ENVIRONMENTAL IMPACT ASSESSMENT

For the Proposed Harbour Construction Phase 1 of Kulhudhuffushi, H. Dhaal Atoll, Maldives

Proposed by

Ministry of Construction and Public Infra Structure

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for

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Table of Contents

Table of Figures

List of Tables

Non Technical summary

This report discusses the findings of a socio-cultural and environmental impact study undertaken by Water Solutions Private Limited, Maldives, up on invitation from the Maldives Transport and Contracting Company (MTCC).

The existing harbour of Kulhudhuffushi island in Haa Dhaal Atoll of the Maldives is found to be inadequate in terms of size and facilities and need to be modernised. In this regard the Ministry of construction and Public Infrastructure (MCPI) under the mandate of create coastal infrastructure development from the government's side, have awarded this project to MTCC. MTCC has won the project in a competitive bidding process.

This project involves the construction and development of Kulhudhuffushi harbour (Phase 1), with improved infrastructures. The harbour of Kulhudhuffushi has been damaged to various extents and requires repair and upgrading, including deepening the harbour basin, and increasing the size. This EIA has been prepared to assess the social and environmental impacts of this proposed construction and development of Kulhudhuffushi harbour phase 1.

Kulhudhuffushi Harbour Phase 1 will be built about 140 meters away from the existing shore line. The dredge spoil from the harbour basin will be used to back fill and reclaim the gap between the existing shoreline and proposed harbour basin there by adding approximately 9 hectares to this island. This is a 3% addition of land to the existing land.

Major environmental impacts of the project have been identified as mainly from dredging and disposal of dredged materials. Dredging will be undertaken in the harbour basin and to some extent in the access channel. In view of the assessment, the environmental damages to marine resources have not been considered major due to the following conditions

- Limited boundary of the project
- Due to the confined nature
- Marine flora and fauna has been already affected due to the existing harbour.

The impacts are likely to be felt on an estimated lesser area of the lagoon and reef-flat which already has been impacted by previous harbour building These environmental impacts were assessed for both construction and operation phase of the project.

Mitigation measures for these anticipated impacts have been identified and outlined in detail, including sedimentation control methods and other measures. These mitigation measures will have to be followed in order to minimize environmental damage. Stakeholder consultations were held with various groups, including the community and the client in order to incorporate the socio-economic components in the project. The proposed development plans for Kulhudhufushi has been prepared after considering the needs and requirements from the community by assessing and incorporating the outcomes from the extensive community consultations held during the data collection stage.

It is inevitable that there would be some negative environmental impacts, especially when dredging is undertaken. However, these minor negative impacts out weight the socioeconomic benefits gained by expanding the harbour. As a result, a comprehensive monitoring component has been suggested which takes in to consideration, the most important elements that require

regular checks. This monitoring component will be adhered and will allow the assessment of long term changes, despite the limited nature of the impact. The most important consideration is the socioeconomic impacts that have been assessed mainly as positive in nature. Not only they are positive, but most importantly in the long term.

Therefore, it appears justified from a technical and from an environmental point of view, to carry out the proposed development project if the island is to absorb the economic gains achieved by the project.

1 Introduction

This Environmental Impact Assessment report (EIA) has been prepared to full fill the requirements of the Environmental Protection and Preservation Act, law no. 4/93 for the proposed development of harbour construction (phase 1) in Kulhudhuffushi island, Haa Dhaal atoll, Maldives.

Ministry of Construction and Public Infrastructure has started an access programmed and under this programme many harbours from different parts of Maldives are being upgraded and Kulhudhuffushi is not exception. The project proponent is the government of Maldives with the executing agency as Ministry of Construction and Public Infrastructure (MCPI) and contractor as MTCC.

After expansion and development, the harbour is expected to have additional features, including more space, quay wall constructed with reinforced L-shaped concrete walls, minimum basin depth of 3 meters, breakwaters with boulders at 1.4 meters above mean sea level. These modifications would enhance the harbour and be economically beneficial and accommodate the needs of the islands future development. The expansion has been designed to a minimum maintenance free period of 10 years and a design life of 30 years.

This report will identify the potential impacts (both positive and negative) of the proposed project. The report will look at the project description in detail, existing environmental conditions in Kulhudhuffushi, justifications given by the proponent for undertaking the proposed project components and alternatives. Alternatives to proposed components in terms of design and environmental considerations would be suggested. A mitigation plan and a monitoring programme before, during and after the works would also be suggested. This will ensure that the proposed activities are undertaken with caution and appropriative care so as to protect and preserve the natural environment of the island. Figure 1 shows an aerial view of Kulhudhuffushi Island.

Figure 1: Aerial view of Kulhudhuffushi Island, H. Dhaal Atoll.

The major findings of this report are based on qualitative and quantitative assessments undertaken during site visit from 15th to 18th February 2008. However, due to unavailability of long term site-specific data, the impact assessment methodology has been restricted to field data collected, consultations, experience and professional judgment. Available long term data were collected from available sources, such as long term data on meteorology and climate from global databases.

This EIA has been produced in accordance with the EIA Regulations 2007, issued by the Ministry of Environment, Energy and Water on preparing Environmental Impact Assessment studies.

1.1 Aims and Objectives of the EIA

This report addresses the environmental concerns of the proposed expansion of the harbour in Kulhudhuffushi island in Haa Dhaal Atoll. It helps to achieve the following objectives.

- Allow better project planning
- Assist in mitigating impacts caused due to the redevelopment without compromising environmental damage.
- Promote informed and environmentally sound decision making
- To demonstrate the commitment by the proponent on the importance of environmental protection and preservation.

1.2 Methodologies

Internationally recognized and accepted methods have been used in this environmental evaluation and assessment. This EIA is based mainly on data collected during a field investigation missions from 15th to 18th February 2008 by a team from Water Solutions Private Limited of Maldives. The data collection methods are described in detail under "Methodology".

1.3 EIA Implementation

This EIA has been prepared by a local environmental consulting firm, Water Solutions and the members participated in the team were:

- Ahmed Zahid, BSc. – Environment management and Ecotourism Consultant
- Ibrahim Naeem, BSc. – Marine Biologist
- Hassan Shah –Env Sci. (Team leader and socio economic and cultural surveyor)
- Mohamed Riyaz, Surveying Assistant

1.4 Terms of Reference

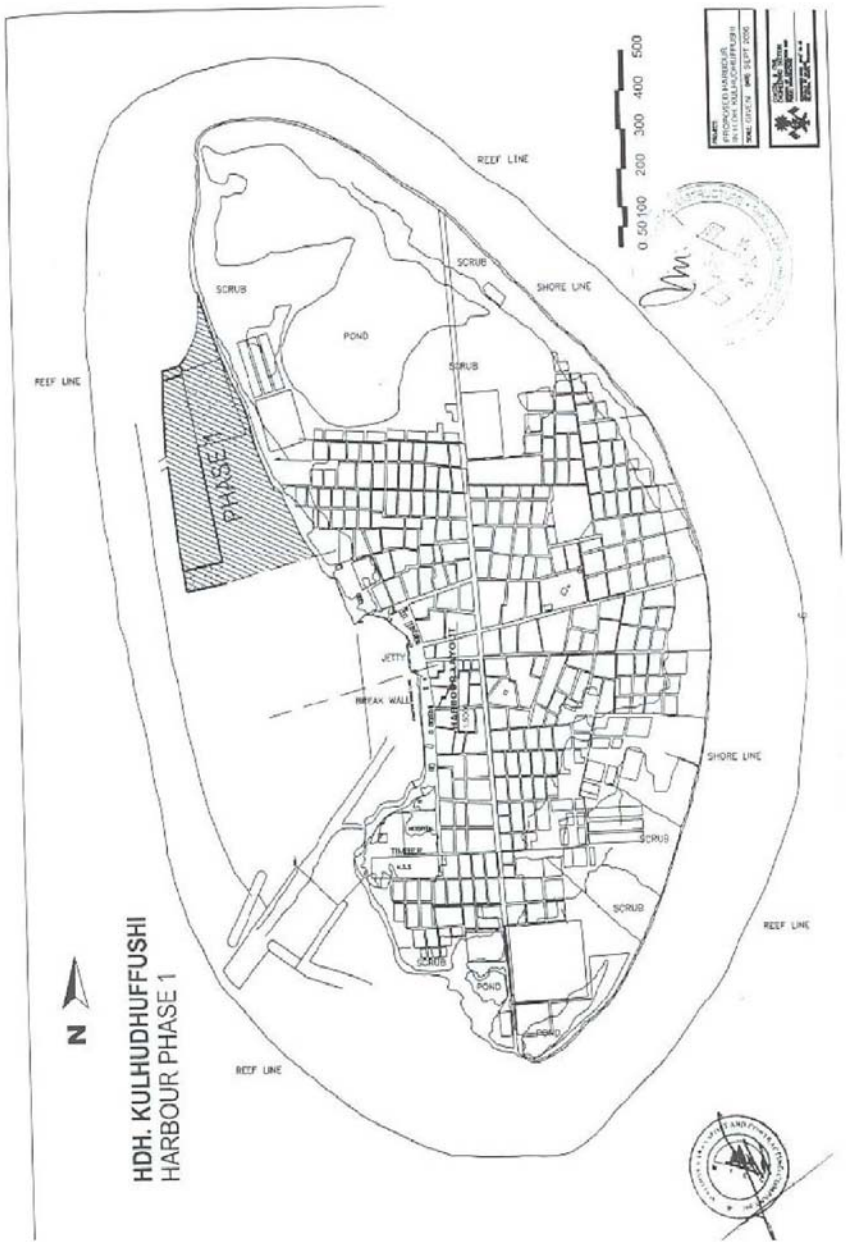
The terms of reference for this EIA have been attached in Appendix K. This EIA has been prepared based on these terms of reference.

2 Project Description

2.1 General context of the study

Kulhudhuffushi Island is the focused island for the development of the northern region. As a result a port known as regional port has been constructed and all the necessary infrastructure and man power development is under way to divert imports directly from overseas. This regional port with other facilities such as education, health and business has created a huge inflow of visitors from the region. To cater for Kulhudhuffushi islanders and its visitors a local harbour has become a basic necessity. In this regard MCPI under the responsibility of planning and managing harbours of the government of Maldives has awarded a contract to MTCC to construct a local harbour along with the detail design. MCPI has divided the development of local harbour into 3 phases and this report is prepared for the phase 1 of the project. The concept for the phase 1 of the Kulhudhuffushi harbour is shown in Figure 2

Figure 2: Concept of Kulhudhuffushi Harbour Phase 1.



This report is prepared for Haa Dhaal Kulhudhuffushi Island. The harbour project project, which will benefit the 8060 residents of Kulhudhuffushi and its visitors, must propose the most suitable infrastructure with the aim of simplifying access to the islands and developing activities related to economic activities.

2.2 Project Proponent

This project is proposed by the government of Maldives with MCPI as the lead executing agency and MTCC as the contractor. The project involves construction of phase 1 of local harbour in the island of **Kulhudhuffushi, Haa Dhaal atoll**, Maldives.

2.3 Background of the Proponent

Ministry of Construction and Public Infrastructure (MCPI)is the government ministry responsible for the development and regulation of the construction sector of the country. It is also the agency which oversees the development of public infrastructure of the country (www.construction.gov.mv). All harbour development projects therefore fall under the responsibility of MCPI. MCPI has undertaken several harbour design and implementation projects throughout the Maldives and have also developed standards and criteria's for developing harbours in the Maldives and the proponent of this project is MCPI

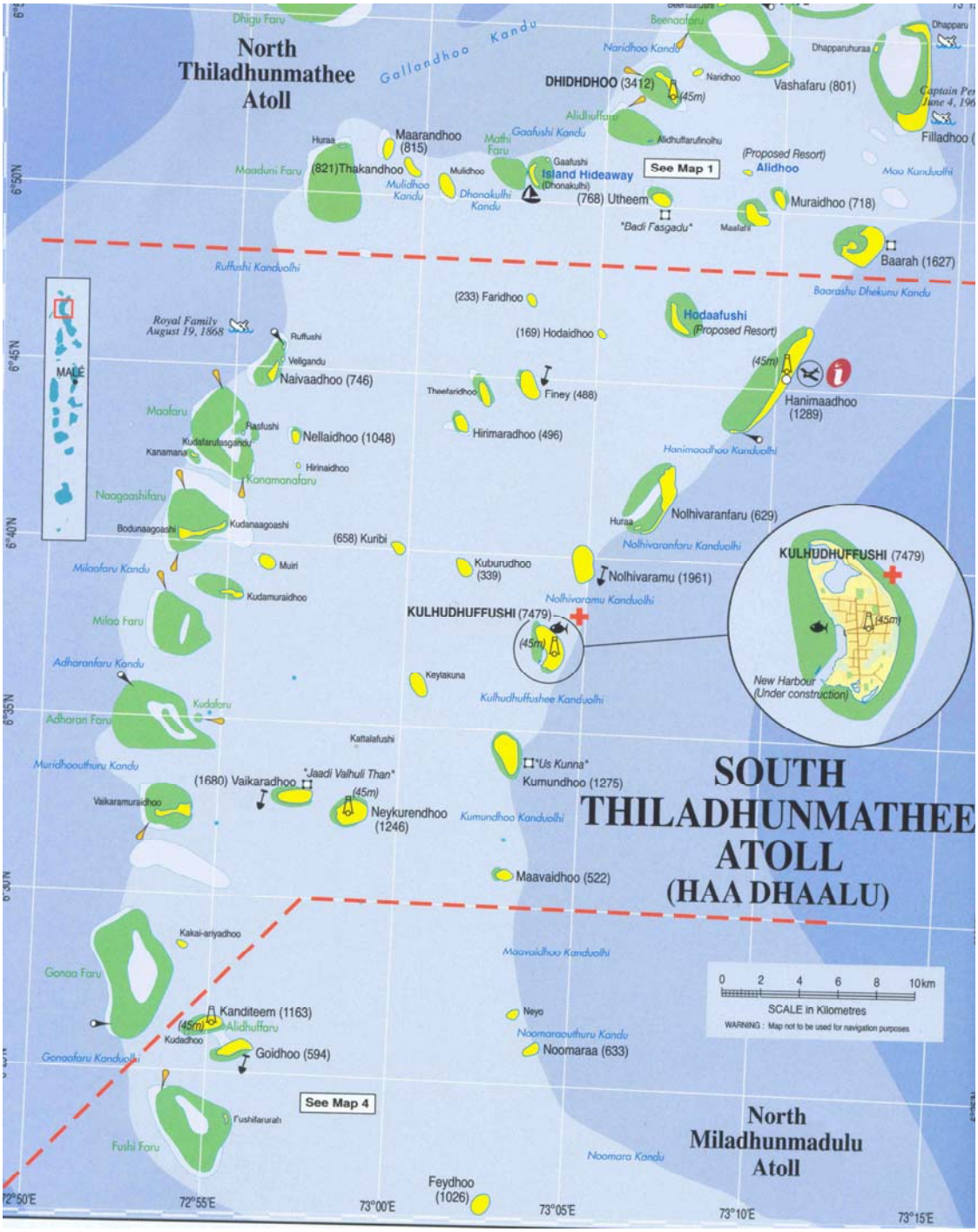
MTCC with a mission statement of Compete, Expand and diversify with Customer Confidence is the leading contractor with in Maldives and has won this project. MTCC was formed on 18th December 1980 with a share capital of 12'500,000 and has been expanding rapidly.

2.4 Project Location and Study Area

The project takes place on the north western side of Kulhudhuffushi island (see Figure 1). Kulhudhuffushi is located in the eastern rim of Haa Dhaalu Atoll in Maldives, approximately 274.15km away from the capital city, Malé. The island is formed in a pea shape on the eastern side of South Thiladhunmathee atoll also known as Haa Dhaalu atoll. The reef of Kulhudhuffushi covers the entire island and there is not other island on this lagoon. The geographical coordinates of the island are 06° 37' N longitude and 73° 04' E Latitude. The total area of the island is 172.20 hectares and has a population of 8060 people. Kulhudhuffushi is the capital of Haa Dhaal Atoll and is among the 14 safe islands selected by the government of Maldives.. At present the island has a regional port on the south western side and a crowded local harbour. The existing local harbour's quay walls were constructed using gunny bags filled with sand cement mixture.

The existing harbour is at present located on the western side of the island and will be expanded during phase 2 and phase three of the project.

Figure 3: Location of Kulhudhuffushi Island, H. Dhaal Atoll.



2.5 Project boundary

The project boundary is confined to the harbour, basin, the immediate lagoon, access channel, coral reef and the adjacent coastline north and south of the harbour. The coral reef on the northern, southern and western side of the reef edge is also contained in the project boundary. See Figure 1 and 2 for the project boundary.

2.6 Geography and formation of Kulhudhuffushi

Kulhudhuffushi is the capital of Haa Dhaal Atoll and this atoll is also popularly known as south Thiladhunmathi.. Kulhudhuffushi is a unique pea shaped island where all the neighbouring islands have to rely on due to the many facilities available on this island. It is approximately 17 km down south west of Hanimaadhoo airport. Kulhudhuffushi was formed on a patched reef o the eastern rim of geographic south Thiladhunmathiee atoll (See Figure 3). The island occupies about 70% of the reef top. There are channels on the both northern and southern side of the island. On the north of Kulhudhufushi is Nolhivaramu separated by the Nolhivaramu Kanduolhi. On the south of Kulhdhufushi is Kumundhoo separated by Kulhudhuffushi Kandu.

The geographical coordinates of the island are longitude 73° 04’ 06” E and latitude 06° 37’ 25”N. The reef system that houses Kulhudhuffushi is oriented in a north-south direction. Within the Reef system, there are no other islands.

The island has a considerable shallow lagoon form both sides. The length of the island is 2500 meters and the width is 800meters.. Access to the island is achieved through an artificially created access channel that is approximately 100 meters wide.

2.7 Need and Justification for the Expansion

The primary justification to undertake this project is to accommodate more vessels and add land area to the island by means of reclamation.

An Environmental Impact Statement for Regional Ports Development by Pescares Italia SRL July 2001 has revealed the most appropriate locations for a port are north-western and south-western part of this island. As a result a Regional Port has been built at south west of the island and now a local harbour has been proposed at North West of the island. Phase 1 of the local harbour of Kulhudhuffushi is in close proximity of the existing harbour and will reduce cost and construction stage operational stage.

Kulhudhuffushi is the most developed island in the northern region and most of the neighbouring island and atolls depend on Kulhudhuffushi for their primary needs. Kulhudhuffushi has the best hospital and schools in the region. It’s the capital of the atoll and existing divisions of many ministries of the central government plays a vital role in expediting the developmental activities. Ministry of Constructions and Public infra structure (MCPI), Maldives National Defence Force (MNDF), and Regional Development Management Office are a few examples and now that leading businessmen’s has started investing opening their branches in this island. All these factors including education, administration and health services have increased the traffic flow in Kulhudhuffushi harbour demanding its size to be increased and modernised.

A regional port has been established in this island and is now under operation. Construction materials and general cargos for this region from overseas are now diverted to Kulhudhuffushi and

soon there will be an increase in port traffic. Population density is increasing this island due to the migration of islanders for education, health care and employment. This project which is only phase 1 of Kulhudhuffushi harbour development programme will add a 3% land to this island. Subsequent phases of harbour expansion as per land use plan will make Kulhudhuffushi one of the most prominent business hub of Maldives.

An L- shaped excavator bed of approximately 200 meters long already exist in the proposed harbour area. This excavator bed was used to transport dredged sand for the road construction and repair works has interfered coastal dynamics and has decreased marine water quality at the north western side of the lagoon with eutrophication (Appendix A).

The tsunami of 26th December 2004 affected many islands in the Maldives. Following tsunami the government initiated a migration programme with incentive schemes. Following tsunami, fourteen safe islands were selected and Kulhudhuffushi is one of them and all the safe island developmental activities are underway. The idea of Safe Island is to extend the population consolidation approach to provide safe areas with basic services during emergencies, with health, transport and communication and buffer stocks of food and water.

As mentioned earlier, Kulhudhuffushi is a vital hub and the projections for future seem very promising with commercial and social activities. Kulhudhuffushi is a convention centre and many nation level workshops, awareness programmes, training programmes and social events are held during the year.

During public consultation and discussion with the island chief has highlighted the difficulties faced by the islanders and visitors due the smaller size of harbour and lack of infrastructure. The harbour urgently requires redevelopment and expansion, if the existing and potential development activities to be sustained and improved. Without the expansion of the proposed harbour, there would be slow growth and economic activity.

Construction of a local harbour with modern facilities will add land, develop economy and will have a clear beneficial impact on health and safety of the islanders and its visitors.

2.8 Project duration

The project is expected to take 11 months.

2.9 Description of the existing harbour

A detail inspection of the harbour was made during the field visits by the consultant and the contractor on different occasions. The western side of the island has been used as the harbour since inhabitancy due to the larger lagoon size, and easier accessibility. A regional port has been established at south western part of the island and is now under operation. A 105m wide access channel exist in this regional port and is been used by all the vessels as an entrance and exit of the harbour. The length and width of the harbour basin of regional port is 210m X 160m respectively and is deepened to 5m at mean sea level. A jetty exists at about 450m from the entrance channel and the docking station for the larger cargo vessel which travel between Male' and Kulhudhuffushi is located at about 850 away from the entrance channel.

Kulhudhuffushi harbour development phase 1 is more confined on the north western part of the island. There is no infra structure at this location, but an excavator bed of length approximately

200m is still seen and was used by trucks to transport dredged sand for the road construction work as per the islanders. The excavator bed has interrupted the sediment and current movement thereby causing a stagnant water body (Appendix B) .A bathymetric survey was carried out at this location and was found to be 0.7m as an average with a sea grass bottom (Appendix C).

2.10 Description of project components

The harbour project and the final layout of the finished harbour in Kulhudhuffushi is illustrated in Appendix D. The local harbour project will have the following main components, namely;

- Construction of the breakwater with boulders of 600-800 kg and will be used. The design of
- Construction of 540m of quay wall capable to withstand heavy loads generated by specific handling equipment such as crane (75 t) and conveyor (L-shaped concrete slabs). The proposed harbour phase 1 is an open lagoon, but at the existing local harbour's quay wall does not serve as a good quay wall. The quay wall has been constructed using sand cement bags with a cement layer on top. At some places, caving of the quay wall was observed.
- Construction quay walls with suitable technique giving a life time of at least 30 years and providing better protection of the vessels (agitation + siltation).
- Dredging the harbour basin to -3.00 m at MSL. and It is estimated to generate 73'000 m^3 of dredge spoil.

Once the expansion project is complete, the harbour will be enhanced and will have a longer life span. The harbour will also be able to accommodate more vessels with improved facilities and capabilities. The proposed layout and construction plan for Kulhudhuffushi is illustrated in Appendix E. Table 1 outlines a summary of major activities proposed for the harbour project with their estimates, in terms of length and volumes of construction required.

Table 1: A summary of the major activities with quantitative linear and volume estimates

DESCRIPTION	UNIT	QUANTITY
L shaped reinforced concrete quay wall	m	570
Breakwaters with boulders	M	520
Dredging of the basin to -3.00 m at MSL (volume of dredge spoil)	M^3	73000

2.11 Project Activities

The proposed project involves redevelopment of the harbour in Kulhudhuffushi island with enhanced measures designed to improve the existing condition and with a greater life span.

New additional features of the harbour will include more space in the harbour basin, reinforced L-shaped quay walls that will last longer and be capable of withstanding greater loads, breakwaters

with boulders and increasing the depth of harbour basin and access channel. The project activities have been divided in to coastal and marine based activities.

2.11.1 Coastal activities

The following coastal activities will take place in the island.

Activity 2: Construction of 570m of quay wall capable to withstand heavy loads generated by specific handling equipment such as crane (75 t) and conveyor (L-shaped concrete slabs).

Activity 3: Construction of 520m breakwaters with suitable technique giving a life time of at least 30 years and providing protection of the vessels (agitation + siltation).

2.11.2 Marine based activities

The following marine based activities will take place on the island.

Activity 1: Construction of the breakwater with boulders of 600-800 kg imported from overseas

Activity 2: Dredging the harbour basin to -3.00 m at MSL

Activity 3: Dredging of the access channel to -3.00 m at MSL

2.11.3 Noise

The ambient noise level was measured using digital sound level meter. It was found to be 60.5 dB. This is just below an average traffic environment and precaution must be taken during construction period to prevent noise pollution.

2.12 Construction Schedule and methodology

The project is expected to be not more than 11 months for construction. A tentative construction schedule is attached as Appendix F.

2.12.1 Construction strategy

The harbour redevelopment project will be undertaken in the planned time period to reduce cost and also reduce the environmental damage. Both coastal and marine based construction activities will be done in parallel to complete the work in the least possible time frame.

2.12.2 Work methods for coastal structures

Coastal structures for this project include jetty and quay walls. Existing jetty will be reconstructed to increase the width and area available for use.

Quay wall will also be constructed similarly using L-shaped reinforced concrete walls (see Appendix G). These L-shaped concrete walls will be placed along the quay wall section where it will be placed upright with a tie rod and concrete slab to stabilize the quay wall when it is loaded. Loading and unloading will be carried by excavators and cranes. Once they are placed, a final top concrete beam will be placed on top which will form the quay wall. Once they are in place and completed, backfilling will be done using part of the sand dredged from the basin.

2.12.3 Works methods for marine based activities

Marine based activities will be dredging and construction of breakwaters. Dredging of the harbour basin and access channels will be done by using excavators. Excavators placed on a barge will be used to dredge the harbour basin. Breakwater construction will also be undertaken using excavators to remove the coral debris, placing and rearranging the boulders.

2.12.4 Management of dredged spoil and its disposal

The project will produce a combined volume of 73,000 cubic meters of sand or dredged spoil which has to be managed in an environmentally acceptable manner. In Kulhudhuffushi, the dredged spoil from the harbour basin will be used to reclaim the lagoon on the south of the harbour. This area has been planned for future expansion by reclamation. It has been proposed to develop fishing related industrial activities in this area as per land use plan (Appendix H). A portion of the dredged material will also be used to back fill the quay wall and jetty once they are completed.

These disposal sites have been thoroughly studied and baseline conditions of these areas have been assessed and discussed in the existing marine environmental section.

2.13 Project Inputs and Outputs

2.13.1 Project Inputs

The types of resources that will go into the redevelopment and from where and how these will be obtained are given in Table 2.

Table 2: Matrix of major inputs during construction period

INPUT RESOURCE(S)	SOURCE/TYPE	HOW TO OBTAIN RESOURCES
Construction workers (15+)	Maldivians	Open bidding by advertising in local papers/other sources
Water supply (construction period)	Well water from the island	From a well that will be dug for this purpose near the site
Electricity/Energy (construction period)	Mobile Diesel generators	Contractors to provide
Construction machinery	Excavators, dredgers, barges, general construction tools, lorries, cranes, loader.	Contractors to provide
Telecommunications	Mobile Phones, Fax Machines, E-mail and internet facilities	Already this services is available in the island
Transport (sea)	Materials to be transported in carrier vessels or large barges.	contractors
Food (during construction period)	Obtained from the island.	local purchase by the contractor
Fuel,	Diesel, Petrol, Lubricants	Local purchase by the contractor

2.13.2 Project Outputs

The type of outputs (products and waste streams) and what is expected to happen to the outputs are given in Table 3.

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

PRODUCTS AND WASTE MATERIALS	ANTICIPATED QUANTITIES	METHOD OF DISPOSAL
Sewage and wastewater Grey water/laundry wastewater	Estimated to be at 150 litres/person/day	Construction workers will be housed in existing houses on rent basis. The island has onsite sanitation system and therefore wastewater will be treated using septic tanks.
Waste oil and grease (hazardous waste)	Approximately 40 litres per month	Stockpiled and sent to landfill in Thilafushi after decommissioning. Alternatively they will be made available for local fisherman for free.
Noise	Only localised to the island environment	Unavoidable during the construction stage but will be minimized.
Air pollution	Limited quantities of dust in the construction area (harbour area).	Mainly arising as a result of dust emission from the construction work such as cement mixing, moving machinery and other processes. Only localised.
Dredged spoil	73,000 cubic meters	73,000 m^3 will be used to reclaim the area between the island and proposed harbour location.

3 Project Setting

3.1 Overview

The project conforms to the requirements of the Environmental Protection and Preservation Act of the Maldives, Law no. 4/93. The EIA has been undertaken in accordance with the EIA Regulation 2007 of the Maldives by registered consultants. Furthermore, it adheres to the principles underlined in the regulations, action plans, programmes and policies of the following Government Ministries.

- Ministry of Environment, Energy and Water
- Ministry of Agriculture and Marine Resources

These are discussed in detail in the following sections.

3.2 Applicable Policies, Laws and Regulations

3.2.1 Environmental Protection and Preservation Act

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

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

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

3.3 Second National Environment Action Plan (1999)

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

Main strategies of the NEAP II are:

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

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

The development of harbour in Kulhudhuffushi will also be in accordance with the main strategies of the NEAP II. The proponent will, fully committed to the EIA and the proposed monitoring programme. The monitoring programme proposed in this report outlines the environmental management strategy and plan. This EIA has also been prepared in consultation with all the key stakeholders, especially the island community and MCPI. Therefore, these measures address the key strategies outlined in the NEAP II.

3.3.1 National Biodiversity Strategy and Action Plan

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

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

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

3.3.2 Regulation on sand and aggregate mining

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

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

3.3.3 Ban on coral mining

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

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

Coral would not be mined in any stage of the project. The EIA report clearly outlines the impacts of dredging and a proper assessment of the affected environment has been undertaken. Rock boulders will be used for breakwater construction.

3.4 Environmental Impact Assessment Regulation 2007

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

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

3.4.1 Post EIA Monitoring, Auditing and Evaluation

The environmental monitoring programme given in EIA reports is an important aspect of the EIA process. The monitoring programme outlines the objectives of the monitoring; the specific information to be collected; the data collection program, and managing the monitoring program. Managing the monitoring programme requires assigning institutional responsibility, reporting

requirements, enforcement capability, and ensuring that adequate resources are provided in terms of funds, skilled staff, etc.

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

3.5 International conventions, treaties and protocols

Some of the international conventions, treaties and protocols of relevance to the proposed project may be identified as follows:

3.5.1 United Nations Convention on Biological Diversity (UNCBD)

The objective of UNCBD 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".

Maldives was one of the first nations to ratify UNCBD. Maldives has developed the National Biodiversity Strategy and Action Plan (NBSAP) in 2002. Formulation of NBSAP was through wide consultation and extensive stakeholder participation.

The proposed project involves dredging and filling beach areas which may have impacts on some biological resources. The creation of breakwaters may also impact reef resources. These impacts and mitigation measures have been dealt with in this report.

3.5.2 Marpol Convention

International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 and includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - and currently includes Prevention of Pollution by Oil; Control of Pollution by Noxious Liquid Substances in Bulk; Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form; Prevention of Pollution by Sewage from Ships; Prevention of Pollution by Garbage from Ships; and Prevention of Air Pollution from Ships.

This Convention has little or no relevance to the proposed harbour development project in Kulhudhuffushi. However, it is worthy of mention since Maldives is a party to the MARPOL and any establishment of appropriate port side facilities in the harbour in Kulhudhuffushi will help ensure that the provisions in the MARPOL convention are fully enforced by ships and other vessels that travel in the territory of the Maldives and pollution of the Maldivian seas are prevented.

The Maldives has guidelines and regulations pertaining to pollution from ships and other vessels which may anchor at any harbour in the Maldives. Vessels requiring discharging slop from tank cleaning and dirty oil bilge should request local agent to provide reception facility. Port Authority does not have slop reception facilities. If any vessel discharges over board or in case any type of oil spill is found in port, the officer in charge of the vessel is required to report to Maldives Ports Authority and Coast Guard to take immediate action.

Furthermore, Government regulation states as follows:

1) It is expressly forbidden for any vessel to dump or discharge into any harbour, lagoon, or into any part of the waters of the Republic of Maldives, refuse, bunker oil, sewage, noxious substances or any materials or substances whatsoever.

2) The Master of any vessel and / or its agents will be held directly responsible for any nature or degree of pollution of the water, lagoons and Islands of the Republic of Maldives through the dumping or discharge of any refuse and / or substances.

3) In the event of any nature or degree of pollution of Territorial Water of the Republic of Maldives due to the dumping or discharge of refuse and / or substances, the master and / or the Agent of the offending vessel shall be subject to an immediate fine deemed by the Authority concerned according to Maldivian Law.

4 Methodology

The section covers methodologies used to collect data on the existing environment.

The key environmental and socio-economic components of the project under consideration are:

Vital Environmental, Social and Economic Components

- Coral reef areas and the marine environment.
- Marine biodiversity
- Marine water quality
- Socio-economic context of the project.

Hence, data collection was undertaken for the above components. In order to study the existing environment of the island, the following data collection methodologies were used during the field visit undertaken between 15th to 17th February 2008.

4.1 General Methodologies of data collection.

Conditions of the existing environment were analyzed by using appropriate scientific methods. The environmental components of the study area were divided into marine and coastal zone. Although terrestrial component was not considered as important for this project, baseline environmental conditions were appraised. The marine environment of the island covered the coral patches, the lagoon and the house reef of, especially around the area expected to have the greatest impact as a result of the proposed project. The coastal environment covered the coastline within the project boundary, the jetties and quay wall construction.

The environmental conditions were assessed by dividing the tasks among different groups – marine, coastal and socioeconomics. The different methods used in assessing and reporting the conditions of the existing environment of the island are outlined in the following subsections.

4.1.1 Mapping and Location identification

The specific areas related to the project in the island, including reef line, shore line, vegetation line, coral patches and marine survey locations (in the project boundary), existing breakwaters and access channel/s were mapped for the assessment. Mapping was undertaken using hand held differential GPS. The location of data collection sites were marked using handheld GPS. These data collection points include water sampling locations, marine survey areas, and proposed dredging areas and reclamation.

4.1.2 Marine Water Quality

One of the main environmental components that would be affected by implementing the project would be marine water quality, especially within the harbour basin and the access channel. Water quality was assessed during the field trip in February 2008 by collecting samples and testing them at National Health Laboratory. Water quality was assessed at selected locations within the possible impact zone. The locations, frequency and parameters to be monitored are given in the Monitoring programme outlined later in the EIA report.

4.1.3 Marine Environment

Marine environmental surveys were conducted to collect data on key environmental components (i.e. the coral reef system), sea grass beds that will be impacted due to the development. Purpose of the surveys was to define and establish marine environmental baseline conditions for impact evaluation during and after the proposed project. Surveys were based on standard marine environmental surveys so that they can be repeatedly carried out to monitor and record changes and assess possible impacts on the marine environment from the proposed work activities. Surveys include quantitative and qualitative surveys. Marine surveys were conducted in the project area where the impacts are likely to occur and also in locations identified for dredged spoil disposal. These methodologies are discussed in detailed under the Marine Environment.

4.1.4 Bathymetric survey

A detailed bathymetric survey was undertaken to assess the baseline condition of the harbour basin and also calculate the wave strength approaching the harbour. Bathymetric surveys were also used to determine the volume of dredging required for the basin and access channels Refer to Appendix C.

4.1.5 Socio-economic data collection

The base line socio- economic condition of the island and the possible impacts of the project to the island community were studied by using various methods including, key informant interviews, utilizing existing data and maps, taking samples from cross sections of the community, focus group interviews and household surveys.

The proposed methodology was shared with the project client. It was suggested to undertake the socioeconomic studies based on the existing data and community meetings.

The socio-economic studies undertaken in the island was targeted to get the in depth information of the community, their perception, values regarding the proposed harbour development project.

The specific objectives of the studies were:

1. to identify the existing socio economic conditions prevailing on the island;
2. to understand the perceptions that the islanders have towards the proposed harbour development project ;
3. to determine the parameters that requires future monitoring to gauge the impact of the proposed harbour development project.

In this regard a study team has visited the island from 15th to 17th February 2008, to conduct field surveys. The team has conducted socio-economic studies of the island and gathered the data based on the following:

1. Key informant's interviews,
2. Community meetings;
3. Date collection from island office.

The socio-economist has met the Island Chiefs, and other officials of the island office and collected baseline information of the island. This includes the population, growth, income generating activities, proposed development projects of the island, community issues.

The team has also attended community meeting organized by the island office, and represented by Island Development Committee, and Harbour Committee. A detailed discussion was held with the committees regarding the proposed development project and gathers the views and perception committee members.

A site inspection was also carried and gathered information about the socio-economic condition of the island.

5 Existing Coastal Environment

5.1 Chapter Brief

This chapter will look at the coastal zone of the island environment which is the area between the vegetation line and the reef flat, but within the identified project boundary. Therefore, this chapter will cover the following:

- General meteorological conditions in the Maldives (in gathering meteorological data, global satellite database and other local and international sources were used).
- Existing coastal environmental conditions of Kulhudhufushi, within the project boundary.
- The different proposed components of the project that will impact upon the coastal environment.

5.2 Existing Coastal Environment

5.2.1 Island Formation and Geography

Refer 2.6 for a description of the geographical formation of Kulhudhuffushi.

5.3 General Meteorological conditions in Maldives

5.3.1 Climate and weather

Information was extracted from (UNEP, 2002).

The Maldives has a warm and humid tropical climate. The weather is dominated by two monsoon periods:

- The South-West (SW) monsoon from May to November (rainy period),
- the North-East (NE) monsoon from January to March (dry period),

when winds blow predominantly from either of these two directions.

The relative humidity ranges from 73% to 85%. Daily temperatures in the country vary very little throughout the year with a mean annual temperature of 28°C.

5.3.2 Wind conditions

5.3.2.1 General information

Wind directions are connected to the monsoons regime. Winds from the NE and ENE are predominant during December to February. During March and April, the direction varies with the general direction being westerly. But strong winds are associated with the SW monsoon season. Gales are uncommon and cyclones are very rare in the Maldives. Stormy weather is more frequent from May to July. Storm gusts of 50 to 60 knots have been recorded at Malé.

The wind and offshore wave climates occurring in the Maldives region, over the period 1993-2004, were extracted from the worldwide database developed by Globocéan. Figure 4 describes the methodology adopted to construct the statistical data for the Maldives and presents the annual, monthly and seasonal wind and offshore wave statistics. An analysis of this database is given hereafter.

It should be mentioned that the database used in this study is sufficient to perform a first assessment of the wind and offshore wave climate in the Maldives region in the case of this pre-project and feasibility study. However, these initial data should be detailed by means of a specific hind cast model during later steps of the project.

5.3.2.2 Annual wind climate

The joint distribution of the wind parameters are:

- V10m: the average wind speed over 10 minutes at a 10 m level of reference,
- Dv: the wind direction associated with V10m.

Figure 4: Maldive Islands - Annual Wind Climate (Globocean database from 1993 to 2004)

Wind speed (m/s) / Direction (°N)	0 / 2	2 / 4	4 / 6	6 / 8	8 / 10	10 / 12	12 / 14	14 / 16	16 / 18	18 / 20	20 / 22	22 / 24	24 / 26	26 / 28	
345															
	0.870	2.464	1.091	0.046											**4.47**
15															
	0.920	4.055	3.023	0.791	0.070										**8.86**
45															
	0.931	4.452	4.372	2.046	0.522	0.031									**12.35**
75															
	0.897	2.799	1.929	0.670	0.108	0.011									**6.41**
105															
	0.734	1.386	0.391	0.037											**2.55**
135															
	0.696	1.071	0.347	0.027											**2.14**
165															
	0.694	1.587	0.732	0.031											**3.04**
195															
	0.987	2.833	1.918	0.258	0.001										**6.00**
225															
	0.923	4.520	6.353	2.783	0.563	0.077									**15.22**
255															
	1.088	5.527	9.123	5.942	1.365	0.130	0.020	0.001							**23.20**
285															
	0.967	3.750	4.502	1.966	0.311	0.014									**11.51**
315															
	0.861	2.202	1.025	0.143	0.010										**4.24**
345															
	10.57	**36.65**	**34.81**	**14.74**	**2.95**	**0.26**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**100**

The corresponding wind rose presented in Figure 4. Wind speed distribution and wind speed exceedance frequency are given in Figure 4**.**

The following points may be emphasised:

Occurrence frequencies in the prevailing directional sectors are the following:

- N15°–N105°: 27.6%,
- N225°-N315°: 49.9%.

Wind speed is lower than 6 m/s for 82% of the observations. However, it should be mentioned that no calm period (wind speed = 0) appears in the database.

Maximum wind speed is in the range from 14 to 16 m/s from the sector N255°-N285°.

10 m/s is exceeded for less than 0.3% of the database.

5.3.2.3 Seasonal distribution of wind statistics

The next Figure presents the seasonal distribution of the wind statistics. These results are presented in Figure 5. The following periods were defined:

- December to March, corresponding to the NE Monsoon,
- April: transitional season No. 1,
- May to October: SW monsoon,
- November: transitional season No 2.

Figure 5: Maldive Islands -Seasonal wind statistics (Globocean database from 1993 to 2004)

WIND OCCURRENCE FREQUENCY PER DIRECTIONAL SECTORS (%)

Season >		NE Monsoon	Transitional season 1	SW Monsoon	Transitional season 2
Wind directional sectors		Dec. to March	April	May to Oct.	November
S1	N15°-N105°	71.35	15.28	1.43	23.96
S2	N105°-N225°	6.13	16.55	17.65	17.62
S3	N225°-N315°	8.42	56.74	77.61	41.11
S4	N315°-N15°	14.10	11.44	3.32	17.31

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

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

5.3.3 Sea level

5.3.3.1 Seasonal fluctuation

Regional mean sea level is affected by a seasonal fluctuation of 0.2 m:

- increase of about 0.1 m from February to April,
- decrease of 0.1 m from September to November.

5.3.4 Tide levels

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

Tidal levels given by the Admiralty Tables (2007) are presented in the following Figure.

Figure 6: Maldives tidal levels in mCD (Admiralty tide tables, 2007)

	Geo. Coordinates		LAT	MLLW	MHLW	MSL (ML)	MLHW	MHHW	HAT
	Lat. (°N)	Long. (°E)							
Standard Port: Cochin (West coast of India)	9° 58'	76° 16'	-0.2	0.3	0.6	0.6	0.8	0.9	1.2
Maldive Islands									
Ihavandhoo	6° 57'	72° 55'		0.3	0.6	0.68	0.9	1.0	
Goidhoo Atoll	4° 51'	72° 55'		0.3	0.5	0.6	0.8	0.9	
Girifushi	4° 19'	73° 55'		0.3	0.4	0.58	0.7	0.9	
Malé	4° 11'	73° 31'		0.3	0.5	0.65	0.8	0.9	
Vattaru	3° 15'	73° 24'		-	-	0.7	0.9	1.0	

With the following definition:

- LAT: Lowest Astronomical Tide,
- MLLW: Mean Lower Low Water,
- MHLW: Mean Higher Low Water,
- MLHW: Mean Lower High Water,
- MHHW: Mean Higher High Water,
- HAT: Highest Astronomical Tide.

5.3.5 Storm surge

Storm surge may increase the water level due to:

- the effect of atmospheric pressure variations. A water level variation of 10 cm occurs with a pressure variation of 10 HPa,
- wind effects, especially in shallow water areas.

An analysis of the available tide gauge measurements is necessary to assess the storm surge. This analysis may be obtained from:

- The National Meteorological Centre, Malé,
- Haa Dhaal Hanimaadhoo Meteorological Office,
- Laamu Kadhdhoo Meteorological Office.

Figure 7: Maldive Islands - Meteorological Centres geographical coordinates in the study area

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

5.3.6 Wave setup

In the wave breaking zone, the water level is locally increased. As a first rough assessment, an increase corresponding to 10% of the deep water wave height can usually be considered.

5.3.7 Sea level rise

Analysis of data from tide gauges measuring sea levels at Malé and Gan meteorological stations shows that the Maldives coastal sea level is rising in the range between 3.9 (Gan) and 4.1 (Malé) mm/year (Khan et al, 2002).

According to the Intergovernmental Panel on Climate Change (IPCC) in its 4th report (2007), the global sea level rose by 1.8 mm/year between 1961 and 2003 and 3.1 mm/year between 1993 and 2003.

The latest predictions for the global sea level rise in the next century, provided by IPCC (2007), are in the range between 0.18 m and 0.59 m depending on the scenario modelled.

5.3.8 Currents

5.3.8.1 General currents

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

5.3.8.2 Tidal currents

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

5.3.9 Offshore wave conditions (in deep water)

5.3.9.1 General information

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

An analysis of the wave climate was performed by using the sea state database developed by CREOCEAN. The simulated sea state cover Indian ocean with a 3°x3° resolution, every 3 hours in the time period 1993-2004.

5.3.9.2 Annual wave climate

The next Figures/Tables present the joint distributions of the wave parameters:

- wave height (Hs) /Direction (Dir),
- wave height (Hs) /Peak period (Tp).

These results correspond to wave conditions in deep water.

Figure 8: Maldive Islands – Annual wave climate (Globocean database from 1993 to 2004)

SIGNIFICANT WAVE HEIGHT/DIRECTION TABLE

Hs(m) / Dirp(°)	0 / 0.5	0.5 / 1	1 / 1.5	1.5 / 2	2 / 2.5	2.5 / 3	3 / 3.5	3.5 / 4	4 / 4.5	4.5 / 5	5 / 5.5	5.5 / 6	6 / 6.5	6.5 / 7	7 / 7.5	7.5 / 8	8 / 8.5	
345																		
	0.001	0.412	0.087															0.50
15																		
	0.001	0.185	0.164	0.007														0.36
45																		
	0.006	0.881	1.946	0.877	0.217	0.001												3.93
75																		
	0.019	0.742	0.652	0.120	0.016													1.55
105																		
	0.006	0.580	0.415	0.030	0.001													1.03
135																		
	0.123	9.493	10.196	6.507	2.316	0.351	0.014											29.00
165																		
	0.088	3.794	5.836	4.833	3.593	0.773	0.057											18.97
195																		
	0.070	10.371	14.201	7.810	3.913	0.914	0.080											37.36
225																		
		0.023	0.366	1.001	1.047	0.359	0.044	0.020										2.86
255																		
		0.047	0.510	1.330	0.995	0.304	0.073	0.024										3.28
285																		
		0.013	0.138	0.321	0.157	0.061												0.69
315																		
		0.355	0.098	0.013														0.47
345																		
	0.31	**26.90**	**34.61**	**22.85**	**12.26**	**2.76**	**0.27**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**100.00**

Figure 8 also presents the following information,

- the annual wave directional distribution,
- the distribution of wave heights (for all directions),
- the wave height exceedance frequency (for all directions),

while figure 9 presents the distribution and exceedance frequency of the peak periods.

The results of the analysis are the following:

- Prevailing wave directions in the annual wave climate are:
- SSE (N135° to N165°),
- S (N165° to N 195°),
- SSW (N195° to N225°).
- 85% of the total number of sea states in the database are included in these preceding sectors. Maximum wave heights in these sectors are in the range 3.0 -3.5 m.

- Waves from the sector N15°-N105° represent only 5.8% of the sea states. Maximum wave heights in this sector are in the range 2.5 -3.0 m.
- Waves from the sector N225°-N315° represent only 6.8% of the sea states.
- Maximum wave heights are in the range 3.5 to 4 m with an occurrence frequency of 0.04%. These waves come from the directional sector N225°-N285°.
- Wave heights greater than
- 2 m represent 15% of the annual sea states,
- 3 m only represent 0.3% of the annual sea states.

Figure 9: Significant wave height / Peak period table

Hs(m) / Tp(s)	0 / 0.5	0.5 / 1	1 / 1.5	1.5 / 2	2 / 2.5	2.5 / 3	3 / 3.5	3.5 / 4	4 / 4.5	4.5 / 5	5 / 5.5	5.5 / 6	6 / 6.5	6.5 / 7	7 / 7.5	7.5 / 8	8 / 8.5	
0																		
																		0.00
2																		
		0.211	0.113															0.32
4																		
	0.004	1.489	2.584	1.563	0.277	0.007												5.92
6																		
	0.123	3.529	2.080	1.162	0.672	0.201	0.043	0.006										7.82
8																		
	0.054	8.298	9.776	8.507	3.578	0.369	0.021	0.019										30.62
10																		
	0.087	5.230	6.682	4.399	4.255	1.362	0.150	0.014										22.18
12																		
	0.031	6.015	9.175	4.432	1.502	0.344	0.019	0.006										21.52
14																		
	0.007	1.815	3.669	2.304	1.628	0.355	0.031											9.81
16																		
	0.006	0.295	0.519	0.472	0.328	0.116	0.004											1.74
18																		
	0.001	0.014	0.013	0.009	0.016	0.010												0.06
20																		
																		0.00
22																		
																		0.00
24																		
																		0.00
26																		
	0.31	26.90	34.61	22.85	12.26	2.76	0.27	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.0

- Concerning the peak period parameter, about 75% of the sea states are in the range from 8 s to 14 s.
- Peak periods greater than 14 s are exceeded more than 10% of the time. Examination of the Hs/Tp tables per directional sector also shows that:
- 9.96% of waves with a peak period greater than 14 s come from the N195°-N225° directional sector,
- 1.64% of waves with a peak period greater than 14 s come from the N165°-N195° directional sector.

These correspond to swells coming from the Austral seas.

5.3.9.3 Seasonal wave climate

The next Figure presents the seasonal distribution of the wave statistics. These results are graphically presented on Figure 10. The following periods were defined:

- December to March, corresponding to the NE Monsoon,
- April: transitional season No 1,
- May to October: SW monsoon,
- November: transitional season No 2.

The results are presented for the same directional sectors as defined for the wind seasonal statistics.

Figure 10: Maldive Islands -Seasonal wind statistics (Globocean database from 1993 to 2004)

WAVE OCCURRENCE FREQUENCY PER DIRECTIONAL SECTORS (%)

Season >		NE Monsoon	Transitional season 1	SW Monsoon	Transitional season 2
Wave directional sectors		Dec. to March	April	May to Oct.	November
S1	N15°-N105°	17.17	0.38	0.00	1.23
S2	N105°-N225°	79.69	96.23	87.92	93.96
S3	N225°-N315°	0.30	3.09	12.08	4.81
S4	N315°-N15°	2.84	0.30	0.00	0.00

The conclusions concerning the seasonal wave climate are the following:

- In all seasons (even during the monsoons), the prevailing wave directional sector is N105°-N225° and more specifically N135°-N225° (the directional sector N105°-N135° represents less than 2% of the sea-states in each season).
- The following can be observed:
- the effect of NE winds during the NE monsoon, when waves coming from the directional sector N15°-N105° represent 17.1% of the sea-states during this period,
- the effect of SW to NW winds during the SW monsoon, when waves coming from the directional sector N225°-N315° represent 12.1% of the sea-state during this period.
- The most severe wave conditions appear during the SW monsoon, when wave heights greater than 2 m are the most frequent (30% of the sea-states during this season).

5.3.10 Extreme sea state conditions in deep water

5.3.10.1 Assessment of extreme wave heights

A first determination of the extreme wave conditions in deep water was performed by using the Peak Over Threshold (POT) method. The results are presented in Figure 11. Peak periods and directional wave sectors are associated with the wave heights assessed for the given return period.

Figure 11: Maldive Islands - Assessment of the extreme wave heights (in deep water)

Return Period (year)	Hs (m)	90% confidence interval (m)	Tp (s)	Directional sector (°N)
1	3.2	3.1 – 3.3	8 to 15	180 – 200 and 240 – 280
10	3.8	3.5 – 4.3	8 to 13	240 - 280
20	3.9	3.6 – 4.5	8 to 13	240 - 280
50	4.1	3.7 – 4.7	8 to 13	240 - 280
100	4.2	3.8 – 4.9	8 to 13	240 - 280

It can be observed that the extreme wave heights appear to be associated with peak periods between 8 and 13 s and appear to come from the N 240°-N280° directional sector. The wave height for the 100-year return period is estimated at 4.2 m.

However, a further analysis should be carried out for nearshore conditions to define the possible extreme wave heights per directional sector depending on the different harbour locations and orientations.

5.3.11 Examples of exceptional storm events

1987

The exceptional flooding of 1987 was due to high water levels which swept over the Maldives, inundated much of Malé and other islands. Flooding appears to have resulted from long distance swell propagation due to a storm located west of Australia (Goda, 1987). High waves of about 2.5 m height with a period of about 15 s hit the coast in association with high spring tides and SW wind.

May 2007

As a recent example of an exceptional storm event, the large swell waves that reached the Republic of Maldives in May 2007 originated from two subsequent storms initiated south of South Africa, propagating across the Indian Ocean north-east, away from the storm area, causing serious flooding in the exposed islands of the Republic of Maldives. A series of large swell waves estimated at 3-4.5 metres swamped some 68 islands in 16 atolls. This event caused damage in Réunion Island as well.

5.4 Cyclones in the Maldives

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

The islands of the Maldives are less prone to tropical cyclones. The northern islands of the country have been affected by weak cyclones that formed in the southern part of the Bay of Bengal and the

Arabian Sea. The number of cyclones directly crossing the Maldives is small. Only 11 cyclones crossed the islands over the entire span of 128 years between 1877 and 2004.

Most of the cyclones crossed the Maldives north of 6.0°N and none of them crossed south of 2.7°N during the period. All the cyclones that affected the Maldives were formed during the months of October to January except one, which formed in April.

The Maldives have not been affected by cyclones since1993.

In the northern islands, the probable maximum storm tide due to cyclones has been estimated to be around 1.82m (storm surge of 0.84 m) for a return period of 100 years. This storm surge was computed taking into account probable maximum winds and probable maximum pressure drops.

5.5 Features of the Coastal Environment within the project location

The coastal environment of the island and in general the project area can be described as having three major characteristics illustrated as:

1. The harbour with the quay wall and breakwaters

2. A dynamic coastline that varies along different parts of the island. The coastline is characterised by a mix of well formed beach, coral rubble coastlines, beach rocks.

3. The coastline on the north of the harbour which mainly consists of coral rubble.

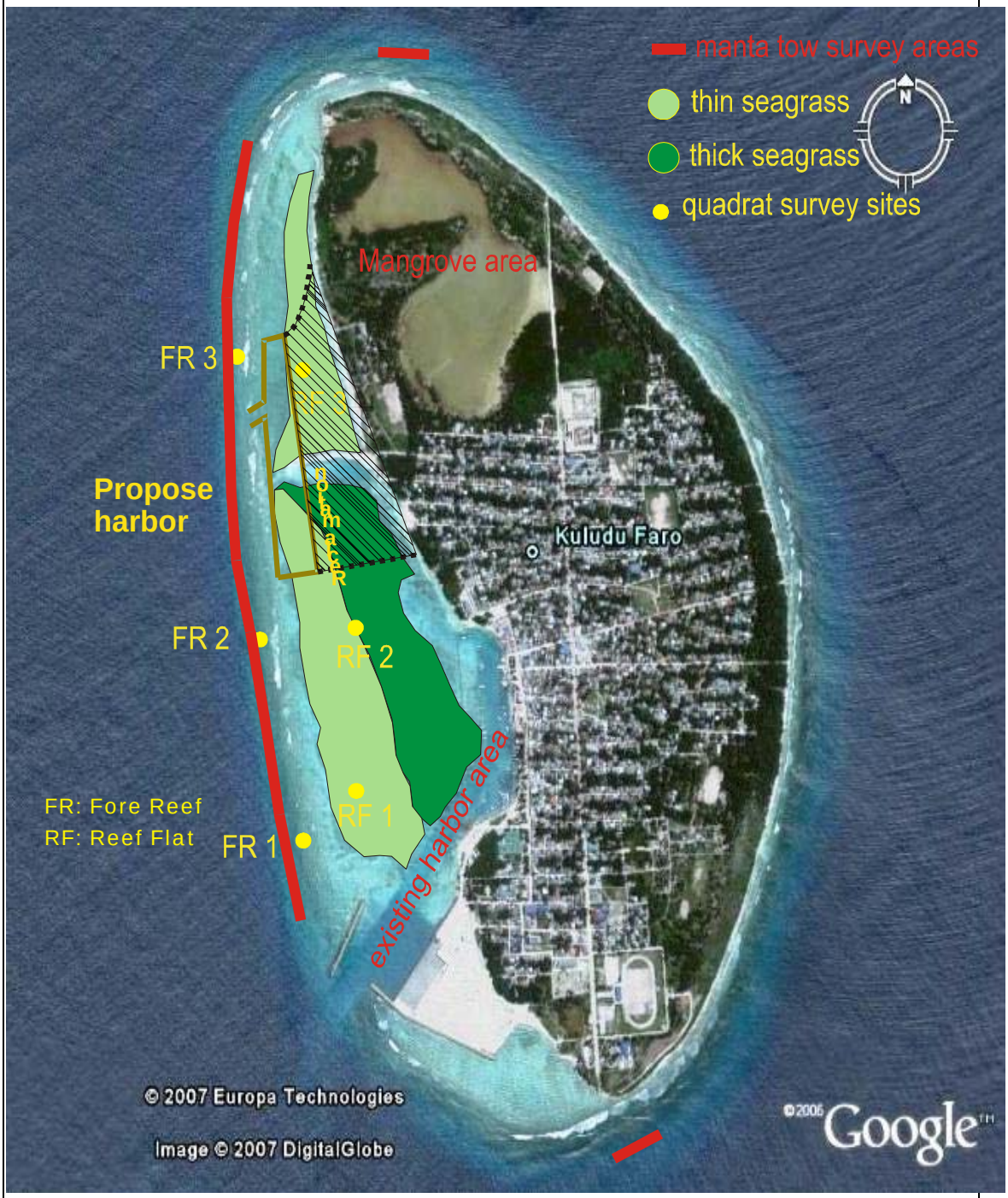
6 Existing Marine Environment

6.1 Chapter Brief

This chapter will look at the marine environment of H.Dh. Kulhudhuffushi Island where a direct or indirect impact from the proposed harbour development project could be affected. Figure 12 shows the survey locations of the proposed harbour phase 1. The chapter will cover the following:

- Methodologies used in data collection.
- Existing conditions of the marine environment of Kulhudhuffushi with specific emphasis on the proposed development area and its possible impact area.

Figure 12. The proposed Development Area and the Survey Sites



6.2 Marine Environmental Surveys

Marine environment was surveyed to assess and obtain baseline data of the existing environmental conditions. Major components of the marine ecosystems surveyed are the reef-flat, the coral thickets, other benthic communities, the fish communities, and the seagrass habitats. The findings of the surveys were used for impact evaluation and mitigation during the proposed development. The survey methods used here are easily replicable and involve in-expansive techniques. Theses surveys will be repeated through out the life of the project and there after to monitor the changes occurring in the biotic and abiotic components of the environment.

6.3 Survey Methods

Quantitative, semi-quantitative and qualitative methods were used to assess the benthic substrate, fish and invertebrates.

6.3.1 The Manta Tow Technique

The manta tow technique was used to assess general status of the benthic communities of the entire western side, and two other locations on the south and north of the island's reef. It enabled visual assessment of large areas of reef within a short time. This technique was frequently used to determine the effects of large-scale disturbances such as those caused by coral bleaching, outbreaks of *Acanthaster* (crown-of-thorn starfish) and storm damage. The technique was useful for selecting sites that are representative of the large areas of the reef.

The technique involved towing of an observer, using a rope and a manta board, behind a small boat powered by an outboard motor. Tows are carried out at a constant speed around the perimeter of a reef and are broken into units of 3 minutes duration. During each 3 minute tow, observations were made on several variables (e.g. percent cover of live coral, dead coral, soft coral, dominant fish, commercially important fish and protected species). These were recorded onto data sheets as categories of integer values and analyzed to determine the status of coral reef system.

6.3.2 The Quadrat Method

The quadrat method was used to quantify benthic substrate types. Same area was assessed for fish population dynamics and invertebrate count. Visual assessment was used in sites where physical or weather conditions hinder the use of quadrat method. This was mainly carried out using the 'timed swims' techniques.

Data from 15 random quadrats (0.25m^2 each) were taken from the selected representative sites on and around the proposed harbour development area and other areas that are out side the proposed development area. Quadrats were thrown randomly over head in a demarcated area. Percentage cover of each benthic substrate is recorded.

Quantitative percent cover data of morphological characteristics of the reef community is obtained using this method and it can be repeated over time to obtain temporal changes. Disadvantages of this method include difficulty in standardizing the life form categories and the limitation of the data collected, on percent cover and relative abundance (English et al. 1997). Quadrat method surveys produce valuable data even though they require considerable effort and skills to record notes underwater.

This study was complemented with extensive underwater photographs of the areas in question. Methodologies adopted for these surveys are internationally accepted (English et al. 1997) and are widely used to assess the status of coral reefs in the Maldives as well.

6.3.3 Timed-Swim Surveys

These surveys were carried out using snorkelling gear for both fish and benthic communities including live coral, dead coral, algae and other sessile organisms. Three swims on a straight path were done on the six selected sites. These sites were GPS-marked and are shown in Table 4. The duration of each swim was 15 minutes for benthic cover and an additional 15 minutes for assessing mobile organism such as fish that are conspicuous. The abundance is given in relation to the occurrence of particular taxa in other similar habitats of the Maldives. There is a tendency to underestimate fish when using this method of fish senses. This results due to rare species not being effectively sampled and failure to observe all the fish present. However, this method represents a quick and easy way of obtaining data in a limited time frame. The data obtained is valid and dependable and can be replicated.

6.4 Description of Existing Marine Environment

H.Dh. Kulhudhuffushi was formed on a patch reef on the eastern rim of geographic Thiladhunmathi atoll. The island occupies about 70% of the reef top. There are channels on the both northern and southern side of the island. On the north of Kulhudhufushi is Nolhivaramu separated by the Nolhivaramu Kanduolhi. On the south of Kulhdhufushi is Kumundhoo separated by Kulhudhuffushi Kandu.

The marine environment around Kulhudhuffushi is being heavily modified since the construction of the island inner harbor and the Regional Port. The reclamation, building of quay-walls, breakwaters and entrance channel must have changed the hydrodynamic flow patterns in many respects. The environmental impacts of these coastal modifications are not well documented since there was no systematic monitoring of the effects of these coastal modifications in the Maldives (Kench et al. 2006)

6.5 Coral Reef System

The reef around Kulhudhuffushi is not well developed with about 4 – 5 percent live coral cover at the fore reef areas. The bottom of reef-flat was dominated by rock, rubble, dead coral remnants and un-consolidated rock. The reef slope on the western side forms a steep slope. The reef-flat on the west of the island is wide and was covered with seagrass – mainly *Thallassia heprichii*.

The eastward reef-slope very close to the island but is about 1000m away from the proposed development area. Therefore no surveys were conducted at this area. It is also worth noting that the predominant monsoonal current is from the west to east, therefore the proposed re-development work will have very little impact on reef-slope on the atoll-outer reef-slope.

Manta tow survey and quadrat surveys were conducted on the whole western side plus two tows on both northern and southern side of the island. Three sites were selected on the fore reef (FR 1, FR 2, FR 3) for assessing benthic substrate cover and fish population.

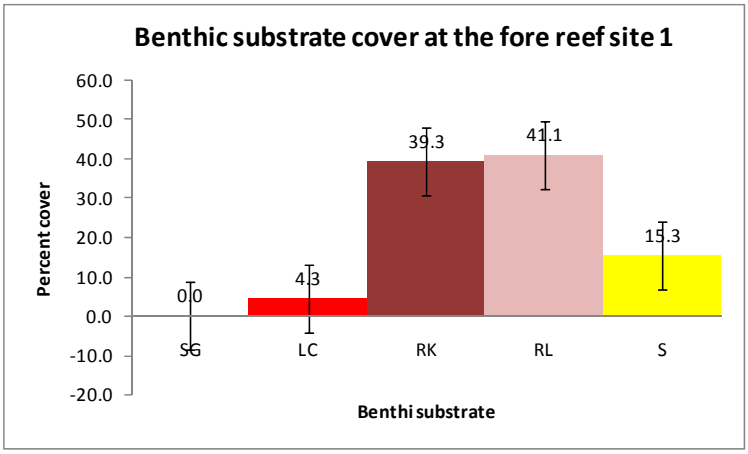
The result of the manta tow revealed that coral cover around the western side of the reef to be about 1 – 10%. The dominant benthic substrate was rock and rubble on this side (see Table 4). Commercial fish species such as serranids, lethrinids, carangids and lutjanids were documented during the manta tow. The parentheses next to the commercial fish species represents the number of individuals encountered in each of the given family. The benthic substrate cover was given in a range of 1 to 10 where 1 represents 1-10% cover, and 10 representing 91 to 100% cover. The integers 1 up to 10 each represent an interval of 10%.

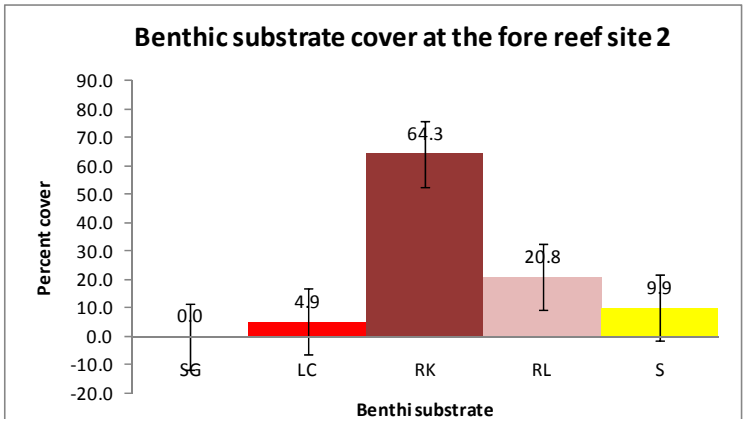
Table 4: Result of the Manta tow survey.
LC = Live coral, RK = Rock, RL = Rubble and S = Sand

Tow. No	Coordinates	Location	LC	RK	RL	S	Dom. Coral Family	Dom. Fish Family	Commercial Species
1	Latitude 6°37'07.51865''N Longitude 73°03'44.47565''E	SW	1	3	4	2	Pocillporidae	Acanthuridae	Serranidae (3), Lethrinidae (6)
2	Latitude 6°37'16.26142''N Longitude 73°03'43.12425''E	W	1	5	2	2	Pocillporidae	Acanthuridae	Serranidae (3), Lethrinidae (2), Carangidae (School)
3	Latitude 6°37'26.11072''N Longitude 73°03'41.46669''E	W	1	5	2	2	Pocillporidae	Acanthuridae	Serranidae (3), Lethrinidae (2), Lutjanidae (School)
4	Latitude 6°37'35.19010''N Longitude 73°03'40.49119''E	W	1	5	3	1	Pocillporidae	Acanthuridae	Serranidae (3), Lethrinidae (2), Lutjanidae (Schools)
5	Latitude 6°37'43.52276''N Longitude 73°03'39.89335''E	NW	1	5	3	1	Acroporidae	Acanthuridae	Serranidae (5), Carangidae (2), Lutjanidae (10)

6	Latitude 6°38'06.07887''N Longitude 73°03'58.93428''E	N	1	6	2	1	Acroporidae	Acanthuridae	Lethrinidae (2), Lutjanidae (15)
7	Latitude 6°36'05.03853''N Longitude 73°04'01.87776''E	NE	1	1	7	1	Poritidae	Balistidae	Carangidae (2)
8	Latitude 6°36'39.56''N Longitude 73°04'09.75''E	S	1	5	3	1	Acroporidae	Lethrinidae	Lethrinidae (2), Lutjanidae (15)

The coral reef system of Kulhudhuffushi is not in very good condition in terms of diversity and percentage live coral cover (see Figure 13). The three sites observed at the fore reef for reef status was presented below graphically. The live coral cover remained rather consistent at the three sites. Percentage of rock was highest at the site 3. The percentage cover of rubble and sand was highest at the site 1. The dominant forms of benthic cover are rock, rubble and sand. Branching forms of *Acropora* spp. (staghorn) and *Pocillopora*, *Galaxea, Porites, Astreopora, Fungia, Astreopora,* corals predominates the live benthic cover. Massive types corals namely *Porites, Favites*, *Goniastrea*, and encrusting type *Montipora, Pavona* were also present. A few soft coral colonies were also seen around the survey area.





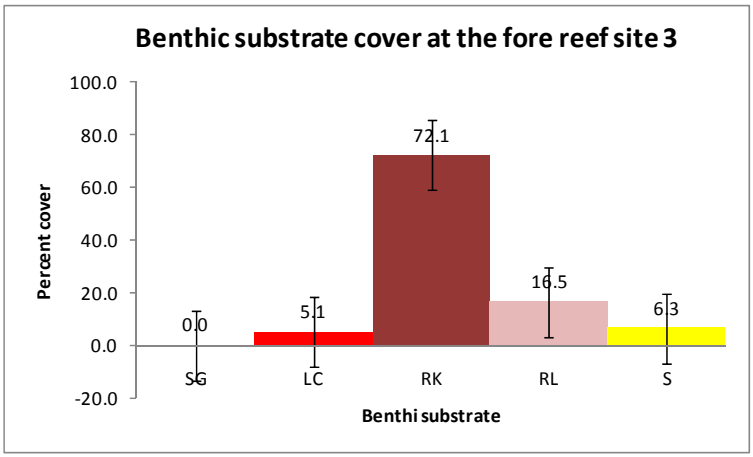


Figure 13: Percentage Cover of Benthic substrate present at the fore reef site.

The benthic covers are give in percentages of the bottom area surveyed LC = Live Coral, RK = Rock, RL = Rubble and S = Sand.

Based on the survey data of the three fore reef sites, rocky and rubble areas were found to be dominant. The photographs below (Figure 14) provide and idea of benthic cover present at the survey sites.

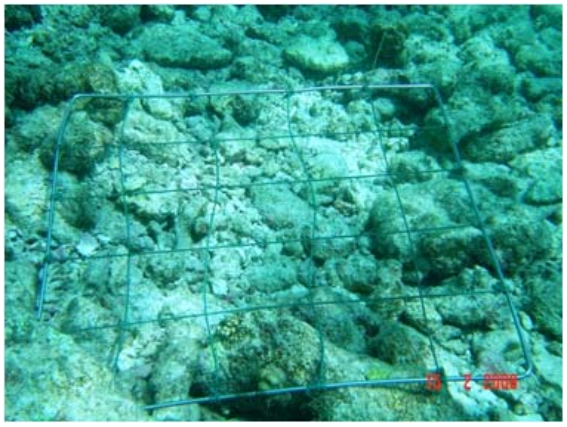
Encrusting coral (*Pachyseris* sp.)

Coral branching (mainly *Acropora* spp.)

Massive coral (*Porites* spp.)

Soft coral

Rock



Rubble

Figure 14: Benthic Substrate observed at the survey area.

6.6 Assesment of Communities in the surveyed Area

The result of 15 minutes swim for fish count around each site (FR 1, FR 2 and FR 3) reveals that the abundance and diversity of fish is moderately good on the proposed development area. This may be due to the presence of a number of live coral colonies. Since most of the area was covered with rock and rubble, fishes associated with this type of environment were encountered. The dominant fish taxa observed in the surveyed area included surgeon fishes (Acanthuridae), wrasses (Labridae) and damselfishes (Pomacentridae) (see Table). The presence of *Acropora* coral colonies was associated with the occurrence of butterfly fishes. These fishes are an indicator of reef health. It is likely that the reef-flat is recovering from the 1998 severe coral bleaching event. Some of the conspicuous fish encountered are shown in the following table.

Table 5: Results of the fish encounter survey at fore reef sites 1, 2 & 3

Family	Species	FR1	FR2	FR3
Acanthuridae	*Acanthurus lineatus*	C	C	C
Acanthuridae	*Acanthurus leucosternon*	R	R	C
Acanthuridae	*Acanthurus tennenti*	C	-	-
Acanthuridae	*Acanthurus triostegus*	C	-	-
Acanthuridae	*Ctenochaetus* sp.	C	C	-
Acanthuridae	*Naso brevirostris*	-	-	R
Acanthuridae	*Naso lituratus*	C	R	R
Acanthuridae	*Zebrasoma scopas*	-	-	R
Balistidae	*Balistapus undulatus*	-	R	R
Balistidae	*Melichthys indicus*	-	R	R
Balistidae	*Rhinecanthus rectangulus*	R	R	-
Balistidae	*Odunus niger*	-	-	R
Balistidae	*Sufflamen bursa*	-	R	-
Blenniidae	*Valencianea striagata*	-	R	-
Carrangidae	*Caranx melampygus*	-	C	-
Chaetodontidae	*Chaetodon auriga*	C	C	R
Chaetodontidae	*Chaetodon citrinellus*	R	-	-
Chaetodontidae	*Chaetodon collare*	-	R	-
Chaetodontidae	*Chaetodon falcula*	R	R	-
Chaetodontidae	*Chaetodon xanthocephalus*	R	-	R
Chaetodontidae	*Forcipiger flavissimus*	-	R	-
Labridae	*Cheilinus trilobatus*	R	-	-
Labridae	*Gomphosus caeruleus*	R	-	-
Labridae	*Helichoeres hortulanus*	-	R	R
Labridae	*Hemigymnus fasciatus*	-	R	-
Labridae	*Labroides dimidiatus*	C	C	-
Labridae	*Novaculichthys taeniourus*	R	-	-
Labridae	*Thalassoma amblycephalum*	-	C	-
Labridae	*Thalassoma hardwicke*	R	R	-
Labridae	*Thalassoma jansenii*	-	-	R
Labridae	*Stethojulis albovittata*	C	-	-
Lethrinidae	*Lethrinus harak*	A	A	C
Lethrinidae	*Lethrinus* sp.	C	-	-
Lethrinidae	*Monotaxis grandoculis*	-	R	C
Lutjanidae	*Aprion virescence*	-	R	-

Lutjanidae	*Lutjanus gibbus*	A	A	-
Malacanthidae	*Malacanthus lattovittaus?*	-	R	R
Mullidae	*Parupeneus barberinus*	C	-	-
Mullidae	*Parupeneus bifasciatus*	-	-	R
Murraenidae	*Gymnothorax javanics*	-	R	-
Penguipedidae	*Parapercis* sp.	C	R	R
Pomacanthidae	*Apolemichthys trimaculatus*	C	C	R
Pomacanthidae	*Pomacanthus imperator*	-	R	-
Pomacentridae	*Abudefduf* sp.	C	-	-
Scaridae	*Cetoscarus bicolor*	-	R	-
Scaridae	*Hipposcarus harid*	C	-	-
Scaridae	*Scarus frenatus*	C	C	R
Scaridae	*Scarus sordidus*	R	-	-
Serranidae	*Epinephelus merra*	-	-	R
Serranidae	*Epinephelus ongus*	R	-	R
Serranidae	*Variola louti*	-	-	R
Siganidae	*Siganus stellatus*	R	-	-

The abundance of fish was given in abundance categories. A = Abundant, C = Common, R = Rare. Commercial fishes belonging to the families Lethrinidae, Lutjanidae, and Serranidae were observed at the survey sites.

Some of the fishes encountered in the survey A – *Acanthurus lineatus*, B - *Gnathodentex aurolineatus.*

6.7 Reef Invertebrates

Two species of mollusks and three species of echinoderms were encountered (see Figure 15). It is worth mentioning that due to the nocturnal nature of mollusks they are hardly seen during the day. What is observed during the timed swims are:

- *Cypraea tigris*
- *Tridacna* sp.
- Common star fish
- Diadema urchin

- Black sea cucumber

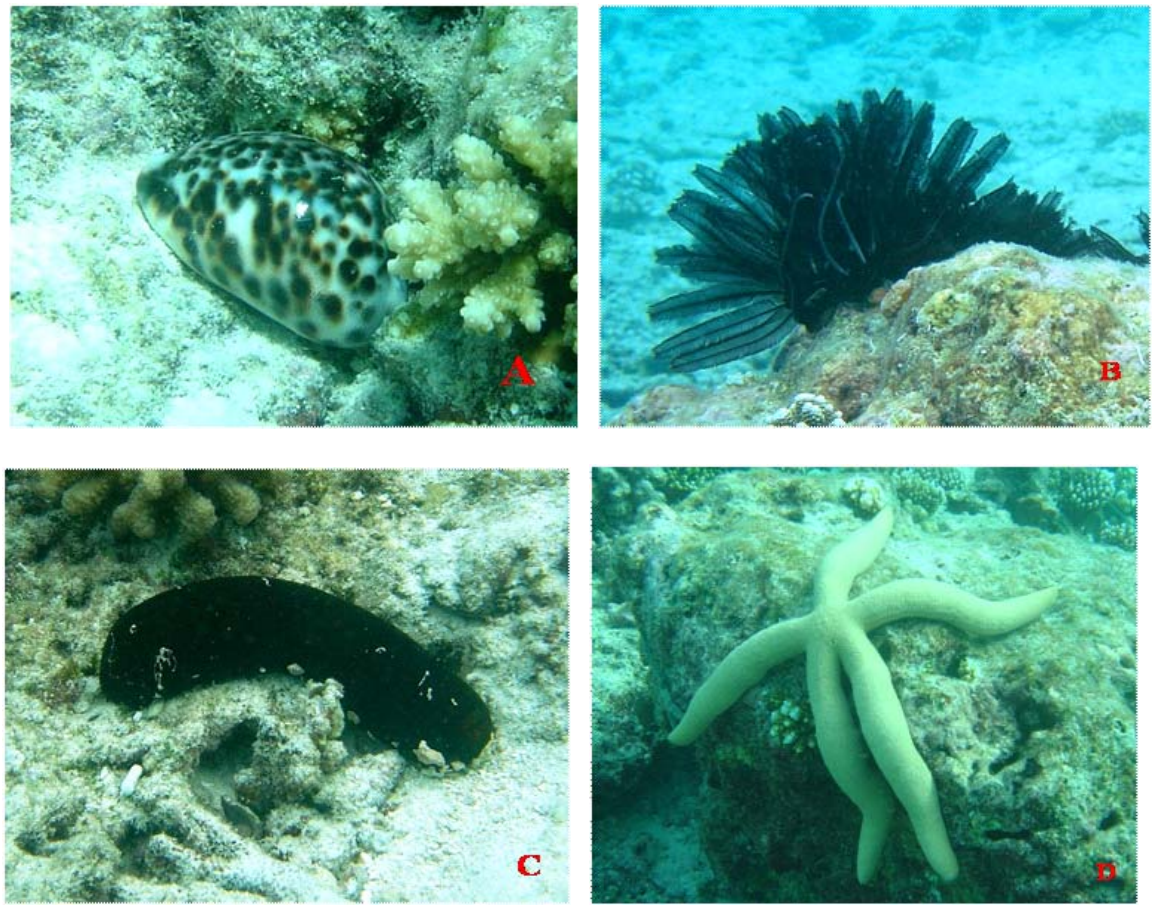


Figure 15: Some of the Invertebrates encountered in sites 1,2 and 3.

A –Tiger cowrie *Cypraea tigris*, B – Feather star, C- sea cucumber, D - Starfish

6.8 The Seagrass Ecosystem

Seagrass beds are known to have high ecological value as they provide important food resources to a wide range of fish and invertebrates (King 1981; SunAqua 2002), both directly (grazing by fish and turtles) and indirectly (through detrital food chains, or provision of shelter to other associated flora and fauna). Furthermore, seagrasses provide structural habitat, shelter and nursery areas to a number of marine flora and fauna, including many species of invertebrates and fish of fisheries value (e.g., King, 1981; Haywood 1995; SunAqua 2002). This may be true for the extensive seagrass beds found in neritic environments. The significance of seagrass ecosystems to Maldivian environment and biodiversity has not been studied yet. However, it is known that seagrass beds play a very important role in protecting shoreline erosion. In the cases Maldives the presence of seagrass around an island has been linked to the eutrophication in coastal areas. The presence of seagrass in the reef-flat of many fishing island is an indicator of this.

The proposed harbour basin is completely covered by seagrass and other marine flora (Dictyota spp, filamentous algae, macro algae, brown algae, blue green algae (*Schizothrix calcicola*, which

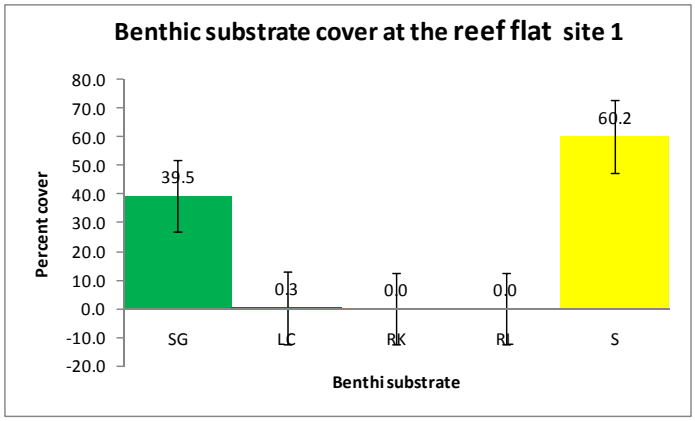
was colonizing on the filamentous wafer like algae) and sea weed. The density of the seagrass varied depending on the locality. The density of the seagrass is controlled by wave energy and strong current in some areas. Two species of sea grass was observed on the seagrass bed, *Thalassia hemprichii* and *Thalassia* sp. (long thin blades). Halimeda was also present at a lower percentage. Sand present there was also of Halimeda origin on top and fine sand underneath.

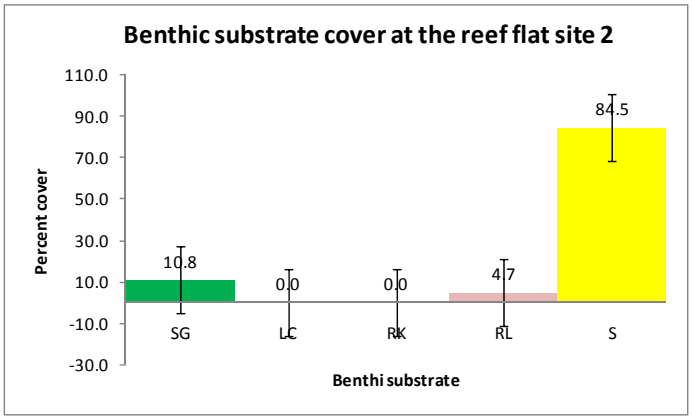
It has been evident based on aerial photo interpretations that the growth of seagrass is in the increasing trend. This growth of sea grass is related to nutrient discharge (sewage, fish waste and generally increase use of harbour area). The dominant species of seagrass was *Thalassia hemprichii*.

During extreme low tides the entire seagrass bed is exposed. The average depth during mean tide is around 0.5m. Seagrass Part of the seagrass bed will be lost during project works. This is considered not too serious as the land use plan prepared by Ministry of Housing and Urban Development shows complete loss of seagrass once the three phase of reclamation and development work is complete. At present the only use of seagrass bed is for collecting cowry shells which are of no significant commercial value.

Quadrat surveys were conducted on three reef flat (RF) sites near the harbour. The results are shown in

Figure **16**. The coverage of seagrass declined as we moved away from the shoreline of the island.





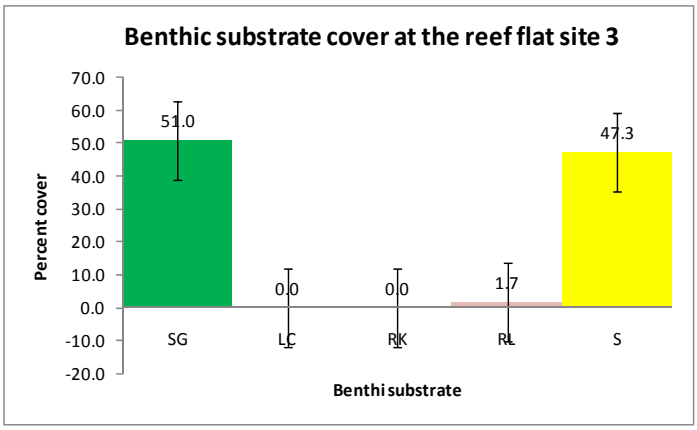


Figure 16: Bottom composition of reef flat survey sites – sea grass area.

The benthic covers are given in percentages of the bottom area surveyed SG = seagrass, LC =live coral, RK = rock, RL = rubble, and S = sand

As can be seen from the results sea grass cover was extensive at the reef flat on the western side of the island. The rest of the area was covered mostly with sand and rubble (see Figure 17). No rock areas were recorded under the quadrat. Live coral species recorded were massive and encrusting life forms of *Porites, Psammacora* and *Pavona*.

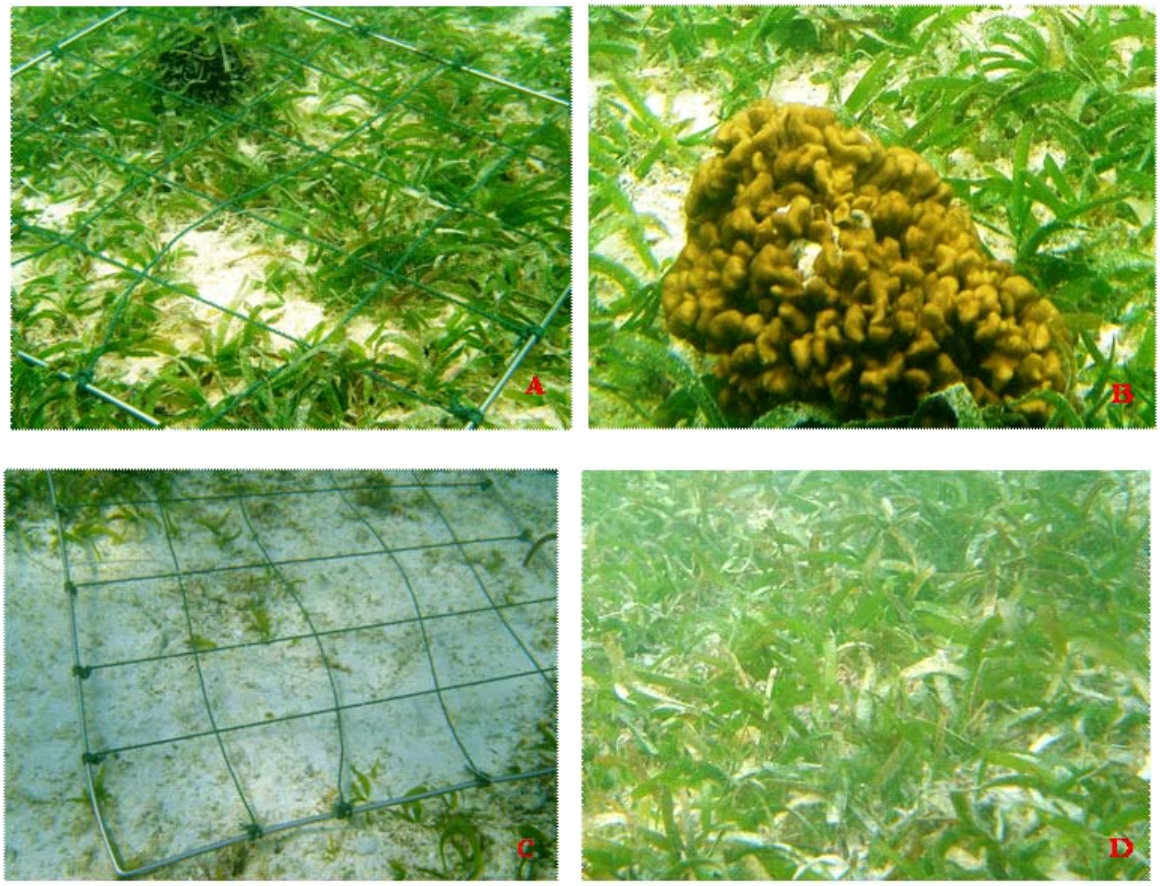


Figure 17: Benthic substrate cover at the reef flat (seagrass sites).

A = Seagrass *Thalassia hemprichii*., B = A live coral colony, C = a large sandy area, D = sedimentation impact on seagrass community due to dredging activities.

A 15 minute encounter survey was conducted for fish, molluscs and echinoderms at the area. Diversity and abundance of fish life was very low at the reef flat seagrass area. The table below summarises the results of fish abundance survey.

Table 6: List of fish species (and their families) encountered on seagrass beds.

Family	Species	RF 1	RF 2	RF 3
Sygnathidae	*Corithoichthys haematopterus*	R	-	-
Gerreidae	*Gerres* sp.	-	R	-
Gobiidae	*Amblygobius semicinctus*	R	-	-
Lethrinidae	*Lethrinus harak*	C	-	C
Labridae	*Helichoeres scapularis*	C	C	-
Labridae	*Helichoeres nebulosus*	-	-	R
Labridae	*Labroides dimediatus*	R	-	-
Labridae	*Cheilinus fasciatus*	-	-	R

Acanthuridae	*Acanthurus triostegus*	C	C	-
Acanthuridae	*Ctenochaetus sp.*	-	R	-
Pomacentridae	*Abudefduf septemfasciatus*	-	R	R
Pomacentridae	*Pomacentrus nagasakiensis*	-	R	R
Pomacentridae	*Stegastes* sp.	-	R	-
Tetraodntidae	*Canthigaster benetti*	R	R	-

The emperor fish *Lethrinus harak* may be considered as an indicator species of the health of the seagrass area. This species generally inhabits in healthy seagrass beds. Most other species that were observed are herbivores that graze on epiphytes.

A large number of invertebrates, mainly sea urchins were observed within the seagrass area. No molluscs were seen during the survey. This may be due to the timing of survey, since most of the molluscs are nocturnal. Thick growth of sea grass also camouflages them making it hard to find. Some of the invertebrates observed at the seagrass area included sea cucumbers.

Figure 18: Two types of sea urchin.

A= Sea urchin (*Echinothrix calararis*), B = Sea urchin (*Diedema* sp).

6.9 Rare and Endangered Species

During the course of baseline survey, not a single rare of individual rare or endangered species was encountered. Therefore the impacts from the proposed project on the rare and endangered species are not clear. Since the area is a major population center the likelihood of getting encountered with such species relatively low.

6.10 Potential Nuisance Species

The dredging of harbors is associated with a shift in the bottom conditions of the harbor basin. The accumulation of silt at the bottom of the harbor may attract fishes and other living things that prefer such a habitat. It has been known that the striped eel cat fish (*Plotosus lineatus*) has infested some of the dredged harbor basins. One such occasion was seen in Th. Kibidhoo where dense schools of *P. lineatus* infested the harbor basin. This species has got deadly poisonous spines which makes this a potentially dangerous species. The small size (max 30cm) and rarity of the fish makes

it potentially worthless economically. It is not clear that whether this species will infest the harbor basin. Based on the past experience with the harbours, there seemed to be no major problems associated with potential nuisance species.

6.11 Environmental condition of the dredge material spoil disposal site

The dredged material disposal sites of Kulhudhuffushi are between the land and quay-walls of the harbor (Phase 1). The bottom of this areas consisted of seagrass, fine sand and rubble. No significantly important benthic life was encountered during the visual observation. The nektonic life consisted of few sand associated species of fish belonging to the families Mullidae, Acanthuridae, and Pinguipedidae. Total number of fish encountered was only 14 during the fifteen minutes visual observation.

6.12 Marine Water Quality

Table 7 outlines the marine water quality results undertaken in February 2008.

Table 7: Marine Water Sampling GPS Locations of Proposed Harbour Phase 1 of Kulhudhuffushi Island.

	LOCATION OF SAMPLE		
PARAMETER TESTED	**Kulhudhuffushi South Western End** Latitude 6°37’07.51865’’N Longitude 73°03’44.47565’’E	**Kulhudhuffushi Western side** Latitude 6°37’35.19010’’N Longitude 73°03’40.49119’’E	**Kulhudhuffushi North Western End** Latitude 6°37’43.52276’’N Longitude 73°03’39.89335’’E
Physical appearance	clear	clear	clear
Nitrate	0.0 mg/L	0.0 mg/L	0.0 mg/L
Dissolved Oxygen	5.2 mg/L	5.1 mg/L	6.3 mg/L
Turbidity	0 NTU	0 NTU	1 NTU
PH	7.3	8	7.4
Phosphate	0.13 mg/L	0.01 mg/L	0.21 mg/L

7 Existing Socio-economic environment

7.1 Chapter Brief

This chapter will look at the socio economic environment of H.Dh. Kulhudhuffushi Island. The chapter will cover the following:

- Socioeconomic profile of Kulhudhuffushi and the region.
- Outcome of the public consultations.

7.2 Introduction

Kulhudhuffushi harbour was built by the government to facilitate access to the island, including loading and unloading of goods, facilitate access of locals and visitors to the island and unloading of fish catches of the locals into the island. The growth of population, increased economic activities and demand for goods has caused more stress on the existing harbour and make it unbearable to meet the growing need and demand of the community.

The harbour project is one of the most important development projects, which is to be undertaken in the island. The project divided into three phases and this is the first phase of the project. First phase includes creating a harbour on the north western side of the island. The dredge spoil will be used to back fill the harbour and hence this will become a harbour come reclamation project.

This report presents the socio-economic status of the island, views of the community of Kulhudhuffushi and the government's responses on the way forwarded for building the harbour and related facilities.

7.3 Socio-Economic Profile of Kulhudhuffushi

7.3.1 Introduction to Haa Dhaalu Atoll

Haa Dhaalu Atoll is 2nd most populous atoll of the Maldives after Addu Atoll. The atoll has a population of 22,489 people living in 16 inhabited islands. Kulhudhufushi is the capital island of the atoll with a registered population of more than 6500 people. Kulhudhufushi is the most populous island of the atoll with more facilities compare to other islands of the atoll. Kulhudhufushi has the northern secondary school, regional hospital, atoll office, northern regional harbour, campuses of Maldives College of Higher Education and other facilities run by the government. Nolhivaranfaru was the old administrative capital of the atoll, where the atoll office was located in the island until 6th May 1992.(Luthfee, 1995) There are 35 uninhabited islands in the atoll, most of which are leased to the atoll people as it is in other atolls of the Maldives.

The government has built a regional airport on Hanimaadhoo island during early 90's, which currently serves the most northern 3 atolls. There are daily flights operated from the capital Male' to Hanimadhoo. The islands including Hanimadhoo, Nolhivaranfaru, Nolhivaramu, Finey, Naivaadhoo, Kurinbi, Keylakunu, Kulhudhuffushi and Kulhudhufushi are islands with historical and archeological values. Although there are no proper assessments done to monitor the historical and archeological values of these islands, until today there are remains of old sites existing in some of these islands. (Luthfee 1995).

Table 8: Quick Facts of Haa Dhaalu Atoll

Total No. of Islands	35
Inhabited Islands	16
Capital	Kulhudhufushi
No. of Women	11274
No. of Men	11699
Total Population	22973

The main income generating activities in the atoll are mainly limited to administrative work, general trade, fishery, Tourism and Agriculture. The government has currently leased new islands from the atoll for tourism development and agriculture. This aims to create more job opportunities for the locals. The number of inhabited islands with small population has become one of the main challenges of the atoll. There are plans to relocate people from some of these islands to Hanimaadhoo and Nolhivaranfaru. The relocation programme started by the government in Nolhivaranfaru is believed to bring people from 2-3 small islands to the island.

The need of a harbour has become essential due to the booming economy of Kulhudhuffushi along with the new regional port established in this island.

7.4 The Island of Kulhudhuffushi

7.4.1 Setting

Kulhudhuffushi is located 274.15km away from the capital Male'. Kulhudhuffushi is the hub for the region with an average area of 170.20 hectares. The island is located at 73^0 04' 06" E and 06^0 37' 25" N. The average length and width of the island is 2500m and 800m respectively. The closest inhabited islands to Kuludhuffushi from the atoll are Nolhivaran and Kumundhoo. Kulhudhuffushi does not have a prominent reef on the eastern side and is separated by channels in between islands. Kulhudhuffushi has got the second best natural harbour in the atoll and this harbour is located on the western side of the island.

7.4.2 Population

Kulhudhuffushi is the most populous island of the atoll with a population density of 50 persons per hectare). The island has a registered population of 8060 people. (Vulnerability and Poverty assessment 2004)

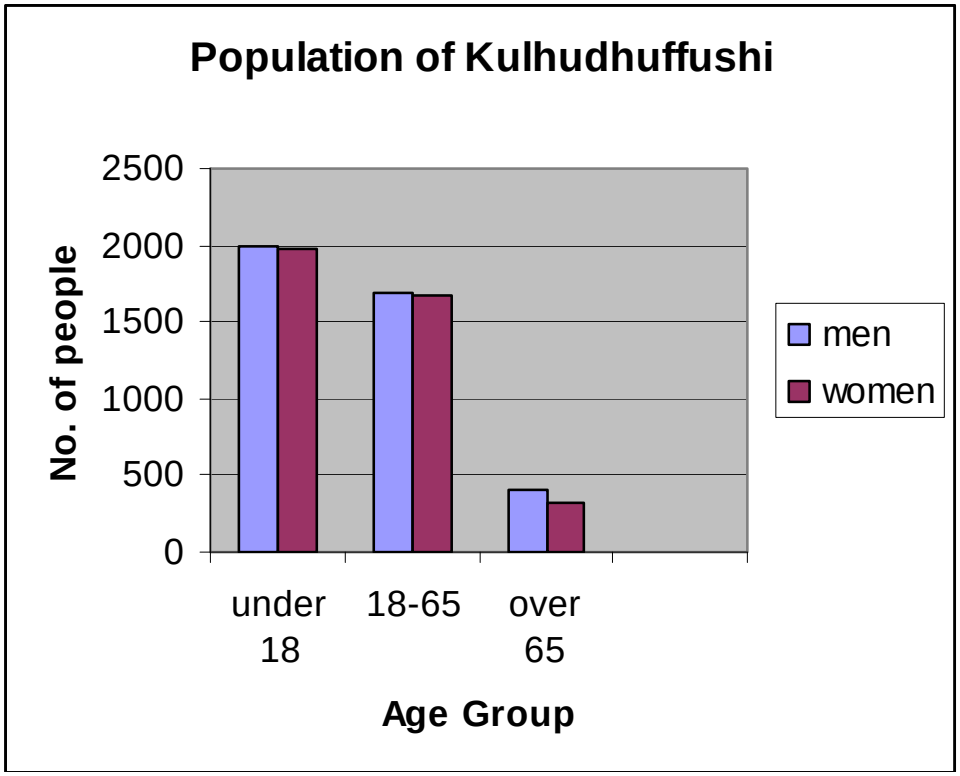


Figure 19 : Population of Kuludhuffushi

The census 2006 has revealed that Kulhudhuffushi stands at the most populous island of the atoll. The average annual growth of this island is 1.02 and is the highest in the atoll.

The total male population of the island is 47% and the female stands at 53%. The population by major age groups reveal that 49% of the population is under 18 years while 42% of the population is between 18 years and 65 years and (9.0%) is above 65 years.

In terms of sex ratio Kulhudhuffushi stands at 89 males per 100 females, which is the third highest sex ration in the atoll, followed Hanimaadhoo and Kulhudhuffushi (Census 2006).

7.4.3 Employment

The major income earning activities of the island people are recorded as fishing. shipping, general trading, masonry and rope making. Agriculture is not a significant economic activity of this island.

Fishing is one of the main occupations of this island and there are 101 fishing vessels out which 65 are fishing mechanised dhoanis, 17 to travel between Male and the atoll and 17 for other purposes.

There are 150 private shops in the island, which also contributes income earning opportunities for the people and help people to get their goods from the island. The dhoanis and boats between Male' and island supply the goods and construction materials to these shops and also to the people.

There are government employees who work at Atoll Office, RDMO, MCPI, Island Office, Court, Regional Hospital and Maldives Police Services who are paid by the government.

7.4.4 Health

The island has a Regional hospital with technical, administrative and support staffs. Kulhudhuffushi Regional Hospital has 12 doctors and 39 nurses provided by the government. In addition to this there are 6 social health workers, 5 family health workers and 8 mid wives along with 6 pharmacists. Kulhudhuffushi Regional Hospital is most popular hospital in the regions and almost all the islands in the regions depend on this hospital for their medication and diagnosis.

7.4.5 Education

Kulhudhuffushi has 4 government run schools and 4 public run education centres and the government school's highest grade is grade 12 and the public school highest grade is grade 1.

Quality of education and lack of sufficient trained local teachers are one the main concern of the island people. This is perhaps one of the reasons why people migrate from the island to the Capital Male'. Housing

Kulhudhuffushi like many other islands of Maldives experience land scarcity and the demand for the land is growing rapidly. The ministry of Atolls Development's website shows that, there are 2127 boundary marked house plots allocated and 206 houses with boundaries not marked, The number of plots not allocated from the available land is only 380 and this indicates the urgency of additional land to this island. The additional land gained by harbour development will help to solve this problem to a significant extent

There is a greater need to develop appropriate land use and land management plans for the island to utilize the available lands on sustainable manner and to avoid any issue that will perhaps arise in the future.

7.4.6 Utilities

Most utilities and services available in the island are run by the community through the Island Office.

7.4.7 Water

There is no community water supply network in the island however the existing 4 public rain water tank helps for the people and visitors to this island. The population depends on rain water, harvested from roof tops as the main source of potable water. There are 2358 rain water storage tanks owned by the households. Water collected in the public tanks are also used by the local fishing dhonis for drinking and cooking.

People complain about the quality of ground water d in most parts of the island. The increasing number of water sealed latrines and installation of home made septic tanks are contributing ground water pollution and salinization.

7.4.8 Sewerage

There is no island wide sewage network for the island and all households have their own system of sewage disposal. The main method of sewage disposal in the island is household septic tanks with

soak pits, which are made locally. The condition of the tanks and soak pits causes ground water contamination due from sewage and waste water. There are more than 1175 water sealed toilets in the island. There are no outfalls connected to the sea.

7.4.9 Solid waste disposal

There is solid waste disposal location marked in the island. All types of waste generated from the houses are supposed to be disposed in this location, however the author has noticed fish cuts disposed on the shore and burning of domestic wastes at individual house plots.

7.4.10 Electricity

Kulhudhuffushi has a power house run by government and has two 450 KV and one 500 KV generators. The Electricity is provided to all house holds and community building 24 hours on tariff basis. Income generates from electricity supply is utilized for the operation and maintenance of the power house and electrical network. LPG is supplied by local traders most of the house depends on LPG for cooking

7.4.11 Transport

The island size require land vehicles and for the purpose of taxi and transport of goods. Foot bikes motor cycles are widely used by the islanders. Most of which are used for carrying goods and construction materials. There are 185 motorbikes 44 motorised four wheelers in the islands.Out of this 44 29 vehicles are private. In additions to this some heavy vehicles are used by MCPI and for the purpose of road making and other works.

There are many sea vessels in the island. Most of which are used as fishing vessels. The island has more than 101 vessels. The local boats which travel between the capital Male and the island, mainly carries goods and construction materials from Male' to the island. The boats are also used by locals as passenger vessels. There are new boats being built and repair and maintenance of these vessels are seen. These vessels need more space which cannot be accessed to the existing harbour.

7.4.12 Telecommunication

There are land line telephone facilities available in the island. The population has access to land line and mobile telephones provided by two local service providers including Dhiraagu and Wathaniya and the land line service provider is only Dhiraagu. Prepaid telephone cards are available from local shops. Internet facilities. Radio sets, Television sets and Video facilities are available in almost all households of the island. Satellite TV systems are also connect to most of the houses. There are Computer systems in some houses, which are mainly used by school children for educational purposes.

7.5 Public consultation

Consultation with the major stake holders of the beneficiary community forms an important part of the process of assessing the environmental and socio-economic impacts of the proposed harbour development project. The consultation process has been used to confirm the issues which need to be considered in the assessment of effects. The consultation process was conducted under the guidance of the island chief and limited to the following form:

- Meetings and interviews with island chiefs; and
- Meetings with Island Development Committee.

The meetings were conducted and assisted by the island chiefs and staffs of island office. The following are the summary of issues raised during the meetings held with island chiefs and island committees.

7.5.1 Meeting and interviews with island chiefs

The meeting was held at island office and was attended by the two little chiefs and environmentalist of the EIA team.

The following issues have emerged from the consultation with island office officials

- Difficulties in using the existing harbour due to lack of facilities;
- Size scarcity and anchoring facilities on the existing harbour;
- The size of the existing harbour is insufficient for the island due to increase in number of sea vessels;
- Continuous concerns and complains of the island community over the slow processing work of the harbour ; and
- The island being the capital of the atoll has got the best facilities in the region forcing people to visit.

7.5.2 Meeting with Island Development Committee

The community meeting was guided by the island chief and officials of the island office. The consultant has explained the committee about the development of harbour project. The harbour development project has been divided into 3 phases and the scope of work for the first phase of the project was clearly explained to attendees by the consultant and a session was opened for the attendee to explain their views and suggestions. A copy of the original list of attendees is attached in Appendix J and the following are important points that the consultant explained to the attendees.

- Dimensions of Harbour development phase 1.
- Maintenance free period
- Design life
- Minimum entrance channel and harbour depth
- Quay wall details

The following main issues have been raised during the meeting.

- The island committee wants the minimum depth of the harbour basin to be minimum 5m instead of 3m. The reason for this is larger cargo vessels travelling between Male' and this island even now face the problem of shallow harbour basin. They predict this will be an issue as the existing regional port will bring more traffic with bigger vessels
- Do not want to go for a reef blasting where necessary and instead find alternative options
- The harbour basin must not be stagnant and they must have adequate circulations
- Want create a safe industrial zone around the harbour
- Shift existing workshops and garages to the land gained by proposed harbour dredging
- The existing harbour was not constructed in accordance with requirements of the island community;

- The new harbour size shall meet the demand of the vessels and future economic development of the island, since the island is known as a major hub from all parts of the northern region. Therefore the harbour shall address these issues and make provisions for providing services to these vessels and which creates more income generating activities for the locals;
- Uncertainties and delaying in construction of the new harbour facility as the proposed upgrading work and new harbour project has already been informed to the community in several occasions, and surveys and assessment were also conducted earlier. ;
- There are new boats building in the island, and these boats can not use the existing harbour mainly due to the size.
- The protected area of this island was discussed and some of the attendees felt that they must conserve the area whereas the others want to reclaim it and used for infrastructure.

8 Environmental and Socioeconomic impacts and mitigation measures

This section will look at the impacts of the proposed harbour expansion programme on the coastal and marine environment. Furthermore, measures to mitigate impacts would be suggested so that overall environmental improvements and damage could be minimized. The following paragraphs outline the coastal and marine impacts that have been identified. The impacts have been identified for both the construction and operational stage.

8.1 Prediction of impacts on the coastal environment

Impacts on the marine environment from the proposed coastal modification have been predicted through analysis of the proposed project, discussions with the project proponent, field surveys, observations and assessment as well as based on field experience of similar works in the country. Quantitative and qualitative data collected from filed work were analyzed to predict the extent and significance of the impacts that may arise from the proposed harbour construction project's activities. The assessment was also based on area calculations of the coastline that fall within the project boundary and anticipated to be impacted.

8.2 Prediction of impacts on the marine environment

Impacts on the marine environment from the proposed coastal modification have been predicted through analysis of the proposed project, discussions with the project proponent, field surveys, observations and assessment as well as based on field experience of similar works in the country. Quantitative and qualitative data collected from filed work were analyzed to predict the extent and significance of the impacts that may arise from the proposed harbour Development project's activities.

8.3 Uncertainties in Impacts Identification

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, geomorpholical or social conditions in a particular place.

Although measures will be taken to mitigate known impacts, there is always the probability that an unforeseen impact will occur. It is also important to note that some of the impacts predicted may turn out to be far greater than predicted. This will make mitigation measures ineffective. To avoid or reduce the chances of such events, it is vital to monitor key important parameters at the vicinity of the project.

8.4 Impacts on the Marine Environment from the Proposed Harbour Expansion Project

Impacts on the marine environment from the proposed coastal modification have been predicted through analysis of the proposed project, discussions with the project proponent, field surveys, observations and assessment as well as based on field experience of similar works in the country. Quantitative and qualitative data collected from filed work were analyzed to predict the extent and significance of the impacts that may arise from the proposed harbour construction project's activities.

Four components of the marine environment that will be impacted are identified as the lagoon, the reef-flat, the seagrass beds and the coral reef system. Quantitative assessment of potential direct and indirect impacts due to the proposed development was based on area calculation of the lagoon and coral reef.

Impacts from these activities will be due to disturbance to the lagoon, seagrass and reef-flat bottom in construction activities and release of fine sediment to the water column.

Indirect impacts will be felt to the pelagic organisms inhabiting these areas that are close to the re-development zone. Indirect and long term impacts on the marine environment will be more accurately assessed by long term monitoring and assessment as part of this environmental assessment.

8.5 Impacts on the Marine Environment

Harbour dredging or deepening projects have both construction and operational impacts on the marine and coastal environment. These impacts may be either short term reversible or long term irreversible damage or alteration to the marine and coastal environment. The impacts identified here will be according its location and magnitude. The intensity or severity of the impacts is further grouped into negligible, minor, moderate and major. This will help in identifying and carrying out remedial and mitigation measures. A description of the impact categories are presented below (LaMer 2006).

- Negligible: no significant impact on environment
- Minor: the impact is short term and cause little impact on the environment which may be reversible on the long run.
- Moderate: Impacts significant, may cause long term environmental concerns but are likely short term, acceptable and justifiable
- Major: long term impact, large scale environmental alterations

Potential environmental impacts predicted for the development will the impacts during construction and irreversible modifications as a result of dredging and excavation. These impacts are presented together with mitigation measures in the (Table).

Dredging and excavation generally lead to major impacts on reef habitats, lagoon and coastal hydrodynamics. The Impacts of excavation and dredging may range from smothering of live corals and other flora and fauna. Coastal modification involved in the construction of the harbour can have short to long term impacts on the on the coastal processes and beach profiles of the island. Specific impacts on the marine environment arising from the proposed project will be mainly an alteration of the bottom of reef-flat where dredging is done and a minor impact on the sediment movement along the shoreline and near the entrance channel, and a minor impact on the benthic and nektonic communities that inhabit in the possible impact area. The predicted impacts are minor because this project is a expansion project. The proposed dredging areas and spoil disposal sites were already sites that were used during the initial construction of the harbour.

8.5.1 Mobilization Impacts

The transport and supply of construction material, the excavator and other heavy duty equipments may have an impact as a result of increased traffic with barges and other large vessels. The impacts may arise from:

- Accidental spillage of construction materials (cement bags, timber, iron bars).
- Accidental oils and other chemical spills.

- Accidental grounding of large vessels.
- Propellers' wake can break fragile corals.
- Anchor damage from the vessels.

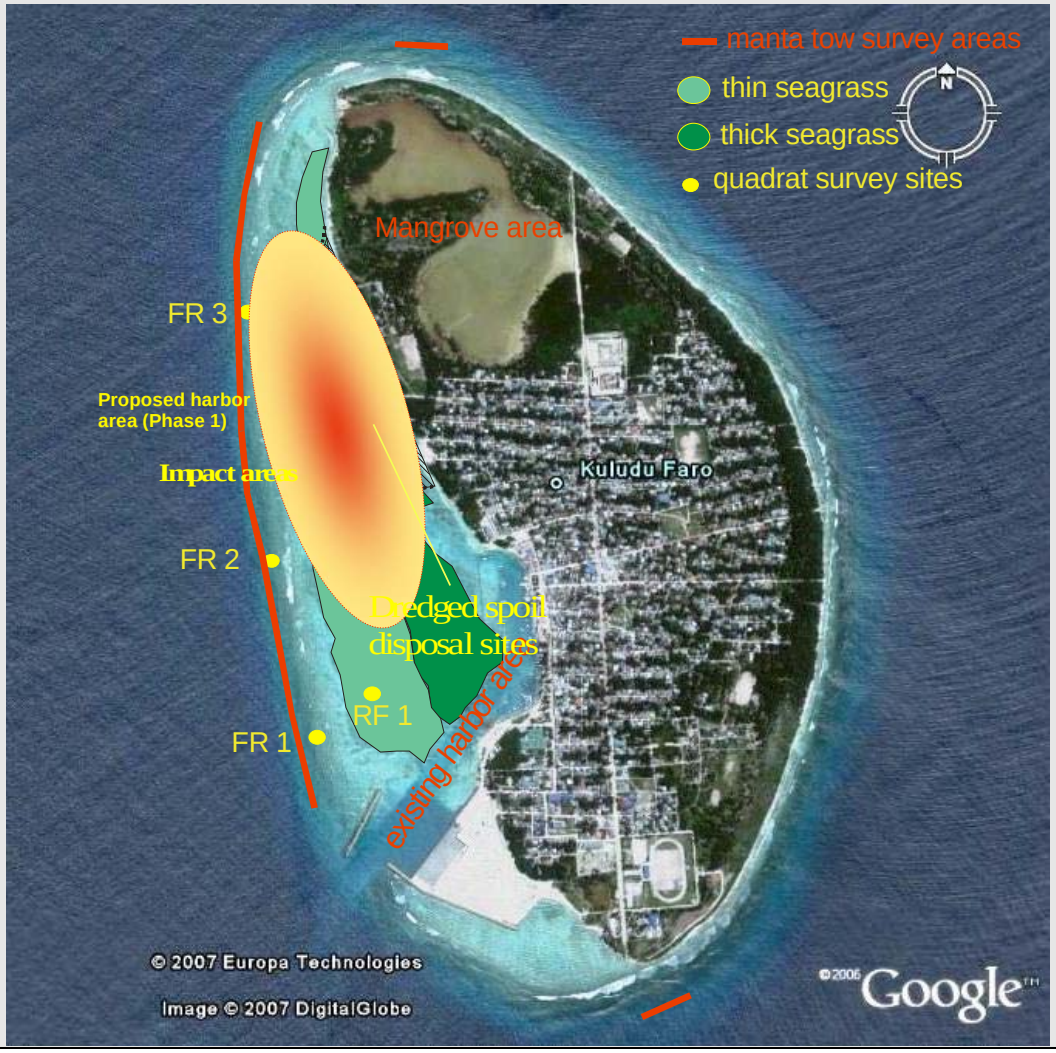
8.5.2 Impacts from Construction Materials and Other Waste

Construction materials such as cement, timber, and fuel for excavators and trucks have the potential to damage the marine environment. Pollution of the lagoon and reef system can be caused by waterborne and windblown debris escaping from the construction.

The dredge material will be disposed at the area located at the map (see Figure 20). Disposing dredge material at the shoreline would have minor irreversible impacts on the near shore habitat since the project will dispose materials on the old disposal sites. Disposal of dredge material at these sites may have a short term positive impacts. This can reduce the rate of beach erosion. However, the long term possible alterations in coastal processes of the area will not be clear only after long term monitoring.

During the construction of the quay-walls, leaching of cement will have short term minor impact on the immediate area. Once the cement is hardened, re-colonization of marine fauna and flora will take place.

Figure 20: Possible impact areas of the proposed harbor development project (Phase 1)



8.5.3 Impacts due to Construction Work

Deepening work of the entrance channel and harbour basin will be carried out using excavators. Therefore the negative impact of sedimentation is unavoidable even with the construction of sandy bund walls. The impacts of sedimentation are short termed since the monsoonal currents will aid in the dispersal and removal of fine suspended materials. Growth and recruitment of live corals may have moderate short term impact due to sedimentation. Nevertheless this impact could be reduced by imposing silt screen protection around barges carrying the excavator to prevent turbidity outside the nearby location of the barges.

The impacts of excessive sedimentation on corals include:

- Direct physical impacts like smothering of corals and other benthic organisms,
- Reduced light penetration reducing the productivity of corals.

- Formation of false bottoms due to unstable shifting of sediments.
- Eutrophication due to increased fine sediments leading to algal blooms.
- Formation of anoxic (black) bottoms under the fine sediments.

Construction of wharfs and protection walls may have impacts on the reef-flat habitat by seepage of cement material. Construction of protection wall include a lot of manual transport of cement bags and other materials, trampling and breakage of live coral is possible at the seaward side of the harbour basin and the sides of the entrance channel.

8.5.4 Monitoring Turbidity levels during dredging and reclamation

Given that the water quality in marine environment of the Maldives is very good, the turbidity levels behind zone of mixing in dredging operations shall be less than 10 NTUs.

The compliance locations given in the monitoring section of this report shall be considered the limits of the temporary mixing zone for turbidity allowed during construction. If monitoring reveals turbidity levels at the compliance location indicated above is greater than 10 NTUs (or 10%) above the associated background turbidity levels, whichever is greater, construction activities shall cease immediately and not resume until corrective measures have been taken and turbidity has returned to acceptable levels.

The following measures shall be taken by the Proponent whenever turbidity levels at the limit of the mixing zone exceed the limits given in this report.

- Immediately cease dredging/reclamation works
- Modify the work procedures or wait for turbidity to clear in the compliance location
- Continue to undertake turbidity tests as given in the monitoring programme
- If the problem persists, use physical barriers to reduce the effects of sedimentation

8.5.5 Impacts of Built Coastal Structures

The impact of anthropogenic physical structures such as breakwaters, access channels and harbours on the coastal processes and marine flora and fauna, can be quite significant and often permanent if they are undertaken in sensitive environments. Most of the coastal works are construction of sea wall and jetty which are at a considerable distance away from the coral reef. Impacts are therefore going to be minor.

8.5.6 Impacts due to Harbour Operation

Impacts associated with the harbour operation can be considered as minor to moderate and short to long term. These impacts include (but are not limited to):

- Poor water quality due to siltation and stagnation of water.
- Impacts due to accidental spillage of oils, other chemicals and waste.
- Hydrodynamic changes forming dead zones in the inner harbour where litter may accumulate

8.6 Significance of the Impacts

Impacts that may arise from activities of the proposed harbour construction project were categorized into the characteristics mentioned in Table 9

The significance of impacts was determined based on these characteristics and analysis of the impacts from this project and other analogous projects. These impacts correspond in the worst case scenario and after mitigation measures were taken.

Table shows the main impacts that will arise from the proposed project activities and their significance based on impact characteristics.

Magnitude of impact is calculated in relation to the total area of the lagoon and the coral reef. Direct geographic range of impact felt will be the immediate proposed development area and indirect impacts will be felt on a larger area due spreading of fine sediment. Duration of the impact is predicted in terms of severity of impacts. The impacts are likely to be felt on an estimated 5% of the lagoon and reef-flat of that extensive reef system. Estimated error of these predictions may vary significantly due to uncertain weather conditions.

Reversibility of impacts was predicted based on natural recovery of the habitats affected. The coral reef naturally takes longer to recover than the lagoon habitats. Significance of the impacts is predicted based on the nature, geographic range where impacts are felt, magnitude, duration and reversibility of the impacts.

Table 9: Significant impacts of the proposed harbour construction project

Impact characteristics	**Harbor basin construction**	**Reclamation**	**Channel construction**
Nature of impacts	Cumulative, long term	Cumulative, long term	Cumulative, long term
Magnitude of impacts	Moderate- negative	Minor- negative on coastal ecosystems. Minor +ve on socioeconomic aspects: more land	Minor-negative
Geographical range and environmental attributes	Direct impact on 1000m^2 of reef-flat and lagoon Direct impact on coral reef on 400m^2 Direct impact on seagrass bed 500m^2 Indirect impact on 4000m^2 of	Direct impact on 500m^2 of reef-flat and lagoon Direct impact on coral reef on 200m^2 Indirect impact on 1000m^2 of reef-flat and lagoon	Direct impact on 8000m^2 of reef-flat and lagoon Direct impact on coral reef on 300m^2 Direct impact on seagrass bed 200m^2 Indirect impact on

Impact characteristics	Harbor basin construction	Reclamation	Channel construction
	reef-flat and lagoon		3000m^2 of reef-flat and lagoon
Duration of impacts	Short term on coral reef and lagoon and long term on reef-flat, seagrass beds and beach	Permanent alteration of physical and biological system of the sea bed and marine life	Short term on coral reef and lagoon and long term on reef-flat and seagrass beds.
Reversibility of impacts	Permanent alteration of physical and biological system of the harbor basin, Short term reversible impacts on coral reefs, lagoon and reef-flat and seagrass beds adjacent to the harbor basin	Irreversible impact on the benthic life of the filled area	Permanent alteration of physical and biological system of the entrance channel basin and sand dumping site, short term reversible impacts on coral reefs, lagoon and reef-flat and seagrass beds adjacent to the entrance channel basin
Significance of the impacts	Minor impacts on the harbor basin, shore-line and beach, moderate impacts on the adjacent areas of reef-flat and other environmental attributes	Moderate impact on benthic communities. Impacts to hydrodynamic process unclear.	Minor impacts on the entrance channel basin and sand dumping site, moderate impacts on the adjacent areas of reef-flat and other environmental attributes

8.7 2.4. Mitigating the Impacts

Several actions can be taken to minimize the above mentioned impacts. Expert consultations, past experience and local knowledge are essential in reducing the impacts. Mitigation measures are

employed to eliminate or reduce the severity of any predicted impacts. This will ultimately improve the environmental outcomes of the project. The predicted impacts on the coastal environment of Kulhudhuffushi can be mitigated by joint cooperation and careful environmental planning. All parties, the Island authorities and the contractors must work carefully to eliminate or reduce the identified risks. Given the magnitude of impacts for this project, the adverse effects can be mitigated at virtually no cost if best environmental practice and precautionary principles are used.

Supervision and inspection of the project activities are imperative to minimize adverse impacts. Therefore, competent environmental consultants with experienced in same or similar work in the local environment will be consulted and allowed to inspect and monitor the work activities of the project life-cycle.

Supervision of work will be carried out by a competent and independent party with experience of similar work and its possible impacts to the environment. Supervising party will not be in anyway related to the contracted party to ensure that mitigation measures were taken even at extra project costs. Supervising party will carry out compliance monitoring and reporting to ensure that the predicted impacts are not exceeded. If predicted impacts were exceeded, the work will be halted and impacts re-assessed and reported.

Proposed project's work will be carried out to coincide with low tide and easterly current so as to minimize effects of sediment on the reef. The work will be carried out in calm weather and sea condition.

Machinery, equipment and vessels used in the project activities will be maintained in good condition and operated in a manner that they do not pose a risk of the environmental degradation.

All work activities will be kept to the minimum period of time to reduce impacts on the environment.

The monitoring programme specified in this report will be followed and reported in both work phase and operation phase.

Table 10 provides more information on potential impacts during construction and operation of the harbour expansion project and mitigation measures (LaMer 2006).

8.8 Socio economic impacts of the proposed project

8.8.1 Easy accesses to the island.

The proposed harbour will make it easier for the island fishermen, visitors and local traders and public to have easy access to the island. The existing harbour has limitations in terms of access to the island due to lack of proper facilities including proper anchoring facilities. The existing harbour area cannot be access by large vessels due to inadequate depth and lack of minimum width in some areas of the access channel. The island being located near the good fishing grounds, dhonis from all parts of the northern region visits the island and which will help the island people to make more income if necessary services and facilities are available.

8.8.2 Protection for fishing and other vessels

The local fishermen have started to build bigger fishing vessels to meet the demand of more fish catch. The existing harbour cannot be accessed by bigger fishing vessels, since it has limited area. This has become the major concern of the local fishermen. The harbour has no proper seawalls

causing damages to vessels during high seas. The proposed new harbour development project will address the issues.

8.8.3 Decrease accidents during access

The lack of anchoring facilities, proper landing jetty and size of the harbour causes the vessels to use smaller boats to access the harbour. This method is used to load and unload the goods. This very often causes accidents whereby causing greater losses to the goods and sometimes to the workers. Although proper data is not available on the number of accidents and losses causes to the goods and workers, it is believed that this can be very much reduced after completion of the new harbour.

8.8.4 Other impacts

There are other positive impacts which can be summarized but not limited as described below.

- Create a service market after providing water and fuel for vessels;
- Increase visitors for the island due to easy access especially from tourist resorts;
- Increase fishing catch by using larger fishing vessels;
- Increase income of local community

8.8.5 Other issues

The main negative impact would be dissatisfaction of the community due slow progress of the project and lack of proper harbour management procedures. These issues need to be addressed to avoid any community unrest and future operation and maintenance of the harbour and its facilities.

Table 10: Summary of Potential environmental impacts during construction and operation of the harbour construction project and mitigation measures identified to minimize the impacts

Potential impacts	Mitigation measures	Impact locality	Development phase	Intensity and reversibility	Responsible authority	Projected cost (MRf)
Impacts on commercial species	Shortening the duration of the project: minimizing the spread of sediment by making bund walls, creating awareness on these species	Reef-flat and ref-slope, sea grass and lagoon	During construction	Minor- -ve impacts, not fully clear, most likely little change	Contractor, Island authorities	N/A
Littering on and marine environment	Avoided by proper planning in ways transportation and disposal. Use 3R- reduce, re-use, recycle. Proper disposal	Reef-flat, lagoon, seagrass and land	During construction	Minor to moderate, short -term -ve impact. Reversible	Contractor, Island authorities	N/A
Damage to reef by Loading/unloading works	Raising awareness and utilizing environmental best practice, careful planning	Reef-flat and reef-slope, seagrass and lagoon	During construction	Minor, short term –ve impact. Reversible over long run	Contractor, Island authorities	N/A
Sedimentation and siltation on the reef and lagoon due to excavation works	Creation of a sand bund to reduce the sedimentation impact, carried out in low tides and use of silt screen around barges during excavation works. Create a bund where possible to avoid from siltation.	Reef-flat and reef slope lagoon	During construction	Minor, short term –ve impact. Reversible over long run	Contractor, Island authorities	N/A
Loss of habitat,	Clearly marking the areas to	Reef-flat,	During	Moderate, short term	Contractor, Island	N/A

Potential impacts	Mitigation measures	Impact locality	Development phase	Intensity and reversibility	Responsible authority	Projected cost (MRf)
Impacts on commercial species	Shortening the duration of the project: minimizing the spread of sediment by making bund walls, creating awareness on these species	Reef-flat and ref-slope, sea grass and lagoon	During construction	Minor- -ve impacts, not fully clear, most likely little change	Contractor, Island authorities	N/A
damage or death of coral at the entrance area, harbour basin and protection wall area	be excavated. Dredging will be carried out on already partially dredged areas	seagrass and lagoon	construction	–ve impact since these are new dredging sites	authorities	
Loss of habitat at the spoil disposal site	Clearly marking the areas to be filled by means of silt curtains or bund walls	Reef-flat, seagrass and lagoon	During construction	Minor, long term –ve impact. Most likely irreversible.	Contractor	N/A
Loss of habitat at the land reclamation site.	Clearly marking the areas to be filled either by a silt curtain or a bund walls	Reef-flat, seagrass and lagoon	During construction	Minor, long term –ve impact. Most likely irreversible.	Contractor	Bund to be forecasted to prevent high turbididty level for the return flow (cost already included in the project cost)
Habitat modification at the spoil disposal site	The material will be disposed at seagrass bed with strictly marking the areas to be filled	Reef-flat, and beach	During construction and Operational phase	Moderate, long term –ve impact. Most likely irreversible.	Contractor, Island authorities	N/A

Potential impacts	Mitigation measures	Impact locality	Development phase	Intensity and reversibility	Responsible authority	Projected cost (MRf)
Impacts on commercial species	Shortening the duration of the project: minimizing the spread of sediment by making bund walls, creating awareness on these species	Reef-flat and ref-slope, sea grass and lagoon	During construction	Minor- -ve impacts, not fully clear, most likely little change	Contractor, Island authorities	N/A
Impacts of storm-water drainage and coastal flooding.	The spoil will be disposed adjacent to the beach. The elevation will be maintained at the same level of the adjacent areas.	Coastal area	During construction and Operational phase	Minor impacts not fully clear. Most likely no change. It must be studied during detailed design phase	Contractor, Island authorities,	Sedimentological expertise to be included in the detailed design phase
Impact of dredging works on the existing operations of the lagoon	Dredging will be carried in a manner that will not interfere with the operation of the harbour	Entrance channel and harbour	During construction	Minor, –ve impacts on the operation of the harbour	Contractor, Island authorities	N/A
Air pollution	Completing the excavation works as soon as possible.	Air	During construction	Minor, short term –ve impact. Reversible	Contractor	N/A
Noise pollution	Completing the excavation works as soon as possible, avoid working at night	Land	During construction	Minor, short –ve term impact. Reversible	Contractor	N/A
Possible erosion due to obstruction of littoral sediment movement	Keep part of the dredge material on the island to supplement areas showing erosion and undertaking maintenance dredging	Beach and harbour basin	Operational phase	Minor and unpredictable impact. Most likely no change	Island authorities,	Cost is difficult to estimate since the timing of impact unpredictable

Potential impacts	Mitigation measures	Impact locality	Development phase	Intensity and reversibility	Responsible authority	Projected cost (MRf)
Impacts on commercial species	Shortening the duration of the project: minimizing the spread of sediment by making bund walls, creating awareness on these species	Reef-flat and ref-slope, sea grass and lagoon	During construction	Minor- -ve impacts, not fully clear, most likely little change	Contractor, Island authorities	N/A
	regularly					Sedimentological expertise to be included in the detailed design phase
Solid waste	Employee a staff for monitoring and cleaning the harbour	harbour	Operational phase	Minor, long term –ve impact Reversible	Contractor	monthly salary equivalent to 3000.00
Accidental spillage	Put up sign boards, provide awareness for the satf/labourers	harbour	Operational phase	Minor, short term –ve impact Reversible	Island authorities	5000.00 -9000.00
Construction of new breakwaters, jetties and new L-shaped quay wall using reinforced concrete prefab walls.	Construction works other than dredging will be mainly quay wall and jetty construction using pre-fab L-shaped concrete walls. Impacts of these works on the marine environment will be negligible as they will be executed on dry land.	Harbour area, mainly along the quay wall and breakwater length.	During construction	Minor, short term –ve impact. Most likely Reversible.	Contractor	No cost. A clause will be included in the contract document for the contractors to use debris.

Potential impacts	Mitigation measures	Impact locality	Development phase	Intensity and reversibility	Responsible authority	Projected cost (MRf)
Impacts on commercial species	Shortening the duration of the project: minimizing the spread of sediment by making bund walls, creating awareness on these species	Reef-flat and ref-slope, sea grass and lagoon	During construction	Minor- -ve impacts, not fully clear, most likely little change	Contractor, Island authorities	N/A
	Proper construction methods to ensure that only work are confined within the designated areas.					
Impact on coastal stability of adjacent shore line.	Disposing the dredge spoil and resulting reclamation must be levelled and compacted and riveted to minimize sand loss caused by erosion.	Coastline and beach (erosion predicted at the north-western end)	During construction and operational stage	Minor to Moderate, long term	Contractor, Client	Is Part of monitoring and monitoring cost has been included in the project.

9 Stakeholder Consultations

This project involves various stakeholders at different levels. From the initial project planning stage, stakeholder consultations have taken place at various levels. For this EIA, stakeholder consultations were undertaken with the client and the community extensively at various stages. During the consultations with the client, their plans and expectations were noted while at the same time, the community consultations were used as a mechanism to gather information for the proposed development programme. As the harbour comes under the jurisdiction of MCPI, the formal channel of communication in place will be directly between the MCPI and the island community. However, for this study, the consultants engaged in direct communication with the client, the community and other relevant agencies. Once the project goes in to implementation, then MCPI will be the lead government agency overlooking the works.

Stakeholder consultations were held with the following agencies and groups.

9.1 Consultation with the proponent

Discussions were focused on gathering preliminary data and information from the client before the field visit. The client was also briefed about the environmental components and how the data would be collected. The client briefed about the present policies and construction practice of the government for harbour projects. The purpose of this meeting was to present the findings of the technical study and obtain clients approval for the proposed expansion programme. During the meeting, the project consultant presented the study and the findings for each island. Brief environmental presentations were also presented by the projects local partners, Water Solutions Pvt. Ltd. The presentation focused on the environmental components of the study that mainly focused on the structure and the content of the EIA report.

9.2 Consultations with the Project Consultants

As environmental consultants, Water Solutions also undertook consultations with the project's lead consultant to discuss environmental issues related to the project. The major environmental concern for Kulhudhuffushi was identified as the impacts on marine environment. The dredged materials from the harbour basin will be disposed to fill the gap between proposed quay wall and existing shoreline. Discussions were undertaken for the proposed harbour project so that the environmental damage could be minimized by allowing methods and materials to be reused in the new project.

9.3 Consultations with the local community

Comprehensive Informal and formal consultations and discussions were held with the community through randomly discussing with the islanders, fisherman and also by means of a formal community meeting. Generally, consultations were held to assess and identify the different socio-economical aspects of the project. The discussions were also used as a means to identify what the community / local fisherman considered as the most significant difficulties, constraints and what aspirations they have regarding the project. These consultations also helped to gather other information that are usually not documented in the island office such as harbour traffic at different periods of the year.

More details of the socio-economic aspects have been presented in the "Socio-economic" section of the report.

9.4 List of persons consulted

Following are the names and designation of persons consulted.

NAME	DESIGNATION	OFFICE
Mr. Saeed Ismail	Little Island Chief	Kulhudhuffushi Island office
Mr. Ali Mohamed	Vice President	Island Development Committee
Members*		Harbour Committee
Members*		Island Development Committee
Members*		General public including fisherman and boat owners

*Note: Names and contact address of all those who participated were recorded. The list of the attendees could be found in the Appendix (Appendix J).

10 Alternatives

In this project, there are very few alternatives that can be suggested. It is a requirement as per the EIA Regulations to provide two alternatives to be suggested. Hence two alternatives have been suggested in addition to the no project alternative. These alternatives are discussed below:

10.1 No Project Option

The no project option takes the following into account.

- The existing harbour continues to congest and deteriorate in quality.
- No additional measures or upgrading are proposed
- The future development of the island will be hindered

The main advantages and disadvantages of these are given in Table .

Table 11: Advantages and disadvantages of the no project option

Strategy	Advantages	Disadvantages
Allow the existing harbour to congest and deteriorate in quality	Environmental problems related to expansion of harbour can be avoided No construction costs to the Proponent and hence there is a short term benefit	No expansion means that the islanders and other users of the harbour will have difficulties, especially as traffic increases. Sedimentation in the harbour basin will be a threat to boats during low tide. It will disrupt the future development of the island. Other industrial activities such as fishing and boat building, cargo loading/unloading cannot be expanded.
Expand and construct the harbour by dredging , revetment and breakwater	Environmental problems related to sedimentation can be avoided. No upgrading costs to the Proponent and hence there is a short term benefit	Value of the island may deteriorate. The island will not be preferred by other vessels mainly fishing and safari vessels. Fishing activities cannot grow and be developed. The island community will not get the economic benefit from expansion.

Construction of quay wall, break waters and jetty	Cost can be eliminated.	The quay wall will not last for many years and the resulting deterioration will be more costly to rehabilitate. Quay wall cannot take greater loads. Breakwaters will not serve what they are intended for. Jetty cannot serve the vessels that require their use. Existing harbour's congestion will grow

10.2 Design Alternatives

It is not practical to relocate the harbour as the environmental and economic consequences would be much more. Therefore, at the design stage, alternative options were considered which is discussed below.

10.2.1 Sheet piling the quay wall.

Sheet piling the quay wall will allow greater live load carrying capacity. This option, although it was considered has been rejected as it is not predicted that the island will have traffic and cargo that require sheet piling in the near future and also due to the existence of the regional port. If it is required, then the harbour will have to be upgraded with more facilities. Sheet piling will also be environmentally more damaging. Therefore, this option was also rejected.

10.3 Alternative locations

The present location is most suitable for Kulhudhuffushi, despite it being on the western side and despite that it has been recommended in the previous reports. During the south west monsoon the large lagoon and the reef will protect the harbour.

Other alternative location would be the southern side towards west (Appendix H), but this location is not preferred as it is already reserved for the green area as per the land use plan. This area will be developed as sports and recreational zone with parks and public beaches.

The other alternative location is the far north western part of island. This location is in close proximity with the protected wetland area and would have negative environmental impacts if a harbour is built at the said location. In addition to this, strong waves from Kulhudhuffushi-Nolhivaram channel is experienced here making unjustifiable to build a harbour at this location.

10.4 Alternative Disposal location

One of the alternatives for disposal of dredge spoil would be the wetland which has been marked as a protected area.

10.5 Preferred alternative

Several alternatives have been preferred including no project options and design alternatives. An alternative location has not been considered as the environmental and economic considerations cannot be justified for this project. Hence, with the limited options and alternatives, the preferred alternative for this project is north western part of Kulhudhuffushi Island (Figure 1). Mitigation measures have been proposed for this. Nevertheless, it can be reminded that the proposed harbour area location is already partially dredged and an excavator bed exists.

10.5.1 Mitigation measures for the proposed alternative

Following mitigation measures are proposed:

- Dispose the dredge spoil by assessing baseline condition of the disposal area. They can then be used for reclamation or back filling of the harbour.
- Stockpiling the dredged material in a way to avoid surface runoff during rain. This is important to prevent them from entering marine waters. Stock piling will be done inside a bund and leveling and compaction will be done.
- Stockpiling them away from the main populated area and away from economic activities where it can become a nuisance if kept for too long.

11 Environmental Monitoring

11.1 Introduction

Environmental monitoring is essential to ensure that potential impacts are minimized and to mitigate unanticipated impacts. The parameters that are most relevant for monitoring the impacts that may arise from the proposed harbour construction project are included in the monitoring plan. These include turbidity and nutrient, sedimentation, beach profile and live coral cover and nektonic fauna. Monitoring will be carried out as part of the environmental impact assessment and mitigation of possible negative impacts from the proposed project.

The objectives of the monitoring plan are to measure:

- live coral cover and nektonic fauna
- the amount of sedimentation on the reef
- water quality and visibility
- beach profile and hydrodynamic changes only in the project boundary
- impacts are accurate and mitigation measures taken are effective and
- the thresholds are kept within the baseline limits predicted.
- Assess socioeconomic changes

Table 12 summarizes the various aspects of the monitoring program and the costs.

11.2 Cost of Monitoring

The proponent has committed fully for the monitoring programme outlined in this report. The cost indicated below is for monitoring the project during the construction stage and operational stage. Monitoring will be undertaken by subcontracting the work to an independent consultant or a consulting firm.

The amount indicated is the total cost of monitoring during the construction and operational phase (2 years after the construction). Monitoring will include, Marine and Coastal environmental monitoring plans identified in the report. Summary monitoring reports will be provided every two months and final report will be provided at the end of the construction stage and will adhere to Schedule M of the EIA Regulations, 2007.

11.3 Methods of monitoring

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

As socioeconomic changes take more time to materialize, socio-economic monitoring will be undertaken using qualitative and quantitative surveys done after 18 months of project completion. One survey will be sufficient to assess the impacts. Quantitative monitoring will mainly focus on the indicators outlined in the baseline socio-economic assessment outlined in this report, which can be obtained from:

- Household surveys
- The island office, health facility
- Published reports, surveys, and studies.

Table 13 outlines the indicators for socioeconomic monitoring. These indicators in the table are not limited but have been considered as the important aspects of monitoring.

Table 12: Aspects of the social and environmental monitoring program with cost breakdown

Monitoring Attribute	Indicator	Methodology	Monitoring Frequency	Estimated Cost
Coral and other benthic cover.	Percent cover	LIT	Upon completion of the project and once a year there after.	US$ 350 per survey
Diversity and abundance of fish communities	Number / percentage of fish present	Visual fish census	Upon completion of the project and once a year there after.	US$ 100 per survey
Siltation/ Sedimentation	Quantity of sediment	Quantitative assessment of sediment loading using Sediment traps	Prior and during the project works; and after 2 months, there after once a year	US$ 150 per survey
Seawater quality	DO, nutrients and turbidity	Lab analysis	Twice during the project, 2 months after the completion, there after once a year	US$ 100 per test performed
Beach profile	Beach dynamics	D-GPS tracks along the beach	Once during the project, 2 months after the completion, there after once a year	US$ 100 per survey
Hydrodynamic	Changes in the current movements	Drouge tracks at a recording interval of 60s	Once during the project, 2 months after the completion, there after once a year	US$ 100 per survey
Socio-economic survey	Outlined in Table 13	User survey	Once, preferably after 18 months from the completion of the project.	US $ 750

Table 13: Indicators for socioeconomic impact monitoring.

CATEGORY	INDICATOR	METHOD
Service quality	Efficiency of operation and maintenance of harbour.	User survey
	Services available to vessels	User survey, island and atoll administration data
	Five main operation and maintenance problems.	User survey.
	Care and use of harbour facilities.	User survey evidence of facilities
Financial sustainability	Income generated from the harbour and related activities.	Financial statements/audit reports, user surveys
	Safety of harbour.	Safety standards enforced by MCPI and Transport Minsitry
Safety	Records of accidents or injuries.	Health record and island office records.
	Advocacy of users.	User interviews
Institutional arrangements	Functioning of Harbour management committee	Island and Atoll office /line Ministry
	Participation of public.	Minutes of Island Development Committee Meetings/
	Regulatory / management regime	Island and atoll office. MCPI and atolls ministry.
	Complaints dealt	Correspondences/records
Mobility of vessels /traffic analysis	Development plans	Island and atoll office/line agencies
	Vessel types, size and numbers	Island office
	Frequency of use	Island office
Employment	New employment created as a result of the harbour construction	Island office, interviews, published reports
Demography	Population	Island office, census data
	Population migration	Island office, census data

Table 14: Detail cost of monitoring during construction period and for two years

DESCRIPTION	UNIT COST (US$)	TOTAL (US$)
Logistics (A total of 4 trips to be made during the construction stage and during the 2 years monitoring period)		
Return air transport (2 people) to Haa dhaal atoll via air.	80 x 2 x 4	**640.00**
Return Sea transport to Kulhudhuffushi from Hanimaadhoo airport, Haadhaal Atoll.	400 x 4	**16,00.00**
Food and accommodation for two (3 days)	60 x 2 x 4	**480.00**
Survey costs		
Cost of undertaking the environmental surveys during the project construction stage and for the first year	2,350.00	**2,350.00**
Cost of undertaking the environmental surveys during the second year	650.00	**650.00**
Social survey (once after 18 months from completion of the harbour)		**750.00**
Sub Total		**6,470.00**
10 % contingency (to account for variation in transport costs)		**647.00**
Grand total for monitoring during construction stage and for two years (Seven thousand one hundred and seventeen US Dollars only)		**7,117.00**

11.4 Monitoring responsibility

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

11.5 Monitoring Report

A detail monitoring report will be compiled after the completion of the civil works based on the data collected for monitoring the parameters included in the monitoring program. This report will be submitted to the relevant government agencies for compliance.

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

12 Conclusion

This EIA report has identified the major impacts of the proposed harbour project in Kulhudhuffushi. The project will only have its environmental impacts on the project boundaries which are confined to a limited area in the marine and coastal environment of Kulhudhuffushi. Environmental impacts don't appear to be major, as this area has already been affected due to the previous harbour projects. Similarly, the scale of the activities and the locality is limited to the project boundary only. Socioeconomic impacts have also been assessed in depth and it is evident that there would be several positive socioeconomic impacts. Dredging activities have already started at this location and the existence of the excavator bed has become a waste accumulation point on the north of the bed detoriating marine water quality and giving unfinished scenic view.

The major impacts have been identified as resulting from the dredging works, which has been proposed in the harbour basin and entrance channel. Environmental impacts of this activity will be minimised as the dredge spoil will be used to backfill the proposed harbour providing 3% increase to the land. The report has identified baseline conditions of the predicted impact zones of the marine environment and they appear to be very minor as the reef itself has limited live coral coverage. The assessment has indicated that the impacts are likely to be felt on an estimated 30% of the lagoon and reef-flat of that extensive reef system in Kulhudhuffushi island. However, due to the disposal of dredged spoil, the sea grass beds on the southern side of the existing harbour will be affected. Unlike many other dredging projects, disposal of dredged spoil will not be an issue and this will be used as part of the reclamation at the back of the harbour.

During the dredging stage, good care should be taken to allow only a pre-determined minimum of suspended sediments to escape from the working areas. Mitigation measures, such as screens and bunds should be employed as outlined in the report. Although several alternatives to the proposed project were considered, these alternatives cannot be implemented for various reasons. Alternative locations cannot be considered for this project, as the harbour is already located in the most suitable location and environmental consequences of creating a new harbour in a new location cannot be justified.

The monitoring programme for this project will mainly focus on marine components and for this reason, sedimentation levels on the reef, water quality and visibility and the coral cover has been considered in the monitoring programme. A socioeconomic survey has also been suggested to be undertaken as part of the monitoring after 12 months of project completion.

It appears justified from a technical and from a developmental point of view, to carry out the proposed harbour phase 1 in light of the existing socio-economic developments and forecasts made on the harbour use and traffic increase. There are good reasons from an economic and environmental point of views, to dredge sand for the construction of harbour basin, and land reclamation using this dredge spoil. There would definitely be some environmental impacts, but they are also unavoidable and achieved by economic gains on the other hand. The adverse environmental effects of the project therefore appear to be limited and acceptable, assuming that the mitigation measures proposed are implemented.

13 Declaration of the consultants

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

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

Name: Hassan Shah (EIA 02/07)

Signature:

Date: 12th March 2007

14 References

Admiralty, (2007a). Admiralty sailing directions. West coast of India pilot. NP38.

Admiralty, (2007b) Admiralty tide tables. Indian and South China Sea. Vol. 3 – NP 203-07.

Allison W R. (1996). Snorkeler damage to reef corals in the Maldive Islands, Coral Reefs 15: 215-218

Carsten, M., Alan, H. and White , T. (2002). *Sustainable coastal tourism handbook for the Philippines.* Department of Tourism.

Clark, S., Akester, S. and Naeem, H. (1999). Conservation and Sustainable Use of Coral Reefs: Status of Coral Reef Communities in North Male' Atoll, Maldives; Recovery Following a Severe Bleaching Event in 1998, MacAlister Elliot and Partners Ltd.

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

English, S., Wilkinson, C. and Baker, V. 1997. *Survey Manual for Tropical Marine Resources*. Australian Institute of Marine Science, Townsville, Australia. 390pp.

Environmental Guidelines for Reclamation in Coastal Areas, Environment and Heritage Division, Department of Land, Planning and Environment, January 1999

Globocean (2007). Republic of Maldives. Offshore wind and wave climate

Harriott, V. J. (2002). *Marine tourism impacts and their management on the Great Barrier Reef.* CRC Reef Research Centre Technical Report No. 46. CRC Reef Research Centre, Townsville.

Haveeru (7 December 2003), Overbookings result in tourists diverted away from the Maldives

Kench, PS & Brander, RW 2006. 'Response of reef island shorelines to seasonal climate oscillations: South Maalhosmadulu atoll, Maldives', *Journal of Geophysical Research*, vol. 111, F01001, doi:10.1029/2005JF000323.

Kenchington, R.A., *The Republic of Maldives*, pp 184-204. Managing Marine Environment, Taylor and Francis New York Inc. (1990).

Khan, T.M.A.,Quadir, D.A., Murty T.S. and Kabir, A. (2002). Relative sea level changes in Maldives and Vulnerability of land due to abnormal coastal inundation. Marine geodesy, Volume 25, Issue 1&2. Pages 133-143.

Land and Marine Environmental Resource Group Pvt Ltd. (LaMer) 2006. *Environment Impact Assessment of V. Thinadhoo harbour development project.* LaMer, Maldives, 52pp.

Land and Marine Environmental Resource Group Pvt Ltd. (LaMer) 2005. *ADB, DMTP (TA4394-MLD) Ecosurvey*, LaMer, Maldives, 46pp.

Loya, Y. 1978. A Plotless and transect methods. In: Stoddart, D.R. and R.F. Johannes (eds). *Coral Reefs: research methods*. UNESCO, Paris: pp197-217.

Maldives Recreational Diving Regulation (unofficial translation), Ministry of Tourism 2003, Republic of Maldives

Medio, D., Ormond, R. F. G. and Pearson, M. (1996). Effects of briefing on rates of damage to corals by SCUBA divers. *Biological Conservation* 79: 91-95

MHAHE (2001), *State of the Environment Report*, Ministry of Home Affairs, Housing and Environment, Maldives

MPE (1993), The Environment Protocol, Ministry of Planning and Environment

MPND (2001), *Statistical Year Book of the Maldives 2001*, Ministry of Planning and National Development, Maldives

Segal, B. and Castro, CB. 2001. A Proposed Method for Coral Cover Assessment: A case study in Abrolhos, Brazil. *Bulletin of Marine Science*, 69 (2): 487-496.

Sogreah and Water Solutions. (2007). Post Tsunami Infra Structure Rehabilitation Project: Social and Environmental Impact Assessment for the Rehabilitation of the Harbor in Makunudhoo island, Haa Dhaal Atoll.

Tissot, B. N. and Hallacher, L. E. (2000). Diver Impacts on Coral Reefs at Kealakekua Bay, Hawaii, p8.

Twinning-Ward, L and Butler, R. (2002), Implementing STD on a Small Island: Development and Use of Sustainable Tourism Development Indicators in Samoa, *Journal of Sustainable Tourism* **10**(5)

United Nations Environment Programme. (2002). Maldives: State of the environment.

United Nations Environment Programme. (2005). Maldives: Post Tsunami Environmental Assessment.

Viles, H. and Spencer, T. (1995). *Coral Reefs* pp. 206-252, Coastal Problems: Geomorphology, Ecology and Society at the Coast, Edward Arnold, a division of Hodder Headline PLC, 338 Euston Road, London.

WTO (2002), Final Report of the Asia Pacific Ministerial Conference on Sustainable Development of Ecotourism, Malé, Maldives, 11-13 February 2002

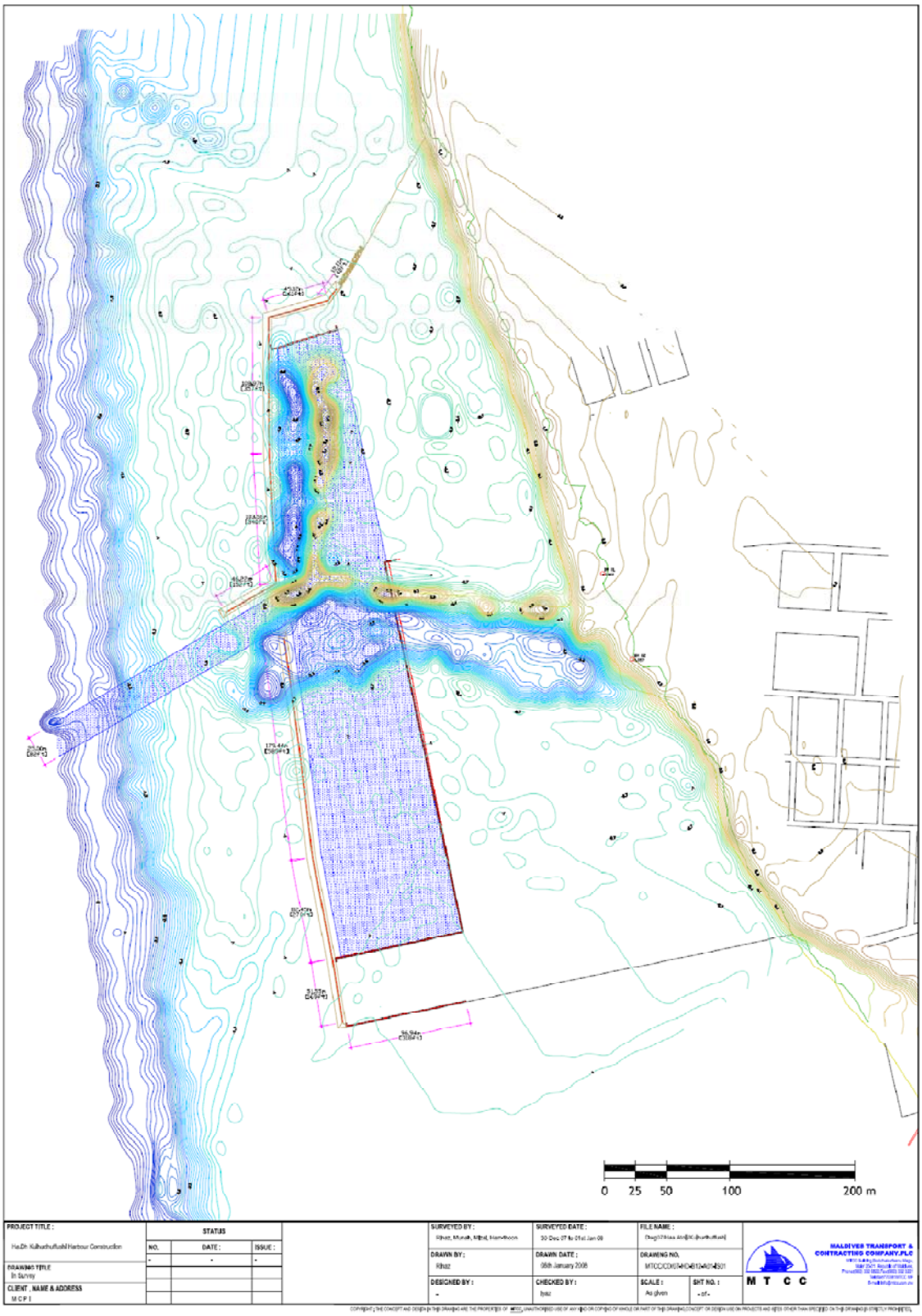
Appendix A: Eutrophication




Appendix B: Excavator Bed




Appendix C: Bathymetric Survey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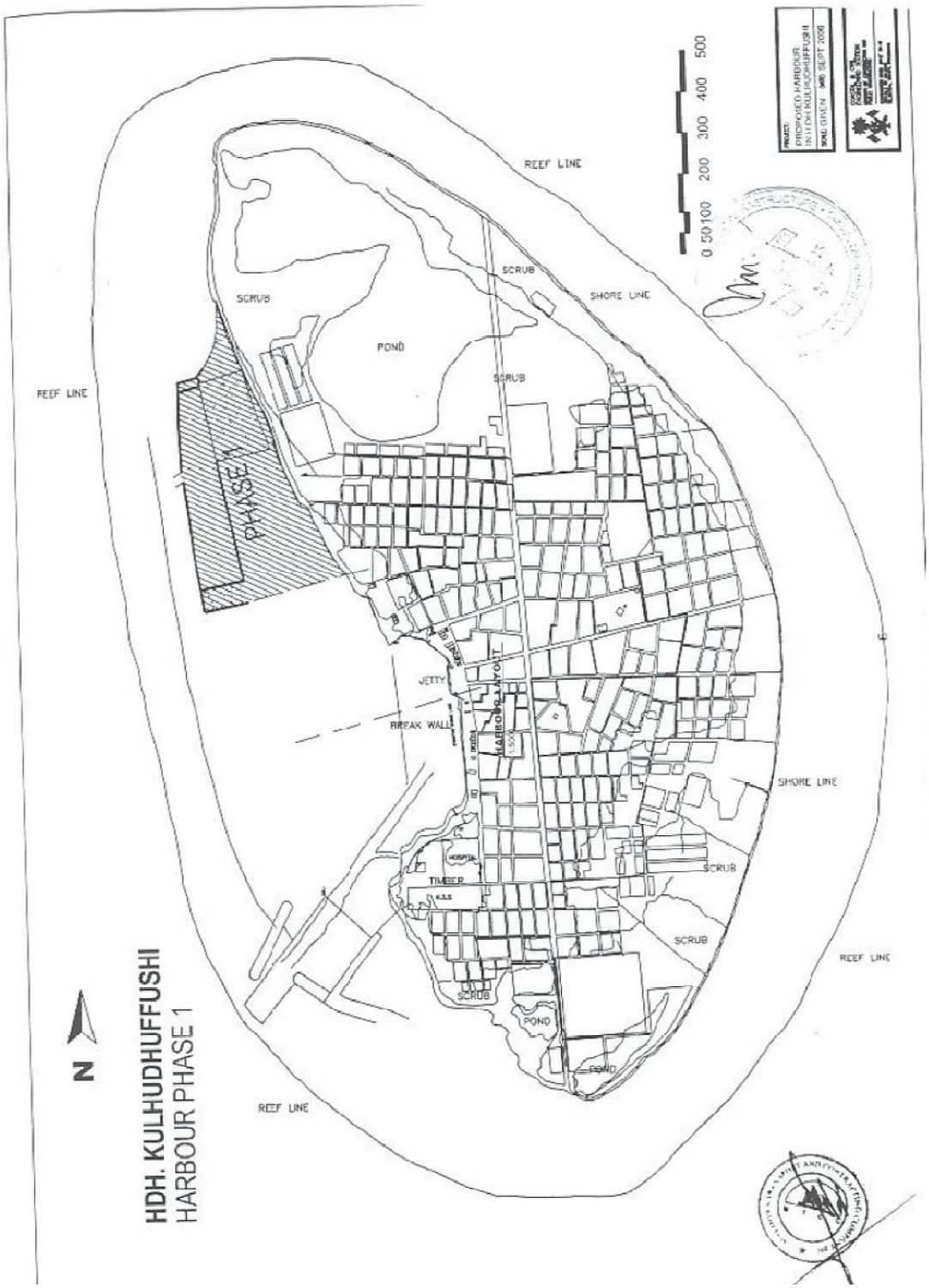
NO.
DATE :
ISSUE :
DRAWING TITLE
In Survey
CLIENT , NAME & ADDRESS
MCPI
SURVEYED BY :
SURVEYED DATE :
FILE NAME :
DRAWN BY :
Khaz
DRAWN DATE :
06th January 2008
DRAWING NO.
DESIGNED BY :
CHECKED BY :
SCALE :
As given
SHT NO. :
MALDIVES TRANSPORT & CONTRACTING COMPANY PLC
M T C C

Appendix D: Layouts of the Finished Harbour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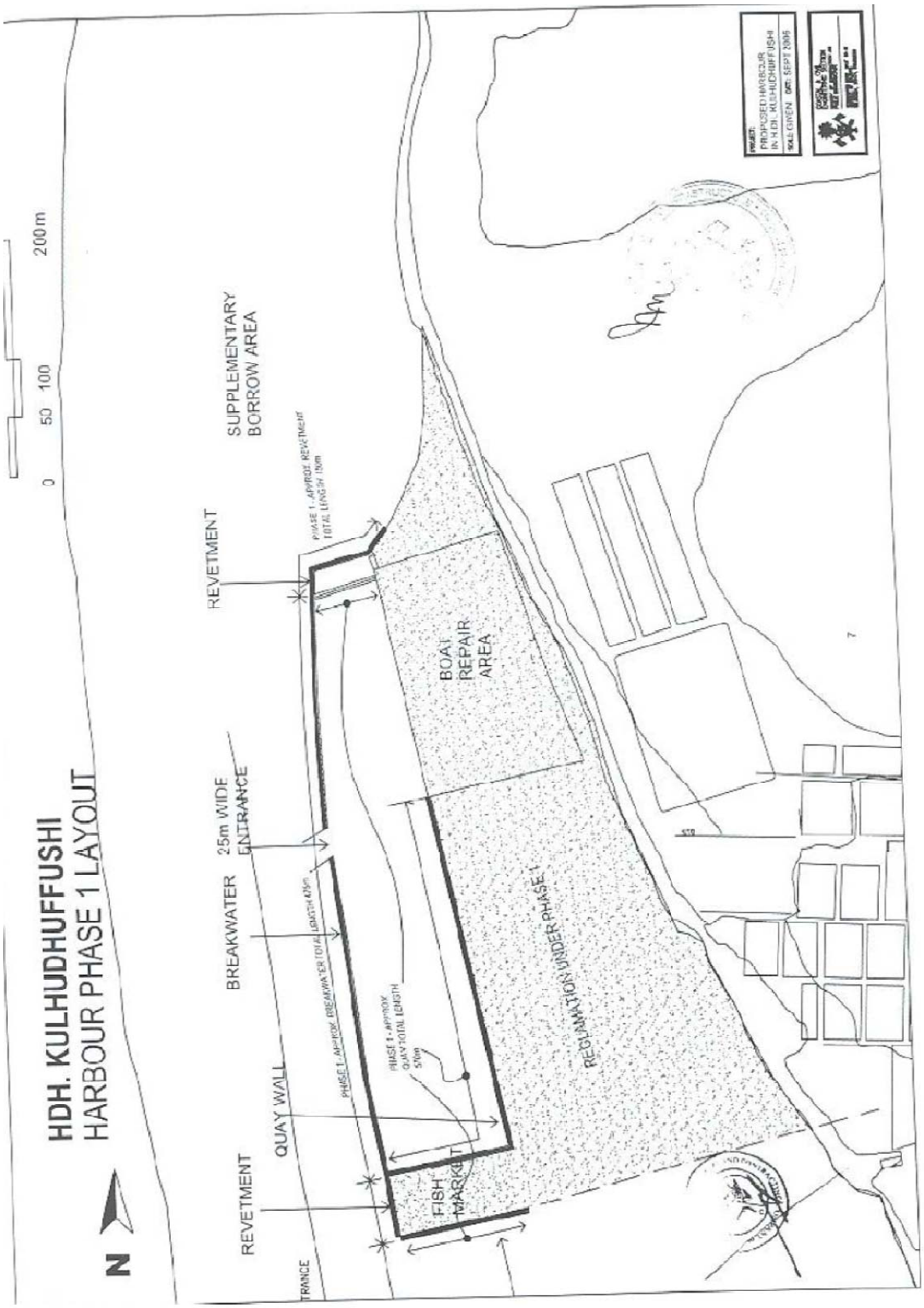
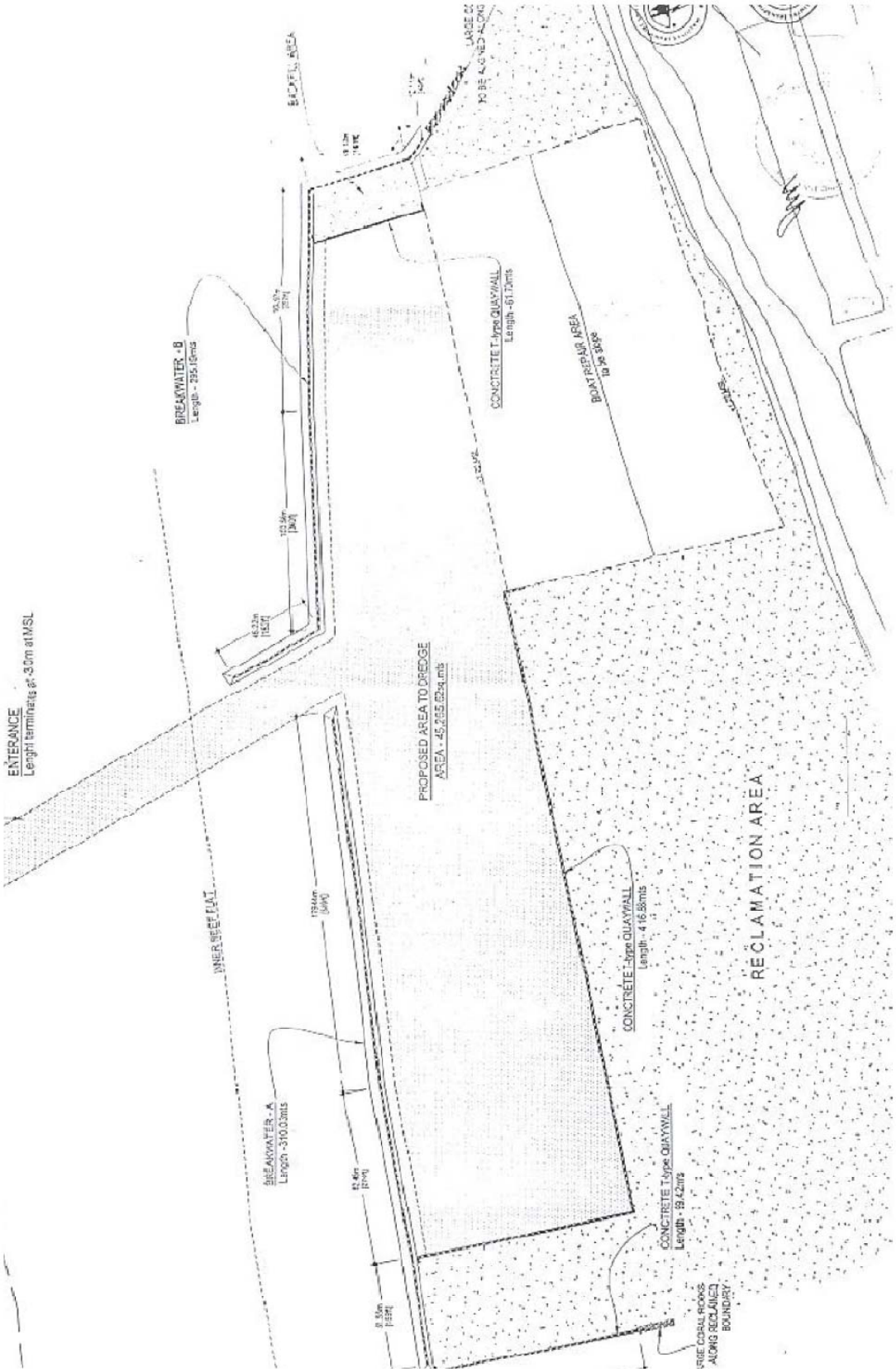
SCRUB
SHORE LINE
POND
PHASE 1
JETTY
BREAK WALL
HARBOUR LAYOUT
TIMBER
HOSPITAL
N
HDH. KULHUDHUFFUSHI
HARBOUR PHASE 1
0 50 100 200 300 400 500


HDH. KULHUDHUFFUSHI
HARBOUR PHASE 1 LAYOUT
N
0 50 100 200 m
SUPPLEMENTARY BORROW AREA
REVETMENT
BREAKWATER
25m WIDE ENTRANCE
QUAY WALL
REVETMENT
FISH MARKET
BOAT REPAIR AREA
RECLAMATION UNDER PHASE I

Appendix E: Proposed Layout of the Construction Plan


ENTERANCE
Lenght terminates at -3.0m at MSL
BREAKWATER - B
Length - 295.15mts
BREAKWATER - A
Length - 310.03mts
INNER REEF FLAT
PROPOSED AREA TO DREDGE
AREA - 45,265.82sq.mts
CONCRETE T-type QUAYWALL
Length - 61.73mts
BOAT REPAIR AREA
CONCRETE T-type QUAYWALL
Length - 416.88mts
CONCRETE T-type QUAYWALL
Length - 59.42mts
RECLAMATION AREA

Appendix F: Tentative Construction Schedule

Tentative Construction Schedule for Phase 1.

Project Start date: 21st January 2008

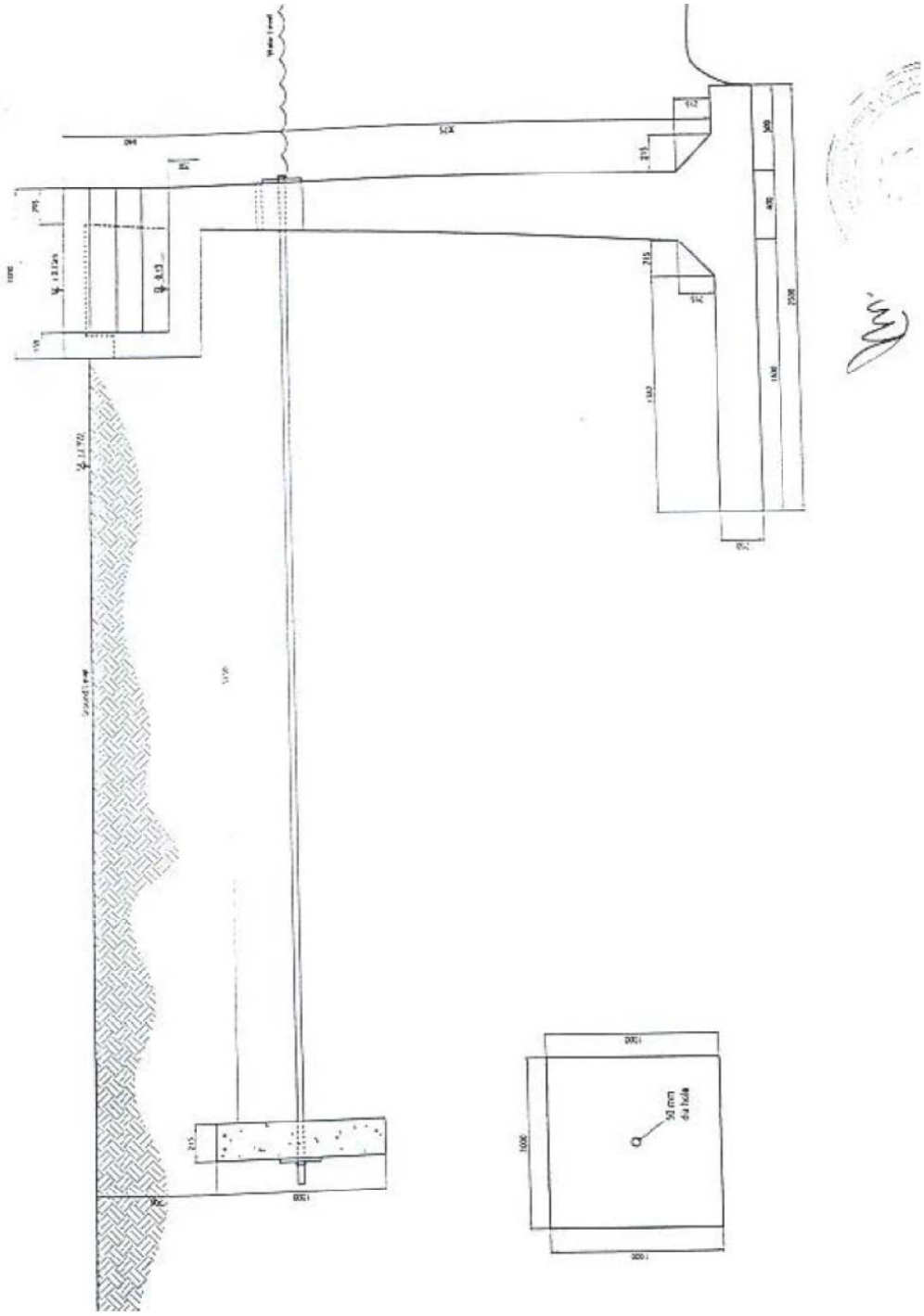
Dredging staring date: 12th March 2008

Quay wall starting date: 06th April 2008

Revetment and break water: 06th April 2008

Completion date: 23rd November 2008

Appendix G: L-Shaped Reinforced Concrete Wall



Appendix H: Land use plan

Appendix I: List of Attendees

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1	ﷺ	ﷺ	ﷺ
2	ﷺ	ﷺ	ﷺ
3	ﷺ	ﷺ	ﷺ
4	ﷺ	ﷺ	ﷺ
5	ﷺ	ﷺ	ﷺ
6	ﷺ	ﷺ	ﷺ
7	ﷺ	ﷺ	ﷺ
8	ﷺ	ﷺ	ﷺ
9	ﷺ	ﷺ	ﷺ
10	ﷺ	ﷺ	ﷺ
11	ﷺ	ﷺ	ﷺ
12	ﷺ	ﷺ	ﷺ
13	ﷺ	ﷺ	ﷺ
14	ﷺ	ﷺ	ﷺ
15	ﷺ	ﷺ	ﷺ
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[illegible]

ކުޅުދުއްފުށީ ބަނދަރު [illegible] 17 ފެބުރުއަރީ 2008 [illegible] 21:00 [illegible]

[illegible]

17 ފެބުރުއަރީ 2008

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([illegible])

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1	އަލްފާޟިލް އިބްރާހީމް [illegible]	[signature]
2	އަލްފާޟިލް އަބްދުއްރަޙީމް އަޙްމަދު [illegible]	[signature]
3	އަލްފާޟިލް އަޙްމަދު އިސްމާއީލް [illegible]	[signature]
4	އަލްފާޟިލް ސަޢީދު އަޙްމަދު [illegible]	[signature]
5	އަލްފާޟިލް [illegible] އިބްރާހީމް [illegible]	[signature]
6	އަލްފާޟިލް އާދަމް މުޙައްމަދު [illegible]	[signature]
7	އަލްފާޟިލް މުޙައްމަދު [illegible]	
8	އަލްފާޟިލް މުޙައްމަދު [illegible]	[signature]
9	އަލްފާޟިލް [illegible] އަޙްމަދު [illegible]	[signature]
10	އަލްފާޟިލް [illegible]	[signature]

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	ތަކުރުސޮފ ދެތަދަކ ތިމ ހ	16
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	ތަކުރުސޮފ ތ ތ ތ	24

Appendix J: CV's of Consultants

Names and Registration Certificate numbers of the EIA consultants

Ibrahim Naeem - EIA Registration no: EIA13/07

Hassan Shah – EIA Registration no: EIAT 02/07

CURRICULUM VITAE

Name Ibrahim NAEEM

Home Address:

Ma. Zenion

Malé 20 – 03

Republic of Maldives

Tel: +(960) 32 1933, or 31 3735

Hand-phone: +(960) 781461

E-mail: naeembe@hotmail.com

Office Address:

Marine Research Centre

Malé, Republic of Maldives

Tel: +(960) 32 2242

Fax: +(960) 32 2509

E-mail: inaeem@mrc.gov.mv

naeembe@yahoo.com

Date of Birth: 04 September 1971

Sex: Male

Nationality: Maldivian

Marital status: Married

Languages: Dhivehi (mother tongue), English (good), Japanese (basic).

Education

Bachelor of Science (Major in Aquatic Science), Burapha University, Chonburi, Thailand,

June 2001 to March 2004

University Entrance Diploma, University of Wollongong (Australia) / Institute of Management and Administration (Maldives) 1999

GCE O Level, University of London, January 1991

Basic Japanese Language Certificate

July to December 1995, Kochi University, Japan

Professional Training Courses / Study Tours

International Training Course: on **Extension Methodology and Coastal Resources Management.**

Southeast Asian Fisheries Development Center, Samut-prakan, Thailand.

October – December 1994.

International Training Course: **Group Training Course on Marine Ranch (Farm) System.**

Japan International Cooperation Agency, Usa Marine Biological Institute, Kochi University, Kochi, Japan. July – December 1995.

International Training Course: **Introductory Training Course on Brackish-water Aquaculture.**

National Prawn Fry Production and Research Center, Kedah, Malaysia.

July – August 1996.

International Training Course: **Group Training Course on Conservation and Sustainable Management of Coral Reefs,**

Japan International Cooperation Agency, Environment Agency and Marine Parks Centre of Japan,

Okinawa International Centre, Okinawa, Japan,

May – July 2000.

Pearl Culture Study Tour to Japan, 2-12 June 1997.

South Asia Coral Reef Survey Methods Training Workshop Conducted by Global Coral Reef Monitoring Network, Bandos Maldives. 3-14 May 1998.

Certified **PADI-Divemaster, and PADI-Research Diver**, PADI-Europe, Switzerland, 1998.

Completed Coastal Navigation Course Conducted by Maritime Training Centre, Maldives College of Higher Education. Male', Maldives. 7th February - 25th March 1999. Certificate Of Competency "Skipper Class5" Awarded by Ministry of Transport and Civil Aviation. Male' Maldives.

Coral Reef Degradation in Indian Ocean (CORDIO) Training Programme in Coral Reef Survey Design and Field Work. 23 - 31 January 2000. Malé, Maldives.

Workshops Attended

Molecular Techniques for Biodiversity Research, The fourth Annual Conference of CEMES, Chulalongkorn University, Bangkok, Thailand. 11-12 December 2002.

Maldives Dive Safety Day Workshop, Dan - Europe/Dan - Maldives Bandos Island Resort. Bandos Island Resort, Maldives. 4 August 1999.

Workshop on Health of the Environment–Safety of the Diver. Malé, Maldives. 18 Oct.1990.

Workshop on Youth on Fisheries, R. Ugoofaaru, Maldives. 7-9 December 1997

Worked in the Secretariat in the IRRM Workshop, 16-20 March 1996, Malé, Maldives.

National Bio-safety Workshop 2004

Employment Record

April 2004 to date	Aquaculture Research Officer
Sept. 99 to April 04	Assistant Research Officer
June 1995 Sep. 1999	Fisheries Research Assistant at Marine Research Section (MRC)
1991 - 1995	Trainee (MRS)

Work Experience

- Worked on Reef Fish Research and Resources Survey (1991).
- Assisted in Fish Aggregating Device deployment and monitoring programme conducted in the central atolls (1992)
- Assisted in grouper research, and giant clam research and Integrated Reef Resources Management Programme.
- Currently involved in the management and monitoring of aquarium fishery in the Maldives.
- Participated in the Tuna Tagging Programme carried out by MRS (1995) Assists in Tuna Length Frequency Sampling Program
- Responsible for collection, identification and compilation of biological data of marine flora and fauna of Maldives, with particular interest on fishes. Revised, edited and compiled the "Fishes of the Maldives" Catalogue (1997)
- Working in the Coral Reef Research Unit – assisting with coral reef monitoring and carrying out ecological and biological surveys of coral reefs.
- Working as a Technical Assistant in the Pearl Culture Pilot Programme
- Worked in a lots of EIA projects for the resort development
- Currently working on the initiation and development of mariculture in the Maldives.

Other Experience

- Computing - good working knowledge of Word and Excel.
- Photography - including black and white processing and underwater photography.
- Driving license and motor boat license holder

Reports and Publications

Naeem, I. (1996) Captive Rearing of Fish in Cages (in Dhivehi). Rasain. Vol. 16. 7pp

Naeem, I. (1997) Captive Rearing of Fish in Cages (in Dhivehi). Rasain. Vol. 17. 3pp.

Naeem, I. (1998) Captive Rearing of Fish in Cages (in Dhivehi). Rasain. Vol. 18. 8pp

Naeem, I. (1997) Pearl Oyster Species that are Viable for Cultivation in the Maldives. (in Dhivehi). Rasain. Vol. 17. 4pp.

Naeem, I. (1998) Coral Bleaching- What is going on? (in Dhivehi). Rasain. Vol. 18. 8Pp

Naeem, I. (1999) Fishermen, be aware! (in Dhivehi). Rasain. Vol. 19. 4pp

Naeem, I. et al. (1998) Coral Bleaching in the Maldives–1998 MRS/MOFA & E.R.U/MPHRE, 14pp.

Naeem, I. and M. S. Adam (1996). Guide to Aquarium Fishes of Maldives. (Unpublished).

Zahir, H. and I. Naeem. (1996). Generic Guide to Selected Corals of Maldives. Marine Research Centre, Ministry of Fisheries, Agriculture and marine Resources. Maldives. 128pp

Zahir, H. and Naeem I. et. al. (1998). Reef Check Maldives 1997 and 1998. Marine Research Centre

Special Projects

Catalogue of Fishes of the Maldives: Review, edit and update the four volumes of Catalogue of Fishes of Maldives published by MRC and compiled it as one volume with over 70 new entries. The book (408 pages) was published in 1997.

Referees

Dr. Charles Anderson	Dr. Abdullah Naseer
Fishery Biologist	Director
C/O Marine Research Centre	Marine Research Centre
Malé 20-06,	Malé 20-06,
Rep. of Maldives	Rep. of Maldives.

CURRICULUM VITAE

1	NAME	Hassan Shah
2	DATE OF BIRTH	18th September 1972
3	PLACE OF BIRTH	Maldives
4	NATIONALITY	Maldivian
5	MARITAL STATUS	Married
6	POSTAL ADDRESS	G. Kanzudhoshuge, Male', Maldives
7	PERMANENT ADDRESS	Bageechaage. S.Maradhoofeydhoo, Maldives. Tel: (960) 689 1050 Fax: (960) 689 1049
8	CONTACTS	Cell Phone: (960) 777 8941 Email: (personal) shaahu@hotmail.com
9	EDUCATION	May 2005, B.Sc in Environmental Science, Yuvaraja's college, University of Mysore, India

Jan 1998 to May 1999, second year in Civil and Environmental Engineering, A twining programme of the University of Adelaide at Sepang Institute of Technology (SIT),Klang, Malaysia

May 14, 1998 IELTS, Kuala Lampur, Malaysia.

Jan 1997 to Nov 1997, Degree Foundation studies in Science and Engineering, A twining programme of University of Adelaide and Sepang Institute of Technology (SIT),Klang, Malaysia

June 1994, London GCE A'L, Chemistry and Physics. 1992 to 1994, Science Education Center, Male', Maldives

Jan 1992, London GCE O'L, Biology, Chemistry, Economics, English, Integrated Science, Human Biology, Mathematics, Physics.

1985 to 1992, Male' English School, Male', Maldives

10 OTHER TRAINING

July 22, 1996 – August 3 1996, Environmental Health, Ngee Ann Polytechnic, Singapore

Feb 24th to Feb 28th 2008, PIANC-COPEDEC VII, 7th International Conference on Coastal and Port engineering in developing countries, Dubai

11 LANGUAGES

	Reading	*Writing*	*Speaking*
English	Fluent	Fluent	Fluent
Dhivehi	Fluent	Fluent	Fluent

12 PROFESSIONAL SOCIETIES

Nil

13 COUNTRIES OF WORK EXPERIENCE

Maldives, Thailand, Singapore, New Zealand

14 EMPLOYMENT RECORD

May 2005 to Dec 2005, Director Water solutions Pvt. Ltd. Male', Maldives. (A private company formed by a group of graduated friends to provide consultancies for water, waste water and Environmental matters.

14 June 1999 21st Dec 2005: Director, F & C Private Limited, Male', Maldives. (A Private and family owned company carrying general trade, importing, PSA for Airlines and courier services and others)

January 2000 to July 2002, Director, Discover Maldives Pvt, Ltd. Male', Maldives. (A sister company of F & C Pvt. Ltd specializing in Travel and tours)

1998 to 2002, Director, Innovative Design and Engineering Private Limited. (A company formed by a group of friends from science and engineering background to carry out EIA's, Environmental Auditing and Monitoring for various projects and resorts in Maldives)

** November 1995 to January 1997: Assistant Project Officer, Maldives Water and Sanitation Authority, Ministry of Health, Male', Maldives

** July 1995 to November 1995 Project Officer Trainee, Maldives Water and Sanitation Authority, Ministry of Health, Male'

** November 1994 to June 1995, Project Officer Trainee, Maldives Water and Sanitation Authority, Male, Maldives

15 WORK EXPERIENCE May 2005 to date, Director at Water solutions Pvt. Ltd. Duties involved were obtain projects for the company, attend field visits and collect field data's and write repots. Participate in the IEE's and EIA'S at professional levels.

14 June 1999 to 14 June 2002, Director at F & C Pvt. Ltd. Duties involved in importing garments, gifts, toys and other items from various countries and selling them in the competitive Market of Male, Maldives.

- January 2000 to July 2002, Director, Discover Maldives Pvt, Ltd. Male', Maldives. (A travel agency owned by family members). Approaching to other travel agencies, hoteliers and resorts and signing contracts with them to send tourists and guests to their hotels.

1998 to 2002, Director, Innovative Design and Engineering Private Limited. Arrange and participate in carrying out land profile surveys, EIA's, and resort monitoring in Maldives.

** November 1995 to 6 January 1997: Assistant Project Officer, Maldives Water and Sanitation Authority, Ministry of Health, Male' Maldives

- Responsibilities were to arrange and attending meetings with

relevant government bodies concerning water supply and sanitation.
- Acting as a counterpart to the Sort Term Consultants (STC), working with other consultants and STCs to set standards and regulations concerning water supply and sanitation both in the urban and rural areas of Maldives.

** July 1995 to November 1995, Project Officer Trainee Maldives Water and Sanitation Authority, Ministry of Health, Male'

- Duties include working with consultants to set standards and regulations concerning water supply, sewage collection, disposal and sanitation.

** November 1994 to June 1995, Project Officer Trainee, Maldives Water and Sanitation Authority, Male, Maldives
- Assisting Section Head in arranging training on the islands for the construction of rainwater tanks.
- Listing and purchasing the necessary items for construction of rainwater tanks.
- Preparing progress reports for the section head.
- Collecting the data with regard to water quality on the islands.
- Acting as a counterpart with the civil engineer and visiting islands to carry our land profile surveys and designing small bore sewerage systems

16 OTHER EXPERIENCE / RESPONSIBILITIES

17 SIGNIFICANT RESEARCH PAPERS -

18 ACADAMIC REFEREES

Dr. S.Suresh,Msc,Ph.D

Lecturer, Department of Environmental Science

Yuvaraja's College, University of Mysore,

Mysore 570005

Karnataka India.

Mobil: (+91) 9448755001

Email: sureshakumar12@yahoo.com

19 PROFESSIONAL & OTHER REFEREES

Ahmed Zahid, Water Solutions Pvt. Ltd, H. Alihuras, Male', Maldives.

Tel: (960) 3341643

Mobil: (960) 778 1535

Fax:(960) 334 1643

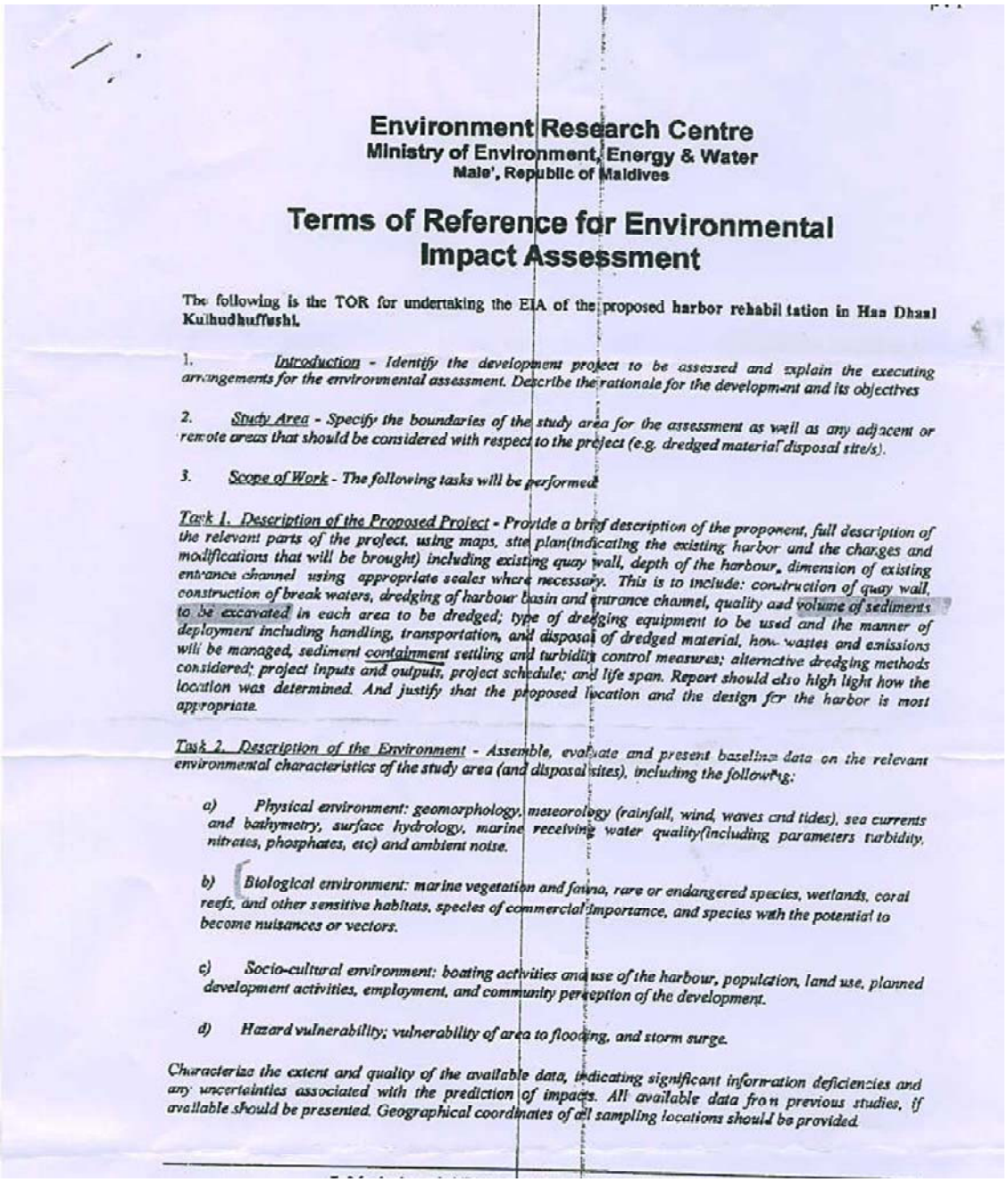
Email: zahid@sandcays.com

I, the undersigned, certify that to the best of my knowledge and belief, this Curriculum Vitae correctly describes myself, my qualifications and my experience.

Signature: 

Date: 10th February 2008

Appendix K: Terms of Reference



Environment Research Centre
Ministry of Environment, Energy & Water
Male', Republic of Maldives

Terms of Reference for Environmental Impact Assessment

The following is the TOR for undertaking the EIA of the proposed harbor rehabilitation in Haa Dhaal Kulhudhuffushi.

1. *Introduction - Identify the development project to be assessed and explain the executing arrangements for the environmental assessment. Describe the rationale for the development and its objectives*

2. *Study Area - Specify the boundaries of the study area for the assessment as well as any adjacent or remote areas that should be considered with respect to the project (e.g. dredged material disposal site/s).*

3. *Scope of Work - The following tasks will be performed*

Task 1. Description of the Proposed Project - Provide a brief description of the proponent, full description of the relevant parts of the project, using maps, site plan(indicating the existing harbor and the charges and modifications that will be brought) including existing quay wall, depth of the harbour, dimension of existing entrance channel using appropriate scales where necessary. This is to include: construction of quay wall, construction of break waters, dredging of harbour basin and entrance channel, quality and volume of sediments to be excavated in each area to be dredged; type of dredging equipment to be used and the manner of deployment including handling, transportation, and disposal of dredged material, how wastes and emissions will be managed, sediment containment settling and turbidity control measures; alternative dredging methods considered; project inputs and outputs, project schedule; and life span. Report should also high light how the location was determined. And justify that the proposed location and the design for the harbor is most appropriate.

Task 2. Description of the Environment - Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area (and disposal sites), including the following:

a) Physical environment: geomorphology, meteorology (rainfall, wind, waves and tides), sea currents and bathymetry, surface hydrology, marine receiving water quality(including parameters turbidity, nitrates, phosphates, etc) and ambient noise.

b) Biological environment: marine vegetation and fauna, rare or endangered species, wetlands, coral reefs, and other sensitive habitats, species of commercial importance, and species with the potential to become nuisances or vectors.

c) Socio-cultural environment: boating activities and use of the harbour, population, land use, planned development activities, employment, and community perception of the development.

d) Hazard vulnerability; vulnerability of area to flooding, and storm surge.

Characterize the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts. All available data from previous studies, if available should be presented. Geographical coordinates of all sampling locations should be provided.

Task 3. Legislative and Regulatory Considerations - Describe 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.

Task 4. Determine the Potential Impacts of the Proposed Project – Identify impacts related to dredging, spoil disposal and possible land filling. Distinguish between significant impacts that are positive and negative, direct and indirect (= triggering), and short and long term both during construction phase and operational phase. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making. Special attention will be paid to:

- *Effects of the project (dredging and spoil disposal) on water quality and existing coastal ecosystems and resources, area of the reef house that are likely to be impacted should be indicated and significance of this impacts defined due to the proposed harbor rehabilitation.*

- *Effects of storm water drainage from proposed spoil disposal sites, including potential for off-site flooding.*

- *Effects of dredging on the coastal stability of adjacent shorelines, potential erosion prone areas that may arise due to this project.*

- *Effects of dredging works on the existing operations of the lagoon.*

- *Identify unique impacts on Kulhudhuffushi island environment.*

Task 5. Analysis of Alternatives to the Proposed Project. – Describe the alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". This includes dredging vessel types and disposal sites. The alternatives should be focused more on alternative technologies for construction of the quay wall and breakwater and alternative methods of dredging. At least one alternative must be selected as preferred alternative and mitigation measures must be described for this alternative. Distinguish the most environmentally friendly alternatives.

Task 6. Mitigation and Management of Negative Impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to dredge spoil disposal and dispersal/sedimentation control. Mitigation measures should be identified for both construction and operational phase. Cost of the mitigation measures, equipment and resources required to implement those measures. A commitment regarding the mitigation measures should be submitted by the responsible person.

Task 7. Development of a Monitoring Plan – Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for dredging/disposal operations. One year time frame should be outlined for monitoring focused on the construction and operational phase. Detail of the monitoring programme including the physical and biological parameters for monitoring, frequency, duration, cost, commitment from responsible person, detailed reporting time table and ways and means of undertaking the monitoring programme.

Task 8. Assist in Inter-Agency Coordination and Public/NGO Participation – Identify appropriate mechanisms for providing information on dredging activities and progress of project to stakeholders. Assist in co-ordinating the environmental assessment with the relevant government agencies and in obtaining the views of local stakeholders and affected groups. (It is anticipated that there will be considerable public interest concerning issues of location of the harbor, sediment disposal and turbidity with and the economic benefits to be derived from the project.) Stakeholder consultations with ministry of construction and public infra structure, MEEW and at least one contractor with experience in undertaking harbour rehabilitation works in Maldives.

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 Report, 2007.

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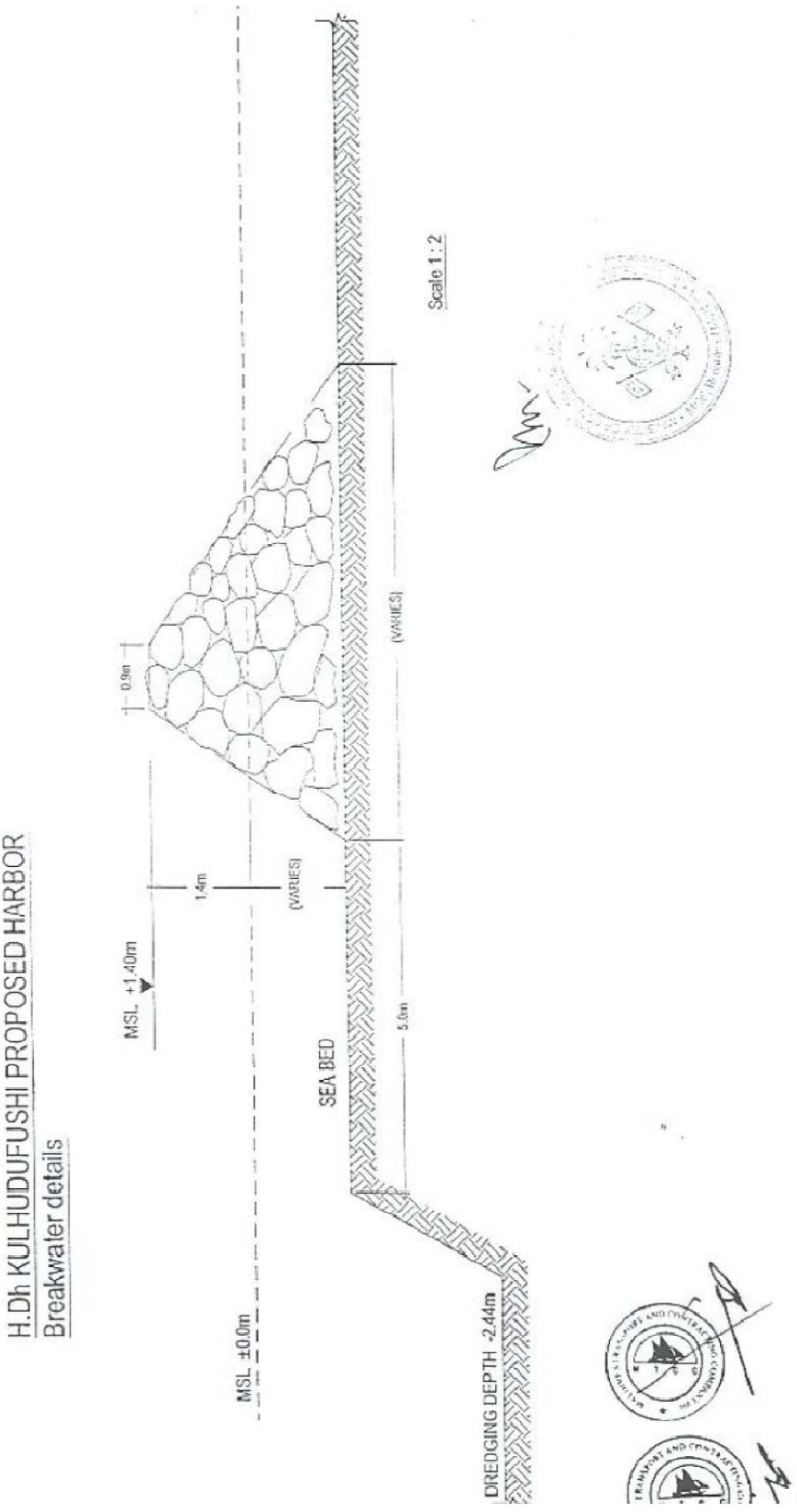
(27 January 2008)

ToR for harbor rehabilitation in Haa Dhaal Kulhudhuffushi Island, Maldives

Appendix L: Break Water Details


H.Dh KULHUDUFUSHI PROPOSED HARBOR
Breakwater details
Scale 1 : 2
MSL +1.40m
MSL ±0.0m
1.4m
(VARIES)
SEA BED
5.0m
(VARIES)
0.9m
DREDGING DEPTH -2.44m

Appendix L: Commitment letter for monitoring

بسم الله الرحمن الرحيم

M T C C

CONTRACTING DEPARTMENT
MALDIVES TRANSPORT AND CONTRACTING COMPANY PLC

Reg. No.: 68

Ref: MTCC-CD/174/2008/02

Date: Sunday, 16th March 2008

Mr.Ahmed Saleem,
Director General
Environment Research Center
Ministry of Environment Energy and Water
Male' Rep of Maldives

Dear sir,

Project: Hdh. Kulhuduffushi harbor construction
Sub: Commitment to undertake the environmental monitoring program
Ref:
Encl:

Reference is made to the proposed development of a local harbour at H. Dhaal, Kulhudhuffushi Island by MTCC.

Hence we would like to confirm our commitment to the proposed monitoring program highlighted in EIA report that has been specifically prepared for the development of the Harbour Phase 1.

Warm regards

Abdulla Thasleem
Senior Engineer
Contracting Department
Maldives Transport and Contracting Company Plc

trusted

MTCC Building, Boduthakurufaanu Magu, Male' 20181, Republic of Maldives
Phone: (+960) 332 6822, Fax: (+960) 333 2835, Email: contracting@mtcc.com.mv, Website: www.mtcc.com.mv