ENVIRONMENT IMPACT ASSESSMENT

FOR THE PROPOSED

AIRPORT DEVELOPMENT PROJECT

IN MAAFARU ISLAND, NOONU ATOLL

December 2014

Prepared for

Millennium Capital Management Private Limited

Male’, Maldives

Consultant

CDE Consulting, Maldives
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<th>Description</th>
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<tbody>
<tr>
<td>COADS</td>
<td>Comprehensive Ocean-Atmosphere Data Set</td>
</tr>
<tr>
<td>DO</td>
<td>Dissolved Oxygen</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>IPPC</td>
<td>International Plant Protection Convention</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for Conservation of Nature</td>
</tr>
<tr>
<td>KWp</td>
<td>Kilowatt peak</td>
</tr>
<tr>
<td>MCM</td>
<td>Millenium Capital Management Private Limited</td>
</tr>
<tr>
<td>MEE</td>
<td>Ministry of Environment and Energy</td>
</tr>
<tr>
<td>MHI</td>
<td>Ministry of Housing and Infrastructure</td>
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<tr>
<td>MoFA</td>
<td>Ministry of Fisheries and Agriculture</td>
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<tr>
<td>MoTAC</td>
<td>Ministry of Tourism, Arts and Culture</td>
</tr>
<tr>
<td>MoTCA</td>
<td>Ministry of Tourism and Civil Aviation</td>
</tr>
<tr>
<td>MSL</td>
<td>Mean Sea Level</td>
</tr>
<tr>
<td>MWSC</td>
<td>Maldives Water and Sewerage Company</td>
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<tr>
<td>NAPA</td>
<td>National Adaptation Programme of Action</td>
</tr>
<tr>
<td>NE</td>
<td>North East</td>
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<td>Term of Reference</td>
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<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change and the Kyoto Protocol</td>
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Acknowledgement

The lead author of this report is Dr. Ahmed Shaig who is also the EIA Expert in the team.

Additional assessments were undertaken by the following team members.

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Field assistance was provided by the following members

Mr. Mohamed Ali (Marine Survey Assistant)

Mr. Ali Moosa Didi (Surveying and cartography)

Mr. Mohamed Nashwan Abdul Matheen (Surveying and cartography)

The curriculum vitae’s of the EIA consultants are attached in Appendix K of this report.
Lead Consultant’s Declaration

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

Dr Ahmed Shaig
Proponent’s Declaration

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(See Appendix N)
Executive Summary

The purpose of this document is to fulfil the requirements to get necessary environmental clearance from the Environmental Protection Agency (EPA) to implement the proposed airport development project at Maafaru Island, Noonu Atoll. The proponent of this project is Millenium Capital Management (MCM) Private Limited, Male’ Maldives. The southern half of Maafaru Island has been leased by the Island Council and Regional Airport to the proponent in 2013. Maafaru Island is one of the largest inhabited islands in Noonu Atoll and the airport is being built on the uninhabited southern half of the island.

Maafaru Island was originally leased to Noonu Hotels Private Limited for airport development. An EIA was prepared and approved for the original project in 2009. Since then, the Government has cancelled the agreement with Noonu Hotels. It was then rebid and MCM won the rights to develop the airport. This EIA is to get the approvals for their revised airport development plan.

The aim of this project is to improve the transport link between Male’ and north central Maldives, particularly Noonu Atoll.

The project involves construction of a domestic airport on Maafaru Island. The airport will consist of a 1800m runway, aircraft parking aprons, passenger terminal, air traffic control facilities, fire and safety facilities and utilities among others. The airport will also dredge a reef entrance and harbour basin, and construct a jetty specifically to access the airport. The eastern shoreline of the airport will be protected using a revetment. The operation stage of the project involves operating the domestic airport.

The main components of this project are mobilization and setup; vegetation clearance, dredging reef entrance and harbour basin; backfilling and levelling low lying areas and marshlands in Maafaru; constructing runway and apron; constructing service building and utilities; establishing air traffic controls, fire and safety and navigation systems; and constructing shore protection measures.

All project designs are in conformance to the laws and regulations of the Maldives, and relevant international conventions that Maldives is party to. The key laws and regulations applicable to this project are: Environmental Protection and Preservation Act, Decentralization Act, Environmental Impact Assessment Regulation 2012, Waste Management Regulation, Regulation on Cutting Down and Uprooting Trees, Dredging and Reclamation Regulation, and Dewatering Regulation. Preliminary approvals have been granted for the concept by MoFA. This project has Dredging and Reclamation Approval has also been granted by EPA. In addition, there are a number of permits to be obtained for the operation of aerodrome. The presence of mangrove
vegetation poses a challenge to meet the requirements of the Regulation on Cutting Down and Uprooting Trees but the small number of trees involved makes it suitable for relocation.

The proposed site has been modified due to human activities. Overall, the island and reef system represents a typical inhabited island with modified vegetation for forestry, contaminated groundwater and moderately good reef system. The proposed site has been partially cleared under the original area but 90% of the vegetation is still intact. There is a sand bed on the western side created by the previous developers. Maafaru Island’s vegetation system is extensive. There are five marshland areas on the island, three of which will be backfilled under this project. One of the marshland areas contains some mangrove vegetation. The central marshland area has recently connected to open lagoon, bringing in juvenile marine life. The site may be considered a breeding site but no concrete evidence was found in this evaluation to classify the site as a breeding site. The mangrove vegetation area is very small but 85% of these trees will have to be relocated. The island topography is varied and will require extensive backfilling to level the site. The reef system is in moderately good condition. The deep lagoon contains some good live coral colonies. The proposed dredging footprint does not contain any live coral colonies but contains an extensive seagrass bed. The island is undergoing erosion on the northern and eastern side but the proposed airport site is generally stable.

Significant impacts are expected to arise mainly during the construction phase of the project. These impacts include significant loss of terrestrial biodiversity. Of particular concern is the removal of over 20,000 trees, relocation of mangrove vegetation, and backfilling a recently active marshland with juvenile life. Impacts will also be felt on marine biodiversity due to dredging and reclamation due to associated direct removal, turbidity and sedimentation; contamination of marine and ground water and soil due to accidental spillage/leakage of construction materials and waste; increased turbidity and sedimentation of the water column due to coastal activities; changes to coastal hydrodynamics; salinization of ground water due to use of dredged sand for backfilling and risks to the health of construction workers.

Major potential impacts from the operations phase include pollution of air, water and soil due to emissions from island operations such as power generation, water production and flight operations; bird collisions; potential fuel leaks into soil and ground water; impacts from waste accumulation and alteration of faunal species behaviour.

Mitigation measures have been proposed to minimise anticipated impacts. These include measure to minimise sedimentation and turbidity in the lagoon, salinization and contamination of ground water, loss of useable trees, loss of mangrove vegetation, social discontent, coastal erosion and safety of workers and passengers. Among these, all large trees and coconut palms which can be transplanted to other islands will be made available for transport. Discussions are
EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

underway with Lh. Huruvalhi, proposed resort to be reclaimed on Dhiffushi Reef, N. Dhigurah and proposed island to be reclaimed in K. Thunbafushi. No sites have been finalised yet. All mangrove plants will be relocated to the southernmost wetland or to a nearby island such as Kendhikulhudhoo.

Alternative options have been evaluated for the most significant impacts. Among these alternative locations for the proposed airport location were considered, including Manadhoo, Dhigurah and Medhufaru. Among these, only Medhufaru has the space to build a 1800 m runway but it has a number of pristine marshlands which may involve higher impacts than Maafaru. Alternative layouts for the airport were also considered but all other options involve significant reclamation, which subsequently will involve high marine environmental impacts. Alternative borrow areas were evaluated, including an option not to dredge the lagoon. It involved excavating the foot print of vegetation removal area and using the material to level the low lying areas. However, since dredging is required, the reuse of dredge waste for reclamation was preferred. Alternatives were also evaluated for shore protection design and material, and dredging technologies.

Consultations were held with Noonu Atoll Council, Maafaru Island Council, Manadhoo Island Council, Maafaru public, management of Irufushi and some staff members of Irufushi. There is overwhelming support for the project. Some members of the public from the islands on the western rim (Velidhoo and Holhudhoo) expressed concern about their distance to Maafaru Airport and would have preferred a more central location for the airport.

The Environmental Management Plan (EMP) for this project is designed to produce a framework for anticipated impacts, including practicable and achievable performance requirements and systems for monitoring, reporting and implementing corrective actions. In addition, it will also provide evidence of compliance to legislation, policies, guidelines and requirements of relevant authorities.

Monitoring plan is designed to assess any changes to the physical environment as well as operational aspects of the resort. The total cost of mitigation and monitoring are estimated between US$5,000 per year.

The main conclusion of this report is to move forward with the proposed development on grounds of very high socio-economic benefits which outweigh the environmental impacts form the project. The project does have significant terrestrial environmental impacts. However, the scale of the impacts is not irreversible at a regional or atoll level. The loss of the mangrove vegetation is insignificant compared to the mangrove vegetation that exists in Noonu Atoll. The number of wetlands in the near vicinity of Maafaru is also quite substantial and will allow for the migratory birds relocate. The establishment of marshland as a habitat for juveniles is a very
recent development (since 2009) and it does not appear that the marine species are using it as a permanent breeding site. The site is also not listed as a sensitive environment owing to the limited presence of sensitive ecosystems.

Environmental and socio-economic risks associated with the project are expected to be significantly reduced if the mitigation measures and monitoring programme presented in the report are properly implemented within the framework of the environmental management plan.
EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

Prepared by: CDE Consultancy
EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

Prepared by: CDE Consultancy

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Prepared by: CDE Consultancy

EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

Prepared by: CDE Consultancy

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1 INTRODUCTION

1.1 Purpose of the EIA

This Environment Impact Assessment (EIA) report is an evaluation of the potential environmental impacts the proposed Airport Development Project in Maafaru, Noonu Atoll. The proponent of this project is Millennium Capital Management Private Limited registered in the Maldives. The project contractor has not been finalised yet. The EIA consultant is CDE Consulting.

This EIA has been developed based on the Term of Reference (ToR) issued by Environmental Protection Agency (EPA) on 13 August 2014. This document is submitted by the proponent to EPA to fulfil the requirements for an EIA under Article 5 of the Environment Protection and Preservation Act (4/93). The EIA Regulations 2007 have been used as the basis for developing this document.

1.2 Project Proponent

The proponent of this project is Millennium Capital Management (MCM) Private Limited. MCM was registered in the Maldives on 2008 and is an asset management company that is aiming to become a premier institute for sourcing capital management solutions within Maldives. At present its activities span from construction, real estate, tourism, fuel supply and trade. Its current portfolio of companies include High Sea International Pvt Ltd, Souvenir Marine Pvt Ltd, Property Scene Pvt Ltd, Fuel Express Maldives, Hike Maldives Pvt Ltd, Envision Medicials Pvt Ltd, Marine Equipment Pvt Ltd, Antifire Pvt Ltd, CAD construction and Tourmaline Resorts. They have a number of ongoing projects in the planning and financing stage including the proposed resort development project in Dhiffushi Reef and two other locations.

Maafaru is going to be their first airport development project.

Contact details for the proponent are:

MCM Pvt Ltd,
1st Floor, M. Shura Manzil
Fareedhee Magu,
Male’, Republic of Maldives
Phone: (960) 3315540
email: info@mcm.com.mv
1.3 Background and Rationale of the Project

In the year 2006, the Government embarked on a plan to expand and develop the air transport network with a particular emphasis on private sector participation in the industry. As a key incentive for private developers to invest in the airports, an additional tourist resort and an ‘airport hotel’ were included as part of a ‘packaged’ project. Under this programme, a network of eight airports were identified and tendered to interested parties. Maafaru Island was one of the islands within this network.

The project was initially awarded to Noonu Hotels & Resorts Development. A separate EIA was prepared by Noonu Hotels and approved for this project. However, in 2013, the Government decided to terminate the contract and rebid the project. Millennium Capital Management Private Limited acquired the rights in 2014 to move forward with the project.

The proposed project has multiple aims and benefits both at a national and a local level. At the national level the project will assist in the development of the national transport grid and in the expansion of tourism industry. It is expected that air travel will increase following the development of the airport and that tourist arrivals will increase in response to the increased bed capacity. At a local level, the inhabitants of Noonu Atoll will have access to air transport who otherwise have to cross the notoriously rough Kaashidhoo Channel for travel to Male’. Moreover, the significant economic multiplier effects from the airport operations in the atoll are expected to flow into the Atoll and in particular Maafaru Island economy. These include the development of auxiliary services, employment opportunities and developments in the manufacturing sector.
1.4 Project Scope

The project components are divided into Phases as follows:

Phase I – Preliminary Works

1. Mobilization and site setup
2. Vegetation clearance
3. Construction island access facilities: Construct a jetty and dredge reef entrance and harbour basin
4. Backfilling low lying areas

Phase II – Airport Construction

5. Construct permanent shore protection measures
6. Construction of utilities – power, water, sewage and waste management
7. Construct the airstrip and apron
8. Construct the main buildings, including terminal, fire and other facilities
9. Construction of roads
10. Construction of Administration and Staff Facilities
11. Revegetation
12. Demobilization

Phase III – Airport Operation

1.5 Aim and Objectives

The aim of this project is to improve the transport link between Male’ and north central Maldives and particularly Noonu Atoll.

The objective of MCM is to build, own and operate an advanced domestic airport in Noonu Atoll. The specific objectives of the project are as follows:

- Develop the infrastructure and facilities necessary to operate the N. Maafaru Domestic Airport within the Civil Aviation Regulations.
- Locate, design and operate all project facilities in a manner that results in minimal impact to the natural and socioeconomic environment of the island; and
Comply with all Maldivian regulations, including constructing and operating the project to Guidelines.

1.6 Consultants, Contractors and Government Institutions

All the EIA related work is undertaken by consultants from CDE Consulting. Design criteria and technical specifications have been developed by Regional Airports. The contractor has not been identified at the time of submission of this report.

The Government agency relevant to this development is Regional Airports department in Ministry of Tourism.

All coordination related to the project will be carried out by special project team established by the proponent.

1.7 Project Financing

It is estimated that the project will cost around US$ 6-9 million. No donor agencies are involved in this project. The project finance is provided through privately arranged bank loans and equity. The project will be executed by MCM.

1.8 Scope and Terms of Reference of EIA

The scope of this EIA is broadly based on the Environmental Impact Assessment Regulations 2007. The assessment more specifically adheres to the Terms of Reference (ToR) issued by the Environmental Protection Agency on 13 August 2014. The ToR is based on scoping meetings held between the stakeholders on 23 July 2014. A copy of the ToR is attached in Appendix A.

The EIA report contains the following main aspects.

A description of the project including the need for the project, how the project will be undertaken, full description of the relevant parts of the project, implementation schedules, site plans and summary of project inputs and outputs (Chapter 1&2).

A description of the pertinent national and international legislation, regulations and policies that are relevant and applicable to the project and a demonstration of how the project conforms to these aspects (Chapter 3)

Information about the exiting baseline environmental conditions of the site. These include coastal and marine environment of the site and natural hazard vulnerability of the site (Chapter 4).
An assessment of the potential impacts during both construction and operational stages of the project as well as identification and cost of the potential mitigation measures to prevent or reduce significant negative impacts during both construction and operation stages of the project (Chapter 5).

Assessment of alternatives for the proposed project (Chapter 6)

Details of the environmental monitoring plan (Chapter 7).

Potential gaps in information (Chapter 8)

Main conclusions (Chapter 9)

1.9 Assessment Methodology

1.9.1 General Approach

This EIA is broadly guided by the EIA Regulations 2012.

This report has been prepared to ensure that the significant environmental and social impacts of the proposed project at the preconstruction, construction, operation and demobilising stages have been considered and assessed at the project planning phase.

The process followed in the preparation of this EIA report consists of six parts. These are: scoping consultations; literature review; field surveys; stakeholder consultations; analysis of results; and compilation of the assessment in the form of a report.

In order to conduct a broad based and inclusive study, the proponent and the consultant have from the onset ensured the exercise is participatory. As such, discussions have been held with community members in the projects area and relevant stakeholders with the assistance and coordination of the proponent.

Much of the baseline information for this study is based on the original EIA. The rest of this section summarises the methods used in the original EIA.

1.9.2 The Study Area

The area impacted by projects like these can be quite wide particularly when the socio-economic impacts are considered. The study area of this project considers that the entire island and much of the reef system of the island will be affected by the development and that Maafaru and nearby inhabited islands will experience the bulk of the socio-economic change.
Based on the results of the initial scoping of potential environmental impacts and the identification of sensitive aspects of the environment we have identified the following geographical areas likely to be affected at the various stages of the Project:

- During construction temporary and permanent impacts will occur primarily on Maafaru Island and the reef system with 500 m radius of the shoreline. The most direct physical impact will be on-site in the area of the actual physical interventions, particularly vegetation removal and coastal development footprints. To ensure the impacts are fully covered the entire island environment system is studied.

- During operation of the island most impacts will be confined to the area that will be affected by construction impacts.

- There will also be induced development impacts due to the project, mainly in the form of positive socio-economic benefits to Maafaru and the nearby islands, atoll and region.

Study area boundary is presented in Figure 1.1 and survey locations map for the project is attached in Appendix F.
1.9.3 Field Observations

Field assessments were undertaken in Maafaru between 25 and 30 August 2014. Field visits mainly covered water quality, flora, fauna, soil conditions, wetland environments, marine environment and lagoon condition of the proposed project sites. In addition, stakeholder consultations were carried out in Maafaru and nearby islands during the trip.

Coastal Processes

Beach profiles were taken from designated locations around the island using standard levelling techniques. These profile locations are marked in Appendix F. The measurement of beach profiles involves standard practice of surveying with a staff and a dumpy level. Measurements were taken along the beach profile line at different intervals, wherever there occurred a distinctive morphological feature, such as beach ridge, high water mark, an erosion scarp, dip, rise, or other significant break in the beach slope up to a minimum distance of 30 m from the Benchmark. Other beach attributes such as beach rock were marked using handheld GPS.

Lagoon currents were measures using drogue method. About 3 measurements were undertaken from every site and an average value is determined.

Tide data has been taken from Male’ International Airport Tide Gauge.

Wave patterns have been estimated using secondary studies and visual field assessments.

Marine Assessments

Manta tow survey

Manta tow survey was conducted to determine the general benthic cover and reef condition along the study area. A snorkeler (observer) was towed behind a slow moving boat, along the reef edge for a series of set periods of 2 minutes. At each stop the observed noted down the estimate percentage coverage of live corals, dead corals, sand/silt and rubble along the tow area. The GPS coordinates were recorded at the start and end of each new tow.

Line Transect Survey

A 50m transect line was deployed at four sites as shown in Appendix F. The observer swam across this line noting down the percentage cover of benthic substrates hard coral (Scleractinia), soft corals (Alcyonacea), rock, rubble, sand and algae at 5 m intervals of the line including 2.5 m area on either side of the centre line. Mean percentage cover for each benthic substrate was then calculated for the transect line. Two replicates were done at each survey location.
The aim was to conduct a fish census and determine the benthic composition at these sites.

The benthic composition of the substrate was assessed by taking ten high-resolution images every 5 m (pictures covering 0.5m² of the seabed) along the same transect line used for the fish surveys. These were later analysed using CPCe. CPCe, or Coral Point Count with excel extension, developed by the National Coral Reef Institute, is software designed to determine coral community coverage and diversity using transect photographs. Underwater photographic frames are overlaid by a matrix of randomly generated points, and the fauna/flora of species or substrate type lying beneath each point is identified. 20 random points per picture were analysed to characterize the substrate composition (sample size: 200 points per transect).

**Fish census**

Fish census was carried at each line transect survey location. All fishes observed along 50 m belt transect at each site was recorded and their abundance recorded as follows: Single (1), Few (2-10), Many (11-100) and Abundant (>100).

**Timed swim**

Timed swim carried out at three locations, to qualitatively determine the benthic substrate composition at these locations. Swims were timed at 5 minutes, during which two observed swam across the site noting down the main benthic substrates, seagrass and coral species observed. Three replicate swims were made at each site.

**Water Quality**

Water quality was assessed from MWSC laboratory. Water quality samples were taken at different locations selected based on proposed developments. Parameters measured include electrical conductivity, total dissolved solids (TDS), salinity, pH, temperature, and dissolved oxygen (DO). Nitrates, nitrites and phosphates were analysed at the Public Health Laboratory which uses methods prescribed in “Standard Methods for Examining Water and Wastewater”. Samples were collected in clean 1.5L PET bottles after washing them with the water to be sampled. Water samples were collected at mid depth. Biological samples were collected in sterilized 100 ml glass bottles provided by the Public Health Laboratory.

**Terrestrial Flora and Fauna**

Terrestrial fauna was limited to visual observations during the period of the survey.

The main methodology used for vegetation assessment was vegetation transect method and remote sensing. The vegetation transect method involves recording the species and their abundance along specific lines across the island. There were a number of footpaths across the
island, which made the assessment relatively easy. Transects are used mainly to record species abundance and occurrence.

The second method used was remote sensing technology. A high resolution satellite image was used to classify the island vegetation. An extensive grid of ground truthing data were established and manual classification was carried out based on variations in colour band combinations. The classification system used was devised for small coral islands by CDE Consulting and has been tested in other similar assessments.

The initial imagery used was Landsat 7 ETM+ dated 21 June 2001 and Quickbird Imagery Standard dated 14 February 2014. Image accuracy for Landsat 7 was 30 m and Quickbird was 6.5 m and is delivered radiometrically and sensor corrected. Landsat 7 ETM+ images are quite a low resolution were found to be inadequate when dealing with small coral islands. It is also outdated considering the changes on the island. However, it does have an Infra-red layer which is very efficient in detecting variations in vegetation cover. Quickbird images on the other hand have much higher resolution suitable even for manual classification in a small land area. Hence, Landsat Image was used for preliminary classification and as a cross check for visual classification using Quickbird images. Although the Landsat 7 image is out-dated, it is still valuable in determining the forestry areas due to relatively minimal changes on the island during this period. New vegetation growth was mapped using GPS and ground truthing.

The band combinations used for Quickbird is 4-3-2 which provides good contrast to vegetation colour.

The images itself has an error of 2.4 m. Manual measurements can reduce the accuracy significantly depending on the vegetation classes used. The specified classes for this assessment (see the following sections) ensured that these errors were kept to a minimum by using identifiable classes. Error levels for coconut groves and coastal vegetation particularly strand vegetation are very low with a confidence level of over 90%. Error Levels for mixed vegetation are high with confidence level around 70%. The ground truthing grid data is used partly as manual training data. The team which undertook this assessment has experience in mapping other coral islands which also reduces the interpretation errors significantly. The goal for this assessment is not to give an exact classification but to provide a crude estimate of the entire vegetation system. This method is to some extent better than the limited transect data method currently used in the EIAs of Maldives. The error levels for this exercise are well within acceptable range for the objectives at hand.
1.9.4 Desk Study Review

A literature review was conducted to acquire background information on the site and its environment as well as to identify possible environmental impacts of similar developments in island settings. In this context, the EIA Regulations 2012, best practices from similar development activities, scientific studies undertaken in similar settings around Maldives and previous documents/historical publications was considered.

The literature review comprised of, but is not limited to, the following:

- The original EIA for the airport development project in Maafaru Island
- Terrestrial Ecosystem monitoring Study for North Province
- EIA for resort development in N. Dhigurah Island
- EIA for airport development in R. Ifuru Island
- Island development plans of Maafaru.
- Master plan concept submitted by the proponent to Ministry of Tourism.
- Relevant regulations, including Civil aviation regulations, dredging and reclamation regulation, Dewatering Regulation and Regulation on cutting down and uprooting trees.

1.9.5 Public and Key Stakeholder Consultation

Stakeholder consultations were undertaken with the following stakeholders:

- Atoll Council in Manadhoo
- Regional Airports
- Maafaru Island Council
- Maafaru public
- Irufushi Island resort management and some staff
- The proponent

1.9.6 Data Analysis

The EIA experts used their experience and knowledge in their respective fields to analyse the data from the previous studies and field visits in order to determine the potential impacts of the proposed projects, the severity of effects arising from these impacts and how any adverse impacts can be best mitigated and positive impacts enhanced. This analysis provides the
framework for the recommendations on corrective actions and remedial measures and provides the basis for the formulation of the environmental management plan which forms part of this repo EIA

**1.9.7 Report Format**

The report format and structure presented here follows the report formatting guidelines issued by EPA.

**1.10 Study Team Members**

The team members of this EIA are:
Dr. Ahmed Shaig (EIA and coastal environment Specialist)
Dr. Simad Saeed (Social Environment Specialist)
Ms. Nashiya Saeed (Social Environment Specialist)
Mr. Ali Nishaman (Terrestrial Environment Expert)
Mr. Mohamed Faizan (Marine Environment Specialist)
Mr. Mohamed Ali (Marine Environment Specialist)
Mr. Ali Moosa Didi (Terrestrial surveying and bathymetry)

The curriculum vitae’s of the EIA consultants are attached in Appendix K of this report

**1.11 Limitations of the study**

Project information and planning and background data were not fully prepared or decided during the conduct of this study. However, available documents in connection with data provided particularly the concept plan, experiences of CDE in other islands, particularly in the numerous resort and airport development assessments were used as the basis for preparation of this document. Therefore, it will be possible to analyse, implement mitigation and suggest monitoring measures to the most relevant negative impacts.

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. As noted earlier, there is also no long term data and information regarding the particular site under consideration, which makes it difficult to predict impacts. However, the level of uncertainty is partially minimised due to the experience of resort and operation in similar settings in the Maldives. Nevertheless, it is important to consider that there will be uncertainties and voluntary monitoring of natural processes as described in the monitoring programme is absolutely essential.
### Table 1.1: Limitation of the study

<table>
<thead>
<tr>
<th>Issue/Item</th>
<th>Required Information</th>
<th>Current Status / action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport Detailed Master Plan</td>
<td>Final Master Plan, discussed with and approved by Regional Airports</td>
<td>At present, there is a concept plan but the details can be worked out after the EIA approval.</td>
</tr>
<tr>
<td>Engineering designs</td>
<td>Detailed engineering designs for the land based structures to determine the extent of excavations and chemicals to be used in construction</td>
<td>Details can only be worked out after the EIA approval.</td>
</tr>
<tr>
<td>Details of the utility machinery and equipment</td>
<td>Exact model of the desalination plant, power plant and sewerage system (where relevant) is required to determine the process flows and procedures</td>
<td>Use concept plan. Base the assessment on minimal requirement of the EPA for the establishment of these facilities.</td>
</tr>
<tr>
<td>Natural Hazard Risks</td>
<td>Detailed modelling of flooding and storm damage risks</td>
<td>Data not available at local level; use broad level studies undertaken for Maldives</td>
</tr>
<tr>
<td>Air transport demand</td>
<td>Detailed demand analysis forecasts for the next 10 years</td>
<td>Not available; Use the existing data from published sources</td>
</tr>
<tr>
<td>Environmental baseline data</td>
<td>Historical and long-term records on reef and lagoon environment. Detailed data on geology, hydrogeology and soil. Long-term site specific or even regional data (at least 2 years). Most critical data include current, wave and sediment movement history. Air quality measurements Socio-economic data of Maafaru and nearby atolls</td>
<td>Baseline snapshots of the site taken to design mitigation measures Estimated based on other similar studies in Maldives Snapshot data for currents taken; wave studies in Baa atoll used Assumed as pristine Primary data collection will be time consuming; Secondary sources will be used</td>
</tr>
<tr>
<td>Environmental Standards</td>
<td>Environmental Standards for Air and Noise Quality</td>
<td>USEPA standards followed</td>
</tr>
<tr>
<td>Wave Modelling</td>
<td>Long to Medium-term site specific data</td>
<td>Not enough time to collect data; no facilities in Maldives to undertake high level modelling;</td>
</tr>
<tr>
<td>Current Modelling</td>
<td>Long to Medium-term site specific data</td>
<td>Not enough time to collect data; no facilities in Maldives to undertake</td>
</tr>
<tr>
<td>Issue/Item</td>
<td>Required Information</td>
<td>Current Status / action</td>
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<tr>
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<tr>
<td>Sediment plume dispersal modelling</td>
<td>Long to Medium-term site specific data</td>
<td>Not enough time to collect data; no facilities in Maldives to undertake high level modelling</td>
</tr>
<tr>
<td>Ground water recharge modelling</td>
<td>Similar studies in Maldives</td>
<td>No similar studies undertaken for reclaimed islands of Maldives; High degree of uncertainty</td>
</tr>
</tbody>
</table>
2 PROJECT DESCRIPTION

2.1 Project Location

Maafaru Island is located on the eastern rim of Noonu atoll at approximately 05° 49' 55" N and 73° 28' 49" E (see Figure 2.1). With a width of about 0.6 km and roughly 4.6 km in length, Maafaru is one of the largest inhabited islands of the Maldives with a total land area of approximately 119 Ha. At present, the island population stands at 616 persons (National Bureau of Statistics, 2014).

The island is in close proximity (see Figure 2.2) to most inhabited islands of Noonu atoll: Landhoo (5.5 km), Maalhendhoo (8.2 km), (Manadhoo 9.5 km), Lhohi (10.3 km) and Kudafari (10.1 km). Its nearest resort islands are Zitahli Resorts and Spa (12 km), Irufushi Beach and Spa (19 km), Cheval Blanc Randheli (21 km) and Velaa Private Island (30 km).

The proposed project site is located on the southern half of Maafaru Island. The coordinated for the proposed site are presented in Appendix D under approvals from the Atoll Council. Under the current agreement between the Government of Maldives and the proponent the southern half of Maafaru Island and the reef system up to the reef edge belongs to proponent. Approximately 65.35 Ha of land and 426 Ha of lagoon have been handed over to the proponent.

2.2 Project Outline and Project Site Plan

The proposed site plan is presented in Appendix B. A Reduced version of the site plan is provided in Figure 2.3 and the coastal works site plan is presented in Figure 2.4.

As noted in Chapter 1, the project components are divided into Phases as follows:

Phase I – Preliminary Works

1. Mobilization and site setup
2. Vegetation clearance
3. Construction island access facilities: Construct a jetty and dredge reef entrance and harbour basin
4. Backfilling low lying areas

Phase II – Airport Construction

5. Construct permanent shore protection measures
6. Construction of utilities – power, water, sewage and waste management
7. Construct the airstrip and apron

8. Construct the main buildings, including terminal, fire and other facilities

9. Construction of roads

10. Construction of Administration and Staff Facilities

11. Revegetation

12. Demobilization

Phase III – Airport Operation

Details of the proposed project components are outlined in the next section. The project boundary and estimated impact zones for the revised site plan are identified in Figures 2.5 below.
Figure 2.1: Location map of Maafaru Island
Figure 2.2: Locality map showing nearby islands and registered environmentally sensitive areas

Legend
- Distance
- Terrestrial Protected Areas
- Marine Protected Areas
- Environmentally Sensitive Areas
- Island

Maafaru Island
Noonu Atoll
Locality Map

Map Prepared by CDE Consulting
Date: 20/10/2014
Figure 2.3: Airport development Site Plan (Reduced version)

Legend
- Airport Boundary
- Airport Security Fence
- Airport Buildings
- Airfield Roads
- Runway Strip and Apron
- Runway End Safety Zone
- Runway Clearance
- Jetty
- Revetment
- Harbour Basin
- Reef Entrance

Maafaru Island, Noonu Atoll
Proposed Airport Development Project Site Plan
PROJECTION: Transverse Mercator (UTM Zone 43 N);
HORIZONTAL DATUM: WGS84;
All features based on GPS service (Mar 2014)
Satellite image: 2014
Map version: 2012/12/2014
Surveyed and Prepared by: CDE Consulting, Maldives
Figure 2.4: Dredging and Backfilling Site Plan (Reduced version)
Figure 2.5: Estimated Affected Area Boundary
2.3 Existing Site Conditions

The proposed site can be regarded partially modified environment. Maafaru Island is an inhabited island contains numerous modifications akin to other similar settings. The island contains a built environment, coastal modifications in the form of a harbor and reef entrance, and terrestrial modifications through forestry and agriculture.

The proposed site itself has been partially modified. Much of the area has been used for forestry in past with large stretches of planted coconut palms. Some areas have also been cleared by the previous developer, particularly the previously planned centre line of the air strip and temporary storage areas.

There has also been a natural event which led to the death of a number of coconut palms within the low lying marshy areas and its immediate vicinity. This may have been the result of salinization following partial natural opening of the narrow strip between the lagoon and marshy area. This aspect is explored in more detail in the existing environment section.

The proposed site has very strong wave conditions on the eastern side and generally calm conditions on the western side of the lagoon. The eastern side requires coastal protection to minimize erosion following coastal vegetation removal.

The island lagoon has one of the largest seagrass beds in the northern Maldives. The proposed dredging is to be carried out on the seagrass bed which will affect the seagrass ecology.

The proposed site also has numerous low lying areas including marshy areas, which will need to be backfilled with dredged sand to level the site. The low areas will also play an important role in the drainage patterns during operation.

There are no areas listed as marine sensitive areas within 10 km of the site.
2.4 Detailed Project Outline and Work Methodology

2.4.1 Dredging Reef Entrance and Harbour Basin

2.4.1.1 Scope of Works

This component mainly involves dredging a 342 m reef entrance and a 100 m x 100 m harbour basin. The dredge waste from this activity will be used for backfilling and levelling the island. The width of the reef entrance has been expanded to 30 m to source the required sand for backfilling.

Details of the channel area are presented in Appendix B and Figure 2.4.

2.4.1.2 Timing, Coordination and mobilization

Weather and Climate

– Wave conditions will be strong during peak period of SW monsoon and dredging activities may be hampered during severe weather in SW monsoon.

Coordination

– Coordination with regards to the other components of the project, particularly the backfilling and shore protection will be carefully planned.

– Sand from the reef entrance dredging component will be transported for backfilling areas via trucks on a temporary sand bed.

Dredging Equipment and Fleet

– The likely dredging fleet will consist of the following:
  o Four excavators
  o Three trucks
  o Two loaders
  o Two barges
2.4.1.3 Justifications

**Need for a reef entrance and harbour basin**

Detailed bathymetric survey of the area shows that the lagoon along the proposed access areas is between -1.0 and -2.0 m MSL within the lagoon and around -3.0 m MSL on the deep lagoon slope. While this may be suitable for the lighter and shallow draught speed boats to access, these depths are not suitable for fully loaded passenger vessels. Moreover, the wave conditions in the lagoon may pose a safety risk to passengers when trying to access the lagoon during the NE monsoon and during low tide periods. The high volume of marine traffic anticipated on the island is another concern as the chances of grounding are higher.

The alternative option is to use the existing harbour basin on Maafaru Island. The difficulty in this option is the use of additional vehicles to shuttle between the airport and harbour. The existing island harbour is barely enough for Maafaru Island’s cargo and fishing vessels. There is a risk that the activities in Maafaru harbour may delay the landing of passenger vessels, particularly when the resorts bring their tourists. The distance involved also increases the cost for local passengers arriving from other islands to reach the airport.

Moreover, the airport may be subleased to another party to manage. Under such circumstances it is better for the airport to manage their own infrastructure rather than relying on external facility to access the island.

At present, Hanimaadhoo and Gan airport have their own harbour facilities as well.

**Location**

The proposed location has been finalised based on wave conditions and distance to the functional areas of the island. The proposed location is central and provides shortest distance to the airport facilities, removing the need for additional vehicles. The proposed area is also expected to be the calmest location for most days of the year, compared to other options.

**Design**

The proposed design is based on the principle that a detached harbour will have the least impact on the coastal processes operating around the island. A minimum distance of 50 m has been set between the low tide line and the basin. The jetties on concrete stilts provide currents and sediment flow along the beach.

The width of the reef entrance has been increased to 30 m to compensate for the dredge material required for backfilling. The alternative would be to enlarge the harbour basin or to dredge another location. This option has been preferred based on the lowest environmental impact.


Equipment

Dredging will be undertaken with an excavator as it is the only practical option for a small scale job such as this. The excavator will be mounted on a barge when dredging the reef entrance and transported to the beach via the barge. Excavator will be mounted on a temporary sand bed when dredging the harbour basin and removed once constructed.

Additional sand beds may be required for the construction of the reef entrance.

2.4.1.4 Design Details

General Specifications

− The detailed dredging site plan is presented in Appendix B.

− The entrance channel and harbour basin shall be dredged to a minimum depth of -4.0 meters below Mean Sea Level (MSL) where required.

− Channel design layout shall consider minimum sediment accumulation inside the basin to allow for a maintenance dredging period of not less than 5 years.

2.4.1.5 Dredge Area and Volume

A summary of the dredge area details are presented in the table below.

Table 2.1: Dredging specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reef Entrance Dimensions</td>
<td>342 m x 30 m</td>
</tr>
<tr>
<td>Reef entrance dredge area</td>
<td>10,260 sq m</td>
</tr>
<tr>
<td>Reef Entrance Dredge depth</td>
<td>-4.0 m MSL</td>
</tr>
<tr>
<td>Reef Entrance Dredge Volume</td>
<td>30,000 cbm</td>
</tr>
<tr>
<td>Harbour Basin Dimensions</td>
<td>100 m x 100 m</td>
</tr>
<tr>
<td>Basin Dredge Area</td>
<td>10,000 sq m</td>
</tr>
<tr>
<td>Basin Dredge Depth</td>
<td>-4.0 m MSL</td>
</tr>
<tr>
<td>Basin Dredge Volume</td>
<td>30,000 cbm</td>
</tr>
<tr>
<td>Total Dredge Volume (Reef entrance, and basin dredging)</td>
<td>60,000 cbm</td>
</tr>
</tbody>
</table>
Reef Entrance Design

- Entrance channel shall be dredged to a minimum depth of -4.0 meters below MSL.
- The dredged waste should be placed no closer than 10 m from the channel.
- Channel profile should be sloped on the sides.

Figure 2.6: Cross-section of entrance channel

2.4.2 Backfilling

2.4.2.1 Scope of Works

This component involves backfilling the low lying areas within the proposed project footprint. This includes the all tarmac areas such as the runway strip and apron and all marshy areas within the runway clearance zone and runway end safety zone. The area covered is 125,000 sq m and approximately 50,000 cbm may be required to fill the footprint.

2.4.2.2 Sand Borrow Area

See section 2.4.1
2.4.2.3 Design Details

The design details are as follows:

**Table 2.2: Backfill area design details**

<table>
<thead>
<tr>
<th>Component</th>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marshy areas</td>
<td>Backfill Depth</td>
<td>+ 0.8 m</td>
</tr>
<tr>
<td></td>
<td>Backfill Area</td>
<td>40,500 m</td>
</tr>
<tr>
<td>All other areas</td>
<td>Backfill Area</td>
<td>17,000 sq m</td>
</tr>
<tr>
<td></td>
<td>Average backfill Depth</td>
<td>+0.3 m</td>
</tr>
<tr>
<td>Total</td>
<td>Average backfill depth</td>
<td>+0.45</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>125,000 sq m</td>
</tr>
<tr>
<td></td>
<td>Volume required</td>
<td>50,000 cbm</td>
</tr>
</tbody>
</table>

2.4.2.4 Quality and characteristics of fill material

The condition of material below the 1-2 m from the lagoon bed is not known. The surveys were not based on drilling and therefore will only provide an indication of the material on the top 1-2 m of the seabed. Given the high cost of marine borehole drilling no such studies have been carried out. Thus, at the moment, the guarantees are based on experiences from other similar projects. Experience indicates that reef strata up to 12 m is fairly uniform comprising mainly sand to coarse sand.

All available details of the fill material characteristics are provided in the existing environment section.

2.4.2.5 Transportation

Transportation will be via barges, first to a holding location on the beach where it will be left to drain saltwater. Secondly, it will be transported again on trucks to the designated backfill areas on trucks.

2.4.2.6 Emergency Plan for Spills

No spills are anticipated as the works are to be carried out by an excavator.
2.4.2.7 **Labour Requirements and Availability**

The tentative list of labour requirements is given in Table 2.3:

**Table 2.3: List of labour requirements for dredging and backfilling**

<table>
<thead>
<tr>
<th>Activity or work group</th>
<th>Specialists</th>
<th>Labourers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dredge fleet</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Dry fill</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Special equipment</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Workshop</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Administration</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>

Specialist labour will be required to undertake specific tasks. A total of 17 jobs may be available for the locals from the project. However, no specific quota for local or foreigners have been established. It is unlikely that the required specialists may be available from Maldives, hence, the use of foreign labour at least for some jobs is inevitable.

2.4.2.8 **Housing of Temporary Labour**

Majority of the workforce will be accommodated on rented houses in Maafaru Island.

2.4.3 **Shore protection measures**

2.4.3.1 **Scope of Works**

The project proposes to install a shore protection measures on the eastern side of the island covering 1900 m in total.

2.4.3.2 **Design Details**

**Foreshore revetment**

A foreshore revetment will be constructed around the island to prevent erosion. The options have been explored for the design: a geobag revetment, armour rock revetment, concrete tetrapod design or sand-cement bag revetment. The final choice will depend on the quotations received from the contractor. For now, the proposed design is a geobag revetment. Alternative options have been explored in more detail in the alternatives chapter.
The proposed design for the geobag revetment is provided in Figure 2.7. Detailed design is presented in Appendix C. The design details of the geobag revetment are presented in Table 2.5 below. The design consists of the series of geobags filled with sand to be placed on the beach slope on top of a layer of geotextile. The bottom two bags in the structure are buried in the lagoon bottom and the geotextile layer is wrapped around the toe bag to prevent scouring related damage (See Figure 2.7).

![Figure 2.7: Proposed geobag revetment design](image)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revetment Length</td>
<td>1900 m</td>
</tr>
<tr>
<td>Revetment Width</td>
<td>13 m</td>
</tr>
<tr>
<td>Slope</td>
<td>1:10</td>
</tr>
<tr>
<td>Elevation</td>
<td>+1.6 m MSL</td>
</tr>
<tr>
<td>Material Type</td>
<td>Tencate Geotextile Bags</td>
</tr>
<tr>
<td>Bag Size</td>
<td>1.4 m x 1.8 m</td>
</tr>
<tr>
<td>No of Bags</td>
<td>10,893 bags</td>
</tr>
</tbody>
</table>

An alternative design proposed for the foreshore revetment is rock boulders. Proposed design for the geobag revetment is provided in Figure 2.8. Detailed design is presented in Appendix C. The design details of the alternative rock revetment are presented in Table 2.6 below.

The rock revetment will be constructed on the beach slope by using the beach as a base layer and placing the rocks over them. A geotextile layer will be placed on the beach before placing the rock boulders, to prevent scouring.
Table 2.6: Design specifications for the proposed alternative rock boulder revetment

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revetment Length</td>
<td>1500 m</td>
</tr>
<tr>
<td>Revetment Width</td>
<td>13 m</td>
</tr>
<tr>
<td>Slope</td>
<td>1:10</td>
</tr>
<tr>
<td>Elevation</td>
<td>+1.8 m MSL</td>
</tr>
<tr>
<td>Material Type</td>
<td>Amour rock</td>
</tr>
<tr>
<td>Rock Size</td>
<td>200-300 kg</td>
</tr>
<tr>
<td>Rock Volume</td>
<td>19,000 MT</td>
</tr>
</tbody>
</table>

2.4.3.3 Justifications for design options

The proposed foreshore revetment has been considered primarily based on the length of protection involved, available space on the reef, wave conditions at the site, cost and practicability. The choice of geobags is primarily based on practicality and cost. The option of an armour rock revetment is the best choice but the costs could be prohibitive depending on the contractor quotes. Geobags have been a proven technology against moderate wave activity and thus suitable for the proposed site.

The armour rock breakwater has been proposed for the harbour area based on durability. The harbour needs to be safe and the structure needs to be durable to minimise future maintenance. The length involved is small, which minimises the cost implications.

The only option available for quaywall is steel sheet piles due to the depth involved.
2.4.4 Airport Construction

2.4.4.1 Vegetation Removal and Management

Scope of works

The scope of works involves removal of vegetation (all trees, stumps, roots, logs, rubbish and shrubs) from the development footprint and disposing or reusing them efficiently. Almost all large trees that can be transported out of Maafaru, will be transported out. The designated site at present have not been finalised but discussions are underway with two major reclamation projects.

Vegetation Clearing

All roots, stumps, etc., shall be removed to a depth of approximately 400 to 600 mm below the lower elevation of the excavation. The width of excavation will be 3 ft from the base of the tree. All holes remaining after clearing and grubbing will be backfilled and compacted to ninety percent of Standard Proctor Density at a moisture content of between optimum and plus 3 percent of optimum as directed by the Engineer. On areas required for excavation and material sources, stumps, roots etc., will be removed to the complete extent necessary to prevent such objectionable matter becoming mixed with the material to be used in construction.

It is estimated that 264,000 m$^3$ of vegetated area will have to be cleared which accounts for about 27.8% of Maafaru Islands’ existing vegetation cover. Of particular importance is the removal about 32% of the island’s dense coconut groves, 85% of mangrove forests and 24% of mixed vegetation groves which consists of medium to large sized trees. Detailed estimates of the number of trees and percentage of trees to be removed are provided in section 4.2.1.

It is anticipated that about roughly 15000-20000 medium to large trees, mainly coconut trees, funa, un, Dhiiga, and Hirundhu of the larger varieties will be removed completely for airport construction. In addition, 20,000-25,000 bush trees and about 1000-1500 mangrove bushes may have to be removed.

These figures have been derived using a combination of remote sensing technology, field observations and consultations with the inhabitants. It uses a density analyses method where a low, medium and high area (in sq m) for a given tree type is calculated and divided against the vegetation classes. The density is derived from actual sampling during field assessment. Caution is raised here that no tree count figures can be exact due to high density of vegetation cover in Maafaru. What is provided in this report is the best guess estimate and should not be used for legal or compensation purposes.
Clearing will begin from the undergrowth. The plants will be uprooted by digging at about 1 m away from the base of the tree and about 1.5 m deep. The roots will be removed using a chain saw. The excavator will then load the tree onto a truck using a purpose built belt. The leaves will be cut into half except for the crown. Coconut trees and large funa trees will be removed last.

The proposed removal footprint also contains about 30,000 sq m of marsh land, where at present, there is no vegetation cover. The existing mangrove vegetation is described separately above.

The medium to large trees removed will be transported to the harbour area for loading on to a barge. The barge will transfer the trees to the designated re-plantation site.

Once at the re-plantation site, the trees will be unloaded using an excavation and a purpose built belt and unloaded on to the island. The excavator will then place each tree in pre-dug holes.

The specific islands for transportation has not been finalised at the time of this EIA. Negotiations are underway for a number of newly planned developments (see below).

**Compensation for trees**

Compensation for trees (mainly coconut palms) cut down from the public areas will be paid by the Government. The island office estimated the number of coconut trees as 17,000. It is known that compensation has been already paid under the previously planned development. However, since the allocated for the airport has slightly expanded north, some additional compensation may be required for the new trees. It is understood that the Island Council will arrange for the compensation.

**Measures to mitigate effects of deforestation**

Only the designated foot print of the development area will be removed. Tree removal in the buildings area will be undertaken last. Only the building foot prints will be removed first and the remaining trees will be removed once a transplantation site has been identified.

Removed trees will be used transplanted to other islands where possible. Negotiations are currently underway to reuse the removed trees for the following activities:

- Use for landscaping in the proposed resort to be reclaimed on Dhiffushi Reef in Male’ Atoll,
- Use for landscaping in the proposed resort in Lh. Huruvalhi.
- Use for landscaping in the proposed resort in N. Dhigurah
• Use for landscaping in the proposed industrial island K. Thunbafushi Island, which is planned for reclamation.
• Use for landscaping in N. Velidhoo.
• Reuse for revegetating other resorts being planned as part of the package contract to develop the airport.
• Trees of special value, such as medicinal value (for example, Kandhu and Kandholhu) will be separated during removal and allowed to be taken by the nearby islanders and others from the atoll interested in them.

Among the above, the proposed projects in Dhiffushi reef, Huruvalhi and Dhigurah already have EIA approvals. Thunbafushi Island has its EIA under evaluation. It will be the responsibility of these parties to get any necessary approvals to transport the trees to their respective islands.

As the regulation of cutting, uprooting and transport of trees, requires the replanting of two trees per one tree removed, the proponent will establish a long term tree plan to plant twice the number of trees that will be removed. This will be achieved as per the following schedule.

• About 80-90% of the large trees cut down that is of reusable quality will be replanted in nearby islands as identified above.
• It is anticipated that an additional 50% (of the required 200%) could be planted during landscaping of the airport area and other resort properties planned by the proponent.
• A long-term tree replanting programme will be started to support islands of Noonu and Male’ Atolls undertaking land reclamation projects.
• Revegetation will be carried out according to their natural pattern of occurrence. The coastal areas will be revegetated with coastal vegetation, primarily magoo and kuredhi. The next layer will be a mix of medium to small trees and the final layer will large trees and coconut palms.

2.4.4.2 Runway construction

Excavation and backfilling

Earth will be excavated to a depth of 300 mm from the existing ground level and the excavated material will be stock piled. After all holes and depressions are filled with the approved material, the sub grade will be brought up to the lines and grades required and will be compacted to 95 percent standard proctor density. The subgrade will be kept free from all roots and weak spots. Any weak spots that develop under traffic will be repaired with suitable material as they develop. To prevent growth of weeds, the subgrade should be treated with an approved herbicide.
Backfilling will be undertaken in low lying areas to level the ground. A comprehensive level survey will be required after vegetation clearance to determine the exact levels of backfilling. Backfilling will use dredged sand from the lagoon, which has been left for a few days on the beach to drain the salt water.

**Compacted subgrade**

The subgrade will be graded and levelled. The material will be compacted to a minimum of 95 percent of Standard Proctor Density at a moisture content of between optimum and plus 3 percent of optimum. Soil will not be compacted at less than the optimum moisture content. If the material fails to meet the density specified the course shall be reworked, as necessary, to obtain the specified compaction. Static tire roller to be used to carry out compaction or other roller approved by the Engineer. The CBR value for the compacted sub grade will be (not less than) 20 percent.

Compaction will be undertaken by applying conventional method of using heavy drum roller.

**Constructing the runway**

The runway strip will be constructed using porous asphalt. Porous asphalt is known for its effectiveness in managing the storm water from the runway. Concrete drainages will be constructed on both sides of the runway to manage stormwater runoff.

Special equipment and an asphalt plant will be required to undertake the works. Equipment and tools used for asphalt overlay will include asphalt plant, asphalt paver, single drum tire roller, three wheel roller, pneumatic roller, bitumen sprayer, aggregate spreader, tar barrel bucket, air compressor and diesel generator to power the tools.

**2.4.4.3 Airport building and ancillary services construction**

The following buildings and ancillary services will be established on the island.

- Terminal building
- Installation of security measures, including fencing.
- Control tower
- Weather monitoring station
- Radar station
- Staff complex
- Provisions for quarantine
- Vehicle garage/car park
- Fuel storage and supply
• Provisions for controlling fuel spills
• Communications, equipment and supplies
• Fire and Safety building
• Emergency care unit/clinic/health room
• Waste management and sewage disposal
• Utilities building which houses power and water plants

2.4.4.4 Utilities – Power and water infrastructure

Power

Power for the construction stage will be provided initially using a 50 kVA generator.

Power for the operations stage will be provided mainly using two 250 kVA synchronised prime fuel oil generator sets. One unit will be used as a backup.

The emission rating for power generation engines will be at US EPA/CARB Tier of 2. The specifications of the generators will be decided based on the quotations and technology assessments. Under the new Guideline for Power System Approval of the Maldives Energy Authority, power generation plants have to be registered. The environmental considerations and compliance will be addressed later in this report but the technical specifications of the generators will be provided during the application for registration.

The power house is located in the utilities building. The building will house the desalination plants, in addition to the generator sets. The structure is specially designed to be noise and vibration proof as much as possible with floor padding and wall insulations, among other measures.

The planned power distribution network was not finalised at the time of this report submission. However the following information can be derived from the existing concept drawings. Power supplies to the buildings will follow the main footpaths and supply to the rest of the islands will follow the main roads. The land areas will require excavation up to 600 mm. All cabling and connections will conform to the Maldives Electricity Regulation.

Fuel storage requirements of the include diesel, petrol and aviation fuel. Aviation fuel will be stored in two 170 m³ steel tank, about 6 m high and 6 m in diameter. Petrol will be stored in an underground tank. A separate 15 m² purified fuel storage tanks will also be constructed. In addition, the facility will have separate pump stations for each fuel type and diesel oil purifier room.
The fuel tank will be bunded by solid concrete walls and will rise to at least 1600 mm above ground level. All underground tanks will also be bunded by concrete structures before placing the steel tanks.

Fuel transportation from the harbour to the fuel tanks will be using appropriately sealed piping. Pipes will be placed 800 mm below ground level and will have safely valves and pipe line condition monitoring setups at designated locations around the island.

**Water**

Water for the construction stage will be provided using a 50 m$^3$/day temporary plant.

During operations a 50 tonne-per-day plant will be installed. The construction stage 50 m$^3$/day plant will be used as a backup.

The desalination plant building will be sound and vibration proofed.

Sea water intake for desalination will be using a borehole of intake pipelines on the western side. No final decision has been taken at the time of the EIA.

The plants will operate on an estimated 45% product water recovery, hence, with 55% brine output. The brine outfall is proposed to be located on the western side of the island, under the jetty, about 50 m from the shore (See Figure 2.7). If the intake is from the lagoon, the brine outfall pipe will be located along the sewage outfall pipe, as shown discussed in the alternatives chapter. The pipeline will be made of uPVC.

The water distribution network has not been finalised at the time of this EIA. There will be two distribution pipe systems. The first will transfer the water from the intake to the RO unit using a 100 Ø UPVC pipes. The second will be the main distribution line for the treated water using 80 Ø UPVC pipes. Distribution to facilities will be using 40 Ø UPVC pipes.

Rainwater will be harvested and stored on tanks. The preliminary design plans to install two rainwater tanks with a total capacity of 50 tonnes. In addition, one storage tank with a capacity of 100 tonnes will be installed to store desalinated water. Together, the total storage capacity is 150 tonnes, or 4-5 days of water.

The product water will be according to standards defined by EPA Maldives. Where standards are not defined for specific parameters the product water will meet EU standards applicable to water intended for human consumption.

The proposed desalination plants can produce fresh water from sea water pumped at 16 m$^3$ per hour with TDS of 45,000 ppm at 25°C. The water produced from the plants will have a quality
TDS <500 ppm at a pressure of less than 2 Bar. The system efficiency is rated at 45%. The brine outfall can handle a TDS of 60,000 at 9 m³ per hour.

Water security logistics will be elaborated during detailed designing.

2.4.4.5 Waste Management Plan

The waste generated from clearing the trees will be sorted to reusable and disposable green wastes. The segregated reusable waste will be allowed to be taken by the island community under the supervision of the contractor. The disposable green waste will be burnt in a designated area of the project site. It is estimated that an amount of 10,000 m³ of disposable green waste will be generated after cutting down the trees.

All other wastes would be general domestic waste arising from material consumption by construction workforce. These will be managed according to Environment Ministry 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.

For more details of the construction stage waste management plan, refer to chapter 6.

A waste management site will be established on the eastern end, near the fence, away from the main facilities. The site will be demarcated using boundary walls and specific areas will be designated for waste sorting, especially for temporary green waste storage. A shredder is planned to be placed for green waste.

The capacity of the waste management facility is to process 3-4 tonnes per day.

2.4.4.6 Sewerage System

The sewage system will include septic tanks and outfall.

The sewage outfall is proposed to be located outside the reef on the northern eastern of the island, at a distance of about 220 m from the shore (see Figure 2.9 below). The piping will be placed on the sea bed and anchored using concrete weights. The pipeline will be extended to a depth of 5 m on the reef slope.

There is no alternative location given the presence of the runway and inappropriateness in using the western side lagoon for sewage outflow.
Figure 2.9: Water intake, brine outfall and sewage outfall locations
2.5 Work Methodology

2.5.1 Site Setup

The site is at present has a cleared mobilization area which was used by the previous developer. These sites will be used where practical.

2.5.2 Mobilisation of equipment and materials

Site mobilisation involves the mobilisation of construction equipment, materials and workforce to the site and providing necessary storage for materials and site access and services for the workforce. This activity has its environmental consequences including transport-related impacts, site-access related impacts and workforce related impacts. These will be considered in detail in Chapter 5 of this report. All site mobilisation and construction related activities will be undertaken in a planned manner in order to avoid excessive cost and environmental implications.

2.5.3 Reef Entrance Dredging

2.5.3.1 Timing and Coordination

This will be one of the first steps in the dredging process.

The local weather conditions especially the monsoonal variations is likely to affect the construction activities and equipment operation. Particular activities such as marine construction and dredging works may be hampered during the peak SW monsoon severe weather.

Coordination with regards to the mobilization component of the project will be carefully planned

2.5.3.2 Dredging Method

Dredging for the reef entrance and harbour basin will begin by excavator mounted on a sand bed. The dredge material will be transported to the reclamation site via trucks. First the harbour landing area will be constructed. The excavator will have a bucket size of about 1.5 m$^3$.

Dredging the harbour basin will begin from the seaward side. A temporary sand bed will be constructed to transport the sand to the designated storage areas. The bed will be removed as soon as dredging the channel is completed.

All material dredged will be temporarily stored near the beach for 2-3 day to let the salt water drain. It will then be moved to backfill areas on trucks (see next section).
**Dredging alternatives**

Use of a dredger was considered as an alternative. However, due to the limited scope of this project and the requirement to backfill it was impractical to use one.

**2.5.4 Backfilling**

Backfilling will be done by transporting sand in tipper trucks and spreading using a loader. It will be compacted to the required level using a compactor.

**2.5.5 Shore Protection and harbour works**

The project has not finalised the material to be used for construction. If the geobags are used, purpose designed steel stands will be constructed to hold the geobags in place for filling. Filling will be undertaken using an excavator. Once filled, the bags will be stitched at the top and removed. Filling will be done on site. A geotextile layer will be placed on the profiled beach and the bags will be placed using a crane or an excavator.

If armour rock will be used, the site will be prepared by placing a geotextile sheet along the profiled beach. Rocks will be placed using an excavator or a crane. Rocks will be transported to the site in truck from the newly dredged harbour. Rocks will be transported to the island on barges.

**2.5.6 Construction System, Concrete Batching Plant and Asphalt batching plant**

All land based buildings will be constructed using traditional block and steel placed on concrete platforms supported by concrete piles where required. There is no information available currently on the requirements for space and equipment for the proposed manufacture of piles on the site.

Consideration is being given to having a small concrete batching plant located on the site to produce the volume of concrete that will be required during construction.

A mobile asphalt batching plant will be used lay the runway and apron. All material will be imported and prepared on site.

**2.5.7 Dewatering, Excavation and Pipeline Installation**

Pipeline for the proposed water, power and sewage network is proposed to be installed at a depth of 0.6 m to 1.0 m on the sides of the foot paths. Excavation to a maximum depth of 1.2 m may be required. A mini excavator will be used to trenching works. Where instability of the sand/soil
conditions are experienced, trench shoring is to be used to maintain the vertical integrity of the sidewalls.

It is expected that only minor dewatering will be required in low areas during construction and installation of pipe networks. The water table is expected to lie on average between 0.8 m below ground level in low areas and 1.2 m in other areas. Water table bay not be fully developed at the time of pipeline construction,

All water removed during dewatering will be discharged onto the ground for re-percolation back into the water table as outlined in the EPA guidelines.

The outfall pipeline will be placed on the lagoon bed and will be secured with concrete anchor blocks of a mass sufficient to prevent the movement of the pipeline during heavy wave activity. Anchor blocks will be placed at intervals of 6 m to center.

### 2.6 Project Schedule and Life Span

Mobilisation for the project will begin after the EIA is approved. It is anticipated that the completion of the whole project will take approximately 18 months. The preliminary work plan is provided in Appendix E. The actual details may be dependent on the final contractor.

#### 2.6.1 Work Sequence

Vegetation removal works is the first step in the project. Channel dredging and land reclamation will follow one the levelling and backfilling areas are identified. This will be followed by shore protection activities.

The first infrastructure that will be developed is the runway and the apron. The first activities relating to permanent construction include the desalination plant/power house and staff accommodation. This will ensure that some of the services could be used during the construction stage as well. The construction of the key buildings will be given priority.

Demobilisation and site clearance will be the final activity of the construction program.

### 2.7 Labour Requirements and Services

#### 2.7.1 Workforce

It is projected that the total number of employees during the construction stage will be around 150 - 200. These workers will mainly be accommodated on the rented housing in Maafaru Island. If required, a temporary accommodation area will be constructed from disposable
material. However, it is not expected that all the 200 workers will be present on the island at once in any given time.

During operation stage about 20-30 persons are expected to be employed, possibly increasing significantly with the expansion of airport services.

2.7.2 Services

The Contractor is expected to provide workers with meals and appropriate entertainment facilities including radio and television. The Proponent would not be responsible for any of the services to be provided to the Contractor’s staff or workers.

2.8 Waste Management, Logistics and Safety Measures

2.8.1 Site Office andTemporary Accommodation

As noted above, the existing facilities in Maafaru Island will be initially used for accommodation and site office.

A site office and temporary accommodation blocks will be constructed at the initial phase.

2.8.2 Procurement

Procurement of materials will take place in three stages. An initial shipment of materials comprising of basic building materials would be ordered soon after a preliminary agreement has been reached with the contractor. The first procurement and delivery is expected be completed within seven weeks from order confirmation. The remaining building materials along with the basic finishing material will be ordered to time their arrival within three months after construction starts.

The contractors for coastal works will transport their own material and equipment, including armour rock, geobags and associated equipment.

2.8.3 Utilities and waste management

See Section 2.4.4.4 and 2.4.4.5.

2.8.4 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 bunded
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 bunded location to minimize risk of spill

2.8.5 Health and Safety Measures

The following health and safety measures will be implemented during the construction stage.

- Contractor would ensure that Health and Safety procedures are complied.
- 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.
- Health checks will be administered before work commences
- Warning signs, barricades or warning devices will be provided and used.
- Necessary safety gear will be worn at all times.
- Fire extinguishing equipment would be readily available and employees will be trained in its use.
- Oxygen, acetylene or LPG bottles will not be left free-standing.
- First aid kits will be made available on site
- The construction site will be properly closed to unauthorised personnel

2.8.6 Emergency Spill Response Plan

An emergency response plan for chemical and oil spills would be in place before construction commenced. It would include preventive and preparatory measures, including:

- Placement of storage areas away from sensitive environment
- Storage in secure, bunded locations
- Training of employees on good environmental practice and response protocols
- Installing warning signs and barricades where needed
- Installing response kits at accessible locations. The kit would include absorbents, personal protective equipment and clean-up tools.
- Acquiring material safety data sheets for all hazardous chemicals

Additionally, the response plan would include:
• Risk assessment, including identification of hazards, potential triggers, contaminant pathways, and impact thresholds for different chemicals
• Response procedure, defining roles and responsibilities of key personnel
• Communication protocols—among responsible personnel, and to authorities and neighbours, if required
• Long-term environmental monitoring, if required.

2.8.7 Fire Prevention

Fire extinguishing equipment would be readily available and employees will be trained in its use. In general, water-based fire extinguishers would be used.

Oxygen, acetylene or LPG bottles will not be left free-standing. All welding and cutting will be done in accordance to high safety regulations by experienced personnel.

2.9 Summary of Project Inputs and Outputs

The types of materials that will go into the development and from where and how this will be obtained are given in Table 2.7 and the type of outputs (products and waste streams) and what is expected to happen to the outputs are given in Table 2.8.

Table 2.7: Major Project Inputs

<table>
<thead>
<tr>
<th>Input resource(s)</th>
<th>Source/Type</th>
<th>How to obtain resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction workers</td>
<td>Local and foreign, mainly foreign</td>
<td>Recruiting agencies, etc.</td>
</tr>
<tr>
<td>Engineers and Site supervisors</td>
<td>Local and foreign</td>
<td>Advertise in local papers, social networks, etc.</td>
</tr>
<tr>
<td>Construction material</td>
<td>Timber; electrical cables and wires, DBs and MCBs, PVC pipes, light weight concrete blocks, reinforcement steel bars, sand, cement, aggregates, telephone cable CAT 5, PVC conduits, floor and wall tiles, gypsum boards, calcium silicate boards, zinc coated corrugated metal roof, paint, varnish, lacquer, thinner, geobags, armour rock, asphalt...etc.</td>
<td>Import and purchase where locally available at competitive prices – Main Contractor’s responsibility.</td>
</tr>
<tr>
<td>Maintenance material</td>
<td>Similar to above</td>
<td>Import or purchase locally where available</td>
</tr>
<tr>
<td>Water supply (during construction)</td>
<td>Desalinated water</td>
<td>10 m³/day desalination plant and Community wells (designated by island)</td>
</tr>
</tbody>
</table>
### Table 2.8: Major Project Outputs

<table>
<thead>
<tr>
<th>Products and waste materials</th>
<th>Anticipated quantities</th>
<th>Method of disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green waste from site clearance</td>
<td>Large quantity</td>
<td>Burnt or mulched on site and used for nursery and landscaping needs.</td>
</tr>
<tr>
<td>Construction waste (general)</td>
<td>Small quantities</td>
<td>Combustibles: Burnt/incinerated Others: Sent to designated landfill</td>
</tr>
<tr>
<td>Dredge waste</td>
<td>Large quantity</td>
<td>Backfilling; geobags; construction</td>
</tr>
<tr>
<td>Waste oil</td>
<td>Small quantities</td>
<td>incinerated</td>
</tr>
<tr>
<td>Hazardous waste (diesel)</td>
<td>Small quantities</td>
<td>Barrelled and sent to designated landfill as part of overall hazardous waste management programme of the island</td>
</tr>
</tbody>
</table>

### 2.10 Demobilization

Demobilization plan depends on the contractor. In general, the proponent advocates a phased demobilization plan to commence in the last month of the contract. Machinery transported from Male’ will have to be demobilized on one specific date.
3 POLICY AND LEGAL FRAMEWORK

These legal and policy provisions have to be fully respected in carrying out the proposed development. All contractors and sub-contractors will be informed of these requirements. This project conforms to all relevant laws and regulations of the Maldives.

3.1 Relevant Legislation

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

The Environmental Protection and Preservation Act (4/93) enacted on 19 March 1993 is the framework law related to environment protection in the Maldives. The authority responsible for the Environment Act is the Ministry of Environment and Energy.

Articles 2, 4, 5, 6, 7, and 8 of the law are relevant to the Maafaru Airport Construction Project.

Article 2 states that the concerned government authorities shall provide the necessary guidelines and advise on environmental protection in accordance with the prevailing conditions and needs of the country. All concerned parties shall take due considerations of the guidelines provided by the government authorities.

The project developers and contractors shall abide by any guidelines or advice given by the concerned Government authorities for the project.

Article 4 states that the Ministry of Environment shall be responsible for identifying protected areas and natural reserves and for drawing up the necessary rules and regulations for their protections and preservation.

The project developers and contractors shall ensure that there is no negative impact from the proposed project on sensitive environments in the vicinity or protected species.

According to Article 5 (a) of the Act, an Environmental Impact Assessment study shall be submitted to the Ministry of Environment before implementing any development project that may have a potential impact on the environment.

According to Article 5 (b), The Ministry of Environment shall formulate the guidelines for EIA and shall determine the projects that need such assessment as mentioned in paragraph (a) of this clause.

This report is prepared to fulfil this clause.
According to Article 6, the Ministry of 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.

*All project developer and contractors shall be aware of this provision and contractors shall take all practical measures to ensure there is no irreversible and significant negative impact of the projects on the environment.*

Article 7 of the EPPA (4/93) states that any type of waste, oil, poisonous gases or any substances that may have harmful effects on the environment shall not be disposed within the territory of the Maldives. In cases where the disposal of the substances becomes absolutely necessary, they shall be disposed only within the areas designated for the purpose by the government. If such waste is to be incinerated, appropriate precaution should be taken to avoid any harm to the health of the population.

*All project contractors shall comply with the Environmental Management Plan presented in this report, which specifies how the wastes, oil and gases generated by the project will be disposed.*

Article 8 of the EPPA (4/93) states that Hazardous/Toxic or Nuclear Wastes that is harmful to human health and the environment shall not be disposed anywhere within the territory of the country.

*Any hazardous wastes that may be generated from this project shall be transferred to the designated waste site in Thilafushi or Vandhoo for disposal according to Government regulations and standards. It should not be disposed on the Island, as it does not have the necessary facility.*

### 3.1.2 The Civil Aviation Act of the Maldives 2001

The Civil Aviation Act of the Maldives relates to registration and operation of civil aircraft and building, registration, operation and use of civil aerodromes and other matters relating to civil aviation and safety relating to civil aviation.

According to the Act, building, registration and usage of civil aerodromes in the Maldives shall be in accordance with the Act and regulations made under the Act. Accordingly, any aerodrome in the Maldives shall be constructed only after land or space required for such purpose has been obtained lawfully and only after submission and approval of the drawings, details and other information required under the Act and regulations made under the Act.

The Civil Aviation Act of the Maldives provides wide statutory powers to the Civil Aviation Ministry including setting out guidelines and making regulations regarding safety of civil
aerodromes, maintaining standards of safety zones and demarcation of a certain area surrounding the aerodrome for activities such as:

- Construction of buildings and other structures
- Planting and cultivating trees and other crops
- Driving and parking of various types of vehicles
- Illuminating, rearing of birds and having airborne objects and engage in other operations that will endanger the safety of civil aviation.

The Civil Aviation Act of the Maldives also outlines the penalties for breaching the Act and any Regulations under the Act.

*The aerodrome master plan has been prepared based on the Civil Aviation and its subsequent regulations. The facility will be approved by the Civil Aviation Authority before commencement of operation.*

### 3.1.3 Land Act

The Land Act provides for allocation and releasing of land for different needs as well as releasing of public land for housing. The Act also states the conditions that govern the using of, owning, selling, renting and transferring of ownership of public and private land.

*The proposed site in Maafaru Island for development has been designated an infrastructure zone and has been separated from the jurisdiction of the Atoll Council for administrative purposes. The project has approvals from Atoll Council and Regional Airports to use the land (See Appendix D).*

### 3.2 Relevant Regulations and Guidelines

#### 3.2.1 The Civil Aviation Regulations

The Maldivian Civil Aviation Regulations (MCAR) was introduced in July 2007, aimed at complying with the requirements of the International Civil Aviation Organisation (ICAO). The MCAR comprise of important regulatory measures such as Aerodrome Rules, Air Traffic Control, Conditions of Flight, Rescue and Fire Fighting Services, Airport and Aircraft Security, Accident Investigation, Protection of the Environment and Fees for Licenses and Charges for Airport Navigation Services. The MCAR also now consists of an Aerodrome Standards Manual which came into effect on 15th December 2008. The manual is a comprehensive guideline of the MCAR as per the requirements of the ICAO. Accordingly, this project, particularly the proposed domestic airport component will comply with the MCAR and its Aerodrome Standards Manual.
The following outline the primary components of the Civil Aviation Regulations that are relevant to this project:

**Aerodrome Rules**

According to MCAR, aircrafts shall not land at any place in the Maldives unless the place has been certified as an aerodrome under MCAR and its use is authorized by the Director of Civil Aviation according to the terms prescribed in MCAR. These include the applicant’s competency and sound safety measures, having regarded in particular to the physical characteristics of and the surrounding of the aerodrome.

MCAR also states that any licensed aerodrome open to public use shall be open to any aircraft used in the service of the Maldives and also to any aircraft which possesses the nationality of a Contracting State on the same terms and conditions as for Maldivian aircraft. All aircraft which possesses the nationality of a Contracting State shall also be entitled to use such aerodromes and such visual and non-visual aids to air navigation as open to public use.

The aerodrome operator has many obligations including compliance with standards and practices specified in MCAR and with any conditions endorsed in the certificate pursuant to MCAR. The aerodrome operator shall establish a Safety Management System for the aerodrome describing the structure of the organization and the duties, powers and responsibilities of the officials in the organization structure, with a view to ensuring that operations are carried out in a demonstrably controlled way and are improved where necessary. Furthermore, Rescue and Fire Fighting Services are mandatory for all aerodromes approved for schedule and/or non-schedule traffic with aeroplanes carrying passengers.

*The facility will be certified by the Civil Aviation Authority before commencement of operation. These will include compliance to all safety clauses and operating standards.*

**Obstruction Clearance and Marking**

MCAR specifies that:

Whenever any object located in the vicinity of an aerodrome for public use constitutes an obstruction or potential hazard to aircraft moving in the vicinity of the aerodrome, the occupier of the place or, in the case of a movable object, the person having the management of it shall comply with terms of a notice from the Director within the time specified in the notice to either remove the object or a portion of it or to install and operate lights on the object and mark it in accordance with the requirements of the notice.
According to the Civil Aviation Department, it is ideal to have the runway away from the island vegetation. This will ensure maximum safety in terms of obstruction to aircraft flight path and also reduce the number of accidents due to ignorant crossing on the runway by trespassers.

The buildings and structures considered within the obstruction zone will be clearly marked with the relevant colours and lighting used where required.

Zoning of Land and Waters in the Vicinity of Aerodromes

MCAR specifies that, with effect upon publication in a local newspaper, the Director of Civil Aviation may by order restrict the use of land or waters in the vicinity of an aerodrome for public uses for the purpose of protecting the approach and transitional surfaces of an aerodrome in accordance with the material standards and recommended practices for air navigation services prescribed under the Chicago Convention. Such an order may provide for: Prohibition of the erection of or limitation of the height of buildings, structures or things;

- Prohibition of the planting of or limitation of the height of any trees; Prohibition of sowing or growing any plant or crop; and Prohibition of the bringing of vessels or vehicles or anchoring, mooring or parking of any vessel or vehicle.

However, different provisions may be made with respect to different areas and an order only becomes effective upon publication in a local newspaper.

The proponent will request the Civil Aviation Authority to issue the relevant order to restrict the development and airspace around the aerodrome.

Dumping of Rubbish

As the presence of waste food stuffs, in the vicinity of an aerodrome for public use, may constitute an attraction to birds as to create potential hazard to aircraft using or flying in the vicinity of that aerodrome, MCAR specifies that the Director by notice may prohibit the leaving or bringing on of waste food in an area of land or water in the vicinity of the aerodrome.

Hence to minimise the attraction to birds, waste food items or other rubbish has to be kept in closed containers and the aerodrome should be kept clean at all times.

All waste will be managed as per the established waste management plan. Particular attention will be given to provide dustbins for food waste.
Delivery of Aviation Fuel and Checking Quality

MCAR specifies that, a person who manages an aviation fuel installation on an aerodrome shall not permit any fuel to be delivered or cause to be delivered to that installation or from it to an aircraft unless;

When the aviation fuel is delivered into the installation,

- the installation is capable of storing and dispensing fuel so as not to render it unfit for use in the aircraft;
- the installation is marked in a manner appropriate to the grade of fuel stored or if different grades are stored in different parts each part is so marked;
- in the case of delivery into an installation from a vehicle or vessel, the fuel has been sampled and is of a grade appropriate to that installation or that part of the installation as the case may be and is fit for use by aircraft;

When any aviation fuel is dispensed from the installation, he/she is satisfied as result of sampling, the fuel is found to be fit for use in aircraft.

These regulations do not apply in respect of fuel, which has been removed from an aircraft and is intended for use in another aircraft operated by the same operator as the aircraft from which it has been removed.

A person shall not cause or permit any aviation fuel to be dispensed for use in an aircraft if he or she knows or has reason to believe that the fuel is not fit for such use.

The fuelling facility will be licenced by Civil Aviation authority and will be operated by a trained and a licensed professional.

Aeronautical Lights and Dangerous Lights

For Aeronautical lights MCAR specifies that;

- A person, except with the permission of the Director and in accordance with the conditions of the permission, shall not establish, maintain or alter the character of:
  - An aeronautical beacon; or
  - An aeronautical ground light (other than an aeronautical beacon), which forms part of the lighting system for use by aircraft taking off or landing at such an aerodrome
• A person shall not damage or interfere with an aeronautical ground light established by or with the permission of the Director.

• For Dangerous lights MCAR specifies that;
  o A person shall not exhibit a light which;
  o Because of its glare may endanger aircraft taking off or landing at an aerodrome or using an A.T.S route; or
  o Because it may be mistaken for an aeronautical ground light, may endanger aircraft.

Upon service of a notice from the Director and within the period specified in the notice the occupier of the place at which the dangerous light is located or the person in charge thereof shall permanently extinguish the dangerous light or take such other measures as may be specified in the notice.

Air Navigational Aids

MCAR requires that Aeronautical Radio Stations shall be certified and purpose approved by the Director and that the equipment shall be of a type the specification of which has been approved by the Director for the purpose for which it is to be used and such conditions as are specified in the approval are complied with. Only those approved and checked for the specified purpose shall provide navigational aid to aircraft, except unless the aeronautical radio station is used solely for the purpose of enabling communications to be made by or on behalf of the operator of an aircraft and the pilot in command of an aircraft.

Aeronautical Radio Stations in Maafaru will be licenced from CAS before commencement of operation.

Protection of the Environment

The Maldives Civil Aviation Regulations (MCAR) specifies certification requirements for noise, fuel venting and smoke emissions to standards the same as or equal in stringency to those prescribed in pursuance of the Chicago Convention.

Suppression of Aircraft Noise and Vibration

For the suppression or mitigation of aircraft noise and vibrations, MCAR states that;

For the purpose of limiting or mitigating the effect of noise or vibration caused by aircraft, whether landing, taking off, on an aerodrome, the Director may, by notice published in such manner as the Director considers sufficient;
• Direct the operator of an aircraft which is to take off or land at an aerodrome to secure that, after the aircraft takes off, or, as the case may be, before it lands at an aerodrome, such requirements as specified in the notice are complied with;

• Direct the operator of an aircraft which is within an aerodrome to secure compliance with such directions with respect to the taxying of the aircraft and running of power plants (whether installed in an aircraft or otherwise) as are specified in the notice; or

• Prohibit aircraft from taking off or landing at an aerodrome during certain periods, or limit the number of occasions on which they may take off and land at an aerodrome during certain periods.

MCAR also includes penalties for non-compliance with the above measures.

*All public buildings will be sound proofed to the required levels.*

### 3.2.2 Environmental Impact Assessment Regulations 2012

Environmental Impact Assessment regulations were issued by Environment Environmental Impact Assessment regulations were issued by Environment Ministry on 8 May 2012. 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 programme. This report follows the principles and procedures for EIA outlined in the EIA regulations.

The EIA report is reviewed by MEE 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 Ministry. The project proponent is committed to implement all impact mitigation measures that are specified in this EIA report. Furthermore, the proponent is committed to environmental monitoring and shall fulfil environmental monitoring requirements that may be specified in the EIA decision note as a condition for project approval.

*This report complies with the EIA regulations*

### 3.2.3 Regulation on Sand and Coral Mining

Regulation on sand mining covers sand mining from uninhabited islands that have been leased; sand mining from the coastal zone of other uninhabited islands; and aggregate mining from uninhabited islands that have been leased and from the coastal zone of other uninhabited islands.
Coral mining from house reef and atoll rim has been banned through a directive from President’s Office dated 26 September 1990.

_Sand should not be mined from any part of an existing island. Sand should also not be mined from within 100 ft. of the shoreline of the existing Maafaru Island. Please see regulation on dredging and reclamation for further controls._

### 3.2.4 Regulation on Cutting Down, Uprooting, Digging Out and Export of Trees and Palms from One Island to Another

Pursuant to the Environment Protection and Preservation Act of Maldives 1993, the Environment Ministry made a bylaw with the purpose of educating developers about the importance of trees including best management practices for maintaining trees and provide standards for preservation of trees in the Maldives and set down rules and regulations to be adhered to prior to commencing felling, uprooting, digging out and exporting of trees and palms from one island to another in Maldives.

The by law states that the cutting down, uprooting, digging out and export of trees and palms from one island to another can only be done if it is absolutely necessary and there is no other alternative. It further states that for every tree or palm removed in the Maldives two more should be planted and grown in the island.

The by law prohibits the removal of the following tree types;

- The coastal vegetation growing around the islands extending to about 15 meters into the island
- All the trees and palms growing in mangrove and wetlands spreading to 15 meters of land area;
- All the trees that are in a Government protected areas;
- Trees that are being protected by the Government in order to protect species of animal/organisms that live in such trees; and
- Trees/palms that is abnormal in structure.

_This project will require removal of prohibited vegetation as the island is narrow and has no alternative location for airstrip location. It requires the removal of coastal vegetation on the eastern side, removal of mangrove plants in the marshy areas and removal of some large trees such as Nika trees. Mitigation measures have been proposed in the report to minimise the impacts of coastal vegetation removal and mangrove plant removal._
3.2.5 Regulation on Dredging and Land Reclamation

The regulation of Dredging and Land Reclamation was published on 2 April 2013 with the aim of minimising environmental impacts associated with dredging activities in islands and reefs across Maldives.

- The regulation defines the rationales acceptable for dredging as those related to approved development activities on inhabited islands and economic islands. It defines that those activities should be if utmost necessity for dredging to be considered.
- All dredging and reclamation activities must be approved by EPA in writing. The process includes the submission of project information to EPA along with a scaled before and after map.
- The regulation defines rationales for reclamation as those absolutely necessary for social, economic or safety purposes.
- Beach replenishment is restricted from 10 m of the registered shoreline in resort islands
- Dredging is restricted in the following areas:
  - 500 m from the ocean side reef edge
  - 50 m from any island vegetation line
  - An environmentally sensitive site
- Land reclamation is restricted within 200 m of a sensitive area.
- Land reclamation cannot exceed 30% of the house reef area

*The proposed dredging design has been prepared according to this regulation and has the Dredging and Reclamation approval from the EPA (See Appendix D).*

3.2.6 Dewatering Regulation (Regulation No. 2013/R-1697)

This regulation is drafted under the Act number 4/93 (Maldives Environment Protection and Preservation Act) and issued on 31st December 2013. The main purpose of the regulation is to minimize the impact of dewatering activities on ground water table and also to decrease the impacts on the receiving environment of the disposed water. The regulation encourages prevention of contamination and damage to ground water table, protect the living organisms as well as the environment from the negative impacts due to dewatering activities.

This regulation is to be enforced by EPA of the Maldives.
If dewatering is to be carried out for any development purposes in any of the islands in Maldives, it shall be done by gaining a written approval from the enforcing agency or an agency assigned by the enforcing body. However, dewatering done at individual level i.e., from a bore well or for the purpose of installing a bore well and water drawn for agricultural purposes are considered exceptions from the regulation.

Dewatering can only be to be carried out, after gaining approval by submitting “the dewatering approval form” in the annex 1 to the enforcing body for approval with all the required documents expressed and with an administrative fee of Rs 500. Water quality tests results also have to be submitted as one of the required component.

The regulation also guides on where and how the extracted water shall be disposed of, and how it has to be handled. According to the regulation, permission can be granted for dewatering at a stretch for a maximum of 28 days, for which a sum of Rs 500 should be paid per day. This amount is liable to be increased with the number of days increased.

A fine not exceeding Rs 100 million may be charged for violation.

*This project is unlikely to require pumping during excavation works. In the event that pumping is required, the proponent will be required to get an approval from EPA before commencing excavation.*

### 3.2.7 Waste Management Regulation 2013

Waste Management Regulation (WMR) was published on August 2013 and came into effect in February 2014. It will be implemented by EPA. The aim of WMR is to implement the national waste policy, which contains specific provisions to:

- Implement measures to minimize impacts on human health
- Formulate and implement waste management standards
- Implement an integrated framework for sustainable waste management
- Encourage waste minimisation, reuse and recycling
- Implement Polluter-Pays Principle
- Introduce Extended Producer Responsibility

WMR contains four main sections:

- Waste management standards: Defines standards for waste collection, transfer, treatment, storage, waste site management, landfills and managing hazardous waste.
- Waste management Permits: Defines approval procedures for waste sites
- Waster transfer: Standards and permits required for waste transport on land and sea, including trans-boundary movements.
- Reporting requirements: Defines reporting and monitoring requirements and procedures.
- Enforcement: Defines procedures to implement WRM and penalties for non-compliance.

The proponent shall register the waste site and any vessels used for transporting waste to Thilafushi or Vandhoo.

The proponent should also ensure compliance from the subcontractors in handling and transport of waste from the island to the designated waste site.

### 3.2.8 The Environmental Liability Regulation (Regulation 2011/R-9)

This law is pursuant to Article 22 of national constitution that states that protection, preservation and maintenance of the Maldivian natural environment, the richness of the living species, the natural resources and the beauty of the Maldives for the present generations as well as for the future generations is a basic obligation of the Maldivian government. The government shall enforce that the activities conducted in order to gain economic and social development should be of sustainable nature that protect the environment and such activities shall not deteriorate the environment, endanger any species, damage the environment, and shall not waste any natural resources.

This regulation is also pursuant to Environment Protection and Preservation Act of Maldives (4/93). The regulation is aimed at maintaining equal standards for reprimanding and enforcing environmental liabilities, fines for those who violate the rules and regulations and give guidance to those who are involved in the implementation process of the regulations pursuant to Preservation Act of Maldives (4/93).

One of the key objectives of the environmental liability regulation is also to practice polluter-pay-principles in the Maldives.

*All project developer and contractors shall be aware of this provision and contractors shall take all practical measures to ensure that all relevant laws and regulations, and the EMP proposed in this EIA is followed.*

### 3.2.9 Compliance

In general, the proposed developments are in compliance with the laws and regulations described above. Where there is a special requirement to comply, the EMP identifies measures and mechanisms required to comply.
3.3 Environmental Permits Required for the Project

3.3.1 Approval of the concept and site plan

The Regional Airports will have to approve the concept plan and site plan for the proposed project before the EIA could be approved.

*This project has conditional approval from Regional Airports (See Appendix D).*

3.3.2 Environmental Impact Assessment (EIA) Decision Note

The most important environmental permit to initiate project work would be a decision regarding this EIA. The EIA Decision Note, as it is referred to, shall govern the manner in which the project activities must be undertaken. This EIA report assists decision makers in understanding the existing environment and potential 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.

3.3.3 Registration of Desalination Plants

According to Desalination Regulation of the Maldives, all desalination plants operating in the Maldives catering for public water supplies and commercial purposes would have to be registered with Environmental Protection Agency (EPA) former Maldives Water and Sanitation Authority (MWSA). Therefore, the desalination plants to be installed in the new island would have to be registered with EPA. For this, the Proponent will be required to submit the EIA Decision Note for this EIA report, completed application forms with all details of the plant to be registered. A copy of the relevant section of this EIA may be appended to the forms as justification for the desalination plants.

3.3.4 Domestic Wastewater Disposal Consent

The General Guidelines for Domestic Wastewater Disposal issued by the EPA former MWSA in 2006 requires wastewater disposal to be undertaken with written consent of the Agency. A copy of the guidelines can be obtained from the EPA.

3.3.5 Dewatering Permit

A dewatering permit is required for the project during excavation works. A separate application will have to be made to the EPA to get the permit. Permission can be granted for dewatering at a
stretch for a maximum of 28 days, for which a sum of Rf500 should be paid per day. This amount is liable to be increased with the number of days increased.

3.3.6 Dredging and Reclamation Permit

Prior to any costal work that requires dredging or reclamation, a special permit has to be taken from the EPA. A specific form published by EPA has to be completed and submitted for the approval. EIA application form will only be accepted when the form is submitted with the costal modification approval given by EPA in writing.

*As noted above, the proposed reclamation design has been prepared according to this regulation and has the Dredging and Reclamation approval from the EPA (See Appendix D).*

3.3.7 Operating Licence for Aerodrome

The project will require an operating licence from Department of Civil Aviation before commencement of operation.

*The proponent will apply for a licence once the construction phase is completed.*

3.4 Responsible Institutions

The main government institutions that have roles and responsibilities relevant to this project are summarised below.

3.4.1 Civil Aviation Authority, Ministry of Tourism

Civil Aviation Department is the agency responsible for issuing permits based on compliance for the proposed airport. The project has conceptual approval from Regional Airports but once the aerodrome is completed, it is the responsibility of the CAA to monitor the compliance of the airport.

3.4.2 Ministry of Environment and Energy

The Ministry of Environment is mandated for the effective implementation of the Environmental Protection Act of the country and has the statutory power over issues related to the environment. It has the central control over the environment protection, management, conservation and environmental emergencies. The Ministry operates mainly at a policy level and the more regulatory and technical assessment activities are mandated to the Environmental Protection Agency (EPA). In this respect EPA has now been mandated to manage all issues relating to Environmental Impact Assessment of individual projects.
The Ministry of Environment also seeks the advice of National Commission for the Protection of Environment (NCPE) on all significant environmental matters. The commission is appointed by the president and is mandated to advise the Minister of Environment on environmental matters such as environment assessment, planning and management, and political decisions with regard to the protection of environment.

3.4.3 Atoll Council

The Maldives is grouped into 20 administrative areas under a new local governance system. Noonu Atoll has an elected Atoll Council located in Manadhoo. The Atoll Council Office is the main focal point of Government Ministries in Male’ and they co-ordinate and liaise with government ministries and elected island councils on all issues relating to the Atoll. A copy of this EIA will be submitted to the Atoll Council.

Atoll Council’s letter of receipt is attached to the report.

3.5 Guiding Policies and Documents

3.5.1 National Environmental Action Plan II (NEAP II)

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

Accordingly, the key strategies of the NEAP II are:

− Continuous assessment of the state of the environment in the Maldives, including impacts of human activities on land, atmosphere, freshwater, lagoons, reefs and the ocean; and the effects of these activities on human well-being

− Development and implementation of management methods suitable for the natural and social environment of the Maldives and maintain or enhance environmental quality and protect human health, while at the same time using resources on a sustainable basis

− Ensure stakeholder participation in the decision making process by consultation and collaboration with all relevant sectors of society

− Preparation and implementation of comprehensive national environmental legislation in order to provide for responsible and effective management of the environment
Adhering to international and regional environmental conventions and agreements and implementation of commitments embodied in such conventions. Furthermore, NEAP II specifies priority actions in the following areas:

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

### 3.5.2 Waste Management Policy

The aim of the waste management policy is to formulate and implement guidelines and means for solid waste management in order to maintain a healthy environment. Accordingly, the key elements of the policy include:

- Ensure safe disposal of solid waste and encourage recycling and reduction of waste generated;
- Develop guidelines on waste management and disposal and advocate to enforce such guidelines through inter-sectoral collaboration;
- Ensure safe disposal of chemical, hazardous and industrial waste.

*The proponents of this project must be aware of the policy and all solid and hazardous waste produced in this project should be disposed according to the Environmental Management Plan for the project, which reflects the principles of the Waste Management Policy.*

### 3.6 International Conventions

#### 3.6.1 Convention on Biological Diversity

The Maldives is a party to the United Nations Convention on Biological Diversity. The objective of the convention is “the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate
transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding”. The proposed development activities outlined in this project does not fall on any area recognised for its ecological value. Therefore it is unlikely there will be a major loss of biodiversity. The loss is not going to be significant at atoll or national level. Yet, it is recommended that the developer ensure that silt screens are used during dredging works, construction of the jetty and breakwaters to minimise any impact on the marine biodiversity.

3.6.2 International Plant Protection Convention

The Maldives has become a party to the International Plant Protection Convention (IPPC) as a step to protecting native plant species in the Maldives from the risk of diseases introduced by imported plant varieties. The Maldives adhered to the IPPC on 3 October 2006 and the Convention requires that certificates of phytosanitary condition and origin of consignments of plants and plant products be used for import and export of plants and plant materials. Contracting parties have the full authority to regulate entry of plants and plant products and may prescribe restrictions on imports or prohibit importation of particular plants or plant products. Thus it is advisable that the proponent be aware of the requirements of IPPC and obtains the necessary phytosanitary certificates if any plants are to be imported to stabilise the beach or for landscaping.

3.6.3 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, in the implementation of the project, careful attention needs to be given to ensure energy efficiency and reduce transport related fuel consumption. Furthermore, planting of beach vegetation would help in mitigation of greenhouse gas emissions from the project.
The IPCC defines adaptation “as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects.” Various type of adaptation include anticipatory and reactive adaptation; private and public adaptation; and autonomous and planned adaptation. The adaptation policies and strategies of the Maldives are given in the Maldives National Adaptation Programme of Action (NAPA). The replenishment of the beach can be considered as a long-term adaptation measure against beach erosion caused by rising sea levels.
4 EXISTING ENVIRONMENT

4.1 Physical Environment

4.1.1 Geological setting

Maafaru is one of the largest islands in Maldives with a length of 4500m and a width of 500 m at its widest point. The total surface area of the island is 119.1 Ha (1.19 km²). Much of the beach area is highly mobile and therefore should not be considered permanent land.

The reef of Maafaru, with a surface area of 1,233 Ha (12.3 km²), is one of the largest reef systems in Thiladhunmathi Atoll. However, it is still considered a small system compared to similar reef systems around the rest of the country. The reef is characterised by a deep lagoon approximately 214 ha large and -6 to -7 m deep. Apart from a natural reef entrance on the northeastern side, the depth of the reef flat is shallow averaging less than -1.5 m MSL.

Maafaru Island is located at the eastern side of the reef system, approximately 140 m from the reef edge. The island is generally low lying with an average elevation of +1.3m MSL. Maafaru should be considered a well-established island and appears to be constantly growing towards north albeit at a slow rate.

The influence of Indian Ocean oceanographic and climatic factors on the geologic setting and environment is likely to be pronounced in Maafaru as it is on the eastern rim of the atoll. Environmental forcing is mainly dominated by monsoonal and tidal currents.

4.1.2 Meteorology

4.1.2.1 Climate

The climate in Maldives is warm and humid, typical of the tropics. The average temperature ranges between 25°C to 30°C and relative humidity varies from 73 percent to 85 percent. The annual average rainfall is approximately 1,948mm. As Maldives lies on the equator, Maldives receives plenty of sunshine throughout the year. Significant variation is observed in the climate between the northern and the southern atolls. The annual average rainfall in the southern atolls is higher than the northern atolls. In addition, greater extremes of temperature are also recorded in the southern atolls. On average southern atolls receive 2704 hours of sunshine each year. Table 4.1 provides a summary of key meteorological findings for Maldives. The nearest meteorological station is National Meteorological Centre on Hullhule’ Island. This study uses National Metrological Centre due to more comprehensive data.
Table 4.1: Key Meteorological Information of the Maldives

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

4.1.2.2 Monsoons

The climate of Maldives is characterised by the monsoons of Indian Ocean. Monsoon wind reversal significantly affects weather patterns. Two monsoon seasons are observed in Maldives: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns. The southwest monsoon is the rainy season while the northeast monsoon is the dry season. The southwest monsoon occurs from May to September and the northeast monsoon is from December to February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.

4.1.2.3 Winds

The winds that occur across Maldives are mostly determined by the monsoon seasons. The two monsoons are considered mild given that Maldives is located close to the equator. As a result, strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to July. During stormy conditions gusts of up to 60 knots have been recorded at Male’.

Wind has been uniform in speed and direction over the past twenty-plus monsoon seasons in the Maldives (Naseer, 2003). Wind speed is usually higher in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms-1 for the period 1975 to 2001. Mean wind speed as highest during the months May and October in the central region. Wind analysis indicates that the monsoon is considerably stronger in central and northern region of Maldives compared to the south (Naseer, 2003).
Besides the annual monsoonal wind variations there are occasional tropical climatic disturbances (tropical storms or low intensity tropical cyclones) in the central region which increases wind speeds up to 110 km/h, precipitation to 30 to 40 cm over a 24 hour period and storm surges up to 3 m in open ocean (UNDP, 2006).

Table 4.2 summarises the wind conditions in central Maldives throughout a year. Medium term meteorological data from Hulhule meteorological centre (see Figure 4.2, Figure 4.3 and Figure 4.4) and findings from long-term Comprehensive Ocean-Atmosphere Data Set (COADS) are used in this analysis.

Table 4.2: Summary of General Wind Conditions from National Meteorological Centre

<table>
<thead>
<tr>
<th>Season</th>
<th>Month</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE - Monsoon</td>
<td>December</td>
<td>Predominantly from NW-NE.</td>
</tr>
<tr>
<td></td>
<td>January</td>
<td>High Speeds from W</td>
</tr>
<tr>
<td></td>
<td>February</td>
<td></td>
</tr>
<tr>
<td>Transition Period 1</td>
<td>March</td>
<td>From all directions. Mainly W.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Speeds from W.</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td></td>
</tr>
<tr>
<td>SW - Monsoon</td>
<td>May</td>
<td>Mainly from W.</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>High Speeds from W.</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td></td>
</tr>
<tr>
<td></td>
<td>August</td>
<td></td>
</tr>
<tr>
<td></td>
<td>September</td>
<td></td>
</tr>
<tr>
<td>Transition Period 2</td>
<td>October</td>
<td>Mainly from W.</td>
</tr>
<tr>
<td></td>
<td>November</td>
<td>High Speeds from W.</td>
</tr>
</tbody>
</table>
Figure 4.2 Monthly Frequencies of Wind Direction in Central Maldives based on National Meteorological Center 10 year Data (adapted from Naseer, 2003).

Figure 4.3 24 Year Wind Frequency Recorded at National Meteorological Center.
The Disaster Risk Profile of Maldives (UNDP, 2006) reports 11 cyclonic events over the Maldives in the last 128 years and only one event over the central Maldives. All of these events were of category 1 cyclones. There have been no cyclonic events since 1993.

Maafaru Island is located in a moderate to low risk cyclonic hazard zone which has the potential for a maximum probable cyclonic wind speed of 55.9 kts (UNDP, 2006).

The project site is expected to receive regular annual strong winds during the peak SW monsoon.

**4.1.2.4 Rainfall**

The average annual rainfall for the archipelago is 2,124 mm. There are regional variations in average annual rainfall: southern atolls receive approximately 2,280 mm, and northern atolls receive approximately 1,790 mm annually (MEC, 2004). Mean monthly rainfall also varies substantially throughout the year with the dry season getting considerably less rainfall. This pattern is less prominent in the southern half, however. The proportions of flood and drought years are relatively small throughout the archipelago, and the southern half is less prone to drought (UNDP, 2006).

The mean annual rainfall in Hulhule’ is 1991.5 mm with a Standard Deviation of 316.4 mm and the mean monthly rainfall is 191.6 mm. Rainfall varies throughout the year with mean highest rainfall during October, December and May and lowest between February and April (See Figure 4.5).
Analysis of daily maximum annual rainfall data shows high variability, including extremes (see Figure 4.6 below). However, no significant long term trends are evident in the Hulhule data.

Figure 4.6 Maximum daily rainfall by year in Hulhule’ (1975-2005) - (Source: Hay, 2006)
The probable maximum precipitations predicted for Hulhule’ by UNDP (2006) are shown in Table 4.3.

**Table 4.3 Probable Maximum Precipitation for various Return periods in Hulhule’**

<table>
<thead>
<tr>
<th>Station</th>
<th>Return Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50 year</td>
</tr>
<tr>
<td>Hulhule’</td>
<td>187.4</td>
</tr>
</tbody>
</table>

*Source (UNDP, 2006)*

### 4.1.2.5 Temperature

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

There is considerable inter annual variability in extreme temperatures for Hulhule as shown in Figure 4.7. A maximum temperature of at least 33.5°C is rare at Hulhule and has a return period of 20 yrs (Hay, 2006).

*Figure 4.7 Maximum Temperature by year in Hulhule’- 1975–2005 (Source: Hay, 2006)*
4.1.3 Hydrology

4.1.3.1 Waves

There are two major types of waves observed along the islands of Maldives. The first type is wave generated by local monsoon wind with a period of 3-8 seconds and the second type is swells generated by distance storms with a period of 14-20 seconds [Kench et. al (2006), DHI(1999), Binnie Black & Veatch (2000), Lanka Hydraulics (1988a & 1998b)]. The local monsoon predominantly generates wind waves which are typically strongest during April-July in the south-west monsoon period. Wave data for Male and Hulhulé’ between June 1988 and January 1990 (Lanka Hydraulics 1988a & 1998b) shows that the maximum significant wave height (Hs) recorded for June was 1.23 m with a mean period (Tm) of 7.53s. The maximum recorded Hs for July was 1.51 m with a Tm of 7.74s. The mean wave periods were 5.0 – 9.0s and the peak wave periods were within 8.0 – 13.0s.

Maldives experiences occasional flooding caused by long distance swell waves that are generated by South Indian Ocean storms (Goda 1988). The swell waves of height 3 meters that flooded Male’ and Hulhulé’ in 1987 are said to have originated from a low pressure system off west coast of Australia (refer the next section for more detail). In addition, Maldives have recently been subject to earthquake generated tsunami reaching heights of 4.0m on land (UNEP, 2005). Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than 1 occasion, most notable has been the 1883 tsunami resulting from the volcanic explosion of Karakatoa (Choi et al., 2003).

There are two major types of waves reaching Maafaru Island: long distance swells waves and monsoonal wind waves (see Figure 4.8). It is exposed to wind generated waves during both monsoons and during transition periods (see Figure 4.8). The local monsoonal wind waves generated during the SW monsoon affects the western side of the reef and the western shoreline. The wide fetch within the atoll allows moderately strong wave setup outside the western rim of the reef system. These waves are generally with a period of 2-5 seconds and sometime at 0.5 m within the atoll. It may reach heights of 0.2 to 0.3 m within the reef lagoon as well. The western side receives the strongest waves during the peak SW monsoon and during transition periods. The eastern side receives strong swell waves year round and wind waves during NE monsoon. The intensity of the SW monsoon wind waves are somewhat reduced on the eastern side.

In general, the shorelines of the proposed site is exposed to strong wave activity on the eastern side and moderate to low wave activity on the western side. Being located on the eastern rim of North Male’ Atoll, the reef system is exposed to SE and NE periodic swells. The eastern side also lies exposed to the Indian Ocean and is considered the oceanward side of the reef system.
4.1.3.2 Swell Waves and Storm Surges

The long distance swell waves approach mainly from a SE direction (See Figure 4.8) and is dominant throughout the year (Young, 1999). These waves come with a wave period of 14-20 seconds with a maximum height of 3.0 m in open ocean. The island’s western shoreline is protected from the SE swells.

Waves studies around Maldives have identified the presence of swell waves approaching predominantly from a southwest to a southerly direction Kench et. al (2006), Young (1999), DHI(1999), Binnie Black & Veatch (2000) and Naseer (2003). Being located on the eastern rim of Male’ Atoll, Maafaru Island Reef is protected from predominant swell waves from the SW as well as the abnormal swell waves originating from intense storms in the southern hemisphere between 73°E and 130°E longitude. Waves generated from abnormal events could travel against the predominant swell propagation patterns (Goda, 1998), causing flooding on the eastern and southern islands of Maldives (UNDP, 2009). Some of these waves may penetrate the reef passes on the western rim and reach the western side of Maafaru Reef, albeit with a reduced intensity due to the presence of islands within the atoll lagoon.

Wave activity may be strongest on the western side during the peak SW monsoon in May, October and November.
Figure 4.8 Estimated wave patterns around the proposed site

- **Wind waves approaching from the predominant wind direction:** partially reduced due to presence of western rim reefs and islands/reefs within atoll lagoon.

- **Very Strong NE monsoon wind waves:** periodic swells, project site exposed directly to Indian Ocean swells.

- **Strong SW monsoon wind waves:** partially protected due to presence of islands and reefs within the atoll.

- **Strong year-round SE long distance swell waves:** project site exposed directly to Indian Ocean swells.
EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

Figure 4.9: Observed current flow patterns on the reef during August
4.1.3.3 **Currents**

Currents that affect the reef system of Maafaru Reef can be caused by tidal currents, wind-induced currents and wave-induced currents. It is presumed that generally current flow through the country is defined by the two-monsoon season winds. Westward flowing currents are dominant from January to March with the change in current flow pattern taking place in April and December (Kench et. al, 2006). In April the westward currents become weak while the eastward currents start to take over. In December the eastward currents are weak with the westward currents becoming more prominent. Hence, currents within the site are very likely to be heavily influenced by the monsoons.

The estimated patterns in current flow during NE monsoon transition and SW monsoon are presented in Figure 4.9.

In-situ current assessment was undertaken on the project site during August, representing the SW monsoon conditions. Observations were undertaken using drogue method over 1-2 days, measuring only during flood tide. Measurements were undertaken as a grid to determine the various patterns off the reef, on reef flat and deep lagoon.

The current flow during August was generally easterly direction. Currents on the ends of the reef had speeds of over 0.3 m/s owing to the westerly winds.

The speed of flow on the reef flat slows down. Flow on the reef flat on average was less than 0.2 m/s.

4.1.3.4 **Tidal Pattern**

Water levels at the site vary mainly in response to tides, storm surge or tsunamis. Tides in the Maldives are mixed and semi-diurnal/diurnal. Tidal variations are referred to the standard station in at Hulhulé Island. Typical spring and neap tidal ranges are approximately 1.0m and 0.3m, respectively (MEC, 2004). Maximum spring tidal range in Hulhulé is approximately 1.1m. There is also a 0.2 m seasonal fluctuation in regional mean sea level, with an increase of about 0.1m during February to April and a decrease of 0.1m during September to November. Table 4.4 summarizes the tidal elevations reported at Hulhulé, which is representative of tidal conditions at the project site.
Table 4.4: Tidal Variations at Male’ International Airport (Source: MEC, 2004)

<table>
<thead>
<tr>
<th>Tide Level</th>
<th>Referred to Mean Sea level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Astronomical Tide (HAT)</td>
<td>+0.64</td>
</tr>
<tr>
<td>Mean Higher High Water (MHHW)</td>
<td>+0.34</td>
</tr>
<tr>
<td>Mean Lower High Water (MLHW)</td>
<td>+0.14</td>
</tr>
<tr>
<td>Mean Sea Level (MSL)</td>
<td>0.00</td>
</tr>
<tr>
<td>Mean Higher Low Water (MHLW)</td>
<td>-0.16</td>
</tr>
<tr>
<td>Mean Lower Low Water (MHLW)</td>
<td>-0.36</td>
</tr>
<tr>
<td>Lowest Astronomical Tide (LAT)</td>
<td>-0.56</td>
</tr>
</tbody>
</table>

The predicted tide curve for the period for the month of February and March at Hulhule Tide Gauge is presented in Figure 4.10 and 4.11 below.

Figure 4.10: Predicted tides for February 2012, based on data from Department of Meteorology, Maldives

Figure 4.11: Predicted tides for March 2012, based on data supplied from Department of Meteorology, Maldives
4.1.4 Beach

4.1.4.1 Beach erosion and coastal changes

Historical changes and long-term erosion

Analysis of historical changes to beach was undertaken using remote sensing technology by comparing aerial photographs from 1969 (see figure 4.12) against shoreline data from GPS surveys from 2008 and 2014.

The results show that the island has undergone shoreline changes in some sections of the island over the last 45 years. Comparison of data between 1969 and 2014 shows that, shoreline had shifted significantly on the northern end and the eastern side. Overall approximately 2.1 ha has eroded on the northern side and about 7.0 Ha has accreted on the NW and western side (excluding the reclaimed 0.9 Ha land around the jetty). Beach had retreated 150 m on the northern tip over the last 45 years. This material has been relocated to the NW side where the beach advanced a 144 m. The changes on the northern tip are typical of north-south oriented islands located on the eastern rim of the atoll. Similarly the shift of 150 m is in line with similar shifts observed in other islands of Noonu Atoll. However, the growth of 7 ha of new land is remarkable on an eastern rim island. Much of this material would have come from the western side lagoon and through erosion on the eastern shoreline. The presence of a deep opening on the NE corner of the reef may also have assisted in the significantly high sediment production rate of the reef, as observed in the growing reef flat width.

Beach retreat on the western side, immediately SE of the settlement is about 126 m over the last 45 years. A total of 3.4 ha have been eroded and evidence of recent severe erosion is present in the dead vegetation in the lagoon. About half of the eroded material is found immediately north of the site where a 1.4 Ha land has accreted. The remaining material could have moved northward and on to the western side. The significant retreat on the eastern side is also remarkable and only a few island islands on the eastern rim of northern Maldives have undergone such erosion on its eastern shoreline.

The rest of the island beach on the eastern side has remained fairly stable although a slow retreat of 6-7 m over the 45 years could be observed.

The western side shoreline in general has advanced at a very slow rate. However there have also been patches of erosion, the most notable of which is the area where shoreline was naturally breached for the lagoon to connect with the marshland.

This assessment shows the long-term trend based on two points in temporal scale, but it discounts the periodic shifts that may have occurred in between.
Comparison of data from the last 15 years shows the same trends as observed in the medium-term. Erosion on the eastern side, as discussed above, has accelerated over the last 12 years.

**Predicted short-term beach changes**

The volatility of the northern end of the island is likely to continue but at a slower rate for the next few years. The severe erosion on the eastern side is likely to continue the same speed until the shoreline forms a smooth line.

The proposed site is exposed to erosion on the eastern side, albeit at a slow pace. Coastal protection may be required at some stage.

**4.1.4.2 Beach Characteristics**

Beach characteristics could be usefully determined by two main features: i) beach composition; ii) beach profiles.

**Beach composition and sediment characteristics**

The beach material on the western side generally comprise of fine sand. The reclaimed area contains mixed rubble due to dredged material.

The south western side of the island generally comprise of coarse to very coarse material.

**Beach Profiles**

Beach profiles provide invaluable information about the sediment volume, beach slope and changes to volume and slope over time. In addition the slope, height and width are good indicators of wave and wind conditions, and erosion dominant areas. In general, gentler slopes and wider widths indicate an accreting area with generally lower wave energy and erosion at the time of the survey. Steeper slopes indicate stronger wave energy particularly if the beach material is composed of coarser material. Steeper slopes are also associated with severe erosion, in other areas.

Beach profiles for the island are presented in Appendix L.

**4.1.4.3 Seasonal Sediment Movement Pattern**

Much of the seasonal movement is restricted to the northern and southern end of the island, which is the general movement pattern in elongated, north-south oriented islands.
During the NE monsoon the sand pit on the northern end shift wester ward. The process starts during the NE transition period and reaches the maximum extent by the end of February. The process reverses in the SW monsoon with sand shifting east ward.

The western shoreline maintains a fairly constant beach width throughout the year, although the high tide line reaches higher level during the SW monsoon.

Similarly, the eastern shoreline only has minimal movement throughout the year, owing to the year round wave driven currents.

4.1.4.4 Pictorial description of Coastal Conditions

A pictorial summary of the coastal conditions on the eastern and western side of the island is provided in Figure 4.14 and 4.15.

Western side

The northern tip of the island contains a comparatively small sand pit which shifts seasonally (Figure 4.14, D).

The northern half of the western side is fairly stable for most parts of the year but lacks a beach (See Figure 4.15, C). The existing jetty area has been reclaimed from dredged sand but has no solid shore perpendicular structures to obstruct sediment flow (Figure 4.14, B)

Beach on the southern half is narrow with the high tide line reaching into the vegetation (Figure 4.14, F).

There is a naturally breached area on the beach which connects the lagoon and the marsh land (Figure 4.14, E)

The southern half of the western side is characterised by a seasonal beach with some pioneer vegetation (Figure 4.14, G).

Eastern side

The northern half of the western side does not have beach and the high tide line reaches the vegetation line. There is also persistent but slow erosion in the NE corner (Figure 4.15, A, B). The area immediately SE of the settlement is undergoing severe erosion (Figure 4.14, D). Eroded material are being deposited immediately north of the site (Figure 4.14, C).

The southern half of the eastern side contains a narrow and a comparatively steeper slope with coarse sand (Figure 4.14, B).
Figure 4.12: Historical photograph of Maafaru - 1969
EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

Figure 4.13: Historical changes to shoreline – 1969 and 2014

- **Erosion:**
  - Beach retreated 150 m in the last 45 years eroding 2.1 Ha and depositing them on the NW.

- **Accretion:**
  - Beach advanced 144 m in the last 45 years accreting 8.6 Ha on the western side.
  - Beach advanced 62 m accreting 1.4 Ha; vegetation in the area is still very young suggesting erosion is recent.
  - Vegetated area on average advanced 15 m mostly likely due to high deposition; evidence visible in vegetation.

- **Severe Erosion:**
  - Beach retreated 126 m eroding 3.4 Ha; erosion continues today.

- **Erosion/Accretion:**
  - Southern tip has been mobile eroding and accreting about 0.4 Ha.
  - There was an observed vegetation line retreat of about 5-8 m in the 45 yr period.
Figure 4.14: Pictorial summary of coastal conditions on the western side of Maafaru
Figure 4.15: Pictorial summary of coastal conditions on the eastern side of Maafaru
4.1.5 Marine water quality assessment

The primary objective of the lagoon water quality sampling was to determine the baseline conditions of the marine water in around the island. Water samples were collected from 4 different locations. All water quality tests were done at the MWSC laboratory.

Appendix G shows the test results of the marine water samples collected on August 2014.

The water quality around the site is generally of acceptable standards.

Water quality tests were done at the National Health Laboratory (NHL). Tests covered both biological and ambient conditions as shown in Table 4.5. The results indicate that sea water around Maafaru is reasonably pollution free. Water at all sampling locations are clear and have normal pH levels and trace amounts of nitrates and phosphates. Salinity levels are within the range 32.53-32.61 (o/oo) and therefore fit into the normal seawater levels. Additionally, BOD levels too, are well within the acceptable range.

Table 4.5 Marine water quality assessment results from MWSC laboratory

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Optimal Range (EPA)</th>
<th>SW1</th>
<th>SW2</th>
<th>SW3</th>
<th>SW4</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>8.0 – 8.3</td>
<td>8.13</td>
<td>8.17</td>
<td>8.06</td>
<td>8.18</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>18 - 32</td>
<td>22.0</td>
<td>21.9</td>
<td>21.5</td>
<td>22.4</td>
</tr>
<tr>
<td>Salinity (o/oo)</td>
<td></td>
<td>33.82</td>
<td>33.63</td>
<td>33.15</td>
<td>33.85</td>
</tr>
<tr>
<td>Nitrate (mg/L)</td>
<td>&lt;5</td>
<td>2.5</td>
<td>1.7</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Phosphate (mg/L)</td>
<td>0.005 – 0.020</td>
<td>&lt;0.05</td>
<td>0.06</td>
<td>0.06</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Total Petroleum Hydrocarbon</td>
<td>0.5</td>
<td>0.1</td>
<td>0.1</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Total Suspended Solids (mg/l)</td>
<td>-</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Biological Oxygen Demand (BOD)- (mg/l)</td>
<td>&lt;2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

4.1.6 Bathymetry

A detailed bathymetric survey of the island and its reef system was undertaken during April 2008 for the original EIA and during August 2014 along the proposed coastal work areas. Survey results have been summarised in bathy charts presented in Appendix H. The depth figures presented are in meters below MSL.
The reef flat areas on the east of the island have a fairly flat depth ranging from -1.0 to -1.3 m MSL. Areas west of the island gently slope into the deep lagoon. The beach line is closest to the reef line on the eastern side. Here, the impact of the sedimentation resulting from the periodical shifts in beach has been responsible for a shallower reef flat. Reef edges drop off from 2.0 to 7.0 m in most part of the reef system.

The most notable feature on the reef system is the deep lagoon at the centre reaching -6.0 m MSL. Depths within the deep lagoon range between -3.0 to -6.0 MSL. There also exists a natural reef entrance with a depth ranging from -3.0 to -5.0 m spanning 100 m wide.

The water depths within the existing main entrance channel are around -4.5 m MSL.

The proposed sites for reef entrance and harbour have average depths between -1.0 and -1.5 m MSL.

4.1.7 Topography

Maafaru is generally low lying island with an average elevation of +0.8 m MSL. Topographic variations were analysed for a sample transect towards the centre of the island (see figure 4.16 below). At this location, the overall elevation is fairly consistent throughout the island at about 0.7 m.

The coastal ridge on the eastern shoreline is the highest point in the transect, reaching 1.5 m MSL. This higher ridge is the result of strong wave activity on the oceanward side and wind activity during NE monsoon. The shoreline on the western side is also higher with an elevation of 1.0 m. The lower ridge height is most likely due to the absence of breaking waves in the region.

Visual surveys in the rest of the island showed that there are numerous depressions on the island, some with significant areas of wetland. The water table could generally be reached with close proximity during high tide. There are four distinct marsh areas on the island (See Appendix I): (i) Kandoofaa Kulhi; (ii) Vakabe Hasanu Fengandu; (iii) Chakagandu; (iv) Rashu kulhi and: (v) Kolhufushi Kulhi. Among these, Kandoofaa Kulhi and Vakabe Hasanu Fengandu has now joined and appears as a single marsh area. Both these marshes and Chakagandu falls within the footprint of the proposed backfill area.

These features will have major implications for the project.

- The proposed runway needs to be on flat land. However, due to significant variations in topography, backfilling will be required in the entire area to make it suitable for construction.
• The low elevation and depressions may lead to rainfall related flooding, especially if vegetation is cleared. Suitable drainage system will be required for the island if it is to be developed.

![Topographic Transect](image)

**Figure 4.16: Topographic transect of Maafaru just south of the boundary line**

4.1.8 Soil

The soil in Maafaru Island is relatively well established. Soil profiles were taken at two locations during the field visit to Maafaru under the original EIA. Geographical coordinates of the two locations were recorded using a differential GPS and the earth was dug to the depth of groundwater. These locations are presented in Appendix F. Figure 4.17 and 4.18 provide the details of the soil profiles.

The profile for site 2 represented the general soil profile of the island. There is a thick layer of humus or dark soil (0.3m) representative of the well-established vegetation system. This specific site had a layer of coral remnants. It is unclear whether that this is a natural occurrence or a result of past human activities. This layer was only presented in a few areas.

The profile for site 1 represented the general soil profile of the lower areas of the island. There is a layer of mud and wet layer of humus reaching up to 0.2 m. The ground water could be reached at 0.9 m at the lowest tide.
EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

Figure 4.17: Photographic Representation of Soil Profile One

Figure 4.18: Photographic Representation of Soil Profile Two
4.1.9 Ground Water

Appendix G shows the test results of the marine water samples collected on August 2014.

Groundwater assessment was conducted to assess the ambient conditions of groundwater. The water table stands approximately 0.8 to 1.1 m below ground level at MSL, but varied with changing tide.

As illustrated from Table 4.6, the investigations of groundwater revealed that the groundwater of Maafaru is fairly contaminated. The salinity of G1, G2 and G3 are 3.10 ppt, 34.19 ppt and 0.39 ppt respectively. The high salinity of G2 could be attributed to the fact it is located in a marshland. Additionally, since G1 is situated at an agricultural area, irrigation may have led to the rise in salinity of the groundwater.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Results</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G1</td>
<td>G2</td>
<td>G3</td>
</tr>
<tr>
<td>pH</td>
<td>7.27</td>
<td>8.32</td>
<td>7.62</td>
</tr>
<tr>
<td>Temperature</td>
<td>20.9</td>
<td>21.7</td>
<td>21.3</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>3.10</td>
<td>34.19</td>
<td>0.39</td>
</tr>
<tr>
<td>Phosphate (mg/l)</td>
<td>0.06</td>
<td>0.05</td>
<td>0.37</td>
</tr>
<tr>
<td>Nitrate (mg/l)</td>
<td>1.8</td>
<td>1.7</td>
<td>29.8</td>
</tr>
<tr>
<td>Biological Oxygen Demand (mg/l)</td>
<td>3</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Total Suspended Solids (mg/l)</td>
<td>29</td>
<td>6</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Coliform, Faecal</td>
<td>TNTC</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total Petroleum Hydrocarbon (TPH)</td>
<td>0.2</td>
<td>0.2</td>
<td>1.9</td>
</tr>
</tbody>
</table>

The total coliform content per 100ml for G1 is too numerous to count, while the values for G2 and G3 are 1 and 4 respectively. Since WHO standards for drinking water state that the total coliform content must be nil, the groundwater of Maafaru is not suitable for drinking. Additionally, BOD levels are also quite high with values ranging from 2-18 mg/l. BOD level is especially high in GW3, at 18mg/l owing to the fact that it is located in the settlement area. The high coliform and BOD levels in the groundwater can be accounted to the fact that there are no proper sewage systems in Maafaru.

For sewage disposal, the local community has been using pour-flush latrines connected to septic tanks that have the probability of seeping into groundwater thus contaminating it. Hence, even though groundwater will not be extracted for any of the proposed development activities, the
proposed development activities anticipate population growth in Maafaru. Therefore, it is strongly advised to establish a proper sewer system and find alternative sources of potable water such as desalinated water for cooking, washing and bathing purposes for the local community of Maafaru.

4.1.10 Land and marine resource use

Maafaru, as noted above, is an inhabited island. The airport has been planned for the non-inhabited zone of the island. The indicative land use patterns in Maafaru, prior to the designation of the proposed area for airport development, are presented in Figure 4.19 below.

The following land use activities were practised on the island prior to the development proposal.

- The existing settlement area is limited to a 21 ha area in the north. Settlement expansion rate is slow given the slow population growth.
• Areas adjacent to the settlement (approximately 42 Ha) have been generally considered as areas for future settlement expansion.
• The southern half of the island has generally been considered for varuvaa and is under the jurisdiction of the island office.
• In the uninhabited areas there are common property resources in which coconut trees have been allocated to individuals in the island. These individuals have the right to sell or use the produce from these trees and may charge others to do so. It is generally assigned on a caretaker verbal agreement by the island office.
• Agricultural activities were limited on the island, although new land appears to have been cleared for agriculture.
• The existing land use in the vast area south of the settlement could best be summed up as common property resources, where the inhabitants collect firewood, coconuts, wood and medicinal plants for personal use.
• Commercial use of the common property resources was observed in some households where thatching coconut leaves contributes a significant proportion of their livelihood.
• The uninhabited areas of Maafaru are also renowned for medicinal plants. It was reported that people from other islands travel to the island specifically to collect medicinal plants particularly, ‘Kandholhu’ and ‘Kandhu’.

4.1.11 Marine resource use

The following marine resource uses were identified through interviews with the locals.

• The western reef rim is regularly used for snorkelling by nearby resorts, particularly Irufushi resort and Spa.
• The atoll ward lagoon and the oceanward lagoon are commonly used for fishing activities. It is reported that fishing could usually be done on shore using lines, indicating the abundance of various reef fishes in the lagoon.
• The reef environment has been in the past used for extensive reef and bait fishing. Remnants of these activities can be found in the reef system with declining fish stock (as reported by fishermen) and anchor damage to reef.

4.1.12 Lagoon Environment

The reef of Maafaru is considerably large with a surface area of 1,233 Ha (12.3 km²). The reef is characterised by a deep lagoon approximately 214 ha large and -6 to -7 m deep. Apart from a natural reef entrance on the northeastern side, the depth of the reef flat is shallow averaging less than -1.5 m MSL. Figure 4.20 summarizes the different lagoon and reef bottom characteristics of the Maafaru Reef system.
The lagoon system comprises various zones of differing characteristics. On the eastern end is the oceanward reef slope. This area is characterised by a mix of live and dead corals. Average live coral cover in the area is estimated at 20%. The total surface area of the outer reef slope is 200 ha (see Table 4.7 below).

The oceanward reef flat zone is comprised mainly of sand and rubble. The wave breaker zone comprises of an algal ridge which is commonly found in such conditions. The total area of the eastern reef flat is 232 ha or 12% of the reef system. There is a natural reef entrance on the north-eastern end of the island along the reef flat.

The atoll ward (lagoonward) lagoon comprises mainly of an intermediate sand bottom zone, a shallow sand bottom zone and an intermediate sand and rubble bottom zone. Most of these areas have fairly consistent depth between 1.5 – 2.0 m MSL and have very low or no live coral cover.

The western end of the reef flat comprises of a live coral cover zone. Much of the lagoon bottom in this area is sand and rubble. The area beyond the live coral cover zone is the atoll ward reef slope. Here again there is a moderate level of live coral cover.

One of the most dominant features of the reef system is a thila or a submerged reef system on the southern end of the island. This area comprises of approximately 21% of the total reef system. Development activities on the island may affect this area, given that there is a constant flow from the lagoon system and on to the ‘thila’.

The other notable feature of the lagoon system is the extensive occurrence of seagrass beds, covering 225 ha or 18% of the reef system (See Figure 4.21).
Figure 4.20: Reef physiographic zones of the proposed site
Figure 4.21: Reef physiographic and ecological zones of the proposed site
4.2 Biological Environment

4.2.1 Terrestrial ecology

4.2.1.1 Flora

General characteristics

Maafaru is amongst the largest in Noonu Atoll and has a well-established vegetation system. A large proportion of the vegetation system (43%) is dominated by areas of medium to large trees or climax forests. About one third of the island consists of coconut dominated forests. The northern half of the island is generally older have more mature vegetation, while the southern half has a higher proportion of sublittoral bush vegetation.

Much of the island vegetation system, particularly on the northern half has been heavily modified. Numerous areas have been cleared, particularly the undergrowth, and new species have been introduced for agricultural and forestry purposes. The large patches of coconut dominated forests partially resemble palms planted for forestry. Coastal vegetation around the settlement areas have been largely cleared and replaced with larger trees. There are also areas where waste has been dumped into the coastal vegetation.

The island has numerous low lying areas, including coastal and inland marshes. These areas generally don’t have vegetation cover on them, in particular, areas with surface water. As noted in section 4.1.7, there are five distinct marsh areas on the island. Among these Kandoofaa Kulhi and peripheral areas of Vakabe Hasamu Fengandu contains some mangrove vegetation, while the rest of the marshes mainly contain Kuredhi trees.

The littoral vegetation is largely present on the southern half and the northern ends of the island. The northern half beach has been fairly mobile, which has resulting in young vegetation to grow in the newly accreted areas and the littoral vegetation to be removed through erosion on the eroding areas.

A number of invasive species were observed, including Ginaveli and Mirihi. Similarly some medicinal plants such as Kandholhu were observed in abundance.

A large area of dead coconut palms was observed on the island. The site corresponds to the existing marshland. This issue was reported in the media on 24th January 2013 (Moosa, 2013). According to the reports, 20,000 coconut palms were eroded. The locals noted that the event began around 2008 and is related to a natural opening on the western shoreline separating the marshland and the lagoon. The locals also claim that the natural opening was the result of hydrodynamic changes following the construction of a sand bed about 950 m north from the...
opening. It is beyond the scope of this EIA to evaluate the causes of this change. However, the newly created coastal marshland is now rich in life and could be considered a breeding ground for some marine species.

Some old trees were not observed on the island including Nika.

The following subsections discuss the findings in more detail. An inventory of plants observed during the field visits along the transects are presented in Table 4.10.

Vegetation Types

For the purposes of this assessment, the major groups of vegetation can be classed into the following categories of vegetation and land use. The main reason for this adoption is the specific nature of vegetation in small coral islands. Vegetation classification was undertaken using remote sensing and GIS software based on the methodology outlined at the start of this section. The results of the vegetation classification are presented is Appendix J.

1. Coconut Dominated Forest: There are about 6-7 patches of these areas covering about 37% of the island. About four of these patches partially fall within the footprint of this project. The top layer of the forest is dominated by Coconut trees (Cocos nucifera). The central layers comprise of Boa-kashikeyo (Pandanus tectorus), Midhili (Terminalia catappa), Funa (Calophyllum inophyllum), Dhun’buri (Ochrosia borbonica), Dhiggaa (Hibiscus tiliaeceus), Jack in the box (Kandhu) and less frequent occurrence Dhakandhaa (Premna obtusifolia) and Nika (Banyan tree).

2. Sub littoral Thicket: Covers about 20 Ha of the island. Dominated by Boa-kashikeyo (Pandanus tectorus), Magoo (Scaevola taccada), Uni (Guettarda speciosa), Dhiggaa (Hibiscus tiliaeceus), Midhili (Terminalia catappa), Kaani (Cordia subcordata), Ahi (Morinda Citrifolia), Dhakandhaa (Premna obtusifolia) and Hirundhu (Thespesia populnea). The bottom layer is dominated by Magoo (Scaevola taccada), Kuredhi (Pemphis Acidula) and Binhima gas (Desmodium triflorum).

3. Other forests: Dominated by Funa (Calophyllum inophyllum), Dhiggaa (Hibiscus tiliaeceus), Jack in the box (Kandhu), Kaani (Cordia subcordata) with sparsely distributed Coconut trees (Cocos nucifera), Magoo (Scaevola taccada), Nika (Banyan tree) and Dhakandhaa (Premna obtusifolia).

4. Littoral edge scrubland: Vegetation is mainly dominated by Magoo (Scaevola taccada) Boashi (Tournefortia argentea), Halaveli (Suriana maritima) and Kuredhi (Pemphis Acidula).
5. Coastal strand vegetation: A narrow stretch of strand vegetation dominated by Kuredhi (*Pemphis Acidula*).

6. Beach Pioneers and Halophytes: Pioneer vegetation, namely *Lupturus repens*, *Launaea pinnatifida* and *Thuarea involuta* was also observed.

7. Waste Land and Grassland: Dominated by Mirihi (*Cyperus conglomeratus*), *Lupturus repens* and *Thuarea involuta*.

8. Mangrove Vegetation: Dominated by Burevi (*Lumnitzera racemosa*).

The area and proportion of vegetation classes in relation to the overall island vegetation cover is presented in Table 4.7 below:

**Table 4.7: Area and percentage cover by vegetation class**

<table>
<thead>
<tr>
<th>Code</th>
<th>Vegetation group</th>
<th>Area (sq m)</th>
<th>% of Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDF</td>
<td>Coconut Dominated Forest</td>
<td>441,860.97</td>
<td>36.83</td>
</tr>
<tr>
<td>BA</td>
<td>Built-up Area</td>
<td>209,991.21</td>
<td>17.50</td>
</tr>
<tr>
<td>SLT</td>
<td>Sublittoral Thicket</td>
<td>205,236.71</td>
<td>17.10</td>
</tr>
<tr>
<td>LES</td>
<td>Littoral Edge Scrubland</td>
<td>139,653.51</td>
<td>11.64</td>
</tr>
<tr>
<td>OF</td>
<td>Other Forests</td>
<td>77,961.05</td>
<td>6.50</td>
</tr>
<tr>
<td>SM</td>
<td>Salt Marsh</td>
<td>38,863.59</td>
<td>3.24</td>
</tr>
<tr>
<td>WG</td>
<td>Wastelands or Grasslands</td>
<td>25,413.27</td>
<td>2.12</td>
</tr>
<tr>
<td>OA</td>
<td>Open Areas</td>
<td>23,165.89</td>
<td>1.93</td>
</tr>
<tr>
<td>CSV</td>
<td>Coastal Strand Vegetation</td>
<td>20,707.03</td>
<td>1.73</td>
</tr>
<tr>
<td>BPH</td>
<td>Beach Pioneers Halophytes</td>
<td>10,004.76</td>
<td>0.83</td>
</tr>
<tr>
<td>MV</td>
<td>Mangrove Vegetation</td>
<td>6,323.07</td>
<td>0.53</td>
</tr>
<tr>
<td>IM</td>
<td>Inland Marsh</td>
<td>683.83</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1,199,864.89</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Estimates of number of trees**

Based on the vegetation classification system and ground truthing data, the density of vegetation in each the classified zones were used to estimate the number of trees on the island. Due to the high uncertainties involved in this calculation, especially with regard to the smaller trees, a low, medium and high estimate was used. The findings from this assessment are summarized in the table below. It is estimated that there are about 150,000 – 300,000 trees on the island, excluding the built-up area, marshlands and grassland areas.
Table 4.8: Estimated number of trees by vegetation class

<table>
<thead>
<tr>
<th>Vegetation group</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut Dominated Forest</td>
<td>110,465.24</td>
<td>49,095.66</td>
<td>17,674.44</td>
</tr>
<tr>
<td>Sublittoral Thicket</td>
<td>91,216.31</td>
<td>51,309.18</td>
<td>22,804.08</td>
</tr>
<tr>
<td>Littoral Edge Scrubland</td>
<td>62,068.23</td>
<td>34,913.38</td>
<td>15,517.06</td>
</tr>
<tr>
<td>Other Forests</td>
<td>19,490.26</td>
<td>8,662.34</td>
<td>3,118.44</td>
</tr>
<tr>
<td>Coastal Strand Vegetation</td>
<td>9,203.13</td>
<td>5,176.76</td>
<td>2,300.78</td>
</tr>
<tr>
<td>Mangrove Vegetation</td>
<td>2,810.25</td>
<td>1,800.77</td>
<td>702.56</td>
</tr>
<tr>
<td>Total</td>
<td>295,253.42</td>
<td>150,738.08</td>
<td>62,117.36</td>
</tr>
</tbody>
</table>

These figures have been derived using a combination of remote sensing technology, field observations and consultations with the inhabitants. It uses a density analyses method where a low, medium and high area (in sq m) for a given tree type is calculated and divided against the vegetation classes. The density is derived from actual sampling during field assessment. Caution is raised here that no tree count figures can be exact due to high density of vegetation cover in Maafaru. What is provided in this report is the best guess estimate and should not be used for legal or compensation purposes.

Vegetation removal

The area required for vegetation removal was overlaid with the existing land use classification map (See Appendix J) to derive the following map (see Figure 4.35). Based on this information and those described above, amount of vegetation to be removed is estimated in Table 4.9. Two type of removal is expected. First the runway area is expected to be completely cleared. Secondly, the general public area is only expected to be partially cleared and vegetation is required for aesthetic purposes. Only the building foot prints and necessary vegetation will be removed in the latter.

It is anticipated that about roughly 15000-20000 medium to large trees, mainly coconut trees, and other woody species will be removed for airport construction. In addition, 20,000-25,000 bush trees and about 1000-1500 mangrove bushes may have to be removed.
Table 4.9: Estimated number of trees to be removed by vegetation class

<table>
<thead>
<tr>
<th>Code</th>
<th>Vegetation group</th>
<th>Area (sq m)</th>
<th>% of Island vegetation cover</th>
<th>% of Island vegetation removed from each class</th>
<th>Estimated number of trees removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDF</td>
<td>Coconut Dominated Forest</td>
<td>139,481.44</td>
<td>14.7%</td>
<td>32%</td>
<td>15,497.94</td>
</tr>
<tr>
<td>OF</td>
<td>Other Forests</td>
<td>19,783.16</td>
<td>2.1%</td>
<td>25%</td>
<td>2,198.13</td>
</tr>
<tr>
<td>LES</td>
<td>Littoral Edge Scrubland</td>
<td>27,108.38</td>
<td>2.9%</td>
<td>19%</td>
<td>6,777.09</td>
</tr>
<tr>
<td>WG</td>
<td>Wastelands or Grasslands</td>
<td>11,708.85</td>
<td>1.2%</td>
<td>46%</td>
<td></td>
</tr>
<tr>
<td>SLT</td>
<td>Sublittoral Thicket</td>
<td>59,747.54</td>
<td>6.3%</td>
<td>29%</td>
<td>14,936.89</td>
</tr>
<tr>
<td>MV</td>
<td>Mangrove Vegetation</td>
<td>6,323.07</td>
<td>0.7%</td>
<td>85%</td>
<td>1,500.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>264,152.43</strong></td>
<td><strong>27.8%</strong></td>
<td></td>
<td><strong>40,990.81</strong></td>
</tr>
</tbody>
</table>

4.2.1.2 Fauna

Birds

Although terrestrial faunal diversity is generally poor in the islands of Maldives, several bird species were heard while taking the line transect (for the vegetation survey) in the area of the proposed development in Maafaru. According to the locals, birds commonly found in the area for the proposed development were Kaalhu (Crow/Corvus splendens), Kulhee Kukulhu (Watercock/Gallicrex cinerea), Dhivehi Koveli (Asian Koel/Eudynamys scolopacea scolopacea), Din-din Koveli, Kulhee Kanbili (Common Moorhen/Gallinula chloropus), Dhivehi Kanbili (Maldivian Water Hen/Amaurornis phoenicurus maldivus), Maakanaa (Grey Heron/Ardea cinerea), Raabondhi (Black-crowned Night Heron/Nycticorax nycticorax), Bodu Raabondhi (Western Reef Egret/Egretta gularis), Reyru and Fenfoahdhooni (Yellow Wagtail/Motacilla flava). Furthermore, during the transitional period from Hulhangu to Iruvai season, the migratory birds seen, particularly in the ‘Vakabe Hassanu Fengadu’ area are Iruvaahudhu (Cattle Egret/Bubulus ibis), Kalhu Bulhi Thunbi (Glossy Ibis/Plegadis falcinellus), Bondana Ilohi (Curlew Sandpiper/Calidris ferruginea), Rathafai (Ruddy Turnstone/Arenaria interpres), Alaka (Grey Plover/Pluvialis squatarola), Reyru (Northern Shoveler/Anas clypeata), Kunburu Reyru (Garganey/Anas querquedula) and Rathu Reyru (Ferruginous Pochard/Aythya nyroca). Except from Kaalhu (Crow/Corvus splendens), all other bird species are protected species under the EPP Act 1993.

Birds that were reported by locals are listed in Table 4.11 Below.
Reptiles and Mammals

A number of mud or mangrove crabs and several crab holes were seen in the marshy and mangrove area. Mangrove crabs are a vital part of mangrove ecology and flow of water through their holes influence nutrient cycling. It is also believed that the holes of the mud/mangrove crabs absorb power of destructive waves such as tsunamis as many islands in the north of Maldives consisting of Mangrove ecosystems and numerous mud/mangrove crabs including Noonu Kendhikulhudhoo and Shaviyani Fonadhoo had minimal impact from the tsunami that occurred on 26th December 2004. However, Noonu Maafaru was badly hit during that event.

Records of reptiles and mammals are minimal. Two species were identified: namely one gecko (*Hemidactylus frenatus*) and the Common garden lizard (*Calotes versicolor*). Amongst pests, rats were observed in moderate numbers on the island. List of fauna observed and reported on the island is listed in Table 4.11.
Figure 4.22: Vegetation classes in the removal footprint

Legend

<table>
<thead>
<tr>
<th>Vegetation Class</th>
<th>Area (sq m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut Dominated Forest</td>
<td>139481.44</td>
</tr>
<tr>
<td>Inland Marsh</td>
<td>683.83</td>
</tr>
<tr>
<td>Littoral Edge Scrubland</td>
<td>27108.38</td>
</tr>
<tr>
<td>Mangrove Vegetation</td>
<td>6323.07</td>
</tr>
<tr>
<td>Other Forests</td>
<td>19783.16</td>
</tr>
<tr>
<td>Salt Marsh</td>
<td>30009.73</td>
</tr>
<tr>
<td>Sublittoral Thicket</td>
<td>59747.54</td>
</tr>
<tr>
<td>Wastelands or Grasslands</td>
<td>11708.85</td>
</tr>
</tbody>
</table>

Maafaru Island, Noonu Atoll
Proposed Airport Development
Vegetation Removal Footprint

Prepared by: CDE Consultancy
### Table 4.10: Vegetation inventory of Maafaru Island

<table>
<thead>
<tr>
<th>Category</th>
<th>Family</th>
<th>Scientific</th>
<th>English</th>
<th>Dhivehi</th>
<th>Distribution (ACFOR)</th>
<th>Additional Info</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trees</strong></td>
<td>Arecaceae</td>
<td><em>Cocos nucifera</em></td>
<td>Coconut palm</td>
<td>Dhivehi ruh</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combretaceae</td>
<td><em>Terminalia catappa</em></td>
<td>Country almond</td>
<td>Midhili</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malvaceae</td>
<td><em>Hibiscus tilaeus</em></td>
<td>Sea hibiscus</td>
<td>Dhiggaa</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pandanaceae</td>
<td><em>Pandanus tectorus</em></td>
<td>Screw pine</td>
<td>Boa kashikeyo</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rubiaceae</td>
<td><em>Guettarda speciosa</em></td>
<td>Nit pitcha</td>
<td>Uni</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malvaceae</td>
<td><em>Thespisia populnea</em></td>
<td>Tulip tree</td>
<td>Hirun’dhu</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ehretiaceae</td>
<td><em>Cordia subcordata</em></td>
<td>Sea trumpet</td>
<td>Kaani/Kauni</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gutierrezaceae</td>
<td><em>Calophyllum inophyllum</em></td>
<td>Alexander Laurelwood tree</td>
<td>Funa</td>
<td>O</td>
<td>Mainly occurs in small groves</td>
</tr>
<tr>
<td></td>
<td>Apocynaceae</td>
<td><em>Ochrosia borbonica</em></td>
<td>Corkwood</td>
<td>Dhun'buri</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pandanaceae</td>
<td><em>Pandanus odoratissimus</em></td>
<td>Panadanus</td>
<td>Maakashikeyo</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moraceae</td>
<td><em>Ficus benghalensis</em></td>
<td>Banyan tree</td>
<td>Nika/Kiri</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verbenaceae</td>
<td><em>Premna obtusifolia</em></td>
<td>Tulip tree</td>
<td>Dhakan'dhaa</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liliaceae</td>
<td><em>Similax china</em></td>
<td>China root</td>
<td>Ethumadhu</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rubiaceae</td>
<td><em>Morinda citrifolia</em></td>
<td>Cheese fruit</td>
<td>Ahi</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Simaroubaceae</td>
<td><em>Suriana maritima</em></td>
<td>Tassel plant</td>
<td>Halaveli</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hernandiaceae</td>
<td><em>Hernandia peltata</em></td>
<td>Jack in the box</td>
<td>Mas kan’dhu</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rubiaceae</td>
<td><em>Morinda Citrifolia</em></td>
<td>Cheese fruit</td>
<td>Ahi</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rhizophoraceae</td>
<td><em>Lumnitzera racemosa</em></td>
<td>Mangrove</td>
<td>Burevi</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td>Goodeniaceae</td>
<td><em>Scaevola taccada</em></td>
<td>Sea Lettuce</td>
<td>Magoo</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lythraceae</td>
<td><em>Pemphis acidula</em></td>
<td>Iron wood</td>
<td>Kuredhi/Keredhi</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fabaceae/Papilionaceae</td>
<td><em>Desmodium triflorum</em></td>
<td>Binhima gas</td>
<td>O</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cucurbitaceae</td>
<td><em>Benincasa hispida</em></td>
<td>Was gourd</td>
<td>Fufoo</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boraginaceae</td>
<td><em>Tournefortia argentea</em></td>
<td>Boashi</td>
<td>O</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 4.11: Fauna inventory of Maafaru Island proposed airport site

<table>
<thead>
<tr>
<th>Class</th>
<th>Order</th>
<th>Family</th>
<th>Species</th>
<th>DIVEHI NAME (Male’ / Addu)</th>
<th>ENGLISH NAME</th>
<th>Observed/Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birds</strong></td>
<td>Ciconiiformes</td>
<td>Ardeidae</td>
<td>Casmerodius albus</td>
<td>Iruvaahudhu</td>
<td>Great White Egret</td>
<td>Reported</td>
</tr>
<tr>
<td></td>
<td>Passeriformes</td>
<td>Corvidae</td>
<td>Corvus splendens</td>
<td>Kaalhu</td>
<td>Maldivian House Crow</td>
<td>Observed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(maledivicus)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sternae</td>
<td>Sterna summatrana</td>
<td>Kiru Dhooni</td>
<td>Black-naped Tern</td>
<td>Observed</td>
</tr>
<tr>
<td></td>
<td>Phaethontiformes</td>
<td>Phaethontidae</td>
<td>Phaethon lepturus</td>
<td>Dhandifulhu Dhooni</td>
<td>White-Tailed Tropic bird</td>
<td>Reported</td>
</tr>
<tr>
<td></td>
<td>Guiformes</td>
<td>Rallidae</td>
<td>Gallicrex cinerea</td>
<td>Kulhee Kukulhu</td>
<td>Watercock</td>
<td>Reported</td>
</tr>
<tr>
<td></td>
<td>Cuculiformes</td>
<td>Cuculidae</td>
<td>Eudynamys scolopacea scolopacea</td>
<td>Dhivehi Koveli</td>
<td>Asian Koel</td>
<td>Reported</td>
</tr>
</tbody>
</table>

1**NOTE: ACFOR scale: A: Abundant; C: Common; F: Frequent; O: Occasional; R: Rare**
### EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

<table>
<thead>
<tr>
<th>Class</th>
<th>Order</th>
<th>Family</th>
<th>Species</th>
<th>DIVEHI NAME (Male’ / Addu)</th>
<th>ENGLISH NAME</th>
<th>Observed/Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gruiformes</td>
<td>Rallidae</td>
<td>Gallinula chloropus</td>
<td>Kulhee Kanbili</td>
<td>Common Moorhen</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Gruiformes</td>
<td>Rallidae</td>
<td>Amaurornis phoenicus maldivus</td>
<td>Dhivehi Kanbili</td>
<td>Maldivian Water Hen</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Pelecaniformes</td>
<td>Ardeidae</td>
<td>Ardea cinerea</td>
<td>Maakanaa</td>
<td>Grey Heron</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Pelecaniformes</td>
<td>Ardeidae</td>
<td>Nycticorax nycticorax</td>
<td>Raabondhi</td>
<td>Black-crowned Night Heron</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Pelecaniformes</td>
<td>Ardeidae</td>
<td>Egretta gularis</td>
<td>Bodu Raabondhi</td>
<td>Western Reef Egret</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Anseriformes</td>
<td>Anatidae</td>
<td>Anas clypeata</td>
<td>Reyru</td>
<td>Northern Shoveler</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Anseriformes</td>
<td>Anatidae</td>
<td>Anas querquedula</td>
<td>Kumburu Reyru</td>
<td>Garganey</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Anseriformes</td>
<td>Anatidae</td>
<td>Aythya nyroca</td>
<td>Rathu Reyru</td>
<td>Ferruginous Pochard</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Charadriiformes</td>
<td>Scolopacida</td>
<td>Calidris ferruginea</td>
<td>Bondana Iloolhi</td>
<td>Curlew Sandpiper</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Charadriiformes</td>
<td>Scolopacida</td>
<td>Pluvialis squatarola</td>
<td>Alaka</td>
<td>Grey Plover</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Anseriformes</td>
<td>Anatidae</td>
<td>Aythya nyroca</td>
<td>Rathu Reyru</td>
<td>Ferruginous Pochard</td>
<td>Reported</td>
<td></td>
</tr>
<tr>
<td>Mammals</td>
<td>CHIROPTERA</td>
<td>Pteropus hypomelanus maris</td>
<td>Vaa / Vaula</td>
<td>Variable Flying Fox,</td>
<td>Observed</td>
<td></td>
</tr>
<tr>
<td>RODENTIA</td>
<td>Muridae</td>
<td>Rattus sp</td>
<td>Meedhaa / Meedhala</td>
<td>Rat</td>
<td>Observed</td>
<td></td>
</tr>
<tr>
<td>Reptiles</td>
<td>Squamata</td>
<td>Agamidae</td>
<td>Calotes versicolor</td>
<td>Bondu / Bondah</td>
<td>Common garden lizard</td>
<td>Observed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gekkonidae</td>
<td>Hemidactylus frenatus (TBC)</td>
<td>Hoana / Hoana</td>
<td>Gecko</td>
<td>Observed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cheloniidae</td>
<td>C. mydas</td>
<td>Velaa</td>
<td>Green Turtle</td>
<td>Observed</td>
</tr>
<tr>
<td>Crustaceans</td>
<td>Decapoda</td>
<td>Ocypodidae</td>
<td>Ocypode ceratophthalmus</td>
<td>Kiru kakuni</td>
<td>Ghost crab</td>
<td>Observed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ocypodidae</td>
<td>Uca sp.</td>
<td>Fiddler crab</td>
<td>Observed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parapagurida</td>
<td></td>
<td>Hermit crab</td>
<td>Observed</td>
<td></td>
</tr>
</tbody>
</table>
4.2.2  Marine Environment

The aim of this assessment is to establish the baseline condition at the proposed project location. Assessments were carried out on 29th August 2014. The weather during the survey was sunny with calm sea conditions. The main objectives of the assessments were:

- to determine the general status of the reef associated with the island
- to assess the condition of the marine environment which will be directly impacted by the project
- to determine the fish species abundance and composition of the reef system.

4.2.2.1  Fish and invertebrates species assemblages, abundance and benthic composition

Transect 1

Transect 1 was laid at 5 m depth, along the reef edge. Visibility at the site was good, extending about 5 m. The highest benthic substrate at this site is dead rock (98% of the survey area). Live coral cover was very low, making less than 2% of the area.

![Benthic substrate composition along transect 1](image)

*Figure 4.23: Benthic substrate composition along transect 1*
A total of 20 fish species belonging to 7 different fish families were recorded along transect 1. The highest number of species from families Labridae (7 species) and Chaetodontidae (4 species). The highest number of individuals were recorded from *Pomacentrus indicus* (Indian Damsel).

**Table 4.12: Fishes recorded along transect 1**

<table>
<thead>
<tr>
<th>Species</th>
<th>Record abundance per size Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 - 10 cm</td>
</tr>
<tr>
<td><em>Cephalopholis argus</em></td>
<td></td>
</tr>
<tr>
<td><em>Parupeneus macronema</em></td>
<td></td>
</tr>
<tr>
<td><em>Chaetodon lunula</em></td>
<td></td>
</tr>
<tr>
<td><em>Chaetodon kleinii</em></td>
<td></td>
</tr>
<tr>
<td><em>Chaetodon auriga</em></td>
<td></td>
</tr>
<tr>
<td><em>Chaetodon collare</em></td>
<td></td>
</tr>
<tr>
<td><em>Pomacentrus indicus</em></td>
<td></td>
</tr>
<tr>
<td><em>Pomacentrus chrysurus</em></td>
<td></td>
</tr>
<tr>
<td><em>Abudefduf vaigiensis</em></td>
<td></td>
</tr>
<tr>
<td><em>Halichoeres hortulanus</em></td>
<td></td>
</tr>
<tr>
<td><em>Labroides dimidiatus</em></td>
<td></td>
</tr>
<tr>
<td><em>Gomphosus caeruleus</em></td>
<td></td>
</tr>
<tr>
<td><em>Thalassoma amblycephalum</em></td>
<td></td>
</tr>
<tr>
<td><em>Thalassoma janseni</em></td>
<td></td>
</tr>
<tr>
<td><em>Cheilinus trilobatus</em></td>
<td></td>
</tr>
<tr>
<td><em>Stethojulis strigiventer</em></td>
<td></td>
</tr>
<tr>
<td><em>Acanthurus lineatus</em></td>
<td></td>
</tr>
<tr>
<td><em>Ctenochaetus striatus</em></td>
<td></td>
</tr>
<tr>
<td><em>Melichthys indicus</em></td>
<td></td>
</tr>
<tr>
<td><em>Rhinocenthus rectangulus</em></td>
<td></td>
</tr>
</tbody>
</table>
Transect 2

Transect 2 was laid along the reef edge, at 4 m depth. Visibility at the site was good, extending about 5 m. Live coral cover was low at this site, making up less than 10% of the survey area. Main coral species observed belong to Porites (massive). Dead rock was the main benthic substrate, making up 90% of the survey area.

![Figure 4.25: Benthic substrate composition at transect 2](image)

A total of 36 fish species belonging to 13 fish families were recorded along transect 2. The highest number of fish species were recorded from families Labridae (10 species) and Pomacentridae (4 species). Highest number of individuals were recorded from *Thalassoma amblycephalum* (Two-tone Wrasse).
### Table 4.13: Fishes and invertebrates recorded along transect 2

<table>
<thead>
<tr>
<th>Species</th>
<th>Record abundance per size Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 - 10 cm</td>
</tr>
<tr>
<td>Sargocentron caudimaculatum</td>
<td>2</td>
</tr>
<tr>
<td>Cephalopholis argus</td>
<td>2</td>
</tr>
<tr>
<td>Parupeneus macronema</td>
<td>2</td>
</tr>
<tr>
<td>Kyphosus cinerascens</td>
<td>2</td>
</tr>
<tr>
<td>Chaetodon trisfasciatus</td>
<td>2</td>
</tr>
<tr>
<td>Chaetodon auriga</td>
<td>2</td>
</tr>
<tr>
<td>Chaetodon collare</td>
<td>2</td>
</tr>
<tr>
<td>Centropyge multispinis</td>
<td>2</td>
</tr>
<tr>
<td>Pomacentrus nagasakensis</td>
<td>3</td>
</tr>
<tr>
<td>Pomacentrus indicus</td>
<td>2</td>
</tr>
<tr>
<td>Pomacentrus philippinus</td>
<td>2</td>
</tr>
<tr>
<td>Pomacentrus chrysurus</td>
<td>2</td>
</tr>
<tr>
<td>Halichoeres hortulanus</td>
<td>2</td>
</tr>
<tr>
<td>Labroides dimidiatus</td>
<td>2</td>
</tr>
<tr>
<td>Labroides bicolor</td>
<td>2</td>
</tr>
<tr>
<td>Gomphosus caeruleus</td>
<td>2</td>
</tr>
<tr>
<td>Thalassoma amblycepalum</td>
<td>5</td>
</tr>
<tr>
<td>Thalassoma lunare</td>
<td>2</td>
</tr>
<tr>
<td>Cheilinus trilobatus</td>
<td>2</td>
</tr>
<tr>
<td>Hemigymnus fasciatus</td>
<td>2</td>
</tr>
<tr>
<td>Coris frerei</td>
<td></td>
</tr>
<tr>
<td>Hemigymnus melapterus</td>
<td>1</td>
</tr>
<tr>
<td>Scarus strongylocephalus</td>
<td>1</td>
</tr>
<tr>
<td>Scarus sordidus</td>
<td>3</td>
</tr>
<tr>
<td>Colotomus carolinus</td>
<td>2</td>
</tr>
<tr>
<td>Zanclus cornutus</td>
<td>2</td>
</tr>
<tr>
<td>Acanthurus leucosternin</td>
<td>2</td>
</tr>
<tr>
<td>Acanthurus nigricauda</td>
<td>5</td>
</tr>
<tr>
<td>Ctenochaetus striatus</td>
<td>4</td>
</tr>
<tr>
<td>Zebrasoma desjardini</td>
<td>2</td>
</tr>
<tr>
<td>Naso lituratus</td>
<td>2</td>
</tr>
<tr>
<td>Balistapus undulatus</td>
<td>2</td>
</tr>
<tr>
<td>Melichthys indicus</td>
<td>2</td>
</tr>
<tr>
<td>Cantherhinus pardalis</td>
<td>1</td>
</tr>
<tr>
<td>Pearsonothuria graeffei</td>
<td>2</td>
</tr>
<tr>
<td>Culcita schmedeliana</td>
<td>2</td>
</tr>
<tr>
<td>Tridacna maxima</td>
<td>2</td>
</tr>
</tbody>
</table>
Transect 3

Transect 3 was laid at 4 m depth, along the reef edge. The visibility at this site was very good, extending 10 m. Live coral cover along this transect line was high, making up about 36% of the survey area. The main coral species observed belong to Porites (Massive). Dead rock made up about 49% of the survey area.

A total of 26 fish species belonging to 12 different fish families were recorded along transect 3. Highest number of species and individuals were recorded from the family Pomacentridae (5 species).

Figure 4.27: Benthic substrate composition along transect 3

Figure 4.28: Select photos along transect 3
Table 4.14: Fish and invertebrate recorded along transect 3

<table>
<thead>
<tr>
<th>Species</th>
<th>Record abundance per size Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 - 10 cm</td>
</tr>
<tr>
<td>Sargocentron caudimaculatum</td>
<td>2</td>
</tr>
<tr>
<td>Sargocentron spiniferum</td>
<td></td>
</tr>
<tr>
<td>Cephalopholis argus</td>
<td>2</td>
</tr>
<tr>
<td>Aethaloperca rogaa</td>
<td>2</td>
</tr>
<tr>
<td>Plectorhinchus vittatus</td>
<td>2</td>
</tr>
<tr>
<td>Plectorhinchus gibbosus</td>
<td></td>
</tr>
<tr>
<td>Plectorhinchus obscurus</td>
<td></td>
</tr>
<tr>
<td>Monotaxis grandoculis</td>
<td>2</td>
</tr>
<tr>
<td>Lutjanus bohar</td>
<td>2</td>
</tr>
<tr>
<td>Chaetodon auriga</td>
<td>2</td>
</tr>
<tr>
<td>Chaetodon collare</td>
<td>2</td>
</tr>
<tr>
<td>Forcipiger flavissimus</td>
<td>2</td>
</tr>
<tr>
<td>Centropyge multispinis</td>
<td></td>
</tr>
<tr>
<td>Pomacentrus nagasakensis</td>
<td>3</td>
</tr>
<tr>
<td>Pomacentrus indicus</td>
<td>3</td>
</tr>
<tr>
<td>Pomacentrus philippinus</td>
<td>2</td>
</tr>
<tr>
<td>Abudefduf vaigiensis</td>
<td></td>
</tr>
<tr>
<td>Pomacentrus pavo</td>
<td>3</td>
</tr>
<tr>
<td>Labroides dimidiatus</td>
<td>2</td>
</tr>
<tr>
<td>Scarus strongylocephalus</td>
<td></td>
</tr>
<tr>
<td>Scarus sordidus</td>
<td>2</td>
</tr>
<tr>
<td>Scarus ghobban</td>
<td>1</td>
</tr>
<tr>
<td>Acanthurus leucosternini</td>
<td>2</td>
</tr>
<tr>
<td>Ctenochaetus striatus</td>
<td>3</td>
</tr>
<tr>
<td>Naso brevirostris</td>
<td></td>
</tr>
<tr>
<td>Canthigaster valentini</td>
<td>2</td>
</tr>
<tr>
<td>Tridacna maxima</td>
<td></td>
</tr>
</tbody>
</table>

4.2.2.2 Timed Swims

Site A

The beach at this site is covered in a thick layer of wrack (seagrass debris). The lagoon appears in a dirty green colour, due to the large seagrass bed that forms the lagoon bottom.
Section of the lagoon has been modified, to create an 80 - 100 m long sand bed that extends from the beach towards the lagoon. Sand has been sourced from the adjacent area by excavating an area 15 - 20 m width, to a depth of 3 m. This seabed obstructs the flow of longshore current in this area. As a result seagrass debris was observed accumulated in large quantities, slowly decomposing in the lagoon, giving off a distinct pungent odour.

The lagoon is generally shallow, 0.5 - 1.5 m depth, except the dredged areas which has a depth of 3 m. The dominant seagrass species at this area observed were *Thalassia hemprichii* and *Cymodocea serrulata*. In addition clumps of *Halimeda sp* and *Valonia fastigata* were observed among the seagrass bed.
One species of sea cucumber (Black sea cucumber - *Actinopyga miliaris*) was observed in the lagoon during the survey. In addition, a Hawksbill Turtle (*Eretmochelys imbricata*) and a few Green Turtles (*Chelonia mydas*) were observed sheltering in the seagrass bed at this lagoon. The seagrass bed provides turtles a good source of nourishment and shelter.

The main fishes observed at this site were juvenile Wrasses and Triggerfishes. In addition, few juvenile Blacktip Reef Sharks (*Carcharhinus melanopterus*) were observed near the shore, foraging for food.

**Site B**

The beaches along the ocean ward of the island are sandy white. Unlike the atoll wards lagoon, no seagrass was observed at this site. The lagoon was shallow, ranging between 0.5 - 1 m. This area is mainly made up of sand and coral rubble.
Massive corals (*Porites*, *Goniopora* and *Favites* species) and Blue Coral (*Heliopora coerulea*) colonies were observed scattered across the lagoon. The top of massive corals were cut off, this could be due to the shallow depth and strong wave action at this site. Main fishes observed at this site were Surgeonfishes and Wrasses.

Further out, from the wave break point the reef flat extends about 50 - 100 m, with a gentle slope. The depth varied 8 - 9 m, coral life observed was low, mainly juvenile massive coral species. One species of sea cucumber (*Pearsonothuria graffei*) was observed among the rocky bottom along the reef flat. The dominant fish species observed at this site was Red-toothed Triggerfishes (*Odonus niger*)
Site C

This site was similar to Site A, the lagoon bottom near shore was made up a large seagrass bed (dominated by *Thalassia hemprichii* and *Cymodocea serrulata* species). Main fish species observed at this lagoon bottom were also juvenile Wrasses and Triggerfishes. Green Turtles were also observed at this site.

![Figure 4.34: Lagoon bottom at site C](image)

Live corals observed was low, within the lagoon. However further away from the lagoon near the reefs edge large Porites colonies (massive form) were observed. Live coral was higher closer to the reef edge and larger fishes were observed at this area.

### 4.2.3 Marine protected areas and sensitive sites

There are no sensitive or protected environments within a 10 km radius of the site (see Figure 2.2).

### 4.2.4 Breeding or nursery grounds for protected or endangered species

All coral reef areas have the potential to be used as breeding/nurseries for reef fishes. No literature is available to indicate that reef system of Maafaru is used as breeding/nursery for fishes, crustaceans, marine mammals, sharks or turtles. Further studies are required to determine the specificity of the sites.

The inland marsh areas of *Vakabe Hasanu Fengandu* and to some extent, *Kandoofaa Kulhi* has been identified as a frequenting site for the young of some marine species. This was a recent occurrence (since 2008, according to locals) created due to the unusual natural opening between the marshland and the lagoon. A number of young marine life including, sharks, rays and unidentifiable species of fish was observed during the field visit. This site may well be breeding
ground but the time available for this EIA was not sufficient to declare this site as a breeding
ground.

Maafaru lagoon is also well known as feeding site for a large number of turtles. It is also a well-
known turtle breeding island. Three nests were observed during the field visit (See Appendix J).

4.3 Hazard Vulnerability of the Site

According to the UNDP Disaster Risk Assessment Report of Maldives in 2006, proposed
extension of Maafaru is located in an area exposed to tsunamis wind storms, storm surges and
swell waves. It does not identify the island as being exposed to heavy rainfall flooding. The
Indian Ocean tsunami of 2004 devastated parts of the settlement and affected the livelihood of
the inhabitants. Maafaru was identified as one of the most affected islands in Noonu Atoll.

Historical records also state that Maafaru was severely affected in 1955 when a storm devastated
parts of the island and flooded up to 300 m from the oceanward coastline. This event is known to
have affected almost all the islands in Thiladhunmathi Atoll.

The following parameters can be deduced for the Male’ Region based on Disaster Assessment

**Tsunami:** Maximum probable wave height range 0.8-2.50

**Cyclone or storm (wind):** Probable maximum wind speed 84.2 knots (category 2 cyclone).

**Storm surge:** predicted storm surge height – 0.45; predicted storm tide height 1.38.

**Rainfall:** probable maximum daily rainfall for Hanimaadhoo for a 500 year return period 175.6
mm

Based on these parameters, field surveys and planned design parameters of the island, the
methodology for risk assessment identified in the Detailed Island Risk Assessment Reports
(UNDP, 2009) and findings from Ali (2005) was used to assess the hazard risks on the site.
However, the results should be treated with caution as this is a preliminary risk assessment. A
more comprehensive assessment will require a longer time frame and a lot of data, which is
beyond the scope of this EIA.

In general, due to the proposed high elevation of the island and its relative location within the
atoll, the proposed island may be relatively safe from most predicted high intensity hazard events
in Maldives. The table below summarises the key findings from the assessment.
Table 4.15: Predicted disaster risks in Maafaru

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Swell Waves/storm surges</td>
<td>1.4 m</td>
<td>&lt; 1.2 m</td>
<td>&gt; 1.2 m</td>
</tr>
<tr>
<td>(wave heights on reef flat – Average Island ridge height +1.6 m above reef flat)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tsunami</td>
<td>2.5 m</td>
<td>&lt;1.5m</td>
<td>&gt; 1.5 m</td>
</tr>
<tr>
<td>(wave heights on reef flat)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW monsoon high seas</td>
<td>0.5m</td>
<td>&lt;1.2m</td>
<td>&gt; 1.2 m</td>
</tr>
<tr>
<td>(For a 24 hour period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy Rainfall</td>
<td>175mm</td>
<td>&lt;60mm</td>
<td>&gt; 60mm</td>
</tr>
<tr>
<td>(For a 24 hour period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind storm</td>
<td>84.2 knots</td>
<td>&lt;30 knots</td>
<td>&gt; 30 knots</td>
</tr>
<tr>
<td>(MMI value)</td>
<td>I</td>
<td>&lt; IV</td>
<td>&gt; IV</td>
</tr>
</tbody>
</table>

Prepared by: CDE Consultancy
4.4 Socio-Economic Setting

4.4.1 Noonu Atoll Socio-economic setting

4.4.1.1 Demography

The most recent Census conducted in 2014, recorded 11,243 distributed across thirteen administrative islands of Noonu atoll. In Census 2006 the population of Noonu atoll was 10,080 (MPND 2006). This shows a population increase of 10% in eight years. However the registered population for Noonu atoll according to the Population Report for the first quarter of 2014 indicates a population of 15,896 people (Atoll Office). There are 5 major population centers in the atoll; Velidhoo, Holhudhoo, Manadhoo the Capital Island, Henbadhoo and Kendhikulhudhoo. Together they account for more than 55% of the atoll population (See table below). Magoodhoo and Fodhdhoo have populations below 500 in each island and another five inhabited islands (Maalhendhoo, Kudafari, Landhoo, Maafaru, Lhohi and Miladhoo) have populations below 900. The small size of population is often an indicator of poor economic progress in these islands. Maafaru is the only administrative island in Noonu atoll with declining growth rates. There has been an 18% decline in population since Census 2000. The average growth rate between Census 2006 and Census 2014 for Maafaru shows a negative growth rate of -1.92.

Table 4.16: Population of Noonu Atoll

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Henbadhoo</td>
<td>710</td>
<td>5%</td>
<td>1463</td>
<td>396</td>
<td>417</td>
<td>2.34</td>
</tr>
<tr>
<td>Kendhikulhudhoo</td>
<td>1756</td>
<td>11%</td>
<td>1331</td>
<td>1209</td>
<td>1114</td>
<td>0.84</td>
</tr>
<tr>
<td>Maalhendhoo</td>
<td>859</td>
<td>5%</td>
<td>667</td>
<td>561</td>
<td>567</td>
<td>1.44</td>
</tr>
<tr>
<td>Kudafari</td>
<td>789</td>
<td>5%</td>
<td>480</td>
<td>381</td>
<td>394</td>
<td>1.92</td>
</tr>
<tr>
<td>Landhoo</td>
<td>1013</td>
<td>6%</td>
<td>668</td>
<td>582</td>
<td>653</td>
<td>1.39</td>
</tr>
<tr>
<td>Maafaru</td>
<td>1127</td>
<td>7%</td>
<td>616</td>
<td>716</td>
<td>758</td>
<td>-1.92</td>
</tr>
<tr>
<td>Lhohi</td>
<td>869</td>
<td>5%</td>
<td>611</td>
<td>557</td>
<td>525</td>
<td>0.32</td>
</tr>
<tr>
<td>Miladhoo</td>
<td>1430</td>
<td>9%</td>
<td>809</td>
<td>817</td>
<td>808</td>
<td>0.09</td>
</tr>
<tr>
<td>Magoodhoo</td>
<td>398</td>
<td>2%</td>
<td>258</td>
<td>209</td>
<td>242</td>
<td>2.34</td>
</tr>
<tr>
<td>Manadhoo</td>
<td>1839</td>
<td>12%</td>
<td>1408</td>
<td>1221</td>
<td>1238</td>
<td>1.00</td>
</tr>
<tr>
<td>Holhudhoo</td>
<td>2146</td>
<td>14%</td>
<td>1682</td>
<td>1526</td>
<td>1559</td>
<td>0.22</td>
</tr>
<tr>
<td>Fodhdhoo</td>
<td>456</td>
<td>2%</td>
<td>228</td>
<td>200</td>
<td>275</td>
<td>0.85</td>
</tr>
<tr>
<td>Velidhoo</td>
<td>2508</td>
<td>16%</td>
<td>1987</td>
<td>1705</td>
<td>1864</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Source: Department of National Planning
Maafaru has the second largest land area and the lowest population density amongst the administrative islands of Noonu atoll.

**Table 4.17: Land area and population density of Noonu Atoll**

<table>
<thead>
<tr>
<th>Locality</th>
<th>Land Area 2008 (hectares)</th>
<th>Local Population Census 2006</th>
<th>Population Density per hectare</th>
<th>Distance to Male' (kilometres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fodhdhoo</td>
<td>26.7</td>
<td>200</td>
<td>7</td>
<td>177.4</td>
</tr>
<tr>
<td>Hebadhoo</td>
<td>14.0</td>
<td>396</td>
<td>28</td>
<td>201.5</td>
</tr>
<tr>
<td>Holhudhoo</td>
<td>19.9</td>
<td>1,527</td>
<td>77</td>
<td>177.9</td>
</tr>
<tr>
<td>Kedhikolhudhoo</td>
<td>207.7</td>
<td>1,204</td>
<td>6</td>
<td>197.6</td>
</tr>
<tr>
<td>Kudafari</td>
<td>28.8</td>
<td>373</td>
<td>13</td>
<td>190.0</td>
</tr>
<tr>
<td>Landhoo</td>
<td>86.8</td>
<td>582</td>
<td>7</td>
<td>189.6</td>
</tr>
<tr>
<td>Lhohi</td>
<td>40.4</td>
<td>552</td>
<td>14</td>
<td>182.9</td>
</tr>
<tr>
<td><strong>Maafaru</strong></td>
<td><strong>130.5</strong></td>
<td><strong>710</strong></td>
<td><strong>5</strong></td>
<td><strong>184.3</strong></td>
</tr>
<tr>
<td>Maalhendhoo</td>
<td>48.4</td>
<td>561</td>
<td>12</td>
<td>192.2</td>
</tr>
<tr>
<td>Magoodhoo</td>
<td>37.2</td>
<td>209</td>
<td>6</td>
<td>178.7</td>
</tr>
<tr>
<td>Manadhoo</td>
<td>106.7</td>
<td>1,201</td>
<td>11</td>
<td>177.0</td>
</tr>
<tr>
<td>Miladhoo</td>
<td>22.0</td>
<td>784</td>
<td>36</td>
<td>180.2</td>
</tr>
<tr>
<td>Velidhoo</td>
<td>43.5</td>
<td>1,716</td>
<td>39</td>
<td>168.2</td>
</tr>
</tbody>
</table>

Source: Department of National Planning

The majority of the population of Noonu atoll is above 18 years of age, which is 69% of the total population of Noonu atoll. Maafaru has 4% of its population as elderly and 61% of the population in children and school going age in 2006 (MPND 2006). This signifies a larger youth population in Maafaru at present, opening up more opportunities for employment. The male to female ration in the island is second lowest in Maafaru with 75 males per 100 females.
Table 4.18: Sex ratio and working age population of Noonu atoll

<table>
<thead>
<tr>
<th>Island Name</th>
<th>Sex Ratio (males per females) 2006</th>
<th>Children &amp; School age</th>
<th>Working Age Old</th>
<th>Elderly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henbadhoo</td>
<td>68</td>
<td>60%</td>
<td>38%</td>
<td>2%</td>
</tr>
<tr>
<td>Kendhikolhudhoo</td>
<td>88</td>
<td>58%</td>
<td>37%</td>
<td>5%</td>
</tr>
<tr>
<td>Maalhendhoo</td>
<td>98</td>
<td>54%</td>
<td>41%</td>
<td>5%</td>
</tr>
<tr>
<td>Kudafari</td>
<td>80</td>
<td>56%</td>
<td>38%</td>
<td>6%</td>
</tr>
<tr>
<td>Landhoo</td>
<td>80</td>
<td>57%</td>
<td>39%</td>
<td>4%</td>
</tr>
<tr>
<td>Maafaru</td>
<td>75</td>
<td>61%</td>
<td>35%</td>
<td>4%</td>
</tr>
<tr>
<td>Lhohi</td>
<td>97</td>
<td>59%</td>
<td>38%</td>
<td>3%</td>
</tr>
<tr>
<td>Miladhoo</td>
<td>75</td>
<td>57%</td>
<td>37%</td>
<td>6%</td>
</tr>
<tr>
<td>Magoodhoo</td>
<td>79</td>
<td>55%</td>
<td>38%</td>
<td>6%</td>
</tr>
<tr>
<td>Manadhoo</td>
<td>89</td>
<td>58%</td>
<td>37%</td>
<td>5%</td>
</tr>
<tr>
<td>Holhudhoo</td>
<td>80</td>
<td>60%</td>
<td>35%</td>
<td>5%</td>
</tr>
<tr>
<td>Fodhdhoo</td>
<td>82</td>
<td>47%</td>
<td>49%</td>
<td>4%</td>
</tr>
<tr>
<td>Velidhoo</td>
<td>92</td>
<td>57%</td>
<td>40%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Source: Department of National Planning

Historically Noonu atoll comprised of more administrative islands within the atoll but migration due to erosion and other factors have shifted populations and administration according to the thirteen islands today. Trends from the past reveal that:

- Noonu atoll Burehifasdhoo and Maavelaavaru were historically populated islands.
- People from N. Raafushi moved to N. Velidhoo.
- People in N. Ekulhivaru moved to R. Kothaifaru and then to N. Kuredhivaru.
- People from N. Kuredhivaru were first moved first to N. Bomasdhoo on 27 June 1943 and then to Sh. Farukolhufunadhoo on 26 September 1970 due to severe erosion of the island.
- N. Tholhendhoo people were moved to N. Kendhikolhudhoo on 30 December 1992.

4.4.1.2 Governance

Traditionally each atoll had a capital island for governing the atoll, most significantly based on the population size. The atoll capital used to be governed by an atoll chief appointed by the President. And each island had an island chief and deputy chief appointed by the President. Under the new Constitution of the Maldives (2008), Decentralization Act was ratified, which gave powers for elected councilors to represent the island governance. Under the new Act, the first elected councilors took oath in 2009. Today the island governance is managed by elected councilors with minimum 5 councilors in each island and an atoll council residing in the capital island.
In Noonu atoll, Manadhoo is the capital island. The atoll capital changed on 1 November 1959 from Manadhoo to Holhudhoo and back to Manadhoo again on 20 December 1960.

4.4.1.3 Health

The Atoll Hospital is located in Manadhoo, the atoll capital. The nearest Regional Hospital is in Raa Atoll Ugoofaaru. Smaller islands have health posts or health centers generally and hence have to travel to nearby islands for medical treatment. Better health care is generally available in Manadhoo, Velidhoo and Holhudhoo in comparison to other islands of the atoll.

Although Maldives has low prevalence of HIV and other sexually transmitted infections, HIV/AIDS remains a major risk. By June 2012, a total of 17 HIV positive cases had been reported among Maldivians and 303 cases among the expatriate migrant labour force have been reported (UNDP 2012). To date, unprotected heterosexual sex is the main mode of transmission. The high level of drug use including injecting drug use and unsafe sexual practices make Maldives highly vulnerable to HIV epidemic.

4.4.1.4 Occupational health and safety

There is a growing problem of occupation related accidents and injuries leading to death and disabilities in the Maldives. Due to lack of legal requirements for reporting and record keeping of work related injuries and diseases; no information is available with regard to the incidence.

There are some specific occupations that expose people to injuries and illnesses in the Maldives. Divers are exposed to the risk of nitrogen narcosis and barotraumas resulting from descent or ascent and decompression sickness due to arterial embolism. Fishermen are exposed to extreme weathers, accidents on board, ultraviolet radiation, glares from the sea surface and psychosocial problems. Fish processing workers are exposed to ergonomic hazards resulting from repetitive movements, skin allergies to fish proteins and rubber gloves and frostbite. Fiberglass boat building is an expanding chemical based activity. Unprotected workers in confined spaces are exposed to toxic chemicals like acetone, methyl ethyl ketone peroxide, styrene etc. Long-term exposure to these chemicals can result in severe damage to nervous system, liver and kidneys. Some of these are possible carcinogens.

4.4.1.5 Education

School enrolments are generally high in Noonu atoll. There is a government school in every island. Except for Magoodhoo and Fodhdhoo, education up to year 10 lower secondary level is available in all the other inhabited islands. Manadhoo, Holhudhoo and Kendhikulhudhoo provide education up to year 12 higher secondary levels. Magoodhoo and Fodhdhoo have total 36 and
27 students studying respectively in their school. Hence conventional method of education delivery and to get enough enrolments to sustain secondary education might be a challenge. In 2013 there were 144 males and 109 females completing year 10 secondary schooling in Noonu atoll. High youth school leavers are a positive step for youth internship, training and employment opportunities within the atoll. The atoll council identifies Holhudhoo and Kendhikulhudhoo as the islands best for education in Noonu atoll.

4.4.1.6 Housing

There are 1811 households and 1802 living quarters in all administrative islands of Noonu atoll with an average household size of 6 persons per household. Housing conditions are generally good throughout the atoll (MPND, 2006). However, better housing conditions prevail in Velidhoo, Holhudhoo and Manadhoo, while below average housing conditions could be observed in lowly populated islands. Multi-story housing is almost negligible in the islands.

Maafaru has 137 households, which are also the number of living quarters on the island. Hence each family in the island has a separate living quarter at the time on Census in 2006 (MPND 2006).

Table 4.19: Housing conditions of Noonu Atoll

<table>
<thead>
<tr>
<th>Locality</th>
<th>Total households</th>
<th>Living quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative Islands</td>
<td>1,811</td>
<td>1,802</td>
</tr>
<tr>
<td>Hebadhoo</td>
<td>79</td>
<td>79</td>
</tr>
<tr>
<td>Kedhikolhudhoo</td>
<td>204</td>
<td>204</td>
</tr>
<tr>
<td>Maalhendhoo</td>
<td>109</td>
<td>108</td>
</tr>
<tr>
<td>Kudafari</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>Landhoo</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td><strong>Maafaru</strong></td>
<td><strong>137</strong></td>
<td><strong>137</strong></td>
</tr>
<tr>
<td>Lhohi</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>Miladhoo</td>
<td>143</td>
<td>139</td>
</tr>
<tr>
<td>Magoodhoo</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>Manadhoo</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Holhudhoo</td>
<td>264</td>
<td>264</td>
</tr>
<tr>
<td>Fodhdhoo</td>
<td>50</td>
<td>49</td>
</tr>
<tr>
<td>Velidhoo</td>
<td>305</td>
<td>302</td>
</tr>
</tbody>
</table>

Source: Department of National Planning
4.4.1.7 Physical or cultural heritage

Maafaru is not identified as a historically significant island in Noonu atoll. Hukuru miskiy used to be the oldest recognized structure in the island, which was constructed between 1750 and 1757. The mosque has been demolished in the recent past for construction of a new mosque in the area. Maafaru also has a heap of gravel, which has not been investigated according to Maldives Centre for Historical and Linguistic research. This heap is however not a recognized landmark in the island and it is not in located in the allocated land for airport development.

Landhoo is one of the most historically significant islands in Noonu atoll. Landhoo has ruins of a Buddhist monastery with remains seen to date, known as ‘Redhinge Maabadhige’. A mound called ‘Usgandu’ and another mound called Redhinge gaafuni’ is to observed on the island. Miladhoo is the second historically important island in the atoll. There is a presence of a historical monastery in the island. The significance of Miladhoo is such that the atoll Miladhunmadulu is named after Miladhoo. On Lhohi, on the southern shore of the island exists a ruin called ‘Hanguraama faszadu’. Present day Velaa resort, ‘Velaavaru’ has ruins of what appears to be a mosque with a well.

4.4.1.8 Safety

Data for the past six years from 2008 to 2013 indicate theft and drugs with related crimes as the most serious offences nationwide. Theft and Drugs offences have increased by 40% over the past five years. Other offences also indicate towards on the rise. The table below shows the offences from 2008 to 2013 recorded by Maldives Police Service.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Theft</td>
<td>6683</td>
<td>6571</td>
<td>4734</td>
<td>4001</td>
<td>4007</td>
<td>3917</td>
</tr>
<tr>
<td>Drugs</td>
<td>3970</td>
<td>2534</td>
<td>1824</td>
<td>1617</td>
<td>2258</td>
<td>2427</td>
</tr>
<tr>
<td>Lost items</td>
<td>1983</td>
<td>1508</td>
<td>1479</td>
<td>1713</td>
<td>2139</td>
<td>1520</td>
</tr>
<tr>
<td>Traffic accidents</td>
<td>1940</td>
<td>1990</td>
<td>2257</td>
<td>2448</td>
<td>2610</td>
<td>3105</td>
</tr>
<tr>
<td>Assault</td>
<td>1394</td>
<td>1414</td>
<td>1418</td>
<td>1637</td>
<td>1998</td>
<td>1612</td>
</tr>
<tr>
<td>Robbery</td>
<td>729</td>
<td>972</td>
<td>718</td>
<td>547</td>
<td>591</td>
<td>598</td>
</tr>
<tr>
<td>Vandalism</td>
<td>728</td>
<td>880</td>
<td>775</td>
<td>849</td>
<td>902</td>
<td>648</td>
</tr>
<tr>
<td>Sexual offences</td>
<td>573</td>
<td>577</td>
<td>642</td>
<td>523</td>
<td>564</td>
<td>469</td>
</tr>
<tr>
<td>Embezzlement</td>
<td>391</td>
<td>311</td>
<td>364</td>
<td>406</td>
<td>391</td>
<td>328</td>
</tr>
<tr>
<td>Cheque bounce</td>
<td>289</td>
<td>308</td>
<td>303</td>
<td>469</td>
<td>601</td>
<td>282</td>
</tr>
<tr>
<td>Domestic violence</td>
<td>207</td>
<td>179</td>
<td>146</td>
<td>84</td>
<td>110</td>
<td>114</td>
</tr>
<tr>
<td>Counterfeit and forgery</td>
<td>97</td>
<td>126</td>
<td>136</td>
<td>167</td>
<td>133</td>
<td>99</td>
</tr>
</tbody>
</table>

Source: Maldives Police Service
The table below summarizes the types of cases filed for Noonu atoll in the year 2012. (MPND, Statistical Yearbook 2013). In Maafaru, there were 35 civil cases and 19 family cases recorded. Criminal cases for adults above 18 years of age were 8 and children below 18 years of age were 2 cases reported in the year 2012.

Table 4.21: Cases filed for Noonu atoll in 2012

<table>
<thead>
<tr>
<th>Island</th>
<th>Criminal cases above 18</th>
<th>Criminal cases below 18</th>
<th>Civil cases</th>
<th>Family cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henbadhoo</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>Kendhikulhudhoo</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Kulhudhoo Avashu</td>
<td>4</td>
<td>0</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Maalhendhoo</td>
<td>7</td>
<td>0</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Kudafari</td>
<td>6</td>
<td>0</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Landhoo</td>
<td>4</td>
<td>1</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td><strong>Maafaru</strong></td>
<td><strong>8</strong></td>
<td><strong>2</strong></td>
<td><strong>35</strong></td>
<td><strong>19</strong></td>
</tr>
<tr>
<td>Lohi</td>
<td>9</td>
<td>0</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Miladhoo</td>
<td>12</td>
<td>0</td>
<td>29</td>
<td>25</td>
</tr>
<tr>
<td>Magoodhoo</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>4</td>
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<tr>
<td>Manadhoo</td>
<td>9</td>
<td>1</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>Holhudhoo</td>
<td>8</td>
<td>0</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>Fohhohdho</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Velidhoo</td>
<td>17</td>
<td>0</td>
<td>82</td>
<td>59</td>
</tr>
</tbody>
</table>

Source: MPND, Statistical Yearbook 2013

### 4.4.1.9 Economy

#### Economic activities and industries

In the past, the main economic activities in Noonu Atoll had been fishing. Over the past few years, new activities such as employment in tourism sector and tourism related work has increased. Boat building has become dominant in islands like Velidhoo. According to Census 2006 employment data, majority of the population was employed in manufacturing, tourism, public service and construction sector (see table below). Resort development in Noonu Atoll since 2007 has resulted 4 operational resorts by 2014. Approximately 1000 jobs have been created in Noonu atoll from the operational resorts. The economies of most islands have been undergoing gradual restructuring with the decline of fishing industry and more people being employed in the tourism sector and the manufacturing sector with employment in resorts and safari boat building.
There were no tourist resorts in Noonu atoll prior to 2007. But at present, Noonu atoll has some of the most prestigious hotel brands recognized internationally and locally. Cheval Blanc Randheli island (Lui Vuitton), Irufushi island, Velaa Private Island and Zitali located in Noonu atoll are some of the top luxury brands of resorts in the Maldives. Randheli Island Lui Vuitton is currently recognized as the most luxurious resort in the Maldives. There are further 7 resorts in the pipeline for future development. They include Ekulhivaru, Huivani, Kuredhivaru, Huvandhumaa vattaru, Raafushi and Dhigurah Island.

In the past, there were a considerable proportion of people employed in other atolls such as Lhaviyani, Baa, Kaafu atolls and in safari boats. It is seen that with opportunities for employment in resorts within the atoll, people return to their islands and prefer to serve from closer to family with more frequent opportunities for travel to their home islands and spend time with family.

Velidhoo Island has undergone major restructuring from a predominantly fishing island to a manufacturing and tourism based economy. A fair proportion of its registered working age
population live outside the island, employed in resorts and in Safari vessels. Velidhoo also has a thriving boat building industry specialized in Safari Boat building. There are about 10 tourist Safari Boats that belong to Velidhoo island. Guesthouse tourism is an emerging economic activity in Velidhoo. There are 4 guesthouses operational in the island. Furthermore, there are 5 fishing vessels, 2 specialized for yellow fin tuna (kanneli) fishery. Velidhoo has also been rigged with social issues such as drug abuse and anti-social behavior.

Holludhoo island also has a fair number of working population employed in resorts and in resort construction. The island of Manadhoo being the atoll capital is on the other hand more an administrative island with the largest proportion of population employed in the public sector. However, there are a number of young people who complete education and cannot get in to public sector jobs, and aspire for training opportunities and employment in the resorts.

Miladhoo and Magoodhoo have small populations. Magoodhoo is predominantly fishery island. They also engage in agriculture work. Miladhoo has its working population in resort employment, construction work and in yellow fin tuna fishery.

Employment

Total employed persons in the Maldives in 2006 were 110,231 (MDNP Census 2006). Employment by sector shows, in 2006, the highest number of persons was employed in manufacturing (19,259), followed by public administration and defense (15,949) and hotels and restaurants (12,090). The changes in the labour force by sector show that the number of persons active in fishing fell from 11,498 in 1990 to 8,388 in 2006. On the other hand, number of persons active in agriculture increased from 2,619 in 1990 to 4,236 in 2006. Local employment in fisheries sector peaked in 1995 with 12,555 persons. However, fisheries sector provided employment to 19 percent of employed males in the atolls and was second only to tourism in 2006. Additionally, tourism, which accounted for the highest sectorial contribution to GDP, constitutes for 12% of employment and government is the single largest employer.
The total employed persons in Noonu atoll in 2006 were 3440 persons (MDNP Census 2006). Sectorial employment share composition shows, the largest proportion of employed persons were in the manufacturing sector (37%) followed by wholesale and retail trade (8%) and construction (7%). Transport, storage and communication composited 3% of the employed persons in Noonu atoll.
Share of employment by sector in the administrative islands of Noonu atoll shows, the total employed persons in Maafaru is 245. The largest proportion of employed persons is engaged in manufacturing activities resulting mainly from fisheries activities, which is also the second largest employed sector of Maafaru. Education is the third largest sector of employment in Maafaru. Transport, storage and communication in Maafaru is low with only 8 employed persons employed in the sector.

Table 4.23: Employment shares by sector for all administrative islands of Noonu atoll

<table>
<thead>
<tr>
<th>Island</th>
<th>Total employed</th>
<th>Agriculture and forestry</th>
<th>Fishing</th>
<th>Quarrying</th>
<th>Manufacturing</th>
<th>Electricity, gas and water</th>
<th>Construction</th>
<th>Wholesale and retail trade</th>
<th>Hotels and restaurants</th>
<th>Transport, storage and communication</th>
<th>Financial intermediation</th>
<th>Real estate, renting and leasing</th>
<th>Public administration and defense</th>
<th>Education</th>
<th>Health and social work</th>
<th>Public administration and defense</th>
<th>Other community, social and personal services activities</th>
<th>Extra-territorial organizations and bodies</th>
<th>Not stated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henbadhoo</td>
<td>146</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>73</td>
<td>1</td>
<td>9</td>
<td>12</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>11</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Kendhikulhudhoo</td>
<td>481</td>
<td>23</td>
<td>54</td>
<td>0</td>
<td>168</td>
<td>3</td>
<td>22</td>
<td>41</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>21</td>
<td>45</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>64</td>
</tr>
<tr>
<td>Maalhendho o</td>
<td>184</td>
<td>1</td>
<td>23</td>
<td>0</td>
<td>86</td>
<td>2</td>
<td>8</td>
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<td>4</td>
<td>4</td>
<td>0</td>
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<tr>
<td>Kudafari</td>
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<td>1</td>
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<td>9</td>
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<td>9</td>
<td>21</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Landhoo</td>
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<td>38</td>
<td>1</td>
<td>123</td>
<td>2</td>
<td>7</td>
<td>18</td>
<td>0</td>
<td>9</td>
<td>0</td>
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<td>7</td>
<td>6</td>
<td>0</td>
<td>10</td>
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<tr>
<td>Maafaru</td>
<td>245</td>
<td>0</td>
<td>26</td>
<td>2</td>
<td>131</td>
<td>2</td>
<td>14</td>
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<td>8</td>
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<td>0</td>
<td>11</td>
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<td>1</td>
<td>5</td>
<td>0</td>
<td>17</td>
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</tr>
<tr>
<td>Lhohi</td>
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<td>8</td>
<td>0</td>
<td>70</td>
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<td>16</td>
<td>10</td>
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<td>5</td>
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<td>14</td>
<td>3</td>
<td>3</td>
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</tr>
<tr>
<td>Miladhoo</td>
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<td>7</td>
<td>0</td>
<td>62</td>
<td>0</td>
<td>9</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>0</td>
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<td>13</td>
<td>21</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Magoodhoo</td>
<td>96</td>
<td>7</td>
<td>24</td>
<td>0</td>
<td>22</td>
<td>1</td>
<td>3</td>
<td>14</td>
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<td>0</td>
<td>0</td>
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<td>7</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Manadhoo</td>
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<td>2</td>
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<td>1</td>
<td>130</td>
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<td>73</td>
<td>43</td>
<td>3</td>
<td>8</td>
<td>0</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Holhudhoo</td>
<td>515</td>
<td>33</td>
<td>23</td>
<td>7</td>
<td>127</td>
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<td>30</td>
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<td>35</td>
</tr>
<tr>
<td>Fohdhdhoo</td>
<td>96</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>37</td>
<td>1</td>
<td>12</td>
<td>7</td>
<td>0</td>
<td>5</td>
<td>0</td>
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<td>0</td>
<td>6</td>
<td>0</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Velidhoo</td>
<td>537</td>
<td>21</td>
<td>22</td>
<td>4</td>
<td>207</td>
<td>1</td>
<td>2</td>
<td>50</td>
<td>61</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td>49</td>
<td>1</td>
<td>8</td>
<td>18</td>
<td>0</td>
<td>29</td>
</tr>
</tbody>
</table>

Source: Census 2006 (Department of National Planning)

4.4.1.10 Poverty aspects

The Maldives has already achieved the Millennium Development Goal (MDG) to reduce income poverty. The MDG target 1 is to reduce by half the proportion of population below US$1 Purchasing Power Parity (PPP) per day. In 1997, the proportion of population whose income was less than US$1 PPP (MVR 4.34) a day was 3 percent.20 By 2004, the proportion of population below this poverty line was reduced to 1 percent of the population.
The majority of households now share the higher national income. The average monthly household income has increased from MVR9,603 in 2003 to MVR16,736 in 2010. The average household income has grown at a rate of 8.26 percent per annum. Median monthly household income has doubled from MVR5,235 in 2003 to MVR10,679 by 2010. The median is about MVR6,000 less than the average income.

There are significant differences in household income levels between Male’ and Atolls. In 2010, the average household monthly income for Male’ was MVR28,909 compared to MVR11,200 in Atolls. The median household income of MVR18,000 for Male’ is much higher compared to MVR8,466 in the Atolls15. Major disparities also exist between Male’ and the atolls in access to higher education, employment, health, and recreation.

4.4.1.11 Transportation

Noonu atoll does not have an airport within the atoll. There is no inter-atoll ferry operational within Noonu atoll. Transport to Noonu atoll is either by seaplanes used for commercial purpose in tourist transfer, by speedboat ferries, dhonis or boats. These options are not easily accessible or cost effective for the community of Noonu atoll. Speedboat fares for an individual travelling would cost up to MVR 24,000 and although sea planes are relatively cheaper at MVT 900 one way, access is limited to mainly people with contacts in the resorts.

Maafaru island, proposed for airport development is between 6 and 30 kilometers from the nearest island and to the farthest island consecutively by a speedboat transfer. The farthest away administrative islands to Maafaru are Holhudhoo, Velidhoo and Fodhdhoo. For these islands, it takes more than 30 minutes to reach by speedboat. However, the rest of the islands are within 7 minutes to 20 minutes access to Maafaru by speedboat, which is a reasonable amount.
Table 4.24: Transport distance in km and time in minutes taken to reach islands of Noonu atoll

<table>
<thead>
<tr>
<th>Islands</th>
<th>Landhoo</th>
<th>Maalhairdhoo</th>
<th>Manadhoo</th>
<th>Kudufari</th>
<th>Lhohi</th>
<th>Milladho</th>
<th>Magodhoo</th>
<th>Kendikoilhudhoo</th>
<th>Hendhadhoo</th>
<th>Holhudhoo</th>
<th>Velidhoo</th>
<th>Foddhoo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>18</td>
<td>25</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>Time to airport in Minutes (Gulf Craft 51km/hr)</td>
<td>7</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>15</td>
<td>16</td>
<td>18</td>
<td>21</td>
<td>29</td>
<td>34</td>
<td>35</td>
</tr>
<tr>
<td>Time to airport in Minutes (Gulf Craft 29km/hr)</td>
<td>13</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>22</td>
<td>27</td>
<td>28</td>
<td>32</td>
<td>37</td>
<td>51</td>
<td>59</td>
<td>62</td>
</tr>
<tr>
<td>Time to airport in Minutes (Dhooni 13km/hr)</td>
<td>29</td>
<td>40</td>
<td>45</td>
<td>48</td>
<td>50</td>
<td>60</td>
<td>63</td>
<td>71</td>
<td>84</td>
<td>114</td>
<td>132</td>
<td>139</td>
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</table>

Seaplane Transfer from Male to Islands

<table>
<thead>
<tr>
<th>Islands</th>
<th>Landhoo</th>
<th>Maalhairdhoo</th>
<th>Manadhoo</th>
<th>Kudufari</th>
<th>Lhohi</th>
<th>Milladho</th>
<th>Magodhoo</th>
<th>Kendikoilhudhoo</th>
<th>Hendhadhoo</th>
<th>Holhudhoo</th>
<th>Velidhoo</th>
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<td>Distance</td>
<td>189</td>
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<td>178</td>
<td>197</td>
<td>199</td>
<td>177</td>
<td>167</td>
<td>177</td>
</tr>
<tr>
<td>Time to airport in Minutes (Seaplane 240 km/hr)</td>
<td>47</td>
<td>48</td>
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<td>47</td>
<td>46</td>
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<td>44</td>
<td>42</td>
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</table>

Resorts

<table>
<thead>
<tr>
<th>Resorts</th>
<th>Huwaldhumaavaru</th>
<th>Kudufunafaru</th>
<th>Dhigurah</th>
<th>Medhufushi</th>
<th>Randheili</th>
<th>Ekalivaru</th>
<th>Raafushi</th>
<th>Fuswavelavaru</th>
<th>Malvelavaru</th>
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<tbody>
<tr>
<td>Distance</td>
<td>4</td>
<td>13</td>
<td>16</td>
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<td>21</td>
<td>23</td>
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<tr>
<td>Time to airport in Minutes (Gulf Craft 51km/hr)</td>
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<td>15</td>
<td>19</td>
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<td>27</td>
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<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Time to airport in Minutes (Gulf Craft 29km/hr)</td>
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<td>26</td>
<td>34</td>
<td>39</td>
<td>43</td>
<td>48</td>
<td>57</td>
<td>62</td>
<td>70</td>
</tr>
<tr>
<td>Time to airport in Minutes (Dhooni 13km/hr)</td>
<td>18</td>
<td>58</td>
<td>76</td>
<td>88</td>
<td>97</td>
<td>107</td>
<td>128</td>
<td>138</td>
<td>155</td>
</tr>
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</table>

Seaplane Transfer from Male to resorts

<table>
<thead>
<tr>
<th>Resorts</th>
<th>Huwaldhumaavaru</th>
<th>Kudufunafaru</th>
<th>Dhigurah</th>
<th>Medhufushi</th>
<th>Randheili</th>
<th>Ekalivaru</th>
<th>Raafushi</th>
<th>Fuswavelavaru</th>
<th>Malvelavaru</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>185</td>
<td>190</td>
<td>173</td>
<td>175</td>
<td>169</td>
<td>198</td>
<td>165</td>
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<td>184</td>
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<tr>
<td>Time to airport in Minutes (Seaplane 240 km/hr)</td>
<td>46</td>
<td>47</td>
<td>43</td>
<td>44</td>
<td>42</td>
<td>49</td>
<td>41</td>
<td>47</td>
<td>46</td>
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</table>
4.4.1.12 Energy

The table below gives the energy use for the islands in Noonu atoll. The total installed capacity for all the administrative islands combines in Noonu atoll is 2MW. Electricity cable in Maafaru was installed in the year 2007. At present electricity in Maafaru is provided by Fenaka Corporation. Maafaru has 3 generator sets with total installed capacity of 170.8 kW for the use of the island. Their daily peak load is 85 kW.

Table 4.25: Electricity use by administrative islands of Noonu atoll

<table>
<thead>
<tr>
<th>Island name</th>
<th>Population</th>
<th>Electricity provider</th>
<th>Daily peak load</th>
<th>Installed capacity</th>
<th>Installed generator sets</th>
<th>Yearly electricity production</th>
<th>Electricity cable installed year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hebadhoo</td>
<td>697</td>
<td>FENAKA</td>
<td>45</td>
<td>150</td>
<td>50, 52, 48</td>
<td>347403</td>
<td>1996</td>
</tr>
<tr>
<td>Kedhikolhudhoo</td>
<td>1715</td>
<td>FENAKA</td>
<td>194</td>
<td>214</td>
<td>150, 64</td>
<td>929052</td>
<td>2009</td>
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<tr>
<td>Maalhendhoo</td>
<td>847</td>
<td>FENAKA</td>
<td>72</td>
<td>210</td>
<td>50, 80, 80</td>
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<tr>
<td>Kudafari</td>
<td>780</td>
<td>FENAKA</td>
<td>69</td>
<td>138</td>
<td>80, 58</td>
<td>400320</td>
<td>2006</td>
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<tr>
<td>Landhoo</td>
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<td>FENAKA</td>
<td>110</td>
<td>176</td>
<td>80, 48, 48</td>
<td>697680</td>
<td>1998</td>
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<tr>
<td>Maafaru</td>
<td>1113</td>
<td>FENAKA</td>
<td>85</td>
<td>170.8</td>
<td>56, 84.8, 30</td>
<td>699216</td>
<td>2007</td>
</tr>
<tr>
<td>Lhohi</td>
<td>849</td>
<td>FENAKA</td>
<td>70</td>
<td>168</td>
<td>80, 48, 40</td>
<td>373776</td>
<td>1997</td>
</tr>
<tr>
<td>Miladhoo</td>
<td>1412</td>
<td>FENAKA</td>
<td>125</td>
<td>262</td>
<td>127, 55, 80</td>
<td>450000</td>
<td>2006</td>
</tr>
<tr>
<td>Magoodhoo</td>
<td>388</td>
<td>FENAKA</td>
<td>9.4</td>
<td>30</td>
<td>30</td>
<td>13956</td>
<td>2010</td>
</tr>
<tr>
<td>Manadhoo</td>
<td>1822</td>
<td>FENAKA</td>
<td>325</td>
<td>268</td>
<td>108, 160</td>
<td>1340244</td>
<td>2008</td>
</tr>
<tr>
<td>Holhudhoo</td>
<td>697</td>
<td>FENAKA</td>
<td>45</td>
<td>150</td>
<td>50, 52, 48</td>
<td>347403</td>
<td>1996</td>
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<tr>
<td>Fodhdhoo</td>
<td>446</td>
<td>FENAKA</td>
<td>35.99</td>
<td>69.4</td>
<td>38, 31.4</td>
<td>142668</td>
<td>2011</td>
</tr>
</tbody>
</table>

Source: Energy outlook, Ministry of Environment
5 IMPACT IDENTIFICATION

5.1 Introduction

Potential adverse and beneficial impacts of construction and operation stage of the resort development are identified and evaluated in this section. Significant impacts are identified and evaluated in two stages. The first stage identifies the environmental and socio-economic components that may be impacted from key project activities. The second stage determines the significance of impacts of each component. The following sections provide details of the evaluation of impacts.

For the purpose of this EIA, the chain of events linking activities to specific impacts and knock-on effects are represented in flowcharts to allow for easier interpretation. This is because the cause-effect relationship between a specific activity and its potential impacts are rarely linear and in most cases, a series of casual factors linked to different activities create the conditions that cause an impact. Three separate flowcharts were developed and organized to display logically the following sequence of events:

Activity ➔ Casual Factor ➔ Potential Impacts ➔ Short Term Effects ➔ Long Term Effects

Accordingly, Figure 5.1 below illustrates the flowcharts. The first chart will show the potential negative impacts of the proposed development activities during the construction stage and the second chart will show the potential negative impacts of the proposed development activities during the operation stage. Finally the third chart will show the potential positive impacts expected to arise once the project is complete (operation stage). It should be noted that no potential positive impacts could be identified for the construction stage of the proposed development activities.

5.2 Evaluation of Cumulative Impacts

While direct primary impacts are relatively easy to identify and evaluate, special consideration needs to be afforded to evaluating cumulative impacts. While it is relatively simple to identify and evaluate direct primary impacts, the complex nature of natural systems makes it difficult to accurately predict synergistic and interactive impacts of a particular development project. On the other hand, it is relatively simple to identify potential additive impacts.

The following sources of cumulative impacts were considered in evaluating the potential impacts of the resort development project.
- Time crowding: overall impacts of many similar concurrent developments. E.g. While many marine species and birds are relatively versatile and can relocate to other similar habitats following disturbances, concurrent developments in nearby habitats will reduce their chances of relocation and survival.

- Space crowding: high density of impacts on a single environmental medium. E.g. release of effluent from different sources into the same area.

- Indirect impacts: secondary and tertiary impacts resulting from an activity. E.g. groundwater contamination can affect the growth of terrestrial plants, which result in loss of habitat for terrestrial fauna.

- Triggers and thresholds: ecological systems can undergo fundamental changes beyond certain thresholds. Standards and guidelines have been developed based on anticipated threshold levels, for instance, in determining water quality. Such standards have been considered, where available.


### Figure 5.1: Negative impacts during construction

<table>
<thead>
<tr>
<th>ACTIVITIES</th>
<th>CASUAL FACTORS</th>
<th>POTENTIAL NEGATIVE IMPACTS</th>
<th>SHORT TERM EFFECTS</th>
<th>LONG TERM EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dredging and Reclamation</td>
<td>Changes to hydrodynamics and sediment movement</td>
<td>Erosion</td>
<td>Seasonal erosion</td>
<td>Increased long-term coastal erosion</td>
</tr>
<tr>
<td></td>
<td>Increased turbidity</td>
<td>Siltation in the lagoon bottom</td>
<td>Reduced coral growth and recruitment rate</td>
<td>Decreased availability of fish</td>
</tr>
<tr>
<td></td>
<td>Siltation &amp; Sedimentation</td>
<td>Smothering of corals and reduced light penetration</td>
<td>Altered habitat and species composition</td>
<td>Loss of tourist attractions</td>
</tr>
<tr>
<td></td>
<td>Accidental spill of oil and toxic substances</td>
<td>Siltation in the lagoon bottom</td>
<td>Increased reliance on rain water or desalinated water</td>
<td>Human health risks leading to increased public and private health costs</td>
</tr>
<tr>
<td></td>
<td>Increased surface run-off and sediment deposition in the near shore areas</td>
<td>Marine water contamination</td>
<td>Nuisance to the community</td>
<td>Economic concerns</td>
</tr>
<tr>
<td>Construction of coastal protection Measures</td>
<td></td>
<td>Ground water contamination</td>
<td>May alter species behaviour</td>
<td></td>
</tr>
<tr>
<td>Vegetation clearing &amp; transplantation</td>
<td></td>
<td>Noise and air pollution</td>
<td>Landscape aesthetic degradation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vegetation Removal</td>
<td>Vibrations</td>
<td>Turtles may stop nesting on the eastern side</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vegetation transportation and transplanting</td>
<td>Loss of floral species</td>
<td>Reduced biodiversity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mishandling of solid (non-biodegradable) and hazardous waste generated</td>
<td>Loss of fauna - birds, bats, rats, insects, invertebrates</td>
<td>Rainfall Flooding</td>
<td></td>
</tr>
<tr>
<td>Construction of buildings and runway</td>
<td>Backfilling</td>
<td>Changes to Topography</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prepared by: CDE Consultancy
Figure 5.2: Potential negative impacts during operation
5.3 Impacts on Natural Environment during Construction

5.3.1 Ambient Noise Level, Air Quality and Greenhouse Gas Emissions

During the mobilisation of equipment and operation of heavy machinery, it is anticipated that significant noise will be generated. Noise vibrations may alter species behaviour. In addition, dust and emissions, including greenhouse gases, from vehicle and machinery exhausts will degrade the air quality. However, these adverse impacts will be short term and can be mitigated to avoid nuisance to the resident worker community. With proper mitigation measures, it is unlikely that noise and air pollution impacts will cause long term effects such as human health risks leading to increased public and private health costs. While emitted greenhouse gases can persist in the atmosphere in the long term, the level of emission is expected to be negligible.

5.3.2 Marine Water Quality

Coastal construction activities will involve significant adverse impacts on the marine water quality. The most significant will be the turbidity impacts from the dredging andshore protection activities. Turbidity higher than certain threshold levels for longer periods of time will have significant impacts on marine life (see next section).

Suspended sediments are carried by water and/or accumulate in a loose unconsolidated form on the reef bottom. While large particles settle on the bottom of the water body, sediment particles less than 0.063 mm in size (mostly clay and silt) will remain suspended in the water column. Suspended sediment will be easily dispersed thereby causing sedimentation on the reef.

Construction activities require the use of chemical substances such as fuel, oil and paints. Accidental spillage of such substances, particularly during transportation or offloading, and the construction of overwater structures, can lead to marine water contamination. The spillage of construction material during construction of the overwater villas is a particular concern, given the probable longer length of construction period.

The prefabrication onshore would reduce any possibility of spilling of cement and concrete into the water column during construction of jetty. However, there would be some degree of disturbance to the water column due to equipment mobilization and placement of structures. Sediment dispersal will occur at a moderate scale. The marine environment is likely to be moderately affected.

Dredging and reclamation will also involve disturbance to bottom sediments, generating sediment plumes.

Furthermore, significant quantities of waste will be generated from all construction related activities where any mishandling of solid (non-biodegradable) waste and hazardous waste will
also contaminate the marine water. Therefore, special care should be taken when handling oil, solid waste and hazardous waste to entirely avoid any accidental spills and leakage.

Sometimes chemicals are used to clear and control vegetation, and these contaminants may also reach the marine environment leading to eutrophication affecting biological life.

### 5.3.3 Marine Biodiversity

Construction stage of the project is expected to have direct and indirect adverse impacts on the flora and fauna of the marine environment. The impact foot prints and affected live coral zones are identified in Figure 6.1.

Direct impacts on marine biodiversity will include permanent loss of benthic organisms, habitats and coral colonies within the dredging foot print, due to direct removal at the borrow site or burial during the sand bed construction. The most significant impact on marine biodiversity will be felt on the seagrass bed, where all seagrass within the foot print will be removed and other areas within a 100m radius will be significantly affected. The sedimentation is also likely to temporarily discourage the turtles to use the site.

In addition, lagoon bottom is a habitat for certain organisms such as worms, molluscs, amphipod etc. which are important food sources for bottom feeders such as certain species of fishes. However, it has been found elsewhere that lagoon bottom dwelling organisms re-establish within few months after such disturbances. Baseline assessments showed that there is no live coral cover on the dredging foot print. The proposed over water structure sites do not have live coral cover.

A significant amount of siltation and sedimentation of the lagoon waters is anticipated. Similarly, increased turbidity of the lagoon water is expected. These factors will cause adverse impacts such as smothering of corals and reduced light penetration to the seagrass, coral and benthic communities. Under normal circumstances, corals have a self-cleansing mechanism and can withstand a certain rate of sedimentation. Hence, detrimental impacts such as reduced coral growth and recruitment rate and decreased visibility can be short term effects. However, if the sedimentation exceeds the rate at which corals can self-clean then it may lead to serious detrimental impacts such as coral mortality and alteration of habitat and species composition within the lagoon.

The resilience and survival rates of coral colonies against sedimentation also depend on the type of coral. Branching corals such as Acropora are more tolerant to sedimentation while plate and brain corals are more sensitive to sedimentation and sand can be trapped more easily. The lagoon faros and the atoll lagoon ward side coral colonies contain a large proportion of plate corals which are likely to bleach if buried for more than 48 hours. The live colonies within the deep lagoon are most at risk. Fortunately they are located away from the dredge site.
Fish population is often affected when their gills are stuck by suspended sediments. There will be loss of habitat for a large portion of the juvenile species. Most species will stay out of the harm’s way by moving to safer areas of the lagoon. However, the juveniles may lose their habitats and this may affect the fish population in the short term.

Frequent short-term exposures or chronic long-term exposure to sedimentation and turbidity will result in mortality for many coral species. If moderate levels of impacts on a coral reef persist for particularly long periods of time, the coral reef may undergo changes in diversity, with more sensitive coral species gradually being replaced by more tolerant ones. This may result in an overall reduction in the biodiversity of the coral reef. The risk and severity of impacts from dredging activities on coral reefs are directly related to both the intensity and duration of impacts causing stress.

The intake and outfall pipes will require placement of concrete blocks along the placement line within the lagoon up. Lagoon benthos along the excavation line will be directly impacted.

Degradation of the water quality due to spillage of substance used in construction and construction waste, and sedimentation due to disturbance of bottom sediments and generation of sediment plumes would degrade the habitat of marine organisms. In particular, significant increases in the level of suspended and bedded sediment within the water column for a prolonged period will alter the habitat and adversely affect the living organisms at the site.

Foraging behaviour of fishes may be impeded by turbid conditions as well; gills maybe clogged by sediment particles and sediment deposition may cover and suffocate eggs and larvae of benthic spawning fishes. Prolonged exposure to high sediment levels can lead to a decrease in fish immunity against parasites and diseases. As fishes can readily disperse they are likely to relocate to nearby reefs if high sediment conditions persist.

In addition, sedimentation is likely to cause major shifts in invertebrate populations as sediment is deposited at the crevices/crannies blocking their habitat. This favours domination of invertebrate populations that are more tolerant of the condition. The overall population diversity, size and quality of reef ecosystem are likely to decline due to increased and prolonged sedimentation arising from the proposed activities.

The proposed backfilling within Kandoofaa Kulhi and Vakabe Hasunu Fengandu will permanently alter the marine life using these sites. The young marine life and those breeding within the area will relocate. Depending on the timing of backfilling works, some of these species may be severely affected.
5.3.4 Changes in Hydrodynamics

During dredging and shore protection works there is a high likelihood of abrupt changes to coastal hydrodynamics. Based on experience from similar projects, it is anticipated that the local current patterns around the borrow area is likely to get stronger. Dredging from borrow area may attract more sediment to be transported offshore to adjust for the steep profile. Further, the dredged area is likely to act as sediment sink and therefore lagoon conditions may take a number of years to stabilise against the prevailing conditions.

Current patterns around the borrow area are also likely to change but are expected to be localised. The proposed channel will also have increased current flow and increased wave energy through the channel. However, the channel is too narrow to have a significant effect.

The proposed revetment may alter the current flow and wave activity in the area. Wave deflection from the structure may create standing waves, making the area rough. Due to the uniform nature of the structure, current flow may also increase along the shoreline. However, given that the structure is designed as a revetment, the amount of energy deflected back is expected to smaller or similar to the existing beach.
Figure 6.1: Marine impact footprint
5.3.5 Coastal Processes

Development of coastal infrastructure in highly dynamic coastal areas of Maldives without considering proper engineering options is known to have serious consequences (Kench et al., 2003). Coastal infrastructure often alters natural environment processes operating around a site. The proposed harbour basin and the channel will increase the pressure on the beach immediate next to it and is likely to undergo moderate erosion.

Coastal process on the eastern side will be altered due to the new revetment. Sediment flow will be ceased for a period of time due to the presence of the structure. However, erosion will be controlled in the areas and the natural sediment flow is likely to be restored in the medium term. The sloped revetment will facilitate to speed up the process.

Erosion is also possible in the areas where the revetment and the unprotected each areas meet.

5.3.6 Impact on unique habitats

There are no listed marine Environmentally Sensitive Sites near Maafaru. However, as noted above, the loss of *Kandoofaa Kulhi* and *Vakabe Hasanu Fengandu* will be a significant loss for Maafaru Island. It is expected that the use of these sites by juvenile marine life will cease. The site is also known to be frequented by birds. There is no site of equivalent value in Maafaru Islands for the birds to use. There will also be a loss of mangrove trees, about 85% of which will be permanently removed. The loss of marine life using the site may not be substantial as the site has only become activity after 2009 following the natural connection of marshland to the lagoon. The loss of bird roosting site and mangrove trees will be irreversible.

Fortunately, there are large wetland areas with better ecological value in the nearby Kedhikullhudhoo, Karinmavattaru, Maalhendhoo, Burehifasdhoo and Bodulhaimendhoo. Thus, the overall impact on bird roosting behavior of the region may not be affected.

The construction of the revetment may also affect turtle nesting behavior. However, the most common nesting sites on the island (SE shoreline) are not affected.

The loss of seagrass patches is also a concern but the affected area of the seagrass bed in less than mere 10% of the overall seagrass bed.

5.3.7 Impact on visual amenity

The proposed project site is located well away from any existing resort island. The loss of vegetation cover on the island, particularly during construction, will reduce the overall visual amenity of Maafaru Island.
5.3.8 Groundwater and Soil Condition

The construction and development of the island is expected to have some impact on the quality and quantity groundwater and soil condition.

The most significant impact is expected to come from the proposed backfilling activity where marine sand is going to be placed in the existing marshlands. The sand will be left to dry on a designated site before being placed in the low lying areas. Although much of the salt would have drained, the effects of salt will be very much present in the newly placed sand. There will be a chance of further salinizing the ground water system and making the soil highly alkaline.

Following backfilling, soil will take some time to form. The exact timing is unknown as no such detailed studies have been undertaken in the Maldives. However, anecdotal evidence suggests that the soil system may take a number of years, perhaps in excess of 10 years to establish. Thus, artificial strengthening of the soil system will be required for any planting activities.

During the constructional phase oil, paint or other chemicals will need to be handled properly. Mishandling of fuel has led to serious pollution of soil and groundwater aquifer in some of the resort construction projects. There have also been reports of spilled oil near temporary generator sets in other projects. This sort of pollution may sometimes have long-term irreversible effects since such contamination does not degrade itself and is expensive to clean up.

During the construction stage, civil works including excavation will be undertaken to make way for foundations for major infrastructure of the island. Erection of these structures will require removal of sand and possibly dewatering of groundwater for concrete foundations. Therefore, this stage of construction will affect the soil and groundwater and may potentially cause saline intrusion. The extent and level of salinization will depend on the location of the structure being built. In general, excavation and dewatering in areas close to the vadose zone or areas close to the beach makes the groundwater vulnerable to salinization.

The barren land after backfilling will expose the soil to wind and water erosion. Excavation for building foundations and pipelines can also expose groundwater and the deeper sections of the soil to more harmful contaminants such as oils and hydrocarbons from vehicles and other machineries used during the construction that may contaminate the land. The groundwater is likely to be affected in the following manner:

- Absence of vegetation can expose the land to wind erosion
- Increased chance of construction related accidental chemical and oil leaks in to the ground; the possibility of saltwater intrusion triggered by disturbances from excavation and other civil works.
Use of machinery and equipment has the potential to contaminate land.

Solid waste and wastewater generation during the construction stage can also affect the groundwater, if they are mishandled and mismanaged during the construction stage. The risk is moderate as construction will be well supervised and managed by project staff to ensure that waste is handled and disposed properly.

Groundwater pollution can also occur as a result of poorly designed and poorly addressed wastewater systems. Leaking sewerage systems such as septic tanks may pollute the soil. This in turn will lead to the formation and accumulation in the aquifer of hazardous gases such as hydrogen sulphide. Eventually, the immediate vicinity of the ground water aquifer may become polluted and cause hazards to human health in medium to long-term. Therefore, even temporary sewage and wastewater systems during the construction stage have to be designed and constructed properly so as to avoid leakages into the ground.

5.3.9 Changes to Drainage

Backfilling can cause variations in the topography, leading to unintended changes the drainage patterns. At present the island appears to have a number of low lying areas with varying elevations. Depending the elevation of the backfill areas, the surrounding areas might get severely flooded, particularly around the backfilled marshlands.

The construction of runway will increase the surface runoff on the runway area. Measures are required to manage this flow.

5.3.10 Terrestrial Flora and Fauna

Vegetation clearing is one of the most significant impacts of the proposed project. It is anticipated that about roughly 20,000 trees, mainly coconut trees, funa, uni, Dhigga, Hirundhu and boakeyo trees will be removed completely for airport construction. A total of over 30,000 trees (including bushes) may have to be removed. This loss is irreversible as the area has to be left cleared for the rest of the airport operation period.

The removal of coastal vegetation means that the island is exposed to severe erosion and periodic flooding. The risk of tsunami damage is also increased five-fold due to the absence of any protective barrier. This is a serious breach of island defences and will have to compensate by artificial breakwaters.

Loss of vegetation means, loss of fauna that depend on those vegetation. Such species include birds, rats, fruit bats and invertebrates.
The area for the proposed project also contains mangrove habitats that will be completely destroyed by the construction of runway and airport development. As noted above, the total loss of the mangrove habitat will be the most serious and irreversible impact of the proposed project activities. This is because removal of mangrove habitat will cause local extinction of mud/mangrove crabs, fresh water fish (Beyngu) as well as migratory birds that are commonly seen in the ‘Vakabe Hassanu Fengadu’ area during the transitional period from Hulhangu to Iruvai season. The majority of birds generally seen during that period are protected species under the EPP Act 1993.

Loss of vegetation will also act to increase greenhouse gas emissions, since trees are a known carbon sink.

Changes to the vegetation regime of the island will be imminent. Dominant species on the island will be replaced by grass and creeper varieties.

The large holes left on the ground after tree removal could assist in soil degradation if coupled with periods of heavy rainfall. However, since the backfilling and levelling will be undertaken shortly afterwards the impacts would be short-lived.

Furthermore, turtle nesting grounds on the eastern side of Maafaru may be temporarily affected during construction. During construction stage turtles may stop nesting on the eastern side due to noise, vibrations, light and increased human activity in that area. It is anticipated that alteration of migratory patterns of birds commonly seen in that area and landscape aesthetic degradation will be short term effects.

5.3.11 Impacts from transplantation

The project proposes to transplant all large trees to other islands. Although the destination islands are yet to be finalised, some common impacts could be identified from transplantations.

- During transplantation, a successful re-establishment will largely depend on regeneration of roots, healthy condition of the roots, trucks and branches, and maintaining the necessary levels of moisture around the roots during transportation and after replanting.
- Lack of coordination during transport can hamper the survival rate of the trees. For example, if mechanisms to dig holes are not ready by the time the trees are transported, they would be left exposed for longer periods.
- There are known cases of pests been introduced to receiving islands during transplantation. The three most common types of pests are rats, rhino beetle and coconut hispid beetle. Amongst these, the rats and rhino beetles were observed on Maafaru, raising the potential for pest export.
5.3.12 Impacts from waste

A significant volume of green waste will be generated from the project. These need to be managed to avoid major environmental problem on Maafaru.

Waste is also expected from the dredging activities, particularly access dredge material and larger coral material.

Solid waste, waste water and sewage generated by the workforce may affect the groundwater and general terrestrial environment of the island.

Construction waste will also be generated all the proposed developments.

5.4 Impacts on the Natural Environment during Operational Phase

5.4.1 Coastal Processes

Given that areas where coastal vegetation is removed will be protected using shore protection measures, there will be no impacts on the beach.

The borrow areas will also act as sediments sinks and the deeper waters may cause an increase in wave activity.

The construction of revetment and breakwater will cause waved to be deflected back creating standing waves and increasing the wave activity near the shoreline. However, the proposed revetment design will minimise the deflection.

5.4.2 Marine Water Quality

Operational stage activities that can potentially lead to degradation of the marine water quality include improper disposal of solid waste into the marine environment (including waste generated on land and littering from boats), in adequate mixing and dilution of brine from the desalination plant and effluent from the sewage treatment plant.

The Environmental Management Plan presented in Section 7 of the report includes methods for proper disposal of solid waste, thereby mitigating the risk of marine environment degradation due to solid waste.

Adverse impacts on marine water quality are expected due to sewage/ wastewater disposal. Since the island will use a septic tank system, the sewage will be pumped directly into the ocean. However, given the small number of workers expected to be resident on the island, and the relatively smaller number of passengers, the amount of wastewater discharged from pipe is
expected to be dispersed quickly into the sea to negligible levels. The locations of the wastewater effluent and brine outfalls are also proposed with consideration of the wave and current conditions in the area, in order to ensure good mixing and thorough dilution.

5.4.3 Marine Biodiversity

Degradation of the marine environment due to solid waste, sewage/wastewater and brine discharge can affect the marine biodiversity in the area as well. However, as discussed above, these impacts are moderate to low, given the measures taken to mitigate the risk of such impacts.

5.4.4 Ground Water Quality and Quantity

During the operation of the airport, any accidental spill or leakage of oil, fuel, sewage and mishandling of solid (non-biodegradable) waste and hazardous waste will contaminate the marine and/or groundwater. As described earlier, in the Maldives, groundwater contamination is an irreversible impact due to the absence of impermeable layers to separate the freshwater lens in independent reservoirs. Accordingly, any point sources of pollution would cause the contamination of the entire island groundwater resources. Consumption of such contaminated groundwater, may lead to serious health risks leading to increased public and private health costs. Furthermore, contamination of groundwater will force the local community to rely on rainwater or desalinated water that will also be costly (rainwater can be costly due to the need for increased storage capacity). Therefore, special care should be taken when handling oil, fuel, solid waste and hazardous waste to entirely avoid any accidental spills and leakage.

Fuel tanks within the island will have bund walls to contain at least 110% of the tank capacity, in case of an accident. Other hazardous materials will have proper labels and material safety datasheets (MSDS) clearly labelled. Access and use of these substances will also be strictly controlled and monitored by specially trained personnel. Therefore, with these mitigation measures, the likelihood of any groundwater contamination is not expected.

5.4.5 Introduced Species

It is anticipated that exotic species will be introduced to the existing environment of Maafaru. Cargo from air transport may carry exotic species. Exotic species can cause significant ecological damage such as alteration of native species composition in the short term and local extinction of native species in the long term if proper mitigations measures are not taken.

Use of chemical fertilizers, pesticides and insecticides may also be of concern. Given the narrow size of the island and its potential water lens, and reclaimed nature of the soil system, it may be necessary to extensively use fertilizers for land scaping and revegetation. The island may require the use of pesticides and insecticides for rodent and vector control. Introduction of such
measures should consider its potential positive and negative impacts on the terrestrial flora and fauna.

5.4.6 Alteration of Species Behaviour

Increased light from the operation of the airport may alter species behaviour. Short term effects may be alteration of local species composition while local extinction maybe long term effects. However, with proper mitigation measures, such adverse impacts can be made insignificant.

5.4.7 Bird Collisions

Once the airport operation commences, one of the significant detrimental impacts will be bird collisions. Short term negative effects include interference with the migratory patterns of migratory species commonly found around Noonu Atoll while effects of long term maybe local extinction of protected bird species. Bird collisions will also have economic costs as they are a hazard to aircrafts. Generally bird collisions are the greatest when birds hit aircraft during landing and take-off.

5.4.8 Waste Management

Operational stage of the airport will generate moderate quantities of solid waste. Likely types of waste generated include packaging, green waste, cans, bottles, hazardous waste (used fuels etc).

Solid waste management is likely to cause indirect moderate environmental impact with proper mitigation measures.

5.4.9 Ambient Noise Level and Air Quality

Noise from movement of aircraft and traffic going to and from the airport will be the most significant adverse impact once the operation of the airport commences. The effects of noise pollution include interference with speech, disturbance to sleep and increased anxiety and stress levels. Long term effects may be health risks such as hearing impairment leading to increased public and private health costs. Noise and vibrations may also alter species behaviour, particular behaviour of fauna such as birds and bats that depend on auditory communication. Even though noise levels will be a nuisance and has detrimental ecological impacts, the severity of the impacts can be considerably reduced with appropriate mitigation measures as the significance of noise depends on the volume, duration, time of the day and frequency.

Emissions from the power generation is expected to be the only significant source of air quality degradation, along with motorised vehicles. Air pollution from road traffic can affect local air quality, but the effects are not expected to be significant.
The powerhouse will be designed with appropriate insulation to minimise the radiation of heat, soot filters at the chimneys and chimneys height appropriately to minimise the soot emission and effective dispersion outside the boundaries of the island environment. The powerhouse and desalination plant are proposed to be adequately sound proofed to achieve the allowable limits of 70 -75 dB(A) at 3 meters radius.

5.5 Impacts on the Socio-economic Environment

5.5.1 Impacts on accessibility and transportation

A distance map of Maafaru Island is presented in Figure 6.2.

With the development of an airport in Maafaru Island, accessibility to Noonu atoll as well as Maafaru Island would increase significantly. Currently, there is no inter-atoll ferry operating within Noonu atoll. The alternative option for access to Noonu atoll are by boat which takes about 10 hours to reach the atoll from Male’, and is the most cost effective option to travel to the atoll. Speedboat takes about 4 hours to reach Noonu atoll from Male’ but expenditure for one journey is around MVR 24,000 equivalent to USD1,500. Seaplane costs MVR 900 (USD60) for a one-way journey and would take approximately 50 minutes to reach Noonu atoll. But, these alternatives are not easily available for all the community members. Seaplane caters for tourist transfer to resorts and those who have networking bonds with the resorts are at a better advantage to access the free seats available at the moment.

Hence reliable access for transport from airport development will be a major positive factor for Noonu atoll residents. The accessibility to Hulhule airport will increase significantly on a daily basis. But given the present domestic flight travel route scenario, where multiple stops add additional miles and time to the journey, it is predicted that more than efficiency in speed of the journey, the ease and comfort of transport would be the benefitting factor for the users of the airport. Furthermore, with airport development, 24 hour access is possible, whereas seaplanes operate during daylight hours. There is also the possibility and option of flight charters for emergency and other purposes.

This accessibility increase would have significant impact on existing economic sectors such as tourism, fisheries, agriculture, trade and other social sectors such as education, health and etc. A plausible positive impact is for boost in air cargo, particularly for transport of frozen goods such as meat and poultry products and perishables such as vegetables and fruits used for consumption by local residents and the tourist resorts.

An airport development is also foreseen to improve post and courier services and unaccompanied baggage service.
5.5.2 Business and Employment Opportunities

The potential beneficial impacts of the proposed development are mainly socio-economic impacts.

Socioeconomic benefits of the construction stage include:

- Employment opportunities during construction works
- Business opportunity for local suppliers
- Opportunity for local contract workers
- Opportunity for locals to rent out property, equipment, machinery, vehicles and vessels.

5.5.3 Generation of employment opportunities and local capacity building

The major positive socio-economic impact of the project will be the generation of employment opportunities. The construction phase will create demand for construction workers and contractors, as well as suppliers of construction material, equipment and machinery. More than a hundred new jobs will be created in the construction phase. Preference will be given to locals.

The operational phase will also create 50-60 new jobs. Half of these jobs are expected to be reserved for locals with the necessary experience. Furthermore, capacity-building and training programmes for locals will also be carried out as part of a Human Resource Development initiative.

5.5.4 Human Health

Health and safety risks arising from construction work is high, especially due to the use of specialised equipment and machinery. Accidents related to equipment use can lead to injury, and fatalities. Materials used in construction, in addition to the equipment and machinery, also involve risks to health and safety. Accidental spills/leakage of hazardous substances can contaminate the site and pose risks to human health, including workers on the site and the local population.

5.5.5 Local Culture

Influx of large numbers of expatriate workers for construction projects can lead to conflicts between the local population and the workers. Such problems are not expected to arise in this
5.5.6 Demand for Resources and Services

Once the island is operational, there will be additional burden on the landfill site in Vandhoo or Thilafushi. Most of the waste generated will be handled on site, but certain materials like non-combustible and hazardous waste will need to be handled at the waste management site at Vandhoo or Thilafushi. There will be an overall long term moderate impact as a result.

There will not be any additional burden on other utilities, since the island will be developed as a self-sufficient entity with its own power supply, water desalination plant and sewage system.

5.5.7 Poverty aspects

It is expected that poverty within the atoll and Maafaru island will improve with more economic opportunities, employment opportunities and better opportunities for trade of goods for the people of Noonu atoll. New jobs will be created, more favourable conditions for micro and small businesses are foreseen and better access to social services is expected. Also market size for transaction of goods would increase and at some points transaction costs of certain goods are expected to reduce as well. All these effects would overall improve poverty of the atoll.

5.5.8 Impacts on tourism

It is forecasted that impacts on tourism will benefit guesthouse tourism in inhabited islands, improve local tourism and resort tourism. An airport adding more reliable connectivity is expected to create a more favourable investment climate for guesthouse tourism development, with cheaper, reliable scheduled access to the atoll.

It would also improve local tourism, to explore and enjoy cultural tourism and explore underwater diving adventures within the atoll. Furthermore, festivals such as Eid and other holidays could expect to have a boost in visitors for families and youth from the atoll and other atolls to travel for celebrations.

5.5.9 Natural resource access and use

With an airport development, it is expected that the residents would lose access to a significant area of unutilised land. People will lose access to flora and fauna in the area. The users of palm fronds for thatch will lose accessibility from the area. Furthermore, an airport infrastructure is a long-term permanent investment and entails opportunity cost in terms of restricted access to the area for other economic and social uses. The utilization of land for other opportunities will be lost, as the infrastructure once developed cannot be easily substituted.
For tourist resorts, more reliable daytime arrivals and opportunity for night-time arrivals is a likely positive impact from airport development. This facilitates better travel planning for visitors from short stay markets such as China, Japan and other East Asian markets.

5.5.10 Impacts of demography

With an airport development, no significant change to fertility is predicted. But positive impact on return migration is expected. The number of people seeking employment from other atolls is expected to increase and there is likelihood of foreign employment for unskilled and technical works of skills lacking within the country. Hence human settlement is likely to be positively impacted.

5.5.11 Impacts on governance

With the development of an airport, a separate governing body and management team for the operations of the airport will be introduced for decision-making and power relations within the atoll. The governing body and management team will be run by a private company and will be in charge of operations of the day-to-day affairs of the airport. Hence the new structure is not likely to impact the power and governance structures existing within the atoll. However, trust building and networking relationship with the institutions in Maafaru and within the atoll will be essential for smooth and successful operations.

5.5.12 Impacts on health

With the development of an airport, the people of Noonu atoll are likely to have better opportunity for good health with likelihood to healthy food supply to their islands. In terms of health care, the people will have better accessibility to health service providers in Male’ and other parts of Maldives and also connectivity to Hulhule airport for international travels abroad for medical care. This is likely to improve health care services for maternal delivery, childcare, accidents and emergency services and other medical conditions requiring treatment options not available within the atoll. It is also expected that tourist resorts would have better opportunity and confidence in health services in case of emergencies requiring visitors to be transferred for health care services to Male’ or overseas.

An airport will increase daily mobility of people to the atoll and contact with people with illnesses resulting in diseases spread. There are rare chances of communicable disease outbreaks and spread of some diseases from travelers, which might be unidentified at earlier stages.
5.5.13 Impacts on housing

The land used for airport development is unutilized land and hence no adverse impacts to housing are expected from airport development in the planned area. The airport construction will be designed according to aviation guidelines within boundaries set from human settlement. Houses on the island might affect from noise from arrivals and departures of flights.

From real estate and housing market side, there is likelihood that, with more mobility and migration for employment, houses in Maafaru and Noonu atoll will have better opportunity for leasing and hence will impact positively on the community resulting in income opportunities. Furthermore, it is also expected to improve the quality of housing with new demand created.

5.5.14 Impacts on the use of land

The airport is to be developed on part of the island presently used for common good by people of Maafaru. The property of people on the area has been given compensation in exchange for the land. There is no physical infrastructure developed for economic activities or social activities on the land. The people of Maafaru expressed strongly in the need for an airport and they find the allocated area as most suitable for airport development. Maafaru is however not the most ideal location for all the future airport users within the atoll. Nonetheless, it is agreed by all users of the atoll to develop Maafaru as an airport. The members of the atoll council also agree on Maafaru for airport development. The use of land will have impacts on natural resource use and other uses. There will be opportunity cost arising from land use for airport. However, the benefits from airport development will far outweigh the costs of missed opportunity.
EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

Figure 6.2: Distance map from Maafaru Airport

Legend
- Maafaru
- Resorts
- Inhabited
- Uninhabited

Distance
- 0.5 hrs by Dhoani
- 0.5 hours by Small Gulf Craft
- 0.5 hours by Large Gulf Craft

Map developed by CDE Consulting
December 2016

Prepared by: CDE Consulting

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5.6 Mitigation Measures for Significant Adverse Impacts

5.6.1 Air and Noise Pollution

Project activities that can lead to air and noise pollution are operation of equipment and machinery, including dredger, electricity generators and desalination plants, both during construction and operations.

Mitigation Measures

- Properly tune and maintain all vehicles and machinery
- Keep ground/soil damp to minimize dust/topsoil erosion by wind
- Conduct construction activities during daytime to minimize nuisance to humans and fauna
- Insulate terminal building, power generator and desalination plant house with appropriate material
- Monitor all occupational areas to ensure noise levels do not exceed WHO standards
- Ensure compliance with the Maldives Civil Aviation Act and Maldives Civil Aviation Regulations and penalise non-compliance.
- Place noise quotas on night flights such as not allowing the noisiest aircrafts to land or take off

The main cost would be for insulation of the power house and desalination plant house. This would cost about USD 20,000.

5.6.2 Increased Turbidity and Sedimentation

Dredging, shore protection and associated turbidity and sedimentation is the most significant impact of this project.

Mitigation Measures

- The impact from dredging the reef entrance is most difficult to control. The use of silt screens is the preferred option for the borrow areas within the lagoon. However, given the relatively short time required to complete the reef entrance no measures are proposed.
- Complete works in shortest time period possible; contingencies should be made available for the possibility of dredge failure as has been witnessed in some other dredging projects in the Maldives.
- Carry out work in low tide hours, calm condition and preferably during NE monsoon.
5.6.3 Contamination of Marine Water, Groundwater and Land

5.6.3.1 Construction Activities

Construction activities that can lead to contamination of groundwater, soil and marine waters include:

- Accidental spillage of construction materials
- Improper storage of chemicals and raw materials used for construction
- Improper stockpiling and disposal of construction stage waste

**Mitigation Measures**

- Oil, solid waste & hazardous waste handled carefully & transported in sealed containers.
- All paints, lubricants, and other chemicals used on site stored in a secure and bunded location
- All raw materials stored away from the vicinity of the coastal areas
- General refuse stockpiled in one central area
- Keep spill cleanup materials readily available
- Train workers in spill prevention and cleanup, and designate responsible individuals
- Properly tune and maintain all machinery
- Carry out construction activities user the supervision of a suitably experiences person
- Pre-fabricate columns and footings away from shore

Costs are to be included in the contract value and are mainly the responsibility of the contractor.

5.6.3.2 Wastewater

Wastewater contamination of the marine water, groundwater and soil can occur due to:

- Leakage from temporary septic tanks used by construction workforce
- Leakage of untreated wastewater from the operation stage sewerage system into the island
- Disposal of untreated wastewater from the operation stage sewerage system into the island/ sea
- Disposal of wastewater effluent from vessels within the island reef system

**Mitigation Measures**

- Properly construct and maintain septic tanks
• Undertake regular inspection of operation stage sewerage system for timely detection and repair of any leakages
• Dispose of sewage in suitable location to allow dilution

Mitigation measures mainly involve routine maintenance activities, and do not include additional costs.

5.6.3.3 Solid Waste

Improper disposal of solid waste during construction and operation, including from vessels used by the island, can contaminate the receiving environment. Strategic measures and actions proposed for effective solid waste management are included in the Environmental Management Plan (Section 7).

Mitigation Measures

• All public areas of the island should be equipped with trash bins within easy reach and sign should be displayed to encourage use of trash bins. Proper disposal of food waste is essential as bird nuisance may pose risk of bird collision.
• Give clear instruction regarding procedures for handling of chemicals and solid waste during construction

Costs of these measures are estimated at USD3000.

5.6.3.4 Fuel

Fuel spillage/leakage during handling and storage can also contaminate the receiving environment.

Mitigation Measures

• Diesel fuel will be stored in a steel fuel storage tank located near the generators
• Aviation fuel storage areas must be easily accessible and fuel bowsers must undertake refueling on sealed concrete floors.
• LPG and kerosene barrels will be stored in an appropriate building
• All areas on the island where diesel or other fuels are stored and handled (fuel tank, generator service tanks, filling station for canisters (boats), kerosene store and tanks) will be sealed with a fuel-resistant impervious lining to avoid any percolation of hazardous liquids into the ground.
• Fuel will be handled at sealed areas only
• In transportation, the danger of spilling diesel fuel into the sea or the coral environment as well as on the island will be reduced by tight fittings and appropriate material.
Precautions to avoid spilling of diesel fuel (filling up of tanks and canisters, refueling of boats) will also be given by instructions to the staff ("handle fuel carefully, avoid spilling")

- Appropriate execution of construction and sealing of the main fuel tank
- Regular inspections of the welded seams of fuel tanks will be carried out
- Care should be taken in the refueling process of boats to avoid any spillage of fuel

These mitigation measures mainly involve routine maintenance activities, and do not include additional costs.

5.6.4 Groundwater Depletion

Groundwater depletion can occur due to dewatering for construction of building foundations and excavation for laying utility pipelines.

Mitigation Measures

- Discharge extracted water within the island to assist aquifer recharge

5.6.5 Change in Coastal Processes

As noted above the areas where coastal vegetation are removed is planned to be protected using a revetment.

Mitigation Measures

- Construct the proposed coastal protection measures on time
- Carry out work in low tide hours and in calm condition
- Complete works in shortest time period possible to allow structures to adjust to prevailing wave conditions
- Use manual methods as far as possible

Construction activities are included in the contract value and are the contractor’s responsibility.

5.6.6 Impacts on Terrestrial Vegetation and Fauna

Mitigation Measures

- The scheduling of the vegetation clearing activities will be timed with other sites who intend to receive vegetation from Maafaru. All the large and mature trees removed will be transplanted to other islands where practical.
• All clearing works will be carried out during day time to minimise disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication, turtles nesting on the eastern side of Maafaru and to the local community.

• The developer will plant two trees for every single large tree lost form the activity. A long-term tree replanting programme will be started to support islands of Noonu, Lhaviyani and Kaafu Atoll undertaking land reclamation projects.

• Breakwater/revetments will be construction to mitigate coastal erosion associated with vegetation clearing.

• Vegetation clearing will be only done for the trees that will require clearing. Any trees that can be retained will be retained.

• Strict guidelines and construction monitoring is required during the vegetation removal stage to ensure that every single large tree could be replanted.

• The replanting activities on the receiving islands should consider natural profiling of vegetation. Coastal vegetation should comprise of species such as kuredhi and magoo and the larger trees should be placed inland rather than on the coastline.

• Use native species for landscaping as far as possible.

• Manage and monitor effects of any introduced species on local biodiversity.

• Monitor pest sightings and take action to control infestations.

• Clear green waste to prevent pest infestations.

• Trees should be dug at least 3 foot wide of the trunk.

• The root system should be watered to keep it wet and cemented before digging.

• The roots should be kept wet during transportation.

• A monitoring mechanism to check the survival rate of trees must me established after replanting.

• Holes should be dug on the receiving site prior to receiving the trees.

• Where possible, leave the trees after cutting down for a few hours before transporting and check for any pests before loading on to the vessel.

• The receiving island should consider using insecticides and pesticides upon receiving the new trees.

• Relocate all the mangrove vegetation to the southernmost marshland of Maafaru. This may require some vegetation removal around the marsh. Alternatively, it may be transplanted to an island with a large marsh land in Noonu Atoll.

Costs involved in these measures are routine and are included in the contract value. A cost US$30 may be incurred for each mangrove plant transplanted.
5.6.7 **Removal of Marine Organisms/ Marine Habitat Destruction**

Coastal activities such as dredging, backfilling and construction of coastal structures can lead to direct removal of benthic organisms and destruction of marine habitat.

*Mitigation Measures*

- Minimize affected area and preserve areas not in direct footprint for relocation of fauna
- When back filling the marshlands, start work adjacent to the existing dry area and gradually go outwards. This is to allow the marine animals to escape into the lagoon
- Do not fill the existing opening in the beach that connects the lagoon to marshland.

The main cost would be for relocation of live coral, which is estimated to be about USD 30 per sq m.

5.6.8 **Changes to Drainage**

*Mitigation Measures*

- Artificial drainage systems should be put in place, where relevant between the newly backfilled land and the existing sections of the island.
- The runway strip will be constructed using porous asphalt and concrete drainages will be constructed on both sides of the runway to manage stormwater runoff.

The drainage systems may cost about US$80,000.

5.6.9 **Bird Collisions**

*Mitigation Measures*

- Place lidded garbage bins within the airport boundary for disposal of waste and ensure that bins are always closed and no waste, rubbish or garbage that may attract birds are lying around.
- Ensure compliance with the Maldives Civil Aviation Act and Maldives Civil Aviation Regulations and penalise non-compliance.
- Place a quota on the number of aircraft landings and take-offs at the airport
- Establish bird scaring mechanisms such as placing scarecrows.

Investment in bird control measure are expected to be around US$20,000.
5.6.10 Occupational Health Impacts

Occupational health impacts may occur due to:

- Accidents during machine and equipment operation
- Exposure to chemical contamination in water/air
- Respiratory health impacts due to air pollution during construction
- High noise level during construction
- High noise level in powerhouse and desalination plant house during construction and operation

Mitigation Measures

- All health and safety precautions described in Section 2.8.5 will be implemented. They include the following.
  - Health checks will be administered before work commences
  - Warning signs, barricades or warning devices will be provided and used.
  - Necessary safety gear will be worn at all times. These include safety gloves, construction boots, face masks, ear muffs, etc.
  - Fire extinguishing equipment would be readily available and employees will be trained in its use.
  - Oxygen, acetylene or LPG bottles will not be left free-standing.
  - First aid kits will be made available on site
  - The construction site will be properly closed to unauthorized personnel
- The building housing electricity generators and desalination plant will be properly insulated to mitigate noise pollution in the vicinity

Cost of insulation of the powerhouse and desalination plant house is estimated to be about USD 10,000.

5.6.11 Increased Demand on Waste Disposal Facilities

Solid waste generation during construction and operation will put extra burden on the existing waste management facilities in Thilafushi.

Mitigation Measures

- Raise awareness among the staff about environmental friendly practices.
- A separate waste management area will be established within the island that will deal with waste management issues.
- Hazardous waste will be transported to waste management centre in Thilafushi.
- Waste oil from the generators will be collected and will be incinerated. It is estimated that 200 litres of waste oil will be generated per month. Storage and transport of these oils involves of ground water leakage if mishandled.
5.6.12 Social Conflicts

Mitigation Measures

- Employ local residents as far as possible
- Provide proper orientation to all workers regarding local values and customs
- Inform and consult all stakeholders at all stages of the project
6 ALTERNATIVES

6.1 “No-project” Alternative

The no project option takes the following into account.

− The existing island remains as it is in its natural state
− The airport will not be reallocated to another island in the atoll for development and therefore the proposal will be abandoned.

The comparison of benefits of each alternative is provided in the table below.

Table 7.1 Summary of no project alternative

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Environmental problems related to development can be avoided. Absence of reclamation activities keeps the lagoon and reef in good health; avoidance of extensive land clearing will keep the terrestrial environment intact; the turtle and marine animals which relies in Maafaru for breeding and feeding will sustain in the future; the wetland environments of Maafaru will remain intact.</td>
<td>• The island remains economically stagnant and the opportunity cost on Maldivian economy is very high.</td>
</tr>
<tr>
<td>• No development costs to the Proponent</td>
<td>• Loss of business to the Proponent</td>
</tr>
<tr>
<td>• The potential resource use conflicts related to Maafaru lagoon and common property resources may be avoided</td>
<td>• Loss of government revenue</td>
</tr>
<tr>
<td></td>
<td>• Loss of economic opportunities for the atoll population</td>
</tr>
<tr>
<td></td>
<td>• Loss of opportunity to improve transport</td>
</tr>
<tr>
<td></td>
<td>• Political and social problems due to lack of employment and economic development opportunities</td>
</tr>
</tbody>
</table>

The environmental problems associated with this project are numerous with the most significant being irreversible terrestrial impacts. On environmental grounds the no project option is preferred but on socio-economic grounds the completion of the project is preferred.

The modern day mitigation technologies if followed properly as prescribed in this document will ensure negative impacts are managed efficiently, when implemented properly. It is recommended to proceed with the project with the mitigation measures proposed.
6.2 Alternative Location for Airport

The concerns relating to Maafaru as the airport island are twofold: first Maafaru is not in a central location to provide access to eastern rim islands; and second is those relating to the environmental sensitivity of Maafaru wetlands. Potential alternative islands that could be considered based on these factors are Dhigurah, Medhufaru and Manadhoo.

Dhigurah and Medhufaru are two large uninhabited islands, both with a land area of about 46 Ha and a length of 1500 m. Manadhoo is the Atoll Capital with a land area of 102 m and length of 1700 m. A 1200 m runway can be easily accommodated in all three islands without the need for land reclamation. However, the proposed 1800 m runway on Maafaru cannot be accommodated on Dhigurah and Manadhoo. Medhufaru on the other hand can accommodate a 1800 m runway and more after reclamation.

In terms of accessibility, all three options other than Maafaru Island serve a slightly large population within a 1 hour dhoni ride (See Figure 7.2). In terms of location, Dhigurah Island provides better coverage to most of the population and existing resorts.

Medhufaru, while being the most suitable island to accommodate a 1800 m runway, contains wetland environments of equal or more importance to Maafaru Island. Since Medhufaru is an uninhabited island, its environment is, at present, in more pristine condition than the highly modified Maafaru Island.

The island of Dhigurah is at present leased to develop a resort island but no physical development has begun on the island. Medhufaru Island is also leased for agricultural purposes.

Given the practicality of building a 1800 m runway is only available in Medhufaru and Maafaru, and that Medhufaru has more sensitive environments compared to Maafaru, the preferred location is Maafaru.

6.3 Alternate Runway Location

The present runway requires clearing of a large area of vegetation and is considered one of the main impacts of the project. Alternate options to minimise these impacts are to develop the runway and ancillary facilities on reclaimed land. Figure 7.2 below shows three alternate options for runway relocation and Table 7.2 provides their advantages and disadvantages.
Table 7.2: Summary of Impacts from Alternate Options

<table>
<thead>
<tr>
<th></th>
<th>Current option</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practicality</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Terrestrial impacts</td>
<td>V. High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Marine &amp; coastal</td>
<td>High</td>
<td>V. High</td>
<td>V. High</td>
<td>V. High</td>
</tr>
<tr>
<td>impacts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social impacts</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Economic impacts</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>V. High</td>
</tr>
</tbody>
</table>

**Option 1:** This option reduces the terrestrial environmental impacts and has similar impacts on the marine environment as the current option. In terms of environmental impacts, this would be a preferred option when compared to the exiting option. However, there is a practical limitation in this option since the settlement falls directly in the flight approach path and is too close to cater for the needs of the airport operations safety.
Option 2: This option involves shifting the runway to the western end of the lagoon. This will involve significant impacts on the reef environment and the ‘bay’ created between the runway and the main island runs the risk of becoming stagnant, especially with seaweed growth. The impact is negligible on the terrestrial environment.

Option 3: This option involves reclaiming land from the northern end of the island. This is a better alternative than the current option, in the sense that:

- it reduces the terrestrial impacts,
- leaves much of the island environment untouched,
- socially more acceptable as there is no loss of common property resources
- There is potential to expand the runway to 3700 m (close to the length of present Hulhule airport runway)
- Economically beneficial as traffic to the airport will be diverted through Maafaru harbour and roads. This will improve small business opportunities such as taxi service and café’s.

However, this option will involve significant impacts on the marine environment and a significant increase in reclamation costs. It is also much closer to the settlement, increasing the noise pollution. It also has the potential to affect the coastal areas of other islands within atoll lagoon.

Preferred option: All these options will involve significant environmental impacts on the island. It is difficult ascertain which one will have lowest total impacts as they effect different aspects of the environment (for example vegetation vs. coral reefs). The most economical option is the presently proposed option as it involves less reclamation.

6.4 Alternative location for borrow site

The proposed borrow sites have been designed to meet the requirements for backfilling. It utilizes the proposed reef entrance and the harbor basin to acquire sand, thereby limiting the environmental impact footprint. It also provides a solution to the dredge waste disposal.

An alternative would be to dredge a borrow area specifically to acquire sand for backfilling. In doing so, the scale of the reef entrance and borrow areas could be slightly reduced. The alternative borrow location in the lagoon is shown in Figure 7.3.

The disadvantage of this option is the unnecessary extension of impact footprint, which is sufficient to rule it out.

Should there be a shortage of sand, there is an option to dredge the alternative sites or to expand the reef entrance to 50 m. In this case, the alternative site is preferred as widening the reef
entrance any further will have repercussions on hydrodynamics and erosional pressures on the beach.

Another alternative to excavate the island within the footprint where vegetation removal is required and redistribute the soil evenly across the required backfilling zone. In doing so, the higher elevations will provide material for the lower areas and only the net amount will need to be excavated from the lagoon. This option is plausible but a decision cannot be taken without a comprehensive topographic survey, which is only possible after vegetation clearing. The impact footprint of this option is still the same as the original footprint. Impacts are also expected to be moderate as the soil will, in any case, be exposed.

However, given the need for a reef entrance and harbor basin and the potential for dredge waste reuse, the preferred option is the currently proposed option.

6.5 Alternative options for island access

An alternative option considered for island access is to use the Maafaru Island’s access jetty for the airport. This will require a shuttle bus service or taxi service to transfer passengers to and from the jetty to the airport terminal. If this option is to be considered, the existing island harbour needs to be substantially renovated, including the construction of a new jetty or a quaywall. The proponent will also have to invest in passenger buses to ensure that passengers from other islands are given access to the jetty. The existing roads will also need to be substantially developed for the vehicles to operate.

The main advantage of this option is the economic multiplier effects for Maafaru community. Since all passengers pass through their island, it provides an opportunity for small businesses such as tourist shops, utility shops and food outlets. Depending on the arrangement with the proponent, they may also provide a taxi service similar to Gan in Addu City. There will be substantial support from the community as well. If the proponent decided to upgrade the existing harbour facility, it also provides the dual benefit of community infrastructure development and airport development.

The disadvantages of this option are costs and inconveniences for the passengers. If a taxi service is introduced, the cost of reaching the airport will be higher. Thus, this option adds a burden to the rest of Noonu Atoll and provides a benefit to Maafaru community at the expense of the rest of the population.

At present, harbour is in a poor state, not fit to be used for an airport. Repairing the jetty or harbour will depend on the cooperation from both the Government and the Island Council. The proponents have no control over the development of the harbour in Maafaru.
EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

Noonu Atoll has some of the most exclusive resorts in the Maldives, such as the Cheval Blanc at Randheli and Velaa Private Island. A key clientele of the airport is expected to be guests visiting these high end resorts in their private jets. For these clients, privacy is of utmost importance. Using a land transport to access a jetty in Maafaru Island is a hindrance to privacy. Since, Maafaru jetty is a public location, maintaining security for these high profile visitors is also a challenge.

Moreover, the proposed project needs sand for backfilling. Accessing sand from the closest possible location is crucial for the project. Thus, creating a reef entrance and harbour basin provides viable and practical option to source sand.

Based on this assessment, creating a separate reef entrance is the preferred option.

6.6 Alternative Outfall Locations

The proposed location for the sewage outfall is outside the reef on the eastern side (See Figure 7.4). There is no alternative location as the western side is the atoll lagoon and the rest of the western side is inaccessible since any pipe will need to cross the runway.

The proposed location for the brine outfall is into the lagoon on the western side, under the arrival jetty. The proposed alternative is to combine the brine outfall pipe with the sewage outfall pipe. This would minimise the footprint of the pipelines, thereby reducing environmental impact of pipeline construction.

The options for water intake have not been decided at the time of this EIA. If a bore hole is used, the proposed brine outfall can be retained. If the lagoon is preferred for intake, then the preferred outfall location is on the eastern side, along with the sewage outfall pipe.

6.7 Alternative shore protection designs

Shore protection measures will form a significant cost of the overall project. The following are some of the options that could be considered as alternatives.

Table 7.3: Summary of alternative shore protection designs

<table>
<thead>
<tr>
<th>Options</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submerged near shore</td>
<td>- Avoids direct changes to the shoreline by placing the structures off shore</td>
<td>- Expensive</td>
</tr>
<tr>
<td>breakwater</td>
<td>- Can completely reduce wave energy and thereby creating a permanent beach</td>
<td>- Less efficient in reducing wave energy than the raised breakwater.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Requires beach maintenance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Not suitable for an industrial island</td>
</tr>
</tbody>
</table>
### EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

<table>
<thead>
<tr>
<th>Options</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- No change to aesthetics of the environment</td>
<td>- Need to construct breakwater right around the island.</td>
</tr>
<tr>
<td></td>
<td>- facilitates better seasonal sediment circulation around the island</td>
<td>- Additional impacts on reef</td>
</tr>
<tr>
<td>Raised near shore breakwater</td>
<td>- Avoids direct changes to the shoreline by placing the structures off shore</td>
<td>- Issues in water circulation and stagnation behind the breakwater</td>
</tr>
<tr>
<td></td>
<td>- Can completely reduce wave energy and thereby creating a permanent beach</td>
<td>- Very Expensive</td>
</tr>
<tr>
<td>Foreshore Revetment (current proposal)</td>
<td>- The sloping gradient ensures that wave energy is absorbed rather than deflected back, reducing the effects of standing waves.</td>
<td>- High cost</td>
</tr>
<tr>
<td></td>
<td>- Cost effective; uses local material to some extent</td>
<td>- Aesthetic issues</td>
</tr>
<tr>
<td></td>
<td>- Allows beach environment to function unobstructed, if there is sand outside the revetment; works like a beach rock area.</td>
<td>- absence of recreational beach</td>
</tr>
<tr>
<td></td>
<td>- Is a proven design in other islands</td>
<td>- Is sometimes slippery and can be a hazard.</td>
</tr>
<tr>
<td>Foreshore Seawall</td>
<td>- Mitigates erosion effectively by providing a permanent barrier</td>
<td>- May require high maintenance depending on workmanship.</td>
</tr>
<tr>
<td></td>
<td>- Comparatively cheaper to construct.</td>
<td></td>
</tr>
</tbody>
</table>

The preferred option for shore protection is a foreshore revetment based on lower cost, durability and efficiency in shore protection.
6.8 Alternative shore protection material

A number of alternatives could be used for coastal protection material both to improve the effectiveness and reduce the costs of development. The key alternatives are sand-cement bag revetments, concrete s-block revetments, concrete tetra pods or geo-bags. Comparison of these alternatives is provided below.

Table 7.4: Summary of alternative shore protection designs

<table>
<thead>
<tr>
<th>Alternatives / Environmental impacts</th>
<th>Armour rock (present option)</th>
<th>Concrete tetrapods</th>
<th>Sand-cement bag revetment</th>
<th>Concrete S-block revetment</th>
<th>Geobags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength against strong waves</td>
<td>Very High</td>
<td>Very High</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Applicability to current conditions</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Construction material</td>
<td>Rock</td>
<td>Concrete and aggregate</td>
<td>Sand and cement</td>
<td>Concrete and aggregate</td>
<td>Sand, geo textile</td>
</tr>
<tr>
<td>Maintenance requirement</td>
<td>Low</td>
<td>Very Low</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Durability</td>
<td>Very High</td>
<td>Very High</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Environmental Impacts during construction</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Aesthetic Impacts</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Cost</td>
<td>High</td>
<td>Very High</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
</tbody>
</table>

In general, the applicability of all options presented above is high for the proposed conditions on the island, albeit with the appropriate designs. In terms of environmental impacts during construction, all methods requiring sand as a material have had impacts on sand resources in the past. The proponent has decided that durability, low maintenance and low cost are key requirements due to the nature of this investment. Hence, the preferred method by the proponent is armour rock followed by geobags.
6.9 Dredging Alternatives

Table 7.5 indicates the alternative methods for dredging the reef entrance.

**Table 7.5: Summary of Dredging Alternatives**

<table>
<thead>
<tr>
<th>Dredging Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutter Suction Dredge (CSD)</td>
<td>Simple logistics</td>
<td>Not practical when the material is used for back filling</td>
</tr>
<tr>
<td><em>dredging sand and coral material from the shallow reef flat</em></td>
<td>Less negative impact on the ecology of the borrow area and nearby sensitive areas compared to THSD</td>
<td>Requires highly skilled operators</td>
</tr>
<tr>
<td></td>
<td>Impact of the re-suspension from the CSD at the borrow area can be better controlled than from the THSD at the atoll lagoon.</td>
<td>High costs</td>
</tr>
<tr>
<td>Excavator on temporary sand bed</td>
<td>Most common method practiced by contractors for small scale projects</td>
<td>Smothering of corals and increased siltation due to extra dredging for the creation of temporary sand bed</td>
</tr>
<tr>
<td></td>
<td>Does not require specialized skill</td>
<td>Project duration will be longer</td>
</tr>
<tr>
<td></td>
<td>Very cost-effective</td>
<td>Dredging depth will be limited to -4.5 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project cost higher if a contractor is used</td>
</tr>
</tbody>
</table>

The preferred option for sand sourcing is dredging sand from the immediate reef using an excavator mounted on temporary sand bed.
6.10 Sedimentation control measures

Table 7.6 indicates the alternative technologies for the sediment containment.

**Table 7.6 Summary of sediment containment measures**

<table>
<thead>
<tr>
<th>Type of Measure</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bund Wall (preferred option)</td>
<td>Effective method for containing sediments</td>
<td>High impact on marine environment when creating and removing the bund.</td>
</tr>
<tr>
<td></td>
<td>Durable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost effective</td>
<td></td>
</tr>
<tr>
<td>Silt screen</td>
<td>Durable</td>
<td>Large quantities not locally available</td>
</tr>
<tr>
<td></td>
<td>Easy to handle</td>
<td>Costly.</td>
</tr>
<tr>
<td></td>
<td>Environmentally friendly</td>
<td>Sometimes ineffective in SW monsoon conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May damage coral reefs during deployment.</td>
</tr>
</tbody>
</table>

Bund walls are preferred for the dredging activities undertaken during SW monsoon, due to the large amount of sedimentation anticipated.
Figure 7.2: Alternative locations for the airport
Figure 7.3: Alternative borrow areas

- **Alternative Borrow Area A**
  - Dimensions: 100 m x 100 m
  - Dredge depth: -4.0 m
  - Excavated Volume: 30,000 cbm

- **Proposed Vegetation removal zones** to be levelled by excavating 0.2 m of soil and redistributing across backfill area
  - Area: 188,000 sq m
  - Volume: 67,000 sq m

- **Revised Backfill Areas**
  - Total Area: 60,000 sq m
  - Average backfill height: 0.35 m
  - Estimated Volume: 27,000 cbm

- **Coastal backfill zone**

- **Boundary Line**

---

**Legend**

- **Airport Boundary**
- **Alternative Borrow Areas**
- **Jetty**
- **Revetment**
- **Backfill Areas**

---

Maafaru Island, Noonu Atoll
Proposed Airport Project
Alternative Borrow Areas

PROJECTION: Transverse Mercator (UTM Zone 43 N),
HORIZONTAL DATUM: WGS84;
All features based on GPS surveys (Nov 2014)
Map version: 24/12/2014
Surveyed and Prepared by: CDE Consulting, Maldives
Figure 7.4: Alternative intake and outfall locations
7 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) is an important component of the EIA process, needed to determine the accuracy of impact prediction, the adequacy of mitigation measures, and level of compliance with commitments regarding implementation of mitigation measures and monitoring of relevant environmental aspects.

The main objectives of the environmental management plan are to:

- Produce a framework for managing anticipated impacts, including practicable and achievable performance requirements and systems for monitoring, reporting and implementing corrective actions.
- Provide evidence of compliance to legislation, policies, guidelines and requirements of relevant authorities.

7.1 Environmental Management System

The environmental management framework for the proposed project is based on the standards and policies set out by the Environmental Protection Agency of the Maldives.

- **Environmental Management Planning and establishment of key performance indicators:** The EMP specifies environmental management measures and required performance standards
- **Monitoring and corrective action:** The implementation of EMP measures will be monitored. Any inconsistencies between the EMP and its on-site implementation will be identified and addressed through corrective actions
- **Auditing, reviews and improvement:** The EMP will be reviewed. Improvements to the EMP will be made as necessary to achieve desired environmental outcomes.

The environmental management strategy is demonstrated in the following figure.
7.2 Management Structure and Responsibilities

The following parties are involved in the EMP of this project:

- Project proponent
- Environmental consultant
- Environmental Protection Agency (EPA)

The roles and responsibilities of the parties involved are as follows.

7.2.1 Project proponent

- Execution of all project activities
- Preparation of EMP
7.2.2 Environmental Consultant

- Preparation of EMP
- Monitoring of performance of project activities according to the EMP
- Auditing the EMP to ensure desired outcomes are achieved
- Making amendments to the EMP according to the results of the audits
- Preparation of environmental monitoring report as required by the EPA (detailed in Chapter 8 of this report)

7.2.3 Environmental Protection Agency

- Review environmental monitoring report
- Intervention in the event of a breach in environmental permit conditions

7.3 Non-Conformances and Corrective Action

All non-conformances to the environmental permit conditions, observed during monitoring will be documented.

Necessary corrective actions and preventative actions will be identified

Corrective actions will be implemented, with systematic follow-ups to ensure effectiveness of these measures.

7.4 Reporting

Reporting shall be undertaken to provide evidence of the ongoing implementation of the EMP and will cover any training activities, site conditions and operations, monitoring data, details of non-conformances, incidents, complaints and follow up action, results of audits and reviews. Reporting shall be undertaken by the project proponent and the Environmental Consultant.

The environmental reporting process is summarized in the figure below. All non-compliances and complaints during the execution of the project are to be reported to the EPA. The environmental management plan for execution of the project is provided below.
Figure 8.2: Environmental Management Plan for construction and operation phase

**Environmental Protection Agency**
- Issues raised from periodic review of project
- Recording of complaints

**Project proponent**
- Training of personnel
- Environmental monitoring
- Recording of incidents
- Recording of complaints and follow up actions
- Review of EMP

**Environmental consultant**
- Training of personnel
- Environmental monitoring audits
- Review of EMP

Preparation of draft environmental report

Submission of report

Annual environmental monitoring report finalized

Prepared by: CDE Consulting
### Table 8.1: Environmental management plan for construction and operation phase

<table>
<thead>
<tr>
<th>Activity</th>
<th>Management measures</th>
<th>Responsible party</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training of staff and contractors</td>
<td>All construction workers and project management staff provided with information on general environmental issues, compliance with environmental permits and EMP. All staff involved with environmental monitoring provided with training in environmental monitoring procedures.</td>
<td>Proponent &amp; Environmental Consultant</td>
<td>Before commencement of construction activities</td>
</tr>
<tr>
<td>Documenting non-conformances and corrective actions</td>
<td>All non-conformances to the environmental permit conditions, observed during monitoring will be documented. Necessary corrective actions and preventative actions will be identified Corrective actions implemented, with systematic follow ups to ensure effectiveness of these measures</td>
<td>Proponent &amp; Environmental consultant</td>
<td>Continuous during construction phase</td>
</tr>
<tr>
<td>Managing marine environment impacts</td>
<td>Deploying sediment control measures Complete works in shortest time period possible Prepare contingencies for equipment failure. Carry out work in low tide hours, calm condition Carry out work in NE monsoon, is possible Minimize affected area and preserve areas not in direct footprint for relocation of fauna When back filling the marshlands, start work adjacent to the existing dry area and</td>
<td>Contractor</td>
<td>Continuous during construction phase</td>
</tr>
<tr>
<td>Activity</td>
<td>Management measures</td>
<td>Responsible party</td>
<td>Timing</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>Gradually go outwards.</td>
<td>Do not fill the existing opening in the beach that connects the lagoon to marshland.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control of water and soil contamination</td>
<td>Oil, solid waste &amp; hazardous waste handled carefully &amp; transported in sealed containers.</td>
<td>Proponent</td>
<td>Continuous during construction phase</td>
</tr>
<tr>
<td></td>
<td>All paints, lubricants, and other chemicals used on site stored in a secure and bunded location</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All raw materials stored away from the vicinity of the coastal areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General refuse stockpiled in one central area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Keep spill clean-up materials readily available</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Train workers in spill prevention and clean-up, and designate responsible individuals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Properly tune and maintain all machinery</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carry out construction activities user the supervision of a suitably experiences person</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre-fabricate columns and footings away from shore</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regular visual inspection of surrounding marine environment for waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid waste management</td>
<td>All public areas equipped with trash bins</td>
<td>Proponent/contractor</td>
<td>Continuous, during construction and</td>
</tr>
<tr>
<td></td>
<td>Give clear instruction regarding procedures for handling of chemicals and solid</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prepared by: CDE Consulting
<table>
<thead>
<tr>
<th>Activity</th>
<th>Management measures</th>
<th>Responsible party</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>waste during construction</td>
<td>Raise awareness among the staff about environmental friendly practices.</td>
<td></td>
<td>operation phase</td>
</tr>
<tr>
<td></td>
<td>A separate waste management area established</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hazardous waste transported to waste management centre in Thilafushi.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waste oil from the generators incinerated.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water management</td>
<td>Control water use and avoid excessive irrigation</td>
<td>Proponent</td>
<td>Continuous throughout construction</td>
</tr>
<tr>
<td></td>
<td>Maintain septic tanks and avoid seepage of untreated wastewater into soil and groundwater</td>
<td></td>
<td>and operation phase</td>
</tr>
<tr>
<td></td>
<td>Discharge extracted water within the island to assist aquifer recharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel management</td>
<td>Diesel fuel stored in a steel fuel storage tank located near the generators</td>
<td>Proponent</td>
<td>Continuous throughout construction</td>
</tr>
<tr>
<td></td>
<td>Aviation fuel storage areas made easily accessible and fuel bowsers refuel on sealed concrete floors.</td>
<td></td>
<td>and operation phase</td>
</tr>
<tr>
<td></td>
<td>LPG and kerosene barrels will be stored in an appropriate building</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All areas on the island where diesel or other fuels are stored and handled is be sealed with a fuel-resistant impervious lining.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure tight fittings and appropriate material in transportation,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Precautions to avoid spilling of diesel fuel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Activity Management measures

<table>
<thead>
<tr>
<th>Activity</th>
<th>Management measures</th>
<th>Responsible party</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appropriate execution of construction and sealing of the main fuel tank</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Regular inspections of the welded seams of fuel tanks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sewage Management</strong></td>
<td><strong>Properly construct and maintain septic tanks</strong></td>
<td>Proponent</td>
<td>Continuous throughout operation phase</td>
</tr>
<tr>
<td></td>
<td><strong>Undertake regular inspection of sewerage system</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Dispose of sewage in suitable location to allow dilution</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Coastal process impact minimization</strong></td>
<td><strong>Construct the proposed coastal protection measures on time</strong></td>
<td>Proponent</td>
<td>Continuous during construction phase</td>
</tr>
<tr>
<td></td>
<td><strong>Carry out work in low tide hours and in calm condition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Complete works in shortest time period possible</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Managing flora and fauna removal</strong></td>
<td><strong>The scheduling of the vegetation clearing activities</strong></td>
<td>Proponent</td>
<td>Continuous during construction phase</td>
</tr>
<tr>
<td></td>
<td><strong>clearing works will be carried out during day time</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Plant two trees for every single large tree lost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Breakwater/revetments will be construction to mitigate coastal erosion associated with vegetation clearing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Only remove trees in areas that will require clearing.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Strict guidelines and construction monitoring</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Natural profiling of vegetation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>Management measures</td>
<td>Responsible party</td>
<td>Timing</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>-------------------------------</td>
</tr>
</tbody>
</table>
| Use native species for landscaping as far as possible | Manage and monitor effects of any introduced species on local biodiversity  
Monitor pest sightings and take action to control infestations  
Clear green waste to prevent pest infestations  
Trees should be dug at least 3 foot wide of the trunk.  
The root system should be watered to keep it wet and cemented before digging.  
The roots should be kept wet during transportation.  
A monitoring mechanism to check the survival rate of trees  
Where possible, leave the trees after cutting down for a few hours before transporting  
Relocate all the mangrove vegetation to the southernmost marshland of Maafaru. Alternatively, it may be transplanted to an island with a large marsh land in Noonu Atoll. | Proponent       | Continuous during construction phase |
| Artificial drainage system installation | The runway strip will be constructed using porous asphalt and concrete drainages will be constructed on both sides of the runway to manage stormwater runoff.                                                                                                                                                                                                  | Proponent       | Continuous during construction phase |
| Place lidded garbage bins within the airport boundary. |                                                                                                                                                                                                                                                                                                                                                                           |                  | Continuous throughout         |
**Activity** | **Management measures** | **Responsible party** | **Timing**
---|---|---|---
Ensure compliance with the Maldives Civil Aviation Act and Maldives Civil Aviation Regulations and penalise non-compliance. | | operation phase
Place a quota on the number of aircraft landings and take-offs at the airport | | 
Establish bird scaring mechanisms such as placing scarecrows | | 
**Occupational Health Impact management** | Implement health and safety precautions described in Section 2.8.5 | Proponent | Continuous throughout construction and operation phase
Proper insulation in powerhouse | | 
**Social Conflict management** | Employ local residents as far as possible | Proponent | Continuous throughout construction and operation phase
Provide proper orientation to all workers regarding local values and customs | | 
Inform and consult all stakeholders at all stages of the project | | 
**Supervision of project activities** | Assign suitably experienced and qualified personnel to supervise the entire project and ensure that all activities are carried out with minimal adverse impact on the environment | Proponent | Before commencement of the project
8 ENVIRONMENTAL MONITORING PLAN

8.1 Introduction

This chapter will outline the monitoring plan for the proposed project. Environmental monitoring is essential because, although with proper mitigation measures, the overall environmental damage can be significantly minimized, an unforeseen impact may still occur. Furthermore, some of the impacts predicted may turn out to be far greater than predicted, making mitigation measures ineffective. Therefore, in order to avoid or reduce the chances of such events, regular and frequent environmental monitoring is vital.

8.2 Objectives of the Monitoring Plan

The main objectives of the monitoring plan are:

1) To identify whether the predicted impacts are accurate and mitigation measures taken are effective

2) To identify any unforeseen impacts so that appropriate mitigation measures can be taken at the earliest

3) To identify and resolve any issues of social unrest at the earliest

4) To eliminate or reduce environmental costs

8.3 Construction Phase Monitoring Plan

Table 8.1 below summarizes the key aspects of the construction phase monitoring plan. The Table indicates the methodology, frequency and estimated cost for each monitoring attribute that will be required for the proposed project.
### Table 8.1: Monitoring Schedule for Construction Stage

<table>
<thead>
<tr>
<th>Monitoring Attribute</th>
<th>Indicator</th>
<th>Methodology</th>
<th>Frequency</th>
<th>Indicative cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Contamination (Marine)</td>
<td>Water quality(^1)</td>
<td>Laboratory analysis</td>
<td>On every six months during construction and once annually during operational phase</td>
<td>US$300 per survey</td>
</tr>
<tr>
<td>Water contamination (ground water)</td>
<td>Water quality(^2)</td>
<td>Laboratory analysis</td>
<td>On every six months during construction and once annually during operational phase</td>
<td>US$300 per survey</td>
</tr>
<tr>
<td>Solid Waste monitoring</td>
<td>Waste generation levels</td>
<td>Daily assessment of waste quantities and records of ultimate disposal Waste census</td>
<td>Monthly during the construction and annually during operation</td>
<td>US$100 per survey</td>
</tr>
<tr>
<td>Marine Water Contamination</td>
<td>Water quality</td>
<td>Laboratory analysis</td>
<td>On completion of project and thereafter annually</td>
<td>US$300 per survey</td>
</tr>
<tr>
<td></td>
<td>Oil spills</td>
<td>Visual observation</td>
<td>Weekly for the duration of the project</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Oil leakage from machinery or vessels</td>
<td>Maintenance and tuning of all machinery &amp; vessels</td>
<td>Weekly during the construction phase</td>
<td>US$75 per week</td>
</tr>
</tbody>
</table>

\(^1\) Parameters for analyses is provided by EPA in its water quality assessment guidelines for EIA
### EIA for the proposed Airport Development Project in Maafaru, Noonu Atoll

<table>
<thead>
<tr>
<th>Monitoring Attribute</th>
<th>Indicator</th>
<th>Methodology</th>
<th>Frequency</th>
<th>Indicative cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coral reef health</td>
<td>Percentage of coral cover (both live and dead)</td>
<td>Line transect survey; Fish census; Manta tow</td>
<td>Once before initiation of project and completion of project, and thereafter annually</td>
<td>US$500 per survey</td>
</tr>
<tr>
<td></td>
<td>Species composition of coral communities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Numbers, species composition, and structure of fish populations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal conditions</td>
<td>beach line (at high tide &amp; low tide) new island</td>
<td>D-GPS tracks along the beach</td>
<td></td>
<td>US$300 per survey</td>
</tr>
<tr>
<td></td>
<td>Longshore currents</td>
<td>Drogue method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Depth</td>
<td>Water Depth</td>
<td>Sonarmite or handheld echosounder</td>
<td>Two months after completion of the project and thereafter annually.</td>
<td>US$500 per survey</td>
</tr>
<tr>
<td>Vegetation</td>
<td>No of trees removed from the island</td>
<td>Logs</td>
<td>Weekly for the duration of the project; Annually thereafter</td>
<td>Included in administrative costs</td>
</tr>
</tbody>
</table>
### Operations Phase Monitoring Plan

#### Terrestrial Environment

With the completion of the construction, monitoring will be undertaken for terrestrial environment in conjunction with a more comprehensive program of monitoring for the whole island. There will be a performance evaluation plan and indicators in place once the airport is operational to evaluate the changes and impacts on the terrestrial environment. Performance indicators that would apply to the terrestrial environment include indicators for:

- The extent of the remaining vegetation cover in the island.
- The number of trees successfully replanted and the number of trees that fails to survive.
- Noise levels from the operation of the airport and their social and ecological effects (mainly on birds and turtles).
- Effects of night flight operations on turtle breeding.
- Changes in air quality due to vegetation removal.
- Evidence of soil contamination.
- Changes to turtle breeding and feeding activity; turtle abundance

<table>
<thead>
<tr>
<th>Monitoring Attribute</th>
<th>Indicator</th>
<th>Methodology</th>
<th>Frequency</th>
<th>Indicative cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>Number of foreigners and locals employed</td>
<td>Logs</td>
<td>Annually</td>
<td>Included in administrative costs</td>
</tr>
<tr>
<td>Social conflicts</td>
<td>Reported incidences of social conflicts related to the island</td>
<td>Logs</td>
<td>Annually</td>
<td>Included in administrative costs</td>
</tr>
</tbody>
</table>
- Changes to bird species behaviour and their presence; effects of birds scaring mechanisms.
- Changes in bird colonies and other animal species.
- Land loss due to coastal erosion
- Changes to the shoreline
- Changes to groundwater aquifer and its quality, particularly, salinity.

**Table 8.2: Implementation schedule for the terrestrial environment monitoring**

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency of monitoring</th>
<th>Main Concerns to address</th>
<th>What to monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flora</td>
<td>Six monthly</td>
<td>Vegetation regrowth in newly replanted trees.</td>
<td>Presence, loss or damage</td>
</tr>
<tr>
<td>Flora</td>
<td>Annually</td>
<td>Vegetation loss or increase indicates either damage or improvement to the flora.</td>
<td>The amounts of vegetation cover in the newly revegetated zones of the airport.</td>
</tr>
<tr>
<td>Fauna - Birds</td>
<td>Three monthly</td>
<td>Assess whether bird numbers are decreasing or increasing.</td>
<td>Bird species and numbers</td>
</tr>
<tr>
<td>Fauna – turtle nesting sites</td>
<td>Three monthly</td>
<td>Identification of turtle nesting sites within the island</td>
<td>Number of turtle nests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Identification nesting activity during night operations</td>
<td>Number of turtles found in lagoon</td>
</tr>
<tr>
<td>Soil</td>
<td>Six monthly</td>
<td>Ensure that airport operation activities do not contaminate the soil and land, especially as a result of fuel and chemical storage, transportation handling and use.</td>
<td>Evidence of soil contamination in high risk locations such as outside the fuel storage area, near the power house, garages (if any).</td>
</tr>
<tr>
<td>Air and noise</td>
<td>Three monthly</td>
<td>Changes in noise levels and air quality</td>
<td>Noise and air quality measurements in standard units</td>
</tr>
</tbody>
</table>

**8.4.1.1 Water quality**

Monitoring and auditing of ground and marine water quality is vital for environmental protection of islands. Considering this as an important component, a baseline data set was gathered based on the existing data and field surveys conducted for the EIA. This monitoring programme would be required to ensure the implementation of the recommended water quality mitigation measures and to assess the effectiveness of these measures. If monitoring results indicate that the water
quality is not improving after the implementation of the recommended mitigation measures, then appropriate alternatives need to be carefully considered.

Table 8.3 outlines the implementation schedule for water quality monitoring, both ground and marine water. Baseline data for groundwater was collected from two locations. However, once the proposed development goes into operation, additional monitoring locations will be identified and selected for continuous monitoring. These locations will be preserved and marked for monitoring purpose.

Table 8.3: Implementation schedule for the water quality monitoring programme

<table>
<thead>
<tr>
<th>Type of water and location</th>
<th>Frequency of monitoring</th>
<th>Main Concerns to address</th>
<th>Parameters to monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground water from the well from which baseline data was collected</td>
<td>Every month for the first year and then three monthly</td>
<td>Assess the changes to groundwater quality in terms of salinity.</td>
<td>Electrical conductivity</td>
</tr>
<tr>
<td>Ground water from the well from which baseline data was collected</td>
<td>Every month for the first year and then three monthly</td>
<td>Assess the changes to groundwater quality in terms of nitrates and phosphates.</td>
<td>Nitrates and Phosphates</td>
</tr>
<tr>
<td>Ground water from selected locations</td>
<td>Every month for the first year and then three monthly</td>
<td>Identify any faecal contamination from a possible leak from the retention tank or the sewerage network.</td>
<td>Faecal, total coliforms</td>
</tr>
<tr>
<td>Ground water from selected locations</td>
<td>Every three months for the first year and then twice a year</td>
<td>To assess oil contamination from and around the location where oil is stored or from around the power house</td>
<td>Hydrocarbons</td>
</tr>
<tr>
<td>Seawater quality of the lagoon near the brine discharge location</td>
<td>Every three months</td>
<td>Water quality control in the immediate lagoon to ensure that water quality is not affected by brine discharge.</td>
<td>Temperature variance, Salinity</td>
</tr>
<tr>
<td>Seawater quality of the lagoon from all the five locations from where baseline data was collected.</td>
<td>Every six months</td>
<td>Assess changes to water quality in terms of nutrient loading</td>
<td>Nitrates and Phosphates</td>
</tr>
<tr>
<td>Seawater quality near the sewage outfall</td>
<td>Every three months</td>
<td>Water quality of the lagoon around the outfall and ensure quality standards are within acceptable limits.</td>
<td>BOD5, Nitrates, Phosphates, Faecal and total coliforms,</td>
</tr>
</tbody>
</table>
8.4.2 Monitoring the marine environment

Ecological change often occurs gradually over time. Therefore, long term monitoring and research programs are necessary to accurately assess environmental change. This is particularly true when the change is due to small but chronic perturbations to the environment which have a cumulative effect. It should be kept in mind that (1) many ecological processes are slow occurring over a number of years, (2) inter-annual variability is often high, (3) short term studies miss rare but important events, and (4) monitoring only reveals recent historical events. It should be noted, however, that the proposed activities involve high level turbidity and sedimentation and therefore may have faster rate of environmental change.

The objectives of this monitoring programme are to detect and document the changes occurring to the reef system due to the proposed project. The purpose will be to 1) assess the magnitude of the impacts resulting from the various phases of the project activities 2) evaluate the success of a particular management action, 3) to quantify the change in abundances of certain marine organisms, e.g. indicator species near a sewage outfall and elsewhere to compare.

Table 8.4 gives the coral reef monitoring schedule recommended for the long-term evaluation of reef system and ambient marine environment for impact assessment and mitigation of impacts.

**Table 8.4: Reef monitoring schedule**

<table>
<thead>
<tr>
<th>Parameter/Method</th>
<th>Frequency of Monitoring</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Environmental Parameters</td>
<td>Twice a month in construction once every month in operation</td>
<td>Important to the ‘health’ of living marine resources, reefs and fish populations and other benthos</td>
</tr>
<tr>
<td>Temperature, Salinity, Turbidity/light penetration, Currents</td>
<td>Once every year or following a significant natural event e.g. coral bleaching, COT infestation etc.</td>
<td>Broad scale qualitative and semi-quantitative assessment of general status of the reef system / coral and other benthic recruitment</td>
</tr>
<tr>
<td>General status of reef Manta Tow Technique</td>
<td>Once a month in construction once every 6 months in operation</td>
<td>Broad scale semi quantitative assessment of anthropogenic activities e.g. wastes disposal, amount of rubbish on the reef and general appeal of the reef system</td>
</tr>
<tr>
<td>Marine Environmental Aesthetic Survey using Time Swim and Manta Tow Technique</td>
<td>Once in 3 months in construction once every 6 months in operation</td>
<td>Quantitative assessment of fish population of selected species</td>
</tr>
<tr>
<td>Fish population structure / Underwater Fish Census</td>
<td>Once every 3 months in construction once every 6 months in operation</td>
<td>Quantitative assessment of temporal changes in the reef system e.g. coral growth rates</td>
</tr>
<tr>
<td>Benthic cover of reef / Permanent Photo quadrats</td>
<td>Twice a week in construction once every 3 months in operation</td>
<td>Quantitative assessment of sediment loading on the reef benthos.</td>
</tr>
<tr>
<td>Sedimentation / Sediment traps deployment/collection</td>
<td>Twice a month in</td>
<td>Quantitative assessment of Nitrogen</td>
</tr>
<tr>
<td>Water quality test / Nitrates,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8.4.3 Coastal zone monitoring

The coastal environment of the island including beaches and bathymetry of the lagoon may be affected as a result of the proposed development. Therefore it may be necessary to monitor beach profiles at monthly intervals during the proposed construction phase and thereafter.

Table 8.5 gives the monitoring requirements for the coastal zone to assess the effectiveness of the mitigation measures so that alternatives can be identified if the measures taken are ineffective.

Table 8.5: Environmental monitoring requirements for the coastal zone

<table>
<thead>
<tr>
<th>Monitoring Parameter</th>
<th>Indicators</th>
<th>Baseline/Reference values</th>
<th>Technique</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach lines</td>
<td>Sediment distribution</td>
<td>Baseline given in EIA report</td>
<td>Differential GPS</td>
<td>3-monthly</td>
</tr>
<tr>
<td>Beach Profiles</td>
<td>Rates of accretion and/or erosion</td>
<td>Baseline data collected by EIA consultants</td>
<td>Beach profile surveys</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Currents</td>
<td>Nearshore currents</td>
<td>To be established</td>
<td>Drogue (spaghetti diagrams)</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Coastal Water Quality</td>
<td>Nutrients, DO, Coliforms, pH and toxic substances</td>
<td>Internationally recognised safety reference values available</td>
<td>Laboratory Analysis</td>
<td>Twice a year for standard monitoring. More frequently in port basins and adjacent waters.</td>
</tr>
</tbody>
</table>

8.5 Socio-economic impact monitoring

Impacts on employment, trade of local good and improved transportation are the key impact areas identified for this project. The following indicators are proposed to measure the socio-economic impacts. While some of this data can be obtained from official sources other data has to be obtained through surveys using pre-designed questionnaires. Since the social and economic impacts of the project are as important as the physical environmental impacts the project proponent should give due attention to socio-economic impact monitoring.
Table 8.6 Monitoring socio-economic conditions

<table>
<thead>
<tr>
<th>Impact Area</th>
<th>Data sought</th>
<th>Min. Frequency</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>Percentage of employees from the atoll and nearby islands</td>
<td>Once a year</td>
<td>To understand the impacts on employment and income levels from the project</td>
</tr>
<tr>
<td></td>
<td>Number of female employees from the atoll and nearby islands</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequency and number of islands to which there is regular ferry from the airport</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unemployment rate in the atoll and nearby islands</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Income poverty in the atoll and nearby islands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade in local goods</td>
<td>Volume of agricultural products exported through the airport</td>
<td>Once a year</td>
<td>To determine the impacts of the airport operation on trade and economic development in the atoll</td>
</tr>
<tr>
<td></td>
<td>Volume of fish products exported through the airport</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Value of local produce exported</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of economic establishments in Maafaru, particularly those servicing the proposed investment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved transportation</td>
<td>No of passengers using the airport</td>
<td>On a yearly basis</td>
<td>To evaluate the changes in transportation patterns in the atoll</td>
</tr>
<tr>
<td></td>
<td>No of passengers using marine transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No of ferry trips reaching Maafaru</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.6 Monitoring report

A detailed environmental monitoring report is required to be compiled and submitted to the Ministry of Environment yearly based on the data collected for monitoring the parameters included in the monitoring plan given in the EIA. This report may be submitted to the relevant Government agencies in order to demonstrate compliance. If required, however, a monitoring report for the proposed work phase may be prepared and submitted to the Ministry of Environment. 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. In addition to this more frequent reporting of environmental monitoring will be communicated among the environmental consultant, project proponent, the contractors and supervisors to ensure possible negative impacts are mitigated appropriately during and after the project.
8.7 Cost of monitoring

The cost of monitoring is estimated to be US$ 5,000 annually. Professional consultants will be hired to undertake the monitoring and the necessary equipment for monitoring will be procured.

8.8 Commitment to monitoring

The proponent is fully committed to undertake the monitoring programme given in this chapter (see Appendix N).
9 STAKEHOLDER CONSULTATIONS

Public consultation

This section reports on the public consultation undertaken on the proposed development of an airport in Noonu atoll Maafaru. Stakeholder perceptions were identified through consultation meeting with Noonu atoll council, interviews during field visit in Manadhoo, Maafaru islands and Irufushi resort and existing information from reports for other projects in the region. To identify more about the impacts of airport development on transport, employment, trade and the change in economic structure, employment monitoring has been included in the monitoring programme and is expected to form an integral and important component of the Annual Monitoring Report.

The public consultation for this EIA was undertaken during the field survey visits. The public consultation was undertaken in Noonu Atoll. The study team visited Manadhoo and Maafaru island and Irufushi resort to seek their views. Stakeholder perceptions were assessed by interviews with selected stakeholders. The key stakeholders identified for assessment were the following groups:

- Noonu atoll council
- Manadhoo Island Council
- Maafaru Island Council
- Irufushi Resort
- Residents of Maafaru island

The participant list is attached in Annex M.

Q.1 What do you think of development of an airport in Noonu atoll?

Everyone consulted from Noonu atoll welcome the idea of an airport in Noonu atoll. They describe transport as one of the biggest challenges to progress in development in Noonu atoll. Their reasoning are distance between Hulhule International airport and capital Male’ from Noonu atoll and the challenges that pose to transport to the atoll. There are no inter-atoll ferries operating within Noonu atoll.

There were differing consensuses on the best ideal location for the airport development. People from Velidhoo and Holhudhoo expressed the distance factor to Maafaru and the rough seas that might pose challenging for their residents to travel to the airport during seasonal changes.
However, they welcome an airport in any island of Noonu atoll to free from the challenges that exist at present for transport to Male’ for access to services and needs.

The public who took part in the consultation meeting in Maafaru expressed unanimous consensus on the idea of developing an airport in Noonu atoll Maafaru island. Their only concern is the delay in the process.

Q2. What benefits do you see in an airport development in this atoll/island?

The people of Noonu atoll highlighted three potential benefits from an airport development in their atoll

a. Ease in transport to the capital island Male’ city for access to health care and for trade, banking and other dealings with the government agencies.
b. Ease in transport for the people of Noonu atoll working in resorts, to fly directly to their home islands instead of flying through Male’. Hence better opportunities for family bonding.
c. Ease in transport for local guesthouse tourism expansion and resort tourism enhancement in the atoll.

Q3. Are there any challenges or negative impacts?

There were no negative impacts identified by the participants, from an airport development in Maafaru island.

Q4. What other opportunities or problems do you see with ease in transportation?

The opportunity for enhancing employment, trade and tourism related activities was shared by the participants

Q5. What do you expect from an airport in Maafaru?

- Jobs both during construction stage and during operational stage for local people were highly expected.
- Easy and efficient access to community members for transportation from the atoll to Male’.
- Opportunities for trade of goods between islands and Male’ and other atolls.

Consultations with Irufushi resort revealed that at present seaplanes operate only during the daylight hours. Hence transfers for night arrivals are halted at the moment and guests are arranged accommodation at airport hotel in Hulhule. With an airport operational within the atoll, night transfers can be made possible which would be more welcoming for the tourist visitors and the resort as well.
Q6. Are there any resource conflicts?

The land allocated in Maafaru for airport development does not have any cultural or heritage sites. Any plants and trees that need to be given compensation have been already arranged. The land is a common resource of the island and the wish of the people in the island is to utilize it for airport development and they express no resource conflicts arising from airport development in the allocated area for airport development.
10 Potential Data Gaps and Assessment Limitations

10.1 Gaps in Information

The environment of Maldives is generally poorly understood. This may be due to the lack of detailed studies in the Maldives. Much of the literatures on coral islands are derived from studies done in the Pacific which unfortunately has very different climatic and geologic settings.

Detailed environmental analysis for an EIA is often required to be undertaken in a relatively short period of time. Give the seasonal climatic variations in Maldives and the differences in local geomorphologic and climate settings in individual islands such a short time frame is often too little to assess selected aspects of the environment. This problem is compounded by the absence of long-term studies in other parts of Maldives. Hence, most EIA’s end up being based on an environmental snapshot of specific point in time. However, experienced EIA specialists can deliver a close match to reality based on a number of similar assessments. In this regard, the following gaps could be identified in information.

− Absence of long-term site specific or even regional data (at least 2 years). Most critical data include current, wave and terrestrial modification history.
− Absence of historical and long-term records on reef and lagoon environment.

These gaps are seriously considered in the assessment and care has been taken to address the issue in designing mitigation measures and the monitoring programme.

10.2 Uncertainties in Impact Prediction

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. As note earlier, there is also no long term data and information regarding the particular site under consideration, which makes it difficult to predict impacts. However, the level of uncertainty is partially minimised due to the experience of past dredging and reclamation projects in similar settings in the Maldives. Nevertheless, it is important to consider that there will be uncertainties and voluntary monitoring of natural processes as described in the monitoring programme is absolutely essential.
11 Conclusions

The key conclusions of this EIA are summarized below.

The project involves construction of domestic airport on Maafaru Island, Noonu Atoll. Maafaru Island is one of the largest Islands in Noonu Atoll and the airport will be developed on the uninhabited southern half of the island. The airport will consist of a 1800m runway, aircraft parking aprons, passenger terminal, air traffic control facilities, fire and safety facilities and utilities, among others. The airport will also dredge a reef entrance and harbour basin, and construct a jetty specifically to access the airport. The eastern shoreline of the airport will be protected using a revetment. The operation stage of the project involves operating the domestic airport.

The main components of this project are mobilization and setup; vegetation clearance, dredging reef entrance and harbour basin; backfilling and levelling low lying areas and marshlands in Maafaru; constructing runway and apron; constructing service building and utilities; establishing air traffic controls, fire and safety and navigation systems; and constructing shore protection measures.

The proposed developments are generally in conformance to the laws and regulations of the Maldives. Additional approvals are required for the following before commencement of project activities, particularly the Dewatering application and approval before commencement of any dewatering activities.

The following approvals will be required before commencement of operations

- Aerodrome certification and licensing from Civil Aviation
- Registration of the power plants with Maldives Energy Authority (if required)
- Registration of Desalination Plant
- Registration of waste facility

The proposed site has been modified due to human activities. Overall, the island and reef system represents a typical inhabited island with modified vegetation for forestry, contaminated groundwater and moderately good reef system. The proposed site has been partially been cleared under the original area but 90% of the vegetation is still intact. There is a sand bed on the western side created by the previous developers. Maafaru Island’s vegetation system is extensive. There are five marshland areas on the island, three of which will be backfilled under this project. One of the marshland areas contains some mangrove vegetation. The central marshland area has recently connected to open lagoon, bringing in juvenile marine life. The site
may be considered a breeding site but no concrete evidence was found in this evaluation to classify the site as a breeding site. The mangrove vegetation area is very small but 85% of these trees will have to be relocated. The island topography is varied and will require extensive backfilling to level the site. The reef system is in moderately good condition. The deep lagoon contains some good live coral colonies. The proposed dredging footprint does not contain any live coral colonies but contains an extensive seagrass bed. The island is undergoing erosion on the northern and eastern side but the proposed airport site is generally stable.

Significant impacts are expected to arise mainly during the construction phase of the project. These impacts include significant loss of terrestrial biodiversity. Of particular concern is the removal of over 20,000 trees, relocation of mangrove vegetation, and backfilling a recently active marshland with juvenile life. Impacts will also be felt on marine biodiversity due dredging and reclamation due to associated direct removal, turbidity and sedimentation; contamination of marine and ground water and soil due to accidental spillage/leakage of construction materials and waste; increased turbidity and sedimentation of the water column due to coastal activities; changes to coastal hydrodynamics; salinization of ground water due to use of dredged sand for backfilling and risks to the health of construction workers. Major potential impacts from the operational phase include pollution of air, water and soil due to emissions from island operations such as power generation, water production and flight operations; bird collisions; potential fuel leaks into soil and ground water; impacts from waste accumulation and alteration of faunal species behaviour.

Mitigation measures have been proposed to minimise anticipated impacts. These include measure to minimise sedimentation and turbidity in the lagoon, salinization and contamination of ground water, loss of useable trees, loss of mangrove vegetation, social discontent, coastal erosion and safety of workers and passengers.

Alternative options have been evaluated for the most significant impacts. Alternatives evaluated include alternative locations for the proposed airport location, including Manadhoo, Dhigurah and Medhufaru; alternative option for locating the runway on Maafaru Island and reef system; alternative borrow areas; alternative shore protection measures, alternative dredging technologies and alternative shore protection materials. The currently proposed options were preferred over the alternatives.

A framework for environmental management has been developed for the airport, in order to manage activities to reduce anticipated impacts and identify and address unanticipated impacts as soon as possible. A monitoring plan has been designed to monitor changes to different natural and social environmental aspects related to the project over time.
Consultations were carried out relevant stakeholders and the project has approvals from the relevant authorities. All parties consulted had no serious concern regarding the proposed new project in Maafaru and concerns have only been raised about the delays in moving the project forward.

The project has significant terrestrial environmental impacts. However, the scale of the impacts are not irreversible at a regional or atoll level. The loss of the mangrove vegetation is insignificant compared to the mangrove vegetation that exists in Noonu Atoll. The number of wetlands in the near vicinity of Maafaru is also quite substantial and will allow for the migratory birds relocate easily. The establishment of marshland as a habitat for juveniles is a very recent development and it does not appear that the marine species are using it as a permanent breeding site. The site is also not listed as a sensitive environment owing to the limited presence of sensitive ecosystems. Thus, this report concludes that the project should be implemented on grounds of very high socio-economic benefits.

Consultations were held with Noon Atoll Council, Maafaru Island Council, Manadhoo Island Council, Maafaru public, management of Irufushi and some staff members of Irufushi. There is overwhelming support for the project. Some members of the public from the islands on the western rim (Velidhoo and Hollhudhoo) expressed concern about their distance to Maafaru Airport and would have preferred a more central location for the airport.

Environmental and socio-economic risks associated with the project are expected to be significantly reduced if the mitigation measures and monitoring programme presented in the report are properly implemented within the framework of the environmental management plan.

The project is expected to provide unprecedented socio-economic benefits to the local community, tourism industry and the country as a whole.
REFERENCES


Moosa, H. F. 2013. ‘Maafaru 20,000 Hussain Fiyaz Moosa ah vure gina ruh maruvejje!’ Haveeru Online, 24 January


Lamer (2011) EIA Report for Resort Development at Kudavillingili, Kudavillingili Development Pvt Ltd.


APPENDIX A – Terms of Reference
Terms of Reference for Environmental Impact Assessment for the Airport Development Project at Maafaru, Noonu Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on 23/07/2014 for undertaking the EIA of the proposed airport development project at Maafaru Island, Noonu Atoll.

While every attempt has been made to ensure that this TOR addresses all of the major issues associated with development proposal, they are not necessarily exhaustive. They should not be interpreted as excluding from consideration matters deemed to be significant but not incorporated in them, or matters currently unforeseen, that emerge as important or significant from environmental studies, or otherwise, during the course of preparation of the EIA report.

1. **Introduction and rationale**—Describe the purpose of the project and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific and if possible quantified. Define the arrangements required for the environmental assessment including how work carried out under this contract is linked to other activities that are carried out or that is being carried out within the project boundary. Identify the donors and the institutional arrangements relevant to this project.

2. **Study area**—Submit a minimum A3 size scaled plan with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size. The study area should include adjacent or remote areas, such as relevant developments and nearby environmentally sensitive sites (e.g., coral reef, sea grass, mangroves, marine protected areas, special bird sites, sensitive species nursery and feeding grounds). Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.

3. **Scope of work**—Identify and number tasks of the project including preparation, construction and decommissioning phases.

   **Task 1. Description of the proposed project**—Provide a full description and justification of the relevant parts of the works, using maps at appropriate scales where necessary. The following should be provided (all inputs and outputs related to the proposed activities shall be justified):

   The main aspects which should be considered in project description include:

   - Land clearing for runway construction
   - Dredging method for channel
   - Vegetation removal and management
   - Construction of the runway and apron
   - Construction of passenger facilities
• Construction of transport facilities including road and access jetty
• Labour requirement and availability
• Coastal protection
• Waste management
• Safety measures including fire prevention
• Utilities (power, water etc...)
• Sewage and waste water disposal/management
• Demobilisation
• Summary of inputs and outputs for each component of the proposed development (airport and harbour)
• Environmental monitoring during construction activities;
• Measures to protect environmental values during construction and once the new island has been established;

Project management (include scheduling and duration of the project and life span of facilities; communication of construction details, progress, target dates, construction/operation/closure of labour camps, access to site, safety, equipment and material storage, fuel management and emergency plan in case of spills)

Vegetation clearance:
• Define the total area of cleared vegetation;
• Estimated number of trees;
• Methods of clearance and vegetation waste disposal.

Dredging access channel and sand for backfilling:
• Location and area of the channel and any other sand burrow areas (s) on a map;
• Justification for the selection of these locations;
• Quantity, quality and characteristics of fill material;
• Indication of guarantees for sufficient availability of fill material;
• Method and equipment used for dredging, including description of positioning system, depth control system and operational control procedures;
• Justification for selecting the methods and equipment;
• Duration of dredging activity;
• Labour requirements and (local) labour availability;
• Housing of temporary labour, and
• Emergency plan in case of spills (diesel, grease, oil)

The EIA report should investigate possibilities for alternatives:
• Operation and positioning options;
• Alternative borrow area locations: have these been considered and if so, give arguments why these alternatives have not been selected, and

Backfilling:
• Methods of levelling and backfilling
• Sand source for levelling and backfilling
• Labour requirements and (local) labour availability.
Water desalination plant:
- Location, desalination capacity, technology and water quality monitoring system;
- Pipeline construction methods, scheduling and drawings;
- Justification for the location of the water intake and brine outfall pipelines;
- Emergency water supply plan.

Power supply plant and oil storage:
- Location and size of generators and facility;
- Fuel transportation technique and volume required;
- Cooling water system including cooling pipe location (if any) and justification;
- Emergency power supply plan;
- Low energy consumption ventures and awareness.

Sewerage plant:
- Plant location, capacity and justification;
- Describe rain water collection and mechanisms used to avoid pipe leakages protecting ground water contamination;
- Justify outfall site selection including the distance from the reef and depth of the pipe using oceanographic and ecological information. Currents and waves ought to quickly disperse the discharged water with little to no impacts on marine ecosystems and economic activities.
- Describe equipment needed and construction methods for laying the offshore pipeline including handling transportation.
- Detail solid waste disposal mechanisms
- Specify an emergency plan if system fails.

Waste management facility:
- Location justification, carrying capacity, materials to be collected and equipment required for waste reduction and recycling;
- Transportation mechanisms and costs;

Coastal Protection
- Designs for shore protection measures
- Justification for the designs
- Construction methods
- Alternative design and construction methods

Runway and Apron
- Designs for runway and apron surfacing
- Equipment and machinery required
- Surfacing material and methods used for construction

Passenger facilities
- Designs and layouts of terminal
- Construction method
Temporary facilities:
- Construction methods, scheduling and operation of temporary facilities including power
generation, oil storage, water supply, waste water treatment, accommodation facilities, waste
management and decommissioning.

Absence of facilities in the country to carry out the water quality tests will not exempt the proponent
from the obligation to provide necessary data. The report should outline the detailed methodology of
data collection utilized to describe the existing environment.

Task 2. Description of the environment – Assemble, evaluate and present the environmental
baseline study/data regarding the study area and timing of the project(e.g. monsoon season). Identify
baseline data gaps and identify studies and the level of detail to be carried out by consultant.
Consideration of likely monitoring requirements should be borne in mind during survey planning, so
that data collected is suitable for use as a baseline. As such all baseline data must be presented in such
a way that they will be usefully applied to future monitoring. The report should outline detailed
methodology of data collection utilized. Wherever possible reference can be made to the Phase I EIA
particularly for terrestrial and marine surveys. Comparisons to the previous date should be provided
where appropriate.

The baseline data will be collected before construction and from at least two benchmarks. All
survey locations shall be referenced with Geographic Positioning System (GPS) including water
sampling points, reef transects, vegetation transects and manta tows sites for posterior data
comparison. Information should be divided into the categories shown below:

*There is a description of the specific data collection requirements attached in the appendix of this
TOR template.

Climate
- Temperature, rainfall, wind, waves (including extreme conditions)
- Risk of storms and storm surges;

Geology and geomorphology
- Offshore/coastal geology and geomorphology of dredge areas (use maps);
- Bathymetry (bottom morphology) of dredge areas (use maps);
- (Seasonal) patterns of coastal erosion and accretion (see appendix for monitoring details), and
- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts
during construction;

Hydrography/hydrodynamics (use maps)
- Tidal ranges and tidal currents;
- Wave climate and wave induced currents;
- Wind induced (seasonal) currents;
- Sea water quality measuring these parameters: temperature, pH, salinity, turbidity,
sedimentation rate, phosphate, nitrate, ammonia, sulphate, BOD and COD.
Ecology

- Identify marine protected areas (MPAs) and sensitive sites such as breeding or nursery grounds for protected or endangered species (e.g. coral reefs, spawning fish sites, nurseries for crustaceans or specific sites for marine mammals, sharks and turtles). Include description of commercial species, species with potential to become nuisances or vector.
- Benthic and fish community monitoring around the island (see appendix for monitoring guidelines);
- Landscape integrity, and
- Include ground water monitoring (See appendix for parameter healthy ranges);
- Marine survey of outfall locations;
- Vegetation line, Shoreline, Beach Profiles, Erosion Prone areas;
- Identify flora and fauna found near Kulhi Area.

Socio-economic environment

- Atoll and Maafaru Demography: total population, sex ratio, density, growth and pressure on land and marine resources;
- Atoll and Maafaru Income situation and distribution
- Atoll and Maafaru Economic activities of both men and women (e.g. fisheries, home gardening, fish processing, employment in industry, government);
- Seasonal changes in activities;
- Accessibility and (public) transport to other island;
- Services quality and accessibility (water supply, waste/water disposal, energy supply, social services like health and education);
- Community needs;
- Sites with historical or cultural interest or sacred places (mosques, graveyard).

Hazard vulnerability:

- Vulnerability of area to flooding and storm surge.

Task 3. Legislative and regulatory considerations – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. Include permits and approvals in the EIA document.

Task 4. Potential impacts (environmental and socio-cultural) of proposed project, incl. all stages
- The EIA report should identify all the impacts, direct and indirect, during and after construction, and evaluate the magnitude and significance of each. Particular attention shall be given to impacts associated with the following:

Impacts on the natural environment

- Loss of terrestrial vegetation and fauna from land preparation works;
- Impacts on marine habitats including damages to coral reefs and seagrass communities, fish stocks, protected areas and protected species;

Environmental Protection Agency
Green Building, 3rd Floor
Handhuvarei Hingham
Male’, Rep. of Maldives, 20392
Tel: [+960] 333 5949
[+960] 333 5951
Fax: [+960] 333 5953
Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv
• Changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology;
• Temporary sediment dispersal in water column (turbidity at the dredging site, reclamation areas and related to shore protection activities), possibly resulting in changes in visibility, smothering of coral reefs and benthic communities and affecting fish and shellfish etc.;
• Impacts on ground water table and quality as a result of construction and operation activities (leaching of salts in the deposited sediments and change in ground water quantity);
• Impacts on landscape integrity/scenery.

Impacts on the socio-economic environment
• Impacts on employment and income, potential for local people to have (temporary or long term) job opportunities (and what kind) in the execution of the works;
• Disturbance to local natural resource users such as fishing areas, other tourism ventures;
• Impacts to nearby resorts and dive sites;
• Level of protection against hazards like sea level rise, storm surges, etc.
• Impact equity (economic activities, employment, income);
• Impacts on accessibility and transportation of goods to island.
• Employment and economic opportunities and diversification;
• Increased demands on natural resources and services (domestic water supply, waste water disposal, treatment systems, solid waste disposal systems, energy supply, etc);
• Social destabilization of the island community, and

Construction related hazards and risks
• Pollution of the natural environment (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste);
• Risk of accidents and pollution on workers and local population.

The methods used to identify the significance of the impacts shall be outlined. One or more of the following methods must be utilized in determining impacts; checklists, matrices, overlays, networks, expert systems and professional judgment. Justification must be provided to the selected methodologies. The report should outline the uncertainties in impact prediction and also outline all positive and negative/short and long-term impacts. Identify impacts that are cumulative and unavoidable.

Task 5. Alternatives to proposed project – Describe alternatives including the “no action option” should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the “no action alternative”. The report should highlight how the location was determined. All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

Task 6. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures. Mitigation measures to avoid or compensate habitat destruction, e.g. temporal sediment control structures, coastal protection structures to reduce erosion, coral reconstruction and MPA replacement areas. Measures for both construction and operation phase shall be identified. Cost the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to
implement the proposed mitigation measures shall also be included. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

**Task 7. Development of monitoring plan** – Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for coastal modification, beach morphology, sediment movement around the island. Ecological monitoring will be submitted to the EPA to evaluate the damages during construction, after project completion and every three months thereafter, up to one year and then on a yearly basis for five years after. The baseline study described in task 2 of section 2 of this document is required for data comparison. Detail of the monitoring program including the physical and biological parameters for monitoring, cost commitment from responsible person to conduct monitoring in the form of a commitment letter, detailed reporting scheduling, costs and methods of undertaking the monitoring program must be provided.

- Water quality, especially turbidity;
- Erosion and accretion changes;
- Temporal sedimentation rates on nearby coral reefs, benthic system and seagrass beds;
- Condition of the sensitive ecosystems and marine resources;
- Re-colonization of the benthic organisms in the borrow areas;
- Environmentally sound site clearance;
- Environmentally sound removal of dredging and other equipment including construction materials, and
- Employment of available local labour force.

* This TOR contains an outline of the parameters that have to be tested (see appendix). All projects are different, therefore additional or less data will be collected for recovery and impact assessments.

**Task 8. Stakeholder consultation, Inter-Agency coordination and public/NGO participation** – Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders, government authorities such as Ministry of Housing, Ministry of Environment, Finance Ministry, MNDF, Ministry of Defence and Security, government agencies, NGOs, engineers/designers, development managers, staff and members of the general public. The EIA report should include a list of people/groups consulted, their contact details and summary of the major outcomes.

**Presentation** - The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2012.
Timeframe for submitting the EIA report – The developer must submit the completed EIA report within 6 months from the date of this Term of Reference.

13th August 2014
APPENDIX B – Site Plan
Coastal backfill zone

Reef entrance
Dimensions: 342 m x 30 m
Dredge depth: -4.0 m
Excavated Volume: 30,000 cbm

Harbour Basin
Dimensions: 340 m x 300 m
Dredge depth: -4.0 m
Excavated Volume: 30,000 cbm

Jetty

Coastal backfill zone

Estimate Volume: 50,000 cbm
Average backfill height: 0.45 m
Total Area: 125,000 sq m

Backfill Areas

Maafaru Island, Noonu Atoll
Proposed Airport Project
Coastal and backfill works Site Plan

Legend

- Airport Boundary
- Jetty

Shore protection
- Revetment
- Harbour Basin
- Reef Entrance
- Backfill Areas

Surveyed and Prepared by: CDE Consulting, Maldives
APPENDIX C – Detailed Drawings
APPENDIX D – Approvals
Regional Airports
Ministry of Tourism

448/PRIV/2014/39

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<th>(Tel)</th>
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<td>332 3776</td>
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<td>Hanimaadho Airport Office</td>
<td>652 0023</td>
<td>791 9842</td>
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# AIRPORT BASIC CONCEPT & BUILDING HEIGHT APPROVALS

## PROPOSED MAAFARU AIRPORT (1800 meter Length)

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<td>2</td>
<td>Runway Width:</td>
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<tr>
<td>3</td>
<td>Strip Length:</td>
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<td>Taxiway Width:</td>
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<tr>
<td>7</td>
<td>Apron Length:</td>
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<td>10</td>
<td>Stopway Width:</td>
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<td>Runway End Safety Area (RESA) Length:</td>
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<td>Transverse gradient:</td>
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## PROPOSED BUILDING HEIGHT

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Regional Airports
Ministry of Tourism

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[Signatures]

MCM -管理局長
REGIONAL AIRPORTS - 航空局
Environmental Protection Agency

203-ADMIN/PRIV/2014/517

प्रतिष्ठानाच्या दृष्ट्या देखील अभावाने झोपड्यांमध्ये व नाघाल्यांमध्ये पाण्याची वातावरणवर्धनाची उपक्रमे साफतमध्ये करून जातात.

प्रतिष्ठानाची पंप, 02 मार्च 2014 रोजी दिलेली प्रदर्शनी व वातावरणवर्धनाची प्रक्रियेसाठी स्थापित केलेली परिसरातील वास्तुप्रकारातील पवन सर्कल किंवा पवन व्यवस्थेचे संरक्षण करून जातात.

विनेक रस्त्याच्या विकल्पात अद्यावधीच व अन्य मूल्यांकांमध्ये पाण्याच्या बेंडीसमजाच्या वातावरणवर्धनाची प्रक्रिया संपन्न करून जातात.

प्रतिष्ठानाची पंप, 1436, 11 जून, 2014 रोजी दिलेली प्रदर्शनी व वातावरणवर्धनाची प्रक्रियेसाठी स्थापित केलेली परिसरातील वास्तुप्रकारातील पवन सर्कल किंवा पवन व्यवस्थेचे संरक्षण करून जातात.

प्रतिष्ठानाच्या पंप, 04 मार्च 2014 रोजी दिलेली प्रदर्शनी व वातावरणवर्धनाची प्रक्रियेसाठी स्थापित केलेली परिसरातील वास्तुप्रकारातील पवन सर्कल किंवा पवन व्यवस्थेचे संरक्षण करून जातात.

Environmental Protection Agency
Green Building, 3rd Floor
Handhuvarree Hingun
Male', Rep. of Maldives, 20392
Tel: +960 333 5949
Email: secretariat@epa.gov.mv
APPENDIX E – Work Plan
## Proposed Maafaru Airport Preliminary Workplan

**Time Frame:** months after GRANT OF APPROVAL for construction

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APPENDIX F – Survey Locations
Maafaru Island
Survey Locations

PROJECTION: Transverse Mercator
IJTAM Zone 43 N; HORIZONTAL DATUM: WGS84;
VERTICAL DATUM: Hulhule Tide Gauge
Map version: 20/12/2014

Surveyed and Prepared by: CDE Consulting, Maldives

Legend
- **Bathymetry**
- **Currents**
- **Ground Water Samples**
- **Soil Profiles**
- **Marine Water Samples**
- **Beach Profiles**
- **Vegetation Transects**
- **Marine Transects**
- **Timed Swims**
- **Settlement**
- **Wetland**
- **Vegetation Line Aug2014**
- **High Tide Line Aug 2014**
- **Low Tide Line Aug 2014**
- **Lagoon**
- **Coral Reef**
- **Outer reef line**

Profiles

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**Marine Transects**

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APPENDIX G – Water Quality Results
# WATER QUALITY TEST REPORT

**Test Report No:** 300678/2014/65

**Date:** 08/09/2014

**Sample Description / Location**

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<tr>
<td>Maafaru</td>
<td>Ground water</td>
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**Sample Type**

GW1

**Sampled Date**

31/8/2014

**Sample Received Date**

1/9/2014

**Test Requisition Form No.**

900158219

**Sample No.**

812975 812976 812977

**Date of Analysis**

1/9/2014 - 7/9/2014

### PARAMETER

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<td>Total Suspended Solids</td>
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<td>6</td>
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<td>Coliform, Faecal</td>
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**Methodology**

- **Nitrate:** Method 10049 (Adapted from HACH DR5000 Spectrophotometer procedure Manual) mg/L
- **pH:** Method 4500-H-8. (adapted from Standard methods for the examination of water and waste water, 21st edition) -
- **Salinity:** Method 2500 B. (adapted from Standard methods for the examination of water and waste water, 21st edition) %
- **Phosphate:** Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual) mg/L
- **Temperature:** Electrometry °C
- **Biological Oxygen Demand:** HACH Method 8043 mg/L
- **Total Petroleum Hydrocarbon (TPH):** UV Fluorescence mg/L
- **Total Suspended Solids:** Method 8006 (Adapted from HACH DR5000 Spectrophotometer procedure Manual) mg/L
- **Coliform, Faecal:** HACH Method 8074 CFU/100mL

**Keys:**

- mg/L: Milligram Per Liter, %: Parts Prr Thousand, °C: Degree Celsius, CFU: Colony Forming Unit
- LOQ: Limit of Quantification

**Checked by:**

Mohamed Eyman
Senior Quality Control

**Approved by:**

Adam Rasheed
Assistant Manager, WQA

---

**Notes:**

- **Sampling Authority:** Sampling was not done by MWSC Laboratory
- **This report shall not be reproduced except in full, without written approval of MWSC**
- **This test report is ONLY FOR THE SAMPLES TESTED.**
- **~ Information Supplied by the customer**
WATER QUALITY TEST REPORT
Test Report No: 300678/2014/66

Customer Information:
CDE Consulting Pvt Ltd
H. Orchidmoge 4th Floor
Ameemu Ahmed Magu
Male'
Rep. of Maldives

Sample Description / Location:
Maafaru

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TEST METHOD

| PARAMETER | ANALYSIS RESULT
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<tr>
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<td>Total Suspended Solids</td>
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Method 8006 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)
Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)
Method 4500-H B. (adapted from Standard methods for the examination of water and waste water, 21st edition)
Method 10049 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)

UNIT

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Keys:
mg/L: Milligram Per Liter, %: Parts Per Thousand, °C: Degree Celscius
LOQ: Limit of Quantification

Checked by: Mohamed Eyman  
Senior Quality Control Officer

Approved by: Adam Rasheed  
Assistant Manager, WQA

Notes:
Sampling Authority: Sampling was not done by MWSC Laboratory
This report shall not be reproduced except in full, without written approval of MWSC
This test report is ONLY FOR THE SAMPLES TESTED.
~ Information Supplied by the customer

******************************************************************************END OF THE REPORT******************************************************************************
APPENDIX H – Bathy Chart
APPENDIX I – Topography
APPENDIX J – Vegetation Classification Results
APPENDIX K – CV’s of Consultants
Ahmed Shaig

Phone: (+960) 77 88 758  shaig@cde.com.mv

Personal Details

Date of Birth: 19/02/1976  Nationality: Maldivian  Gender: Male  Marital Status: Married

Permanent Address: Maldives  Present Address: M. Muleege, Orchid Magu, Male’, Maldives.

Education

PhD, Environmental Science, 2009
James Cook University, Townsville, Australia

Research degree on ‘Settlement Planning for Natural Hazard Resilience in Small Island States: The Population and Development Consolidation Approach’

BSc  Land and Spatial Information Studies/Information Science. (double major), 1999-2001
University of Otago, Dunedin, New Zealand

Diploma in project planning, implementation, monitoring and evaluation, 1995
ILO training Centre, Turin, Italy

Employment History

Director, Environmental Services  2008 to present
CDE Consulting
Republic of Maldives

Supervisor: Dr. Simad Saeed
Phone: +(960) 7777445

Head of environmental wing

Assistant Under-secretary, Spatial Planning  2002-2004
Ministry of Planning and National Development
Republic of Maldives

Supervisor: Hon. Hamdun Hameed
Phone: +(960) 332-3919

Head of Spatial Planning Unit. Relevant Tasks include:
♦ Oversee environment related projects and application of environmental guidelines for planned projects.
♦ Plan, implement and oversee the development of a National GIS;
♦ Aid/facilitate/oversee urban planning, housing, land use planning, natural resource planning and environment related projects; Provide assistance in project planning (includes urban and regional planning, natural resources planning)

Project Manager, National Digital Mapping Project  2005 (8 months)
Ministry of Planning and National Development
Republic of Maldives

Supervisor: Hon. Hamdun Hameed
Phone: +(960) 332-3919

♦ Project involved aerial photography and satellite imagery of entire Maldives, ground surveying of key settlements, digital conversion of data and setting up a Mapping Unit.

Assistant Planning Officer/Planning Officer  1994-1999
Ministry of Planning and National Development
Republic of Maldives

Supervisor: Mr. Mohamed Hunaif
Phone + (960) 331-3040

Relevant tasks involved:
♦ Assisting in the National GIS Development Programme (Junior GIS developer)
♦ Facilitate urban planning, housing, land use planning, natural resource planning and environment related projects.
Experience in Consultancy

- **September 2002:** Member of the team appointed for environmental surveying and carrying capacity assessment of islands for tourism development in the southern atolls of Maldives for Ministry of Tourism Maldives.
- **October 2002:** Developed the Census GIS for United National Population Fund
- **December 2002:** Developed the Maldives Protected Areas Systems GIS for Maldives Home Affairs Housing and Environment.
- **February 2003:** Participated in the preparation of Royal Island and Spa Resort Annual Environmental Monitoring Report for Royal Island and Spa.
- **April 2003:** Member of the team selected for developing town plans for urban centres in Northern and Southern Regional Development Zones, looking specifically into environmental control measures, for Ministry of Planning and National Development.
- **April 2003:** Participated in the preparation of Environmental Impact Statement for Coastal Modifications on Rihiveli, South Malé Atoll, Maldives.
- **April 2003:** Participated in the surveying and preparation of Environmental Impact Statement for the proposed coastal improvements to address coastal erosion concerns on Royal Island Spa Resort, Baa Atoll, Maldives.
- **May 2003:** Participated in the bathymetry survey and preparation of Initial Environmental Examination for Deepening of Existing Entrance Channel to Service Jetty, Soneva Gili Resort and Spa, North Malé Atoll, Maldives
- **May 2003:** Participated in the preparation of Initial Environmental Examination for development of an access channel into the natural inner lagoon (Vili) of Mayafushi resort, North Ari Atoll.
- **May 2003:** Participated in the preparation of Environmental Impact Assessment for Landaa Giraavaru Pvt. Ltd. for the development of a Four Season’s Tourist Resort on the island of Landaa Giraavaru in Baa Atoll, Maldives.
- **June 2003:** Participated in survey and preparation of Initial Environmental Examination for the Development of a Mooring Area and Associated Beach Replenishment in, Boduhithi Club, North Malé Atoll, Maldives.
- **July 2003:** Conducted shoreline and vegetation line of Alimatha Tourist Resort, Vaavu Atoll, Maldives.
- **July 2003:** Participated in conducting and preparation of Fun Island Resort Annual Environmental Monitoring Report.
- **July 2003:** Participated in conducting and preparation of Sun Island Resort Annual Environmental Monitoring Report.
- **July 2003:** Participated in conducting and preparation of Holiday Island Resort Annual Environmental Monitoring Report.
- **August 2003:** Developed the Initial Environmental Examination for the construction of Sun Decks along the southern beach of Kudarah Island Resort.
- **September 2003:** Participated in surveying and preparation of Fonaddoo Environmental Impact Assessment Report for the development of fisheries complex, Fonaddoo, Maldives.
- **October 2003:** Participated in surveying and preparation of Kuda Rah Erosion Study and recommendations for shore protection and erosion prevention
- **November 2003:** Conducted vegetation and shoreline survey of Dhonveli Beach and Spa and Four Seasons Report for the Boundary Delineation between the two islands.
- **December 2003:** Contributed to the Landuse Planning Guidelines of Maldives (environmental aspects) for Ministry of Housing and Urban Development.
- **December 2003:** Contributed to the Development of a Building Code of Maldives for Ministry of Housing and Urban Development.
- **January 2004:** Co-author to the Environmental Guidelines for the Development of Resort Islands in Maldives, Ministry of Tourism.
- **February 2004:** Developed the Baa Atoll Spatial Development Plan for Ministry of Planning and National Development.
April-July 2004: Participated in the preparation of the Environmental aspects of the 8 bid proposals for resort Development for various proponents.

November 2005: Participated in the preparation of EIA for L.Gan Resettlement Project for Ministry of Housing.

December 2005: Participated in the surveying and preparation of EIA for Gn Fuvahmulaku Tourist Hotel Development

November 2005: Developed a GIS for strategic planning to select islands for tourism development for Ministry of Tourism.

January 2006: Local consultant for the Strategic Environmental Assessment (SEA) of Maldives Regional Development Plan, for AGRIFOR Consult Consortium, Belgium.


August 2006: Consultant to the Integrated Climate Change System (ICCS) project – Assessment of vulnerability of Maldives Islands and Beaches to climate change.

September 2006: Consultant to the ICCS project – Assessment of vulnerability of Maldives Infrastructure to climate change.


October 2007: Natural Hazard Assessment consultant to the UNDP Project: Disaster Risk Assessment of Selected Safe Islands in Maldives.

November 2007: Prepared the EIA for proposed coastal protection, beach replenishment and access improvement of Elaa, Thaa Atoll, for Mr Albas Mohamed, H. Merry Rose.

May 2008: Participated in the preparation of EIA for sand sourcing and beach replenishment project of Viligilli Island, Addu Atoll, for Shangri-La at Viligilli.

April 2009: Participated in the preparation of EIA for N. Maafaru Airport Development Project for Noonu Hotels Pvt Ltd.

May 2009: Participated in the preparation of EIA for resort development in Huvandhumaavattaru, Noonu Atoll.


July 2009: Prepared the Environmental EIA for harbour development in Fiyoari, Gaafu Dhaalu Atoll.

July 2009: Participated in the preparation of EIA for Jetty and arrival lounge development project in Gan, Addu Atoll, for Island Aviation Services Private Limited.

July 2009: Team Leader for the socio-economic risk assessment of Selected Safe Islands in Maldives.

August 2009: Coastal erosion data synthesis for selected islands of Maldives, for World Bank Maldives Environmental Management Project.

September 2009: Prepared the beach management plan and development control measures for Reethibeach Island Resort, Baa Atoll.

September 2009: Participated in the preparation of EIA for agricultural island development in Felivaru, Noonu Atoll, for Fantasy Private Limited.

September 2009: Consultant to review the safer islands programme and cost benefit study of mitigation measures in three islands in the Maldives for UNDP.


December 2009: Environmental consultant for advising on resort development and development control measures in Randheli Island, Noonu Atoll.

January 2010: Prepared the beach management plan and development control measures for Shangri-La Island Resort, Addu Atoll.

January 2010: Consultant to the Atoll Ecosystem Conservation project conservation component defining conservation areas and development controls.

February 2010: Prepared the environmental audit of Thunbafushi Island, Kaafu Atoll, for Champa Brothers Private Limited.

Ahmed Shaig page 3
- March 2010: Prepared the beach management plan and development control for Herathera Island Resort, Addu Atoll.
- March 2010: Lead author in the preparation of EIA for power plant upgrading project in Palm Beach Island in Lhaviyani Atoll.
- April 2010: Lead author in the preparation of EIA for seagrass removal and beach replenishment project in Olhuveli Island Resort and Spa, Kaafu Atoll.
- May 2010: Consultant to undertake island environmental scoping studies in 30 islands in North Maldives to determine islands with resort development potential for GMR Group of India.
- May 2010: Lead author in the preparation of EIA for harbour development project in Madidhoo Island, Shaviyani Atoll.
- June 2010: Lead author in the preparation of EIA for deep piling project in Olhuveli Island Resort and Spa, Kaafu Atoll.
- July 2010: Lead author in the preparation of EIA for the development of an aquaculture site in Kanducoigiri, Kaafu Atoll.
- July 2010: Environmental planning consultant for Shangri-La at Viligilli Maldives, Addu Atoll.
- July 2010: Environmental planning consultant to the Addu Land Use Planning project (including defining development controls) in Addu Atoll Maldives for South Province Office.
- August 2010: Environmental Consultant for the Atoll Ecosystem Conservation Project to declare Baa Atoll as a UNESCO Biosphere reserve.
- September 2010: Lead author in the EIA for seagrass removal and beach replenishment project in Herathera Island, Addu Atoll.
- September 2010: Lead author in the EIA for resort redevelopment in Vilamendhoo Island Resort, Ari Atoll.
- September 2010: Lead author in the preparation of EIA for Gulhifalhu land reclamation project in Gulhifalhu, Male’ Atoll, for Capital Investment and Finance Limited, UK.
- September 2010: Participated in the preparation of EIA for sewerage system development project in Miladhoo, Noonu Atoll.
- October 2010: Consultant to undertake the coastal adaptation survey of 40 islands in Maldives for Ministry of Housing and Environment.
- November 2010: Environmental consultant for advising on resort development and development control measures in Maamigili Island, Raa Atoll.
- January 2011: Lead author in the preparation of EIA for sewerage and water system development project in Hithadhoo Island, Addu City for Bi-water International Private Limited.
- February 2011: Lead author in the preparation of EIA for sewerage and water system development project in Maradhoo Island, Addu City for Bi-water International Private Limited.
- March 2011: Lead author in the preparation of EIA for sewerage and water system development project in Feydhoo Island, Addu City for Bi-water International Private Limited.
- April 2011: Lead author in the preparation of EIA for sewerage and water system development project in Maradhoo-Feydhoo Island, Addu City for Bi-water International Private Limited.
- May 2012: Coastal erosion mitigation assessment and planning for Six Senses Laamu, Laamu Atoll.
- January 2012: Lead author in the preparation of EIA for sewerage and water system development project in Fuvahmulah Island, Addu City for Bi-water International Private Limited.
- February 2012: Coastal erosion mitigation assessment and planning for Fushivelavaru Island.
- March 2012: EIA for the proposed resort redevelopment project in Conrad Rangali Island for Champa and Crown Resorts.
- March 2012: EIA for the proposed resort redevelopment project in Gasfinolhu Island Resort, Champa and Crown Resorts.
- May 2012: Environmental consultant for advising on resort development and development control measures in Gasfinolhu Island, Male’ Atoll.
- June 2012: Environmental consultant for advising on resort development and development control measures in Nakachchaa Huraa Island, Male’ Atoll.
- April 2012: Member of the consultant team that prepared the Tourism Opinion and Profile Survey 2011, Ministry of Tourism.
- October 2012: Environmental consultant to the preparation of 4th Tourism Master plan for Ministry of Tourism, Maldives.
- November 2013: Environmental consultant for advising on land reclamation, resort development and development control measures in Dhiffushi Island Reef, Male’ Atoll.
- **January 2013**: Environmental consultant for advising on resort development and development control measures in Hankede Island, Addu Atoll
- **January 2013**: Environmental consultant for advising on resort development and development control measures in Hankede Island, Addu Atoll
- **June 2013**: Local Environment consultant to the WCCM project, HIDRIA and Aquatica, Spain.
1. PROPOSED POSITION: Social Consultant

2. FULL NAME: Simad SAEED

3. ADDRESS: G. Chaman/Male'/Maldives

4. E-MAIL: simad.saeed@gmail.com; simad@cde.com.mv

5. Date of Birth: 31/01/1971

6. NATIONALITY: Maldivian

7. EDUCATION

Doctor of Philosophy – Resource Management and Environmental Science

PhD Thesis Title: Social Capital and Well-Being: Delving into the deep determinants of sustainability

March 2001 to June 2005

Asia Pacific School of Economics and Government

Australian National University, Australia

Master of Science - Environmental Assessment & Management

September 1994- October 1995

Oxford Brookes University, UK

Bachelor of Science (Honours) Environmental Sciences

September 1990- July1993

University of Southampton, UK
8. MEMBERSHIP OF ASSOCIATIONS AND COMMITTEES:

Member, Advisory Committee to the President of the Maldives on Climate Change


Review Editor, Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)

Member of the Special Task Force established by the President of the Maldives to develop the Maldives National Vision 2020

Member, Steering Committee of the Tourism Impacts Study of the Maldives, Ministry of Tourism

Member, Selection Committee for the Presidents Green Resort Award, Ministry of Tourism

Member, Technical Committee of the Maldives Housing and Urban Development Board

Member, Sixth National Development Plan of Maldives - Infrastructure Sub-Committee, Ministry of Planning and National Development

Principal author and leader of the team for the drafting of Second National Environment Action Plan, Ministry of Home Affairs, Housing and Environment

Member, Co-ordination Committee on HulhuMale’ Reclamation, Ministry of Construction and Public Works

Member, Technical Committee on Ports Development, Ministry of Construction and Public Works

Member, Technical Committee on Solid Waste Management, Ministry of Home Affairs, Housing and Environment

Member, Technical Committee of the Southern Atolls Development Project, Ministry of Atolls Administration

Member, National Accounts Project Technical Committee, Ministry of Planning and National Development

Member, Technical Committee on Dredging and Land Reclamation, Ministry of Planning and National Development

9. EMPLOYMENT RECORD

Date: June 2005 – present
Location: Maldives
Company: CDE Pvt Ltd
Position: Managing Director
Description: Managing Director of CDE Consulting registered in the Maldives (C-262/2001) since 2001.

Responsible for executive direction, corporate governance, strategic planning, consultant services management in the company and team leader of several consultancy projects
Dec 2000 – March 2001
Maldives
Ministry of Home Affairs, Housing and Environment, Government of the Republic of Maldives;
Deputy Director
Formulation of environmental policy issue papers for the National Commission for Protection of Environment
Enforcement of National Environment Impact Assessment regulation and procedures in the Maldives
Supervision of the work of the Pollution Control division, EIA division, Climate Change division and Environmental Planning division.
Implementation of the second National Environment Action Plan of the Maldives
Representation of the Maldives at international conferences, seminar and workshops and preparation of briefing papers for Maldives delegations
Implementation of the UNDP/GEF Climate Change Enabling Activity Project of Maldives
Co-ordination of work of International Advisory Board on Climate Change, Local Consultants & Project Team
Development of the first Greenhouse Gas Inventory of the Maldives;
Development of the Climate Change Mitigation Plan;
Preparation of the National Vulnerability Assessment of the Maldives;
Formulation of an Adaptation Plan and Implementation Plan on Climate Change;
Formulation of the first National Communication of the Maldives to UNFCCC.

May 1997 – Dec 2000
Maldives
Ministry of Home Affairs, Housing and Environment, Government of the Republic of Maldives
Assistant Director, Programmes
Implements the National Environmental Impact Assessment procedures
Supervision of the work of the Environmental Assessment Division
Supervision of the work of the Climate Change Division
Supervision of the work of the Pollution Control Division
Formulation of environment and conservation plans
Representing the Maldives at the negotiations of UNFCCC on climate change
Representing the environmental interests of Maldives at international conferences
Work related research and preparation of papers to brief the Minister and executive staff of the Ministry

September 1993 – April 1997
Maldives
Ministry of Planning, Human Resources and Environment, Government of the Republic of Maldives
Assistant Environment Analyst
Drafting of the Environmental Impact Assessment (EIA) Procedures of the Maldives
Undertaking consultations on the EIA Guidelines and Procedures
Presentation of the EIA Guidelines and Procedures of the Maldives to the National Commission of the Protection of the Environment for endorsement
Coordinating the adoption of the EIA guidelines by the Government
Implementation of the Environment Impact Assessment Procedures in the Maldives
10. CONSULTANCY ASSIGNMENTS

<table>
<thead>
<tr>
<th>Date</th>
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<tbody>
<tr>
<td>Client</td>
<td>Ministry of Economic Development</td>
</tr>
<tr>
<td>Position</td>
<td>Team Leader</td>
</tr>
<tr>
<td>Description</td>
<td>Preparation of strategy papers on energy, tourism, and fisheries for the Maldives National Economic Diversification Framework Study</td>
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<tr>
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<tbody>
<tr>
<td>Client</td>
<td>Ministry of Fisheries and Agriculture</td>
</tr>
<tr>
<td>Position</td>
<td>Team Leader</td>
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<tr>
<td>Description</td>
<td>Agriculture Needs Assessment Tool Kit and Baarah Needs Assessment Report</td>
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<tr>
<td>Client</td>
<td>Shaviyani Atoll Council</td>
</tr>
<tr>
<td>Position</td>
<td>Team Leader and Lead Author</td>
</tr>
<tr>
<td>Description</td>
<td>An Assessment of Economic Activities, Opportunities and Challenges in Shaviyani Atoll</td>
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<td>Client</td>
<td>UNDP</td>
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<td>Position</td>
<td>National Consultant</td>
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<td>Description</td>
<td>National Report of the Maldives to the United Conference on Sustainable Development, Rio+20,</td>
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<td>Client</td>
<td>USAID/Chemonics</td>
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<td>Position</td>
<td>National Consultant</td>
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<td>Description</td>
<td>Training for community leaders on climate change, water resources management and sustainable development</td>
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<td>Client</td>
<td>Biwater International</td>
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<tr>
<td>Position</td>
<td>Team Leader/Environment Impact Assessment Expert</td>
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<td>Description</td>
<td>Environmental Impact Assessment Study for Water Supply and Sewerage System in Hulhumeedhoo, Addu City</td>
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<tr>
<td>Client</td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td>Position</td>
<td>National Consultant</td>
</tr>
<tr>
<td>Description</td>
<td>Trans-boundary Diagnostic Analysis (TDA) National Validation, Bay of Bengal Large Marine Ecosystems Project</td>
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<td>Client</td>
<td>Fuvahmulah Atoll Council</td>
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<tr>
<td>Position</td>
<td>Team Leader and Sustainable Development Consultant</td>
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<td>Description</td>
<td>Formulation of Vision Fuvahmulah</td>
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<tr>
<td>Client</td>
<td>UPL Environmental Engineers Limited, India</td>
</tr>
<tr>
<td>Position</td>
<td>Team Leader/Environmental Impact Assessment Expert</td>
</tr>
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<td>Description</td>
<td>Environmental and Social Impact Assessment of Solid Waste Management Project, Thilafushi, Male’ City, Maldives</td>
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<tr>
<td>Client</td>
<td>Biwater International</td>
</tr>
<tr>
<td>Position</td>
<td>Team Leader/Environmental Assessment Expert</td>
</tr>
<tr>
<td>Description</td>
<td>Environmental Impact Assessment Study for Water Supply and Sewerage System in Hithadhoo, Addu City</td>
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</tbody>
</table>
Date: 2011
Client: North Province Office
Position: Team Leader
Description: North Province Sustainable Development Strategy

Date: 2011
Client: UNESCO
Position: National Consultant
Description: Survey on the Impact of Global Financial Crisis on Education in the Maldives

Date: 2011
Client: Ministry of Tourism, Arts and Culture
Position: Team Leader and Lead Author
Description: Maldives Visitor Survey 2010

Date: 2010
Client: European Commission
Position: National Consultant
Description: Evaluation of the European Commission’s Cooperation with Maldives

Date: 2010
Client: Ministry of Tourism, Arts and Culture
Position: Consultant
Description: Preparation of the report on Tourist Profile and Opinion Survey 2008

Date: 2010
Client: South Province Office
Position: Team Leader - Social Expert
Description: Preparation of the Land Use Plan for Addu Atoll

Date: 2009
Client: World Bank - MEMP Project
Position: Social Development Expert
Description: Social Assessment of 46 islands in Noonu, Raa, Baa and Lhaviyani Atolls

Date: 2009
Client: World Bank - MEMP Project
Position: Development and Environment Policy Expert
Description: Technical and Financial Feasibility of Waste Management in Noon, Raa, Baa and Lhaviyani

Date: 2008
Client: UNDP
Position: Social Development Expert
Description: Social and Economic Vulnerability Assessment of 9 islands of the Maldives

Date: 2008
Client: Ministry of Environment, Energy and Water
Position: Development and Environment Policy Expert
Description: Preparation of the Maldives National Sustainable Development Strategy (NSDS)

Date: 2008
Client: Ministry of Housing and Urban Development
Position: Development Policy Expert
Description: Development Strategy and Land Use Plan for Gan Airport
Date: 2008  
Client: UNDP/GEF  
Position: Development and Environment Policy Expert  
Description: Preparation of Baa Atoll Development Plan

Date: 2007  
Client: Ministry of Environment, Energy and Water  
Position: Development and Environment Policy Expert  
Description: Maldives National Capacity Self Assessment for Global Environmental Management

Date: 2007  
Client: Ministry of Environment, Energy and Water  
Position: Development and Environment Policy Expert  
Description: Technology Needs Assessment for Climate Change Adaptation and Mitigation

Date: 2007  
Location: Randheli, Maldives  
Client: Cyprea Pvt Ltd  
Position: EIA Lead Consultant  
Description: Preparation of EIA for tourist resort development in Randheli

Date: 2007  
Location: Maldives  
Client: Ministry of Environment, Energy and Water  
Position: Environment and Development Policy Expert  
Description: Preparation of the Third National Environment Action Plan

Date: 2007  
Location: Addu, Maldives  
Client: Addu Atoll Office  
Position: Development Policy Expert  
Description: Formulation of Vision Addu

Date: 2006  
Location: Maldives  
Client: Ministry of Planning and National Development  
Position: Social Development and Environment Expert  
Description: Preparation of Second Millennium Development Goals Report of the Maldives

Date: 2006  
Location: Maldives  
Client: Ministry of Planning and National Development  
Position: National Facilitator  
Description: Seventh National Development Plan of the Maldives

Date: 2006  
Location: Maldives  
Client: Ministry of Environment, Energy and Water  
Position: Environment Policy Expert  
Description: Preparation of National Adaptation Programme of Action for Climate Change in the Maldives

Date: 2006  
Location: Maldives  
Client: UNDP/Ministry of Atolls Development  
Position: Development Policy Expert  
Description: Preparation and presentation of policy research paper on “A new thinking on governance for development and delivery of public services in the Maldives” for the National Seminar on Atoll Councils and Island Councils
Date: 2006
Location: Maldives
Client: European Commission through AGRIFOR Consult – led consortium
Position: Strategic Environmental Assessment Expert
Description: EC Framework Contract for Strategic Environmental Assessment (SEA) for the Maldives Regional Development Plan

Date: 2006
Location: Maldives
Client: Ministry of Atolls Development
Position: Consultant
Description: Preparation of Island Development Plans for Eydhafushi; Dhaalu Kudahuvadhoo and Laamu Gan

Date: 2006
Location: Gaakoshibee, Shaviyani Atoll, Maldives
Client: ADK Travels Pvt Ltd
Position: EIA Lead Consultant
Description: Environmental Impact Assessment Study for resort development on Gaakoshibee

Date: 2006
Location: Meradhoo, Gaafu Alifu Atoll, Maldives
Client: Xanadu Holdings Pvt Ltd
Position: EIA Lead Consultant
Description: Environmental Impact Assessment Study for resort development on Meradhoo

Date: 2006
Location: Manafaru, Haa Alifu Atoll, Maldives
Client: Tropical Maldives Pvt Ltd
Position: EIA Lead Consultant
Description: Environmental Impact Assessment Study for resort development on Manafaru

Date: 2004
Location: Maldives
Client: Ministry of Tourism, Government of the Maldives
Position: Consultant
Description: Preparation of Environmental Guidelines for Tourist Resort Development and Operation in the Maldives.

Date: 2002
Location: Maldives
Client: United Nations Development Programme, Male'
Position: Consultant/Lead Author
Description: National Assessment Report of the Maldives to the World Summit on Sustainable Development.

Date: 2002
Location: Maldives
Client: South Asia Poverty Alleviation Programme (Kathmandu, Nepal) and United Nations Development Programme, Male'
Position: Consultant
Description: Situation Analysis and Strategy for Change; Poverty and the Environment Maldives National Report Project

Date: 2001
Location: Maldives
Client: Ministry of Home Affairs, Housing and Environment.
Position: Consultant
Date: 2000
Location: Maldives
Company: BFS Consulting Group
Position: Local Consultant
Description: Responsible for the Environmental Impact Assessment and environmental monitoring for the Asian Development Bank financed First Regional Development Project.

Date: 2000
Location: Maldives
Company: BFS Consulting Group, for Ministry of Planning and National Development.
Position: Consultant
Description: Prepared report on the indicators for the Environment and Housing Sector to be included in the National Social Development Management Information System (SOMIS).

Date: 1999
Location: Maldives
Client: Institute of Global Environmental Studies, Japan
Position: Consultant
Description: Study report on Environmental Education needs and opportunities in the Maldives.

Date: 1998
Location: Maldives
Client: Cowrie Investments Private Limited
Position: Consultant
Description: Prepared winning bid proposals submitted to Ministry of Tourism for lease, development and operation of Meedhupparu Resort and Kanuhura Sun Resort and Spa by developer.

Date: 1998
Location: Maldives
Client: Vaaly Brothers Private Limited
Position: Consultant
Description: Prepared the winning bid proposals submitted to the Ministry of Tourism for the lease, development and operation of Medhufushi Resort and Filitheyo Resort by developer.

Date: 1997
Location: Maldives
Client: Sun Travels and Tours Company Private Limited
Position: Consultant
Description: Prepared the winning bid proposals submitted to the Ministry of Tourism for the lease, development and operation of Vilu Reef Resort by developer.

Date: 1996
Location: Maldives
Client: World Health Organisation
Position: Consultant
Description: Health and Environment in the Maldives - A Situation Analysis
11. TRAINING, CONFERENCES AND WORKSHOPS

United Nations Climate Change Conference, COP 18, Doha, Qatar, 26th Nov-08 December 2012.


Trans-boundary Diagnostic Analysis (TDA) Confirmation Meeting, Bay of Bengal Large Marine Ecosystems Project (BOBLME), Phuket, Thailand, 13-14 February 2012.

15th session of the Conference of the Parties to the UNFCCC and the 5th session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol, Copenhagen, Denmark, 07-18 December 2009

Protecting human health from climate change: technical discussions, WHO/SEARO, New Delhi, India, 18-21 August 2009

South-South collaborative study tour to ‘Explore technology options for Climate Change Mitigation and Adaptation in Maldives’, New Delhi, India, 22 – 30 August 2006

Asian Regional Workshop on Capacity Building for Clean Development Mechanism, Bangkok, Thailand, 19-21 October 2005

UNDPCSD Mission to Barbados to formulate Twinning Project on Sustainable Development Indicators for Maldives, Barbados and Costa Rica, Bridgetown, Barbados, May 2001


Third Lead Authors' Meeting of the Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Lisbon, Portugal, 08-11 August 2000

AOSIS Workshop on Preparations for the Fifth Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, Apia, Samoa, 29July -04 August 2000

Tenth Asia-Pacific Seminar on Climate Change, Penang, Malaysia, 9 - 13 July 2000

Final Workshop on the Implementation of Male’ Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia, Kathmandu, Nepal, 1-3 March 2000

Second Lead Authors Meeting of the Third Assessment Report (Working Group II) of the Intergovernmental Panel on Climate Change, Canberra, Australia, 07-10 December 1999


Special Session of the UN General Assembly on the Implementation of the Barbados Programme of Action, New York, USA, 28-29 September 1999

Inception Meeting on the Implementation of NORAD/UNEP Project on Strengthening Environment Assessment and Monitoring Capabilities, Bangkok, Thailand, 19-20 April 1999

Inception Workshop on the Implementation of Male’ Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia, Kathmandu, Nepal, 22-23 February 1999


Seventh Meeting of the Governing Council of South Asia Co-operative Environment Programme, Malé, Maldives, 20-22 April 1998

Preparatory Meeting of the Asia Pacific National Councils for Sustainable Development to the 6th Session of the Commission on Sustainable Development, Bangkok, Thailand, 23-25 March 1998

Regional Dialogue on Air Pollution in South Asian Countries, Bangkok, Thailand, 19-20 March 1998

Third Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, Kyoto, Japan, 01-10 December 1997

Meetings of the Subsidiary Bodies of the United Nations Framework Convention on Climate Change, Bonn, Germany, 20-31 October 1997

SAARC Environment Minister’s Conference, Bandos, Maldives, 15-16 October 1997

Thirteenth Session of the Intergovernmental Panel on Climate Change, Bandos, Maldives, 22-29 September 1997

Meetings of the Subsidiary Bodies of the United Nations Framework Convention on Climate Change, Bonn, Germany, 28 July – 07 August 1997


SAARC Environment Minister’s Conference – Preparatory Meeting for the UN Special Session on Agenda 21, New Delhi, India, 02-03 April 1997


Second Meeting of National Councils for Sustainable Development in Asia and the Pacific, Manila, Philippines, 12 -14 December 1996

Regional Consultative Meeting on Environmentally Sound and Sustainable Development Indicators, Bangkok, Thailand, 26 - 29 November 1996

Commonwealth Asian Region Workshop on Integrating Economic and Environmental Policies and Using Economic Instruments to Promote Environmentally Sound Development, Colombo, Sri Lanka, 11 - 14 November 1996


Eleventh Meeting of the Technical Working Group of the Basel Convention, Manchester, United Kingdom, 9 - 13 September 1996

Regional Inter-Governmental Consultations on Global Environment Outlook (GEO), Kathmandu, Nepal, 23 - 24 July 1996

Asian Workshop on Communication and Education Strategies for Ministries of Environment and Potential Partners, Bangkok, Thailand 17 - 19 July 1996


Intersectoral Consultation on Health and Environment, Malé, Maldives, 17 December 1995
UNEP/SACEP/JNU Workshop on Framework Legislation for Environmental Management in South Asia, New Delhi, India, 11 - 15 Dec 1995

Seventh Meeting of the Conference of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, Vienna, Austria, 5 - 7 Dec 1995

Preparatory Meeting to the Seventh Meeting of the Conference of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, Vienna, Austria, 28 Nov - 1 Dec 1995

SACEP/NORAD Regional Workshop of National Consultants for Assessment of Environmental Training Needs and Opportunities in the South Asia Region, Bandos, Maldives, 16 - 20 July 1995

Inter-Governmental Meeting on Capacity Building for Coastal Environmental Management in the South Asian Seas Region, New Delhi, India, 7 - 9 April 1994

Third Asia Pacific Seminar on Climate Change, Osaka, Japan, 28 - 30 March 1994

UNEP/UNITAR Training Programme on Environmental Law and Policy, Nairobi, Kenya, 29 Nov - 17 Dec 1993


First meeting of the Working Group of Legal and Technical Experts to draft a protocol on liability and compensation under Basel Convention, Geneva, Switzerland, 13 - 17 Sept 1993

12. COUNTRIES OF WORK EXPERIENCE

Maldives

Australia

13. LANGUAGES

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<th>Language</th>
<th>Reading</th>
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14. REFEREES

Prof Jeff Bennett  
Professor of Environmental Management  
Crawford School of Economics and Government  
Australian National University  
Canberra  
+61 2 6125 0154  
Jeff.Bennett@anu.edu.au

Dr. Ahmed Shaig  
Director  
CDE Pvt Ltd  
4F Orchidmance  
Male’  
Male’  
+ 960 3312514  
shaig@cde.com.mv

Mr. Mohamed Khaleel  
Director, Environmental Affairs  
Ministry of Environment  
Government of the Maldives  
Maldives  
+960 3004300  
secretariat@mhe.gov.mv

Signature:  
Date: 23 October 2012
NASHIYA SAEED
CURRICULUM VITAE

1. Proposed Position: Socio economic Consultant

2. Name of Firm: Commerce, Development and Environment Pvt Ltd, Maldives

3. Name of Staff: Nashiya Saeed

4. Date of Birth: February 28, 1984 Nationality: Maldivian

5. Education:
   - Bachelor of Arts: Economic and Political Science, University of Delhi, New Delhi, India – July 2010 to June 2013

6. Countries of Work Experience: Maldives

7. Languages:
   - English: Excellent
   - Dhivehi: Excellent

8. Employment Record:

   May 2009 – Present Socio-Economic Development Consultant
   CDE Consulting
   Male’, Maldives
   - Social and economic impact assessment.
   - Vulnerability assessment
   - Participatory development
   - Participatory rural appraisal.
   - Key areas of interest: Macroeconomic policy, Education policy, Youth Employment, Health Care policy, Social Justice, Social Protection, Child Rights, Gender

   Mar 2008 – May 2009 Executive member and Lead Co-ordinator
   Rights for All (RFA) Male’, Maldives
- Represent RFA at various national level meetings and international missions
- Project and activity planning and executions
- Organizing forums, workshops, events
- Coordinated awareness and public advocacy initiatives within the organization and jointly conducted with Maldivian Civil Society Network
- Media coordination

Sep 2004 – Mar 2008

Clinical Assistant Trainee

Indira Gandhi Memorial Hospital, Male’, Maldives

- Assist in Patient – Doctor communications
- Translation from Dhivehi to English
- Assist doctors in cardiovascular, neurology, orthopaedics, paediatrics, obstetrics & gynaecology, dermatology, psychiatry departments.
- Assist doctors, health care professionals in casualty and emergency department.
- Actively participated in helping the Tsunami victims brought from islands and Male’ from the time they were brought to hospital till they were discharged or admitted to the wards. This included assisting the patients in the observation room, assisted in getting the prescribed medicines, giving them moral support and tending to their needs - 24th December 2004 – 15th January 2005

<table>
<thead>
<tr>
<th>9. Detailed Tasks Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Research</td>
</tr>
<tr>
<td>Community-consultation</td>
</tr>
<tr>
<td>Data Collection</td>
</tr>
<tr>
<td>Data Analysis</td>
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<tr>
<td>Report Writing</td>
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</table>

<table>
<thead>
<tr>
<th>12. Work Undertaken that Best Illustrates Capability to Handle the Tasks Assigned</th>
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<tbody>
<tr>
<td>Work Undertaken that Best Illustrates Capability to Handle the Tasks Assigned</td>
</tr>
<tr>
<td>{Among the assignments in which the staff has been involved, indicate}</td>
</tr>
<tr>
<td>The following information for those assignments that best illustrate staff capability to handle the tasks listed under point 11.}</td>
</tr>
</tbody>
</table>

Name of assignment or project: Maldives Disaster Risk Reduction Baseline Survey
<table>
<thead>
<tr>
<th>Year: 2014</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Location: Maldives</td>
<td>Islands Visited: AA. Thoddoo, L. Gan, GDh. Gaddhoo, HDh. Kulhudhuffushi</td>
</tr>
<tr>
<td></td>
<td>Procuring Entity: UNDP</td>
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<tr>
<td></td>
<td>Main project features: Maldives Disaster Risk Reduction Baseline survey</td>
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<td></td>
<td>Positions held: Socio economic Consultant</td>
</tr>
<tr>
<td></td>
<td>Activities performed: Literature review, methodology design, field research, data analysis and report writing</td>
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</table>

**Name of assignment or project:** Maldives Visitors Survey February 2014

<table>
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<th>Year: 2014</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Location: Maldives</td>
<td></td>
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<tr>
<td>Procuring Entity: Ministry of Tourism</td>
<td>Main project features: Maldives Visitors Survey February 2014</td>
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<td></td>
<td>Positions held: Socio economic Consultant</td>
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<tr>
<td></td>
<td>Activities performed: Data analysis and report writing</td>
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**Name of assignment or project:** Assessment of Deprivations amongst Adolescents

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<tr>
<th>Year: 2013</th>
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</thead>
<tbody>
<tr>
<td>Location: Maldives</td>
<td>Islands visited: S. Hithadhoo, S. Hulhudhoo, N. Manadhoo, N. Velidhoo, AA. Rashoo, AA. Ukulhas</td>
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<tr>
<td></td>
<td>Procuring Entity: UNICEF</td>
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<tr>
<td></td>
<td>Main project features: Assessment of Deprivations amongst Adolescents</td>
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<td></td>
<td>Positions held: Socio economic Consultant</td>
</tr>
<tr>
<td></td>
<td>Activities performed: Literature review, methodology design, field research, comments to report</td>
</tr>
</tbody>
</table>

**Name of assignment or project:**

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<tr>
<td></td>
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<tr>
<td><strong>Maldives Youth and Gender Study</strong></td>
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<tr>
<td>------------------------------------</td>
<td>--------------------------------------------------</td>
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<tr>
<td><strong>Year:</strong> 2013</td>
<td><strong>Location:</strong> Maldives</td>
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<tr>
<td><strong>Procuring Entity:</strong> World Bank</td>
<td><strong>Main project features:</strong> Maldives Youth and Gender Study</td>
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<tr>
<td><strong>Positions held:</strong> Socio economic Consultant</td>
<td><strong>Activities performed:</strong> Research, data analysis and report writing – Author of chapters on Education, Employment and Civic Engagement</td>
</tr>
</tbody>
</table>

**Name of assignment or project:** Maldives Economic Diversification Strategy  
**Year:** 2013  
**Location:** Maldives  
**Procuring Entity:** Ministry of Economic Development  
**Main project features:** Maldives Economic Diversification Strategy  
**Positions held:** Socio economic Consultant  
**Activities performed:** Research, data analysis and report writing

**Name of assignment or project:** An assessment of Economic Activities, Opportunities and Challenges in Shaviyani Atoll  
**Year:** 2012  
**Location:** Maldives  
**Islands Visited:** All islands of Shaviyani Atoll  
**Procuring Entity:** Shaviyani Atoll Council  
**Main project features:** Assessment of Economic Activities, Opportunities and Challenges in Shaviyani Atoll  
**Positions held:** Socio economic Consultant

**Name of assignment or project:** Villingili Island Development Plan  
**Year:** 2012
Location: Maldives
Islands visited: GA. Villingili, GA. Maamutaa
Procuring Entity: Shaviyani Atoll Council
Main project features: Island Development Plan of Villingili island
Positions held: Socio economic Consultant
Activities performed: Community consultations, data collection and report writing – (Author of Education, Health and Governance chapters)

Name of assignment or project: Sustainable Development Strategy – North Province Office
Year: 2011
Location: Maldives
Islands Visited: Selected islands from N, R, B, Lh atoll
Procuring Entity: North Province Office
Main project features:
Positions held: Socio economic Consultant
Activities performed: Community consultations, field research and report writing

Name of assignment or project: Social Assessment of 46 islands
Year: 2009
Location: Maldives
Islands visited: Selected islands from N, R, B, Lh atoll
Procuring Entity: World Bank MEMP Project
Main project features: Social Assessment of 46 islands
Positions held: Associate Consultant (Socio economic)
Activities performed: Community consultations, data collection
| Name of assignment or project: **Technical and Financial Feasibility of Waste Management in Noon, Raa, Baa and Lhaviyani Atoll**  
Year: 2009  
Location: Maldives  
Islands visited: Selected islands from N, R, B, Lh atoll  
Procuring Entity: World Bank MEMP Project  
Main project features:  
Positions held: Associate Consultant (Socioeconomic)  
Activities performed: Community consultations, data collection |  
|  
| Signature | Date: 24 March 2014 |
MOHAMED FAIZAN

PERSONAL DETAILS

Address: H. Pent Land, Lansimoo Goalhi, 20041 Male’, Maldives
Date of Birth: 29th June 1985
Gender: Male
Nationality: Maldivian

Mobile: +960 7975987
Email: Faizan@cde.com.mv

EDUCATION

International Islamic University Malaysia
Bachelor of Biotechnology (Honours) 2006 – 2010

Centre for Higher Education Secondary Education, Male’ Maldives
London Examinations GCE Advanced level certificate 2002-2004

Majeedhiyaa School, Male’, Maldives
London Examinations GCE Ordinary level certificate 1997-2002

EMPLOYMENT

CDE Consulting Pvt Ltd, Maldives (June 2010- Present)
Environmental Consultant – Marine environment monitoring and assessments

Project Assistant to Integrated Climate Change Strategy

CO-CURRICULAR ACTIVITIES

- Information and multimedia secretariat of Student Representative Council 07/08 - International Islamic University Malaysia (2007 - 2008)
- Head of Research and Education Bureau of Science Students Society – International Islamic University Malaysia (2008)

PROFESSIONAL EXPERIENCE

- Environmental Impact Assessment report for the proposed guest swimming pool at Komandoo Maldives Island Resort (April 2012)

- Marine environmental assessment report for the Environmental Suitability report of Baa Atoll Keyodhoo for resort development (March 2012)

- EIA report for the proposed sewerage system at Maduvvari, Raa Atoll (February 2012)

- EIA report for the proposed installation and operation of desalination plant at Hithaadhoo, Baa Atoll (January 2012)
- EIA report for the proposed installation and operation of desalination plant at Kudarikilu Island, Baa Atoll (January 2012)

- Initial Environmental Examination (IEE) report for the proposed relocation of coconut palms from Laamu Hithadhoo to Six Senses Laamu (December 2011)

- Marine environmental assessment and report for the EIA prepared for the proposed harbour development project in Noomara Island, Shaviyani Atoll (December 2011)

- Initial Environmental Examination (IEE) report for the proposed relocation of coconut palms from Rasgetheem to Fushivelavaru Resort (November 2011)

- Baseline environmental assessments and report for the EIA prepared for the development of domestic airport in Ga. Koodoo (September 2011)

- Baseline environmental assessments and report for the proposed channel deepening, beach replenishment and erosion mitigation project at Maamigili Raa Atoll (August 2011)

- Marine environmental assessments and report for the EIA prepared for the proposed reconstruction of AA. Bodufolhodhoo harbour (August 2011)

- Baseline environmental assessments and report for the EIA prepared for the proposed redevelopment of Gasfinolhu Island Resort, EIA (July 2011)

- Marine assessment report for the baseline environmental study for Thilafushi Solid Waste Management Facility (June 2011)

- Marine environmental assessments and report for the EIA prepared for the proposed resort development at Giraavaru Island, Maldives (June 2011)

- Baseline environmental assessments and report for the EIA prepared for the proposed Harbour reconstruction work in Foakaidhoo Island, Shaviyani Atoll (March 2011)

- Co-ordinated the national Household Income and Expenditure Survey (Foreigners) (February 2011)

- Marine environmental assessments and report for the EIA prepared for the proposed Resort development at Villivaru Island, Maldives (February 2011)

- Carried out assessments to determine the baseline conditions of the reefs around Rahfalhu Huraa, Male’ Atoll for the EIA prepared for the proposed development of a picnic island at Rahfalhu Huraa, Male’ Atoll, Maldives (January 2011)

- Carried out marine assessments to determine the condition of the marine environment of Herathera Island Resort, Addu Atoll for the EIA prepared for the removal of seagrass and beach replenishment activities in Herathera Island Resort, Addu Atoll, Maldives. (September 2010)

OTHER SKILLS

- Certified PADI open water diver
Mohamed Ali

ID #: A 094918
Nationality: Maldivian
Languages: English, Sinhalese, Dhivehi
Date of Birth: 13/09/1983
Telephone: 960-790-6007
Email: mohamed.ali@cde.com.mv

Experience
Marine Environmental Specialist June 2011- Present
CDE Consulting

Marine Environment Officer July 2008 – May 2011
Banyan Tree Vabbinfaru

Freelance Lobster Hunter, Shark Fisherman Jan 2007 - July 2008
Laamu Atoll

Dock Assistant Sep 2006 - Jan 2007
Tourist Submarine Maldives

Education and Certifications
PADI Rescue Diver June 2011
PADI Enriched Air Diver June 2011
Emergency First Responder May 2011

Basic Computer Science 2001 - 2006
Singapore Informatics, Colombo Sri Lanka
Profile
I am very passionate about protecting the marine environment. After having worked as both a fisherman and a marine environment officer I am aware of the impact that human activity has on our fragile marine environment. My favorite activities are reef monitoring and planting coral gardens. With my undying passion for the underwater world and also with my vast experience diving all over the Maldives, educating people on the marine environment is my greatest mission, to ensure the preservation and protection of our most valuable treasure. Furthermore, I have got the opportunity to work besides the greatest marine experts in the world namely Prof. J.E.N. Veron, Dr. Norman Queen and Dr. Daphne G. Fautin.

References

N.D. Abdul Azeez Abdul Hakeem
*Former Director of Conservation*
*Mobile: + 960 7784263*
*Banyan Tree Maldives*

Dr. Steve Newman
*Former Marine Lab Manager at Banyan Tree*
*steve.newman@ncl.ac.uk*

Robert James
*Former Marine Lab Manager at Banyan Tree*
PERSONAL DETAILS

Name in Full               : Ali Moosa Didi
Date of Birth             : 18.06.1985
Gender                    : Male
Nationality               : Maldivian

Address:

Permanent                 : Saraasaruge Aage, S.Hithadhoo
                           Neelonfaru Magu

Present                    : Ma. Rose Villa SE, 4th Floor
                           Dhevina Magu
                           Male’

Telephone                  : +960 7912001
                           +960 7703969

EDUCATIONAL QUALIFICATIONS

Madharasthul Islamiya School

- Certification, University of Cambridge General Certification of Education O/L

  Subject
  English
  Mathematics
  Business Account
  Commerce
  Economics

- Secondary School Certificate
  Islamic Studies
  Dhivehi Language

WORK PLACE DETAILS

Commerce Development and Environment Pvt.
Orchid Maage 4th Floor
Ameeru Ahmed Magu
Male’, Republic of Maldives
Telephone: + 960 3312514
Fax: + 960 3315926
E-mail: ali@cde.com.mv

EMPLOYMENT RECORD

Assistant Surveyor

January 2009 – December 2009 Ryco Investment Pvt
HR. Officer

January 2010 – To Current Date Commerce Development & Environment Pvt
Surveyor

WORK EXPERIENCE

Assistant Surveying Officer (Sep 2008 – To Current Date)
- Survey proposed areas for the new projects under the instruction of survey officer.
- Determine precise location and measurements of points, elevations, lines, areas, contours for the construction studying the morphology of the seabed mapmaking and for construction staking, defining and managing parcels data, as-built and profiling.
- Utilize recourses to the optimum level.
- Use company civil/ survey software for contouring, setting alignments, setting points construction, land division.
- Edits and troubleshoot incoming data collector files in accordance with company procedures.
- Processing Survey Data’s Using Topcon Tools, Surfer, Sonar XP, etc
- Reviews and utilize survey crew field notes. -Imports verified data into the appropriate CAD drawing file, using company standards point layer management and description keys.
- Prepares survey drawings and documents using company standards, prototypes, templates and blocks.
- Operate digital cameras and download photo files into database and/or CAD drawings.

- Utilize company scanners to transfer reference maps into CAD files to facilitate utility mapping and property line.

- To perform bathymetric and topographical survey before start of the Projects

- Plotting survey data using AutoCAD 2006-2009

- Processing Survey Data’s Using Topcon Tools, Surfer, Sonar XP, etc.

- Modeling accurate contours

- Preparation of survey maps

- Make sure all the survey instruments are working in good condition.
Ali Nishaman Nizar
G. Dhoores Villa, 20132
06th March 1988
(00) 960 778 5767
ali.nishaman@gmail.com

EDUCATION

Cyprus Forestry College (2006 - 2008)
- Adv. Diploma in Forestry

Center for Higher Secondary Education (2004 - 2006)
- Edexcel - G.C.E. A’levels (Statistics, Business, Accounts)
- Cambridge - Certificate in Advanced English

- Cambridge - O’levels (Mathematics, Economics, Commerce, English, Accounts)

EXPERIENCE

Terrestrial Environment Consultant – CDE Consulting, (July 13 – Present)
- Provides technical assistance to various national and international projects, specifically providing input in areas such as; wetlands, agriculture, forestry, vegetation mapping, mangroves, waste management, composting…etc.
- Working on and contributing to several Environmental Impact Assessment studies.

Local Consultant – Vegetation Expert – Hidria, Spain, (May 13 – Aug 13)
- Worked as a local consultant for Hidria, on developing the Wetland Management Plan for Addu Hithadhoo Eidiqigali Kilhli and Gn.Fuvahmulah Bandaara & Dhandimagu Kilhi.

Agriculture Implementation Officer (AIO) – Project Implementation Unit, MOFA (Oct 10 – Jun 13)
- Worked on the “Post-Tsunami Agriculture and Fisheries Rehabilitation Programme” & the “Fisheries and Agriculture Diversification Programme”
- Focal point for forming and mobilizing agriculture cooperatives in island based communities.

Head of Agriculture Research & Extension – Ministry of Fisheries and Agriculture (Jan 10 – Sept 10)
- Lead a team of 5 staff at the Agriculture Research and Extension Section in the Capital city and an additional 15 staff at our regional research centers in the North and South
- Devised agricultural research programs that develop and improve agriculture in a sustainable manner in the country.

Agriculture Officer – Ministry of Fisheries and Agriculture (Aug 08 – Dec 09)
- Handled the “Training & Extension Unit” (Agriculture Division).
- Planned and coordinated all agriculture related training programs in the Maldives on a daily basis according to the staff availability.

- Worked on a Post-Tsunami forest rehabilitation project.
- Worked with international consultants on several aspects of Maldivian forestry, agriculture and especially focusing upon Maldivian Mangrove ecosystems.
WORKSHOPS / SHORT-TERM TRAININGS ATTENDED

2009,
- Workshop on Strengthening Plant Quarantine and Inspection, Male’, Maldives, 15-16 July 2009
- “Awareness of Food Security” Workshop, Male’, Maldives, 22nd October 2009
- Workshop on Updating and Finalization of the Agriculture Development Master Plan (ADMP), Male, Maldives, 21st December 2009

2010,
- Fisheries & Agriculture Diversification Programme, Financial, Procurement & M&E Training, Male’, Maldives, 26-28 January 2010
- Team Leaders Meeting, 8th Virtual University for Small States of the Commonwealth’s (VUSSC) International Training and Materials Development Workshop, Singapore, 14-20 April 2010
- Prevention, Control and Management of Forest Invasive Species in South Asia, (by APFSIN), Male’, Maldives, 29th April 2010
- Loan Administration Training, Hdh.Kulhudhuhfushi, Maldives, 3-8 July 2010
- Workshop to Finalize the Draft Pesticides and Plant Protection Bill, Male’, Maldives, 12-13 July 2010
- International Workshop on Climate Change Extreme Events Adaptation Practices and Technological Solutions, New Delhi, 16-18 August 2010

2011,
- FADIP “Rolling Baseline Survey” Workshop, Male, Maldives, 2-3 March 2011
- Knowledge Sharing in Asia Workshop #3: Participatory Techniques in the Field, Godavri, Nepal, 30th March 2011 – 2nd April 2011
- Knowledge Sharing in Asia Workshop #2: Writing to Share Knowledge Effectively, Godavri, Nepal, 3-6 April 2011
- Consultation Workshop for Facilitators on Cooperatives and Business Development, UNDP Building, Male, Maldives, 21st April 2011
- AFE’s Workshop on “Value Chain Program Design”, Chiang Mai, Thailand, 12-16 September 2011
- Training of Trainers Workshop on Systematization, Nepal, 8-10 December 2011

2012,
- Workshop on Knowledge Management, tools and techniques (as a trainer for the programme), Maldives, 29th November 2012 – 02nd December 2012
- Partnering 4 Development Forum, UNDP, Paradise Island Resort, 2nd December 2012

2013,
- Consultative Workshop on ICRAF’s Capacity Development Strategy & ICRAF’s South Asian Partner’s Capacity Needs Assessment, BRAC (Bangladesh Rural Advancement Committee) Centre, 30-31 January 2013
- Certificate in Co-operative Poverty Reduction, Co-operative College of Malaysia, Malaysia, 3-21 March 2013
SKILLS
- ICT Competent (MS Applications, Corel Suite...etc)
- Flexible to travel at any time
- Able to Multi-task and work in stressful conditions
- Able to co-ordinate and work with CBPO’s / Co-operatives / NGO’s
- Decision Making Skills
- Logistical Planning Skills
- Good Interpersonal Skills

MEMBERSHIPS IN PROFESSIONAL ASSOCIATIONS
- Bluepeace - an Environmental NGO
  - Advisor on environmental and agricultural issues since the year 2009.
  - Participated in several beach and reef cleanup programs.
  - A member since the year 2008.
- United Artists of Maldives - an association focusing on Maldivian Art and Artisans
  - Sits in the Steering committee of UAM as the Media Coordinator, since January 2013
  - Participated in the International Hay Festival Activities held in the Maldives in 2010.
  - A member since the year 2008.
- UN Global Compact Maldives Network - a network of local private sector parties
  - Representative for Addu Meedhoo Cooperative Society
  - Representative for CDE Consulting

REFEREES
- Dr. Ahmed Shaig,
  Director of Environment, CDE Consulting,
  shaig@cde.com.mv
  +9607788758

- Dr. Aminath Shafia,
  Former State Minister, Ministry of Fisheries and Agriculture,
  shafia@fishagri.gov.mv
  +9607792458

LANGUAGE PROFICIENCY
- Fluent in both writing and reading of Dhivehi (mother tongue)
- Fluent in both writing and reading of English
APPENDIX L – Beach Profiles

Beach Profile 2

Beach Profile 3

Beach Profile 4
Beach Profile 5

Beach Profile 6

Beach Profile 7
APPENDIX M – Participant lists
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
Consultation participant list of council members

Maafaru island council participant list

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Contact number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mohamed Amir</td>
<td>Council president</td>
<td>7568656</td>
</tr>
<tr>
<td>Ali Ahmed</td>
<td>Council member</td>
<td>7677970</td>
</tr>
<tr>
<td>Ahmed Abdul Majeed</td>
<td>Council member</td>
<td>9932012</td>
</tr>
<tr>
<td>Muslim Mohamed</td>
<td>Council member</td>
<td>9669988</td>
</tr>
</tbody>
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Noonu atoll council participant list

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<tr>
<td>Ali Shareef</td>
<td>Atoll council president</td>
<td>9999153</td>
</tr>
<tr>
<td>Adam Faiz</td>
<td>Atoll council member</td>
<td>7911846</td>
</tr>
<tr>
<td>Ali Maajid</td>
<td>Atoll council member</td>
<td>7772343</td>
</tr>
<tr>
<td>Saeed Ibrahim</td>
<td>Assistant Director (Zimmadhaaru isveriyaa)</td>
<td>9943903</td>
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N. Manadhoo council participant list

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Abdul Rahman Sabeeh</td>
<td>Council president</td>
<td>7470458</td>
</tr>
<tr>
<td>Ibrahim Ali</td>
<td>Council vice president</td>
<td>7854714</td>
</tr>
<tr>
<td>Hussain Nazeedhu</td>
<td>Council member</td>
<td>7663335</td>
</tr>
<tr>
<td>Mohmaed Inaz</td>
<td>Council member</td>
<td>7797285</td>
</tr>
<tr>
<td>Ali Shiyaz</td>
<td>Council member</td>
<td>7554055</td>
</tr>
</tbody>
</table>
APPENDIX N – Commitment Letter and Declaration
Hon. Thorig Ibrahim
Minister
Ministry of Housing and Environment
Male’, Republic of Maldives

Dear Sir,

Sub: EIA for the proposed airport construction project in Maafaru Island, Noonu Atoll

As the proponent of the above mentioned project, we guarantee that we have read the report and to the best of our knowledge all non-technical information provided here are accurate and complete.

We also hereby confirm our commitment to carry out and bear costs of environmental mitigation measures and monitoring outlined in the EIA report.

Sincerely,

[Signature]

Hamid Ismail
Chairman