

# Environmental Impact Assessment Report

December, 2008

Development of Hdh.Hanimaadhoo Airport Harbour  
Thiladhunamthee Dhekunuburi  
Republic of Maldives

Proposed by:  
Regional Airports

Prepared and issued by



E-CAD ASSOCIATES PVT LTD  
TOTAL + BUILDING + SOLUTIONS

## **Consultant's Declaration**

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

Name: Ibrahim Naeem (Master of Env. Management.) - EIA 13/2007

**Signature**

A handwritten signature in blue ink, appearing to read 'Ibrahim Naeem', written in a cursive style.

Date: 19<sup>th</sup> December 2008

## CONTENTS

<b>NON-TECHNICAL SUMMARY</b> .....	<b>1</b>
<b>1. INTRODUCTION</b> .....	<b>4</b>
1.1 Background information of the project .....	4
1.2 Project costs .....	4
1.3 The proponent and its experience with similar projects .....	4
1.4 Terms of Reference .....	4
<b>2. PROJECT SETTING</b> .....	<b>5</b>
2.1 Existing plans, policies, guidelines, regulations, laws related to the project .....	5
2.2 Strategic Economic Plan .....	5
2.3 National Development Plan.....	6
2.4 Transport Master Plan.....	7
2.5 Second National Environment Action Plan.....	8
2.6 National Biodiversity Strategy and Action Plan .....	8
2.7 Environment Law .....	9
2.8 Regulations .....	11
2.9 Regulation on sand and aggregate mining.....	12
2.10 Regulation on coral mining.....	12
2.11 Regulation on cutting trees .....	12
<b>3. PROJECT DESCRIPTION</b> .....	<b>13</b>
3.1 Site plan.....	14
3.2 Intended duration of the project .....	15
3.3 Work schedule .....	16
3.4 Need and justification of the project .....	17
<b>4. COMPONENTS OF THE PROJECT, DESIGN AND SCALE</b> .....	<b>18</b>
4.1 Mobilization of equipment and materials.....	18

4.2	Excavation of harbour basin .....	18
4.3	Entrance channel .....	18
4.4	Jetty extension.....	18
4.5	Breakwater construction.....	19
<b>5.</b>	<b>LOCATION OF THE PROJECT.....</b>	<b>20</b>
5.1	Project location.....	22
<b>6.</b>	<b>DESCRIPTION OF THE NATURAL ENVIRONMENT.....</b>	<b>23</b>
6.1	Marine environment .....	25
6.2	Coral reef.....	25
6.3	Lagoon .....	26
6.4	Terrestrial environment .....	26
6.5	Beach.....	26
6.5.1	Vegetation.....	27
6.6	Description of existing terrestrial environment .....	28
6.6.1	Beach environment .....	28
6.7	Beach erosion .....	28
6.8	Beach sediment dynamics.....	29
6.9	Beach profiles .....	30
6.10	Vegetation .....	31
6.10.1	Coastal vegetation.....	34
6.11	Description of existing marine environment.....	37
6.11.1	Coral and other benthic cover .....	38
6.12	Assessment fish communities in the surveyed area.....	40
6.13	Reef invertebrates .....	41
6.14	Rare or endangered species .....	42
6.15	Potential nuisance species .....	43

6.16	Environmental condition of the dredged material disposal sites.....	43
6.17	Bathymetry.....	43
6.18	Currents.....	43
6.19	Waves.....	44
6.20	Tides.....	44
6.21	Wind.....	45
6.22	Marine water quality.....	46
6.23	Socio-economic and population.....	47
6.24	Environmental issues.....	48
<b>7.</b>	<b>METHODOLOGY.....</b>	<b>49</b>
7.1	Marine environment assessment methods.....	49
7.1.1	The Quadrat Method.....	49
7.1.2	Timed-swim surveys.....	49
7.1.3	Coral reef fish visual census.....	50
7.1.4	Bathymetry surveys.....	50
7.1.5	Surface current surveys.....	50
7.1.6	Beach and beach dynamic surveys.....	50
7.1.7	Vegetation surveys.....	50
<b>8.</b>	<b>STAKEHOLDER CONSULTATION.....</b>	<b>51</b>
8.1	Aim.....	51
8.2	Objectives.....	51
8.3	Methodology.....	51
8.4	Outcomes of the Stakeholder Consultations.....	52
8.5	Conclusions of stake holder consultations.....	54
<b>9.</b>	<b>LOCATION AND DESIGN OF THE HARBOUR.....</b>	<b>55</b>
<b>10.</b>	<b>ASSESSMENT OF IMPACTS.....</b>	<b>59</b>
10.1	Introduction.....	59

10.2	Methodology used for Impact Identification.....	59
10.3	Existing Natural and Anthropogenic Impacts .....	61
<b>11.</b>	<b>IMPACTS OF THE PROPOSED PROJECT.....</b>	<b>62</b>
11.1	Physical Impacts in Construction Stage.....	62
11.2	Mobilization of equipment and materials.....	62
11.3	Excavation of harbour basin .....	63
11.3.1	Impact on lagoon.....	64
11.3.2	Impact on coral reef .....	64
11.4	Entrance channel deepening .....	64
11.4.1	Impacts on reef flat (Biotic) .....	65
11.5	Jetty construction .....	65
11.6	Breakwater construction.....	65
11.6.1	Impact on lagoon.....	65
11.6.1.1	Impact on reef flat.....	65
11.7	Ecological Impacts in Construction Stage.....	66
11.8	Physical Impacts of Operation Stage.....	67
11.9	Ecological Impacts of Operation Stage.....	68
11.10	Socio-economic impact .....	68
<b>12.</b>	<b>MITIGATION MEASURES .....</b>	<b>70</b>
12.1	Mitigation measures in construction stage.....	70
12.2	Mitigation Measures in Operation Stage .....	72
<b>13.</b>	<b>EVALUATION OF ALTERNATIVES .....</b>	<b>73</b>
13.1	Alternative location for the harbour .....	73
13.2	Alternative design for the harbour .....	73
13.3	No development option .....	74
<b>14.</b>	<b>IMPACT MONITORING .....</b>	<b>75</b>
14.1	Monitoring of coastal and beach environment .....	75

14.1.1	Monitoring programme for the beach and coastal zone .....	76
14.1.2	Monitoring programme for the terrestrial environment .....	76
14.2	Monitoring programme for the marine environment .....	77
14.2.1	Aim of monitoring .....	77
14.2.2	Objectives of monitoring .....	77
14.3	Breakdown of Monitoring Yearly Monitoring Cost.....	79
<b>15.</b>	<b>CONCLUSIONS.....</b>	<b>80</b>
<b>16.</b>	<b>APPENDICES .....</b>	<b>81</b>
16.1	Appendix 1. Terms of reference .....	81
16.2	Appendix 2. Beach profiles.....	85
16.3	Appendix 3. Bathymetry.....	89
16.4	Appendix 4. Water quality test results.....	91
16.5	Appendix 5 Commitment letter .....	94
<b>17.</b>	<b>REFERENCE .....</b>	<b>96</b>

### List of tables

Table 1	results of fish surveys at 4 areas (9 sites).....	41
Table 2:	Marine water quality test results.....	47
Table 4	impact significance .....	66
Table 5	beach and coastal monitoring programme.....	76
Table 6	terrestrial environment monitoring programme.....	76
Table 7	marine environment monitoring programme.....	78
Table 8	estimated cost of environmental monitoring .....	79

### List of figures

Figure 1	Site plan .....	14
Figure 2	Work schedule.....	16
Figure 3	location of the project .....	22

Figure 4 percentage area cover of Hanimaadhoo environment components .....	23
Figure 5 area cover of Hanimaadhoo environment .....	24
Figure 6 reef-flat of Hanimaadhoo near the proposed development area .....	25
Figure 7 lagoon system.....	26
Figure 8 beach around the proposed development area.....	27
Figure 9 coastal vegetation .....	27
Figure 10 beach environment.....	28
Figure 11 severe beach erosion at the south of island harbour .....	29
Figure 12 beach sediment dynamics and characteristics .....	30
Figure 13 Beach profile location map .....	31
Figure 14 coastal vegetation in the development area.....	32
Figure 15 vegetation survey sites .....	33
Figure 16 coastal vegetation at Site 1 – Magoo dominant.....	34
Figure 17 coastal vegetation at Site 2 – Kuredhi dominant .....	34
Figure 18 coastal vegetation at Site 3 – Magoo dominant.....	35
Figure 19 coastal vegetation at Site 4 – Boashi dominant .....	35
Figure 20 coastal vegetation at Site 5 – Boashi dominant .....	36
Figure 21 coastal vegetation at Site 6 – Magoo dominant.....	36
Figure 22 map of marine environment and surveys sites .....	38
Figure 23 benthic substrate cover.....	39
Figure 24 some of the observed benthic substrates.....	40
Figure 25 some of the fishes observed .....	41
Figure 26 some of the invertebrates seen.....	42
Figure 27 surface current in around the development area.....	44
Figure 28 tidal change .....	45
Figure 29 Right: general wind rose for the Maldives (Environment 2005) and left monthly average wind for HDh. Hanimaadhoo (DoM).....	46

Figure 30 Quick Facts of Haa Dhaalu Atoll .....	47
Figure 31 Population of Hdh. Hanimaadhoo .....	48
Figure 32 stakeholder consultation in the field .....	52
Figure 33 location and design of harbor .....	57
Figure 34 alternative location .....	73

## Non-technical summary

### *Outline of project*

This EIA report is prepared in accordance with Environmental Impact Assessment Regulations, 2007 under the Environmental Protection and Preservation Act (Law No. 4/93). The purpose of this EIA is to fulfill the requirement of the Law and to conduct an assessment of possible impacts on biophysical and human environment arising from proposed development project of Harbour Development in Hanimaadhoo Domestic Airport in H.Dh. Atoll, Maldives. The project is proposed by Regional Airports Office of the Ministry of Housing Transport and Environment (MHTE).

The main construction activities of the proposed project involve re-development of a harbour and an entrance channel at the existing jetty area of the Airport. The construction activities will be completed within six months from the start of the construction phase. The project cost is estimated to be about five million Maldivian Rufiyaa.

The proposed harbour is 285m long and 107m wide. The harbour will be constructed in western side of the island. The harbour will be a detached one which is connected to the island by a jetty. A considerable area will be there between the island and the harbour to facilitate the littoral movements along the coast. No quay wall will be constructed. Berthing will be facilitated by the T-shaped jetty which will be built on concrete pillars. The protection for the inner harbour will be provided by building sand dunes on north, south west-sides of the harbour. The outer sides of these sand dunes will be protected using coral stones collected during the excavation process.

The main operation of the project will be boat operation to and from the Hanimaadhoo Airport and harbouring boats. The boats will include small to medium size speed boats and dhonies used for carrying passengers.

### *Location*

The proposed development project is located in the island of Hanimaadhoo in South Thiladumathee (Haa Dhaalu) Atoll at 06°45'37"N and 73°10'16"E. The closest islands to the project location are inhabited islands of H.A. Baarah and H.A. Muraidhoo approximately 7.97km and 8.98km north of Hanimaadhoo. The islands of Finey and Hirimaradhoo lies approximately 13.46km and 16.80km west of Hanimaadhoo. The islands of Nolvivaramfaru and Nolvivaramu lies approximately 8.56km and 14.70km south of Hanimaadhoo. The Atoll Capital Kulhudhuffushi lies approximately 18.91km south of Hanimaadhoo. Resort islands close to Hanimaadhoo are HA. Alidhoo and HA. Dhonakulhi. Industrial agricultural islands closer to Hanimaadhoo Airport are HA. Maafahi and HDh. Theefaridhoo.

### ***Need and justification of the project***

Hanimaadhoo Domestic Airport is isolated and quite far from the inhabited area of Hanimaadhoo. Travelling from the populated area of Hanimaadhoo to the Airport has been costly and difficult due to the limited number of vehicles available at Hanimaadhoo. Most people departing from Hanimaadhoo Airport come directly to the Airport jetty. At present about 10 flights operate to Hanimaadhoo Airport daily making it the busiest domestic airport in the country. The currently available harbour area and berthing facility (the T-jetty) at many times has been unable to cater for the growing number of passengers who use this airport. The opening of more and more tourist resorts at this region will increase the number of passengers using this airport. Due to the open nature of the harbour at times of rough weather berthing to the jetty become impossible. Since there are no breakwaters to protect the harbour, the basin becomes very rough and anchorage becomes impossible at bad weather conditions. During such instances the passengers have to use the Hanimaadhoo island harbour and transfer the passengers using vehicles.

Therefore the re-development of this harbour can be justified on the grounds of:

1. providing safer access to the passengers who use the airport
2. providing safer anchorage and waiting areas to the vessels using the airport
3. catering for the growing number of passengers who use the airport.

### ***Alternative developments***

Alternative for the proposed development were alternative location of the harbour, alternative design and no development option. Alternative location of the harbour could be at the northern side near the Maldives National Defence Force (MNDF) jetty. However, this alternative was found have potential negative impacts since the airport facility is relatively far from this area. Alternative design could be a conventional harbour attached to the island. This design has proven to be causing disruptions to the littoral drift resulting in severe beach erosion on the leeward side of the Hanimaadhoo harbour. Therefore the proposed location of the harbour and design (a detached harbour) will be selected to re-construct the harbour. The alternative of no development option was found to have negative socio-economic impacts since most of the people who use this airport come from other inhabited islands and resort islands.

### ***Key impacts***

Key impacts of the preferred development option of the proposed project are related to a few activities of the project. These include impacts to the lagoon and reef area from harbour basin excavation, deepening of an entrance channel, disposal of excavated materials and impacts to. Project will also generate non-biodegradable waste including concrete waste. Key impacts of the project are found to be significant in short-term however, justified weighed against socio-economic positive impacts to the island community and to the national economy.

Long-term ecological impacts of the proposed project can only be assessed through long-term monitoring of the entire island environment in relation to the proposed development and operation.

### ***Mitigation measures***

Mitigation measures will be taken by conducting appropriate field surveys and environmental assessment of the area, proposed and alternative locations for development the harbour. The proposed location is based on the fact that there exists a small dredged harbour in this area. Consultation among the proponent, the community and the environmental consultants were conducted to find the most appropriate development options, methods, scale and timing in order to mitigate and minimize potential impacts due to the proposed development project. Optimum size and orientation of the harbour and the entrance channel were proposed based on extensive consultations with the island community, people who use the current airport jetty and technical experts. Specific measures will be taken during construction and of the harbour.

These include selection of best location and design to protect the beach, selection of minimum required size of the harbour based on the airport use and economic activities and future plans of the region. Sandy bunds will be built to reduce the spread of sediment to the reef areas. Waste minimization and environmental monitoring of the harbour development and operation will be conducted to mitigate negative impacts that may arise from the project.

# 1. Introduction

## *1.1 Background information of the project*

The Hanimaadhoo Airport Harbour Re-development Project is being carried out under the Domestic Airports Improvement Programme implemented by the Regional Airports Office of MHTE.

This EIA study is conducted as a legal requirement under the Environmental Protection and Preservation Act of Maldives. Regional Airports as the executing agency has contracted E-CAD Associates Pvt. Ltd. to conduct EIA of Hanimaadhoo Airport Harbour Development Project.

## *1.2 Project costs*

Cost of Hanimaadhoo Domestic Airport's Harbour Development project is estimated to be about five million Maldivian Rufiyaa. The cost of the project may vary depending on a number of factors including the location, benthic substrate type, size and technical aspects of the harbour.

It is a medium scale harbour development project in terms of cost relative to the size of the harbour. Costs involved in the project will be related to excavation of the lagoon basin, extension of jetties and breakwater construction.

## *1.3 The proponent and its experience with similar projects*

Hanimaadhoo Harbour Development Project is proposed by Regional Airports. The proponent has over 15 years of experience in airport and its associated infrastructure development including reclamation and harbour development.

## *1.4 Terms of Reference*

The agreed Terms of Reference for this EIA is attached in Appendix 1 of this report. This EIA has been conducted in accordance with the agreed Terms of Reference.

## 2. Project setting

### *2.1 Existing plans, policies, guidelines, regulations, laws related to the project*

All the activities during both development and implantation stage of the proposed harbour development project will be carried out in accordance with existing plans, policies, guidelines, laws and regulations of Maldives in addition to relevant international conventions to which Maldives is a party to.

It is worth noting that the newly amended Constitution (2008) enforces every one to give special emphasis on environmental preservation and protection when carrying out development activities. Policies and Plans relating to the proposed development project include, Strategic Economic Plan, Seventh National Development Plan 2006 – 2010, Transport Master Plan

### *2.2 Strategic Economic Plan*

According to the Strategic Economic Plan, establishment of linkages among major ports, sub-ports and airports within the Maldives is very important particularly to fisheries, tourism and agriculture sector to facilitate the transportation of passengers and collection and distribution of marine and agriculture products. The Strategic Economic Plan highlights the following in its Ports and logistics services cluster

Fisheries sector

- Collection and distribution of marine products around Maldives
- Export of fish through regional airports
- Replenishment of marine vessels

Agriculture sector

- Collection and distribution of vegetables and fruits around the Maldives
- Replenishment of marine vessels

Tourism sector

- Flying cruise
- Diversified group of visitors and business pursuits

Logistic services

- Attract freight forwarders and other logistic players to base in Maldives

Recommendations of Strategic Economic Plan included to ensure systematic and co-ordinate development of various key ports throughout Maldives as well as to avoid poor regulation of safety standards, adverse impact on environment and duplication of resources, development of a master plan for the port and logistic sectors.

### ***2.3 National Development Plan***

National Development Plan highlights establishment of a reliable inter-regional and intra-regional transportation system to support the development of core economic activities in Maldives and to extend the role of the commercial ports in the south and north and to compliment other ports in South Asia for cargo transshipment in the long-term.

A number of policies and strategies are highlighted under Seventh National Development Plan.

These include;

Policy 1: Ensure that the transport system meets the mobility need of the people

Strategies to implement this policy includes

- Continue access improvement programme for inhabited islands
- Facilitate the development of adequate harbours throughout the country
- Establish a sustainable harbour maintenance programme
- Enable access to finance for private and public enterprises to establish inter-atoll and intra-atoll ferry services
- Enable private and public enterprises to invest in public transportation in the atolls.
- Enable and provide support to private and public enterprises to develop and operate domestic airports
- Ensure the travel need of local passengers integrated and carted for in the seaplane operations.

Policy 2: Facilitate efficient and convenient movement of goods

Strategies to implement this policy include;

- Establish ports and logistics to facilitate movement of goods including food and consumer products to all inhabited islands and strategically locate regional ports and storage facilities for easy access and prompt distribution

Policy 3: Enhance safety measures to minimize transported related deaths and injuries

Strategies to implement this policy includes

- Develop, implement and enforce safety measures and programmes that promote safety behavior in transportation
- Develop and enforce national safety standards for all modes of transport
- Introduce incentives for improving safety compliance
- Ensure safe handling and transportation of fuel and dangerous goods within the country
- Ensure proper installation, maintenance and repair of navigation aids to facilitate night transport activities.

- Promote and encourage insurance coverage for vessels
- Develop, promote and support public awareness, education and information dissemination that advance safe behavior, safe operation and safe practice in sea transport

Policy 4: Ensure affordability, sustainability and acceptable standard of service for each mode of travel

Strategies to implement this policy includes

- Regulate transport pricing that the rights of both the travelers and service providers are protected
- Introduce incentives, public education and awareness programmes to give priority and regard to ensure access to people with special needs, school children and elderly people in public transportation system.
- Encourage all transport sector service provider to introduce cost recovery measures to ensure sustainable and efficient development of the sector
- Introduce cost recovery mechanism for harbours

Policy 5: Promote transport solution that conserve energy, reduce pollution from vessels and protect the natural and built environment

Strategies to implement this policy includes

- Introduce innovative transport pricing schemes and regulatory measures
- Reduce marine pollution from vessel through proper implementation and monitoring of rules and regulations
- Establish marine reception facilities and a contingency plan for sludge, used oil and garbage from vessels

## ***2.4 Transport Master Plan***

The Transport Master Plan highlights the issues of scattered geography and the limited transport opportunities that further add to remoteness and isolation of the island communities from the more developed centers and that isolation is an important element of poverty in many atolls.

Access problem were reported by half of the atoll population due to problems with harbours, absence of jetties, or enclosed nature of the islands by the coral reefs. These factors greatly contributed the unbalanced development in the atolls compared Male' For the past three decades public investment in Male' was more than 50% higher than in atolls.

Recognizing the problem of this unbalanced development the government shifted its development strategy to the atolls to stimulate regional development in five regional growth centers, north, north-central, central, south-central and south of the country which will facilitate balanced provision of economic and social services. The Transport Master Plan emphasizes

regional development and provision of basic infrastructure which includes harbours that will connect regional centers and surrounding islands with Male’.

According to the Transport Master Plan having an efficient and effective transport network that systematically link Male’, the regional centers and the surrounding atoll will be the key to ensuring that socio-economic development of the country is distributed equitably.

### ***2.5 Second National Environment Action Plan***

The aim of Second National Environment Action Plan (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.

The main strategies of 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 oceans and the its effects on well being of our people.
- Development and implementation of management methods suitable for the natural and social environment of the Maldives, maintain and enhance environmental quality and protect human health while at the same time using resources on sustainable basis
- Consultation and collaboration with all the relevant sectors of society to ensure stakeholder participation in the decision making process
- Preparation and implementation of a comprehensive environmental legislation in order to responsible and effective management of the environment
- Adhere to international and regional environmental conventions and agreements and implementation of commitments embodied in such conventions

NEAP II specified priority actions in the following areas

Climate change and sea level rise, coastal zone management, biological diversity conservation, integrated reef resource management, integrated water resource management, management of solid waste and sewerage, pollution control and management of hazardous waste, sustainable tourism development, land resource management and sustainable agriculture, and human settlement and urbanization.

NEAP II also contains environmental policies and guidelines that should be adhered to in the implantation of Hanimaadhoo harbour development project activities

### ***2.6 National Biodiversity Strategy and Action Plan***

The goal of the National Biodiversity Strategy and Action Plan (NBSAP) are:

- Conservation of biological diversity and sustainable utilization of biological resources

- Build capacity for biodiversity conservation through strong governance framework and improved knowledge and understanding
- Foster community participation and support for biodiversity conservation

Consideration of the goals of NBSAP shall be taken into account in implementation of Hanimaadhoo Airport harbour development project activities for minimizing potential loss of biodiversity in the area.

### ***Protected Areas and Environmentally Sensitive Areas***

Under article 4 of the Environment Protection and Preservation Act of Maldives, the Ministry of Environment is vested with the responsibility of identifying and designation of protected areas and natural and drawing up rules and regulations for the management of protected areas and natural reserves in the country.

In the proposed project site or in the vicinity of the site there is no protected area. The site surveys showed that there no environmentally sensitive areas close to the proposed harbour development site.

### ***2.7 Environment Law***

The environment law, Law No.4/93 Environment Protection and Preservation Act of Maldives was enacted in April 1993 as an umbrella law to protect and preserve the environment of the country. The articles and clauses of the law are given below. The clause 5 is directly related to Airport harbour development project in Hanimaadhoo and this study.

### ***Environmental Protection and Preservation Act of Maldives (EPPA)***

#### ***Introduction***

1. The natural environment and its resources are a national heritage that needs to be protected and preserved for the benefit of future generations. The protection and preservation of the country's land and water resources, flora and fauna as well as the beaches, reefs and lagoons and all natural habitats are important for the sustainable development of the country

#### ***Environmental Guidance***

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

#### ***Environmental Protection and Conservation***

3. The Ministry of Environment shall be responsible for formulating policies, as well as rules and regulations regarding the environment in areas that do not already have a designated government authority already carrying out such functions.

### ***Protected Areas and Natural Reserves***

4. (a) The Ministry of Environment shall be responsible for identifying protected areas and natural reserves and for drawing up the necessary rules and regulations for their protection and preservation.

(b) Anyone wishing to establish any such area as mentioned in (a) of this clause, as a protected area or a reserve shall register as such at the Ministry of Environment and abide by the rules and regulations laid by the Ministry

### ***Environmental Impact Assessment (EIA)***

5. (a) An impact assessment study shall be submitted to the Ministry of Environment before implementing any development project that may have a potential impact on the environment

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

### ***The Termination of projects***

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

### ***Waste Disposal, Oil and Poisonous Substances***

7. (a) Any type of waste, oil, poisonous gases or any substance that may have harmful effect on the environment shall not be disposed within the territory of the Maldives.

(b) In case where the disposal of the substance stated in paragraph (a) of this clause becomes absolutely necessary, they shall be disposed only within the areas designated for the purpose by the government. If such waste is to be incinerated, appropriate precautions shall be taken to avoid any harm to the health of the population.

### ***Hazardous/ Toxic or Nuclear Wastes***

8. Hazardous/Toxic or Nuclear Wastes that is harmful to human health and the environment shall not be disposed anywhere within the territory of the country. Permission shall be obtained from the relevant government authority at least 3 months in advance for any trans-boundary movement of such wastes through the territory of the Maldives.

### ***The Penalty for Breaking the Law and Damaging the Environment***

9. (a) The penalty for minor offenses in breach of this law or any regulations made under this law, shall be a fine ranging between Rf 5.00 (five Rufiyaa) and Rf 500.00 (five hundred Rufiyaa) depending on the actual gravity of the offence. The fine shall be levied by the Ministry of Environment or by any other government authority designated by the Ministry.

(b) Except for those offenses that are stated in (a) of this clause, all major offenses, under this law shall carry a fine of not more than Rf 100,000,000.00 (one hundred million Rufiyaa) depending on the seriousness of the offense. The fine shall be levied by the Ministry of Environment.

### ***Compensation***

10. The Government of Maldives reserves the right to claim compensation for all the damages that are caused by the activities that are detrimental to the environment. This include all the activities that area mentioned in clause 7 of this law as well as those activities that take place outside the projects that are identified here as environmentally damaging.

### ***Definition***

11. This law:

- (a) The “environment” means all the living and non-living things that surround and effects the lives of human beings.
- (b) A “project” is any activity that is carried out with the purpose of achieving a certain social or economic objective.

Ministry of Environment has the mandates for protection and preservation of environment. In this respect Ministry of Environment formulates policies, laws, regulations and rules on environmental protection and conservation.

### ***2.8 Regulations***

The most important regulation is Environment Impact Regulations, 2007 enforced under Environment Protection and Preservation Act (Law No. 4/93). The Clauses of Environment Protection and Preservation Act address the following that relate to the proposed project development and implementation.

- An impact assessment study shall be submitted to the relevant Government authority before implementing any development project that may have a potential impact on the environment
- The relevant Authority of Government shall formulate the guidelines for environmental impact assessment and shall determine the projects that need such assessment as mentioned in above
- The Termination of projects. The relevant Government Agency has authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation
- Waste Disposal, Oil and Poisonous Substances. Any type of waste, oil, poisonous gases or any substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives

- Government of Maldives reserves right to claim compensation for all the damages that area caused by the activities that are detrimental to the environment.

In addition to EIA regulations, other relevant regulation will be followed in development and implementation of the proposed project. These regulations include ban on coral mining. Coral mining from house reef and atoll rim reef has been banned since 1990. Sand mining from any island has also been banned since March 2000. Coral or sand will not be used for any purpose for the proposed project.

### **2.9 Regulation on sand and aggregate mining**

This regulation addresses sand mining from islands and bird nesting sand bars. Sand and aggregate mining from beaches of any island whether inhabited or uninhabited is banned for protection of the islands. Permissions for sand and aggregate mining from other areas shall be obtained from the relevant authorities.

### **2.10 Regulation on coral mining**

Coral mining from the house reef of islands and the atoll rim reefs is banned through a directive from the President's Office dated 26th September 1990. According to this policy coral mining shall not be carried out from house reefs of islands and atoll rim reefs and common bait fishing reefs. Coral and sand mining is only allowed for house construction from designated sites and approval from the concerned authorities is required prior to mining activities. Request for coral and sand mining from residents of inhabited islands are required to be submitted to the Atoll Offices through the respective island offices. The island office is required to estimate the quantities of coral or sand required for the applied construction work of houses to ensure that the permission is granted for minimum amounts required. Every island is required to maintain a log book of permissions granted and the amounts mined and the site where mining was carried out.

### **2.11 Regulation on cutting trees**

The regulation on cutting down, uprooting, and digging out trees and export of trees and palms from one island to another was recently issued by the Ministry of Environment Energy and Water. Under Clause 5 (a) of EPPA prior to commencement of any project that may have a negative impact on the environment including cutting down, removal of trees/palms from one island and taking to another for the purpose of agriculture, island development/re-development, construction or to any other purpose shall conduct EIA. Such projects relating to impacts on trees can only commence upon approval from Ministry of Environment. Article 8 of this regulation requires permission to be obtained if more than 10 coconut palms that are grown to height of 15ft are to be removed. The Article 2 (d) of the regulation also enforces replacement of the vegetation that is lost by re-plantation. Logging of inhabited islands must be done under supervision of the island chiefs or an official appointed by the island chief.

### 3. Project description

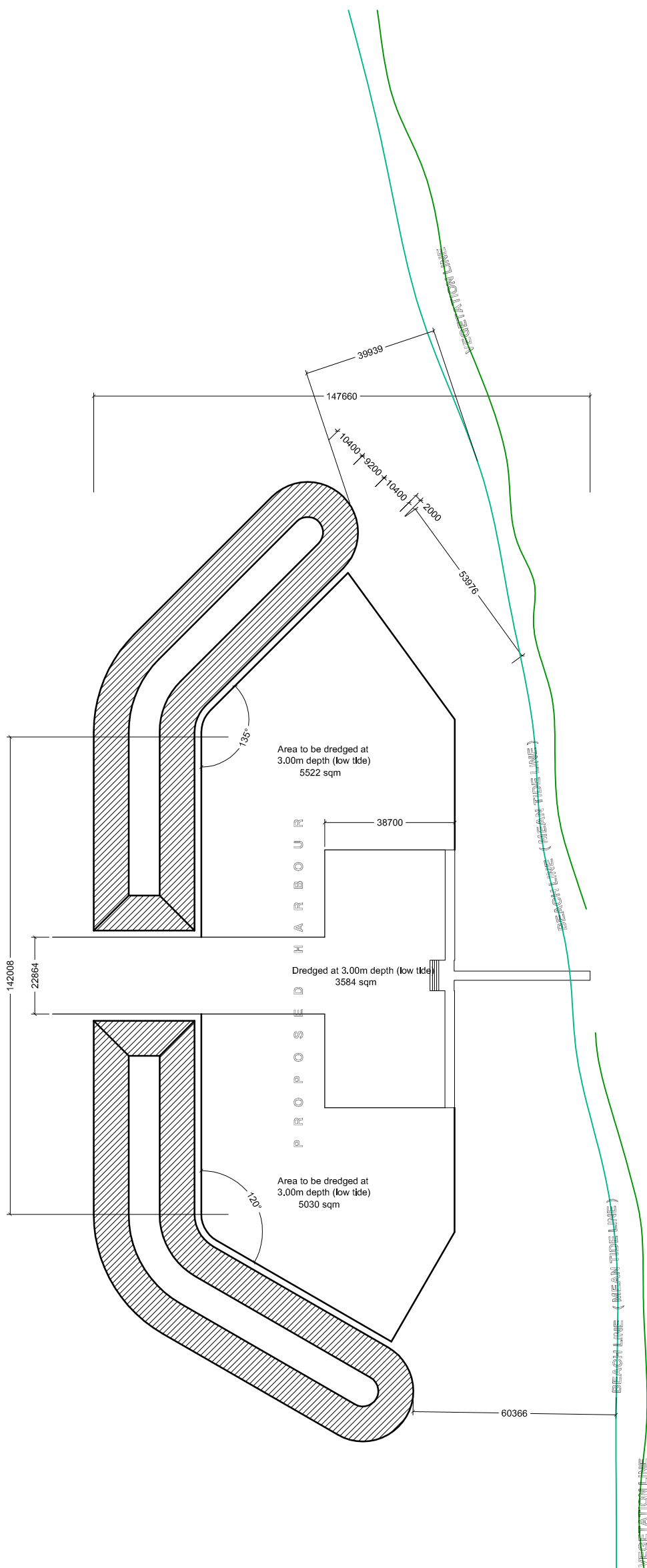
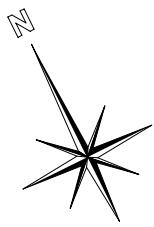
The Hanimaadhoo Airport Harbour Development project is a medium scale development project in terms of cost and potential long-term environmental implications. The project is focused on provision of safe access and a harbour in Hanimaadhoo Domestic Airport under the Regional Airports Development Programme.

The Airport harbour will be developed in the location and to dimensions that can be accommodated within the lagoon area available and to minimize potential negative impacts to the beach and beach dynamics while maximizing social and economic benefits of the harbour. The project involves excavation of the lagoon basin, clearance of an access channel through the reef, construction of breakwaters on rear side of the harbour and extension of existing jetties.

The environmental surveys of the beach and the coastal areas of the Hanimaadhoo showed that the beach and the coastal area of the island is very exposed to high wave energy and currents that constrained locating a harbour in particular sites of the island.

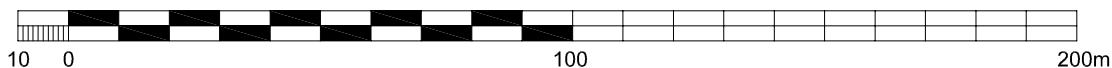
Based on the surveys the proposed location for the harbour is western side of the island as shown in Figure .

The proposed location for the harbour has a sandy beach. A large part of the area has already been dredged before to construct the existing harbour. The coastal vegetation in this area is in rather good condition. This project does not involve any removal of coastal vegetation since the harbour will be connected to the island only by the existing jetty.



# PROPOSED SITE PLAN

SCALE 1 : 1500



**e CAD ASSOCIATES PRIVATE LIMITED**  
 TOTAL + BUILDING + SOLUTIONS  
 M.SILVER STAR, HAVEEREE HINGUN 20-02 MALE, REPUBLIC OF MALDIVES  
 TEL: +960 3344654, FAX: +960 3344653, EMAIL: ecad.associates@gmail.com  
 www.ecadassociates.com

PROJECT:  
**HA. HANIMAADHOO HARBOUR DEVELOPMENT**  
 TITLE:  
 PROPOSED SITE PLAN

CLIENT:  
 REGIONAL AIRPORTS  
 SCALE:  
 AS GIVEN

AMENDMENTS  
 CHECKED BY:

DESIGN BY: -  
 STRUC. DESIGN BY: -  
 SURVEYED BY: H,R/M,M/H,S/LS  
 DRAWN BY: H,R/H/S

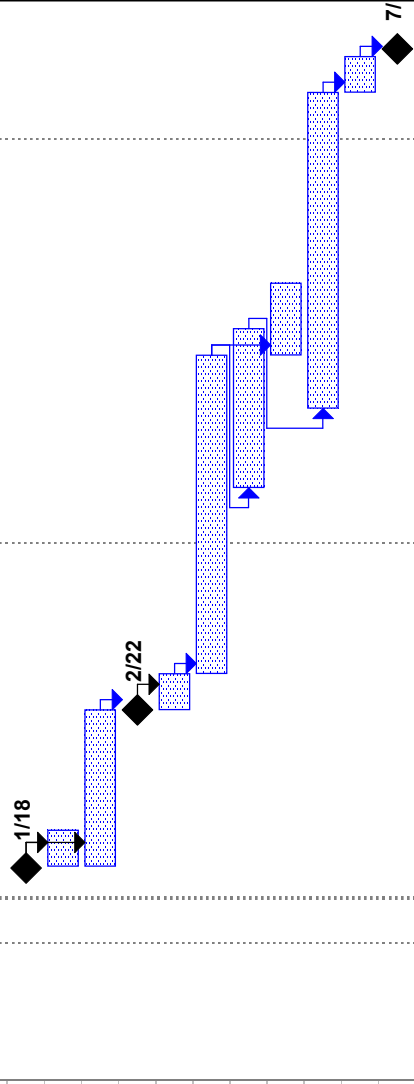
PROJECT. NO:  
 EA - 149  
 DATE:  
 JANUARY 2009  
 SHEET NO:  
 SV - 01

Do not scale drawing. Figured dimensions are to be followed. All measurements must be verified on site. Any discrepancies to be reported to the architect, engineer and/or interior designer. Contractor to provide shop drawings for approval.

### ***3.2 Intended duration of the project***

The intended duration of the proposed Hanimaadhoo Domestic Airport Harbour Development Project is approximately 155 working days. These will include preparation of the EIA report and its approval by the concerned government authority and mobilization of equipment. Proposed periods of different work activities of the Project is given in the work schedule below

ID	Task Name	Duration	Qtr 1, 2009			Qtr 2, 2009			Qtr 3, 2009		
			Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	
1	<b>HANIMAADHOO AIRPORT HARBOR DEVELOPMENT</b>	<b>155 days</b>									
2											
3	EIA Submission for approval	0 days									
4	Detail Designing and Tender document preparation	7 days									
5	EIA Approval (assumed)	30 days									
6	Awarding and Contract Signing of the Project	0 days									
7	Mobilization of equipment and materials	7 days									
8	Excavation of Harbour basin (LWL - 3m)	60 days									
9	Dredge spoil seiving and catagorising	30 days									
10	Entrance Channel deepening	14 days									
11	Breakwater construction	60 days									
12	Demobilization	7 days									
13	Handing over	0 days									



Project: Hanimaadhoo Airport Harbour

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

Page 1

### ***3.4 Need and justification of the project***

Hanimaadhoo Domestic Airport is isolated and quite far from the inhabited area of Hanimaadhoo. Travelling from the populated area of Hanimaadhoo to the Airport has been costly and difficult due to the limited number of vehicles available at Hanimaadhoo. Most people departing from Hanimaadhoo Airport come directly to the Airport jetty. At present about 10 flights operate to Hanimaadhoo Airport daily making it the busiest domestic airport in the country. The currently available harbour area and berthing facility (the T-jetty) at many times has been unable to cater for the growing number of passengers who use this airport. The opening of more and more tourist resorts at this region will increase the number of passengers using this airport. Due to the open nature of the harbour at times of rough weather berthing to the jetty become impossible. Since there are no breakwaters to protect the harbour, the basin becomes very rough and anchorage becomes impossible at bad weather conditions. During such instances the passengers have to use the Hanimaadhoo island harbour and transfer the passengers using vehicles.

Therefore the re-development of this harbour can be justified on the grounds of:

1. providing safer access to the passengers who use the airport
2. providing safer anchorage and waiting areas to the vessels coming to the airport
3. catering for the growing number of passengers who use the airport.

Consultation with the airport harbour users showed that the passengers and boat operators are not satisfied with the current size and shape of the harbour. Due to the small size of the harbour it gets very crowded at times of arrivals and departures. Since there are no breakwaters boats suffered serious damages during rough weather conditions as a result of banging in the jetty.

## 4. Components of the project, design and scale

The proposed harbour development project involves three main components. The first component was environmental and socio-economic surveys of the harbour users to determine the best location, design and technical aspects of a harbour for the airport, which has been completed now. The second component will be mobilization of the equipment and materials needed for the project after approval of the project by the concerned Ministries. The third component will be start of the construction work of the project including excavation of the harbour basin, construction of breakwaters and harbour jetties and clearance of the reef to widen an access channel to the harbour basin.

### *4.1 Mobilization of equipment and materials*

The main equipment mobilized to the site will be excavators, barges and trucks. Materials mobilized to the site will consist of large dead coral heads for construction of breakwaters, cement, aggregates and concrete reinforcement iron and river sand for construction. In addition to these fuel for operation of the equipment will be mobilized to the site.

### *4.2 Excavation of harbour basin*

As shown in the conceptual drawing in figure 33 excavation of the harbour basin will be carried out in the western side of the island using a conventional excavator. An area of approximately 10,552 m<sup>2</sup> of the lagoon bottom will be excavated to a depth of 4m at mean tide. Excavation will be carried out from the rear side of the harbour basin and continued toward the island. Approximately 27,000m<sup>3</sup> of materials will be generated from the proposed excavation work. These materials will be piled on the sides and rear of the harbour as breakwaters. During harbour basin excavation dead coral rocks that are removed will be used as materials for breakwater construction.

### *4.3 Entrance channel*

An entrance channel will be cleared and widened through the reef-flat of the island. The dimensions of this channel will be 400m long and 23m wide. Depth of the channel will be 3m at mean tide. The channel will be cleared by using an excavator. The materials taken from the clearance of the entrance channel will be used as a part of the breakwaters.

### *4.4 Jetty extension*

The harbour front is the existing jetty and in a second phase of the project an extension of the jetty will be constructed using concrete pillars joined together with wooden planks. The jetty will be approximately 250m long and a 3m wide after completion. The top of the jetty will be constructed using wooden planks.

#### ***4.5 Breakwater construction***

Breakwater will be constructed by using the dredged spoil and dead coral stones. Total length of breakwater will be approximately 275m.

## 5. Location of the project

The proposed development project is located in the island of Hanimaadhoo in South Thiladumathee (Haa Dhaalu) Atoll at 06°45'37"N and 73°10'16"E. The closest islands to the project location are inhabited islands of H.A. Baarah and H.A. Muraidhoo approximately 7.97km and 8.98km north of Hanimaadhoo. The islands of Finey and Hirimaradhoo lies approximately 13.46km and 16.80km west of Hanimaadhoo. The islands of Nolhivaramfaru and Nolhivaramu lies approximately 8.56km and 14.70km south of Hanimaadhoo. The Atoll Capital Kulhudhuffushi lies approximately 18.91km south of Hanimaadhoo. Resort islands close to Hanimaadhoo are HA. Alidhoo and HA. Dhonakulhi. Industrial agricultural islands closer to Hanimaadhoo Airport are HA. Maafahi and HDh. Theefaridhoo.

There is no designated protected area or ecologically or environmentally sensitive area identified in the close proximity of the project location.

Hanimaadhoo Island is formed on the atoll-rim reef on the eastern rim of Greater Thiladhumathi Atoll. There is no other island formed on the reef system in which Hanimaadhoo is formed. Hanimaadhoo is relatively large and wide on the northern part of the island.

The proposed harbour will be developed in the lagoon towards south of Hanimaadhoo island where the existing jetty is constructed.

The location of the proposed project and the surrounding environment is shown in figure below.



### 5.1 Project location

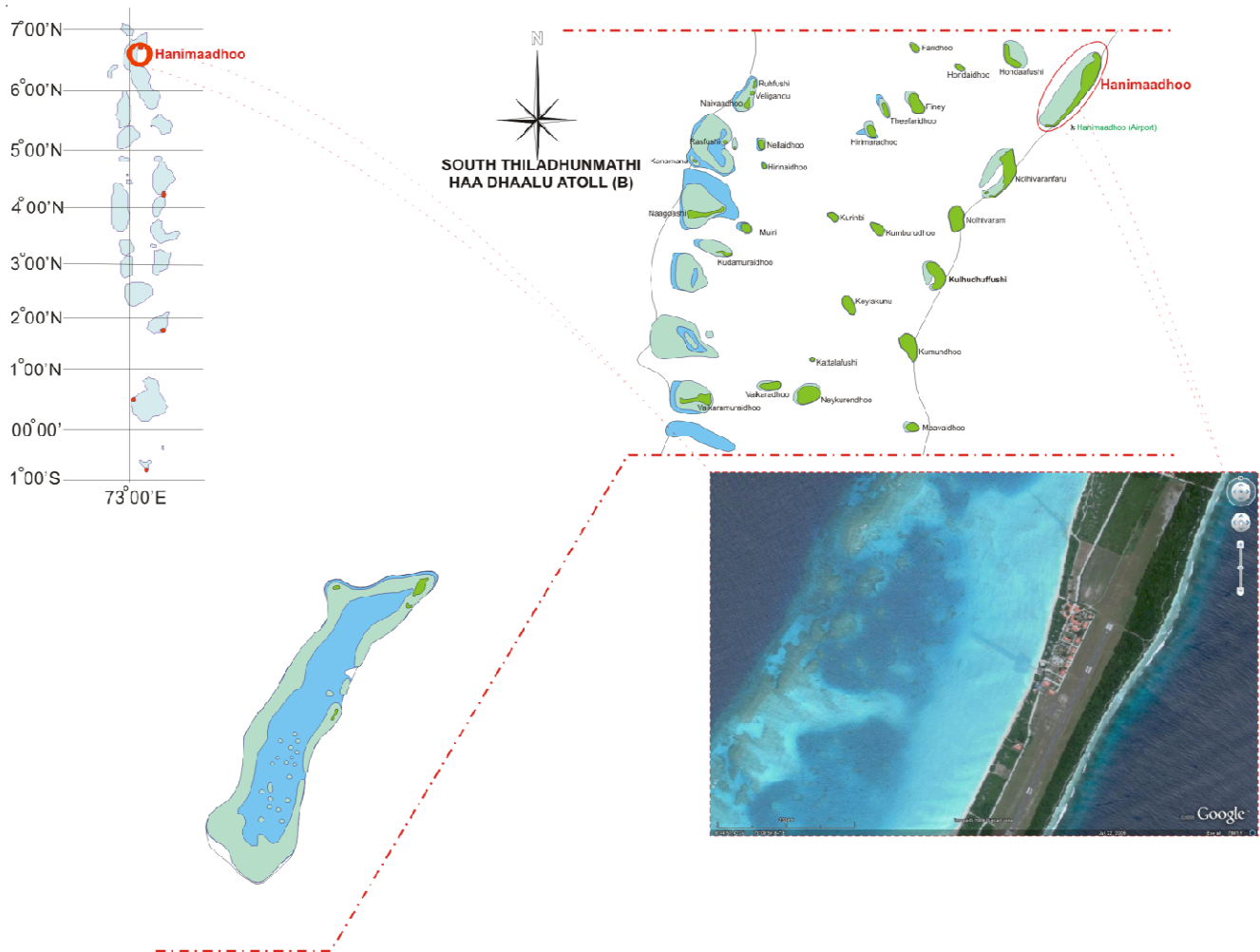


Figure location of the project

## 6. Description of the natural environment

Hanimaadhoo is a relatively large island formed within a small separate coral reef system on the atoll-rim reef of Greater Thiladhumathi Atoll. Haa Dhaalu Atoll is geographically a part of the longest atoll in the country. The atoll consisted of wide channels as the rim reefs surrounding the atoll are relatively discontinuous compared to most other atolls in the country. As a result the islands including Hanimaadhoo are very exposed to waves and currents. Generally stronger monsoon effects are felt within the atoll compared to southern and central atolls.

Since the island is located on the eastern side of the atoll, it is very exposed due to strong waves on the western side. The eastern side of the island reef is very deep and has no proper reef-flat area. The reef-flat in the eastern and northern areas consisted of reef-flat areas that are shallow. The lagoon area in western side of the island is widest measuring approximately 1250m and the lagoon in eastern side of the island has a width of approximately 25m. The eastern side reef has a steep and deep reef slope. As the shallow reef-flat is found in western side of the island, the wave breaker zones are found in this side of the island.

The natural environment of the island consists of terrestrial and marine environment. These environments can be categorized into four distinctive components. They are the coral reef system, the lagoon, the beach and the vegetation. Different sub-categories within each of these components are also found. The following figure shows the different environment and area covered

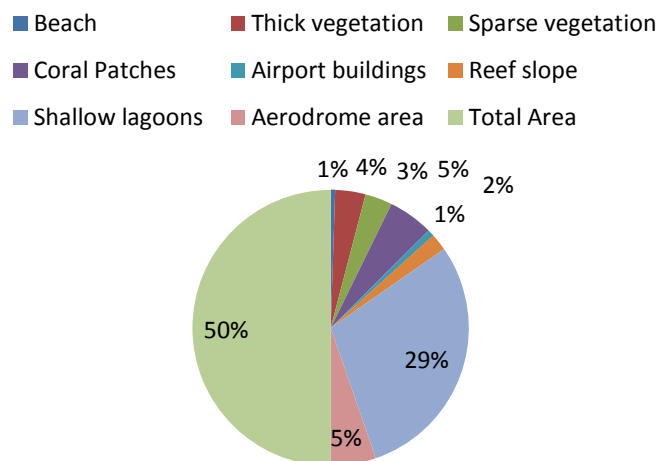


Figure percentage area cover of Hanimaadhoo environment components

The coral reef system consisted of reef slope and reef-flat areas. The lagoon environment consists of the deeper lagoon in western and southern side of the island and shallower lagoon on

northern and eastern side of the island. The beach consisted of more sandy areas in northern, southern and northwestern side of the island. Eastern side of the beach consisted of almost no sand but an extensive stretches of coral stones. The beach of the island is very dynamic and changes intensely with the monsoon system.

The vegetation consisted of peripheral coastal vegetation having more salt tolerant plants with low canopy and the inner vegetation where larger trees are found. All these components of the island functions and interacts each other both physically and ecologically making the island as a system.



Figure area cover of Hanimaadhoo environment

## ***6.1 Marine environment***

The marine environment of the island consisted of two main components; they are the coral reef system and the lagoon. The coral reef and the lagoon cover approximately 73% of the selected area of the island system. The coral reef covers approximately 15% and the lagoon covers approximately 58% of the island system.

Distinctive reef areas exist within the reef system. They are the reef slope and reef-flat. Geomorphology and biodiversity of each of these reef areas are significantly different. The lagoon surrounding the island also consists of two distinctive areas in terms of depth and bottom substrate. They are sandy bottom lagoon area close to the island and rubble and rocky areas further from the shore.

## ***6.2 Coral reef***

The coral reef system of the island oval shaped and oriented in north to south direction and the island is elongated in shape. The island is formed more on northeastern side within the reef system. This formation makes the lagoon on eastern side narrower than other sides. The lagoon on eastern side of the island is more exposed as the reef in the northern side is facing the swells of the Indian Ocean. Eastern and southern side reef-flat is shallower and the lagoon on western side is more protected. A strong surf zone is found at the edge of the reef on entire southern and eastern side of the island.

The coral reef of the island has a linear length and width of approximately 7200m and 1800m respectively. The total reef area was calculated as approximately 300 hectares. Out of this 127 hectares is reef slope.



**Figure reef-flat of Hanimaadhoo near the proposed development area**

### **6.3 Lagoon**

The shallow lagoon area around the island was calculated as approximately 228 hectares. The average depth of the lagoon on western side of the island is deeper than on northern and eastern sides. Lagoon bottom consisted of mostly sand and rubble on the proposed development area.

The western side lagoon is deeper and the depth is more variable compared to northern and eastern side lagoon. The substrate cover on eastern side lagoon consisted of mostly sand and rubbles.



southern side



western side

Figure lagoon system

### **6.4 Terrestrial environment**

The terrestrial environment of the island consisted of two main components; they are the beach environment and the vegetation. The vegetation consisted of coastal vegetation and the inner vegetation. The coastal vegetation consisted of salt tolerant species with low canopy profiles. The inner vegetation consisted of larger and older trees and coconut palms. The beach environment consisted of sandy beach areas in the proposed development area.

### **6.5 Beach**

The sandy beach area is found on mostly northwestern, northern and western sides of the island. The eastern side of the island consisted of some rubble areas. The total beach area on the western side was calculated as 14 hectares.



South of harbour



northern side of harbour

Figure beach around the proposed development area

### 6.5.1 Vegetation

The land area of the island is approximately 259.43 hectares and the vegetated area of the island was calculated as approximately 145 hectares. Residential and other areas without vegetation is approximately 45% of the land area. Thick vegetation with high canopy profile is found in north and central part of the island. The inner vegetation consisted of very old trees. The coastal vegetation is cleared around the existing jetty area (see Figure ).

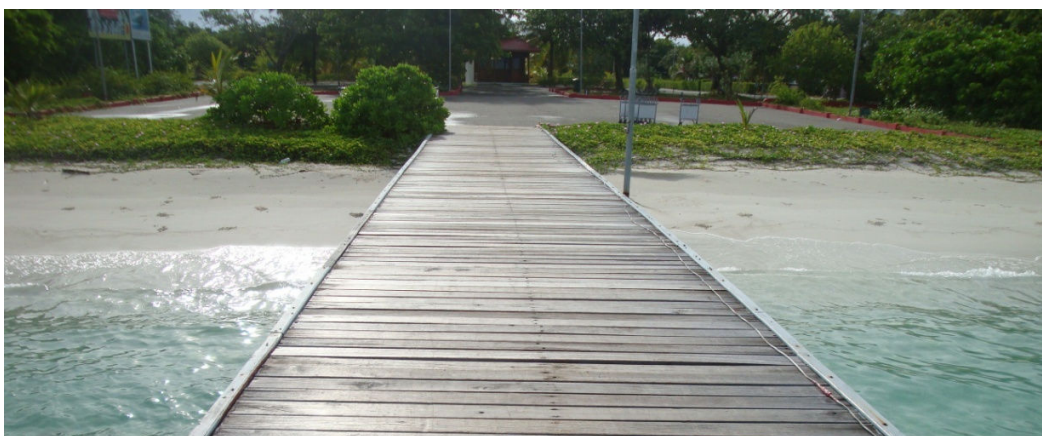


Figure coastal vegetation

## **6.6 Description of existing terrestrial environment**

Terrestrial environment of Hanimaadhoo can be categorized into four main components; they are the i) beach, ii) soil, iii) flora (vegetation) and iv) fauna. Among these terrestrial components of the island's environment, the beach of the island would be most affected by the proposed development. No vegetation clearing would be carried out for this project.

### **6.6.1 Beach environment**

The island has a very dynamic beach area in terms of seasonal beach sediment movement in entire northwestern, western and southwestern sides of the island. The beach in this area consisted of a huge sand budget with very fine-grained sand. The volume of sand in the beach is significantly large compared to most similar islands as the island is larger and higher in elevation above mean sea level in relation to most islands in the country.



Figure beach environment

## **6.7 Beach erosion**

Beach all around Hanimaadhoo receives very high wave energy, especially in northern, eastern and western sides of the island. Continuous and seasonal beach erosion is found around the island. Continuous beach erosion is found in the south of the island harbour. Erosion at this area has become very severe in the past three years. Loss of coastal vegetation has been documented at this area. The infrastructures close to the shore are in danger as the rate of erosion seemed to be increasing. This erosion can be attributed to the structure and design of the island harbour. The protruding island harbour has severely altered the hydrodynamic movement around that area. The Figure below shows the extent of erosion on the southern side of the island harbour.



Figure severe beach erosion at the south of island harbour

### ***6.8 Beach sediment dynamics***

Beach dynamics is the movement of beach materials within the coastal environment with the alternating current regimes and waves caused by monsoon winds. Other factors involved in beach dynamics are shape and orientation of the island, location of the island within the atoll with respect to alternating monsoon current regimes, location of other islands and reefs.

Beach dynamic of the Hanimaadhoo was assessed based on the field surveys, observations and anecdotal data and information. Figure shows the beach dynamic patterns and estimated extent of beach dynamics around the development area.

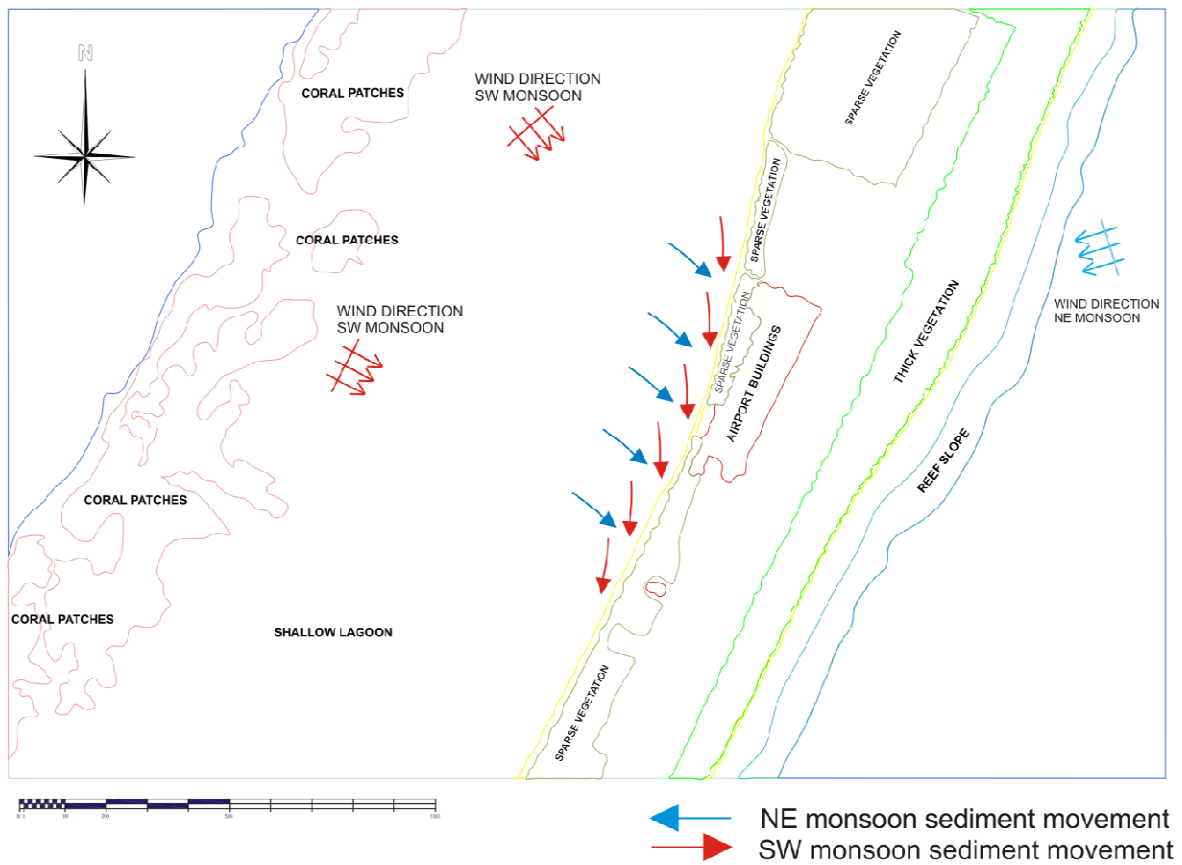


Figure beach sediment dynamics and characteristics

### 6.9 Beach profiles

Beach profiles give useful data on beach dynamics over long-term by providing beach height, beach width and estimated amount of beach materials in a given location at any given time. Beach profiles were taken in six locations around the beach as a baseline for monitoring the beach sediment dynamics over long-term. Beach profiles showed that beach height, beach width and beach materials are comparatively higher than most other islands. Beach profiles are given in Appendix 2.

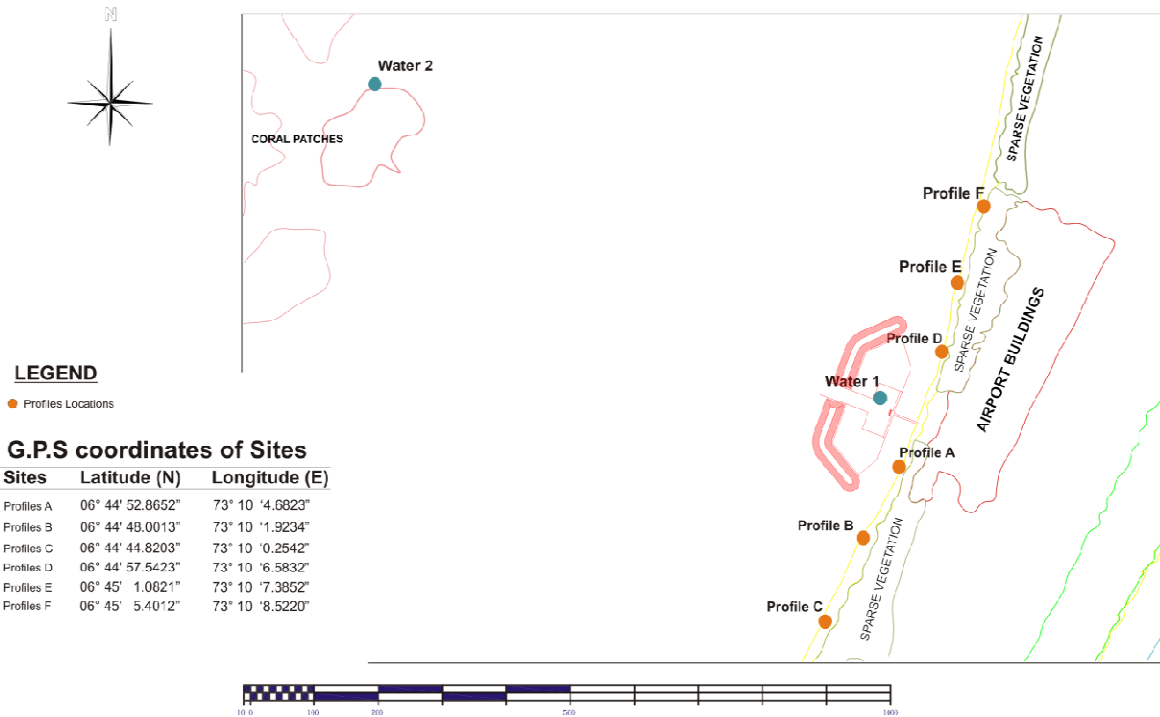


Figure Beach profile location map

### 6.10 Vegetation

Vegetation of the island can be categorized into two different main types; they are the coastal or the peripheral vegetation and the inner vegetation or the vegetation inside the island. The vegetation inside the island can be divided into thickly vegetated area in northeastern side and sparse vegetation in other areas as shown in the areal photograph. The coastal vegetation is a belt of vegetation around the island that consists of more salt tolerant and bushy plants that are more adapted to coastal environment and plays an important role in protecting the island from beach and soil erosion. The inside vegetation consisted of larger and older trees that area more adapted to less salty water. The non-vegetated, the residential and public areas is approximately 114 hectares which is 45% of the land area.



Coastal vegetation is dominated by *Magoo* (left) and *Kuredhi* (right)

Figure coastal vegetation in the development area

The following figure 15 shows the vegetation of the island and coastal vegetation survey sites, assessed by line intercept transects conducted around the island.

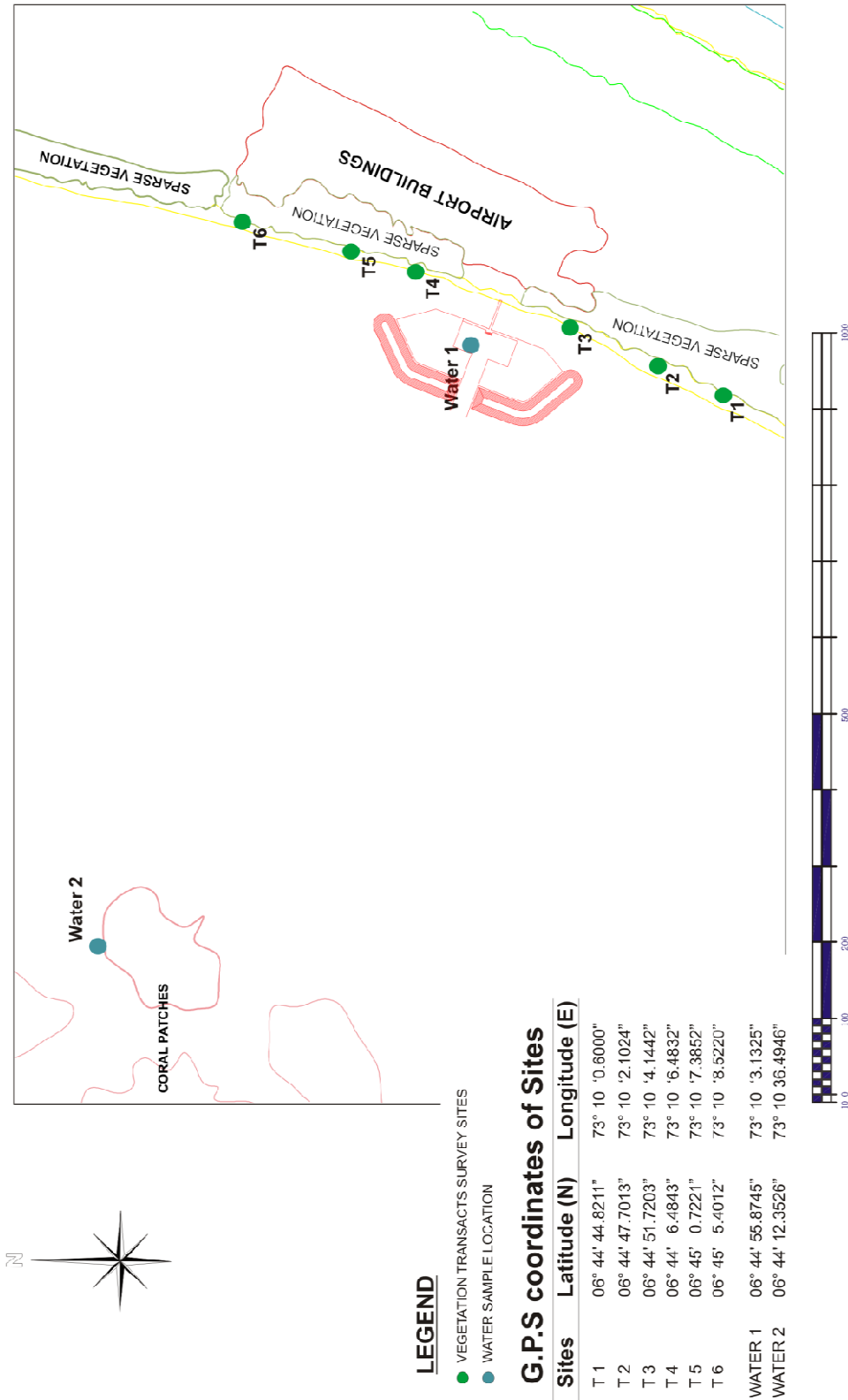


Figure 15 vegetation survey sites

### 6.10.1 Coastal vegetation

Coastal vegetation around the development area is intact in most areas except the existing jetty area and consists of the usual species of plants that are found around the islands in the country. Quantitative surveys of the coastal vegetation in representative locations and location that may be impacted are conducted as shown in figure 15. Surveys were conducted at six sites of the coastal vegetation around the development area.

#### Site 1

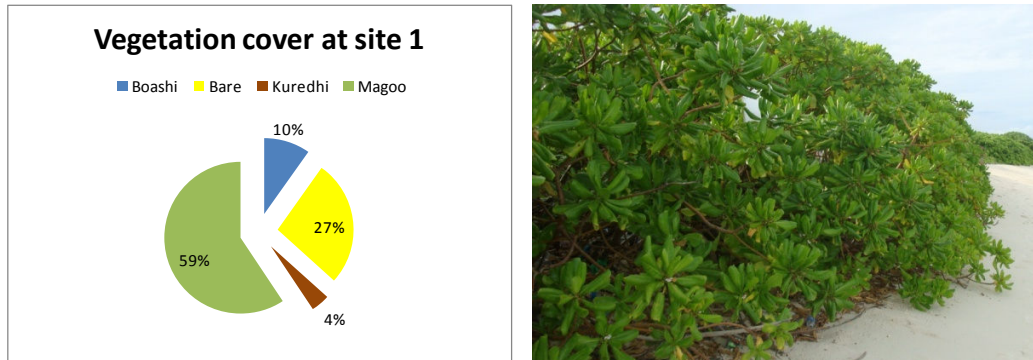


Figure coastal vegetation at Site 1 – Magoo dominant

Site 1 is farthest south from the existing airport jetty. The coastal vegetation consisted of three species and is dominated by Boashi covering approximately 59% of the plants. Boashi in this area covered approximately 10% and Kuredhi plants covered approximately 4% of the coastal vegetation in this site. Approximately 27% of this area has no vegetation.

#### Site 2

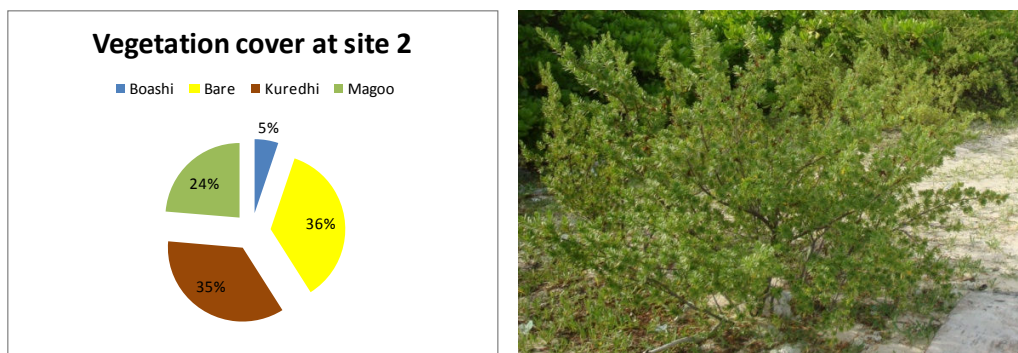


Figure coastal vegetation at Site 2 – Kuredhi dominant

Site 2 is closer to the jetty than site 1 which is on the southward side of the existing airport jetty. Coastal vegetation at this site consisted of three species as shown in the figure above. The dominant species in this area of the coastal vegetation is Kuredhi covering 35% and Magoo covering 24%. Area with no vegetation in this area is approximately 36%.

### Site 3

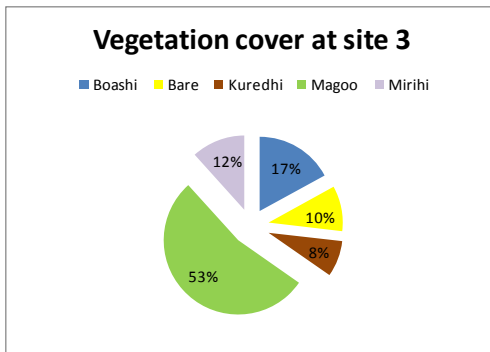


Figure coastal vegetation at Site 3 – Magoo dominant

Site 3 is just south of the existing jetty. Coastal vegetation at this site consisted of 4 species as shown in the above figure. The coastal vegetation at this site is dominated by Magoo covering 53% and Kaani and Boashi covering 17% each. Approximately 10% of this area has no vegetation.

### Site 4

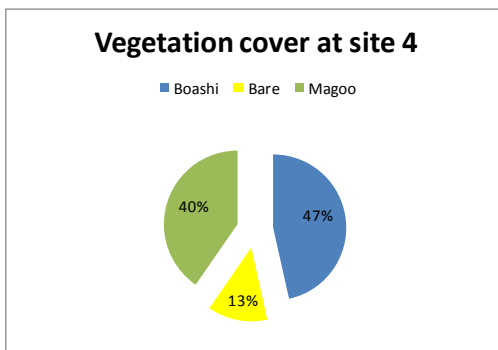


Figure coastal vegetation at Site 4 – Boashi dominant

Site 4 is in just north of existing jetty (closest to the jetty). Coastal vegetation at this site consisted of 2 species and dominated by Boashi covering 47%. Magoo covered about 40% of the vegetation. 13% of the coast line at this site is bare.

### Site 5

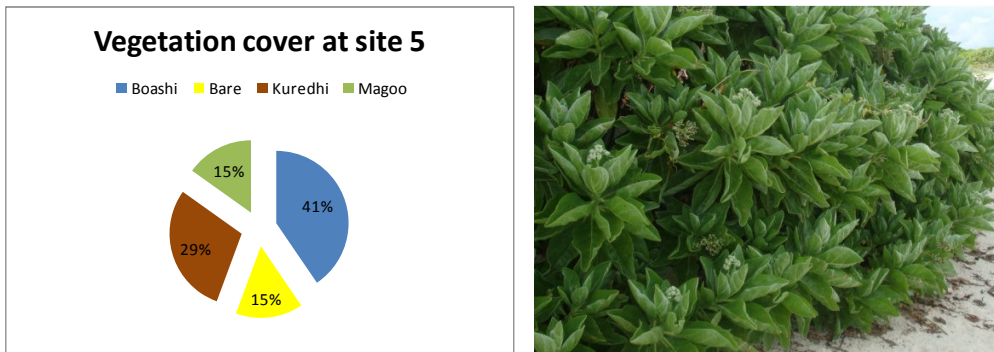


Figure coastal vegetation at Site 5 – Boashi dominant

Site 5 is farther north of site 4 (northern side of existing jetty). Coastal vegetation at this site consisted of 3 species as shown in the above figure. The coastal vegetation at this site is dominated by Boashi covering 41%. Kuredhi covered about 29%. Approximately 15% of this area has no vegetation.

### Site 6



Figure coastal vegetation at Site 6 – Magoo dominant

Site 6 is farthest north of existing jetty. Coastal vegetation at this site consisted of 3 species as shown in the above figure. The coastal vegetation at this site is dominated by Magoo covering 79%. Thanburu covered about 9%. Approximately 5% of this area has no vegetation.

The dominant coastal plant species of the proposed development area included Magoo (Sea lettuce - *Scaveola taccada*). The other common coastal species included Ironwood (*Penphis* sp. - Kuredhi).

Coastal vegetation of Hanimaadhoo compared to most islands can be said as similar in terms of species types, diversity and percentage cover. However, composition of species is different compared to most similar island. The coastal vegetation of Hanimaadhoo is highly dominated by Magoo and Boashi in most of the surveyed areas.

### **6.11 Description of existing marine environment**

Marine environment of Hanimaadhoo can be categorized into two main components; the coral reef environment and the lagoon environment. Different habitats are found within each of these categories of marine environment. The coral reef environment has reef-flat and reef slope having distinctive habitat characteristics.

The reef-flat around Hanimaadhoo is poorly developed with less than 1 percent live coral cover. The bottom of reef-flat was dominated by sand and rubble on the western side. The reef slope on the western and eastern side forms a gradual slope. The reef-flat is rather wide on the western and northwestern side of the island.

No detailed surveys were conducted at the eastern side of the island. It is unlikely that the east-side reef will be impacted from the proposed project since that side is completely opposite separated by the land mass of the island.

The reef system of Hanimaadhoo was semi-quantitatively and qualitatively surveyed using standard marine environmental survey methodologies. The surveyed sites are shown in Figure .

Quadrat surveys were conducted on the 9 representative sites divided into 4 distinct areas that were selected on the reef-flat (Sites 1-9) for assessing benthic substrate cover. The areas are:

Area 1: northern side of the harbour (sites 1, 2 and 3)

Area 2: central part of the harbour (the currently dredged area - site 4)

Area 3: southern side of the harbour (sites 5, 6 and 7)

Area 4: western side of the harbour (west of breakwater - sites 8 and 9)

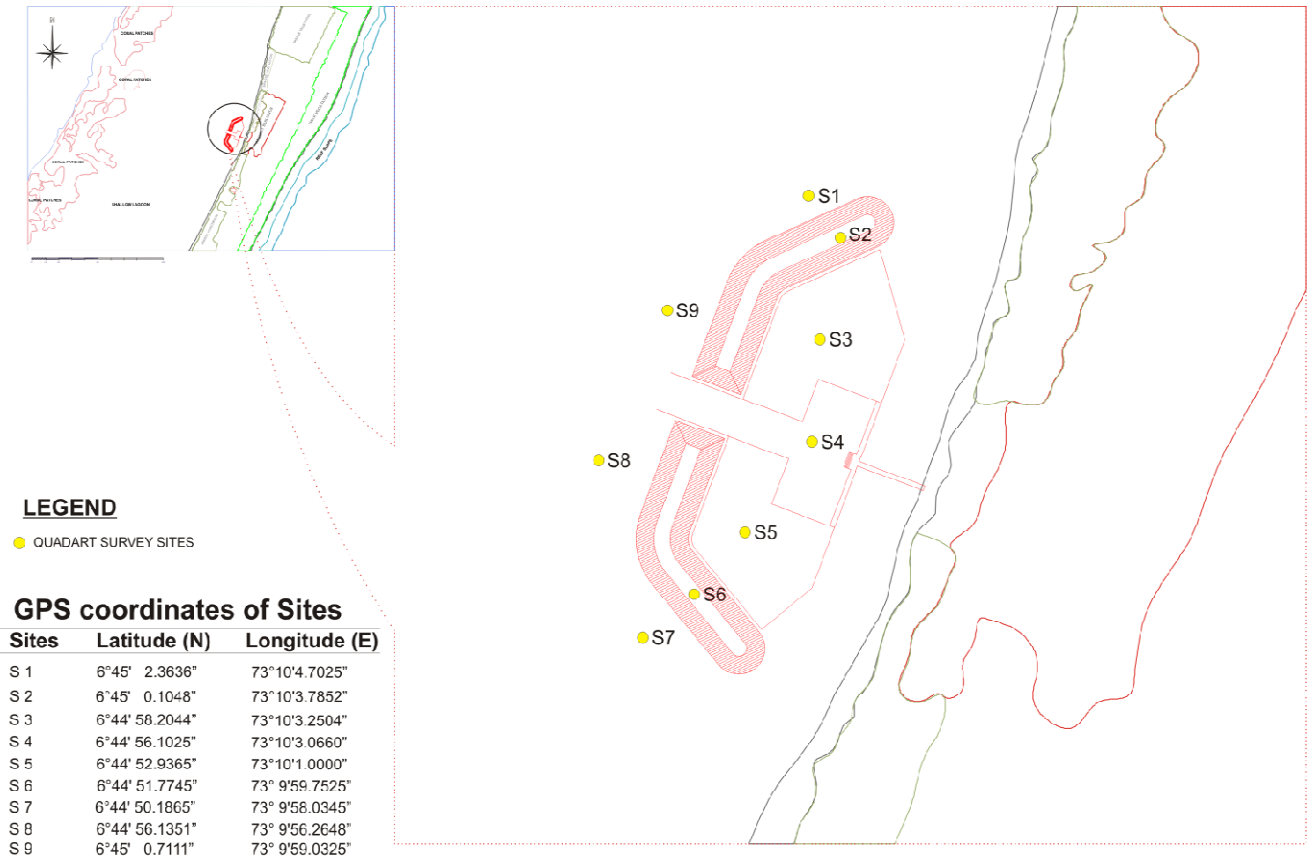


Figure map of marine environment and surveys sites

### 6.11.1 Coral and other benthic cover

Live coral cover at the survey area was extremely low with less than 1 percent cover. Benthic substrate was dominated by sand. Branching forms of *Acropora spp.* (staghorn) and other genus like *Pocillopora* and *Porites*, were encountered at the survey sites. Massive type corals namely *Porites*, *Favites*, *Goniastrea* and encrusting type *Montipora* and *Pavona* were also present. The results of the four surveyed area is represented in the Figure below.

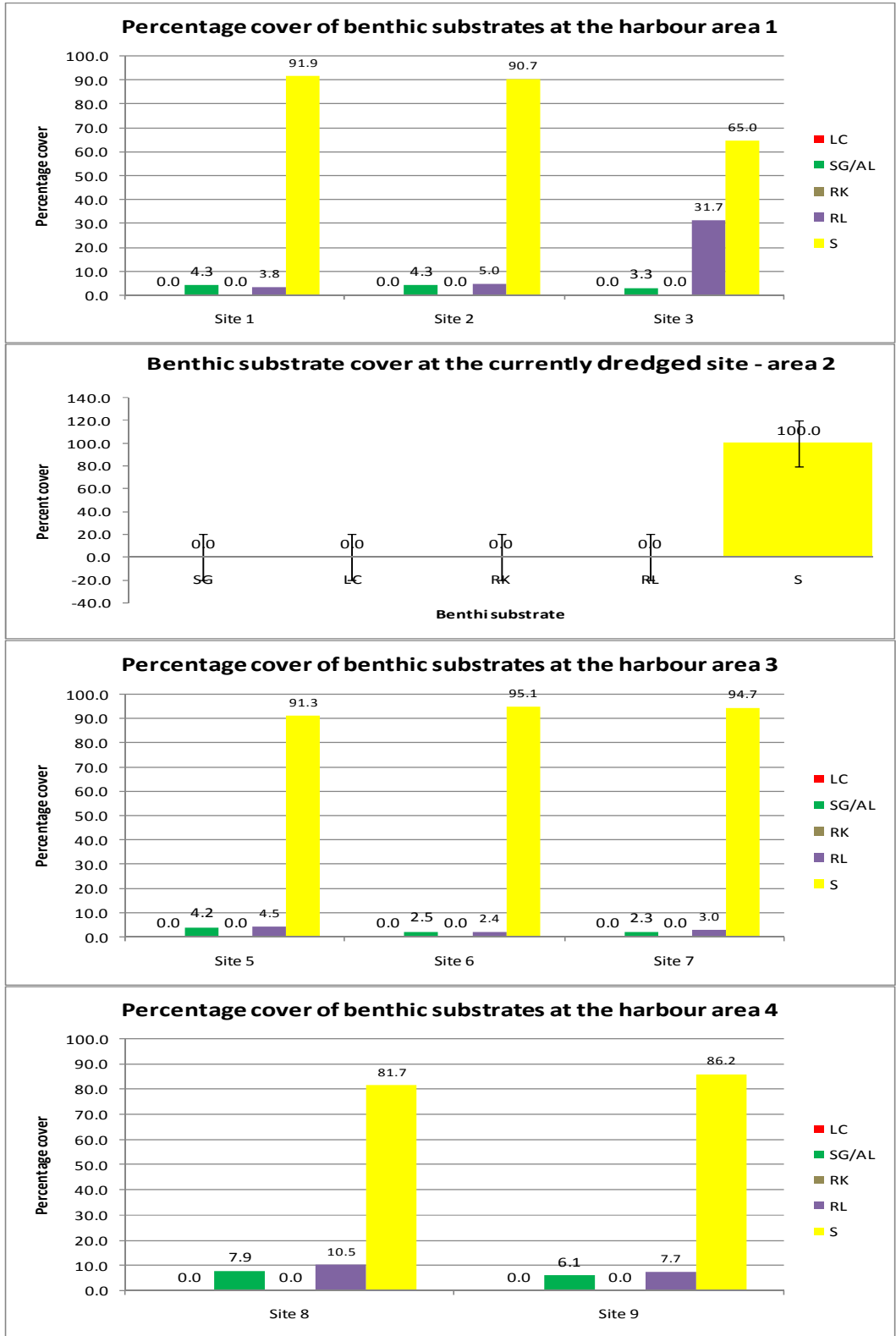
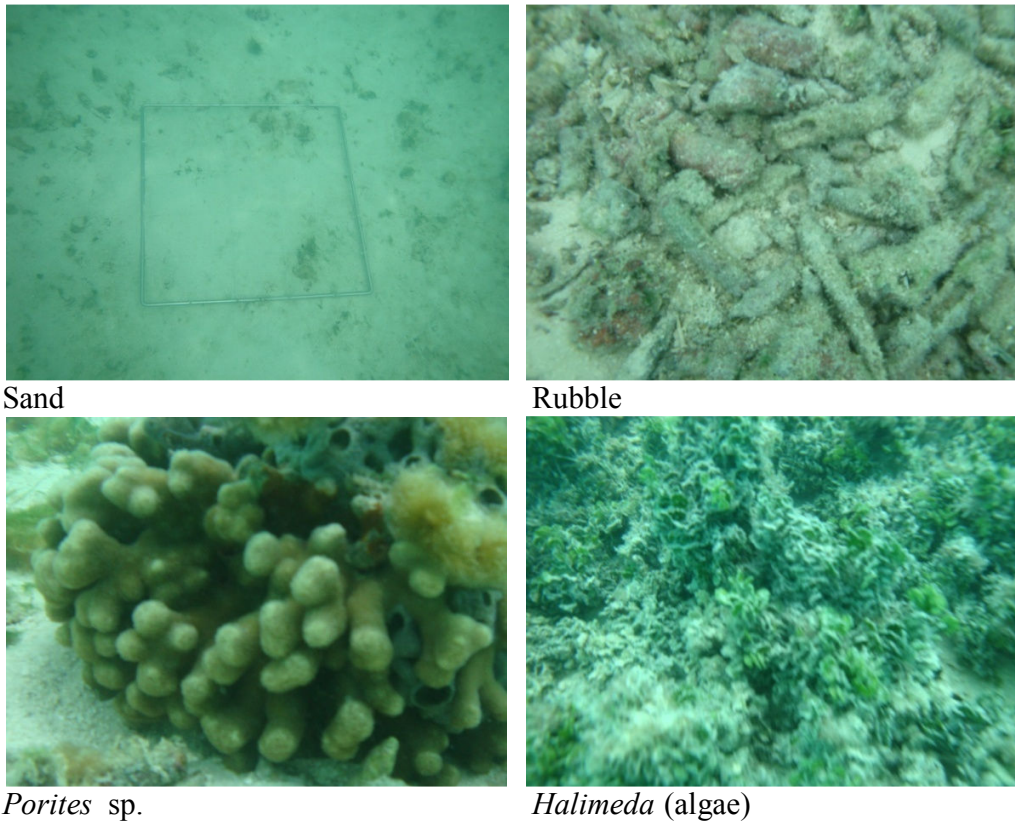


Figure benthic substrate cover

Percentage cover of benthic substrate present at the fore-reef sites. The benthic covers are given in percentages of the bottom area surveyed. LC =live coral, AL = algae, RK = rock, RL = rubble, and S = sand.

Based on the survey data of the 4 reef-flat areas, sandy and rubble areas were found to be dominant. The photographs below (Figure ) shows provide an idea of benthic cover present at the survey sites.



Sand

Rubble

*Porites* sp.

*Halimeda* (algae)

Figure some of the observed benthic substrates

### 6.12 Assessment fish communities in the surveyed area

The result of 15 minutes swim for fish count around each site revealed that the abundance and diversity of fish is poor on the surveyed area. The fish population structure and distribution appears similar at areas 3 and 4. Area 1 (sites 1-3) has got the highest diversity and abundance. Area 2 (the currently dredged area - site 4) has got the least diversity and abundance of fish (see Table ). Dominant fish species encountered included grazers belonging to the families Acanthuridae and Labridae.

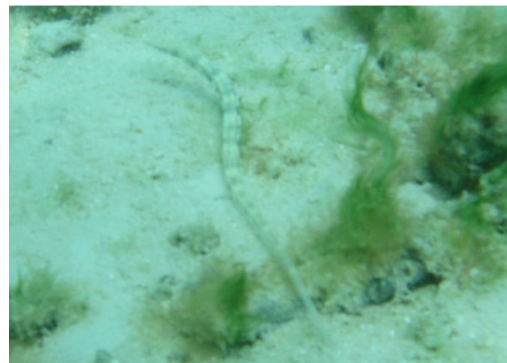
**Table results of fish surveys at 4 areas (9 sites)**

Family	Species	A1	A2	A3	A 4
Acanthuridae	<i>Acanthurus triostegus</i>	C	-	R	R
Acanthuridae	<i>Acanthurus xanthopterus</i>	R	-	R	-
Acanthuridae	<i>Ctenochaetus</i> sp.	R	-	C	R
Acanthuridae	<i>Naso brevirostris</i>	R	-	-	-
Acanthuridae	<i>Zebrasoma scopas</i>	R	-	-	R
Balistidae	<i>Rhinecanthus aculeatus</i>	R	-	R	R
Carrangidae	<i>Caranx melampygus</i>	R	R	-	-
Carrangidae	<i>Caranx</i> sp.	R	-	R	-
Chaetodontidae	<i>Chaetodon auriga</i>	R	-	-	-
Gerreidae	<i>Gerres</i> sp.	R	R	-	R
Labridae	<i>Helichoeres scapularis</i>	C	R	C	C
Labridae	<i>Labroides dimidiatus</i>	R	-	C	R
Lethrinidae	<i>Lethrinus harak</i>	R	-	R	-
Lutjanidae	<i>Lutjanus fulvus</i>	R	-	-	-
Lutjanidae	<i>Lutjanus kasmira</i>	C	-	-	-
Mullidae	<i>Parupeneus macronema</i>	R	-	R	-
Pomacentridae	<i>Dascyllus trimaculatus</i>	-	-	R	-
Signathidae	<i>Corythoichthys haematopterus</i>	R	-	-	R
Scaridae	<i>Hipposcarus harid</i>	R	-	R	-
Tetraodontidae	<i>Canthigaster bennetii</i>	-	R	-	R

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



*L. fulvus* (black tail)



Pipefish – *C. haematopterus*

**Figure some of the fishes observed**

### 6.13 Reef invertebrates

One species of conspicuous mollusks and 4 species of such echinoderms were encountered during the entire survey (). Other than this one species of sea sponge and one species of ascidian was documented. Their relative abundance is very low. 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:

- *Tridacna* sp. (Giant clam)
- Common star fish
- Diadema urchin
- Cream sea cucumber
- Brown sea cucumber
- Ascidian
- Sponge



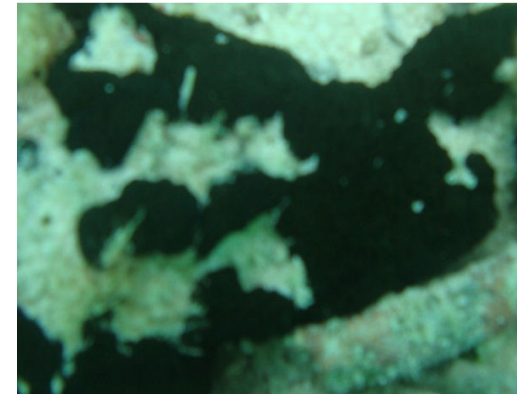
Sea urchin



Cream sea cucumber



Ascidian



Sponge (encrusting)

Figure some of the invertebrates seen

#### 6.14 *Rare or endangered species*

During the course of the baseline survey not a single individual of rare or endangered species was encountered. Therefore, the impacts from the proposed project on the rare and endangered species are not clear.

### **6.15      *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 habitats. It has been known that the Striped eel cat fish (*Plotosus lineatus*) has infested some of the dredged harbor basins. One such occasion was documented in Th. Kibidhoo where dense schools of *P. lineatus* infested the harbor basin. This species has got deadly poisonous spines which makes it a potentially dangerous species. The small size (max 30cm) and rarity of the fish makes it virtually worthless economically. It is not clear that whether this species will infest the Hanimaadhoo airport harbor basin. Based on the past experience with the harbors, there seemed to be no major problems associated with potential nuisance species.

### **6.16      *Environmental condition of the dredged material disposal sites***

The dredged material of Hanimaadhoo airport harbour will be used in building breakwaters on the seaward side of the harbour. Some of the rocks taken during the dredging will be used as a revetment to retain sand at this area. The area marked on the site plan map shows the breakwaters (see Figure ). Few sand associated species of fish belonging to the families Mullidae, and Gerreidae were seen here. No significantly important benthic life was encountered during the visual observation.

### **6.17      *Bathymetry***

Bathymetric surveys were conducted around the potential development area. The bathymetric surveys results are shown in Appendix 3. The bathymetry surveys showed that the lagoon on surveyed area has a depth range of 1 to 2 m in average. Greater depths than 2m is encountered in already dredged areas near the existing jetty. Depth of the lagoon increases moving away from the shoreline and more abruptly as moving further from the shore towards reef slope.

### **6.18      *Currents***

Surface current directions and speed calculated by the drogue release area shown in Figure . Both monsoonal and tidal currents were found around the island. Monsoonal water current around the island is southwesterly during SW monsoon with an average speed of 10cm/s. Direction and strength of monsoonal currents varies with the monsoon twice a year. Tidal currents changes daily with the fluctuating low and high tides. Tidal currents around the island were found to be strong as the island lagoon is large.

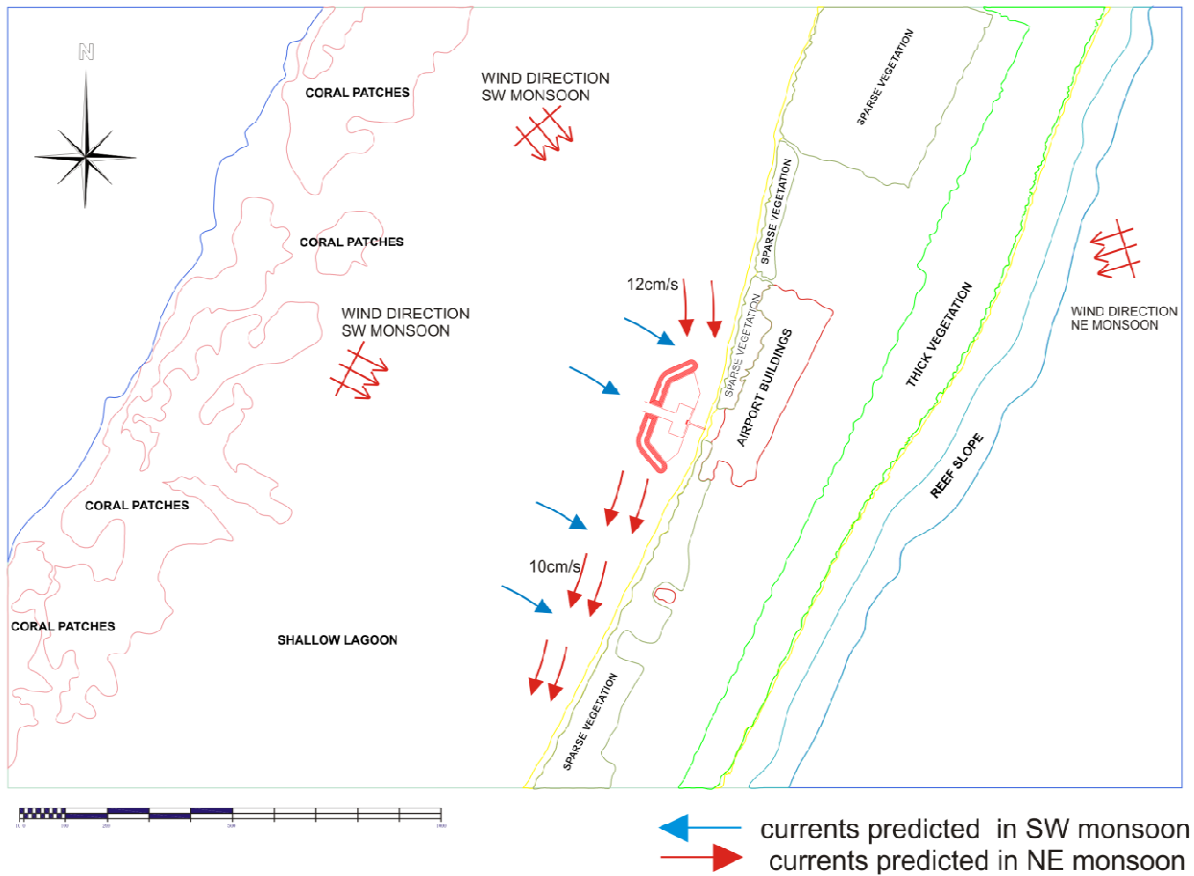


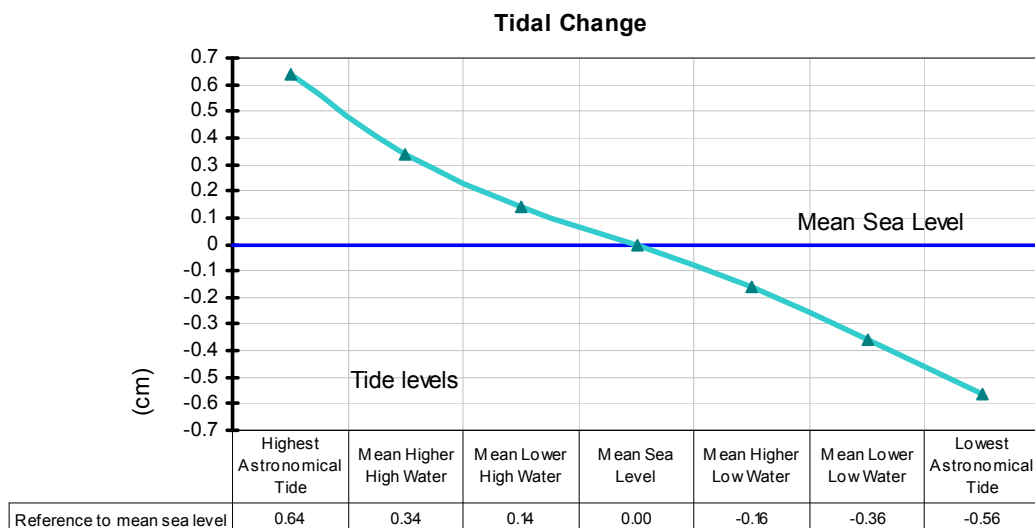
Figure surface current in around the development area

### 6.19 Waves

An extensive surf zone is found in entire southern and eastern side especially in SW monsoon. The surf zone is generated as a result of the extensive reef slope areas in southern and eastern sides of the island. The waves break on the reef crest in the entire southern and eastern side of the island as the reef in these areas is shallow. The wave strength in western side of the island lagoon and the shore is more as the reef in northern side of the island is deep and no prominent reef-crest is formed on this side.

### 6.20 Tides

Like most of the places of the country, semidiurnal tides are experienced in the atoll, that is two high tides and two low tides a day. The tide varies from place to place, depending on the location and on the shape and depth of the basin, channels and reefs and also time of the year.



**Figure tidal change**

The above chart shows the astronomical tidal variation recorded in the country with respect to the mean sea level. Astronomical tides are related to the motion of the earth-moon-sun system, and have a range of periodicities. The highest astronomical tide was recorded as 0.64 cm above the mean sea level and the lowest astronomical tide was recorded as 0.56 below the mean sea level. Tidal variation of 1.2m from lowest to the highest tide levels were recorded in the country.

Tidal variation of approximately 1.5m was recorded in H. Dh. Atoll (South Thiladhunmathee). The variation in tidal change has a profound effect size of the beach area in the islands. In some of the islands surveyed in HA. Atoll, more than half of the beach is flooded during the highest tides. In Hanimaadhoo for instant, approximately over 3% of the area of the beach is flooded during high tides as given by the surveyed high and low tide lines.

### **6.21 Wind**

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

Generally the SW monsoon generates westerly winds and the seas are rougher than the NE monsoon. Due to the strong winds the seas get so rough (in many of the days) that islands like Hanimaadhoo becomes inaccessible on the west and northwest sides during this season. The NE monsoon in the Maldives is marked by east to northeast winds (Woodroffe 1992) which are

generally lighter except during the *Iruvai halha* during which the winds is rather strong with high waves.

Localized climate data for the Island of Hanimaadhoo exists. Therefore, available data on HDh. Hanimaadhoo, and K. Male' is used here (see Figure ).

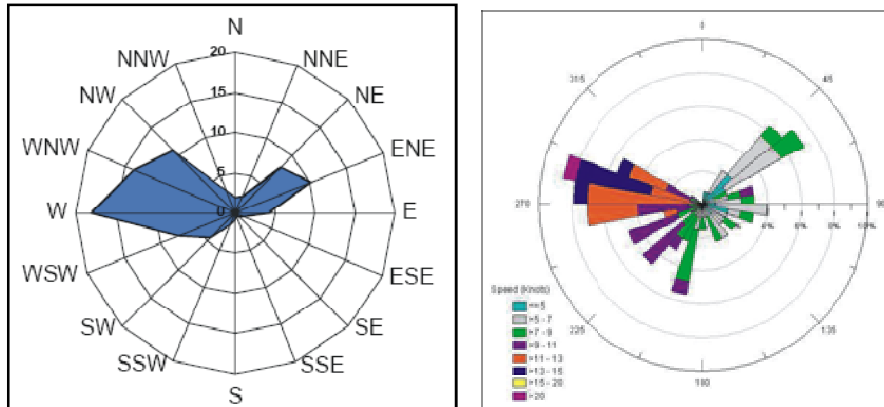


Figure Right: general wind rose for the Maldives (Environment 2005) and left monthly average wind for HDh. Hanimaadhoo (DoM).

General wind rose for the Maldives and HDh. Hanimaadhoo shows that frequency of wind coming directly from the south-west is relatively less and the speed is relatively low. This suggests that the location of the airport harbour is appropriate since the mouth of the entrance channel and the inner harbour will be calmer most part of the year. However, occasionally there will be strong winds coming from SW during the SW monsoon. During such occasions the mouth of the entrance channel may get large waves.

## 6.22 Marine water quality

Marine water samples were taken at 2 locations around the survey area (see Figure ) to establish the baseline status of the water quality in terms of pH, salinity, phosphates, nitrates and turbidity. Parameters describes in the ToR (such as BOD and COD) have been performed.

The seawater samples are Hani 1 (Hanimaadhoo 1) was collected at the harbour basin. Hani 2 (Hanimaadhoo 2) was collected at reef-flat. The following table shows the water quality test results. Water quality was tested at the National Health Laboratory. The result sheet is given at Appendix 4.

Table : Marine water quality test results

PARAMETER	SAMPLE NUMBER		TEST METHOD
	HS1/Water1	HS2/Water2	
Appearance	clear	clear	
DO (mg/L)	9.9	9.9	Spectrophotometer
Salinity (mg/L)	35500	35300	Checkmate II meter
Nitrate (mg/L)	0.0	0.0	Spectrophotometer
Turbidity (NTU)	1	1	Spectrophotometer

### 6.23 Socio-economic and population

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. 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.

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

Figure Quick Facts of Haa Dhaalu Atoll

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 Nolvivaranfaru.

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.

Hanimaadhoo has a land area of 259.47 Hec. The Island is 6500m in length and 730m wide. The distance to Male' is 287.57 km. Hanimaadhoo has a total population of 1696 people.

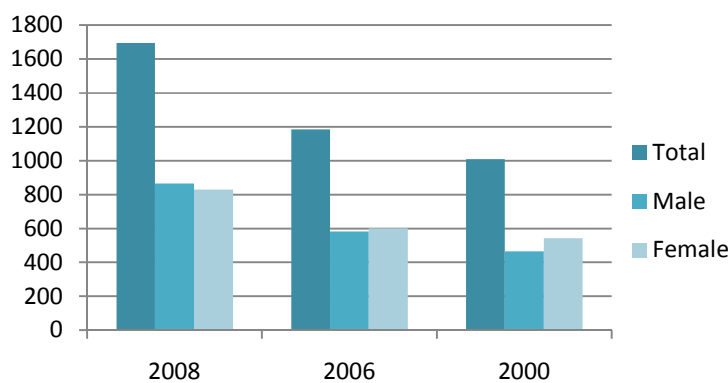


Figure Population of Hdh. Hanimaadhoo

#### 6.24 *Environmental issues*

The significance of population is the impacts on the environment as a result of increased resource exploitation such as fisheries, development activities in the atoll such as land reclamation, harbour development and various other impacts from population pressures such as solid waste and sewage disposal.

The environmental issues are related to population pressures and environmental mismanagement in terms of economic development in the atoll that are found to be increasing, especially in the populated islands such as Kulhudhuffushi where there is intense pressure on land due housing and infrastructure development. Some of the issues are coastal erosion waste management and transportation. Harbours of the islands in the atoll have been developed without proper environmental studies and designs which have led to pollution in the harbours and coastal erosion.

## 7. Methodology

Data for assessment of environmental impact that may arise due to the proposed project were collected using methods most appropriate for specific environmental, social and economic conditions of the island and atoll environment. Quantitative, semi-quantitative and qualitative data were collected for this EIA study.

Assessment of the existing environment was conducted using standard methods that are internationally accepted and locally practiced.

### *7.1 Marine environment assessment methods*

#### *7.1.1 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<sup>2</sup> each) were taken from the selected representative sites on and around the proposed harbor development area and other areas that are outside 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 benthic types 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 lack of information about the life forms of corals 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.

#### *7.1.2 Timed-swim surveys*

These surveys were carried out using snorkeling gear for both fish and benthic communities including live coral, dead coral, algae and other sessile organisms. Four swims on a straight path were done on the four selected sites. These sites were GPS-marked and are shown in various figures. 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. 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.

#### **7.1.3 Coral reef fish visual census**

Coral reef fish populations are assessed by visual census of the fishes along 50m transects. The transects were censused during day light hours by snorkeling in conjunction with coral survey quadrat method. The method is one of the most common quantitative coral reef fish surveys methods used in coral reef surveys.

#### **7.1.4 Bathymetry surveys**

Bathymetry surveys were conducted by using GPS interfaced eco-sounder and position corrections made using total station surveying equipment. Data were presented using a computer software known as Surfer. Computer aided design software is also used in presentation of the bathymetry data collected. A bathymetry map is given in Appendix 3.

#### **7.1.5 Surface current surveys**

Current direction and speed were estimated using drift drogue system in SW monsoon. Buoy was released for a specified times and the distance moved within a given time was used to calculate the speed of surface current around the island. Direction of the surface current was estimated using a magnetic compass. NE monsoon currents were predicted based on surveys around similar geomorphologic and geographic islands.

#### **7.1.6 Beach and beach dynamic surveys**

Beach surveys were conducted by adapting qualitative visual methods and quantitative methods using total station to take beach profiles. A total of 6 beach profiles were taken around the island for assessing the beach slope profiles and amount of beach materials in different areas of the beach.

#### **7.1.7 Vegetation surveys**

Coastal vegetation were surveyed using line intercept transect method. Six sites of the coastal vegetation around the proposed development area were assessed. A total of transects of each 60m long were conducted. Qualitative visual observations of the coastal vegetation were also conducted.

## 8. Stakeholder Consultation

### 8.1 Aim

The stakeholder consultations were aimed at understanding the Government and the community's need for a harbour in the airport area and its environmental consequences and social and economic benefits for the atoll community.

### 8.2 Objectives

The objectives of the consultations were to:

- understand government policies and reservations with respect to airport harbour development in Hanimaadhoo
- discuss and define the scope of the work of the proposed harbour
- discuss and define the methodologies that will be adopted in construction and operation of the harbour
- discuss and define costs and duration of construction
- identify parties responsible for operation and maintenance of the harbour
- identify the needs and wishes of the island community
- identify how to minimize conflicts over location of the harbour within the various community groups within the island
- maximum social and economic benefits
- discuss and define issues over of location of the harbour
- discuss, learn and understand the coastal and beach dynamics of the island from the experiences of the locals
- identify how to minimize potential impacts to the beach and the island

### 8.3 Methodology

The stakeholder consultation was divided into two parts. They are the consultation with the concerned Government authorities and consultation with Hanimaadhoo island community and other people who use airport harbour. Prior to community consultation a preliminary rapid assessment of the island environment in terms of orientation of the island, beach, beach dynamics, reef and reef extent, existing opening through the reef for boat entry was carried out to understand the opinions of the proponent.

Government authorities consulted included Construction Ministry and Regional Airport (the proponent), and Ministry of Environment.

Community consultation consisted of two parts. They are consultation in the field and consultation in various community areas. Consultation in the field involved small groups of locals including fishermen, boat owners and contractors from Hanimaadhoo and other islands. EIA consultants met with these groups in all possible collations for the airport harbour and shared experiences of the locals in terms of potential and inevitable environmental and socio-economic impacts that may be caused due to locating the harbour in any particular locations.



Figure stakeholder consultation in the field

The EIA team also met with the island groups in several locations

These consultations started by giving the people background of the airport harbour development project in Hanimaadhoo and the EIA process. People were made aware of the EIA requirements, its aims and objectives with respect development projects such as harbour. Some of the case studies about consequences of harbour development without following proper EIA process were highlighted to show the community the need for EIA which can minimize negative impacts to the environment.

After giving the background of the airport harbour project and the requirements EIA process, discussions were carried mainly on the proposed design and location of the harbour in terms of its usage practicality. Discussions were also conducted on potential impacts to the beach by constructing a harbour in the identified location and alternative locations.

The EIA team also took the advantage of the opportunity to gain from the knowledge of the locals about the beach dynamics around the island in both monsoons and what happens to the beach in each monsoon.

#### ***8.4 Outcomes of the Stakeholder Consultations***

##### ***Government***

Regional Airports (MHTE) is the Proponent of the project and has a mandate for implementation of the project in Hanimaadhoo airport. As an implementing agency Regional Airports follows

instructions and advice given by other relevant government agencies and is responsible for timely start and completion of the airport harbour project. According to Proponent the construction work of the harbour will start soon after approval of EIA study. The Proponent of the project, is fully supportive of EIA process and willing to accept alternative design for the harbour and the scope of the project that may found to be more appropriate in terms of environmental impact minimization and maximization of social and economic benefits to the island community.

Ministry of Environment has the overall responsibility of overseeing potential environmental impacts due to development projects including harbours and regulates developments projects in terms of potential negative impacts to the environment through EIA regulation passed under the Environmental Protection and Preservation Act (Law No. 3/94) of Maldives. The MHTE is also responsible for coastal and beach protection with respect to beach erosion and taking protection measures. Concerns of MHTE with respect to the harbour development project in Hanimaadhoo were protection of the beach, the coastal vegetation and the island as a whole on long-term basis. In this respect the natural environment of the island shall not be compromised for even a higher cost of the project that may arise due to any alteration of the project (including alternative design of the proposed harbour) identified through EIA. In addition to these concerns of MHTE includes assigning a party responsible for proper operation and maintenance of the harbour.

Housing ministry is responsible for preparing land use plans for the islands. Land use plans play an important role in location of the public facilities such as harbour within the island environment.

Following are the list of officials from government authority consulted

*Ahmed Mahreen – Ministry of Transport and Communication*

*Mohamed Shanoon – Engineering Section, MCPI*

*Aminath Nazima – MOFAMR*

*Aishath Shimla – MOFAMR*

*Mohamed Shaafy – Ministry of Planning*

*Moosa Ibrahim – ERC*

*Ahmed Jameel – Environment Section, MEEW*

### *Atoll community*

Community consultations with atoll people who use the airport harbour revealed that the top priorities of them are safety and protection from rough weather. They have complained about the difficulties they face at times of rough weather when using the airport harbour.

The community consultations indicated that the community is frustrated because of the long delay in providing a safe access to the airport harbour in Hanimaadhoo. Several people from various islands have had serious accidents and injuries when trying to get on land from the boats. Loss of goods namely food items, construction material and other commodities had occurred over the years due unsafe landing to the island. In this respect the community's argument over the proposed detached harbour is that the design will be very inconvenient for safe unloading of their goods.

### *8.5 Conclusions of stake holder consultations*

Public consultation was an important part of the EIA of Hanimaadhoo airport harbour development project in several ways.

- most importantly the project could potentially alter the beach dynamics entirely leading to irreversible erosion of the beach and cause some damage to the island
- the main environmental issue was protection of the natural beach and its aesthetic beauty and prevention of potential erosion of the island.
- in general the community wish to have a conventional type harbour at the airport that will prevent the damage passengers and to the vessels

The stakeholder consultations conducted for the EIA study of construction of airport harbour in Hanimaadhoo provided invaluable information both on environmental and socio-economic impacts that may arise from the project. The consultations will also help to minimize potential negative impacts through taking mitigation in light information collected on physical environment and social environment of Hanimaadhoo. Aim and objectives of the stakeholder consultations were achieved to a satisfactory level.

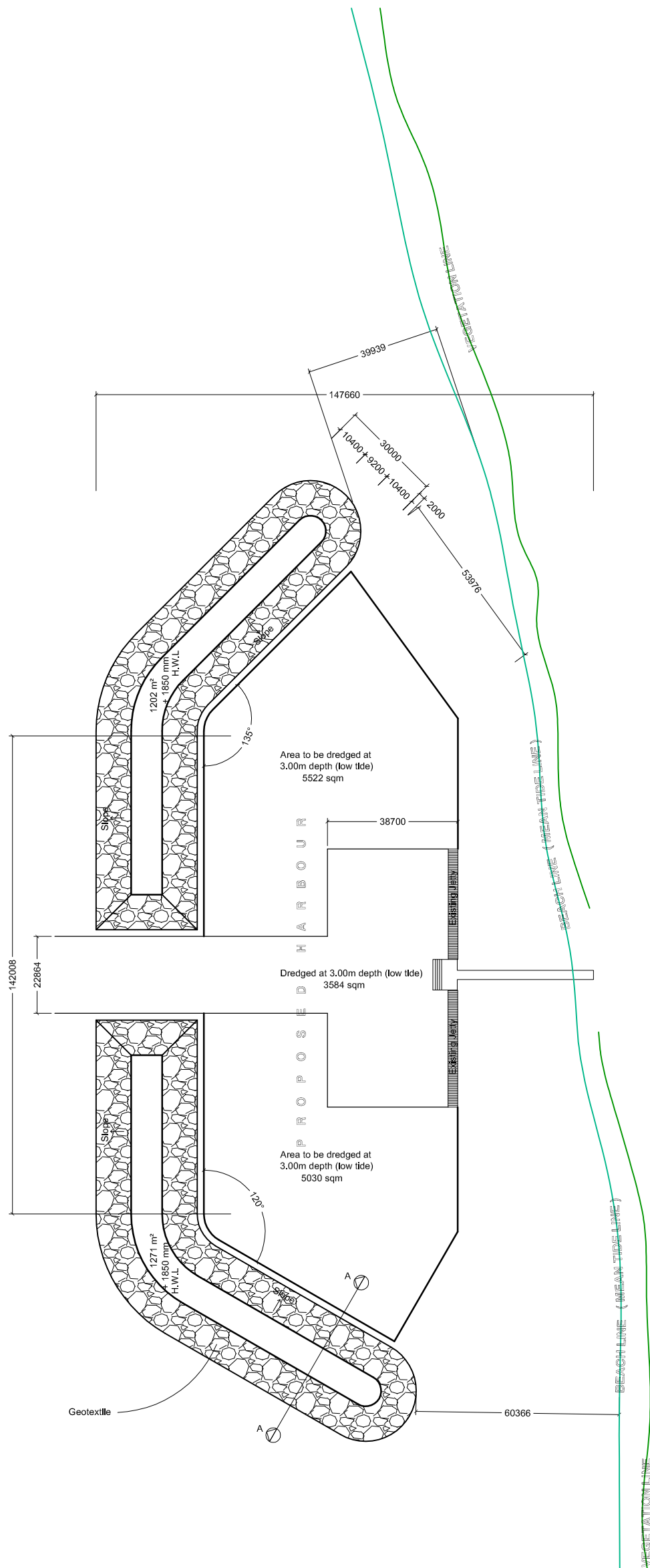
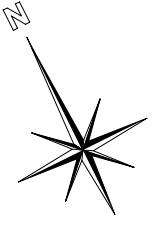
## 9. Location and design of the harbour

The proposed location and design of the harbour is based on the surveys and assessment of the existing physical and social environment of the island. The field surveys concentrated on three locations of the island's coastal and marine environment to select the best location in terms of minimal negative impacts that may cause to the island environment while maximizing the benefits of the proposed harbour development.

The proposed design of the harbour was based on maximizing water flow in and around the harbour area to minimize potential disruption of water flow and beach dynamics around the island. An important factor also considered in the proposed design of the harbour is the needs of the users. This social factor together with environmental factors restricted options for location of a harbour in the island.

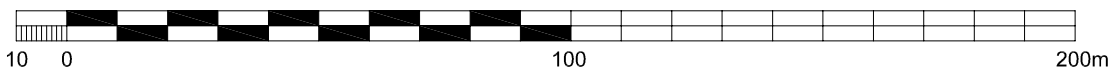
The design and location proposed by the client is a detached harbour, connected by a long jetty on concrete columns near the existing jetty of the Airport (see figure 33).

This option was the first consideration while the environmental and socio-economic surveys and assessments that were conducted in the island. The surveys and assessments revealed that this option would be safer for the beach environment as the beach consisted of an extensive sand budget that is highly dynamic. A detached harbour would do less to alter long-shore currents near the beach.



# PROPOSED DESIGN FOR THE HARBOUR

SCALE 1 : 1500



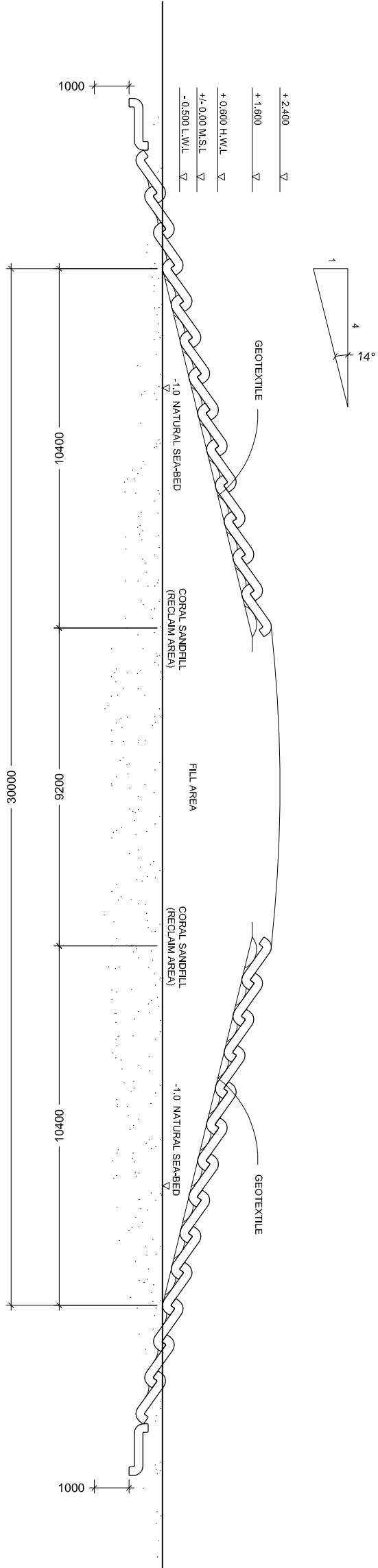
**e CAD ASSOCIATES PRIVATE LIMITED**  
 TOTAL + BUILDING + SOLUTIONS  
 M.SILVER STAR, HAVEEREE HINGUN 20-02 MALE, REPUBLIC OF MALDIVES  
 TEL: +960 3344654, FAX: +960 3344653, EMAIL: ecad.associates@gmail.com  
 www.ecadassociates.com

PROJECT: <b>HA. HANIMAADHOO HARBOUR DEVELOPMENT</b>
TITLE: PROPOSED SITE PLAN

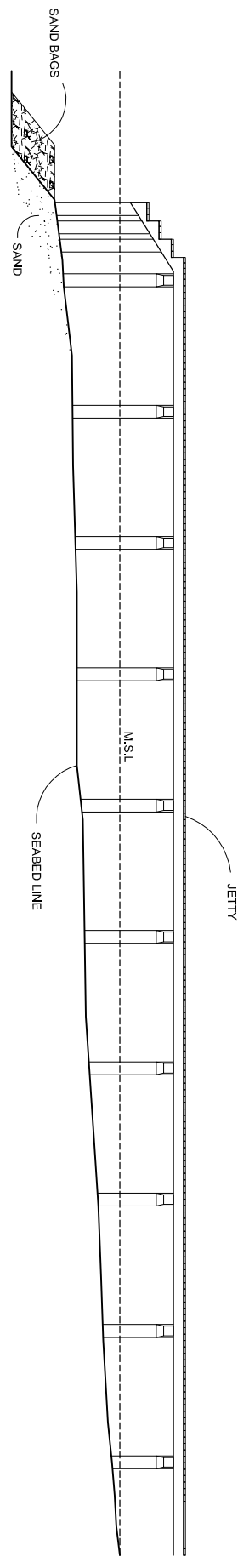
CLIENT: REGIONAL AIRPORTS	AMENDMENTS
SCALE: AS GIVEN	CHECKED BY:

DESIGN BY: -	PROJECT. NO: EA - 149
STRUC. DESIGN BY: -	DATE: JANUARY 2009
SURVEYED BY: H,R/M,M/H,S/LS	SHEET NO: SV - 03
DRAWN BY: H,R/H/S	

Do not scale drawing. Figured dimensions are to be followed. All measurements must be verified on site. Any discrepancies to be reported to the architect, engineer and/or interior designer. Contractor to provide shop drawings for approval.



**CROSS SECTION THROUGH BREAKWATER**  
SCALE 1 : 150



**SECTION THROUGH JETTY**  
SCALE 1 : 150

PROJECT:	HA. HANIMAADHOO HARBOUR DEVELOPMENT
TITLE:	CROSS SECTION THROUGH BREAKWATER & JETTY

CLIENT:	REGIONAL AIRPORTS
SCALE:	AS GIVEN

AMENDMENTS	
CHECKED BY:	

DESIGN BY:	-
STRUC. DESIGN BY:	-
SURVEYED BY:	H,R/M,M/H,S/L/S
DRAWN BY:	H,R/H/S

PROJECT. NO:	EA - 149
DATE:	JANUARY 2009
SHEET NO:	SV - 04

Do not scale drawing. Figured dimensions are to be followed. All measurements must be verified on site. Any discrepancies to be reported to the architect, engineer and/or interior designer. Contractor to provide shop drawings for approval.

## **10. Assessment of impacts**

### **10.1 Introduction**

The Maldives has a very fragile environment: small volcanic islands, rising just a couple of meters above sea level, surrounded by clear, lucid waters over white coral sandy bottom and protected by corals reefs: the back born of the country.

The importance of healthy coral reefs for the country cannot be over emphasized. The islands on which we live are constructed of coral. Reefs protect islands and habitation from destruction by storm waves. Houses were built using coral. Tuna, the mainstay of the Maldivian diet depends on reef ecosystems. Reef-oriented tourism is the largest source of income for the Maldives. Therefore, protection of the natural resources should be a component of any development project.

The growth in the agriculture, tourism and fisheries sectors and related industries and services has posed threats to the quality of the environment and the natural resource stock of the country. This situation has presented serious challenges in ensuring minimal damage to the very environment on which the sustainable development of the Maldives depends.

### **10.2 Methodology used for Impact Identification**

The environmental impacts of the proposed project have been looked into separately as follows:

- a. Existing natural and anthropogenic impacts. Extensive field surveys and assessment of the existing environment of Hanimaadhoo have been conducted to establish the historic and current status.
- b. Negative and positive environmental impacts in construction and operation phase of the proposed harbour. Extensive field surveys and assessment identified potential negative impacts that may result from the work activities of the proposed project.
- c. Potential environmental impacts during the operation or post-construction phase of the proposed project. A long-term monitoring programme will be implemented to identify positive and negative operation and post-construction work of the proposed project.

Impacts on environment of the island system from various activities of the proposed harbour construction and operation, have been identified through analysis of the proposed project, discussions with the project proponent, extensive field surveys, observations and assessment as well as based on field experience of similar other work in the country. Quantitative, semi-

quantitative and qualitative methods were used to collect data and information on the island environment and the proposed project by field work and consultations. These data and information were analyzed to predict significance and extent of impacts that may arise from the proposed project activities. Analogous project data have been used wherever possible since the use of such data is applicable and less time consuming and makes the impact prediction and analysis more accurate.

The problem in data collection imposed by the time constraint, unavailability of data, and gaps in knowledge did not allow for the quantification of impacts on the environment from the proposed work fully and very thoroughly. In addition lack of guidelines on, for instance set standards and acceptable values of turbidity, siltation or sedimentation on the reef and the lagoon during construction and operation, complicated identification of potential impacts due to the project. So this assessment did not compare how much the proposed work could cause siltation/sedimentation on the reef and siltation on lagoon bottom to depart from the standard set values. Consequently it was not possible to use predictive analysis to fully determine the nature, magnitude, extent, significance of the impacts critically. Therefore, it was opted for describing these impacts as determined by expert judgment, in addition to the acquired data and information from the field surveys and assessments.

This assessment identified and quantified the significance of possible negative impacts of the proposed work on the environment. Impacts were identified and described according to their type, extent, short-term or long term, reversible or irreversible and assessed in terms of their significance according to the following categories:

- d. Negligible – the impact is too small to be of any significance (category I);
- e. Minor negative – the impact is undesirable but acceptable (category II);
- f. Moderate negative – the impact give rise to some concern but is likely to be tolerable in short-term or will require judgment as to its acceptability category III);
- g. Major negative – the impact is large scale, give rise to great concern, it should be considered unacceptable and requires a significant change to the proposal (category IV).

### **10.3      *Existing Natural and Anthropogenic Impacts***

The field surveys and assessment revealed that environment of the island system have been impacted both by natural and anthropogenic causes to varying degrees. Impact due to the tsunami in 26 December 2004 was identified not significant in general. Field surveys of the reef, beach, coastal and inland vegetation and general environment showed that there was no significant impact due to the tsunami. Natural impact identified were significant beach erosion especially in south of the island harbour. Major anthropogenic negative impacts included clearance of significant area of vegetation for various developments and sand mining from the beach in central west part of the island.

## 11. Impacts of the proposed project

### 11.1 *Physical Impacts in Construction Stage*

Major negative impacts on environment of the island would be associated mainly with the work activities of the proposed project. Significant negative impacts due to the proposed work activities would be on the lagoon and the reef.

Significant direct and indirect negative impacts arising from the proposed work activities would be attributed to the following activities of the project

- Mobilization of equipment and materials
- Excavation of harbour basin
- Entrance channel deepening
- Breakwater deployment
- Disposal of excavated materials from the harbour basin

### 11.2 *Mobilization of equipment and materials*

The main equipment mobilized to the site will be excavators and trucks. Materials mobilized to the site will consist of coral stones for construction of breakwaters, cement, aggregates and concrete reinforcement iron and river sand for construction and other concrete fabrication. In addition to these fuel for operation of the equipment will be mobilized to the site.

Potential impacts associated with mobilization of these equipment and materials exist. They are:

- Damage to reef from mobilization of heavy equipment such as excavator and trucks
- Spillage of aggregate and river sand to the beaches and the lagoon due to rough weather and high wave conditions. Aesthetic beauty of the beaches will be reduced when river sand is mixed with sand on the beach and difficult to separate.
- Spillage of fuel oil and waste oil to the marine and terrestrial environment. Considerable amounts of fuel will be needed for the operation of the heavy equipments and waste oil will be generated which is difficult to dispose properly.

- Non-biodegradable solid waste generation. Considerable amount of non-biodegradable wastes including waste concrete, concrete iron, gunny bags and timber will be generated. Which will be difficult to properly dispose

### **11.3      *Excavation of harbour basin***

As shown in the conceptual drawing in figure 33 excavation of the harbour basin will be carried out in the western side of the island using a conventional excavator. An area of approximately 10,552m<sup>2</sup> of the lagoon bottom will be excavated to a depth of 4m at mean tide. Excavation will be carried out from the rear side of the harbour basin and continued toward the island. Approximately 27,000m<sup>3</sup> of materials will be generated from the proposed excavation work. These materials will be used to construct islet which will serve as breakwaters on both sides of the harbour.

### ***11.3.1 Impact on lagoon***

Following impacts to the lagoon area and the reef will be associated with the proposed excavation of the harbour basin

- Permanent loss of the natural lagoon bottom habitat in the area. Approximately 10,500m<sup>2</sup> area of the lagoon bottom will be directly impacted as a result of the proposed excavation
- Siltation in the lagoon bottom. Approximately 13,500m<sup>2</sup> may be silted therefore directly impacted
- Alteration of the lagoon bottom habitat and the infauna. Approximately 10,500m<sup>2</sup> of the lagoon bottom may be altered therefore directly impacted
- Turbidity increase in the lagoon water column resulting in decrease in fish and other pelagic populations. Approximately 75,000m<sup>2</sup> of the lagoon area may be indirectly impacted due to turbidity increase resulting from excavation. However this impact will be short-term.

### ***11.3.2 Impact on coral reef***

Coral reef in the western side of the island will be impacted due to the proposed excavation. The impacts to the coral reef include impacts of potential excessive sedimentation on corals. Sedimentation impacts on the coral reef may be felt on an area of approximately 50,000 m<sup>2</sup> of the reef-flat area and indirectly impacted. 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.

Impacts on the coral reef may be short term depending on the intensity of siltation.

## ***11.4 Entrance channel deepening***

Existing entrance channel will be deepened through the reef in western side of the island. The dimensions of this channel will be 400m long and 23m wide. Depth of the channel will be 4m at

mean tide. The channel will be deepened by using an excavator. The materials taken from the clearance of the entrance channel will be used as a part of the breakwaters.

#### ***11.4.1 Impacts on reef flat (Biotic)***

Approximately 1,000 m<sup>2</sup> area of the reef-flat will be cleared to deepen the proposed entrance channel to the harbour. The impact will be permanent loss of corals and other benthic organisms in the area. Indirect impact will be felt in an area of approximately 6,500 m<sup>2</sup> of the reef-flat. Indirect impact to the reef will be mostly resulting from turbidity increase in the lagoon water and siltation in the reef-flat area.

#### ***11.5 Jetty construction***

The harbour front is the existing jetty and in a second phase of the project an extension of the jetty will be constructed using concrete pillars joined together with wooden planks. The jetty will be approximately 250m long and a 3m wide after completion. The pillars will be pre-casted on land and deployed in positions using an excavator as usually done. The main impacts of jetty construction will be excavation and disturbance to the seabed.

#### ***11.6 Breakwater construction***

Breakwater will be constructed by deploying dredged spoil. Total length of breakwater will be approximately 275m. Approximately 27,000m<sup>3</sup> of dredged spoil will be used for this purpose.

##### ***11.6.1 Impact on lagoon***

Impact on lagoon associated with construction of the breakwater include disturbance to the lagoon environment and turbidity increase in the area during construction activities and operation of equipment in the area. These impacts will be short-term and maybe felt in an area of approximately 14,000 m<sup>2</sup>

##### ***11.6.1.1 Impact on reef flat***

Breakwater construction will directly and permanently impact the reef-flat in the area covering the reef-flat. Approximately 9,000 m<sup>2</sup> of the reef-flat will be permanently lost. Indirect impact to the coral reef will be resulting from turbidity increase and sedimentation in the area. Approximately 20,000 m<sup>2</sup> of the reef-flat will be indirectly impacted as a result of breakwater construction.

### 11.7 *Ecological Impacts in Construction Stage*

Potential negative ecological impacts on the marine and coastal environment from the proposed work are more variable and difficult to predict as the long-term data are not available. It is predicted that the following impacts maybe felt due to the proposed harbour development activities.

- Turbidity increase in the water column from spreading of silt plumes.

When lagoon floor is disturbed by excavation, fine sediment and silt may be released into the water column. Lagoon sediments consisting of varying sizes of particles may be suspended for days in the water column cutting down light to photosynthetic reef benthos. The magnitude of this impact will depend on various factors such as size of particles; hydrodynamic conditions; and reef and lagoon topography. In addition to this many infauna and their habitats will be lost. However, it is found that lagoon infauna re-establishes sometime after excavation of the lagoon bottom.

- Possible siltation and excessive sedimentation on coral reef

Excessive sedimentation and siltation on coral reefs is detrimental to corals and other reef benthic organisms as it cuts down necessary light and physically smothers corals and other benthos. This may reduce coral growth and more importantly coral recruitment. Sediment free reef substrate is needed for coral larvae to settle and grow and continue the reef building process. In addition to this some of the coral colonies will be physically removed that may result in loss of other important reef benthic organisms.

- Direct disturbance of the lagoon bottom by excavation may result in loss of habited for some lagoon infauna such as polychaete worms and amphipods which inhabit in the lagoon bottom.

Lagoon bottom is an important habitat for certain organisms such as worms, mollusks, amphipod etc. which are important food sources for bottom feeders such as certain species of fishes. By removing sand from the lagoon bottom would disturb habitats of these organisms.

Long-term ecological impact arising from the proposed work activities is not predicted to be significant in terms of their geographic extent as the proposed work is limited and localized in a small part of the island system. However, long-term monitoring is required to identify ecological impacts more completely and thoroughly.

The following table shows magnitude, duration and significance of predicted impacts to the island environment due to the proposed project work activities.

Table impact significance

Activity	Equipment & material mobilization	Harbour basin excavation	Entrance channel deepening	Jetty construction	Breakwater deployment
Impact nature					
Magnitude of impact / Impact category	Category II Minor negative	Category III Negative	Category III Negative	Category I Minor negative	Category III Negative
Duration of impact	Short-term	Long-term	Long-term	Short-term	Long-term
Reversibility	Reversible	Irreversible	Irreversible	Reversible	irreversible
Impact significance	Insignificant	Significant	Significant	Insignificant	Significant

### **11.8 Physical Impacts of Operation Stage**

The operation or using of the proposed channel and mooring area will not have significant negative physical impacts on the environment of the island system. Based on other similar projects potential operation impacts maybe related to periodic maintenance of the deepened channel through the lagoon and the mooring area. This maintenance impacts is related to periodic deepening that maybe require maintaining the depth of the channel and the mooring area. Magnitude of this impact will depend on the rate of filling up of the area by natural sedimentation. This impact however, small and limited to few activities will be long-term and therefore will be assessed through long-term monitoring. Positive impacts as a result of this project will be safeguarding the island environment from negative impacts such as illegal sand extraction from the beach by the locals Potential operation negative impacts will be as follows;

- Turbidity increase in the lagoon water from the boat activities in the channel and the harbour basin.

Propellers of the boats can disturb lagoon bottom and increase turbidity of the lagoon water as the boats enter, exit and maneuver inside the harbour basin. Aesthetic value of the lagoon maybe reduced in addition to negative impacts of disturbance to the lagoon bottom organisms. Certain pelagic species especially fishes inhabiting in the lagoon maybe negatively impacted due to increased turbidity above the natural level.

- Turbidity increase in the lagoon water of the surrounding as a result of periodic maintenance deepening of the channel and the harbour basin area.

Deepening by excavation of the lagoon bottom will increase turbidity of the lagoon water resulting in similar consequences as mentioned above.

- Alteration of lagoon bottom community as a result of periodic maintenance deepening of the channel and the harbour basin area

Periodic excavation to maintain the needed depth of the harbour basin may not allow for the lagoon bottom organisms to establish and thus benthic community may change. This change may decrease abundance and diversity of lagoon infauna.

- Waste from boats including waste oil

Increased number of boats coming to the island will generate and leave behind more waste including waste lubricating oil from engines of the boats.

- Leakage of fuel on coastal and marine environment

Harbour will lead to increase boat operations in the island and demand for refueling in the island will be created. This will also create potential for leakage of fuel especially in the harbour area.

### ***11.9 Ecological Impacts of Operation Stage***

Biological and ecological impacts related to the proposed development can be long-term and difficult to identify and assess in short-term. These impacts maybe related to chronic turbidity increase in the lagoon water and its consequences to the ecology of the lagoon and the reef. Biodiversity in the area maybe reduced over long-term and community structure of the lagoon bottom may also be changed from the natural status to a different one. Lagoon bottom and pelagic species composition maybe changed to species that are more resilient to high water turbidity.

Ecological impacts of the operation of proposed project will be assessed in detail through implementation of the monitoring programme given in this report.

### ***11.10 Socio-economic impact***

The airport harbour of the Hanimaadhoo has been long awaited by the passengers and boat operators. Positive socio-economic impacts resulting from the project will be safe and convenient access to the airport and protection for the vessels that use airport facilities.

The proposed project will be investing about Rf5 million for harbour development in the island. A significant amount of this may be distributed within the island and the atoll community. In addition to this a number of short-term job opportunities may be created for the island community.



## 12. Mitigation measures

### 12.1 *Mitigation measures in construction stage*

Early planning is the key to minimize the impacts on the marine and coastal environment from the proposed development of airport harbour in Hanimaadhoo. If environmental concerns are considered concurrently with technical and logistical planning of the proposed work and precautions are applied from the outset of the planning process most of the negative impacts of the airport harbour development in Hanimaadhoo identified can be minimized and mitigated.

In all development projects, it is essential to identify possible impacts to the natural environment and suggest best possible ways of minimizing or overcoming those impacts. In this regard a number of mitigation measures were taken to minimize the impacts of construction of the harbour which are identified in the previous section of this report. The following mitigation measures were taken to minimize the impacts from the proposed development of airport harbour in Hanimaadhoo.

- Locations of the proposed harbour is selected based on extensive field surveys and assessment of the terrestrial and the marine environment of the island.
- Two locations most suitable for the proposed harbour construction in terms of feasibility and least impact has been assessed in detail to select most appropriate location.
- The proposed development was assessed to decide the minimum required dimensions of the harbour needed and that can be developed in the existing environment of the island.
- The proposed design and dimensions of the harbour were to minimize potential disruption of current circulation around the island and the beach dynamics to prevent possible beach erosion that may cause from coastal modification by constructing the structures of the harbour.
- The proposed airport harbour development in Hanimaadhoo will be completed in as short period as possible and the work in marine environment will be carried out during outward drift of current so that potential sediment settling on the reef would be minimized. Therefore, the proposed work of channel clearance and lagoon deepening will be conducted when the current direction is away from the reef and the lagoon.
- Vessels and equipment used for the work will be properly maintained at all times during the operation to avoid possible damage to the environment from them.

- No coastal vegetation will be removed.
- Minimum required channel area will be deepened
- No beach rock will be removed
- Waste oil will be carefully collected and taken to Thilafushi for proper disposal
- Solid wastes generation will be minimized through careful planning of work, reuse and recycling wherever possible. The National Solid Waste Management plan will be followed.
- The project manager, and the work force involved during the operation of the work will be briefed of environment friendly practices.
- The work will be properly supervised and monitored to minimize negative effect on the environment.
- The terrestrial and the marine environment will be monitored for potential impacts on the biological and ecological aspects of the environment.
- Littering and accidental disposal of any construction wastes will be avoided by pre-planning modalities for waste disposal or re-use wherever possible. Careful planning of the work activities will be carried out to reduce the amount of waste generated.
- Whenever heavy equipment and vessels are mobilized closer to the reef care will be taken to avoid accidents and damage to the reef

## **12.2 Mitigation Measures in Operation Stage**

Most of the impacts of operation will be identified during operation of the project hence mitigation measures during the operation of the proposed project will be subject to rigorous and continuous environmental monitoring that is presented in this report. Some of the predicted operation impacts are waste from boats including used oil, boat activities and general impacts of increased human activity.

Leakage of fuel may be a potential operational impact to the island environment especially around the harbour area in land and in water. This impact will be minimized through proper refueling facility in the harbour area. Refueling facility will be inspected and maintained regularly to avoid leakages of fuel.

Waste collection bin will be provided in the harbour area to manage the solid waste generated by the boats coming to the harbour.

Environmental monitoring of the harbour operation will be conducted to avoid and mitigate potential impacts to the island environment.

## 13. Evaluation of alternatives

Alternatives developments including no development option for the proposed development have been evaluated. Alternative developments are evaluated based on physical, biological and socio-economic environment of the island as well as the costs and feasibility of the proposed project development.

### 13.1 *Alternative location for the harbour*

Alternative location is the locating the harbour near the MNDF jetty. This location is relatively far from the airport terminals making it very difficult for the passengers. The passengers have to use land transport to commute to the terminal building. This may cause security concerns as well.

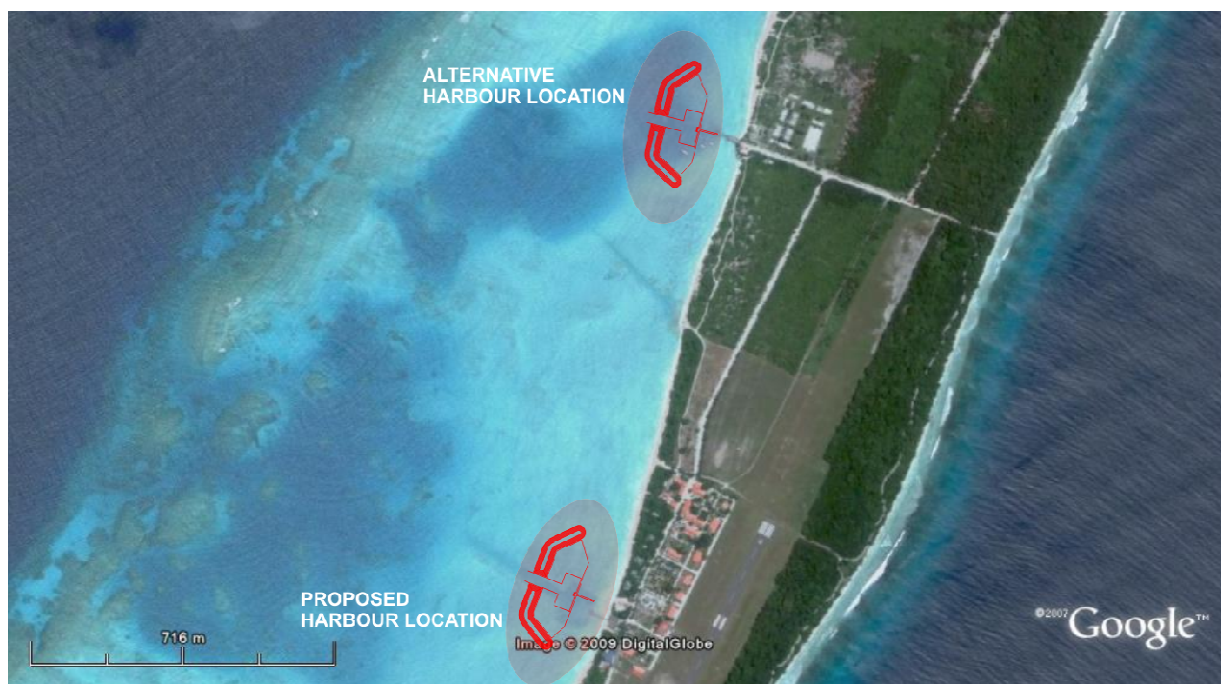


Figure alternative location

### 13.2 *Alternative design for the harbour*

The alternative design would be constructing a conventional harbour that is attached to the island. One such harbour is found in the populated areas of Hanimaadhoo. The effect of such a conventional harbour

on the beach dynamics of the island is very clearly visible from this harbour. The harbour walls will disrupt near-shore hydrodynamics creating severe coastal erosion problems on the lee of the harbour. Because of this bad experience in the same island it is recommended to keep the airport harbour detached from the beach. The option of a conventional harbour can be ruled out given the dynamic nature of Hanimaadhoo beach. Every effort should be given to prevent adverse coastal erosion problems when constructing harbours.

### ***13.3 No development option***

The no project development option can avoid all the negative impacts to the environment. However, no project development option will leave the passengers and boat owners disadvantaged and the development of the island and the atoll will be slowed. This can result in negative impacts on the social and economic conditions of the community in general and an economic loss to the airport operators.

## 14. Impact monitoring

Since most environmental changes occur over long period of time, it is important to implement a specific long-term monitoring programme for the marine and coastal environment. It is important to monitor the effects of development prior to, during and after project implementation. It will also be important to ensure that environmental design criteria are met during construction. This can be achieved by inspections at appropriate intervals during the construction phase. Environmental supervision or inspection during project implementation was not practiced in the Maldives until recently. Recent environmental supervision or inspection has proven to be an effective tool in minimizing the impacts and in ensuring that appropriate precaution and care is employed.

### *14.1 Monitoring of coastal and beach environment*

Coastal and beach monitoring must focus on both construction and operation stages of the proposed project. Coastal and beach monitoring should also consider monsoonal changes and the transitional period and therefore long-term coastal monitoring shall be carried out at least in every three month intervals. The following monitoring requirements may be adequate for the purpose of evaluating potential environmental effects from the proposed development in order to implement more effective mitigation measures.

1. Beach profiles will be taken at designated locations at not more than 100m distance from one another to provide enough data to establish changes in coastline at designated locations and around the island.
2. Bathymetry of the lagoon will conducted every six months to assess sediment dynamics
3. Currents will be monitored using current meters or drogues.
4. Wind and tide data will be obtained from the meteorological records. However, it would be useful to measure wind speed and directions at the site
5. If available, periodic aerial photos may also be used to assess long-term changes to the hydrodynamic and littoral regimes.

### 14.1.1 Monitoring programme for the beach and coastal zone

Following table shows coastal and beach monitoring programme suggested for the proposed airport harbour development project in Hanimaadhoo island.

Table beach and coastal monitoring programme

Parameters / Method	Frequency of monitoring	Purpose
<b>Beach/erosion &amp; accretion</b> Beach profiles	Before and after project implementation and every three months afterwards	Understand the changes to the beach profile of the island and how sand moves around the island
<b>Sediment dynamics</b> Currents (using drogue or current meter)	Before and after project implementation and every three months afterwards	Understand how currents vary in the coastal system and assess its relation to sand movement around the island
<b>Sediment dynamics</b> Bathymetry	Every six months before and after project implementation	To monitor the effects of shoaling
<b>Sediment dynamics</b> Waves and tides	Once or twice a year	Understand effects on coastal environment including erosion & accretion

### 14.1.2 Monitoring programme for the terrestrial environment

Table terrestrial environment monitoring programme

Parameters / Method	Frequency of monitoring	Purpose
<b>Coastal vegetation</b> Transects and visual observations	Twice a year	Understand the changes to the vegetation and vegetation cover as percentage of the island

## **14.2 Monitoring programme for the marine environment**

Suggested marine environmental monitoring programme to assess and mitigate possible major negative impact on the marine environment is given below. The impacts predicted above and the effectiveness of the control and mitigation measures proposed must be evaluated during the work and changes brought if necessary.

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project activities and operation are included in the monitoring plan. These include turbidity and nutrient contents of lagoon water, sedimentation and live coral cover and coral recruitment. Monitoring will be carried out as part of the environmental impact assessment and mitigation of possible negative impacts from the proposed project of the proposed harbour development.

### **14.2.1 Aim of monitoring**

The primary aim of the monitoring is to provide information that will aid impact management, and secondarily to achieve a better understanding of cause-effect relationship and to improve impact prediction and mitigation methods.

### **14.2.2 Objectives of monitoring**

The following monitoring plan is used to measure impacts that occur during the proposed project activities and determine the accuracy of impacts that are predicted and the effectiveness of mitigation measures. The objectives of the monitoring plan are to measure:

- the amount of sedimentation on the reef
- water quality and visibility
- coral cover and recruitment and
- beach erosion

to ensure that these measurements are kept within the baseline limits and predicted impacts are accurate and mitigation measures taken are effective.

The following table shows methods, parameters monitoring, frequency and purpose of the marine environmental monitoring programme.

Table marine environment monitoring programme

Methods / Parameter	Frequency of Monitoring	Purpose
<b>Ambient Environmental</b> Temperature, Salinity, Turbidity/light penetration, Currents	Once a month during the work  And once every two months thereafter	Important to the 'health' of living marine resources, reefs and fish populations and other benthos
<b>Coral reef</b>  Manta Tow Technique or Time Swim	Once after the work is completed  And once every year thereafter	Broad scale qualitative and Semi-quantitative assessment of general status of the reef system / coral and other benthic organisms
<b>Marine Environmental Aesthetic</b> Survey using Time Swim and Manta Tow Technique	Once after the work is completed	Broad scale semi quantitative assessment of anthropogenic activities e.g. wastes disposal, amount of rubbish on the reef and general appeal of the reef system
<b>Fish populations</b>  Underwater Fish Census	Once after the work is completed  And one every year thereafter	Quantitative assessment of fish population of selected species
<b>Coral cover/recruitment</b>  Quadrates	Once after the work is completed  And twice every year thereafter	Quantitative assessment of temporal changes in the reef system e.g. coral growth rates
<b>Sedimentation</b>  Sediment traps deployment/collection	Twice a month during work and Once every 3 months thereafter	Quantitative assessment of sediment loading on the reef benthos.
<b>Water quality</b>  Water quality test	Once every month	Quantitative assessment of Nitrogen and Phosphorous contents and other parameters: Assess total Dissolved Solids

The objectives of this monitoring program are to detect and document the changes occurring to the reef system due to the proposed project. The purpose will be to 1) assess the magnitude of the impacts resulting from the various stages of the proposed work and 2) to take mitigation measures to minimize the negative impacts and protect the reef and the lagoon system of the island.

Table estimated cost of environmental monitoring

**14.3 Breakdown of Monitoring Yearly Monitoring Cost**

Activity	Quantity	Cost	USD
Establishment of baseline environmental status for monitoring	1		5,000/-
Field work	24		10,000/-
Document preparation	4		5,000/-
Logistics (for 12 trips)	1		1,000/-
Travel and accommodation for a team of four	12		20,000/-
<b>Total</b>			<b>41,000/-</b>

## 15. Conclusions

This environmental impact assessment study depicted that the proposed development project will cause both short-term and long-term significant impacts to the marine and coastal environment of the island. The impact to the marine environment arising from the proposed development will be felt on the lagoon environment on southern side of the island from construction of the proposed harbour. The impact will be the loss of the natural habitat for lagoon infauna of the lagoon environment due harbour basin excavation and channel deepening. Short-term impacts of this development activity will be spreading of fine sediment in the lagoon water which will be minimized through appropriate mitigation measures of timing of excavation and completing the project in as short period as possible.

Socio-economic impact of the proposed project will be very positive. Positive socio-economic impacts resulting from the project will be safe and convenient access to the Airport and protection for the vessels using the airport harbour.

This assessment showed that the negative impacts to the island environment arising from the proposed project are relatively low and the project is justified in terms of its benefits to the socio-economic environment of the island community and to the nation as a whole.

## 16. Appendices

### 16.1 *Appendix 1. 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 based on the points discussed in the scoping meeting held on 15 October 2008 for undertaking the EIA of the proposed Airport Harbour Construction at Hanimaadhoo Haa Dhaal Atoll.

This document is a legally binding document prepared after consultation with all relevant stakeholders and the EIA report must strictly follow the activities under this ToR.

1. Introduction - Identify the development project to be assessed.
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, how the project will be undertaken, full description of the relevant parts of the project, using clearly labeled maps, scaled site plan (indicating the changes and modifications that will be brought) including quay wall depth of the harbour, dimension of existing entrance channel using appropriate scales where necessary.

Provide details of extension of harbour, placement of quay wall, sand revetments and breakwaters, dredging of harbour basin, volume of sediments to be excavated in 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, project inputs and outputs, project schedule; and life span. Report should also highlight how the location was determined. And justify that the proposed location and the design for the harbour is most appropriate.

Task 2. Description of the Environment - Where baseline data is to be collected, careful consideration must be given to the design of the survey and sampling programme. Data collection must focus on key issues needing to be examined for the EIA. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that the data collected is suitable for use as a baseline to monitoring impacts.

Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area (and disposal sites), focused on the marine environment, including the following:

- a) Physical environment: geomorphology, meteorology (rainfall, wind, waves and tides), sea currents, surface hydrology, long shore sediment transportation patterns, climatic and oceanographic conditions in the area, bathymetry of possible dredge areas, marine receiving water quality (including parameters; turbidity, dissolved oxygen, salinity, suspended solids, pH, Nitrate, nitrite, phosphate, COD, and BOD among other chemical parameters.)
- b) Biological environment: terrestrial and marine vegetation and fauna, vegetation map showing areas of vegetation clearance, brief description of the marine environment, including lagoon and reef system,



rare or endangered specie, sensitive habitats in Hanimaadhoo, 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, view of fishermen who use the reef and community perception of the development.
- d) Hazard vulnerability; vulnerability of area to storm surge.
- e) At least four beach profiles at different locations should be provided to establish the baseline statistics giving GPS positions of each site.

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. All water samples shall be taken at a depth of 1m from the mean sea level or mid water depth for shallow areas. The report should outline the detailed methodology of data collection utilized to describe the existing environment. Baseline conditions should be presented for the marine environment.

An average of at least 5 measurements must be given for each parameter tested and analyzed from a certified laboratory. Provide details of calibration for any onsite data analysis.

Task 3. Legislative and Regulatory Considerations - Describe the pertinent national and international 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 and spoil disposal that must be included with potential areas that may be affected by siltation and changes to local hydrodynamic regime. Distinguish between significant impacts that are positive and negative, direct and indirect, 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) 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 th's impacts defined due to the proposed harbor development,

- 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 island's environment.

Task 5. Analysis of Alternatives to the Proposed Project - Describe the alternative examined for the proposed project that would achieve the same objective including the "no action alternative". The alternatives should be focused more on alternative technologies for construction of the quay wall and breakwater and alternative



methods of dredging. Alternative location for dredging must also be considered. Determine the best practical environmental options. And mitigation measures must be described for this alternative.

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 containment and turbidity 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. Environmental Management Plan and Monitoring - A time frame should be outlined for monitoring focused on the construction and operational phase. Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for dredging/disposal operations. Detail of the monitoring programme including the physical and biological parameters for monitoring, frequency, duration and cost commitment from responsible person, detailed reporting time table and ways and means of undertaking the monitoring programme must be provided.

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, Ministry of Fisheries, Agriculture and Marine Resources, Ministry of Planning and National Development, MEEW and at least one contractor with experience in undertaking harbour 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 Regulations, 2007.

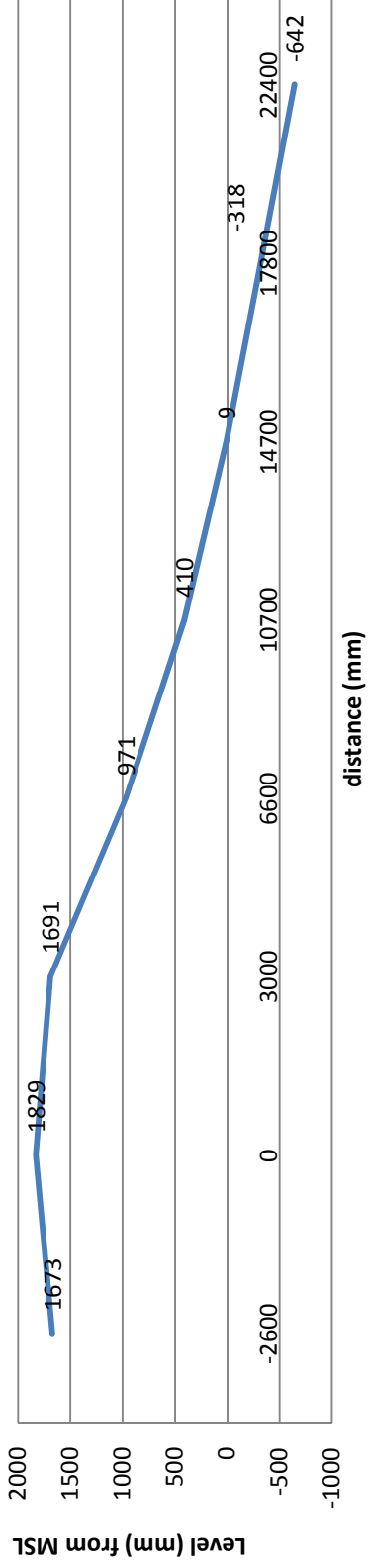
Timeframe for submitting the EIA report - The developer must submit the completed EIA report within 2 months from the date of this Term of Reference.

(02 November 2008)

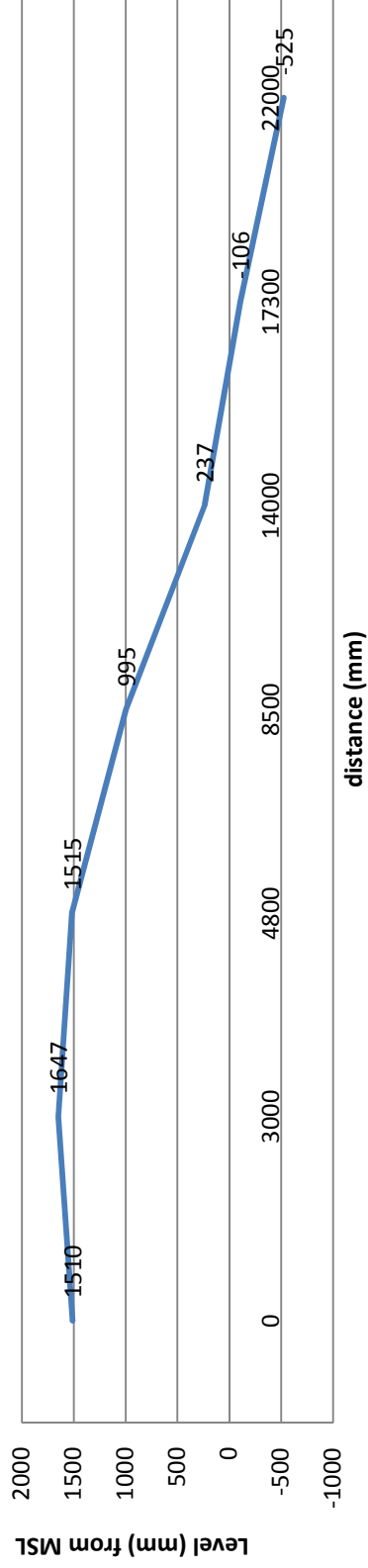


**16.2**      *Appendix 2. Beach profiles*

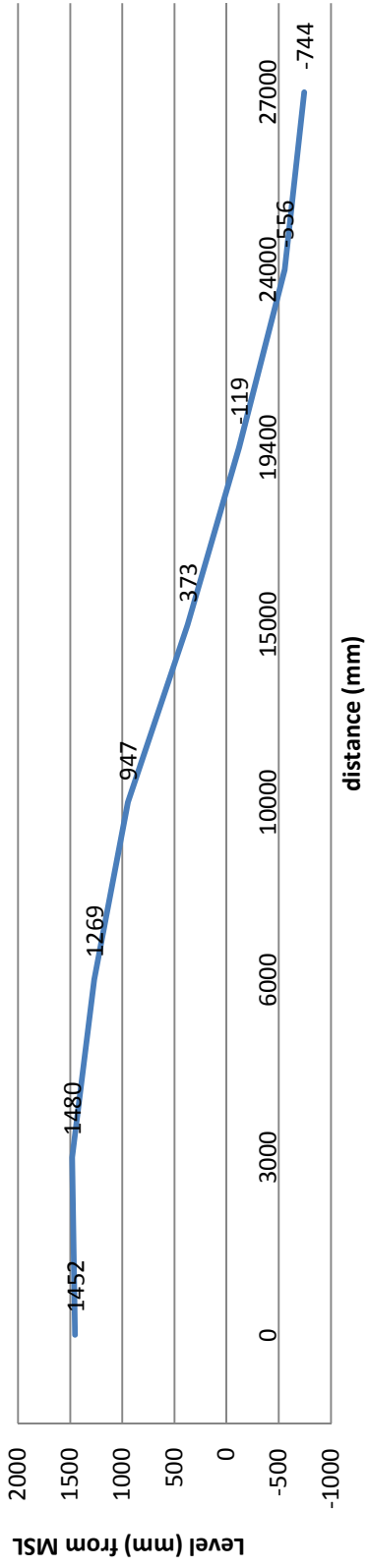
## PROFILE A



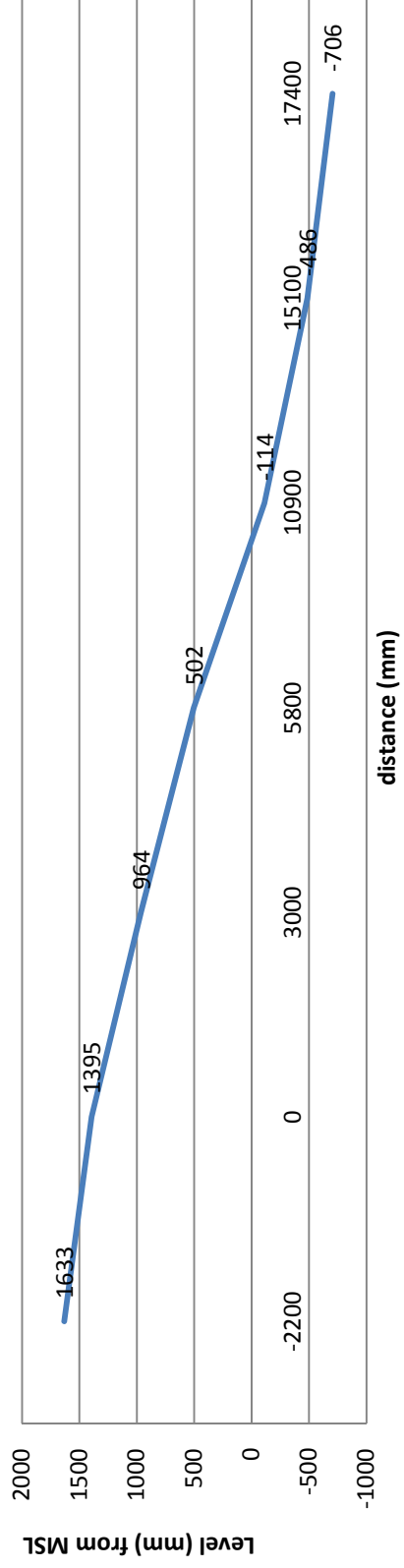
## PROFILE B



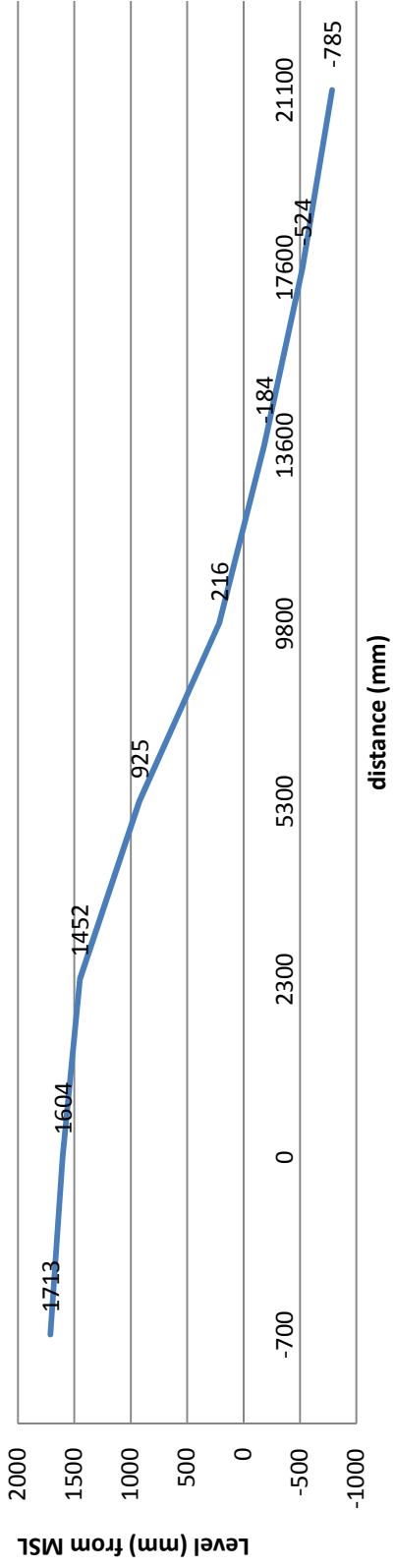
### PROFILE C



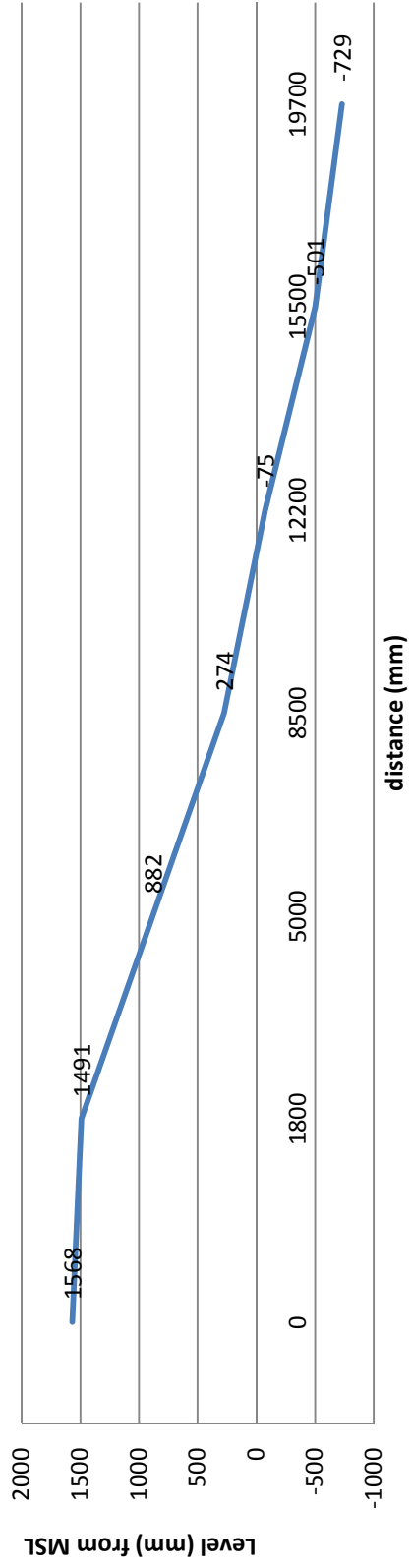
### PROFILE D



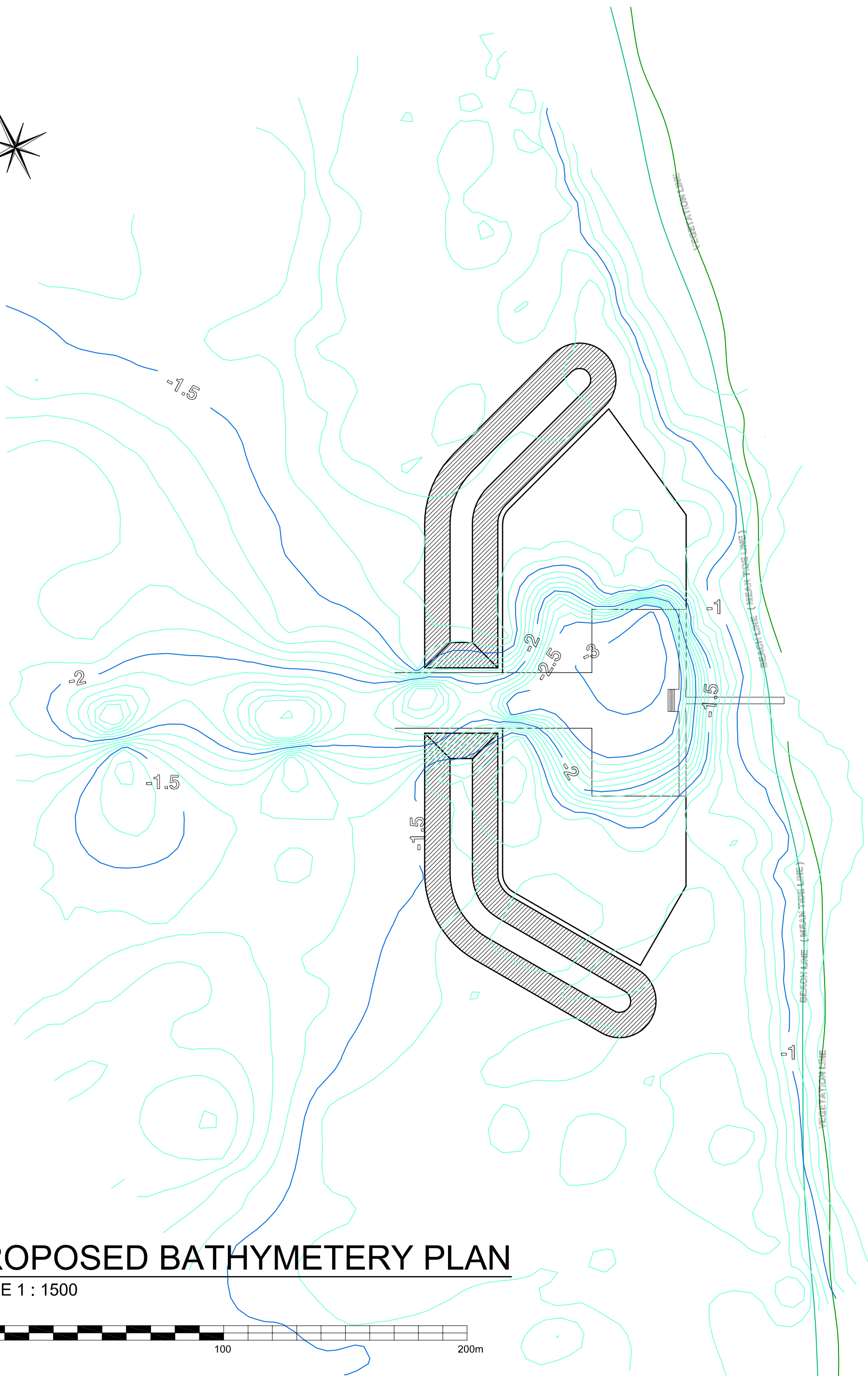
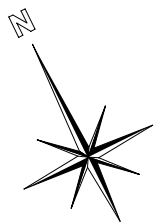
## PROFILE E



## PROFILE F

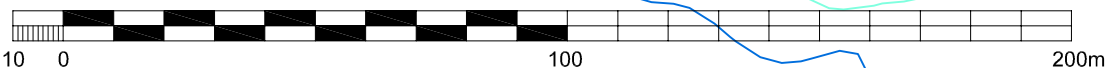


**16.3**      *Appendix 3. Bathymetry*



# PROPOSED BATHYMETERY PLAN

SCALE 1 : 1500



**ECAD ASSOCIATES PRIVATE LIMITED**  
TOTAL + BUILDING + SOLUTIONS  
M.SILVER STAR, HAVEEREE HINGUN 20-02 MALE, REPUBLIC OF MALDIVES  
TEL: +960 3344654, FAX: +960 3344653, EMAIL: ecad.associates@gmail.com  
www.ecadassociates.com

PROJECT:  
**HA. HANIMAADHOO HARBOUR DEVELOPMENT**  
TITLE:  
PROPOSED BATHYMETERY PLAN

CLIENT:  
REGIONAL AIRPORTS  
SCALE:  
AS GIVEN

AMENDMENTS  
\_\_\_\_\_  
\_\_\_\_\_  
CHECKED BY:

DESIGN BY: -  
STRUC. DESIGN BY: -  
SURVEYED BY: H,R/M,M/H,S/L/S  
DRAWN BY: H,R/H/S

PROJECT NO:  
EA - 149  
DATE:  
JANUARY 2009  
SHEET NO:  
SV - 02

Do not scale drawing. Figured dimensions are to be followed. All measurements must be verified on site. Any discrepancies to be reported to the architect, engineer and/or interior designer. Contractor to provide shop drawings for approval.

**16.4**      *Appendix 4. Water quality test results*



National Health Laboratory  
Maldives Food and Drug Authority, Male' Republic of Maldives

WATER CHEMISTRY ANALYTICAL RESULTS

REPORT NUMBER: NHL/TR-WC/RC/1527

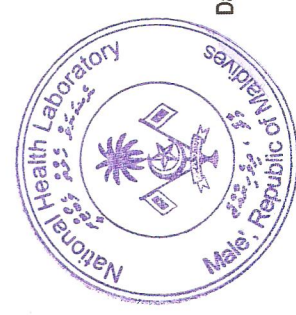
TIME TESTED: -  
COLLECTED BY: MOHAMED MUSTHAFA

•NAME OF CLIENT: E CAD ASSOCIATES PVT LTD •PURPOSE OF TESTING: Quality Monitoring	E-CAD ASSOCIATES PVT LTD HDH.HANIMAADHOO SEA WATER HS1 HDH.HANIMAADHOO SEA WATER HS2	
•LOCATION OF SAMPLE	HDH.HANIMAADHOO SEA WATER HS1 HDH.HANIMAADHOO SEA WATER HS2	
Requisition Form No:	NHL/WC/2008/RQ1207	
•Date sampled	17/10/2008	
•Time Sampled	1915pm	
•Type of water	Sea	
Date tested	19-27/10/2008	
Sample ID	191008WC145      191008WC146	
PARAMETER TESTED	TEST METHOD	
Physical Appearance	Clear	
Turbidity	1 NTU	
Oxygen, Dissolved	9.9 mg/L	
Salinity	35300 mg/L	
Electrical Conductivity	54200 µs/cm	
Total Dissolved Solids	27200 mg/L	
Suspended Solids	0 mg/L	
Nitrite	0.001 mg/L	
Nitrate	0.00 mg/L	
Reactive Phosphate	0.34 mg/L	
Chemical Oxygen Demand	1108 mg/L	
(Adapted from DR/4000™/Spectrophotometer procedure manual) Adapted From Hach 2100 N Turbidimeter Instruction Manual Method 8366 8166 8333,8316(Adapted from DR2010™/4000™/5000™ Spectrophotometer procedure manual) Adapted from corning checkmate lImeter instruction manual Adapted from corning checkmate lImeter instruction manual Adapted from corning checkmate lImeter instruction manual Method 8006( Adapted from DR4000™/5000™ Spectrophotometer procedure manual) Method 8507 (Adapted from DR4000™/6000™ Spectrophotometer procedure manual) Method 8039,8171 (Adapted from DR4000™/5000™ Spectrophotometer procedure manual) Method 8048 (Adapted from DR 2010™ 4000™/5000™ Spectrophotometer procedure manual) Adapted from corning checkmate lImeter instruction manual	(Adapted from DR/4000™/Spectrophotometer procedure manual) Adapted From Hach 2100 N Turbidimeter Instruction Manual Method 8366 8166 8333,8316(Adapted from DR2010™/4000™/5000™ Spectrophotometer procedure manual) Adapted from corning checkmate lImeter instruction manual Adapted from corning checkmate lImeter instruction manual Adapted from corning checkmate lImeter instruction manual Method 8006( Adapted from DR4000™/5000™ Spectrophotometer procedure manual) Method 8507 (Adapted from DR4000™/6000™ Spectrophotometer procedure manual) Method 8039,8171 (Adapted from DR4000™/5000™ Spectrophotometer procedure manual) Method 8048 (Adapted from DR 2010™ 4000™/5000™ Spectrophotometer procedure manual) Adapted from corning checkmate lImeter instruction manual	

COMMENT:

Analysed By  
 Aishath Thirima Latheef

Technical Manager  
 Fathmath Yuna Siraj



Date 30th October 2008

NOTE: • Information supplied by the client

This Result is valid only for this sample. This report is not for duplicate or advertisement without prior approval from NHL

ދިވެހިސަރުކާރުގެ ގެޒެޓް



National Health Laboratory  
Maldives Food and Drug Authority, Male' Republic of Maldives  
WATER MICROBIOLOGY ANALYTICAL RESULTS

REPORT NUMBER: NHL/TR-WM/RC1317

•NAME OF CLIENT: E-Cad Associates pvt Ltd  
•PURPOSE OF TESTING: Quality Monitoring

TIME TESTED: 12:30  
• COLLECTED BY: Mohamed Musthafa

•LOCATION OF SAMPLE	E-Cad Associates pvt Ltd		TEST METHOD
	HDH, Hanimadhoo Sea Water HS1	HDH, Hanimadhoo Sea Water HS2	
Requisition Form No:	NHL/MM-2008/RQ/1108		
•Date sampled/processed	17/10/08	17/10/08	
•Time Sampled	19:15	19:15	
•Type of water	Sea water in sterilized bags		
Date Tested	19/10/08	19/10/08	
Sample ID	191008WM 147	191008WM 148	
PARAMETER TESTED			
Total Coliform Count /100ml	40	0	HPA std method, 2005, W2 issue 4
Faecal Coliform Count (E.Coli) /100ml	0	0	HPA std method, 2005, W2 issue 4

COMMENT:



Authorized by

Analyzed By  
Milina Rasheed

Technical Manager  
Thooma Adam

Date: 20<sup>th</sup> October 2008

NOTE: • Information supplied by the client.

This Result is valid only for this sample. This report is not for duplicate or advertisement without prior approval from NHL

**16.5**      *Appendix 5 Commitment letter*

Regional Airports  
Male  
Maldives  
20<sup>th</sup> December 2008

Mr. Mohamed Aslam  
Minister  
Ministry of Housing, transport and Environment  
Male  
Maldives

Dear Sir,

Re: Development of Hdh. Hanimaadhoo Airport Harbour

As the developer of the above project, we hereby confirm our commitment to carry out the environmental mitigation measures and monitoring program outlined in this EIA report.

Sincerely,

Name:

Designation:

## 17. Reference

- 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. Published by Australian Institute of Marine Science, Townsville
- Kenchington, R.A. (1984). *Large Area Survey of Coral Reef, UNESCO Report in Marine Science*, 21: 92-103
- Kenchington, R.A., *The Republic of Maldives, Managing Marine Environment*, Taylor and Francis New York Inc. (1990).
- Loya, Y. (1978). *Plotless and Transect Methods*.  
Stoddart, D.R. and R.F. Johnnes (editors). "Coral Reefs: Research Methods". UNESCO, Paris.
- Open University (1994)., *Waves, Tides and Shallow Water Processes*,  
Elsivier Science Ltd. Oxford.
- Pernetta, J.C (1993) ed. *Marine Protected Area Needs in the South Asian Region*,  
Volume 3: Maldives, IUCN, Gland, Switzerland.
- Roe D, Dalal-Clayton & Hughes, R (1995). *A Directory of Impact Assessment Guidelines*. International Institute for Environment and Development, Russell Press, Nottingham, UK.
- Salvat, B (1997). *Dredging in Coral Reefs. In Human Impacts on Coral Reefs: Facts and Recommendations*. B. Salvat, ed. Antene Museum . E.P.H.E., French Polynesia.
- State of the Environment Maldives (2002).  
Ministry of Home Affairs, Housing and Environment - Maldives.
- State of the Environment (SoE), 2002, Ministry of Home Affairs, Housing and Environment, Maldives.
- USACE (2001), *US Army Coastal Engineering Manual*, USACE
- Viles, H. and Spencer, T. (1995).  
*Coastal Problems: Geomorphology, Ecology and Society at the Coast*  
Edward Arnold, a division of Hodder Headline PLC, 338 Euston Road, London.