

ENVIRONMENTAL AUDIT

For Registration of Existing Desalination Plant and
Improvement to Existing Football Ground at Kuredu Island
Resort

Lhaviyani Atoll, Maldives

Proposed by:

Kuredu Holdings Private Limited

Prepared by:

CDE Consulting

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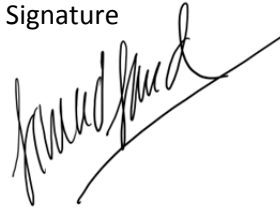
CONSULTANT'S DECLARATION

I certify that statements made in this Environment Audit are true, complete and correct to the best of my knowledge and available information.

Name:

Simad Saeed (EIA 06/2007)

Signature

A handwritten signature in black ink, appearing to read 'Simad Saeed', written over a horizontal line.

NON-TECHNICAL SUMMARY

The purpose of this Environmental Audit report is to fulfill the requirements of the Environmental Protection Agency to carry out the registration of the powerhouse, desalination plant and improvement of existing football ground in Kuredu Island Resort, Lhaviyani Atoll, Maldives.

The power generation system involves a powerhouse building that houses seven diesel fired generator sets with total capacity of 4585 KVA and a fuel storage facility with total capacity of 240,000 litres. Desalination system involves three plants with a total capacity of 210 tonnes of desalinated water per day and two water storage tanks with storing capacity of 1040 tonnes.

The project involves improvements of the existing football ground which is dedicated to the staff purely for their recreational purpose. The major development proposed for this football ground is to level off the ground install drainage system.

The structural integrity of the facilities is considered good. Noise levels are perceived as high for a mixed residential and industrial zone although it must be taken into account that space is limited and location of staff areas near powerhouse is inevitable.

The main environmental impacts associated with this project include, increased noise levels and other emissions, potential risk for ground water and soil contamination due to fuel spills and leaks, damages to vegetation due to heat and smoke generated from the power house, potential impact on the marine environment due to brine discharge from the desalination process. Visual observation identifies no notable damage to existing vegetation around the powerhouse building and no indication of any fuel spills around the powerhouse area. Marine water quality tests identify no significant contamination. Groundwater quality tests are insufficient to draw conclusions.

Improvement to the football grounds is not expected to cause significant adverse impacts. Drainage of water during operation phase will positively affect the groundwater aquifer by contributing to recharging of the aquifer.

Mitigation measures that are in place to reduce the environmental impacts associated with the operation of the two facilities include planting of trees in high noise areas and improved maintenance of generator sets. In order to protect the environment from potential fuel spills, fuel storage facilities are banded to contain any spills and proper pipelines are established for safe fuel transfers.

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

1 INTRODUCTION

1.1 Purpose

The purpose of the report is to meet the legislative requirements of Environmental Protection Agency (EPA) for the registration of the desalination plant and to assess the potential impacts associated with undertaking improvements to the football ground in Kuredu Island Resort.

The EIA Regulation 2007 requires an environmental audit to be undertaken for the registration of the desalination plant and for the improvements to the existing football ground. Likewise, Desalination Regulation of the Maldives requires the EIA Decision Statement be submitted to the relevant authorities for the registration of the facilities.

In addition, an environmental clearance is required for the newly proposed improvements that are to be done at the football ground.

Kuredu Island Resort is currently in operation with 384 rooms and hence, desalination plant is in operation for water supply. Thus, EPA has required an Environmental Audit of the desalination plant.

This report is prepared for Kuredu Holdings Private Limited by CDE Consulting.

1.2 Terms of Reference

The Environmental Audit is prepared based on the Terms of Reference (ToR) issued by EPA on 21 March 2011. According to the ToR, the report should be submitted within three months from the date of issue of the ToR.

The ToR is enclosed in Appendix I of the report.

1.3 Report Outline

This report is organised into seven chapters as described in Table 1.1.

TABLE 1-1 BRIEF DESCRIPTION OF THE CHAPTERS OF THE REPORT

| Chapter | Brief Description |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Chapter 1 | An introduction to the report stating the purpose and content of the report. |
| Chapter 2 | Detail methodology adopted for the EIA report and how appropriate mitigation measures are developed and the whole scope of this EIA report. |
| Chapter 3 | A summary of the policy, planning and legal framework applicable to the audit |

| Chapter | Brief Description |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | and a demonstration of how the existing facilities comply with the existing environmental policies and regulations. |
| Chapter 4 | A description of the project including the project location, information on the proponent, detailed description of project components including site conditions and site plans. |
| Chapter 5 | Detailed description of the existing baseline environmental conditions. |
| Chapter 6 | Information on the operational impacts and mitigation measures of the project. |
| Chapter 7 | Details of the environmental monitoring program |

1.4 Environmental Audit Team Members

The project team members and their areas of contributions are listed in Table 1.2 below. Their complete and updated CV's of are attached in Appendix 2.

TABLE 1-2AUDIT TEAM AND THEIR AREAS OF CONTRIBUTION

| Consultant | Areas of Contribution |
|-----------------|-------------------------------------------------------------------------|
| Dr. Simad Saeed | Team Leader, Social Scientist and Environmental Management and Planning |
| Dr. Ahmed Shaig | Terrestrial Environment |
| Lubna Moosa | Environmental Management and Development |
| Ali MoosaDidi | Surveyor |
| Mohamed Faizan | Marine Biologist |

2 SCOPE AND METHODOLOGY OF EIA

2.1 Scope of the Audit

This Environmental Audit comprises of the assessment necessary for the registration desalination plant and improvement of the existing football ground in the island. A scoping meeting was conducted at EPA on 14th day of March 2011. The meeting was attended by the project proponent and the project consultant and relevant government authorities. The outcome of the scoping meeting is the ToR provided in Appendix 1.

The scope of the audit is to assess the environmental performance of the existing desalination plant at Kuredu Island Resort in order to enable the registration of the plant according to the Desalination Regulation of the Maldives. There is no construction of additional infrastructure in relation to desalination plant however there is a consideration given to the indirect implication of powerhouse.

2.2 Methodology of Audit

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

- + Scoping consultations;
- + Literature review;
- + Field surveys;
- + Analysis of results; and
- + Compilation of the assessment in the form of a report.

The first step of the process covered consultations with the project proponent and government agencies to determine the scope of the Environmental Audit.

The second phase of this project was carried out in parallel with the stakeholder consultations. Literature review being a key element in this process it enables to acquire background information on the site and its environment as well as to identify possible environmental impacts of similar developments in island settings. In this context, the EIA Regulations 2007, best practices from similar development activities, scientific studies undertaken in similar settings around Maldives and previous documents/historical publications was considered.

The third stage involved field assessment on the island and areas covered by the EIA scope. Conditions of the existing environment were analyzed using established scientific methods. Field surveys were undertaken from 03 March 2011.

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

The final stage involved compilation of individual consultants' findings and finalizing the report to submit to EPA.

2.3 Survey and Data Collection

The environmental audit was undertaken by two different aspects. Firstly, legislative compliance was assessed based on requirements of the relevant laws and regulations and, registering authorities. Secondly, environmental impacts of the operations and level of mitigation was investigated. The existing environment was studied using scientific methods to assess the environmental impacts of the operations. A checklist was developed to identify areas and parameters of assessment that should be in compliance with relevant legislation.

Details of the plants were collected by observation of the facilities and interviews with the management.

The environmental components of the study area were divided into terrestrial and marine environment. Terrestrial environment covers the nearby vegetation of the project boundary, groundwater quality and observation of soil near potential oil spill areas. The marine environment covered the lagoon habitats and coral reef system including coral patches, fish communities, and marine water quality.

Noise measurements were taken using a noise meter as spot readings according to regulatory requirements. Visual assessments are also carried during the visit for any degradation of soil quality or alteration to the vegetation near the utility system and also the football ground. Current was not measured from the site however it was based on literature reviews and data analysis from the nearby weather collection center. Similarly tidal data was taken from previous research.

The project involves investigation of quality of ground water, marine waster from the intake and outfall and also the desalinated water. To assess these water qualities of the site, samples were collected in dry clean 1500 ml PET bottles, 250 ml glass bottles and 250 ml sterilized water bottles after washing them with water to be sampled. All parameters were analysed at the National Health Laboratory.

All sampling locations were identified using GPS and are presented in Appendix 3.

3 POLICY AND LEGAL FRAMEWORK

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

3.1 Acts

Acts in this report is defined as the law which is endorsed by the parliament which act as the guideline to produce necessary regulations to further strengthen the whole constitution.

3.1.1 ENVIRONMENT PROTECTION AND PRESERVATION ACT (ACT NO. 4/93)

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

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

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

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

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

Article 9a: The penalty for minor offences in breach of this law or any regulations made under this law, shall be a fine ranging between Rf5.00 (five Rufiyaa) and Rf500.00 (five hundred Rufiyaa), depending on the actual gravity of the offence. The fine shall be levied by the Ministry of Housing and Environment or by any other government authority designated by that Ministry.

Article 9b: Except for those offences that are stated in (a) of this clause, all major offences under this law shall carry a fine of not more than Mrf 100,000,000.00 (one hundred million Rufiyaa), depending on the seriousness of the offence. The fine shall be levied by the Ministry of Housing and Environment.

Article 10: 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. This includes all activities mentioned in Clause No. 7 of this law as well as those activities that take place outside the projects that are identified here as environmentally damaging.

3.2 Regulations and Guidelines

3.2.1 4.3.1 ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS 2007

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

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

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

3.2.2 4.3.2 REGULATION ON THE REGISTRATION OF DESALINATION

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

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

3.2.3 4.3.3 REGULATION ON PROVIDING ELECTRICITY SERVICES

Under this regulation, construction of the powerhouse and, handling and storage of fuel must be according to standards issued by former Ministry of Environment, Energy and Water (MEEW) currently Ministry of Housing and Environment. Currently Maldives Energy Authority is responsible for providing electricity services. This regulation is particularly relevant to this project, specifically for the fuel storage and handling.

3.3 Development Framework and Policies

3.3.1 STRATEGIC ACTION PLAN 2009 – 2013 NATIONAL FRAMEWORK FOR DEVELOPMENT “ANNE DHIVEH RAAJE”

The Strategic Action Plan (SAP) provides the National Development Framework for the period 2009-2013. It has been compiled through consultation with multiple sectors and by reviewing development trends, emerging issues, goals, policies and interventions relevant to the five main pledges and key themes of the MDP Alliance Manifesto.

The five pledges listed below represent the vision on which the people elected this government.

- + Nationwide transport system
- + Ensuring affordable living costs
- + Provision of affordable housing
- + Providing quality healthcare for all
- + Prevention of Narcotics abuse and trafficking

3.3.2 NATIONAL ENERGY POLICY

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

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

1.1.2 POLICY ON WATER

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

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

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

3.4 Environmental Permits Required for the Project

3.4.1 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) DECISION NOTE

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

3.5 International Conventions

3.5.1 VIENNA CONVENTION AND MONTREAL PROTOCOL

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

3.5.2 UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC) AND KYOTO PROTOCOL

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

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

3.6 Key Government Institutions

3.6.1 MINISTRY OF HOUSING AND ENVIRONMENT (MHE)

Ministry of Housing and Environment is the former Ministry of Environment, Energy and Water which is mandated for protection and preservation of environment and natural resources of the country. Under the current government which took office in 2008 restructured itself to present current structure, of EPA.

Within MHE there is a department “Water and Sanitation Department” which formulates the water policy and water based guidelines and also prepares water and sanitation regulation such as Desalination Regulation.

3.6.1.1 *Environmental Protection Agency (EPA)*

The Major task for the EPA is to enforce the EPPA 4/93. EPA has a branch within to monitor and regulate water and sanitation problems. This is formally known as Maldives Water and Sanitation Authority. It also has an EIA section which deals with all the EIA work and their enforcement.

Within EPA there exists “Maldives Water and Sanitation Authority commonly referred as MWSA” which ensures proper enforcement of the laws and regulations formulated and accredited by MHE and specific relevant to

4 PROJECT DESCRIPTION

4.1 Project Proponent

Kuredu Holdings Private Limited is registered at Ministry of Economic Development under the Companies Act of the Republic of Maldives (Law no. 10/96) which came into force on 01st of July 1997, and bounded by the Maldives Companies General Regulations which came in to force in 01st February 2003. Kuredu Holdings Private Limited is the proponent of registration of the powerhouse, the desalination and improvement of the existing football ground.

Kuredu Holdings Private Limited has contracted CDE Consulting to prepare this Environmental Audit.

4.2 Project Site

The utility systems are located at Kuredu Island Resort. Kuredu Island Resort is situated western rim of the Lhaviyani Atoll. Kuredu Island Resort is situated at 5°33'1.70"N and 73°27'48.46"E. The nearest inhabited island (Hinnavaru) is located 8.66 km Southwest of Kuredu Island Resort. While nearest resort (Kanuhuraa Island Resort) to the project location is 4.58 km Southeast. Figure 4.1 below shows the Lhaviyani Atoll and the Project Location.

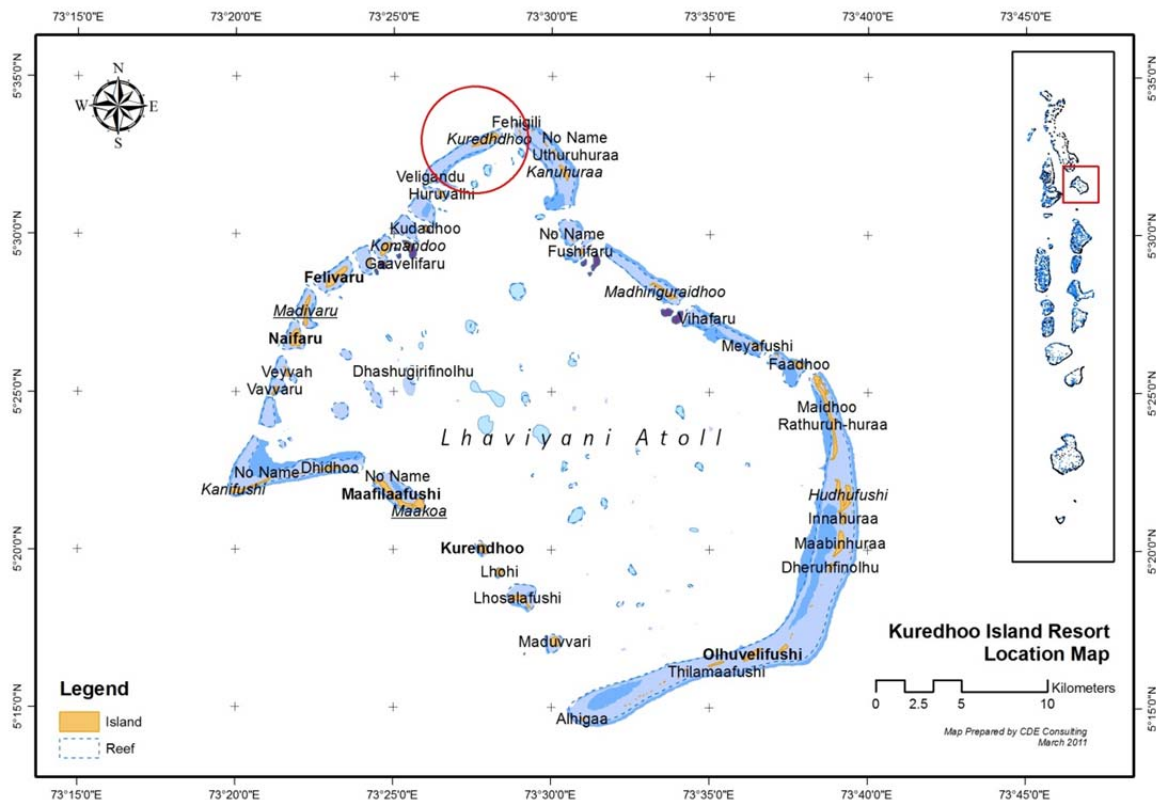


FIGURE 4-1-LOCATION OF KUREDU RESORT WITHIN LHAVIYANI ATOLL



FIGURE 4-2 SATELLITE IMAGE OF KUREDHOO

4.3 Project Objectives

The objective of the desalination plant is to provide freshwater while conserving the groundwater aquifer of the island. Moreover the objective of the improvement of the existing football ground is to provide staff recreational facility and to strengthen unity among the staff. Figure 4.3 shows location of the desalination plant and the football ground in Kuredu.



FIGURE 4-3 LOCATION OF POWERHOUSE, DESALINATION PLANT AND FOOTBALL GROUND (SOURCE GOOGLE EARTH)

4.4 Desalination System

Kuredu Island Resort has five desalination plants with a total capacity of producing 210 tonnes desalinated water daily. These desalinated plants are well kept in a site designated for them with an elevation from the floor for future predications such as flooding in the islands.

Figure 4.4 shows the inside of the desalination plant and Figure 4.5 shows storage tanks of the desalinated water. Water storage capacity is 1040 tons.



FIGURE 4-4 DESALINATION PLANT



FIGURE 4-5 STORAGE TANKS OF DESALINATED PLANTS

There are three seawater intake pipes that are located on the eastern side of the island with a length of 151 m. However the resort did indicate existence of another intake pipe line on the western side of the island which was not located. The inlet feeds water to the sedimentation tank. After screening of the inlet water the water is then filtered for the secondary residues. Finally the water pass through a carbon filter which then undergoes for the first stage of reverse osmosis. This water is needs to be further refined for human consumption; therefore this water is used for gardening purpose and for other consumption purposes. Some of the water stored in the initial tank is be further refined by second reverse osmosis stage and is be subject to further purification process including Ultra Violet radiation and secondary treatment.

During the process of reverse osmosis both in primary and secondary states brine is discharged to the eastern side. The pipe is 0.5 m from the shoreline and therefore brine is discharged within the lagoon

The water produced after the final reverse osmosis stage is connected to all guest rooms and other public areas via underground pipelines. Desalinated water is used for all purposes including, drinking, cooking and cleaning on Kuredu.

4.5 Powerhouse

Powerhouse is located adjacent to the desalination plant. The Powerhouse is located at the center of the island. There are seven generator sets with a capacity of 5500 KCA. The peak demand of the island is 1,450 KWh. This location is at a sufficient distance away from the guest area. Although the powerhouse is located near the staff area there is appropriate distance between the powerhouse and nearest staff buildings.

4.6 Safety

Safety precautions are well addressed in desalination system. The desalination plants have safety equipment's readily available on site, in case of emergency. The resort conducts emergency drill and does the monitoring activities as a mandatory guideline that the resort follows. There are more 16 fire extinguishers placed inside and outside the powerhouse and the desalinated plants. Moreover there is one Angus Hi-Combat AF 120 Mobile foam unit is placed outside the powerhouse which is adjacent to the desalination plant. Figure 4.5 shows this Hi-Combat AF 120 Mobile Foam Unit.

During the safety drills that are being conducted by the resort owner to their workers or staff ensures that the staffs are well prepared and fully aware on an emergency. They will be fully equipped with all necessary skills to ensure that they perform speedy and safely. The Figure 4.6 shows typical fire extinguishers that are extensively used in the islands.

Emergency First Aid kits are available at different places in case of any injury to the staff.



FIGURE 4-6 HI COMBAT AF 120 MOBILE FOAM UNIT (LEFT) AND FIRE EXTINGUISHERS INSTALLED INSIDE DESALINATION PLANT HOUSE (RIGHT)

4.7 Football Ground

The existing football ground is located northeast of the island. The area of the football ground is 0.81 Ha. This football ground is mainly dedicated to the staff and is only used by the staff of the islands for recreational purposes.

The existing football ground is an area with green patches grown at several locations inside the ground. These patches are naturally formed patches which are subjected to mowing occasionally.

The project proposes to level the football ground and if required install drains on the sides. In general the central areas of the ground will be raised to about +200 mm. The additional sand required for leveling is available as stockpiled sand from past excavation project and from the swimming pool project. The proposed layout of the ground is provided in Figure 4-7 below.

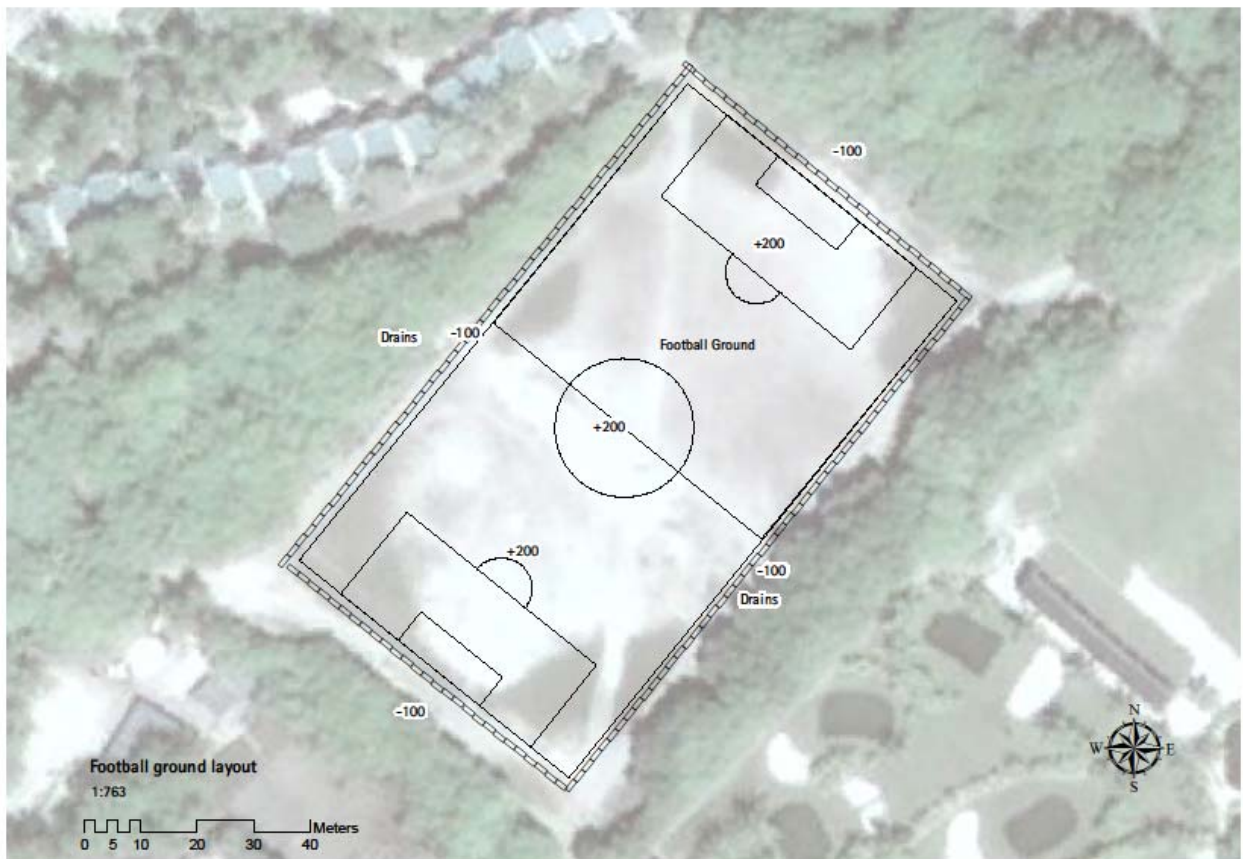


FIGURE 4-7 FLOOR PLAN OF THE FOOTBALL PITCH

The football pitch will be relevelled using a loader. If the drains are required, the excavation will be undertaken by a small excavator. No groundwater extraction is required. Concrete drain panels will be constructed off site and placed on site using excavator.

The major improvement will be installing 0.5 X 0.8 m concrete drainage system along the borders of the football ground as shown in Figure 4.7. The project does not involve plantation of the vegetation in the sport field. Grass will not be planted in the field while grass patches existing on the field will be allowed to grow. This will help prevent introduction of alien species to the flora system of the island. Figure 4.8 shows the existing status of the football ground.



FIGURE 4-8 PROPOSED PROJECT SITE

4.8 Timing and Coordination

- In general, the works are expected to be completed within two (02) months.
- The first phase will involve leveling the football pitch. The second phase will involve establishing the drainage areas.

4.9 Mobilisation of Equipment and Materials

- Site mobilisation involves the mobilisation of construction equipment, materials and workforce to the island and providing necessary storage for materials and site access and services for the workforce.

4.10 Workforce and Services

- There will be about 15 workers during the construction stage. These workers will be accommodated on the island and in temporary accommodation.
- All workforce-related infrastructure and services will be provided on the island.
- The proponent will provide workers with meals and appropriate entertainment facilities including radio and television.

4.11 Utilities

- Existing desalination plant and generator in the island will be utilized to provide water and electricity.
- Existing Sanitation facilities in the island will be provided for the workers.

4.12 Construction Waste Management and Disposal

- Construction waste is expected to be minimal. The construction waste will be reused during concrete work and for leveling. Remaining excavated earth will be stored for later use in an area south of the football pitch.
- There will be no significant green waste since the proposed site is an open area.
- Other wastes would be general domestic waste arising from material consumption by construction workforce. These will be managed according to Tourism Regulations and it would be the Contractor's responsibility to dispose of all construction-related waste during demobilisation along with any other waste. The Contractor will be required to clear all areas of work.

4.13 Pollution Control Measures

The following measures will be taken to ensure minimal pollution during construction stage.

- Machinery will be properly tuned and maintained to reduce emissions and minimize risk of spills/leaks.
- Fuel storage will be banded.
- Spill kits will be maintained around island to handle any liquid spills.
- Septic tanks will be utilized for sewage and wastewater disposal during construction period.
- All paints, lubricants, and other chemicals used on site will be stored in secure and banded location to minimize risk of spill.

4.14 Health and Safety Measures

- The contractor would ensure that Health and Safety procedures are complied with at all times.
- Construction activities would be carried out under the supervision of a suitably experienced person.
- All reasonable precautions will be taken for the safety of employees, and equipment will be operated by competent persons.
- Warning signs, barricades or warning devices will be provided and used. Necessary safety gear will be worn at all times.

4.15 Water Supply

Ground water will be not be extracted for the operation.

The existing desalination plant will be utilized for production of fresh water supply for this development.

4.16 Employment

During construction phase of the swimming pool, about 15 workers will be employed in the project.

5 EXISTING ENVIRONMENT

This section covers the existing environmental conditions of Kuredu, specifically those areas that may be impacted by the operation of the desalination plant and related infrastructure and, impacts from improvements to be made to the football ground.

This chapter is evolved on three major broad environments. They are:

1. Physical Environment:
2. Biological Environment
3. Human Environment

5.1 Study Area and Survey locations

Study area and survey locations is shown Figure 5.1 and a larger version is in Appendix 3.

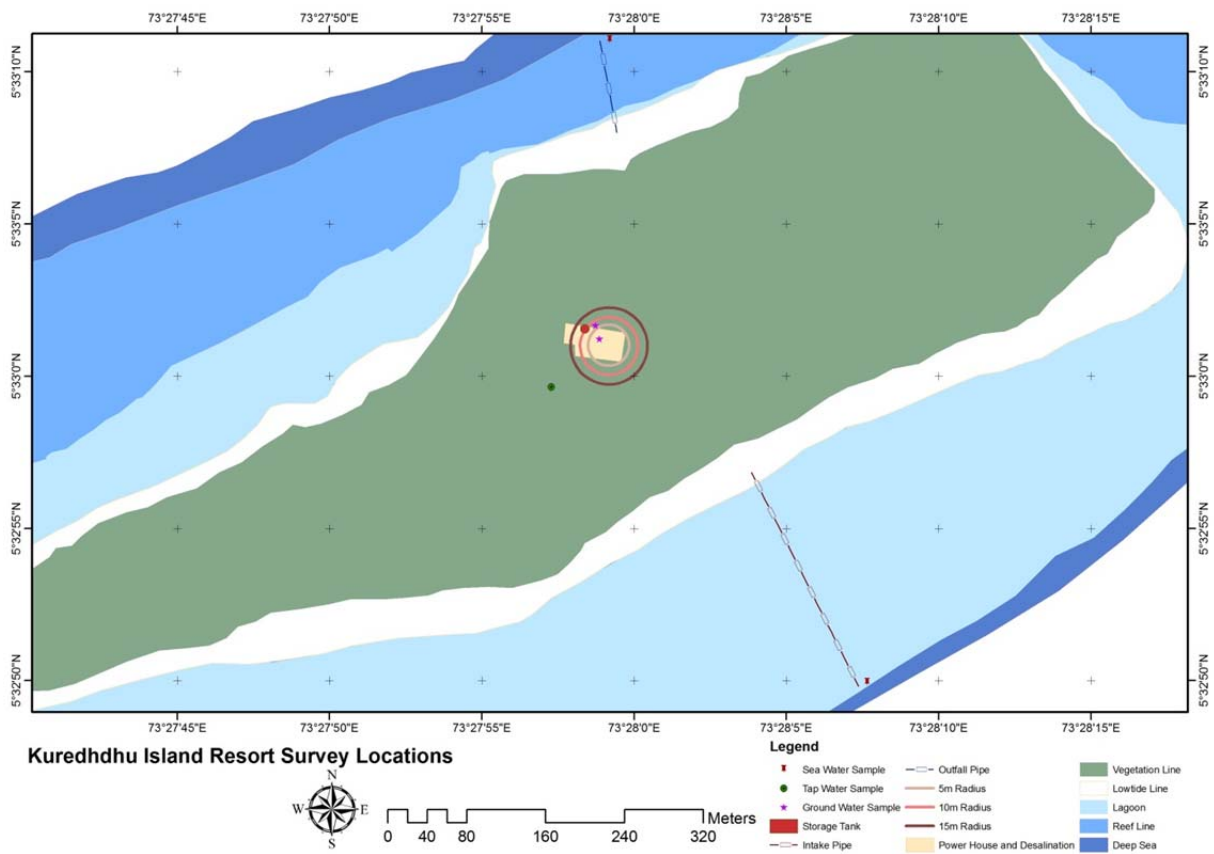


FIGURE 5-1 STUDY BOUNDARY AND SURVEY LOCATIONS OF LH. KUREDU

5.2 Physical Environment

5.2.1 MARINE WATER QUALITY

Marine water quality at the outfalls and intake area was assessed by taking samples from these locations. Samples were tested at the National Health Laboratory. Table 5.1 below gives the results of the tests and the water test reports are provided in Appendix 4. Chemical oxygen demand, biological oxygen demand and dissolved oxygen could not be tested at the laboratory.

TABLE 5-1 RESULT OF THE MARINE WATER QUALITY ASSESMENT

| Parameter Tested | Brine Discharge Outfall | Salt Water Intake |
|----------------------------------------|--------------------------------|--------------------------------|
| Colour (TCU) | 1 | 1 |
| Physical Appearance | Clear with Suspended Particles | Clear with Suspended Particles |
| Temperature (°C) | 27.9 | 27.8 |
| pH | 8.4 | 8.4 |
| Conductivity ($\mu\text{s cm}^{-1}$) | 50,400 | 51,100 |
| COD (mg l^{-1}) | NT* | NT |
| BOD (mg l^{-1}) | NT | NT |
| DO (mg l^{-1}) | NT | NT |

*National Health Laboratory was unable to perform the test

Based on the water quality results given in Table 5.1 seawater quality in the brine discharge area is considered normal. There is no indication that brine discharge is causing hypersalination in the area. This is most likely that water circulation and flushing in the zone is good and therefore dispersing the brine effectively. Seawater in the intake zone is also in normal conditions.

5.2.2 GROUNDWATER QUALITY

Groundwater quality at the impact area was assessed by taking one sample from approximately 1 metre away from the existing powerhouse. A second sample was extracted around 5 meters away from the fuel storage tank. Results of the water quality assessment are presented in Table 5.2.

TABLE 5-2 RESULTS OF THE GROUND WATER QUALITY ASSESMENT

| Parameter Tested | Near Powerhouse | Near Fuel Storage Tank |
|-----------------------|--------------------------------|--------------------------------|
| Apparent Colour (TCU) | 2 | 0 |
| Physical Appearance | Clear with Suspended Particles | Clear with Suspended Particles |

| Parameter Tested | Near Powerhouse | Near Fuel Storage Tank |
|--------------------------------------------|-----------------|------------------------|
| pH | 7.8 | 8.4 |
| Conductivity ($\mu\text{s cm}^{-1}$) | 3770 | 58,400 |
| Total Oil or Carbon (mg l^{-1}) | *NT | NT |
| COD (mg l^{-1}) | NT | NT |
| BOD (mg l^{-1}) | NT | NT |
| DO(mg l^{-1}) | NT | NT |
| Nitrate (mg l^{-1}) | NT | NT |
| Phosphate (mg l^{-1}) | NT | NT |

*NT - National Health Laboratory was unable to perform the test

National Health Laboratory was unable to perform tests for THC, COD, BOD, DO, Nitrate and Phosphate. Therefore chemical impurities of the water sampled could not be further analyzed. Letter indicating the above parameters that were not performed is annexed in Appendix 4.

The main deviation that is apparent from the available tests is the electrical conductivity of the sample collected from near the fuel storage tank which is similar to conductivity of seawater. It is not possible to conclude on the quality of groundwater and therefore it is crucial to monitor groundwater in order to assess the condition of the aquifer.

Groundwater is not being utilized by the resort for any activity; therefore there this variation will not have much impact to the tourists and staff in this resort. However, good groundwater quality is important for the preservation of the environment of the island.

5.2.3 DESALINATED WATER QUALITY

Samples were taken from the desalinated water storage tank and from a common tap. Table 5.3 shows the results of the analysis done on the water samples.

TABLE 5-3 RESULTS OF WATER ANALYSIS FROM DESALINATION PLANTS

| Parameter Tested | Water Storage Tank | Tap Water | WHO drinking water standard |
|----------------------------------------|--------------------|-----------|------------------------------|
| Apparent Colour (TCU) | 0 | 0 | |
| Physical Appearance | Clear | Clear | |
| pH | 8.3 | 8.8 | 6.5 – 8.5 |
| Conductivity ($\mu\text{s cm}^{-1}$) | 532 | 256 | < 1500 $\mu\text{s cm}^{-1}$ |
| BOD (mg l^{-1}) | NT | NT | - |
| DO(mg l^{-1}) | NT | NT | > 5 mg/l |
| Nitrate (mg l^{-1}) | NT | NT | < 50 mg/l |

| Parameter Tested | Water Storage Tank | Tap Water | WHO drinking water standard |
|---------------------------------|--------------------|-----------|-----------------------------|
| Phosphate (mg l ⁻¹) | NT | NT | - |
| Total Coliform/100 ml | 0 | 0 | 0/100 ml |
| Faecal coliform (Ecoli)/100 ml | 0 | 0 | 0/100 ml |

*National Health laboratory was unable to perform the test

Water quality of product water meets the WHO recommended guidelines.

5.3 Meteorology

5.3.1 CLIMATIC SETTING

The Maldives, in general, has a warm and humid tropical climate with average temperatures ranging between 25°C to 30°C (MHAHE, 2001) and relative humidity ranging from 73 per cent to 85 per cent. The country receives an annual average rainfall of 1,948.4mm. There is considerable variation of climate between northern and southern atolls. Table 5.4 provides a summary of key meteorological findings for Maldives in general. General studies on climatic conditions of Maldives were taken into account as the project location does not have any climatic data collection station established. The nearest climate data collecting station is located at Hdh. Hanimaadhoo which is extensively used in this EA.

TABLE 5-4 GENERAL METEOROLOGICAL FINDINGS OF MALDIVES

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

5.3.2 MONSOONS

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

5.3.3 TEMPERATURE AND RAINFALL

The nearest climate data collection station is at Hanimaadhoo Airport at Hdh. Hanimaadhoo. The average annual rainfall is 1977 mm and there is torrential rain during the wet season (Southwest monsoon). Mean daily maximum temperature is 31°C and minimum temperature is 26°C.

5.3.4 WIND

Wind was uniform in speed and in direction over the past twenty-plus monsoon seasons in the Maldives (Naseer, 2003). The wind rose in Figure 5.2 shows the mean daily wind speed and direction at Hdh. Hanimaadhoo Airport. Analysis of the wind data available from the Maldives metrological services concluded that winds are considerably higher in north and central region of the entire nation. Winds from the north-east and the east-north-east are predominant during December to February. During March to April the direction varies with the general direction being westerly. Strong winds are associated with the southwest monsoon season. Gales are uncommon, and cyclones very rare in the Maldives. The stormiest months are typically May, June and July.

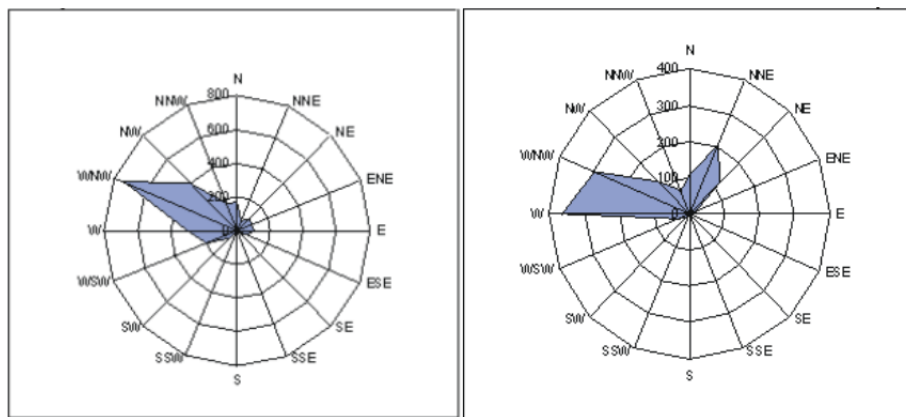


FIGURE 5-2 GENERAL WIND ROSE DIAGRAM FOR MALDIVES

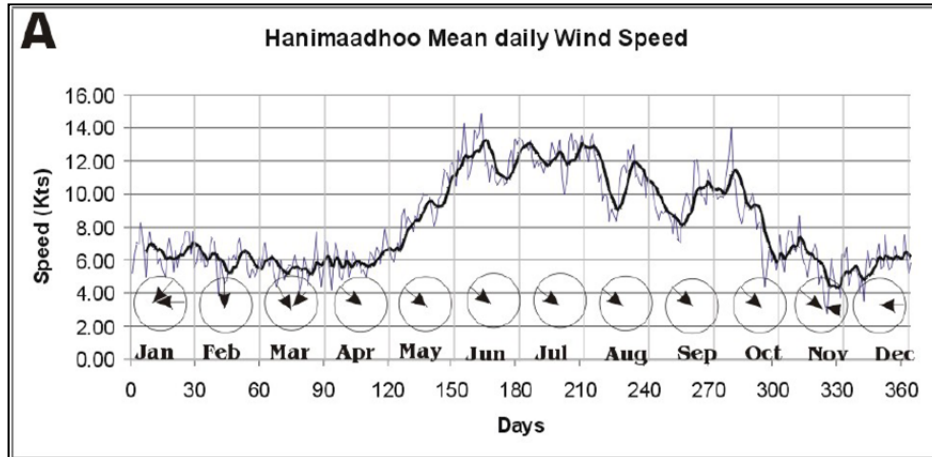


FIGURE 5-3 MEAN DAILY WIND SPEED AND DIRECTION AT HDH. HANIMAADHOO AIRPORT. ARROWS INDICATE DOMINANT WIND DIRECTION (ADAPTATED FROM NASEER, 3003)

5.3.5 WAVES

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

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

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

5.3.6 TIDES

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

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

5.3.7 CURRENTS

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

5.4 Biological Environment

5.4.1 TERRESTRIAL VEGETATION

The vegetation types and frequency of their occurrence around the, desalination plant and around the football ground was assessed through observation. The project area was mainly dominated by Dhivehi Ruh (*Cocosnucifera*), Dhiggaa (*Hibiscus tiliaceus*), Kaani (*Cordiasubcordata*), Hirun’dhu (*Thespesiapopulnea*), Funa and Magoo (*Scaevolataccada*).

Table 5.5 below provides a list of the types of vegetation and the frequency of their occurrence found around the desalination plant building.

TABLE 5-5 RESULTS OF THE VEGETATION ASSESSMENT AROUND DESALINATION PLANT

| Local Name | Common Name | Scientific Name | Family Name | Occurrence |
|-------------|-----------------------|----------------------------------------------|-----------------|------------|
| Dhivehi Ruh | Coconut Palm | Cocosnucifera | Areaceae/Palmae | Abundant |
| Dhiggaa | Sea/beach hibiscus | Hibiscus tiliaceus | Malvaceae | Frequent |
| Hirun’dhu | Thespesia | Thespesia populnea (L.) Soland. ex Correa | Malcaceae | Frequent |
| Funa | Alexander Laurel Wood | Calophyllum inophyllum L. | Clusiaceae | Frequent |
| Magoo | Sea lettuce tree | Scaevola taccada (Gaert.) Roxb | Goodeniaceae | Frequent |

| Local Name | Common Name | Scientific Name | Family Name | Occurrence |
|---------------|-------------|--------------------|-------------|------------|
| Kaani/Kauni | Sea trumpet | Cordia subcordata | Ehretiaceae | Frequent |
| Nika/Kiri gas | Banyan tree | Ficus benghalensis | Moraceae | Once |

During the improvements to the existing football ground no trees will be removed or cleared. Table 5.6 shows type of vegetation with their numbers.

TABLE 5-6 RESULTS OF THE VEGETATION ASSESMENT AROUND FOOTBALL GROUND

| Local Name | Common Name | Scientific Name | Family Name | Occurrence |
|-------------|--------------------------|-----------------------------------|------------------|------------|
| Dhiggaa | Sea/beach hibiscus | Hibiscus tiliaceus | Malvaceae | Abundant |
| Funa | Alexander Laurel Wood | Calophyllum inophyllum L. | Clusiaceae | 12 |
| Dhivehi Ruh | Coconut Palm | Cocos nucifera | Arecaceae/Palmae | 10 |
| Magoo | Sea lettuce tree | Scaevola taccada (Gaert.) Roxb | Goodeniaceae | 3 |
| Ban'bukeyo | Breadfruit | Artocarpus altilis (Z.) Fosb. | Moraceae | 1 |
| Midhili gas | Country almond | Terminalia catappa L. | Combretaceae | 1 |
| Maakashkeyo | Pandanus | Pandanus leucanthus | Pandanaceae | 1 |

5.4.2 MARINE ENVIRONMENT

Lagoon benthos and patch reefs within the lagoon were surveyed using visual observations during snorkelling to establish the general characteristics of the lagoon system. However water conditions were rough and prevented the surveyor from making a detailed observation.

5.4.2.1 Methodology

5.4.2.1.1 Snorkeling survey

Snorkeling scientific visual survey method was employed to assess the benthic cover along the pipes (water uptake pipes for the desalination plant). Estimate cover of hard coral, sand, rubble and dead corals along this pipe line was recorded.

5.4.2.1.2 Fish Census

Fish censuses were conducted by swimming 5 minutes along the pipe line and recording the number of fishes observed. Fishes observed are divided into three categories: High (greater than 10), Moderate (greater than 5, less than 10), Few (less than 5).

5.4.2.2 Benthic composition

Marine environment along the water intake pipes of Kuredu was recorded on 3rd of March 2011. The pipes are laid on almost 76.9% sand, 14.49% rubble and few hard corals were observed growing on the pipe. Concrete blocks used to sink the pipes make up about 2.6% of the total area (Figure 5.4). Main live corals found at this location belong to genera *Pocillopora* (Figure 5.5).

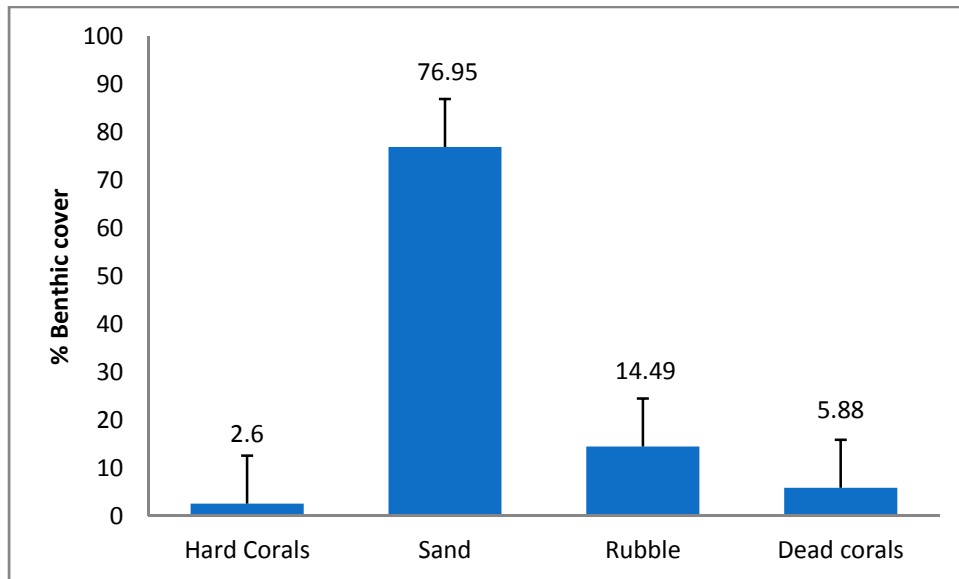


FIGURE 5-4 BENTHIC COMPOSITION ALONG PIPELINES, 3RD MARCH 2011



FIGURE 5-5 MAIN TYPE OF HARD CORAL OBSERVED ALONG PIPE

5.4.2.3 Fish Census

Fishes belonging to major 6 major families were recorded: *Pomacentridae*, *Acanthuridae*, *Lutjanidae*, *Chaetodontidae*, *Balistidae* and *Mullidae* (Figure 5.6). Total number of fish species recorded was 9, belonging to 8 different genera. The abundance of the different fishes observed during the fish census is

given in **Error! Reference source not found.** Large numbers of Humbug Dasyllus (*Dasyllus aruanus*) was recorded taking shelter in the small *Pocillipra* colonies found on the concrete blocks and the pipes.

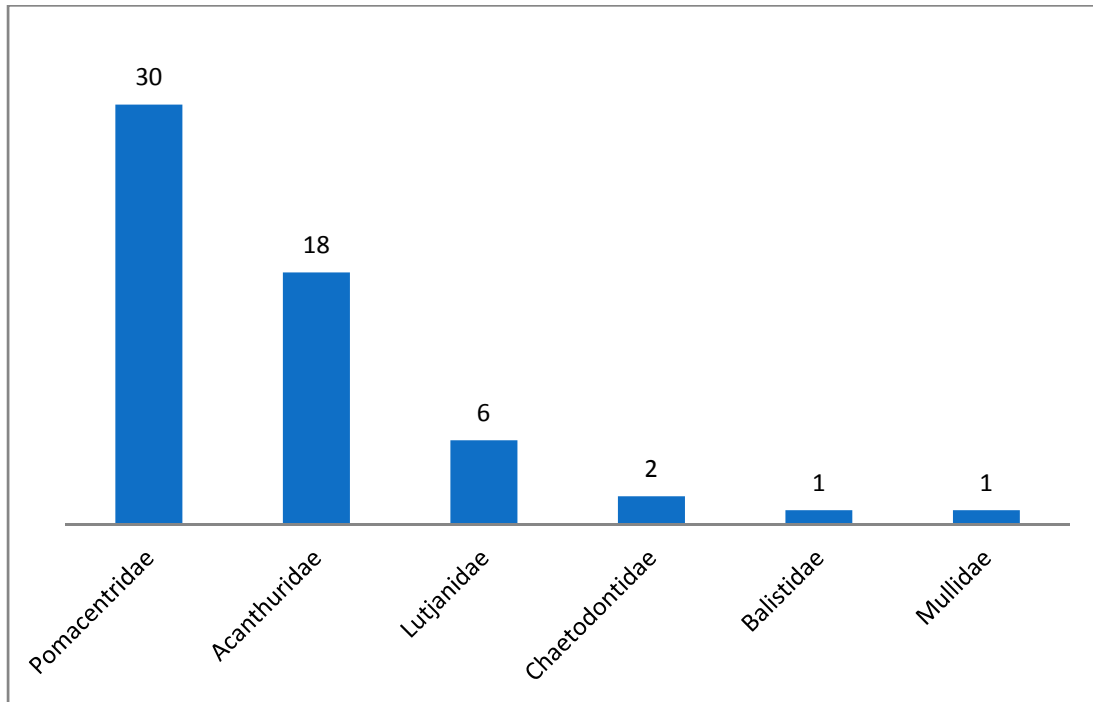


FIGURE 5-6 NUMBER OF FISHES RECORDED BY FAMILY

TABLE 5-7 FISH COUNT ALONG THE PIPE LINES, 3RD MARCH 2011

| Family | Genus | Species | Abundance |
|----------------|--------------|--------------|-----------|
| Acanthuridae | Acanthurus | triostragus | Moderate |
| Acanthuridae | Ctenochaetus | striatus | Moderate |
| Acanthuridae | Naso | brevistris | Moderate |
| Acanthuridae | Acanthurus | tennenti | Few |
| Balistidae | Balistoides | viridescens | Few |
| Chaetodontidae | Chaetodon | zanthophalus | Few |
| Lutjanidae | Lutjanus | gibbus | Moderate |
| Mullidae | Parupeneus | barberinus | Few |
| Pomacentridae | Dasyllus | aruanus | High |

5.5 Human Environment

5.5.1 NOISE

Noise levels around the powerhouse building at a radius of 05 meters, 10 meters and 15 meters were recorded using a handheld sound level meter of 0.1dB resolution. The average noise level around the desalination plant house within 05 m, 10 m and 15 m are respectively. During day time, average noise levels inside the desalination plant house was recorded as 94.5dBA and inside the generators room was recorded as 99.3dBA. Figure 5.7 shows the noise measurements on aerial map of Kuredu Island Resort. A larger version of the figure is provided in Appendix 5.

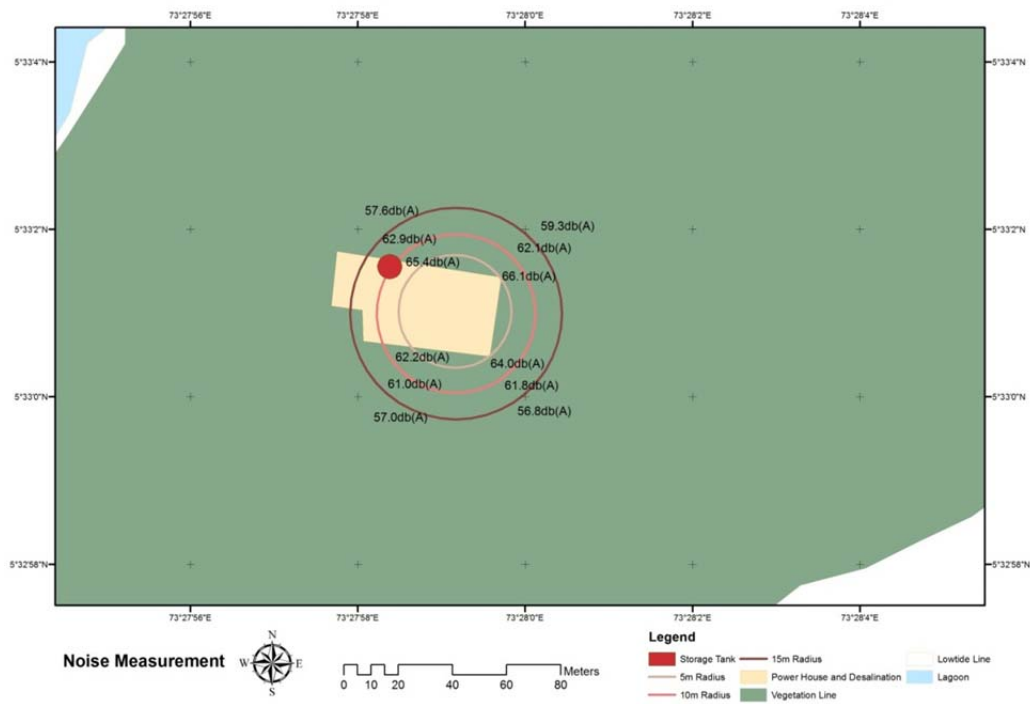


FIGURE 5-7 AVERAGE NOISE MEASUREMENT POPULATED ON AN AERIAL MAP OF KUREDU ISLAND RESORT

5.5.2 AIR QUALITY

General local air quality in Kuredu Island Resort was observed to be in pristine condition.

Air quality of the Maldives is generally considered to be good and in pristine state. As the islands of the Maldives are small, sea breezes flush the air masses over the islands and refresh air over the islands. Sources of local air pollution are insignificant in Maldives. Smoke and other emissions from the powerhouse are emitted to the atmosphere through a high chimney.

6 ENVIRONMENTAL PERFORMANCE AND COMPLIANCE

This chapter provides the environmental performance of the powerhouse, desalination plant as well as the impacts from the improvements proposed for the football ground. In addition, impacts from the operation of the facilities are predicted and mitigation measures that are already in place are highlighted. Where there are significant adverse impacts from the current operational practices mitigation measures are also recommended.

6.1 Methodology

Impacts on the environment from various activities of the proposed development work and operational activity have been identified through a consultative process with the project development team, field surveys, observations and assessment, as well as based on field experience of similar development projects in the country. Analogous research data have been used wherever possible since the use of such data is applicable and less time consuming.

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 installment and operational phases.

This study identifies and quantifies the significance of adverse impacts on the environment from the proposed activity. 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 accordingly.

6.2 Desalination System

6.2.1 SEAWATER INTAKE

Intake water for desalination is seawater using an HDPE pipeline of 151 m length from the desalination plant located on the eastern side of the island beyond the shoreline. The pipeline is properly anchored to the lagoon bottom and buried under the beach but visible in the lagoon. The pipeline is observed to be in good condition. There is no observable adverse impact of the presence of the pipeline in the lagoon bottom.

6.2.2 BRINE DISCHARGE

Brine is discharge around 0.5 m from shoreline. The site was sampled and analyzed for the anomalies. The results indicated that site conditions are normal. Given the depth of the water in the location and the current patterns no impact is observed on the marine environment in of the area. The pipeline is properly anchored to the lagoon bottom and buried under the beach but visible in the lagoon. The pipeline is observed to be in good condition.

6.2.3 NOISE LEVELS

Average noise levels near the desalination plant house area within a radius of 5m are around 62 dBA and 66 dBA. Based on the standards given Table 6.1 it can be said that the noise level in the area is slightly above levels appropriate for mixed residential and industrial zone. It must be noted that given the small size of the island locating of staff buildings near the utilities is unavoidable.

TABLE 6-1 INTERNATIONALLY USED NOISE STANDARDS FOR DIFFERENT ZONES

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

The intake of seawater to the system is provided by two pump station. The pump is observed to be in good condition with minimal noise production.

Further, American National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit for work place noise level is 85 dBA as an 8-hr time weighted average (TWA). This means that exposures at and above this level for longer than 8 hours are considered hazardous. NIOSH also recommends that workers should not be exposed at any time to sound levels exceeding 115dBA, without the use of hearing protectors.

During day time, average noise levels inside the desalination plant house was recorded as 94.5dBA and inside the generators room was recorded as 99.3dBA. Hearing protectors are provided outside the powerhouse and staff were observed to be using them.

In practice the desalination plant does not produce considerable flux with respect to the ambient noise level but in this case the elevation recorded is due to the powerhouse, located adjacent to the desalination plant house. Impact of noise from the desalination plant house is relatively less which is also enhanced by the vegetation buffer zone around the area.

6.2.4 AIR QUALITY

Desalination process in itself does not have a notable direct impact on air quality. Power consumption for the operation of the desalination plant leading to air emissions is one of the most adverse indirect impacts of desalination. Power generation has the potential to reduce air quality and also contributes to increase in greenhouse gases in the atmosphere.

No analyzable data was recorded during the mission but observation of work practices in the power generation process gives a positive deduction that considerable precautions and restrictions have been made to decrease the emission level both in case of solid particulate matter and gaseous form.

6.2.5 VEGETATION CONDITION

There is no indication to suggest that the vegetation is affected by the heat or smoke generated from the powerhouse. Therefore, there is a negligible impact to the vegetation.

6.2.6 IMPACTS ON SOIL AND GROUNDWATER QUALITY

No groundwater is utilized in the desalination process during operation of the plant. Therefore there is no direct adverse impact of desalination on groundwater. Desalination in fact contributes to preserving of groundwater by acting as the main source of water supply in the resort. However, the seawater intake pipes and brine discharge pipes are buried under the ground and have the potential to cause salinization of groundwater aquifer if there are any leakages.

As desalination requires power supply for operation, the potential impacts from operation of the power system can be considered indirect impacts of desalination.

No signs of fuel spill on the ground were observed during the field visit. The resort currently has significant measures in place to avoid fuel spills during fuel handling. These measures include, having bund walls around the fuel storage tanks and having proper pipelines installed to transfer fuel from the tanker to the storage tanks and subsequently to the fuel day tanks and then to engines. Any container holding any type of fuel including lubricating oil, waste oil etc are kept and handled on concrete surface. The area is well maintained and kept clean. Therefore soil and groundwater are protected from mishandling and spill of fuel.

6.2.7 WASTE MANAGEMENT

The critical waste arising from desalination process are expired chemicals, empty chemical containers and membrane. Used chemicals are incinerated and empty chemical containers are kept separately in an area with concrete flooring. The membranes are biodegradable and are disposed at Thilafushi or incinerated.

If handled improperly the waste has the potential to contaminate groundwater resources and also pose risks to occupational health and safety. There is no impact from waste resulting from desalination.

6.2.8 MANAGEMENT AND MAINTENANCE

General management and maintenance practices were investigated for the desalination plant.

- Spare parts list and stock is maintained and kept.
- User manual of the plants are easily available.
- A manual log of the daily operations is kept.
- Desalinated water is treated by UV radiation.

6.3 Football Ground

6.3.1 IMPACTS ON VEGETATION

As the project involves no clearance of large trees vegetation belt around the football ground will be not affected. However during the construction phase, this belt could be covered with dust which is a temporary impact and reversible. The grass patches that are existing on the football ground will not be removed. Similar to the vegetation belt the grass may be covered in dust during construction. There will be no impact on vegetation during operation phase.

6.3.2 LEVELING IMPACTS

Leveling is not expected cause any impacts. In general the central areas of the ground will be raised to about +200 mm. The additional sand required for leveling is available as stockpiled sand from past excavation project and from the swimming pool project. Excavation will be required where drains are necessary in which case excavation will be done using a small excavator and no groundwater extraction will be necessary. Therefore leveling is not expected to cause any significant impacts.

6.3.3 DRAINAGE IMPACTS

If the drains are required, concrete drain panels will be constructed off site and placed on site using excavator. Where excavation is necessary a small excavator will be used and groundwater extraction is not foreseen to be necessary given the shallow depth of excavating. During the construction of drainage system there is the potential for leakages of cement materials into groundwater. To minimize this impacts a plastic lining will be used during the construction phase. Installing drains is not expected to cause significant impacts during construction phase.

During operation, Drainage water would be discharged into the ground by natural groundwater infiltration process. These have potential benefits of recharging the groundwater aquifer. No negative impacts are expected as fertilizers and other chemicals will not be used in the maintenance of the football ground.

6.4 Impact Analysis

Impacts identified are characterized based on the following criteria in order to ascertain the most significant impacts arising from the project.

- + Nature (direct, indirect, cumulative);
- + Magnitude (severe, moderate, low);
- + Duration (short term, long term, intermittent, continuous);
- + Reversibility/irreversibility;
- + Significance (significant, insignificant).

Table 6.1 shows the characterization of the impacts based on the criteria listed above.

| Impact | Nature | Magnitude | Duration | Reversibility | Significance | Mitigation Measures | Residual Significance |
|------------------------------------------------------|-----------------------|-----------|------------|---------------|---------------|-----------------------------------------------------------------|-----------------------|
| Impact on marine environment from seawater intake | Direct; Cumulative | Low | Continuous | Reversible | Insignificant | Monitor marine environment conditions for signs of impact. | Insignificant |
| Impact on marine environment from discharge of brine | Direct; Cumulative | Low | Continuous | Reversible | Insignificant | As above. | Insignificant |
| Noise due to location | Direct | Low | Long term | Reversible | Significant | Plant trees in areas of high noise. | Insignificant |
| Vegetation condition from generators | Direct; Cumulative | Low | Short term | Reversible | Insignificant | As above. | Insignificant |
| Impact on soil due to handling of fuel | Direct; Cumulative | Low | Short term | Reversible | Insignificant | Supervision of fuel handling activities. | Insignificant |
| Impact on groundwater due to handling of fuel | Direct; Cumulative | Moderate | Long term | Irreversible | Significant | Proper supervision of fuel handling activities. | Insignificant |
| Impact from waste | Direct; Cumulative | Low | Continuous | Irreversible | Insignificant | Proper supervision of chemical handling | Insignificant |
| Impact on the vegetation near the football ground | Direct | Low | Short term | Reversible | Insignificant | Spraying with water to prevent dispersion of the dust particles | Insignificant |
| Impact of grass patches on field | Direct; Cumulative | High | Short term | Reversible | Insignificant | Spraying with water to prevent dispersion of the dust particles | Insignificant |
| Cement leakages to ground water | Direct | Low | Long term | Irreversible | Significant | Using proper insulation during the construction phase | Insignificant |
| Drainage water flush | Positive; Direct | High | Long term | Irreversible | Significant | This is a positive impact which refreshes ground water quality | Significant |
| Construction Waste produced in football Ground | Direct | Low | Short term | Irreversible | Insignificant | Waste will be taken to Thilafushi or nearby disposal site | Insignificant |

TABLE 6-2 IMPACT ANALYSIS CHART

6.5 Uncertainties in Impact Prediction

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

Accordingly, the uncertainties associated with measuring impacts for this particular audit are due to limited amount and type of baseline data available for comparing the accumulated impacts measured in the study. However, it is unlikely that the limitations would have significant impacts on the outcomes of the findings.

7 ENVIRONMENTAL MONITORING

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

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

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

7.1 Environmental Management Plan and Monitoring Programme

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

TABLE 7-1 PROPOSED MONITORING TIMETABLE

| Type | Frequency of monitoring | Main Concerns to address | What to monitor |
|------------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vegetation | Six monthly | Damage to existing vegetation due to heat or other emissions generated by the power plant or desalination plant. Damage due to the dust during the construction of drainage and other improvements | Loss or damage to the existing vegetation due to heat, smoke or particulate matter or dust. |
| Soil | Six monthly | Ensure that the powerhouse and desalination plant operation do not contaminate the soil and land, especially as a result of fuel and chemical storage, transportation handling and use. | Evidence of soil contamination in high risk locations such as outside the fuel storage area, near the power house building. |
| Groundwater | Annually | Ensure that the fuel handling activities do not contaminate groundwater aquifer. And also ground water conditions at football ground should be monitored for the abnormalities of TDS | Evidence of grease or oil in groundwater at the location where groundwater quality has been tested for this study. Ground water need to be tested for abnormalities in TDS. |
| Air and noise | Three monthly | Changes in noise levels and air quality. | Noise and air quality measurements in standard units, from the locations where noise level has been measured for this study. |
| Waste oil/chemicals handling | Three monthly | Waste oil / chemicals generated in the operation are properly handled and disposed of. | Procedure followed in handling and disposing waste oil generated from the operations. Quantify the volume of waste oil generated and disposed on monthly basis. |
| Marine Ecology | Annually | Ensure that brine discharged into the lagoon does not affect water quality and the ecology of the marine environment. | Percent live coral cover and overall health of the reef and lagoon benthos at the intake and brine outfall locations. Also seawater quality at the same locations. |
| Structural integrity | Six monthly | Ensure that the pumps, seawater intake and brine outfall pipes, drainage systems of football ground are in good condition. | Check the pipelines, the tanks and drainage system for any leaks or damages. |

Table 7.2 shows the work plan for the annual monitoring plan of the desalination and football ground.

TABLE 7-2 MONITORING WORKPLAN

| Parameter | Months | | | | | | | | | | | |
|----------------------|--------|---|---|---|---|---|---|---|---|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Vegetation | | | | | | | | | | | | |
| Soil | | | | | | | | | | | | |
| Ground Water | | | | | | | | | | | | |
| Air and Noise | | | | | | | | | | | | |
| Waste Oil Handling | | | | | | | | | | | | |
| Marine Ecology | | | | | | | | | | | | |
| Structural Integrity | | | | | | | | | | | | |

7.2 Commitment

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

7.3 Monitoring Report

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

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

7.4 Cost of Monitoring

The proponent has fully committed to perform a highest level of commitment for proper management of the project. Environmental aspects of the monitoring work will be subcontracted to competent local consultants. The costs of annual monitoring for the first year are given in Table 7.3.

TABLE 7-3 ESTIMATED COST BREAKDOWNS FOR MONITORING

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

8 REFERENCES

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APPENDIX 1–TERMS OF REFERENCE

APPENDIX 2–CVS OF CONSULTANTS

APPENDIX 3 – SURVEY LOCATIONS

APPENDIX 4 – WATER TESTS REPORT

APPENDIX 5 – NOISE LEVEL

APPENDIX 6 – COMMITMENT LETTER