47%	North West (321°)
October	North North East (34%) Followed by West	1.13%	North West (320°)
November	North North East (28%) Followed by West	1.82%	North West (320°)
December	North (36%) Followed by East North East	0.97%	North East (38°)

Table 11: Monthly Wind Direction (1990-2010)

The above table presents the seasonal distribution of wind statistics, sourced from Globocean database. The following periods have been defined in the database:

- December to March: NE Monsoon
- April: Transitional season - 1
- May to October: SW monsoon
- November: Transitional season - 2

Season >		NE Monsoon	Transitional Season 1	SW Monsoon	Transitional Season 2
Wind Directional Sectors		Dec. to March	April	May to Oct.	November
S1	N15°-N105°	71.35	15.28	1.43	23.96
S2	N105°-N225°	6.13	16.55	17.65	17.62

S3	N225°-N315°	8.42	56.74	77.61	41.11
S4	N315°-N15°	14.10	11.44	3.32	17.31
Source: Globocean database from 1993 to 2004					

Table 12: Wind Occurrence Frequency per Directional Sectors (%)

These results clearly indicate the prevailing directional sectors during the monsoon seasons:

- N15° to N105° during the NE monsoon, with about 71% of the observations,
- N225° to N315° during the SW monsoon, with about 78% of the observations.

8.9 Waves

Wave energy is important for sediment movements and settlement, and it is also a crucial factor controlling coral growth and reef development. Waves have been attributed to the diversity and the abundance of coral and algal species. These aspects have implications for the type and perhaps the supply of sediment s into the island.

Studies by Lanka Hydraulics on Malé reef indicated that two major types of waves on Maldives coasts: 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. 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.

In addition, Maldives has recently been subject to earthquake generated tsunami reaching heights of 4.0m on land (UNEP, 2005). Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than one occasion, most notable been the 1883 tsunami resulting from the volcanic explosion of Karakatoa.

Season	Total	Long Period	Short Period
NE - Monsoon	Predominantly from E-S. High Waves from E	From S-SW	Mainly E-NE. High waves from E
Transition Period 1	Mainly from SE-E	From S-SW	Mainly from NE-SE

Season	Total	Long Period	Short Period
SW - Monsoon	From SE-SW. Mainly from S. Medium waves also from W	From S-SW	Mainly from SE-S. High waves from E
Transition Period 2	As SW monsoon	From S-SW	From SE-W. Higher waves from E

Table 13: Summary of Wave Condition for Hulhule region

8.10 Tides

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 where the tidal range is small (1m), tides may 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.

8.11 Tide Datum

Tide data is important information in any costal development project as it determines the elevation of the structures relative to a datum. A permanent tidal record stations has been established at Malé International Airport by Maldives Meteorological Services. 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 is -0.56m (MSL).The following table gives a summary of the tide levels for the tide datum that has been widely used in Maldives.

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

Table 14: Summary of the Tide Levels Hulhule Island, Male Atoll

8.12 Tide levels

The tidal regime is semi-diurnal with diurnal inequalities (twice daily). That means 2 high tides and 2 low tides per day, with different heights. Typical spring and neap tidal ranges are approximately 1.0 m and 0.3 m, respectively.

Table below gives the tidal levels in islands of Maldives, including Malé, as sourced from Admiralty Tide Tables for 2007.

	Geo. Coordinates		LAT	MLLW	MHLW	MSL (ML)	MLHW	MHHW	HAT
	Lat. (°N)	Long. (°E)							
Standard Port: Cochin (West coast of India)	9° 58'	76° 16'	-0.2	0.3	0.6	0.6	0.8	0.9	1.2
Maldive Islands									
Ihavandhoo	6° 57'	72° 55'	-	0.3	0.6	0.68	0.9	1.0	-
Goidhoo Atoll	4° 51'	72° 55'	-	0.3	0.5	0.6	0.8	0.9	-
Girifushi	4° 19'	73° 55'	-	0.3	0.4	0.58	0.7	0.9	-
Malé	4° 11'	73° 31'	-	0.3	0.5	0.65	0.8	0.9	-
Vattaru	3° 15'	73° 24'	-	-	-	0.7	0.9	1.0	-
Source: Admiralty Tide Tables, 2007									
Note: LAT - Lowest Astronomical Tide; MLLW - Mean Lower Low Water; MHLW - Mean Higher Low Water; MLHW - Mean Lower High Water; MHHW - Mean Higher High Water; HAT - Highest Astronomical Tide									

Table 15: Maldives Tidal Level (in mm)

8.13 Sea Level Rise

The Maldives, being a low lying small island state, is very vulnerable to climate change and its associated impacts, especially sea level rise. Although the country contributes only 0.001% of global GHGs, it is one of the most susceptible to climate change impacts. The average elevation of Maldivian islands is 1.5 m above mean sea level (MSL). More than 80% of the land area of Maldives is less than 1 m above MSL. The Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report predicts that sea-level rise of up to 0.88m by 2100 will submerge the Maldives completely.

Malé International Airport on Hulhulé Island is the only gateway to the Maldives. The height of the runway is only 2 m above MSL and is extremely vulnerable to climate change related sea level rise. The University of Hawaii Sea Level Center (UHSLC) monitors and gathers data on mean sea level for several stations including Hulhulé. The following graphs show the trend of monthly mean sea level as monitored at Hulhulé station for the period 2007 to 2010.

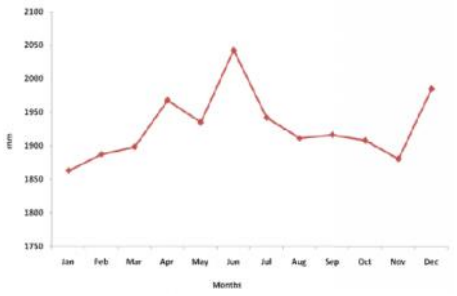
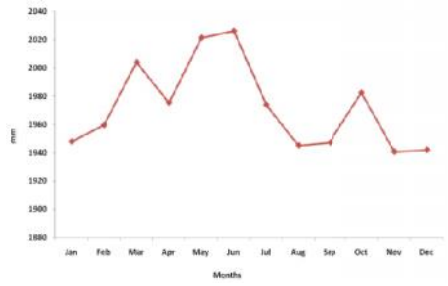
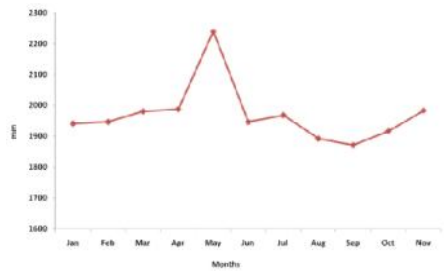
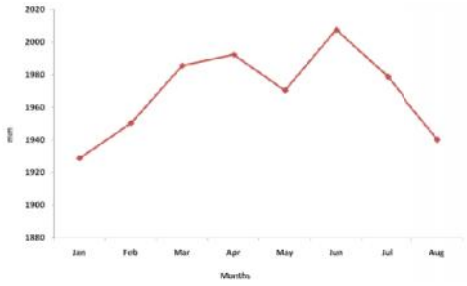
Year 2007	Year 2008
	
Year 2009	Year 2010
	
Source: University of Hawaii Sea Level Center (UHSLC)	

Table 16: Mean Sea Level (in mm) from University of Hawaii Sea Level Center

The present estimates for the sea level rise at the Maldives due to the climatic changes are in order of about 0.5 cm per year. This is based on the fact that the sea level has risen 20cm over the past century (MHHE, 2001).

8.14 Currents

Several currents affect the Maldives Islands. These currents are divided mainly into ocean currents and tidal currents. The ocean currents are stronger than the tidal currents.

A general view of the seasonal current patterns in the Indian Ocean is shown below. The currents flow westward during the northeast monsoon period, and they flow eastward during the southwest monsoon period.

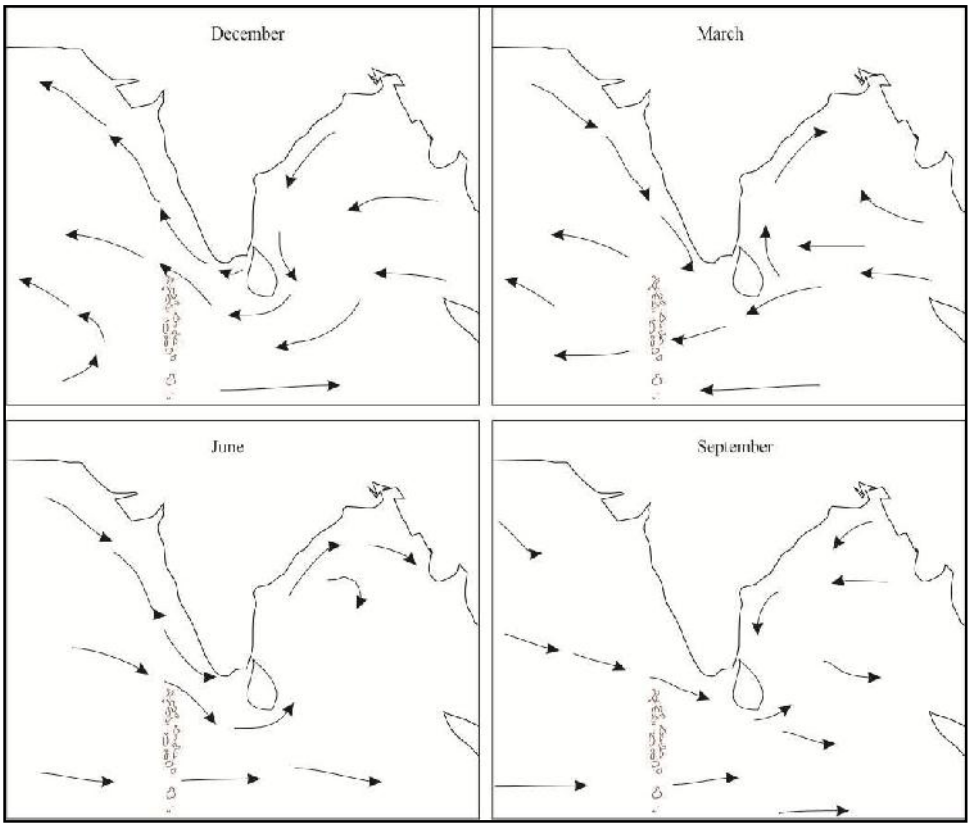


Table 17: Surface Currents around Maldives (by JICA, 1992)

The ocean currents flowing by the Maldives islands are also driven by the monsoonal winds. In the northern part of the Maldives, constant currents flow westward during the northeast monsoon period from December and April and eastward during the southeast monsoon period from May to August.

General, the tidal currents are eastward in flood and westward in ebb, the velocity, however varies by island areas. The current patterns result from reef forms.

Currents tend to be monsoonal in origin, generally setting W during the NE Monsoon (January to March) and E during the SW monsoon (May to October). During the transition months, the currents are variable. Ocean currents flowing through channels between the atolls are driven by the monsoon winds. Current speeds of 1 to 1.5 knots are reported in the Admiralty pilot. However, the current in the E/W channels of the Maldives may attain 5 knots.

8.15 Tidal Currents

Generally, tidal currents in the Maldives are Eastward in flood and Westward in ebb.

8.16 Offshore Wave Conditions (in deep water)

The swells and wind waves experienced by the Maldives are conditioned by the prevailing biannual monsoon and are typically strongest during April and July in the SW monsoon period. During this season, swells generated north of the equator with heights of 2-3 m and periods of 18-20 sec have been reported in the region. However swells originating from cyclones and storm events occurring well south of the equator may occur. Local wave periods are generally in the range 2 to 4 sec and are easily distinguished from the swell waves.

8.17 Cyclones

This paragraph presents information extracted from (UNDP- Developing a Disaster Risk profile for Maldives – May 2006) presenting the characteristics of cyclones in the Maldives.

The islands of the Maldives are less prone to tropical cyclones. The northern islands of the country have been affected by weak cyclones that formed in the southern part of the Bay of Bengal and the Arabian Sea. The number of cyclones directly crossing the Maldives is small. Only 11 cyclones crossed the islands over the entire span of 128 years between 1877 and 2004.

Most of the cyclones crossed the Maldives north of 6.0°N and none of them crossed south of 2.7°N during the period.

All the cyclones that affected the Maldives were formed during the months of October to January except one, which formed in April. The Maldives have not been affected by cyclones since 1993.

In the northern islands, the probable maximum storm tide due to cyclones has been estimated to be around 1.82 m (storm surge of 0.84 m) for a return period of 100

years. This storm surge was computed taking into account probable maximum winds and probable maximum pressure drops.

8.18 Hazards and Disasters

The islands of the Maldives are less prone to tropical cyclones and are only impacted in the northern part of the country by weak cyclones that formed in the southern part of the Bay of Bengal and the Arabian Sea. Since 1877, only 11 cyclones crossed the archipelago. Most of the cyclones crossed Maldives north of 6.0^{o} N and none of them crossed south of 2.7o N during the period. All the cyclones that affected Maldives were formed during the months of October to January except one, which formed in April (UNDP, 2006).

Table 18: Cyclonic Wind Hazard Map (source: UNDP, 2006)

The northern atolls have a greater risk of cyclonic winds and storm surges. This reduces gradually to very low hazard risk in the southern atolls. The maximum probable wind speed in Zone 5 is 96.8 knots (180 kilometres per hour) and the cyclonic storm category is a lower Category 3 on Suffir-Simpson scale. At this speed, high damage is expected from wind, rain and storm surge hazards (UNDP, 2006).

Table 19 shows historical earthquakes around Maldives; and three events of magnitude above 7.0 struck the region which had their sources in the Indian Ocean (UNDP, 2006).

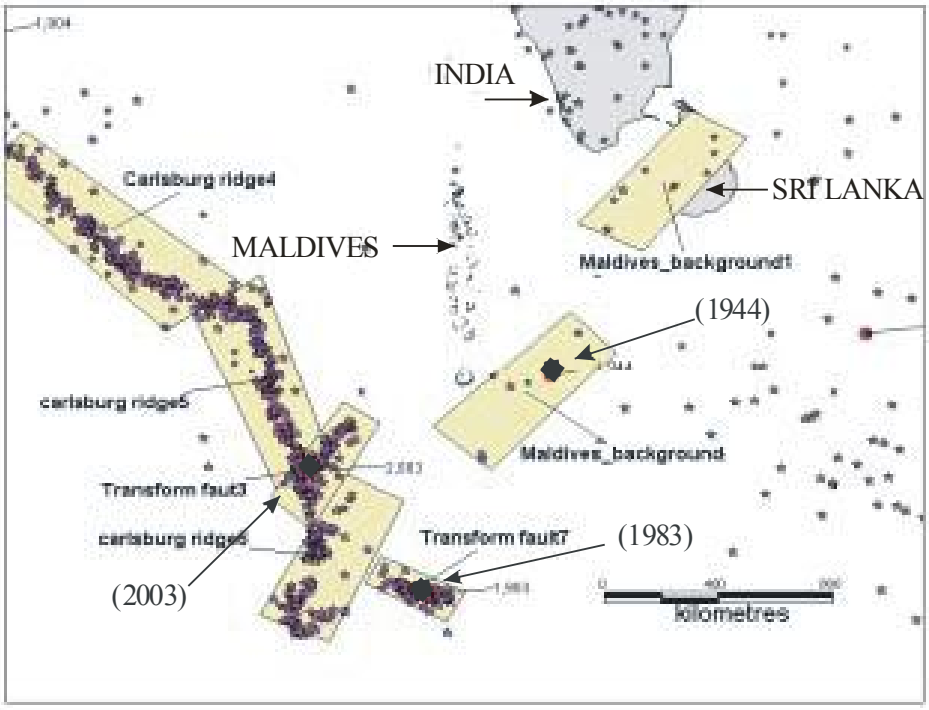


Table 19: Earthquake Epicentres around Maldives (Source: UNDP, 2006)

UNDP (2006) identified that hazard risk from earthquake is low for the Maldives and considered as a disaster risk for only islands located in the south of the country.

Table 20: Earthquake Hazard Zone (source: UNDP, 2006)

Maldives faces tsunami threat largely from the east, and lower threat from the north and south. Islands along the eastern fringe of the atolls are more prone to tsunami hazard than those along the northern and southern fringes. Islands along the western fringe experience a relatively low tsunami hazard. Historically, Maldives has been affected by three earthquakes which had their sources in the Indian Ocean. Of the 85 tsunamis generated since 1816, 67 originated from the Sumatra Subduction zone in the east and 13 from the Makran Coast Zone in the north and Carlsburg

Transform Fault Zone in the south. The probable maximum tsunami wave height is estimated at 4.5 metres.

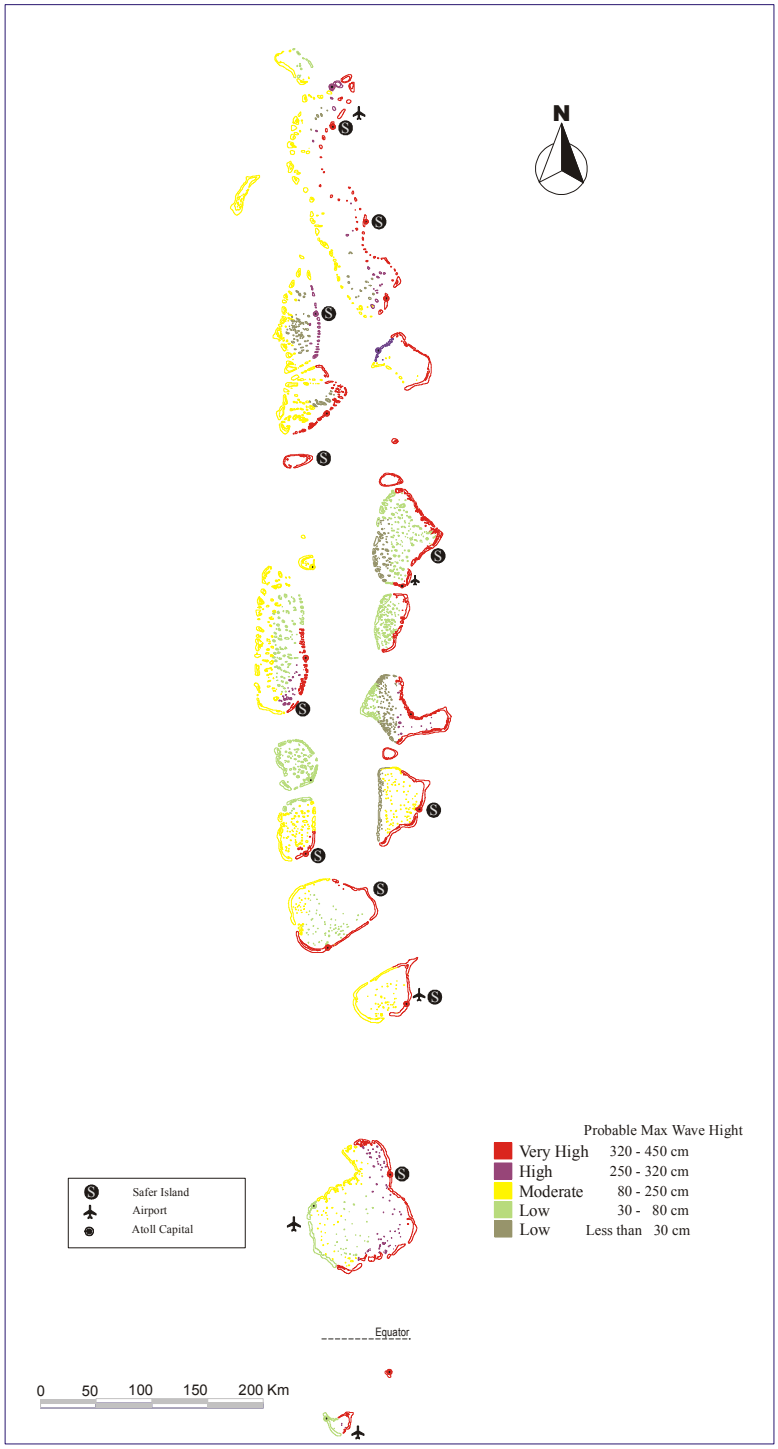


Table 21: Tsunami Hazard Zones (adopted from UNDP, 2006)

8.19 Natural Vulnerability of the Islands

The islands of the Maldives have natural characteristics which make them vulnerable to disasters such as tsunami. An island's Natural Vulnerability depends on geographic and geomorphologic characteristics of the island. These include geographic features of the island like the side of the country where the island is located, the formation of the island, location of the island respect to the atoll, orientation of the island, region of the country where island is located, level of shadow to the island from the reefs and other islands; area of the inland lake found on the island, width of the island's house reef, coastal defence structures on the island, shape of the island and the area of the island. A Model to Integrate the Management of Hazards and Disasters in the National Sustainable Development Planning of the Maldives which was developed as part of the Masters of Science (Hazard and Disaster Management) thesis at the University of Canterbury (Jameel 2007) identified the relationship between natural characteristics of the island and the natural vulnerability of the islands using the data that was collected following the Indian Ocean Tsunami.

Based on the model, Dhonakulhi is not prone to earthquakes as the island is located in the low earthquake zone. However, the island is very prone to cyclones as indicated by the cyclone hazard map. However, the island is moderately prone to tsunamis with a probable maximum wave height of 250 cm. As far as this project is concerned, it will have some impact on the construction from the risk of cyclones and high winds.

8.20 Existing Coastal environment

8.20.1 Features of the Coastal Environment

The coastal environment of Dhonakulhi comprised of mainly white sandy beaches, and shallow lagoon (*falhu*). The reef flat and reef patches (in the lagoon) are not covered in this chapter as it will be covered in the Marine Environment section.

Figures in the following pages represent the different features of the coastal environment of Dhonakulhi and a description of these different features is given in the following sections.

8.20.2 Lagoon

A considerably large lagoon exists on the east side of the island. The depths of the lagoon vary from 0.5m to 3m in the inner lagoon. The depth of the water column on the western side of the island is also low. The narrowest lagoon extent is on the western and where reef extent roughly 30 meters from shore.

The lagoon around the island consists of sandy bottom and rare live coral patches that are more prominent close to the reef flat areas. Between the reef flat and the shore, the lagoon is mostly white sand with some live coral patches and coral rubble. A detail bathymetric survey of the lagoon is attached as an annex.

8.20.3 Beach

There is no distinctive variation in beach composition around the island. However, the beach extent can be seen to vary. The beach material is mainly composed of loose skeletal carbonate sediments, mainly fragments of green calcareous algae Halimeda sp., encrusting and branching red algae, molluscs, foraminiferans, echinoderms and bryozoans. Beach on the northern tip is much wider than the southern tip and a white sandy beach exists on the eastern side of the island during the site visit in January 2012. This beach reduces in size during north east monsoon, as this area is exposed to strong winds, inducing erosion. The south-east side experiences erosion during North East (NE) monsoon and as a result some areas along the cost is affected badly.

8.20.4 Coastal Defence Structures

There are no coastal defence structures constructed around the island. Indirectly, the jetty and marina columns on the western side are the only artificial structures that

provide some protection indirectly. However, no engineering structures are constructed in the island as a coastal protection measure.

8.20.5 Project Components that Affect Coastal Zone

For this project, there are only two components that affect the coastal zone, they are the construction of Arabic and Japanese /Thai restaurants on the eastern side.

There is a small jetty proposed for these two restaurants which are on water. During the NE monsoon, the eastern side is exposed and hence the construction of these two restaurants will provide some protection to the leeward side. Although this is the case, it has been historically observed that the eastern side along this area has a very stable and accreting beach as seen on site and also confirmed by the long term resort staff. This indicates that this area of the coastline is stable. Therefore, the construction of these two restaurants is not expected to exacerbate anything, or induce erosion

The jetties and the restaurants would be built on poles on concrete footings and therefore will allow sediment movement. The structures will be built on pile poles with concrete footings and supported by poles and connected to shore by a narrow jetty providing access to these restaurants. These structures will be placed on the lagoon on eastern side of the island. These structures have been located in a very stable area of the beach and considerable distance from the dynamic thundi so that its impact on sand movement would be minimal. Hence, only the columns of these structures including the access jetties to these water villas will affect the sediment movement.

8.21 Existing Marine Environment

The marine environmental survey at Dhonakulhi was focused on four sites as indicated in the diagrammes attached in the following pages.

Site selection for the marine survey was based on areas where the water villas will be constructed as well as an area close to the reef flat and reef slope areas as well as from control sites.

8.22 Methodology of marine surveys

The methodologies used for the assessment were quantitative complimented by qualitative methods. Line intercept transects (LIT) of 50 meters each was undertaken at each site. In addition, photos were also taken from these locations to support and assess the marine environment. Fish counts were also undertaken to get a snapshot of the fish population. Details of these methodologies are discussed in the methodology section.

General impression and quantitative results of the sites surveyed are described in the following pages. The diagrammes in the following pages illustrates the marine survey locations as well as reef status, their GPS coordinates are outlines below.

8.23 Coral reef

Four sites were surveyed to assess the marine environment as baseline for reef benthic community. The geographical coordinates and the locations are outlined below.

Site 1	6°50'22.12"N	73° 3'28.83"E
Site 2	6°50'29.08"N	73° 3'35.73"E
Site 3	6°50'36.08"N	73° 2'56.71"E
Site 4	6°50'28.02"N	73° 2'59.07"E

Figure 1: GPS coordinates of the survey locations (January 2012).

The following graph illustrates the percentage of live coral cover recorded at sites 1 to 4.

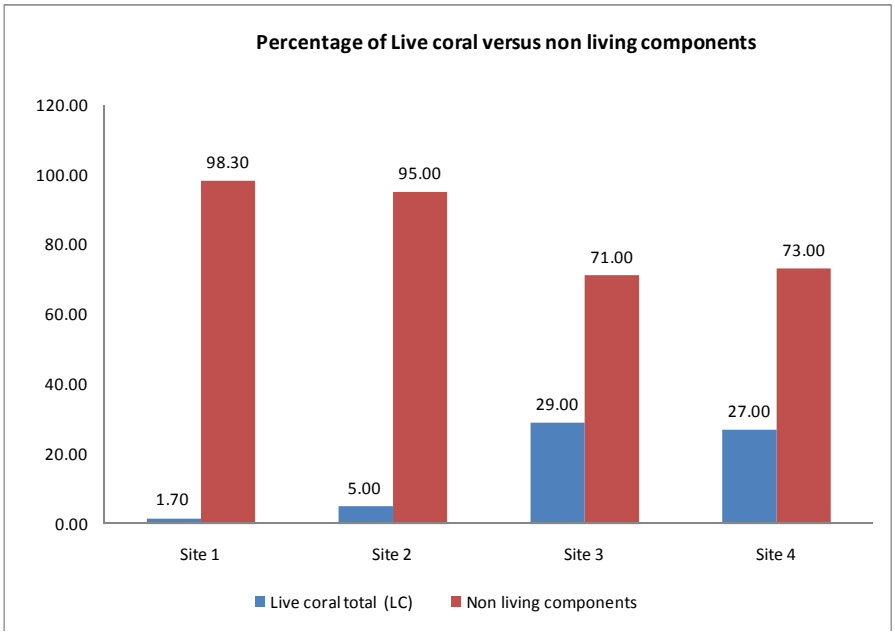


Figure 2: Percentage of live corals versus non living components at all the sites surveyed (January 2012).

In terms of live coral cover, site 3 has 29% which is the highest in comparison to all other sites, while the non living components attributed to over 71%. Site 1 has the lowest percentage in terms of live coral cover which accounted for 1.7% with 98% of the site being covered with non living components. Site 3 and 4 were considered to be very healthy as the percentage of live corals is very high. Site 3 has 29% live corals and 71 percent non living components while site 4 has 27% live corals and 73% non living components.

8.24 Status of coral reef at site 1

Site 1 was observed to have a very high percentage of sand and coral rubble. As can be clearly seen form the aerial photos, this area does not contain high percentage of live corals confirmed by LIT surveys. This is the area proposed for the water villa construction and LIT survey was focused on this site to assess the damage it will cause on this environment. Occasional and sparsely scattered coral massives were observed along this area which were dominated by juvenile fish. In general, the fish population in this area is very low. Some of the broken coral rubbles with algae attracted herbivores (*Acanthurids*) and were seen grazing the algae. This area is exposed to strong waves during North east monsoon (NE) and hence this is attributed to the lack of much live corals in this area. As the lagoon depth is approximately between 0.5 to 2 meters and without adequate hard substrate for the corals to grow, it become difficult for species to grow in this environment often subjected to strong swells, waves and currents.

As the existing environment is not healthy in terms of live coral cover, the proposed development of over water villas is not expected to have a major negative impact on the reef benthos in this area. There is hardly any live corals that can be destroyed during the construction stage. Using an LIT of 50 meters along a 5 meter belt, the live coral covers as well as other elements were estimated, and details are outlined in the following graphs. The fish population was estimated using time swim surveys undertaken for a period of 15 minutes and from the same location.

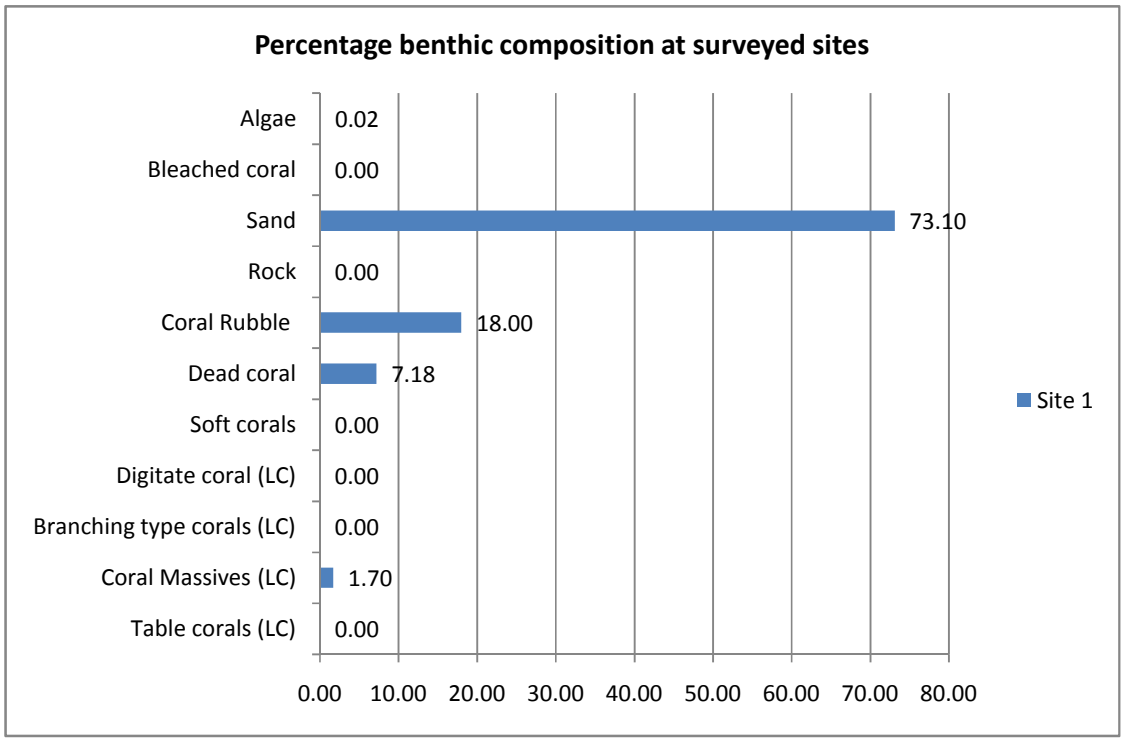


Figure 3: Percentage benthic composition at site 1 (January 2012)

Live coral cover at site 1 was 1.7%. The only type of live corals recorded was Coral Massives). Of the non living components, sand dominated this area with 73%. Percentage of rock was 0% and coral rubbles constitute 18%. No bleached corals were recorded or found.

The conclusion that can be drawn from these results is that the construction of the water villas will not have any serious or significant impact on live corals. Direct damage to corals will be almost negligible as the percentage is very low. Of course, of these living components, most of them will die as a direct result of this activity. Nevertheless, the greatest impact would be from sedimentation caused during the construction period which will indirectly affect the coral reef areas.

8.25 Status of coral reef at site 2

Site 2 has very poor visibility and high sedimentation considered to be arising from the high wave activity as this site is close to the surf zone and reef slope. This site is considered to be slightly healthier than site 1 in terms of live coral cover, but cannot be considered very healthy as the percentage of live coral cover is quite low. Coral patches are numerous towards the reef slope areas. Moving towards the lagoon, the percentage of live coral cover get reduced. There is also lot of coral rubble and broken coral pieces.

There is not much coral diversity. Visibility during the survey was about 7 m and the fish population is considered to be moderate.

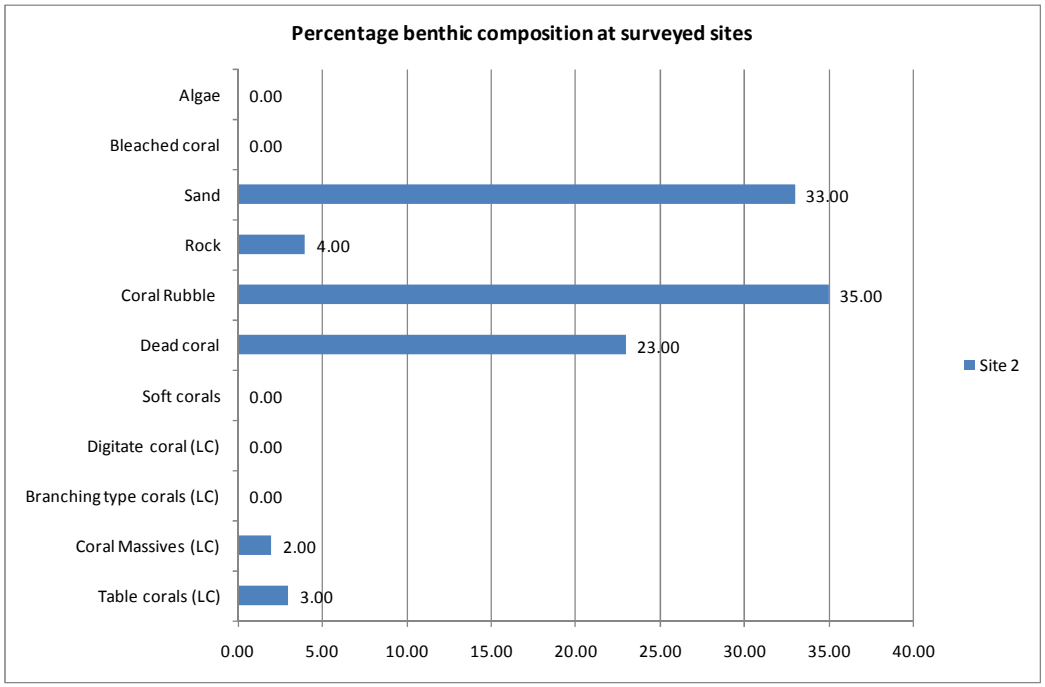


Figure 4: Percentage benthic composition at site 2 (January 2012)

Live coral cover at site 2 was 5%. The dominant type of live corals recorded were Acropora Tabular which accounted for 3%. Two percent (2%) were coral massives. Of the non living components, coral rubble dominated this site with 35%, Hard rocks / rock base accounted to 4% and sand taking up 33%, bleached corals 0% and 0% algae along the transects. During the survey, visibility was generally poor.

The conclusion that can be drawn from these results is that the construction of the water villas will not have any serious or significant impact on live corals at site 2. Direct damage to corals will not occur but will impact indirectly through

sedimentation. Hence, the major impact would be from sedimentation caused during the construction period which will indirectly affect the coral reef at this site.

8.26 Status of coral reef at site 3and 4

Site 3 is the western side of the island and away from the proposed water villa construction zone. At site 3, the reef slope is very healthy, and accounts to more than 29% live coral cover. The coral reef in this side of the house reef are exposed to strong currents throughout the day due to the narrow channel on the west. As a result, there is diverse range and variety of fish life at site 3, most notably plenty of Groupers. Some areas of the slope contains more than 100 percent live corals as the reef bottom is entirely covered with live corals, mostly branching corals, but these were below 5 meters and therefore were not included in the reef transects.

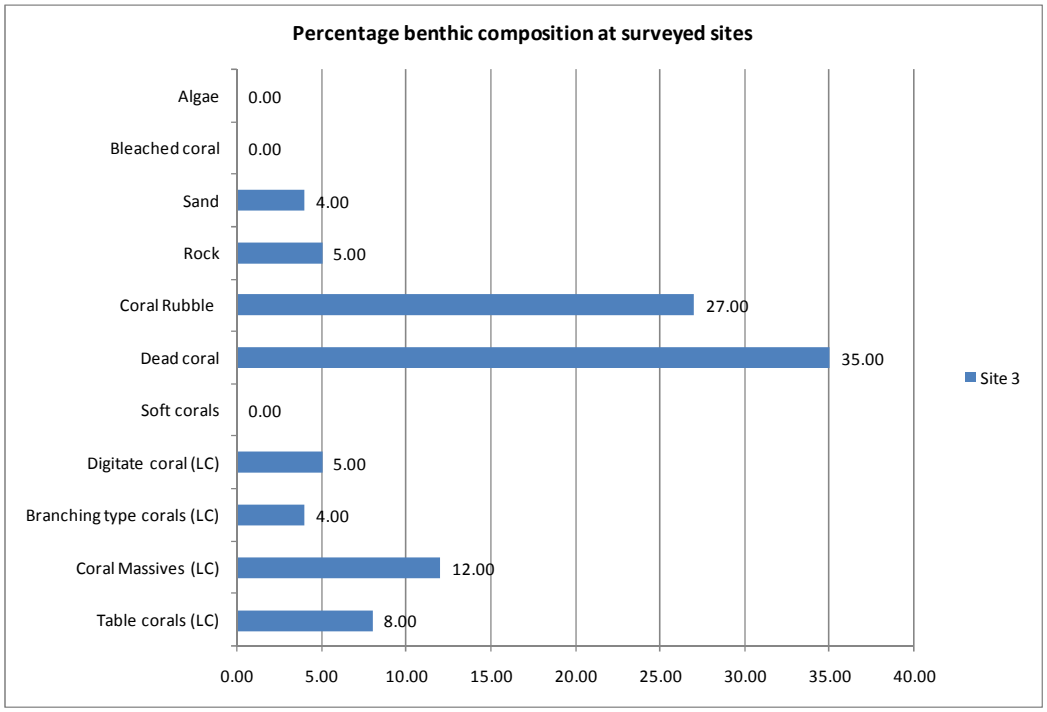


Figure 5: Percentage benthic composition at site 3 (January 2012)

Live coral cover at site 3 was 29%. The dominant type of live corals recorded were Coral Massives which accounted for 12%. Five percent (5%) were Digitate corals, while branching corals accounted for 4% and Table Corals accounted for 8%. Of the non living components, dead corals dominated this site with 35%, Hard rocks / rock base accounted to 5% and sand taking up 4% along the transects.

Similarly, site 4 is also very healthy and contains almost equal amount of live coral cover as illustrated in the following graph.

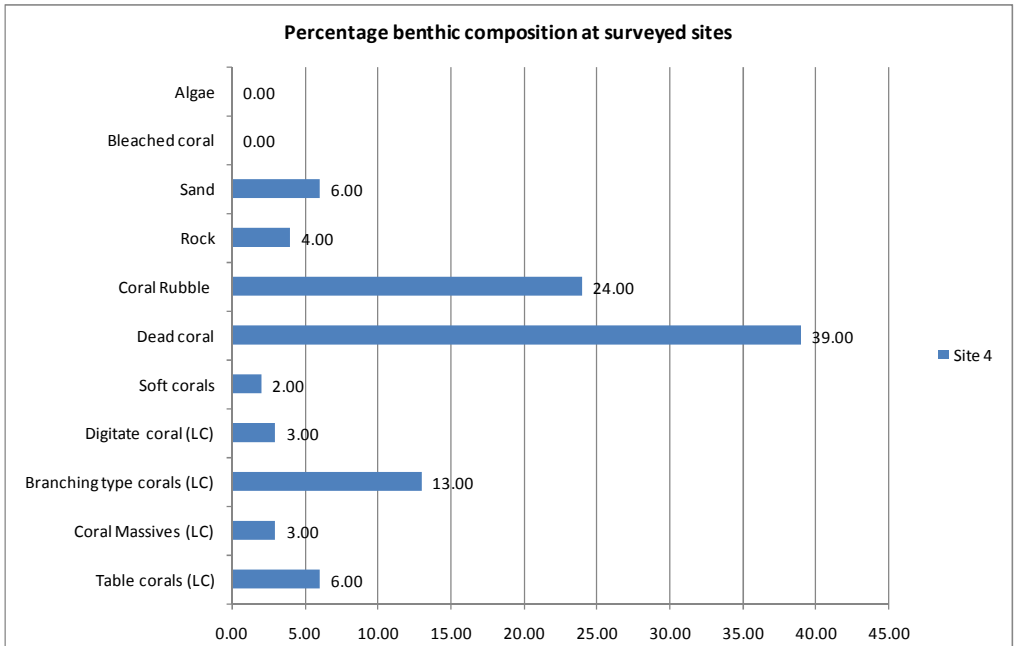


Figure 6: Percentage benthic composition at site 3 (January 2012)

The conclusion that can be drawn from these results is that the western side of the coral reef is very healthy in terms of coral and fish diversity. Despite. The redevelopment activities will therefore not have any impact on this site and also the western side of the house reef. It is ulikely to cause any concern from sedimentation from the water villa construction on the eastern side.

8.27 Status of fish abundance

The amount and type of fish present at a given site can be a good indicator of the marine environment. For example, increased grazers are generally a sign of increased nutrients in the area, thus decreased coral cover and increased algal cover.

		Abundance			
Species name	**Scientific name**	Site 1	Site 2	Site 3	Site 4
Regal angel fish	*Pygoplites diacanthus*	-	R	-	-
Bigeye Bream	*Monotaxis grandoculiz*	-	R	R	A
Schooling banner fish	*henochus acuminatus*	-	-	A	-
Double saddled butterfly fish	*Chaeton falcula*	-	C	C	A
Teardrop butterfly fish	*Chaeton unimaculatus*	-	C	R	-
Chevron butterflyfish	*Chaeton trifascialis*	-	-	-	A
Black pyramid butterflyfish	*Hemitaurichthys zoster*	-	-	R	-
Humbug Dascyllus	*Dascyllus aruanus*	R	-	A	-
Sergent Major	*Abdudefdut vaigiensis*	-	-	C	A
White-belly damselfish	*Amblyglyphidodon Leucogaster*	-	-	-	-
Blackaxil Chromis	*Chromis atripectoralis*	-	-	A	A
Striped fusilier	*Pterocaesio trilineata*	-	-	C	A
Gold-striped emperror	*Gnathodentex aureolineatus*	-	C	R	-
Moorish Idol	*Zanclus cornutus*	-	R	-	-
Bicolor parrotfish	*Cetoscarus bicolor*	-	-	A	-
Palenuse Parrotfish	*Scarus psittacus*	-	R	R	R
Highfin Rudderfish	*Khyphosus Cinerascens*	-	-	-	C
Kashmir Snapper	*Lutjanus Kasmira*	C	-	-	R
Black and white snaper	*Macolor niger*	-	-	R	-
Sabre Squirrel fish	*Sargocentron spiniferum*	-	-		A
Convict surgeon fish	*Acanthurus triostegus*	C	C	R	A
Eye-striped surgeonfish	*Acanthurus Nigricauda*	C	-	C	A
Lined surgeon fish	*Acanthurus lineatus*	-	C	A	R
Powder-blue surgeonfish	*Acanthurus leucosternon*	R	R	C	C
Vlamings Unicornfish	*Naso Vlamingii*	-	C	A	A
Spotted unicorn fish	*Naso brevirostris*	-	-	A	A
Titan triggerfish	*Balistoides Viridescens*	-	C	R	R
Checkerboard Wrasse	*Halichoeres hortulanus*	C	C	A	C
Barred thicklip wrasse	*Hemigymnus fasciatus*		-	R	C
Blunthead wrasse	*Thalassoma amblycephalum*	-	C	A	A

A= Abundant (Meaning that during the 15 minute time swim survey, species counts were recorded more than 50, hence it is difficult to count their numbers).

C=Common (Meaning that during the 15 minute time swim survey, they were spotted occassioanly and throughout the survey, but their numbers were less than 50)

R=Rare (Meaning that during the survey, only few of these species were observed, often 1 or 2.

Table 22: Fish abundance based on the fish survey at survey sites (January 2012)

8.27.1 Marine water quality and bathymetry

The primary objective of the marine water quality sampling was to determine the baseline conditions of the marine water in the project site. Qualitative and quantitative assessments were made on seawater from two locations. The bathymetry of the proposed new water villa area is attached as an annex. Table 23 illustrates the result of the marine water quality test.

Water Quality	Site SW1	Site SW2	Optimal range	Ref
Physical appearance	Clear	Clear		
Electrical Conductivity (us/cm	55100.00	55500.00		
Temperature C	28.00	29.00	18 - 32 Degree Celcius	GBRMPA 2009
Total Dissolved Solids	26850mg/L	26800mg/L		
Salinity (mg/l) or PPT	33300.00	33300.00	3.2% - 4.2%	GBRMPA 2010
pH	8.50	8.40	8 to 8.3. Levels below 7.4 will cause stress	
Turbidity (NTU)	2.00	0.00	3 to 5 NTU. > 5 NTU causes stress	Cooper et al 2008
Suspended solids (mg/l)	8.00	1.00		

Table 23: Results of the marine water quality tests undertaken in Dhonakulhi

8.28 Existing Terrestrial Environment

8.28.1 Section Brief

The terrestrial environment of Dhonakuli was studied by using aerial photo of the island and by undertaking a tree survey of the sites where proposed development would be undertaken on the island. The tree survey was undertaken by visually observing the trees at the study site. The illustration on the following page outlines the terrestrial survey map.

8.28.2 Tree Survey

No significant mature trees were found in the area marked as A on the **Error! Reference source not found.**. Only low vegetation like magoo was found in this area.

Area B, C and D on the **Error! Reference source not found.**, the dominant vegetation was screw pines. Few coconut trees were located on this area. These coconut trees would be relocated on a different site of the island.

Area E on the **Error! Reference source not found.**, had been cleared. Only mature coconut palms and screw pine trees were located in this area of the island. It was found 60 mature coconut trees were located on this site, which falls onto the foot print of the staff block that is proposed to be developed. The coconut trees would be relocated to a different site on the island.

Area F on the **Error! Reference source not found.**, the dominant vegetations are coconut, screw pines and magoo. The coconut trees would be relocated on a different site of the island. The screw pines and magoo would be cleared.

8.28.3 Fauna

Unlike flora, faunal life was difficult to quantify and measure, with the exception of visual observation and recordings done during the visual tree survey. No significant fauna such as bird nests were observed and recorded. However a turtle breeding area was observed on north eastern side of the island. Crabs, mosquitoes and few varieties of snails were observed. Bird life, was observed but no bird sightings were recorded.

8.28.4 Ground water

Groundwater quality was assessed by taking a sample from a groundwater well. The results are illustrated below. No detail assessment of the quantity of ground water was one.

Parameters tested	Results
Physical appearance	clear
Nitrates (mg/L)	0.3
pH	7.5
Temp (C)	28
Phosphates (mg/L)	1.2
Suspended solids (mg/L)	3
Electrical conductivity	2630 us/cm

Table 24: Results of the groundwater quality in Dhonakulhi

9 Environmental Impacts

9.1 Impact Identification

Impact identification has been undertaken by considering the proposed activities and examining the level of impact the proposed development will have on the environment. Each activity was then examined in detail to identify the construction methods, technology and other factors that would determine the potential impact of the various activities.

The proposed project is not expected to bring any major significant negative impacts on the coastal environment. However, there will be negative impacts on the marine environment, mainly the lagoon and indirect impacts on the coral reef of the island. In addition, the proposed project is also not expected to bring any significant negative impact on the coastal environment.

New water villas, presidential suit and two restaurants have been proposed to be constructed on the lagoon which has very limited and small amounts of live corals. The poles of the over water structures will not be solid structures and will allow sediment movement, hence allowing minimal disruption to sediment movement patterns. Despite this, there would still be some direct and indirect impacts on the marine environment.

The development on the island is also not expected to bring any major significant negative impact on the terrestrial environment of the island as almost all the mature trees will be retained. However, during the construction stage, there will be direct and indirect impacts on the terrestrial environment due to the various activities that will be undertaken in the island environment, most notably vegetation removal and removal of large and mature coconut trees.

As the island's north east side is a turtle nesting area, it is expected to have some impacts on their behaviour as the island will have an influx of construction workers at the same time the noise patterns will vary in comparison to what they are at presently exposed. These and other construction related activities will nevertheless impact their behaviour and nesting patterns.

9.2 Assessing Impacts

Environmental impacts of the proposed redevelopment work have been examined through a number of processes. These include consultations with the stakeholders, field surveys, observations and assessment, and field experience gained

from similar development projects implemented throughout the country. Potential positive and negative impacts on the environment have been considered.

The impacts on the marine environment are going to be moderate to high as most of the proposed redevelopment takes place in the lagoon, and most importantly quite further away from the reef flat and reef slope areas which has the highest percentage of live corals. The impacts are categorized into short-term and long-term. Most of the short-term impacts are related to constructional phase, while the long-term impacts are associated with the operational phase.

Possible negative impacts on the environment have been considered in worst-case scenario to recommend mitigation measures in the best possible ways so that these impacts would be minimized and perhaps eliminated in both constructional and operational phases. For example, the anticipated indirect impacts on the coral reef have been slightly exaggerated to account for uncertainties.

This EIA identifies and quantifies the significance of adverse impacts on the environment from the proposed project. Impacts on the environment were identified and described according to their location/attribute, extent (magnitude) and characteristics (such as short-term or long term, direct or indirect, reversible or irreversible) and assessed in terms of their significance according to the following categories:

- Negligible – the impact is too small to be of any significance;
- Minor– the impact is minor;
- Minor adverse – the impact is undesirable but accepted;
- Moderate adverse – the impact give rise to some concern but is likely to be tolerable in short-term (e.g. construction phase) or will require a value judgement as to its acceptability;
- Major adverse – the impact is large scale giving rise to great concern; it should be considered unacceptable and requires significant change or halting of the project.
- Positive – the impact is likely to bring a positive change in the sense that it is aimed at further minimizing the impacts as a result of the proposed actions.

9.3 Uncertainties in Impact Prediction

Environmental impact prediction 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.

There is also limited data and information regarding the particular site under consideration, which makes it difficult to predict impacts.

However, the level of uncertainty, in the case of Dhonakulhi is expected to be low as many similar projects have been undertaken elsewhere in the Maldives. In the marine environment, there is elevated degree of uncertainty as the marine environment is more sensitive in extreme cases such as severe weather conditions. Water villas have not been developed on the island but the locations where the water villas are proposed is sandy lagoon with hardly any live corals. Hence, there is greater certainty about the impact it is going to have on the lagoon. However, the impact from sedimentation is more uncertain as it is more difficult to predict the magnitude. Therefore, these impacts have been considered in assessing the impacts of the new water villas.

Such developments have been undertaken in other parts of the Maldives and their impacts are well known and have been well documented. Therefore, there is very little uncertainty involved in this project with regard to the construction of water villas and other over water structures. Therefore, there is a high degree of accuracy in prediction of the impacts. Environmental impacts will be most significant during the construction period.

9.4 Impacts on the Environment

The impacts on the coastal environment are expected to be minor. The major impacts would be felt through diffraction of waves by the water villas, over water restaurants, access jetties and changes in the current speed and patterns in this area. Therefore, the additional columns of the water villas, and jetties will affect the sediment movement patterns in the lagoon to some extent.

The impacts on the western and northern side beach line is not expected to be significant as the new water villas will be at a considerable distance from the shore and on the south-east side. However, it is difficult to predict the long term changes and hence long term monitoring has been suggested to assess these impacts.

Perhaps, the most significant impact will be felt on the marine environment during the construciton period as there will be lot of civil works in the marine environment.

With regard to the terrestrial environment, it is not expected to have a major significant negative impact, but the vegetation clearance will definitely reduce the tree cover of the island. Despite this, there will not be any major significant impact on the Terrestrial environment. **Error! Reference source not found.** outlines in detail, the

nvironmental impacts of the proposed redevelopment and mitigation measures. Details of the impacts and mitigation measures and their characterization is provided in the following page.

10 Stakeholder Consultations

For the purpose of this project, stakeholder consultations were limited to relevant government agencies, the proponent and the designer / Architects. Methodology for undertaking these discussions was through interviews and discussions.

10.1 Consultation with the Proponent

Consultations were held with the proponent / Developer and operator at various stages of the development process. Water Solutions have been involved from the initial design stage of the project and advice and have been considered in the final design of this project and in the preparation of this EIA. Advise was given on the most appropriate locations for over water development, mainly the water villas and taking in to consideration the importance of offsetting these structures at a reasonable distance from the dynamic sand spit. Advice was also given on the overall development process.

10.2 Consultation with the proponent

Consultations were held with Mr. Ahmed Hafeez, Managing Director of Turquoise Pvt Ltd. The entire development project was discussed and advise was given on various issues. More specifically, advise and consultations were given on the impact of developing water villa jetties that interfere the sand movement at the tip of island. The proposed project has been planned in such that the water villa jetties are constructed direct from the southern sand spit and this was something that was raised as a concern. The main reason why this orientation has been chosen was due to lack of practical alternatives. As can be seen from the site plants attached, that most part of the south east and west have guest villas. Any re-orientation of the water villa access jetty would mean that it will interfere with the existing beach villas on both sides. Hence, this was something that was discussed with the proponent.

10.3 Consultation with the Project Management team and long term staff

Consultations were held with the project management team during the field visit. In general, advise was given on the permits required and the EIA process and the timelines, consultancy regarding various surveys including bathymetric surveys that was necessary, advise on various design concepts and much more. Most importantly discussions were undertaken and advise provided to the team on best management practice and mitigation options during the construction period.

Specifically, waste management methods and details were provided.

10.4 Consultations with the Ministry of Tourism and Civil Aviation

Consultations were held with Mr. Mohamed Nahid, Environment officer of Ministry of Tourism. Following are the main outcome.

- Tourism Ministry's policy is very clear on such redevelopments and all such projects are required to undertake an EIA prior to commencement. Before undertaking and EIA, the proponent also has to obtain the approval of the concept design from Tourism Ministry before commencing an EIA.
- Dhonakulhi project has been approved. Tourism Ministry will mainly look at the general concept and whether it fits with the Tourism regulations, most importantly the usage of space and development foot print does not exceed the required limits.
- Tourism Ministry undertakes regular monitoring and as part of this, such redevelopment projects will also be monitored, but the environmental components of the project will be monitored by EPA.

10.5 Consultations with relevant stakeholders during the scoping meeting

Consultations were held with relevant stakeholders during the EIA scoping meeting in order to develop a scope and terms of reference to the project. The discussions were concentrated on the redevelopment and what areas need to be focused by the EIA team.

As far as this project is concerned, the most significant issue of concern is the development of water villas. When such developments take place over water, there will be lot of secondary impacts, most importantly during the construction stage. Therefore, it is very important to undertake regular monitoring. EPA advised the client and the consultant that the EIA report should contain details of the marine surveys and also to undertake a detail bathymetry of this area.

It is also a concerning issue that most clients do not take environmental elements in the design of the resort. Most of the time, the environment has to be adjusted to the architects dream or imagination, but in fact the opposite should happen. Existing environmental conditions cannot be changed such as direction of wind, erosion prone areas of the island and coral reefs and it is the designers and clients who should ensure that their designs are adjusted according to the existing environment.

EPA is also concerned about storage of materials on the beach during the construction period and emphasised that this practice should not happen in DHonakulhi.

10.6 Consultations with the Architect/Designers

Consultations were held on various occasions with Hannan Yusuf Architects regarding this project and the following were major outcomes from the discussions.

- The Architects were provided with detail bathymetry surveys to decide on the final concept.
- Key sensitive areas of the island's coastline were notified and informed including minimum set back distances from the coastline and the beach.
- The water villas location have also been adjusted in order to suit the operational needs of the resort.
- Various shapes and orientations of the water villas were also explored, but the current design was adopted as it suits the current regulations of Tourism and environment.
- Japanese / Thai and Arabic restaurants have been placed with adequate distance from the beach and on columns so as to minimize the disruption of sediment flow.
- The new structures in the island have been placed in areas where vegetation clearing would not require cutting of large number of trees.
- The development concept for the resort has been developed to avoid any space compromise to the island villas while at the same time ensuring that adequate number of rooms are developed. This required the development of new rooms over water rather than sacrificing the island environment.
- The natural environment of the island will be kept as it is and will not be modified except in the areas where new buildings will be constructed. These are at the back of house and therefore will not have any impact on the spacing needs of the existing island rooms.

11 Alternatives

EIA Regulation requires two alternatives to be suggested for such developments and therefore two alternatives have been suggested in addition to the no project alternative. These alternatives are discussed below:

11.1 No Project Option

- The no project option takes the following into account.
- The resort will operate at its existing capacity.
- No additional infrastructures/services are introduced, therefore, price cannot change and profit margin will decrease year by year
- The main advantages and disadvantages of these are given in Table 25 below.

Table 25: Advantages and disadvantages of the no project option

Strategy	Advantages	Disadvantages
Allow the resort to operate as it is.	Environmental problems related to additional development can be avoided No upgrading costs to the Proponent, short term benefit	With the limited facilities, the resort can only be marketed to high end clients. The resort operation cannot be economically feasible due to land rent resulting from the large size of the island.
Existing beach villas would be left as they are and no construction of new water villas.	Environmental problems related to construction of new water villas can be avoided No upgrading costs to the Proponent, short term benefit	Revenue cannot be increased. Resort cannot make profit from high land rent that needs to be offset with additional rooms.
No construction of the new restaurants	No upgrading cost.	Unable to diversify the market. Unable to increase revenue In the long term, clients may not be easy to attract, resulting in decrease in arrivals. Additional rooms will require more facilities such as restaurants as the market segment will be more diverse.
Construction of new water villas.	Marine environmental damage to the south eastern side lagoon can be avoided by eliminating the need to develop water villas in this area.	No water villas on the south eastern side mean that more alternative locations need to be explored.

11.2 Design Alternatives

11.2.1 Alternative Locations of the water villas

An alternative design and location for the water villas construction is illustrated below. Although this design was considered in the initial stage, this concept was not accepted in so far that it showed development in the lagoon environment exceeding 700 meters from the vegetation line of all uninhabited islands. Hence, this alternative cannot be considered. In this concept, all the new water villas have been lined up along the length of the jetty rather than on both sides of the jetty.

11.3 Alternatives to Construction Technologies

11.3.1 Drilling of the over water villa foundations.

The foundations or the footings of the water villas, restaurants and jetties will be constructed using pine poles. All structures will then be constructed on them. An alternative method is to drill the foundation and poles. In this method, drilling of the sea bed to a depth of 6 m to erect the columns is required in order to ensure that over water structures will be structurally strong. However, the cost of this operation would be much more. Hence, this alternative cannot be considered. Another construction methodology is to use concrete columns and use concrete base as a support. The columns can then be transferred to the preferred location and placed with minimal or no excavation. Hence, this is a better option than drilling.

11.3.2 Construct multiple water villas on few large columns

An alternative method of water villa construction is to construct multiple water villas on few large columns. This method involves constructing large, but few concrete columns on the lagoon and then building multiple water villas on them. This method is illustrated in the following figure. This method was not retained for several reasons. Firstly, this is a very new concept for Maldives and hence requires a greater degree of uncertainty. Secondly, the large columns would be very unattractive. There would be lot of negative visual perception. Thirdly and very importantly, the large surface area of the columns will disrupt the sediment movement greatly than if it was constructed using standard column sizes. Hence, there would be a greater degree of sediment disruption and at present; there is very limited information and experience within Maldives as far as this method is considered.

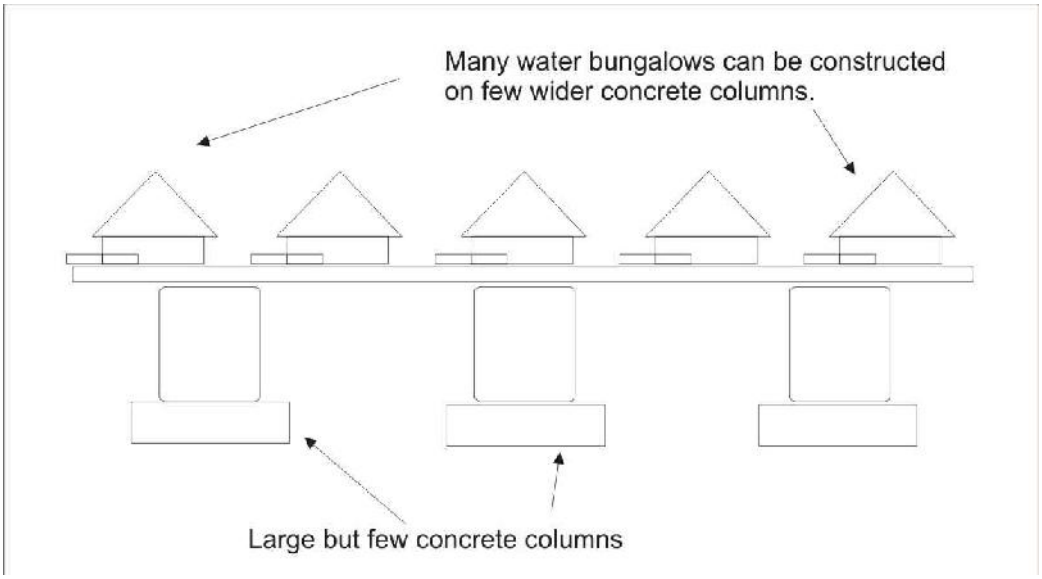


Figure 7: Alternative construction method for water villas.

11.4 Preferred Alternative

The preferred alternative is to use pine poles with concrete footing base.

11.4.1 Mitigation Measures for the Proposed Alternative

- Ensure that minimal or no excavation is done while placing the columns in to position.
- Undertaking the work in low tide hours in order to minimize sedimentation.
- Supervising the work to make sure that no unnecessary damage to the marine environment occurs and pre-casting the footings on land before placing them

12 Environmental Management and Monitoring Plan

12.1 Introduction

Environmental monitoring is essential to ensure that potential impacts are minimized and to mitigate unanticipated impacts. Monitoring will be carried out as part of the environmental impact assessment and monitoring requirements addressed in this EIA report. The following table summarizes the aspects of monitoring.

12.2 Cost of Monitoring

The proponent has committed fully for the monitoring programme outlined in this report. The total cost of undertaking the regular monitoring is estimated in the following table. Cost of monitoring includes all data collection and reporting to the client as well as the relevant government agencies.

12.3 Duration of Monitoring

Monitoring will include marine, terrestrial, social and coastal aspects only. The proposed scheduled for monitoring has been prepared for 12 months during the construction period as well as for two (2) years in the operational period. Hence, this schedule will be applicable for monitoring during the two years of the operational stage after redevelopment. Monitoring will be undertaken by subcontracting the work to an independent consultant or a consulting firm.

12.4 Methods of Monitoring

Environmental monitoring will be undertaken using standard methods described in the Methodology section. Monitoring is recommended for marine, coastal environment, terrestrial and the social environment.

12.5 Monitoring Responsibility

Monitoring responsibility will be with the client and financial provisions will be made in the project to undertake the monitoring.

12.6 Monitoring Report

A detailed monitoring report will be compiled after the completion of the civil works. During the construction period, summary monitoring reports will be provided every two months and final report will be provided at the end of the construction stage and will adhere to Schedule M of the EIA Regulations, 2007. During the operational stage, regular monitoring reports will be provided once every three months. This

report will be submitted to the relevant government agencies for compliance. The report will include details of the site, data collection and analysis, quality control measures, sampling frequency and monitoring analysis and details of methodologies and protocols followed.

Table 26: Schedule for Environmental monitoring for the first 12 months of the construction period as well as per annum during operation period.

Monitoring Attribute	Indicator	Methodology	Monitoring Frequency		Cost during (construction phase).	Cost Per annum (operational phase)
			Construction stage	Operational stage		
Marine environment						
Live Coral cover at survey sites 1 and 2	Percentage live cover	Qualitative & Quantitative	-	Annually		$5,500.00
Diversity and abundance of fish communities	Number / percentage of selected fish	Qualitative & Quantitative	-	Annually		$2,500.00
Marine water quality at survey sites 1, and 2	pH, DO, temp, Faecal coliform	Onsite or Lab analysis	-	Twice annually		$850.00
Siltation	Sediment deposited on reef substrate	Qualitative & Quantitative	Weekly during construction period	Twice annually	No cost. Contractor to undertake this.	$200.00
Terrestrial Environment						
Turtile nesting	Number of turtles nesting on beach	Quantitative	Weekly	Weekly		No cost. Resort security guards to record this as part of their routine work.
Vegetation	Vegetation Cover, numberof coconut trees felled and	Qualitative & Quantitative	-	Annually after construction (resort to provide his info)		$50.00

Monitoring Attribute	Indicator	Methodology	Monitoring Frequency		Cost during (construction phase).	Cost Per annum (operational phase)
			Construction stage	Operational stage		
	replanted elsewhere in island					
Coastal Environment						
Sand transport	Beach profiles	Levelling from specific BMs	Every three months	Every three months	$350.00	$1,200.00
	Nearshore currents	Drogue on the eastern side and south-east side.	Six monthly	Every three months	$100.00	$400.00
	Shore line mapping	Using DGPS	Sixmonthly	Once after completion	$350.00	$550.00
	Erosion	Physical inspection and shoreline mapping	Sixmonthly	Annualy	-	$550.00
Social Environment						
Satisfaction of the employees with regard to the redevelopment	level of satisfaction	Resort Office records	-	Annually		$200.00
Number of employees from nearby islands or the region.	Number of employees	Resort Office records	-	Annually		$200.00
Number of new contracts made with outside contrators for various resort	Number of contracts	Resort Office records	-	Annually		$100.00

Monitoring Attribute	Indicator	Methodology	Monitoring Frequency		Cost during (construction phase).	Cost Per annum (operational phase)
			Construction stage	**Operational stage**		
works during operation stage						
Number new employees after the redevelopment.	Number of employees	Resort Office records		Annually		$200.00
					$1,450.00	**$13,700.00**

13 Conclusion

This EIA report has identified the major impacts of the proposed redevelopment. The project will have its environmental impact on the project boundaries which is confined to the terrestrial, marine and coastal environment of the island. Mitigation measures have been proposed to these anticipated impacts including a detailed environmental management and monitoring programme. It has been assessed that the most significant negative impacts from the proposed development will be on the lagoon bottom, water column and the coral reef system as a result of developing water structures, majority of which will be water villas and their access jetties. More specifically, the most significant impact period will be during construction stage. In the coastal environment, construction of the water villa access jetty along the centre of the southern sand spit is expected to bring some long term changes to sediment movement and thus is a cause of concern which needs to be carefully monitored after the construction. This orientation of the water villas have been proposed in order to leas impact the existing guest villas on the island. It is likely that the movement of sediment around the access jetty will be afected by trapping sand beneath these structures due the effect of supporting piers. Therefore, this structure is expected to have some degree of influence on the long shore sediment transport patterns. Similarly, the over water villas and its jetty will have secondary impacts such as diffraction of waves and altering the long shore current patterns in the lagoon.

The resort's redevelopment plan have been designed and developed to increase the number of guest rooms without disrupting the existing guest rooms on the island. The guest rooms on Dhonakulhi have been developed with lot of space and privacy for each room, which is the defining characteristic of the resort. Large rooms, with complimentary services and facilities like private decks, pools, living space and bar per each guest room requires lot of space which cannot be compromised. Such compromises will affect the special requirements for the existing guest villas on the island. Therefore the goal of the developers is to create additional room without disturbing this balance in the island. Hence, all new guest rooms will be developed over water. As such, the terrestrial environment will not be impacted to an extent where it becomes a serious concern. Nevertheless, vegetation clearing to some extent will be undertaken to developed new structures for the junior and senior staff. This additional accommodation is necessary as the increased guest rooms will require increasing the number of support staff.

This EIA assessment has provided important elements of the environment and where the redevelopment will mostly impact. It appears that the major impacts of this

project will be felt on the marine environment. Therefore, mitigation measures to reduce the impact on the marine environment have been proposed. They include measures such as working in low tide hours, proper supervision to minimize the damage on the marine environment during construction period. In addition, several other mitigation measures including limiting the time frame of construction, proper supervision and other measures are also proposed. The biggest advantage for the environment of Dhonakulhi is that although the over water development takes more than 90% of the overall development, the foot print of the lagoon where water villas will be developed does not contain many live corals. What this means is that the construction activities on the lagoon will not destroy much live corals, which is the number one damage to the marine environment. As a result, there is greater certainty with regard to direct damage to the marine environment. Despite this, sedimentation from the construction works will be of a concern and needs to be dealt with.

Although the social impacts of the project were not assessed in detail, stakeholder consultations were undertaken with key stakeholders. There will be numerous positive impacts of the project. This will mainly be induced through creation of more employment opportunities and increasing the government's revenue from the resort. There will also be indirect positive economic benefits with the expansion by creating more demand for local food produce, goods and services. Contractors will have the opportunity to gain income from various project related work and contribute to the local economy. During the construction period, contractors will heavily rely on nearby local islands, mostly for food supplies, fuel and other similar services. Increased workforce will also create more traffic to these nearby communities for recreation as well as frequent visits that are necessitated by various needs to go to these communities. Hence, these activities will stimulate the local economy. In addition, more employment opportunities in the island will attract locals from the region where they would be able to stay close to their families while working. This will have a very positive impact on the stability of employees in the resort which are all positive socio-economic impacts of the project.

Although several alternatives to the proposed project were considered, these alternatives cannot be implemented for various reasons including issues related to regulations, restrictions on the available land space in the island and many more. The development concept and objective for this redevelopment is to transform the island in to a multi class tourist destination with additional and enhanced services that would cater for both high end and average markets. At the same time, the environmental protection and preservation and operational costs have also been taken in to consideration. Therefore, several design considerations, although initially were considered, it has been avoided due to these reasons.

The environmental management and monitoring programme for this project will mainly focus on marine environment, but coastal and terrestrial components have also been included. The biggest component of the redevelopment being on the marine environment, does not pose a serious risk to the coral reef nor live corals in the lagoon. Therefore, based on the assessment, it seems justified to undertake the redevelopment.

14 Acknowledgements

Various people have assisted the consulting team in preparing this report, name and their designations are listed below. CV's of the field assistants are attached as an annex. Water Solutions would like to thank their support and assistance provided in completion of this report, most importantly in the collection of data.

1- Mr. Faruhath Jameel, Chief Surveyour, Water Solutions.

2- Hamdhulla Shakeeb, Surveying Assistant, Water Solutions.

3- Dhonakulhi island and the management team.

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16 Annex: Terms of reference

17 Annex: Existing Site plan of the resort

18 Annex: New Site plan for the proposed redevelopment

19 Annex: Architectural and Engineering drawings

- Standard water villas
- Over water jetty
- Thai restaurant

20 Annex: Construction Schedule

21 Annex: Bathymetry of the lagoon

22 Annex: CVs of people who assisted the EIA