# ENVIRONMENTAL IMPACT ASSESSMENT

## For the Registration of Desalination Plant and Power House in Summer Island, Kaafu Ziyaarahfushi

**Proposed by**

Kaimoo Travel and Hotel Services

**Prepared by**

Water Solutions Pvt. Ltd., Maldives

November 2010

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# 4 Non Technical summary

- This report discusses the findings of an environmental impact study undertaken by Water Solutions Pvt. Ltd. for the registration of the existing desalination plant and powerhouse in Summer Island Resort. The registration of the existing desalination plant and powerhouse at Summer Island is being proposed by Kaimo Hotel and Travel Services.

- This report identified that the power house location, emission from powerhouse stack, noise from generators, desalinated water, bunding of the fuel tank, discharge of brine from the RO process through the brine outfall are the main components that could have an impact on the environment.

- Since desalination plant and powerhouse are existing facilities on the island and it is being operated, no alternatives have been suggested in this report.

- A number of mitigation measures has been already taken into the design and engineering of the RO Plant and Powerhouse as to minimise the impact on the environment of the island. The powerhouse has been located at the centre of island, on the northern end of the island to minimise the impact of its noise to the guests, sound proofing has been carried out to minimise the noise heard from the power house, the stack of the powerhouse has been raised to minimise the visual impact of smoke, desalination has been introduced as to prevent the dependence on groundwater and their by reducing the groundwater depletion. A bund has been constructed around the fuel tank to prevent the accidental spill of fuel to the environment and their by reducing the groundwater pollution.

- Towards, the end of the report, an environmental monitoring programme for the existing desalination plant and powerhouse has been suggested. This monitoring programme will mainly focus on desalinated water, ground water and marine water quality. Since desalination plant and powerhouse are existing facilities on the island and it is being operated, no alternatives have been suggested in this report.

- Hence the power plant and desalination Reverse Osmosis plant at the island could be registered at Maldives Energy Authority and Environmental Protection Agency.

# 5 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 registration of the existing Desalination Plant and Powerhouse in Summer Island.

## 5.1 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.

The major findings of this report are based on qualitative and quantitative assessments undertaken during site visit in August 2010 and October 2010. The impact assessment methodology has been restricted to field data collected, consultations, experience and professional judgment and available long term data.

## 5.2 Aims and Objectives of the EIA

The objective of the report is to:

- to assess the environmental performance of the existing powerhouse and desalination plant at Summer Island
- to facilitate the application to register of existing powerhouse and desalination plant according to the requirements of the Environmental Protection Agency and the Maldives Energy Authority.
- To demonstrate the commitment by the proponent to undertaken environmental monitoring.
- 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.

## 5.3 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:

- Ahmed Jameel, Environmental Engineer (EIA Registration No: EIA 07/07)
- Abdul Aleem, MPH, BSc. Environmental Health (EIA Registration No: EIA 09/07)
- Verena Wiesbauer Ali, Marine Biologist
- Mohamed Riyaz, Assistant Surveyor

## 5.4 Terms of Reference

The terms of reference for this EIA have been attached as an annex. This EIA has been prepared based on these terms of reference.

# 6 Policy, Legal and administrative Framework

## 6.1 Overview

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

## 6.2 Applicable Policies, Laws and Regulations

### *6.2.1 Environmental Protection and Preservation Act*

Article 5 (a) of the Environmental Protection and Preservation Act (Law No. 4/93) addresses the submission of an EIA. It states that an EIA shall be submitted to MEEW before implementing any developing project that may have a potential impact on the environment.

### *6.2.2 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 Maldives – This guideline also provides a comprehensive outline of the EIA process, including the roles and responsibilities of the consultants and the proponents.

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

### *6.2.3 Tourism Act (Law no. 2/99)*

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

This EIA has been developed in accordance with the Tourism Act

### *6.2.4 Regulation on Protection and Conservation of Environment in the Tourism Industry*

The Regulation on the Protection and Conservation of the Environment in the Tourism Industry came into effect on 20 July 2006. Section 6 of this Regulation deals with water supply in tourist facilities. It requires every resort to have a desalination plant registered according to the Desalination Regulation and requires that daily logs of water quality to be recorded and maintained.

It further states that groundwater shall not be used for drinking by guests or staff, and shall not be supplied to guest rooms or toilets of guest rooms or for use by staff. Furthermore, any type of oil (e.g. used engine oil) or any other chemical which may damage the environment shall not be drained to the ground. The regulation does not cover powerhouses or emissions from power plants including noise.

### *6.2.5 National Energy Policy*

The National Energy Policy is focussed on nation the development of policies towards sustainable energy management and reduction of greenhouse gas emissions. As such the National Energy Policy looks at existing issues, constraints and emerging issues. The policy addresses issues of energy supply, consumption, environment, renewable energy, energy efficiency and sustainability. Sustainable supply and consumption is the main focus of the policy. The government of Maldives is working towards becoming the world's first carbon neutral country by 2020.

### *6.2.6 Desalination Regulation*

The Desalination Regulation states the requirements for application, plant capacity determination, intake and source water, plant operation and maintenance, brine discharge as well as water quality monitoring requirements. The Desalination Regulation of the Maldives came into force from 2002.

### *6.2.7 Air Quality and Water Quality Standards*

The Maldives lacks the necessary environmental standards for the measurement of air and water quality. Therefore, water quality, air quality and noise standards are based on international standards or standards of developed countries. Water quality standards are based on WHO standards. For air quality, the Maldives has not yet established ambient air quality standards to serve as a basis for air quality management.

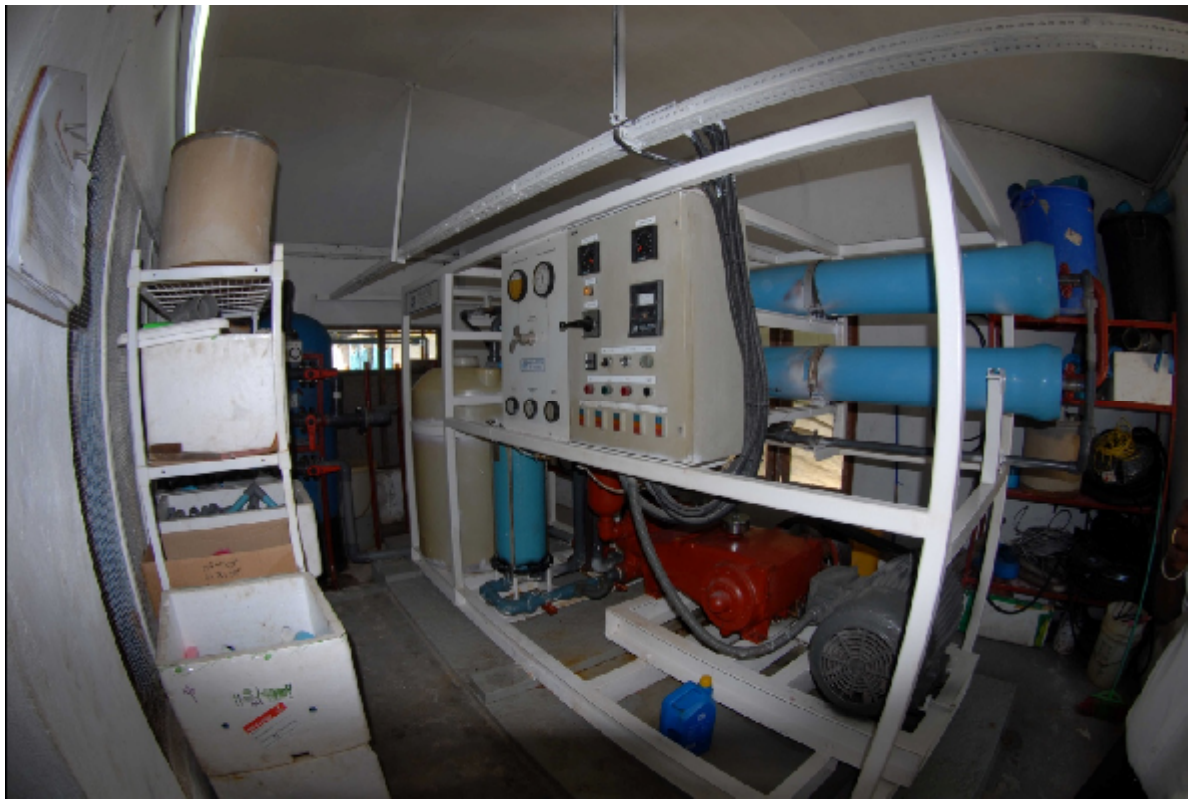

Figure 1: RO Plant

# 7 Project Description

## 7.1 Proponent

Kaimoo Travels and Hotels Service Ltd is a private company registered at the Ministry of Trade and Economic Development. It operates Summer Island as well as other resort islands in the Maldives, like Embudu Village and Equator Village. This EIA has been prepared by Kaimoo Hotels, Travels and Service.

## 7.2 Location and Study Area

The desalination plant and the powerhouse is located at Summer Island Resort at K. Ziyaaraifushi.

## 7.3 Need and Justification

The Environmental Protection Agency and the Maldives Energy Authority requires that desalination plants and power systems are registered at the respective agencies. The existing desalination plants and power systems at Summer Island are also covered by these regulations. Hence as part of the process of registering these systems, this environmental assessment is being undertaken. This EIA is a requirement for these facilities registration.

## 7.4 Study boundary

The boundary of the study is limited to the boundary of the Island of Summer Island.

## 7.5 Description of the Utilities System at the Island

### *7.5.1 Desalination Plant*

The reverse osmosis plant at Summer Island has a 70 MT/Day and 40 MT/Day reverse osmosis plants. The plants can produce fresh water from sea water with TDS of 375,000 ppm at 25 °C. The water produced from the plants have a quality TDS<500 ppm at a pressure of less than 2 Bar. The system efficiency is rated not less than 35%.

The intake for the Desalination plant is located on eastern side of the island. The intake has a customised foot valve. The intake is 40 m long. Seawater from intake pipe is connected to a sedimentation tank through a pump well. The intake water passes through a sedimentation tank to minimize clogging of the membranes from silt present in the water. The sedimentation tank is about 20 tons. The desalination process at the plant uses a reverse osmosis membrane which reduces the salt content producing freshwater, which is returned to sea 50 m away from shore from western and eastern side. Freshwater is pumped into the storage tank which is located at a tower which is 15 m from the ground level. Water pumped into the storage tank is disinfected using chlorine solution for distribution via underground distribution network to all guest rooms and public areas.

### *7.5.2 Power System*

The power system at the island includes the power generation equipments and distribution Equipment. The powered generation equipment includes a power house building, a fuel storage facility and diesel engine generator sets having the capacity of 250 kW x 02 + 350kW x 01 + 200 kW x 01 + 100 kW x 02 (total capacity of 1,150 kW) as the installed capacity of the generator sets. The emission stack is about 10 meter tall.

The powerhouse has installed secondary residential silencer with attenuation of better than 85 dB (A) at 1 meter. The soundproofing ensure a total free field sound level of not more than 85 dB (A) at full load outside the power house.

The distribution equipment includes low voltage armoured underground cables and weather proof outdoor GRP enclosed distribution boxes installed at different locations of the island to provide power to the consumers from the distribution boxes.

A fuel storage tank of capacity 30,000 litres storages the diesel for the powerhouse. The storage tank has a bund around the tank to control the accidental spillage.

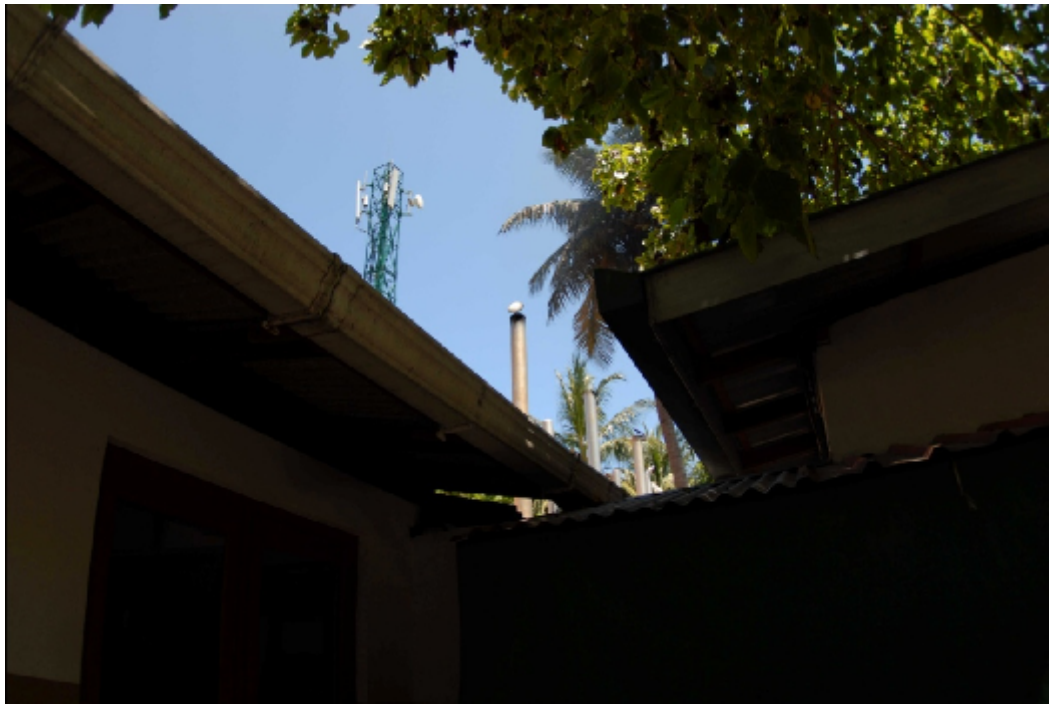

Figure 2: Powerhouse Stack

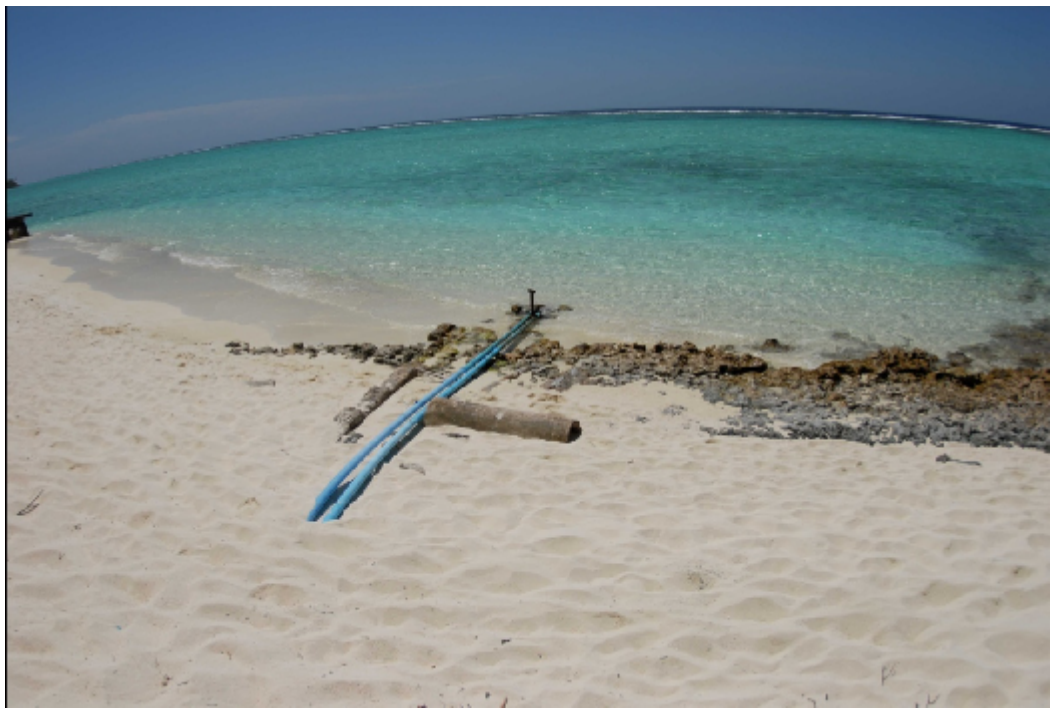

Figure 3: Brine discharge outfall located on western side of the islnad

# 8 Methodology

The section covers methodologies used to collect data on the existing environment. The key environmental components of the project under consideration are coral reef areas, the marine environment and the coastal environment. The following data collection methodologies were used during the field visit undertaken in August 2010 and October 2010.

## 8.1 General Methodologies of data collection

Conditions of the existing environment were analyzed by using appropriate scientific methods. The environmental components of the study area were focused for marine and coastal environment. The marine environment of the island covered the coral reef and the lagoon. Coastal environmental data collection involved taking beach profiles from selected locations and assessing the coastal environment.

## 8.2 Mapping and Location identification

The island, including shore line including the low tide line, mid tide line and high tide line and vegetation lines were mapped for the assessment. Mapping was undertaken using hand held differential GPS and available statellite photos. The location of data collection sites were marked using handheld GPS. These data collection points include marine water sampling locations, marine survey locations and beach profile locations.

## 8.3 Marine Water Quality

Water quality was assessed during the field trip in August 2010 by collecting samples and testing them at National Health Laboratory. The locations, frequency and parameters to be monitored are given in the monitoring programme outlined later in the EIA report.

## 8.4 Marine Environment surveys

Marine environmental surveys were conducted to collect data and establish marine environmental baseline conditions for impact evaluation. Surveys are based on standard marine environmental surveys so that they can be repeatedly carried out to monitor and record changes and assess possible impacts on the marine environment from the proposed work activities. In addition, a series of photo images using an underwater digital camera (SONY DCS-T300, 10 MPix) was taken along the transect lines and in close vicinity around the intake and outfall to support a qualitative survey for benthic assessment studies.

## 8.5 Noise

Noise level was measured using a digital sound level meter Q 1362 from Dick Smith Electronics. The noise level was measured using A weighting, 'A' weighting was used as this enables sound level meter to respond in the same manner as the human ear, which increases and decreases amplitude over the frequency spectrum. The sound level meter that was used for the part of the assessment had an accuracy of ±2 dB.

## 8.6 Aerial photos

Recent satellite photos acquired in April 2008 were used in the assessment. Aerials photos provide useful information such as assisting the analysis of marine environment, identifying wave patterns and changes to shoreline and also vulnerable areas of the island. Satellite aerial photos were purchased from DigitalGlobe. This has been used in this EIA and has been presented in different sections of the report.

# 9 Existing Environment

This section discusses the existing environmental conditions.

## 9.1 Groundwater Condition

Groundwater assessment was conducted to assess the ambient conditions of groundwater. The water table is expected to stands at 1.2 to 1.7 meter below ground. Groundwater was tested atsite using a water quality logger. Groundwater of the island, on the site, was tested for electrical conductivity, pH and nitrates. These investigations of groundwater revealed that the groundwater of the island is relatively fresh. BOD and COD levels cannot be tested in Maldives at present.

| Sample No | Units | G1 | G2 |
|---|---|---|---|
| pH | | 7.3 | 7.6 |
| Temperature | | 25.3 | 25.2 |
| EC | uS/cm | 743 | 785 |
| TDS | mg/l | 369 | 393 |
| BOD* | mg/l | - | - |
| COD* | mg/l | - | - |
| Nitrate | mg/l | 0.01 | 0.01 |
| Phosphate | mg/l | 0.01 | 0.01 |
| E.coli | Count/100ml | 0 | 0 |

Table 1: Results of the groundwater analysis in Summer Island

## 9.2 Noise and Pollutions

Noise levels for the powerhouse are well within acceptable levels. The powerhouse has secondary residential silencer with attenuation of better than 85 dB (A) at 1 meter. Hence the powerhouse does not cause significant noise pollution. Noise is in compliance despite the constraints of locating the powerhouse due to the small size of the island.

## 9.3 Air Quality

The stack at power house does not produce visible smoke and not cause any significant concern to the staff and guest at the island.

## 9.4 Marine water quality

The primary objective of the marine water quality sampling was to determine the baseline conditions of the marine water quality of the lagoon. water quality was tested by sampling at 1 m below sea level from the designated sites. The geographical coordinates were also recorded using a handheld GPS. The qualitative assessment indicates that the sea water is clean and clear. To confirm this, water quality tests were done at the National Health laboratory. The results indicate no pollution from any human activities nor any other source.

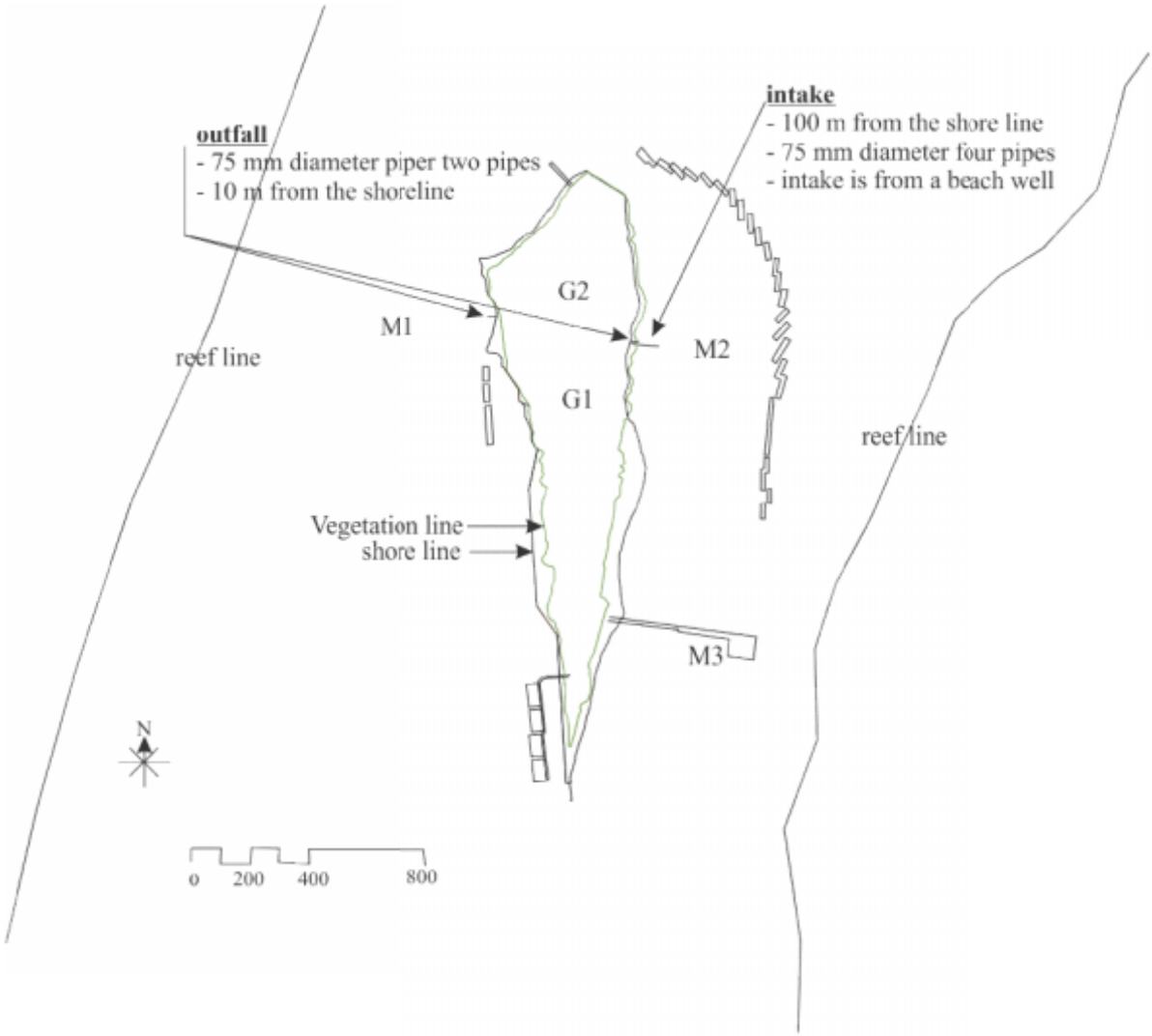


Figure 4: Groundwater and sea water sampling locations

Table 2: Results of the marine water analysis at Summer Island

| Parameters | M1 | M2 | M3 |
|---|---|---|---|
| GPS coordinates | $4^0$32’02.1” N $73^0$22’17.0” E | $4^0$31’01.5” N $73^0$22’24.0” E | $4^0$31’52.3” N $73^0$22’24.4” E |
| pH | 8.5 | 8.3 | 8.5 |
| Temp | 25.1 | 26.2 | 26.5 |
| COD (mg/L) * | - | - | - |
| BOD (mg/L)* | - | - | - |
| DO (% of saturation) | 107 | 102 | 105 |
| Salinity (ppt) | 31.7 | 33.4 | 32.6 |
| Turbidity (NTU) | 0.9 | 1.4 | 1.4 |
| Nitrates (mg/L) | 0.01 | 0.01 | 0.01 |

| | | | |
|---|---|---|---|
| Phosphates (mg/L) | 0.03 | 0.04 | 0.04 |

* not tested due to lack of test availability from lab.

## 9.5 Desalinated Water

Desalinated water from main bar, staff kitchen and storage tank was collected and tested at the National Health laboratory.

Table 3: Results of the desalinated water analysis in Summer Island

| Parameters | Physical appearance | Temp | pH | EC | TDS | Free chlorine |
|---|---|---|---|---|---|---|
| Units | | oC | | µs/cm | mg/L | mg/L |
| Storage Tank | clear | 28.0 | 8.4 | 492 | 228 | <0.02 |
| Staff Kitchen | Clear | 29.1 | 8.4 | 510 | 221 | <0.02 |

## 9.6 Brine Discharge

As part of the assessment of the existing environment of the island, the water q quality of the brine discharge from the RO plant was analysed.

Table 4: Results of the brine discharge from RO plant analysis in Summer Island

| Parameters | Physical appearance | TDS | pH | EC | salinity |
|---|---|---|---|---|---|
| Units | | g/l | | ms/cm | 0/00 |
| Brine discharge from RO Plant | Clear | 25.3 | 8.9 | 54.1 | 38.2 |

## 9.7 Marine Environment

All surveyed areas, do not show any epifaunal growth on the substrate apart from a few scattered *Porites rus* colonies (Figure 6). Sand and coral rubble is present in all areas and composes together 100% of the surveyed substrate (Figure 5).

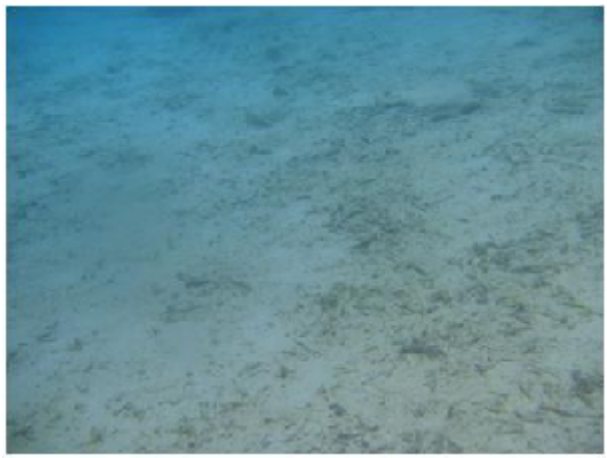

Figure 5 Composition of the seafloor

Figure 6 Loosely scattered *Porites* colonies on the sandfloor

### *9.7.1 Currents and 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.

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

Generally current flow through the Maldives is driven by the dominating two-monsoon season winds. Westwardly flowing currents are dominated from January to March and eastwardly from May to November. The change in currents flow pattern occurs in April and December. In April the westward currents flow are weak and eastward currents flow will slowly take place. Similarly in December eastward currents flows are weak and westward currents will take over slowly.

Studies on current flow process within a coral atoll have shown that waves and tides generate currents across the reef platforms, which are capable of transporting sediments on them. Generally zones of high current speed (jets or rips, 50-80cm/sec) are systematically located around islands.

# 10 Environmental Impacts and Mitigation

## 10.1 Impact Identification

Impact identification has been undertaken by considering the impact of the existing power house and desalinated plant on the island environment.

## 10.2 Assessing Impacts

Environmental impacts of the identified impact 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.

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

This EIA identifies and quantifies the significance of adverse impacts on the environment from the existing utilities systems on the island. 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 operation. 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.

## 10.3 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 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 this site is expected to be low as many utilities have been in operation in a number of resort islands in the Maldives.

## 10.4 Power House location

The powerhouse is located at the centre of the island in the northern area of the island, away from the guest areas. The location of the powerhouse does not create any significant impact on environment.

## 10.5 Power house stack emission

The powerhouse has tuned generators and hence the emission from the powerhouse stack does not cause any significant visible impact on the visual environment of the island.

## 10.6 Noise from generators

The powerhouse has secondary residential silencer with attenuation of 85 dB (A) at 1 meter. The soundproofing achieves a total free field sound level of not more than 85 dB (A) at full load outside the power house.

## 10.7 Noise form desalination plant

The desalination plant does not produce significant level of noise and hence it does not have an impact on the island's environment

## 10.8 Impact on Groundwater

The RO plant use seawater as a source of water for the desalination process. Hence the ground water is not impacted due to the operation of the resort.

## 10.9 Impact on Marine environment due to discharge of Brine from RO Plants

The outfall of the RO plant is located near the shoreline of the island on north side of the island (see Figure 4). The outfalls are located on eastern and western side of the island. Table **4** shows the quality of the brine which is discharge through the RO plant outfall. The brine is discharged to low water level mark, which is located around 10 m from the vegetation line. It is not expected that the hyper-saline water that is discharged into the lagoon will cause significant impact on the marine environment of the island.

## 10.10 Fuel, oil handling and management

The fuel for the generators are stored in the fuel storage tank located near the powerhouse. The fuel storage tank is bunded to prevent accidental leakage of fuel to the ground. Hence, the storage of fuel at the island does not cause significant risk to the ground water contamination at the island.

The waste oil from the generators is recovered from the generators and stored separately in barrels. The waste oil is used in the incinerator to fuel the incineration of the waste. The use of fuel oil in the incinerator reduces the need to transport the used fuel oil to Thilafushi and hence reduces the risk of marine pollution during the loading and transportation of the barrels from the island to Thilafushi.

**Table 5: Summary of the impacts and their characterization**

| Activity | Environmental Impacts | (1) Impact Significance<br>(2) Nature of impact<br>(3) Magnitude of impacts<br>(4) Duration of Impact<br>(5) Reversibility | Mitigation Measures | Significance of mitigation measure | Cost of impact |
|---|---|---|---|---|---|
| Power house location | Noise | (1) moderate<br>(2) cumulative<br>(3) moderate<br>(4) long term<br>(5) reversible | Sound attenuation silencers | significant | Included the project cost |
| Powerhouse stack emission | emission | (1) moderate<br>(2) cumulative<br>(3) moderate<br>(4) longt term<br>(5) reversible | location o f the power house | moderate | NA |
| | | | height of the stack | significant | Included the project cost |
| Noise from generators | noise | (1) moderate<br>(2) cumulative<br>(3) moderate<br>(4) long term<br>(5) reversible | Well tuned, serviced generators | significant | Included the project cost |
| | | | Sound attenuation silencers | significant | Included the project cost |
| Use of desalinated water | Impact on groundwater | (1) positive<br>(2) cumulative<br>(3) significant<br>(4) long term<br>(5) reversible | Protects the groundwater | significant | Included the project cost |
| Bunding the fuel tank | Impact on groundwater | (1) positive<br>(2) cumulative<br>(3) significant<br>(4) long term<br>(5) reversible | Protects the groundwater | significant | Included the project cost |

# 11 Stakeholder Consultations

For the purpose of this EIA stakeholder consultations were limited to relevant government agencies, the proponent and engineers at the resort. Methodology for undertaking these discussions was through interviews and discussions.

## 11.1 Consultation with the proponent

In general, discussions were held with the proponent to obtain information about the existing RO plant and the power house at the island. The major outcome of these consultations is outlined below.

- The RO plant and the power house need a license from the EPA and Maldives Energy Authority.
- EPA and Maldives Energy Authority needs a EIA Decision Statement with the Application for the RO Plant and the powerhouse registration
- Ministry of Tourism has requested to get the RO plant and powerhouse to be registered before 31st December 2010

## 11.2 Consultations with the Ministry of Tourism, Arts and Culture

Consultations were held with officials of Ministry of Tourism, Arts and Culture. Following are the main outcome.

- The RO Plant and the powerhouse need to be registered at the EPA and Maldives Energy Authority respectively
- The Ministry has requested that all the RO Plants and Powerhouses to be registered before 31st December 2010.
- Registration of the RO Plant and Powerhouse would be a prerequisite for the Ministry to give operating license to the resorts

## 11.3 Consultation with the engineer

The Engineer working in the resort was also consulted to obtain their views on the operation and maintenance of the RO plant and the generator at resort. The following are the main outcomes

- RO water is the main water which is used for all the purposes at the resort
- RO Plant and the generators are kept at good operating conditions
- RO plant are backwashed regularly

## 11.4 List of persons consulted

Following are the names and designation of persons consulted.

| Name | Designation | Office |
|---|---|---|
| Mr. Mohamed Adhlee | Assistant Director | Ministry of Tourism, Arts and Culture |
| Mr. Bakuru | Operations Manager | Kaimoo Hotels and Travel Services |
| | Engineer | Summer Island |

# 12 Alternatives

EIA Regulation requires two alternatives to be suggested for EIA and therefore two alternatives have been suggested in addition to the no project alternative.

## 12.1 No Project option

Though EIA regulation has asked to give no project option as alternatives, this is not applicable for this EIA as the power house and desalinated plants are existing facilities on the island.

## 12.2 Alternative water source

One way to minimize the environmental footprint is to source water from another source such as a rainwater or groundwater. At present, there is no storage facility to harvest and store rainwater. Use of abstraction and use of groundwater water is prohibited by Tourism regulations. Hence the option to explore an source of water is not practical.

## 12.3 Construction one outfall for the brine discharge

Presently, two outfalls has been used to discharge the brine from Desalination process. An alternative to existing arrangement is to discard the brine outfall which has been laid on eastern side.

## 12.4 Construction of a beach well for feedwater

Feed water for the RO plant are taken from an intake which is laid on eastern side of the island. due to the shallow depths of the lagoon on this side, the foot valve on the intake gets expose on very low tides. Hence, it is proposed to construct a beach well on eastern side of the island. The beach well in the lagoon on eastern side of the island would have the intake of the intake pipe for the RO plant.

# 13 Environmental management and monitoring plan

## 13.1 Introduction

This section covers the monitoring needs of the powerhouse and desalination plant facilities at Summer Island.

## 13.2 Cost of Monitoring

The proponent has committed fully for the monitoring programme outlined in this report.

## 13.3 Aspects of monitoring

Monitoring will only include groundwater, RO water and marine water quality. Summary monitoring reports will be provided when such is required.

## 13.4 Methods of monitoring

Environmental monitoring will be undertaken using standard methods described in the Methodology section.

**Table 6: Aspects of the environmental monitoring program with cost breakdown**

| Monitoring Attribute | Indicator | Methodology | Monitoring Frequency | Estimated Cost (US$) |
|---|---|---|---|---|
| Marine water quality | pH, temp , Salinity, turbidity, nitrates, phosphates, | Onsite or Lab analysis | Quarterly | 250 per quarter |
| Ground water quality | pH, temp , COD, DO, Salinity, turbidity, nitrates, phosphates, | Onsite or Lab analysis | Quarterly | 250 per quarter |
| RO water quality | suspended solids, TDS, pH, temp, Salinity, turbidity | Onsite or Lab analysis | Quarterly | 250 per quarter |

## 13.5 Monitoring responsibility

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

## 13.6 Monitoring Report

Monitoring report will be compiled based on the baseline data collected for monitoring the parameters included in the monitoring program. 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.

# 14 Conclusion and Recommendations

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 registration of the existing Desalination Plant and Powerhouse in Summer Island.

It has been assessed that the power house location, emission from powerhouse stack, noise from generators, desalinated water, bunding of the fuel tank, discharge of brine from the RO process through the brine outfall are the main components that could have an impact on the environment.

A number of mitigation measures has been already taken into the design and engineering as to minimise the impact on the environment of the island. The powerhouse has been located at the centre of island to minimise the impact of its noise to the guests, sound proofing has been carried out to minimise the noise heard from the power house, the stack of the powerhouse has been raised to minimise the visual impact of smoke, desalination has been introduced as to prevent the depends on groundwater and their by reducing the groundwater depletion. A bund has been constructed around the fuel tank to prevent the accidental spill of fuel to the environment and their by reducing the groundwater pollution.

The monitoring programme for the existing desalination plant and powerhouse will mainly focus on desalinated water, ground water and marine water quality. Since desalination plant and powerhouse are existing facilities on the island and it is being operated, no alternatives have been suggested in this report.

During the EIA study it was found that the existing intake and outfall from the RO plant need some modification. The intake of the RO plant is located on eastern side of the island which has a very shallow lagoon. Hence it is recommended a beach well is constructed on eastern side of the island and the intake is extended to the beach well. Similarly, the hyper – brine from the RO process is presently discharged into the lagoon through an outfall laid on eastern and western side of the island. Hence it is recommended to close the outfall which is located on eastern side of the island.

Hence the power plant and desalination Reverse Osmosis plant at the island could be registered at Maldives Energy Authority and Environmental Protection Agency.

## 15 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.

I certify that the statements in this Environmental Impact Assessment study are true, complete and correct, to our best of our knowledge and ability.

Name: Ahmed Jameel ( EIA 07/07 )

Signature:

## 16 Commitment from the proponent

## 17 References

UNEP (2005) Maldives Post Tsunami Environmental Assessment, United Nations Environment Programme, Geneva

English, S., Wilkinson, C. and Baker, V. (1997). Survey Manual for Tropical Marine Resources (2nd edition), Australian Institute of Marine Science

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Maniku, H. A. (1990) Changes in the Topography of the Maldives, Forum of Writers on Environment (Maldives), Male'

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# 18 Annex: Terms of reference