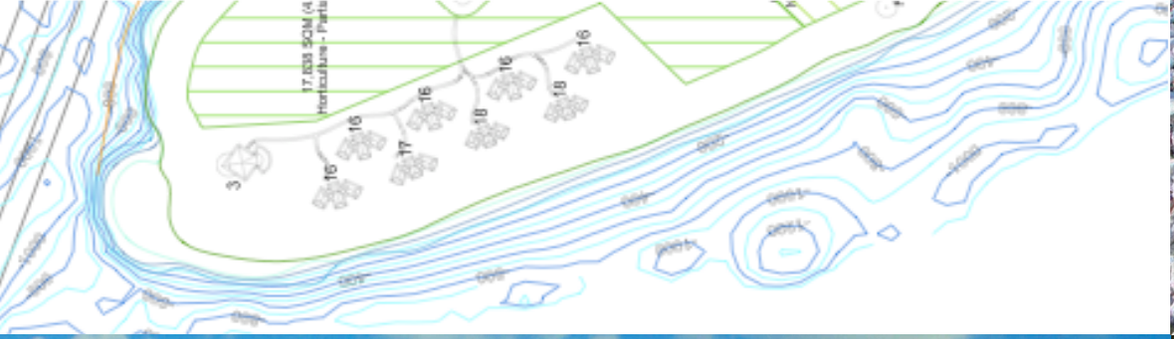

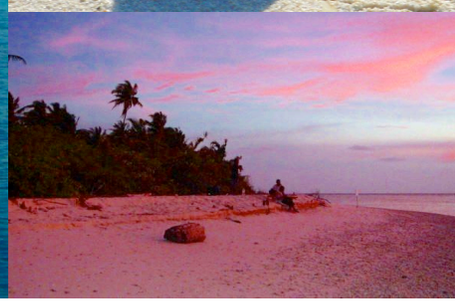

environmental impact assessment report

december, 2007

ga.funadhoo island for agricultural development
north huvadhoo atoll
republic of maldives

Prepared and issued by:

E-CAD ASSOCIATES PVT LTD
TOTAL + BUILDING + SOLUTIONS

Proposed by:

Mr. Ahmed Abdul Azeez
G. Aima

Consultants:

Mr. Ibrahim Naeem
Mr. Hussain Naeem
Mr. Hazim Rasheed
Mr. Hussain Shameem
Mr. Mohamed Musthafa

Consultant's Declaration

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

Name: Ibrahim Naeem **(Master of Env. Mgt.)** – EIA 13/2007

Signature

Date: 31 December 2007

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

Terms of Reference for Environmental Impact Assessment

The following Terms of Reference (ToR) is the outcome of the scoping meeting held between the stakeholders on the proposed **agriculture development project at GA Funadhoo island** that was held on 12 November 2007.

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

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

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

Task 1. Description of the Proposed Project – Describe the proposed project activities with need and justification of the proposed changes. Project description should provide proof of the owner ship of land,owner's approval to the project, ; project schedule; and life span, components as well as the scale of the project.

This should also include description of the harbor development in terms of: quality and volume of sediments to be excavated in each area to be dredged; type of dredging equipment to be used and the manner of deployment including handling, transportation, and disposal of dredged material, sediment containment settling and turbidity control measures; alternative dredging methods considered, details of shore protection measures.

The EIA shall also provide a clearly labeled site plan and a vegetation map of the location for land clearing for land structure construction and agricultural use. The report shall also provide a detailed description of how the clearing activities will be undertaken including work methods, inputs, outputs, how waste from land clearing will be managed, what measures are taken to comply with the ***Regulation on Cutting Down, Uprooting, Digging Out and Export of Trees and Palms from One Island to Another.*** *It should also include details of construction methodologies, project inputs, outputs, details of infrastructure, water supply, power generation and fuel management with particular emphasis on waste oil management.*

Provide a location map and a scaled A3 size site plan showing locations of all proposed infrastructure and set back of all the buildings from the high water mark.

Refer to EIA studies related to such projects and an indication should be given to other similar projects in the area.

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

Description of the site, existing terrestrial environment including demarcations of main vegetation area, soil type and characterizing the main features of vegetation on land ,

Physical environment including wind, wave and currents based on available secondary data and primary data collected at the site,

Marine environment to include baseline coral reef status, lagoon environment, beach sediment dynamics and current regimes around the site, faunal composition including detailed description of the significant habitats and presence of protected or endangered species, with seawater quality parameters. The seawater quality parameters would specifically include; turbidity, dissolved oxygen, salinity, suspended solids, pH, Nitrate, nitrite, phosphate among other chemical parameters.

Geographical coordinates of water sampling points should be provided. A proper assessment of the bathymetric conditions of the project site should be undertaken, including local hydrodynamics. All survey locations shall be referenced with Geographic Positioning System (GPS). All water samples shall be taken at mid depth. The report should outline the detailed methodology of data collection utilized to describe the existing environment

c) Task 3.Stakeholder and Public consultation - . major stakeholder consultation to include Ministry of Fisheries, Agriculture and Marine Resources, Ministry of Environment, Energy and Water and any other relevant stakeholders. Public consultation of nearby inhabited islands if relevant to the project.

Methodology of how the data was collected should be included.

Task 4. Legislative and Regulatory Considerations - Describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. This section should also include how the proposed project conform with the existing plans,policies,guidelines regulations,laws and international conventions.

Task 5 Determine the Potential Impacts of the Proposed Project – the EIA report needs to identify the direct and the indirect impacts to the environment (biophysical,economic,human environment etc.)

Identify the impacts for both construction and operational phase. Identify impacts related to dredging, spoil disposal and possible land filling. Distinguish between significant impacts that are positive and negative, direct and indirect ,and short and long term. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making. Special attention will be paid to:

- *Effects of the project (dredging and spoil disposal) on water quality and existing coastal ecosystems and resources, and*

- *Effects of dredging on the coastal stability of adjacent shorelines.*

- *Effects of the coastal modification on beach and house reef.*

- *Effects of coastal modifications on the potential for flooding of the island.*

- *Effects of vegetation clearing, construction waste and other proposed project activities on land.*

Task 6. Analysis of Alternatives to the Proposed Project. – Describe the alternatives examined for the proposed project that would achieve the same objective including the "no action alternative. This includes alternative construction methodologies; *alternative technologies, material, locations and mitigation options. Distinguish the most environmentally friendly alternatives.*

Task 7. Mitigation and Management of Negative Impacts

Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to vegetation clearing, coastal modifications, dredge spoil disposal and dispersal/sedimentation control. Cost the mitigation measures, commitment, equipment and resources required to implement these measures.

Contingency plan in case of accidents like fire need to be included.

Task 8.Environmental Management Plan and Monitering . Environmental monitoring including parameters that will be monitered should be highlighted with the monitoring methodologies,frequency and the procedure for reporting to the authority.

Presentation - The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Report, 2007.

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(30 December 2007)

Contents

List of Tables

List of Figures

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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 Project Funadhoo at Funadhoo island (in Ga. Atoll, Maldives) as a farming island. The project is proposed by Ahmed Abdul Azeez, G. Aima, Male'.

Funadhoo in Ga. Atoll is one of the several islands leased by Government to develop agriculture throughout the country. The island is leased for 21 years through a tendering process by Ministry of Fisheries, Agriculture and Marine Resources.

The main construction activities of the proposed project involves development of a harbour and a navigation channel in northeastern side of the island, clearance of vegetation in north and central area of the island to construct service buildings and allocate land for farming and eastern side shore protection by filling in with materials taken from proposed harbour area. The construction activities will be completed within one year from the start of the construction phase.

The main operation activities will be cultivation of vegetables, fruits and poultry farming and storage and transportation of these products to nearby islands, Male' and to the resorts that will be developed in the atoll in future. Implementation of the proposed project will last for 20 years.

Location

The proposed development project is located in the island of Funadhoo in North Huvadhoo Atoll at 0°33'42.85" N and 73°31'33.83"E. The nearest airport is Kaadedhoo airport approximately 60km west of Funadhoo. The closest island to the project location is a very small uninhabited island named Funadhoovilingili less than 1km north. The closest inhabited islands to the project location are Kondey (population 383)7km, Dhiyadhoo (population 229) 9km and Gemanafushi (population 1110) 13km south of the project location and Dhaandhoo (population 1563) 9km and Nilandhoo (population 847) 11km north of the project location. The closest resort island which is under development is Hadaha 10km southwest of the project location.

The project location, Funadhoo island is located on eastern rim of Huvadhoo Atoll within a separate coral reef system (within a separate Falhu). Any part of Funadhoo island or reef is not included in the list of sites requiring special protection.

Alternative developments

Various alternative to the proposed development have been suggested in this study including alternative location for the harbour and access/navigation channel, a jetty instead of a harbour, samller scale project, alternative coastal protection, alternative location for the project and no development option. The proposed location of the harbour and the scale of the project were selected in terms of the project feasibility. The preferred coastal protection will be undertaken instead of the laternative of no coastal protection as it will protect the island in long-term. The selected location (island) for the project was based on overall development policy of the Government however, alternative location for the project for instance the inhabited island of Kondey may have less environmental impacts in terms of project development activities. No development option can have negative socio-economic impacts as the economic opportunities for the locals will not be created if no development option was selected. Furthermore no development option can lead to continuation of the present coastal erosion causing severe environmental degradation in the long-term.

Key impacts

Key impacts of the preferred development option of the proposed project is related to a relatively few development activities. These include impacts to the lagoon area from the proposed harbour and access navigation channel development. This activity was found to impact the lagoon from turbidity and alteration of the lagoon bottom. Approximately 4% of the lagoon was found to be impacted due to the proposed harbour development. This will also impact 20% of the eastern side seagrass bed. However, this seagrass bed is not ecologically significant because of poor growth. Construction of harbour protection will also impact 8% of the near shore area. Navigation channel deepening will impact 2% of the lagoon bottom. The proposed shore protection in southern and southeastern side of the island will have a short-term impact of approximately 20% of the eastern and southern coastal area from possible spreading of fine sediment in the lagoon. These impacts are found to be short-term and reversible over a period of time. Partial vegetation clearance will impact approximately 2% of the vegetation as it will involve clearance of only bushes. Main vegetation clearance will impact approximately 5% of the island vegetation. This will have a significant impact as many coconut palms and large trees will be removed. However, the impact will be minimized through relocation of the large trees.

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

operation. Thus an on-going monitoring programme will be conducted in order to assess the long-term ecological impacts of the proposed project.

Mitigation measures

Mitigation measures were taken by conducting appropriate field surveys and environmental assessment of the proposed location with respect to the proposed project. The proposed project is based on extensive field surveys to identify the best locations and scale of the proposed development work and scale of operation. Consultation among the proponent, developers and the environmental consultants were conducted to find the most appropriate development options in order to mitigate and minimize potential impacts due to the proposed development project. Ongoing monitoring will be conducted to find possible long-term and ecological impacts that may arise from the proposed project development and operation.

1. Introduction

1.1 Background information of the project

Project Funadhoo aims to develop and promote agriculture industry in the country specifically in Huvadhoo Atoll, by developing Funadhoo island as an environment friendly and sustainable organic agricultural and farming center. The project has two main components: utilisation of traditional farming methods and appropriate farming technology in cultivation of vegetables and fruits in the island and development of infrastructure in the island needed for the operation of the project.

Environment friendly and sustainable agriculture development in Funadhoo integrates three main goals: environmental stewardship, agriculture profitability, and contribution to local and national economy. Sustainable agriculture in the island will facilitate to grow vegetables and fruits without causing irreversible damage to ecosystem health. Two key issues are biophysical and socio-economic.

The project aims to contribute to national economy directly and indirectly through large scale production of vegetables and fruits, reduction of dependency on imports of such products and creation of employments and employment opportunities especially in the atoll.

The project especially aims to generate commercial benefits by production and promotion of locally produced vegetables and fruits by organic farming. Organically grown vegetables and fruits will be packed to high standards and marketed to upper-market tourist resorts in the country and supermarkets in Male'. Organically grown vegetables and fruit products have a high demand in tourist resorts in the country and worldwide.

Organic farming is a form of agriculture which avoids or largely exclude the use of synthetic fertilisers and pesticides, plant growth regulators and livestock feed additives. Organic farming relies on crop rotation, integrated pest management, animal manures and mechanical cultivation to maintain soil productivity to supply plant nutrients, and to control weed, insects and other pests. The role of organic agriculture is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings.

Infrastructure development needed for the project mainly involves of creation of an access (navigation) channel to the island, a harbour, construction of a powerhouse, storage and staff accommodation buildings. In addition to this infrastructure development, plots of land will be cleared of existing vegetation in order to create land for farming in the central area of the island. The project also involves island shore protection on eastern side of the island by filling in the shore area with material that will be taken from the proposed harbour area.

1.2 Project costs

The value of investment proposed for the first five years is Rf 13,000,000/- (thirteen million Ruffiya) for the lease rent in addition to the capital investment of Rf 20,000,000/- The total investment of for the first five years in Rf 33,000,000/- The proposed infrastructure development cost or capital investment that will incur in the first year is Rf 20,000,000/- . This cost will be related to development of access channel, harbour and structures and facilities namely accommodation, powerhouse, power generators, desalination plant and waste management facility.

1.3 The proponent and its experience with similar projects

The Project Funadhoo is proposed by Mr. Ahmad Abdul Azeez, G. Aima, Male', Maldives. He has similar project experience in development of agriculture islands and tourist resorts in the country.

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 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 agriculture development project will be carried out in accordance with existing plans, policies, guidelines, laws and regulations of Maldives in addition to international conventions to which Maldives is a party to.

Policies and Plans relating to the proposed development project include, Strategic Economic Plan, Seventh national Development Plan 2006 – 2010 and Agriculture Development Master Plan.

According to the Strategic Economic Plan, agriculture continues to play a minor and diminishing role in the economy, constrained by limited availability of cultivable land and the abundance of cheap imports of vegetables and fruits. And apart from domestic consumption need, the continuous influx of tourists will generate an increasing demand for fresh agricultural products. The Strategic Economic Plan also highlights that the agriculture sector has the potential for further development to enable Maldives to become self-sufficient in some vegetables and fruits, save foreign exchange and to provide alternative occupation in the sector. Agriculture development strategies include;

- strengthening development of uninhabited islands into agricultural islands
- recognition of a domestic market of 300,000 and a half a million of tourists
- recognition of influx of cheaper vegetable imports resulting in substantial foreign exchange loss
- distribution of fresh vegetable products to resort
- recognition of lack of capital to finance agriculture development

The Strategic Economic Plan highlights the following areas as possible areas for enhancement

- develop agricultural activities to meet the needs of locals as well as tourists
- establish catalytic roles of the Government to support agriculture development
- set up trade/distribution centers on main the islands within the Northern and Southern Growth Regions regional to facilitate distribution of agriculture products

Under Seventh National Development Plan a number of policies area formulated for development of agriculture.

These include;

- ensuring sustainable agriculture development,
- strengthen human resources for agriculture sector development,
- enhance capacity for technology generation and dissemination
- developing system, networks and physical infrastructure for strengthening marketing and trade and to encourage commercial agriculture, and
- ensure food security and improve nutritional status of the rural and urban populace

The government of Maldives recognizes that the agriculture industry is an important sector for the economy of the country. In this respect a 15 year Agriculture Development Master Plan has been formulated. Under the 15 year Agriculture Development Master Plan the Government is facilitating the private sector to develop of agriculture industry in the country. In this regard the Government has started leasing uninhabited islands on long-term basis for the development of agriculture in the country. In response to this initiative by the Government, the proponent has bided for four islands out of the eleven islands recently announced for leasing for the purpose of agriculture development in the country.

Ministry of Fisheries, Agriculture and Marine Resources is the leading Government Agency having mandates for management of uninhabited islands hence formulates Laws and regulations with respect to leasing of uninhabited islands on long-term basis for such developments. An important Law in this regard is Law No. 20/98 on uninhabited islands of Maldives. Under this Law uninhabited islands shall be leased for a maximum period of 21 years to eligible individuals or parties for the best proposals of development. However, if the initial investment for such development is more than US$10 million, the lease period shall be 35 years. A number of regulations have been formulated and enforced under this Law, including felling of trees for timber, and sand and aggregate collection. Permission shall be obtained from the relevant Government authorities prior to such actions in leased (on Varuvaa) islands.

According to the Lease Agreement between the Government and the lessee of Islands leased on long-term basis for major economic development such as agriculture development, trees shall not be damaged and a written permission shall be obtained from Government prior to felling of trees and collection of sand and aggregate in such islands. Also lessee is responsible for looking after the island in terms of beach and coastal erosion and measures shall be taken

by the lessee in protection the island from such events. Therefore, the Lease Agreement between Government and lessee is an important regulatory document for management of islands leased on long-term basis for economic development including Funadhoo.

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

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.

An important regulation relevant to the proposed project is also the regulation on uninhabited island with respect to felling trees for the purpose of timber resources. According to this

regulation no tree shall be fell without prior permission of relevant Government authorities and trees that need to be fell shall be replaced or replanted elsewhere.

The proponent is committed for huge investments in the development of the agriculture industry in accordance with these existing policies and plans while strictly following all relevant laws and regulation related to the proposed project activities.

3. Project Description

The Project Funadhoo is primarily a medium size agriculture development project. The project is focused on cultivation and production of mainly vegetables and fruits in Ga. Funadhoo island. In order to facilitate production and distribution of vegetables and fruits, the project involves development of necessary infrastructure in the island. The main infrastructure development in the island involves development of a harbour, entrance (navigation) channel to the harbour, building of staff quarters, storage buildings and powerhouse. In addition to these land area allocated to cultivation and farming of vegetables and fruits will be cleared of the existing natural vegetation of the island.

The project is targeted to develop the island as a medium size sustainable agriculture center in the atoll. Production of vegetables and fruits by using organic farming methods and distribution of these products to the tourist resorts, locals and Male' will be the main operational activity of the project.

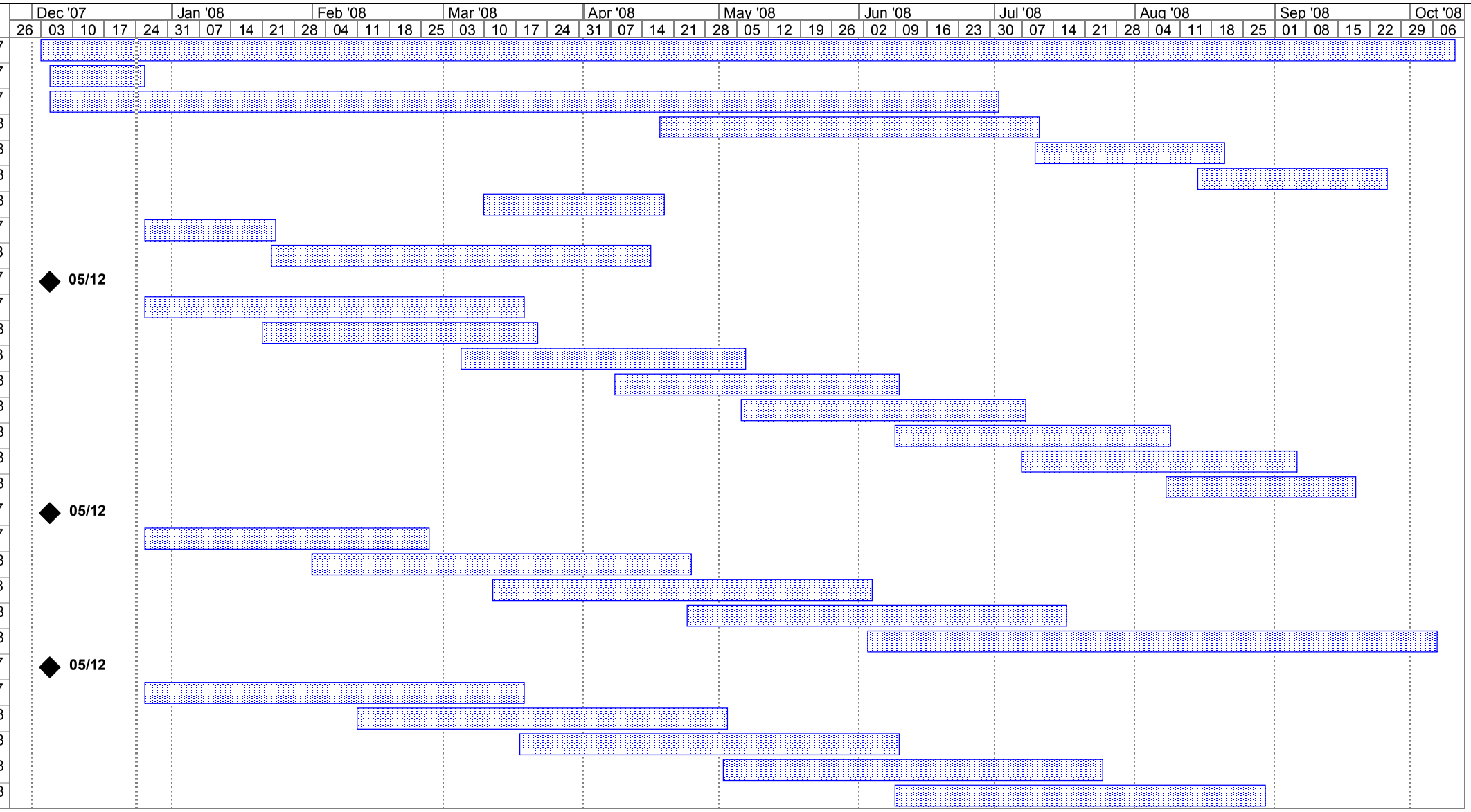
The project aims to develop the agriculture industry, specifically in the atoll and in the country in general. It also aims to contribute to national economy by creating direct and indirect job opportunities related to the project and by reducing dependency on imports of agriculture products therefore saving foreign currency.

The project also aims to; ensure sustainable development of agriculture, strengthen human resource capacity for agriculture sector, and develop networks and physical infrastructure, strengthen marketing and trade and set an example for commercial agriculture in the country.

3.1 Intended duration of the project

The intended duration of the proposed agriculture development project in Funadhoo island is a total of 21 years. Out of these 21 years 1 year is proposed for the project development period. Proposed periods of different work activities of the development stage is given in the work schedule below

ID	Task Name	Duration	Start
1	**FUNADHOO CONSTRUCTION**	225 days	Mon 03/12/07
2	Site Mobilisation	15 days	Wed 05/12/07
3	Harbor	150 days	Wed 05/12/07
4	Land Clearing for Agriculture	60 days	Fri 18/04/08
5	Shop	30 days	Thu 10/07/08
6	Clinic	30 days	Fri 15/08/08
7	Ashi - Relaxing Pavillion	30 days	Mon 10/03/08
8	Vehicle Garage	21 days	Wed 26/12/07
9	Office, Clinic, Lab, Public Toilets	60 days	Wed 23/01/08
10	TEAM A	0 days	Wed 05/12/07
11	Staff Kitchen and Mess	60 days	Wed 26/12/07
12	Mosque	45 days	Mon 21/01/08
13	Carpentry	45 days	Wed 05/03/08
14	Laundry Building	45 days	Tue 08/04/08
15	Store 1	45 days	Tue 06/05/08
16	Sotre 2	45 days	Mon 09/06/08
17	Class Room	45 days	Mon 07/07/08
18	Café	30 days	Fri 08/08/08
19	TEAM B	0 days	Wed 05/12/07
20	Power House and RO Plant	45 days	Wed 26/12/07
21	Staff Units (Standard) 1	60 days	Fri 01/02/08
22	Staff Units (Standard) 2	60 days	Wed 12/03/08
23	Staff Units (Standard) 3	60 days	Thu 24/04/08
24	Owners Bunaglow	90 days	Tue 03/06/08
25	TEAM C	0 days	Wed 05/12/07
26	Staff Units (Standard) 4	60 days	Wed 26/12/07
27	Staff Units (Standard) 5	60 days	Mon 11/02/08
28	Staff Units (Senior) 1	60 days	Tue 18/03/08
29	Staff Units (Senior) 2	60 days	Fri 02/05/08
30	Staff Units (Family) 1	60 days	Mon 09/06/08



Project: Funadhoo Construction
Date: Mon 24/12/07

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

3.3 Need and justification of the project

The contribution to the agriculture sector to GDP has continued to decline in the past. According to Seventh National Development Plan the agriculture industry contributed 2.6 percent of GDP in 2005. However, the agriculture sector plays an important role to the island communities in terms of employment opportunities, source of food and nutrition.

At present lack of development of the agriculture sector resulted in heavy dependency of imports of agriculture products to the country. About 90 percent of the country's demand for food is met from imports making the national food security situation vulnerable.

Import of agriculture products has continued to increase. There has been a 17.5 percent increase in imports of agriculture products from 2003 to 2004. In 2006 vegetable imports was valued at Rf 395 million (Maldives Customs Statistics 2004-2006). In addition to cut flowers and ornamental foliage valued at Rf 12 million. This has been resulting in a significant loss of country's foreign exchange. In this regard it is of strategic importance that agriculture the industry to be developed in the country to save foreign exchange, ensure food security and to create job opportunities.

For development of country's agriculture sector, the Government has started leasing uninhabited islands on long-term basis to carry out agriculture activities on commercial scale. Funadhoo island in North Huvadhoo Atoll is one of the 32 islands leased for development of agriculture. Funadhoo island is leased for a period of 21 years to cultivation, development and promotion of agriculture in the island.

The island had been used for small scale cultivation of vegetables and fruits in the recent past however, abandoned now due to unsustainability of small scale farming. The proposed developments in the island are targeted to medium scale industrial agriculture so that the project can be sustained. The proposed infrastructure developments in the island are minimal, necessary for medium scale industrial agriculture activities. The project is designed to make the project economically feasible as well as to minimize negative environmental impacts due to the project by minimizing infrastructure development.

3.4 Components of the project design, size and scale

The proposed project involves two stages. The first stage will be infrastructure development stage and the second stage will be operation of the proposed activities. During the first stage infrastructure needed for operation of the proposed project will be carried out. The infrastructure development stage will have four main components. These will include development of access channel and harbour, structures on land, coastal protection and clearance of land for cultivation and farming.

3.4.1 Harbour

In order to facilitate operation of the proposed project, an access channel to the island and reasonable size harbour needs to be developed in the island. At present the island has no navigational access to the island or a place to harbour vessels. The project proposes to develop a minimum size harbour needed for the for the proposed operation activities. The proposed scale of the project requires a harbour measuring at least 700m by 600m. The proposed harbour will have a depth of 4m at low tide. The harbour basin will be excavated to a depth of 3m. The harbour will be protected by constructing breakwater system on windward and island side as shown in the site plan

3.4.2 Structures on land

The proposed project will involve building accommodation houses on land for staff. A total of ten buildings for staff and senior staff accommodation will be built mostly on north western side of the island. Each of these buildings will measure 12m x 12m area and accommodate 4 people. These building will all single storeys building lower than the canopy of the island vegetation. In addition utilities buildings like guardhouse, restaurant, laundry, storage building, mosque, stores, and clinic will be built as shown in the site plan. Other main structures will be buildings for powerhouse and desalination plant, fuel storage tank, mechanical workshop and carpentry.

3.4.3 Land clearance

Partial and total land clearance will carried out for building structures and to make land for cultivation of vegetables and fruits, poultry farming and goat rearing. Partial clearance will be carried out as much as possible rather than total clearance of vegetation. Total clearance will be needed for building structures on land mostly in northwestern side of the island. Partial clearance will be carried out for cultivation of vegetables and fruits in the central area of the island as shown in the site plan. Partial clearance is only clearing the bushes and leave large trees. Total clearance will involve cutting down of some large trees. However, as many large tree as possible, those are in the proposed site for buildings will be relocated.

The main components of the operation stage of proposed project involve production and distribution of agriculture and poultry products in the country. Agriculture activities will include; horticulture – cultivation of vegetables and fruits, and floriculture. Poultry farming will include rearing of chicken for production of egg and meat. In addition goat rearing will be carried out for production of meat.

For cultivation of vegetables and fruits, plot sizes of 10,000sq ft. will be taken from central areas of the island. The fields will be divided by tree zones of 50ft. Crop rotation will be practiced to avoid mono cropping and to minimize incidences of pest and diseases. Apart from traditional earth farming, poly bag system of cultivation for ridge pepper, tomato and sweet pepper will be adopted using coco peat and perlite medium. Crops that are suitable for the agro climate condition of the country will be selected for cultivation. The crop types will be selected based on easy marketability and high return types. The target market will be tourist resorts, locals, consumer market in Male' and other islands.

3.5 Location of the project

The proposed development project is located in the island of Funadhoo in North Huvadhoo Atoll at 0°33'42.85" N and 73°31'33.83"E. The nearest airport is Kaadedhoo airport approximately 60km west of Funadhoo.

The closest island to the project location is a very small uninhabited island named Funadhoo vilingili less than 1km north. The closest inhabited islands to the project location are Kondey (population 383)7km, Dhiyadhoo (population 229) 9km and Gemanafushi (population 1110) 13km south of the project location and Dhaandhoo (population 1563) 9km and Nilandhoo (population 847) 11km north of the project location. The closest resort island which is under development is Hadaha 10km southwest of the project location.

The project location, Funadhoo island is located on eastern rim of Huvadhoo Atoll within a separate coral reef system (within a separate Falhu). Any part of Funadhoo island or reef is not included in the list of sites requiring special protection.

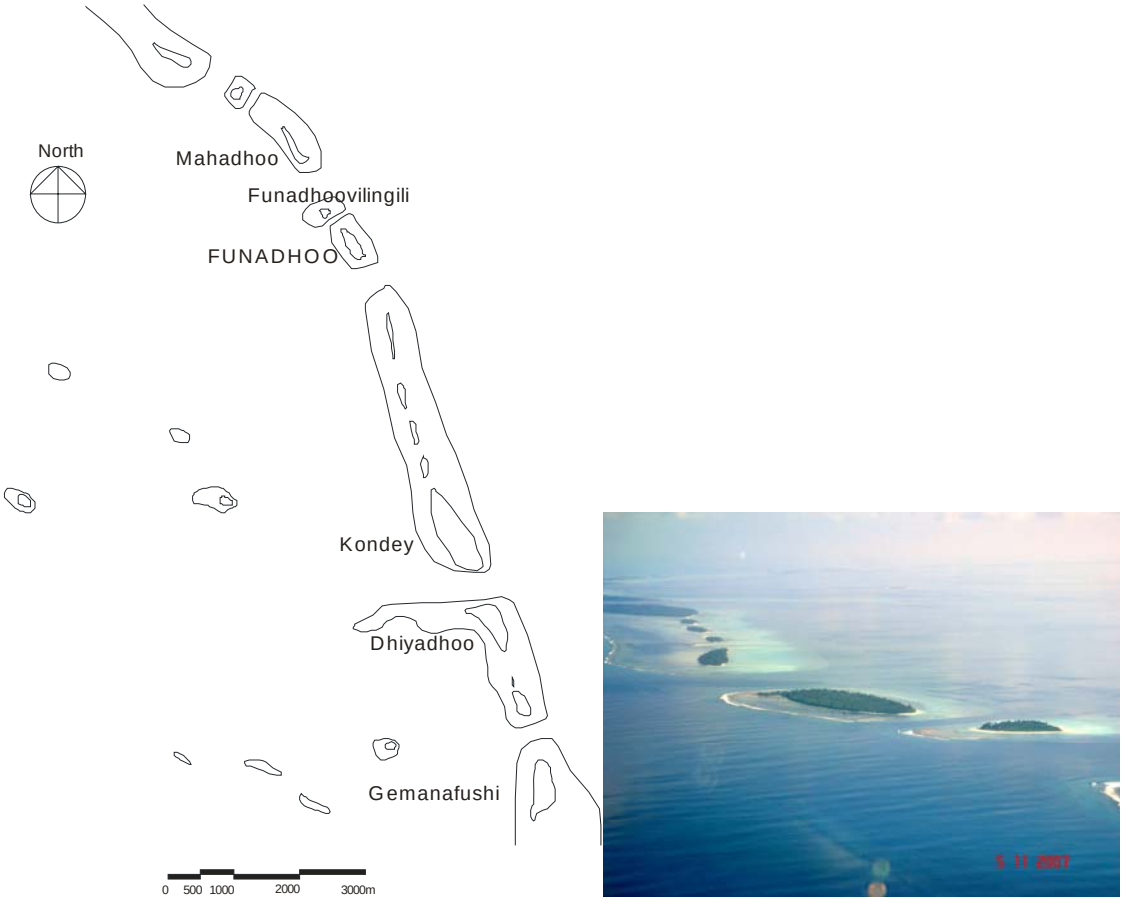
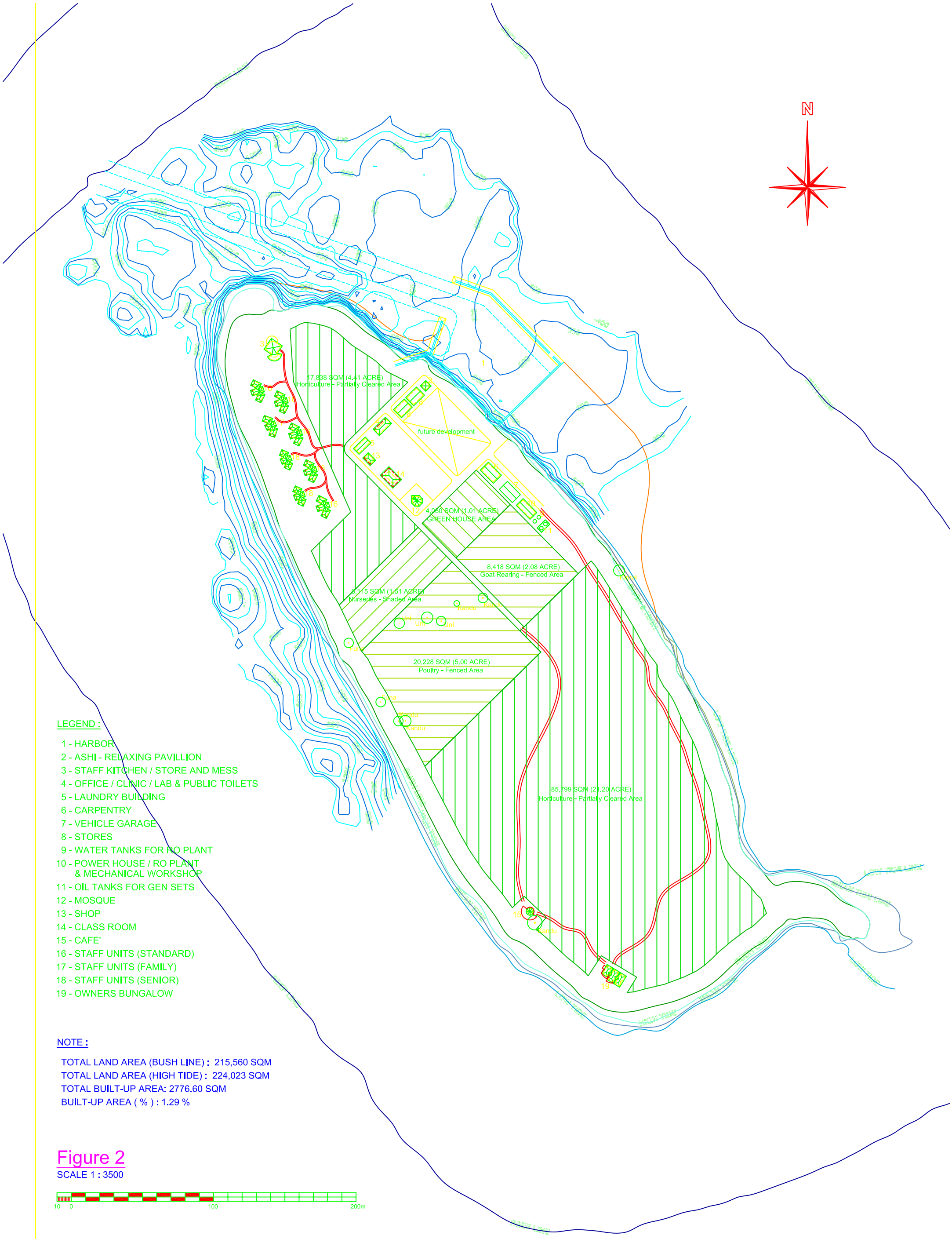


Figure 1 location of the project



LEGEND :

1 - HARBOR
2 - ASHI - RELAXING PAVILLION
3 - STAFF KITCHEN / STORE AND MESS
4 - OFFICE / CLINIC / LAB & PUBLIC TOILETS
5 - LAUNDRY BUILDING
6 - CARPENTRY
7 - VEHICLE GARAGE
8 - STORES
9 - WATER TANKS FOR RO PLANT
10 - POWER HOUSE / RO PLANT & MECHANICAL WORKSHOP
11 - OIL TANKS FOR GEN SETS
12 - MOSQUE
13 - SHOP
14 - CLASS ROOM
15 - CAFE'
16 - STAFF UNITS (STANDARD)
17 - STAFF UNITS (FAMILY)
18 - STAFF UNITS (SENIOR)
19 - OWNERS BUNGALOW

NOTE :

TOTAL LAND AREA (BUSH LINE) : 215,560 SQM
TOTAL LAND AREA (HIGH TIDE) : 224,023 SQM
TOTAL BUILT-UP AREA: 2776.60 SQM
BUILT-UP AREA (%) : 1.29 %

Figure 2

SCALE 1 : 3500

10 0 100 200m

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PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R	PROJECT. NO: EA - 117
			STRUC. DESIGN BY: -	DATE : DECEMBER 2007
TITLE: Figure 2	SCALE: AS GIVEN	CHECKED BY:	SURVEYED BY: H.R/H.S/M.M	SHEET NO: -
			DRAWN BY: H.R/H.S	

4. Description of the Natural Environment

The proposed development project is located in the island of Funadhoo in North Huvadhoo Atoll at 0°33'42.85" N and 73°31'33.83"E. The nearest airport is Kaadedhoo airport approximately 60km west of Funadhoo.

The closest island to the project location is a very small uninhabited island named Funadhoo vilingili less than 1km north. The closest inhabited islands to the project location are Kondey (population 383)7km, Dhiyadhoo (population 229) 9km and Gemanafushi (population 1110) 13km south of the project location and Dhaandhoo (population 1563) 9km and Nilandhoo (population 847) 11km north of the project location. The closest resort island which is under development is Hadaha 10km southwest of the project location.

The project location, Funadhoo island is located on eastern rim of Huvadhoo Atoll within a separate coral reef system (within a separate Falhu). Any part of Funadhoo island or reef is not included in the list of sites requiring special protection.

The vegetated area of the island is approximately 22 hectares (200,000m²). The island is elongated oval shape and found to be stable in terms of erosion and accretion. The total area of coral reef system is approximately 106 hectares. The shallow lagoon area surrounding the island is approximately 27 hectares.

Plate 1 aerial photo (left) and side elevation (right)

As the island is located on eastern rim of the atoll, eastern side of the island is windward side and this side faces open deep ocean. Western side of the island faces the atoll lagoon hence this side is leeward side. As usual the windward reef is structurally well developed and gets

exposed during low tides thus provide shelter to the island. Eastern side reef is deeper and provide less protection to the island.

The lagoon on both sides of the island is similar size however, eastern side lagoon is shallower having less than 1m during low tides whereas western side lagoon is deeper than 1m during low tide.

Seagrass beds are found in the shallow lagoon areas on both sides of the island. Seagrass area on both sides covers approximately 5 hectares. These segrass beds contain two species of seagrass. No unique feature is found within Funadhoo environment.

Eastern side of the island beach area mostly consisted of extensive beach rock, boulders, pebble and rubble. Approximately 40% of the coastline has exposed beach rock. Sandy beach though narrow is found all along western side of the island. Approximately 50% of the island has sandy beach. No serious net beach erosion is found in this island, however, severe seasonal erosion is found on eastern side and on southwestern side.

Plate 2 eastern side coastal vegetation

The coastal vegetation is thick and intact and consisted of mostly sea lettuce on eastern side and sea lettuce and screw pine on eastern side. The inside vegetation consists of mostly Sea hibiscus, screw pine and coconut palms in southern areas of the island. There are approximately 500 coconut palms in the island. The vegetation of the island can be said not matured as there are no large trees found except a few including Barringtonia. Less than 1% of the island is covered with mature tree. Although the vegetation is young the entire island is cover by vegetation. Tsunami impact to the island was found to be minimal as the shallow lagoon areas of the island are not extensive and the island has higher than average elevation.

Plate 3 western side coastal vegetation

A narrow entrance to the lagoon of the island is found through northern side of the island as this side of the reef has very sharp dropoff entrance to the lagoon by small speed boat is easy through this channel. However, it should be deepened and widen for safe and easy access to the island. As the island lagoon is very shallow there is no suitable area for anchoring. Therefore, a proper harbour will be constructed as described above.

The island is within an individual separate reef system in eastern rim of North Huvadhoo Atoll. The reef system is exposed to the open ocean on eastern side and the vast atoll lagoon on western side of it. As the island is formed within a separate reef system, deep channels through the atoll rim on north and south of the island exist. This ensures that the reef system is continuously drenched by an immense body of water as also shown by liveliness and geomorphology of the reef system.

Beach

A considerably large beach is found on entire western side of the island whereas, the eastern side consisted of mostly beach rock, boulders, pebbles and rubble. Approximately 50% of the perimeter of the island consisted of sandy beach. The beach on northwestern side is the most dynamic beach area. Seasonal beach erosion is found around the southwestern side of the island.

Plate 4 western side beach

Marine Environment

Marine environment of the island encompasses three main components. They are the coral reef and the lagoon systems. Distinctive reef areas exist within the reef system. They are the reef slope, reef-flat and patch reefs within the shallow lagoon. Geomorphology and biodiversity of each of these reef areas are also significantly different. The lagoon surrounding the island also consists of two distinctive areas in terms of bottom substrate. They are sandy bottom lagoon area close to the island and patch reef area of the lagoon surrounding the sandy bottom lagoon.

Reef system

Reef system of Funadhoo is elongated oval shape and it is oriented northwest southeast direction. Linear length of the reef system is approximately 1.4km. Total area of the reef system is approximately 56 hectares.

Lagoon system

The shallow lagoon area around the island covers approximately 27 hectares. Lagoon area on western side of the island is approximately twice wider having an average width of 130m and deeper compared to eastern side. The average depth of the western side lagoon close to the shore is approximately 1m at mean tide and gets gradually deeper further from the island. Lagoon bottom consisted of mostly sand and rubble and seagrass beds

Seagrass bed

Seagrass beds are found in the lagoon on both western and eastern sides of the island. These seagrass beds cover approximately 5 hectares (18%) of the lagoon area around the island. The growth of seagrass bed in the lagoon western side of the island is more and at a better status compared to eastern side. However, seagrass growing around the island can be said as poor in general.

Plate 5 western side seagrass bed

4.1 Description of Existing Terrestrial Environment

Terrestrial environment of Funadhoo 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 vegetation and the beach of the island will be most affected by the proposed development. The vegetation will be affected due to the proposed clearance of the bushes. The beach on eastern side has been having severe erosion causing loss of some of the large trees. Therefore the project also proposes to protect the eastern side beach by filling the eroding areas as shown in the site plan.

4.1.1 Beach environment

Fuandhoo has a very dynamic beach area in terms of seasonal erosion and accretion especially on northwestern and south western sides of the island whereas; western side central area has a very stable beach.

The beach area around the island can be categorized into 5 different sections A, B, C, D, and E as shown in the following figure 3. Each of these sections is significantly different in terms of sediment dynamics and sediment compositions. Sections B, C and D consisted of less fine sand but more rubble, cobble, boulders and beach rock in section B. Eastern and southern side (corresponding to sections B, C, D) of the island is the windward side thus the beach on eastern and southern side receives significantly more wave energy than the western side. Given this nature of the island's beach, the beach area around the island can be categorized into two sections in general with respect to sediment dynamics. Sediment dynamics on eastern side beach area is less frequent compared to western side however; more in terms of energetic as it is the windward side and the beach materials consists of larger sizes.

Plate 6 Beach Section A

Section A is the northern sand-spit of the island and consisted of fine sediments forming a significantly large beach area. The northern sand-spit has an area of approximately 1.7 hectares. This sans-spit swings from northwestern side to northeastern side in southwest

monsoon and back to northwestern side in northeast monsoon. The observations showed that beach sediment in this area is confined within section A as observed in many other similar islands. There is no permanent beach erosion in this section of the beach.

Plate 7 Beach Section B

Section B is the eastern side of the island, which is the windward side. This section of the beach consisted of mostly beach rock especially the mid area as seen in the picture above left. The northern areas of section B consisted of some sandy areas with the sand spilling over from the section A during southwest monsoon. The southern areas of section B consisted of mostly pebble and boulders and rubble, pebble being most dominant and rubble being least but significant amounts. Due to the nature of larger size beach materials, dynamics of beach materials is less and occurs during stormy conditions of the monsoon system which occurs annually. Serious beach erosion was found in southern areas of section B as seen in the picture above right.

Plate 8 Beach Section C

Section C is the southeastern side of the island where a narrow extension of the island is formed. This section's beach materials are mostly rubble and some sandy areas at the base of the rubble mount as seen in the picture above left. Central area close to the island of this section consisted of rubble pile of size approximately half a hectare. This area was found to be a

collection point for rubble. Further south of this section consisted of an extensive area of cobble and rubble which get exposed during the low tides as seen in the picture above right. Dynamics of beach material in this section is also observed to be less frequent than in western areas of the island beach. However, serious beach erosion was found in northern areas of section C.

Plate 9 Beach Section D

Section D is the southern side of the island where high energy of dissipating waves is found. Beach materials in this section of the beach consisted of mostly pebble and rubble and some sand as seen in the picture above left. Western side of this section of the beach is the southern san-spit of the island where the beach consisted of fine sand as seen in the picture above right. This sand-spit is a very dynamic beach area where the beach sand moves from west to east during southwest monsoon and the opposite direction during northeast monsoon. Serious beach erosion is found in northwestern and southeastern area of this section of the beach.

Plate 10 Bach Section E

Section E is the central area of the beach in western side of the island where the most stable sandy beach is found as seen in the picture above left. The beach in this section of the island is very long and narrow having a length and a width of approximately 200m and 16m respectively.

Slight seasonal beach erosion is found in southern areas of this section of the beach as seen in the picture above right.

4.1.2 Beach erosion

Seasonal beach erosion was observed to be severe and serious in the western side of the island, especially in southern areas on western and northern areas in western side of the island. Permanent and serious beach erosion is found in southern areas in eastern side of the island. Serious seasonal beach erosion in southwestern side of the island has cause loss of some coastal vegetation including screw pines and a few coconut palms. Permanent beach erosion in southern side of the island has caused loss of larger trees of the coastal vegetation including screw pines and nit pitcha. Permanent beach erosion in southeastern side of the island is causing loss of coconut palms and other large trees in addition busy vegetation consisting of screw pines, sea lettuce and ironwood.

Plate 11 seasonal beach erosion in SWP

Serious seasonal beach erosion in SW side of the island is causing loss of coastal vegetation.

Plate 12 seasonal beach erosion in S. of the island

Serious seasonal beach erosion in southern side of the island is causing loss of coastal vegetation consisting of coconut palms other large trees in addition to screw pines.

Plate 13 permanent beach erosion in S. side

Permanent beach erosion in southeastern side is causing loss of coastal vegetation including coconut palms, screw pines, sea lettuce and risking loss of other larger coastal vegetation including barrintonia and sea hibiscus trees.

Previous beach erosion observed by comparing the aerial photos taken in 1969 (below left) and satellite photos below right) show that there has been significant beach erosion within the last 35 years especially in southern and southeastern areas of the island. The photos below show that a large area from south of the island has been lost due to the erosion of beach and the coastal vegetation. Field observation and analysis of historical aerial photos show that the size of the beach around the island has been significantly reduced due to beach erosion.

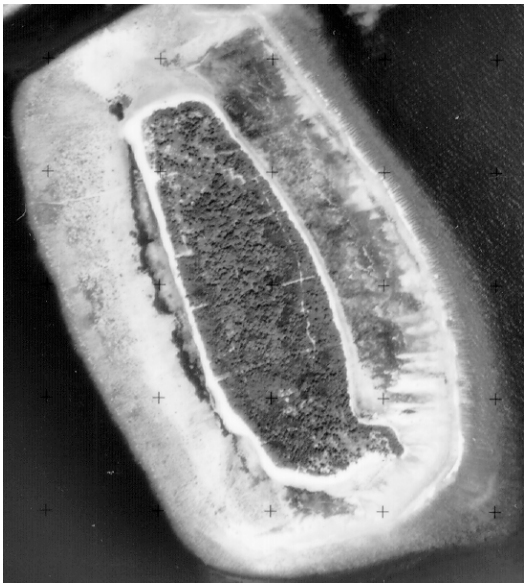


Plate 14 aerial photos of Ga. Funadhoo – 1969 (left) 2005 (right)

Slight seasonal erosion in Section E

Seasonal heavy erosion
in southern area of Section E

Stable beach in northern area of Section E

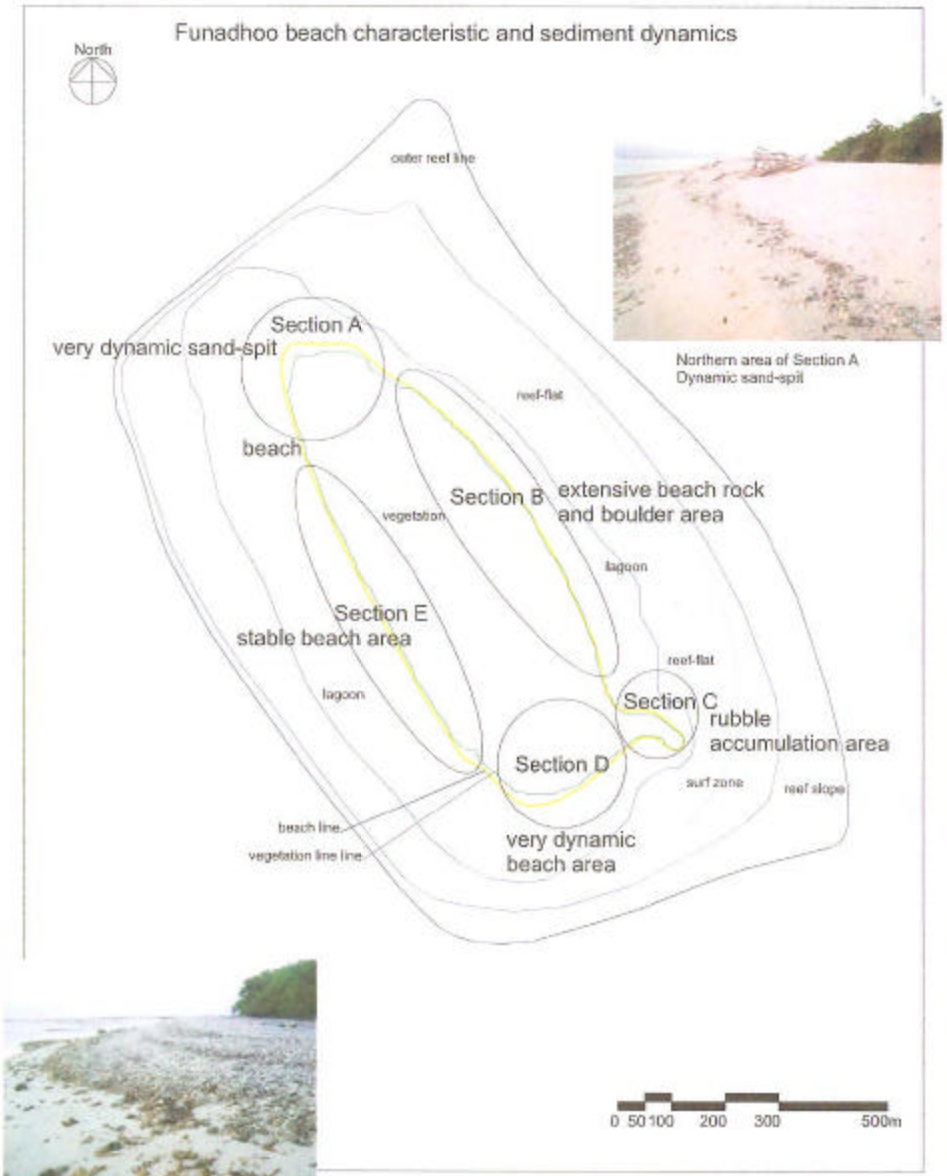
Very dynamic beach in eastern area of
Section D. Slight erosion in SW monsoon

Western area of Section D
A very dynamic beach area

Seasonal heavy beach erosion in
southern area of Section E

Western area of Section A.
A very dynamic beach area forming a sand-spit

Central area of Section E.
A very stable beach area



Section C consisted of extensive rubble area

Northern area of Section A
Dynamic sand-spit

Northern area of Section B consisting of extensive
beach rock and some sandy areas

Central area of Section B consisted of
extensive beach rock

Heavy beach erosion in norther area of Section B

Extensive beach erosion in southern area of
Section B

Figure 3 Beach characteristic map

4.1.3 Beach 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 other islands and reefs.

Funadhoo is an elongated on eastern rim of the atoll, therefore eastern side of the island is very exposed to the wind generated waves. Western side of the island is also very exposed as the atoll is one of the largest atolls. Due north-south orientation and elongated shape of the island, beach dynamics around the island is confines to mostly north and south of the island where sand accumulation is also found. Sand from northwestern area of the island moves north and northwest during SW monsoon and likewise in the southern areas of the island the sand moves from southwestern area to southeastern areas in SW monsoon. This movement of the sand reverses during NE monsoon and a uniform pattern of beach dynamics is found in northern and southern ends of the island. Beach profiles were taken in various locations marked as shown in figure x. to assess the beach dynamics around the island on a long-term basis.

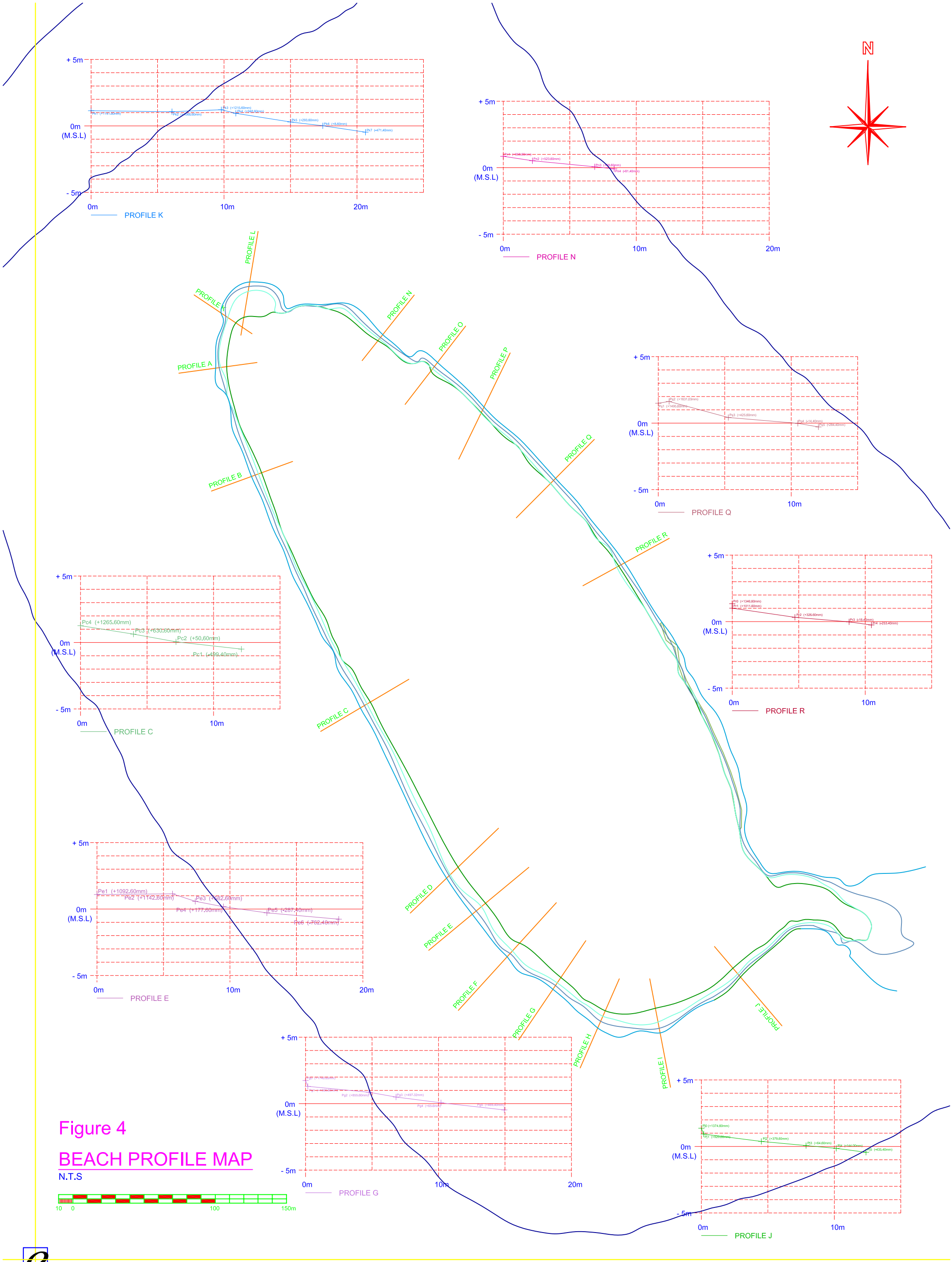


Figure 4

BEACH PROFILE MAP

N.T.S

CAD ASSOCIATES PRIVATE LIMITED

T O T A L + B U I L D I N G + S O L U T I O N S

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w w w . e c a d a s s o c i a t e s . c o m

PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R STRUC. DESIGN BY: - SURVEYED BY: H.R/H.S/M.M DRAWN BY: H.R/H.S
TITLE: Figure 4 - BEACH PROFILE MAP	SCALE: NOT TO SCALE	CHECKED BY:	PROJECT. NO: EA - 117 DATE : DECEMBER 2007 SHEET NO: -

4.1.4 Coastal vegetation

Coastal vegetation around the island is intact consisting of the usual species of plants that are found around the islands in the country. This included Sea lettuce (*Scaveola taccada*), Screw pine (*Pendanus tectoris*), Ironwood (*Penphis* sp.), Seahibicus (*Hibiscus tilaceous*) and Nit pitcha (*Guettarda speciosa*). Composition of these species of plants varied from eastern and western sides and northern and southern sides. Northern area consisted of more Ironwood, western side consisted of more Sea lettuce, southern side consisted of more Screw pines and western side consisted of more Sea hibiscus, Screwpine and varied species. However, the dominant coastal vegetation plant found around the island was Sea lettuce.

Plate 15 eastern side coastal vegetation

Eastern side coastal vegetation (left) consisted of more Sea lettuce and the eastern side coastal vegetation (right) consisted of more varies species however, dominated by Sea lettuce.

Coastal vegetation plays an important role in protecting the island from beach and soil erosion. The coastal vegetation around the island were assessed using line intersect transects. 39 transects were taken at western side and 9 transects were taken on eastern side coastal vegetation of the island as shown in figure 2

The following figure shows the result of transects taken from northeastern side of the island.

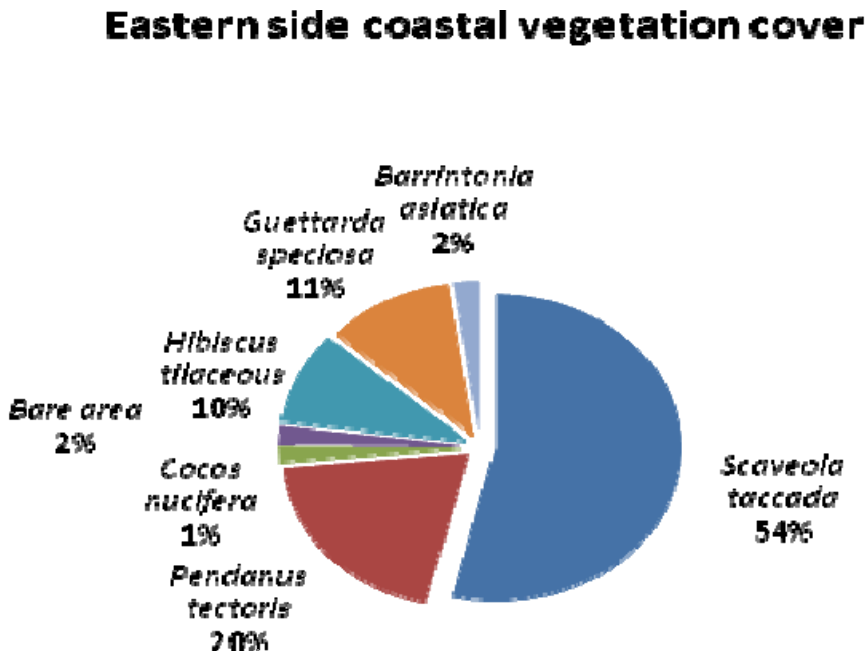


Figure 5 eastern side coastal vegetation cover

The transects taken at norther side of the island showed that the coastal vegetation is dimonated by Sea lettuce (Scaveola taccada) consisting of 54%. Screw pine (Pendanus tectoris) is the next most dominant species found in this area consisting of 20% of the coastal vegetation. Nit pitcha (*Guettarda speciosa*) and Sea hibiscus (*Hibiscus tilaceous*) each species accounted about 10% of the coastal vegetation on eastern side of the island. Coconut palms accounted 1% and Barrintonia accounted 2% of the coastal vegetation by area. 2% of the coastal perimeter were also found to be bare without any bush or plants. Therefore, approximately 98% of the island's coastal vegetation belt is covered with bushes and plants.

Plate 16 western side coastal vegetation

Western side coastal vegetation is dominated by sea lettuce however, has a more varied species composition in comparison with western side.

The following figure shows the result of transects taken from western side of the island.

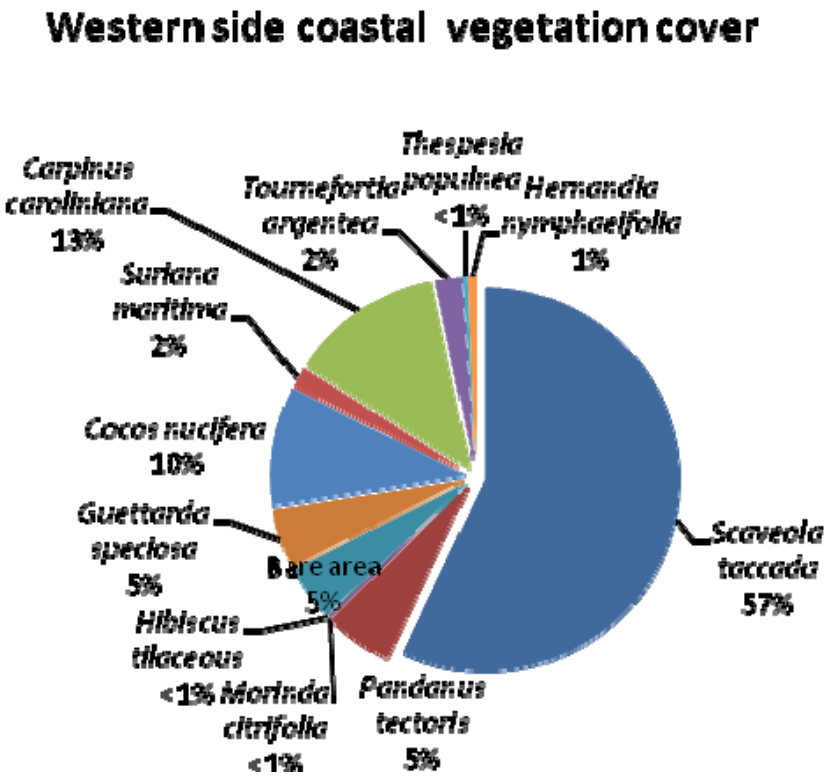


Figure 6 western side coastal vegetation cover

The transects taken at western and southern side of the island also showed that the coastal vegetaion is dominated by Sea lettuce consisting of 57% cover. Next most dominant species found were Ironwood accounting 13% and coconut palms accounting 10% of the coastal vegetaiton. Screw pine and Nit pitcha each accounted 5% of the western side coastal vegetation. Other species of plants found in western side coatsatal vegetation consisted of tree heliotrope (*Tournefotia argentea*), Tassel plant (*Surina maritima*) each accounting 2% and Balsa (*Hernandia nyphaeifolia*), Tulip tree (*Thespesia populnea*), Sea hibiscus (*Hibiscus tilaceous*) and Cheese fruit (*Morinda citrifolia*) accounting 1%. Approximately 5% of the coastal vegetaiton area in western side were found bare without bushes and trees. Therefore approximateley 95% of the western side is covered by coastal vegtation.

Plate 17 western side coastal vegetation

4.1.5 Inner vegetation

Inner vegetation survey included larger trees that significant in terms of species, canopy size and age. Significant large trees were located using total station surveying equipment and shown in figure x. Significant large tree inside the island included Alexander laurel wood tree (*Calophyllum inophylum*, Nit pitcha (*Guettarda speciosa*, Sea putat (*Barrintonia asiatica*), Tree heliotrope (*Tournefortia argentea*) and most significantly Coconut palms (*Cocos nucifera*)

Plate 18 inner vegetation

Locating and marking large trees

Inner vegetation – Sea putat (Barrintonia)

Plate 19 cocnut palms inside the island (left) beauty leaf (right)

Significant inner vegetation – Coconut palms

Beauty leaf (*Callophyllum inophyllum*)

The most Significant inner vegetation in terms of abundance is coconut palms. Coconut palms are more concentrated in the southern area of the island. The inner vegetation was reported to have an approximately 500 coconut palm which are fully matured. Observation also showed that the inner vegetation consisted of hundreds of young coconut palms. Other significant trees marked measured a diameter of 2-3m

In general the vegetation of the island can be said as in natural status and the island has a thick and high vegetation canopy. Comparison of aerial photos taken in 1969 and 2005 showed that the vegetation of the islands had been cleared to create walking paths across and lengthwise of the island. These paths have been covered with vegetation now as shown in recent aerial photos in Plate 14.

Western side coastal vegetation is dominated by sea lettuce *Scaveola taccada*, covering 57%

Ironwood *Carpinus caroliniana*, is next dominant covering 13%

Tournefortia argentea, covers 2% of eastern side coastal vegetation

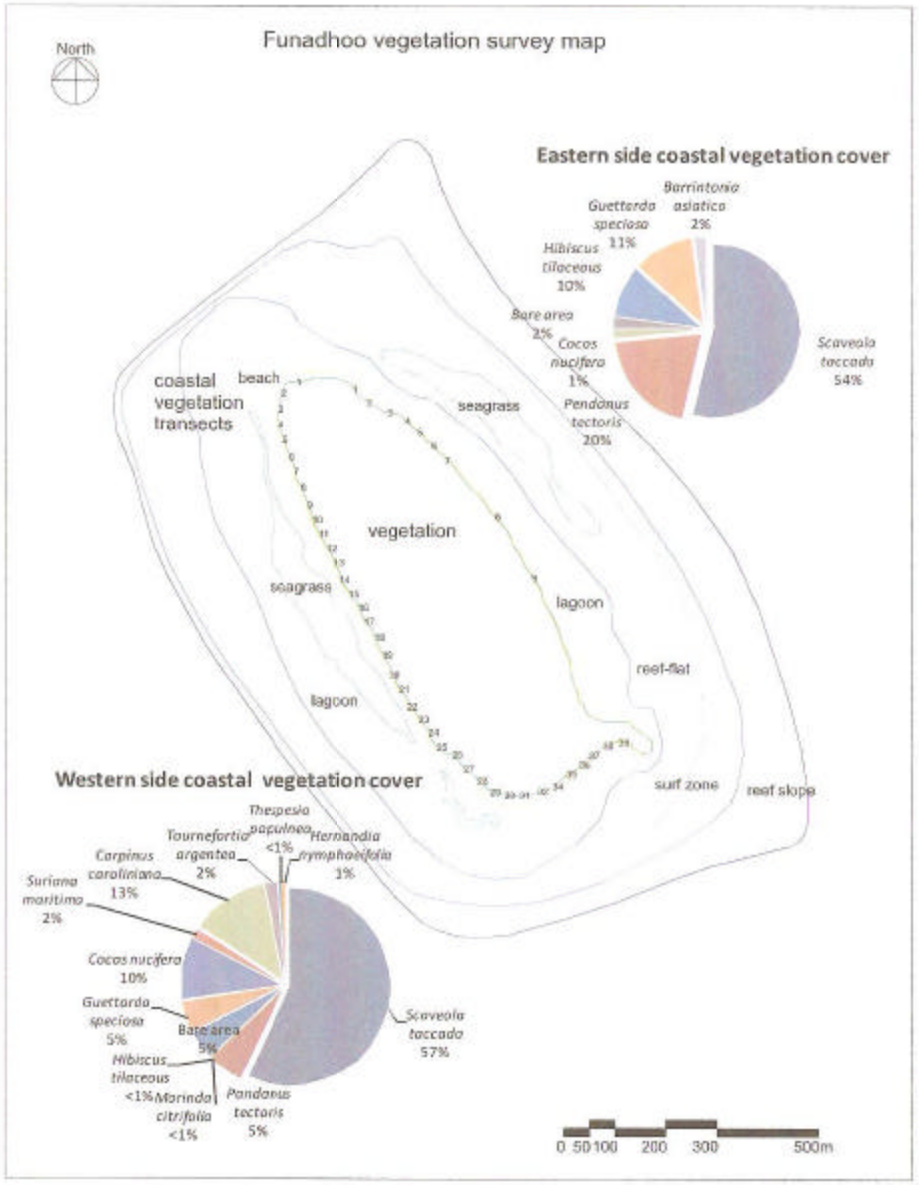
Coconut palms in northeastern side of the island are mostly younger coconut palms

Screwpine *Pendanus tectoris*, covers 5% of western side vegetation

Sea hibiscus *Hibiscus telaceous*, covers <1% of western side vegetation

Tulip tree *Thespesia populnea*, covers <1% of western side vegetation

Western side coastal vegetation consisted of 10% coconut palms, *Cocos nucifera*



Screwpine *Pendanus tectoris*, is second dominant covering 20%

Sea hibiscus *Hibiscus telaceous*, covers 10% of eastern side vegetation

Eastern side coastal vegetation is dominated by sea lettuce *Scaveola taccada*, covering 54%

Nil pitch, *Guettarda speciosa*, covers 11% of eastern side vegetation

Figure 7 Vegetation survey map

4.2 Soil

Funadhoo is a relatively large and matured island in terms of geology and vegetation. The soil profiles taken from various locations of the island showed that the contents of the soil had a high percentage of humus and a relatively thick layer of dark soil below the humus layer. The following photos show the soil profiles taken from four locations inside and on periphery of the island

Profile 1

Profile 2

Profile 3

Plate 20 soil profiles taken at various locations in central and periphery of the island

The soil profile (Profile 2.) taken at central area of the island showed thickness of dark soil layer on top of the white sand is approximately 50cm and the layer of sand between the water level during high tide. and the dark soil layer is approximately 110cm. The periphery of the island has thinner dark layer of soil compared to central areas. The soil profile (Profile 1 and 3) taken at the periphery of the island showed that the thickness of the dark soil layer is approximately 30cm and the white sand layer has a thickness of approximately 100cm.

4.3 Groundwater

Groundwater samples were taken from four locations of the island as shown in figure x. Water samples were taken from eastern (PIT 1), southern side (PIT 2), western side (PIT 3), and northern side (PIT 4) of the island. Water samples were tested at National Health Laboratory for parameters that can be used for analysis of impacts due to the proposed infrastructure development for agriculture and farming activities. The tested parameters were physical appearance, pH, salinity, phosphate, Nitrate and sulphate. The following table shows the results of the water tests.

Table 2 groundwater test results

Sample	1	2	3	4
Parameters tested				
Physical appearance	Pale yellow	Pale yellow	Pale yellow	Pale yellow
pH	6.9	6.8	6.8	6.9
Salinity	1700mg/L	1200mg/L	600mg/L	500mg/L
Phosphate	0.01mg/L	0.12mg/L	0.05mg/L	0.09mg/L
Nitrate	0.0mg/L	0.0mg/L	0.0mg/L	0.0mg/L
Sulphate	75mg/L	65mg/L	26mg/L	21mg/L

Groundwater tests showed that the groundwater of Funadhoo is very similar to other such islands when compared to the same parameters tested from other islands groundwater samples.

As the island is uninhabited the groundwater of the island has not been used for any purpose therefore at natural status. The depth of the groundwater lens is 1.5m during high tide as shown in ther picture below The high salinity of the samples is due to the samples taken from periphery of the island rather than in central area of the island. Central area of the island was not accessible to take water samples due to the thick vegetation in the central area of the island.

Plate 21 depth of groundwater

4.4 Marine environment

4.5 Description of existing marine environment

G.A Funadhoo was formed on small reef system that forms a patch reef-like structure hosting an island at the center. This reef system was on the eastern rim-reef of G.A atoll. Funadhoo occupies approximately a third of this reef system.

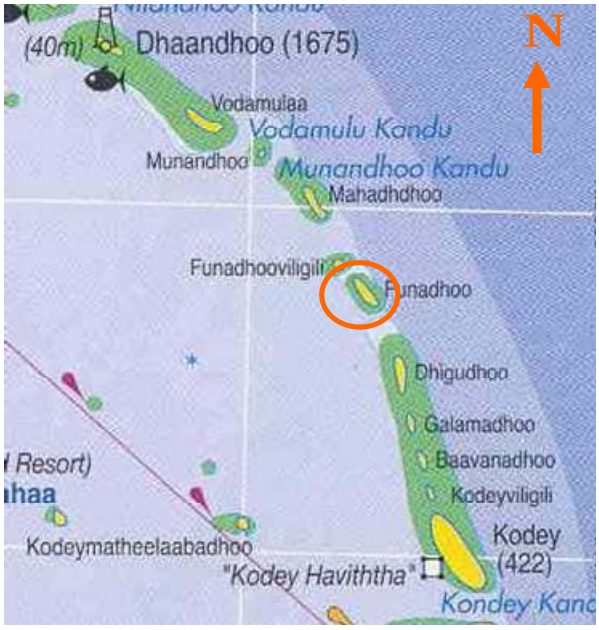


Figure 8 the reef system of Funadhoo

The marine environment around Funadhoo is in almost near pristine condition since the island is uninhabited. However there was evidence of a human settlement in the island. Some of the entrance channels seemed to be manually cleared. The impact of anthropogenic factor on the marine environment can be considered negligible on this island. It is also important to note that environmental impacts of these coastal modifications are not well documented since there was no systematic monitoring of the effects of these coastal modifications in the Maldives (Kench et al. 2006).

4.5.1 Coral Reef System

The reef around Funadhoo is moderately well developed with about 40 percent live coral cover on the western side reef edge and reef slope (see results of Site 1; Figure 9 benthic cover at site 1). The bottom of reef edge was dominated by coral rock followed by Acropora table and

branching corals. The reef slope on the western side forms a somewhat steep slope with very good live coral cover.

Most commonly encountered genera of hard corals are:

- *Acropora*
- *Astreopora*
- *Echinopora*
- *Favia*
- *Fungia*
- *Galaxea*
- *Goniopora*
- *Laptoria*
- *Porites*
- *Pocillopora*

On the eastern and south eastern sides the reef-slope is rather steep and adjoins the Indian Ocean. No quantitative surveys were conducted on this side due to the strong surge and breaking waves on the reef-crest.

The coral reef system of Funadhoo is in good condition in terms of diversity and percentage live coral cover. Live coral was also seen at the atoll rim reef's slope as well as on the reef-flat near the entrance channel. The quadrat survey results for sites 3 and 4 showed that the live coral cover to be about 14 and 21 percent respectively on the northwest and southeast sides of the island respectively (see Figure 9 benthic cover at site 1 and 6). A number of soft coral species were also encountered during the visual observations. Species richness and diversity of corals and fish were also very good at the surveyed sites. A high diversity of butterfly fishes was seen at the sites 1, 3 and 4. This according to Reef Check was an indicator of the health of the reef since most of the butterfly fishes (family *Chaetodontidae*) are obligate coralivores.

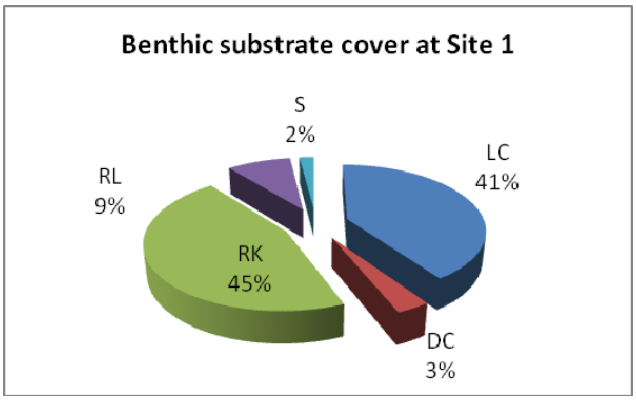


Figure 9 benthic cover at site 1

Percentage cover of benthic substrate present at site 1. The dominant forms of benthic cover are rock and live corals. Branching forms of *Acropora* spp. (staghorn) corals predominates the live benthic cover. Massive types corals namely *Porites* spp., *Favites* spp. and encrusting type *Pavona varians* were also present. The benthic covers are given in percentages of the bottom area surveyed. LC = live corals, DC = dead coral remnants, RK = rock, RL = rubble, and S = sand

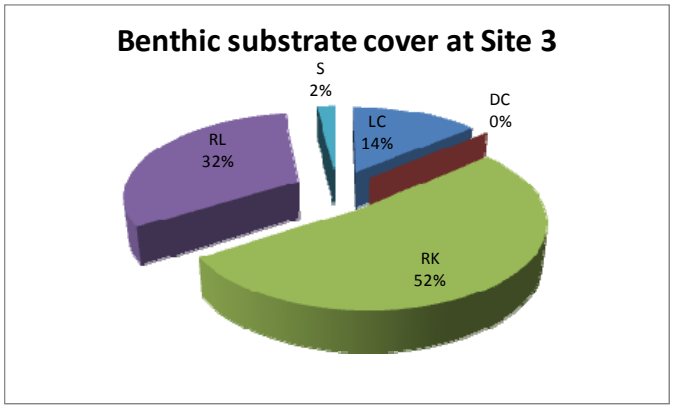


Figure 10 substrate over at site 3

Percentage cover of benthic substrate present at site 3. The dominant forms of benthic cover are rock and rubble. Massive type colonies predominated this area. Branching forms of *Acropora* spp. (staghorn) corals were also present. The benthic covers are given in percentages of the bottom area surveyed. LC = live coral, DC = dead coral remnants, RK = rock, RL = rubble, and S = sand.

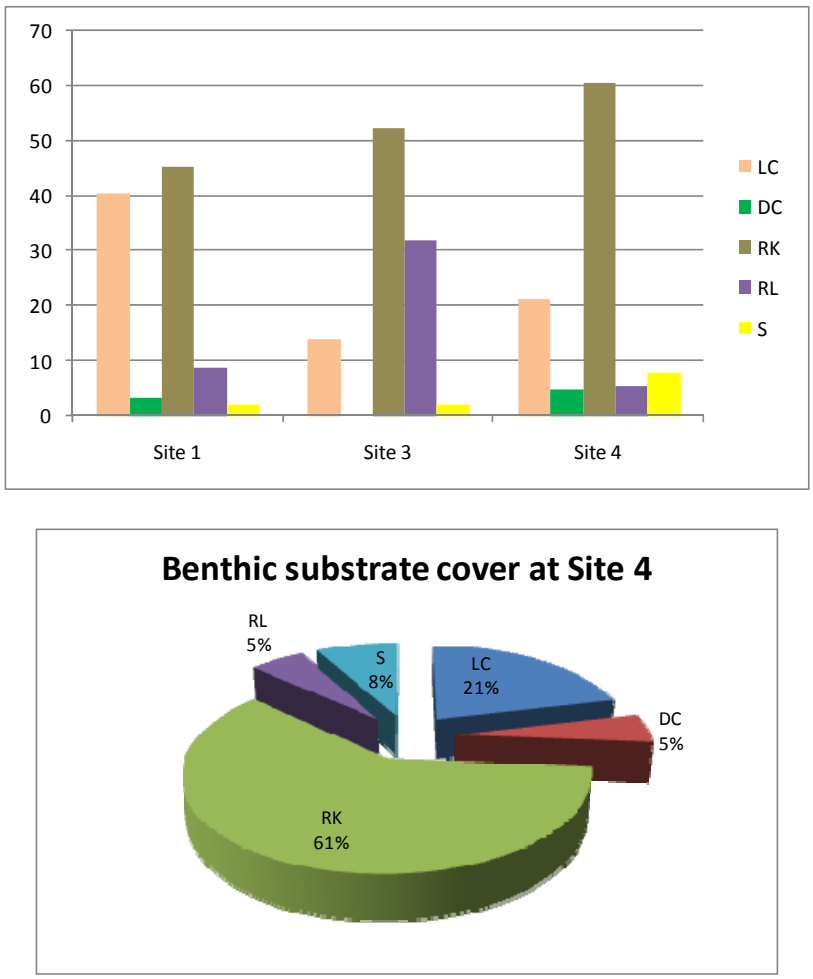


Figure 11 substrate cover at site 4

Percentage cover of benthic substrate present at site 4. The dominant forms of benthic cover are rock and rubble. Massive type colonies predominated this area. Branching forms of *Acropora* spp. (staghorn) corals were also present. The benthic covers are given in percentages of the bottom area surveyed. LC = live coral, DC = dead coral remnants, RK = rock, RL = rubble, and S = sand.

The photographs below shows an idea of benthic cover present at the survey sites.

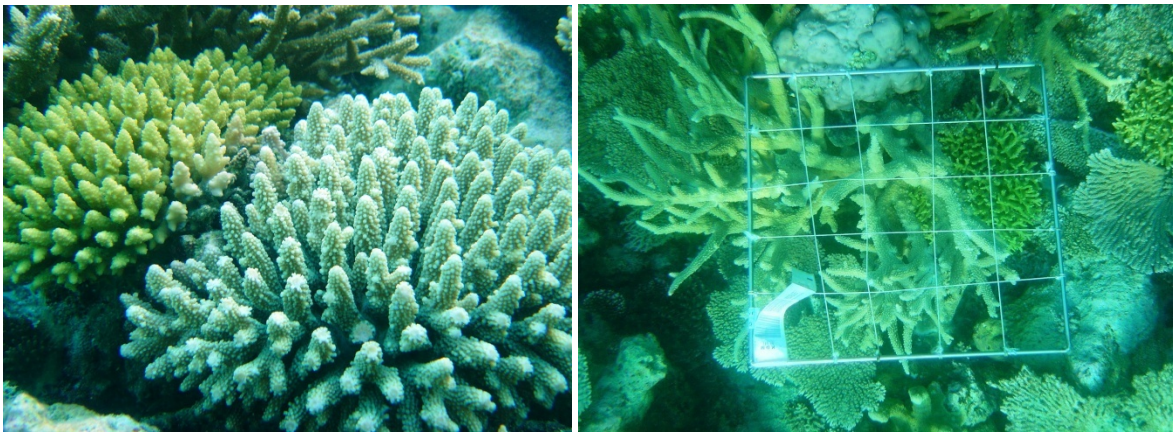


Plate 22 coral digitate (*Acropora sp.*) left coral branching (*Acropora sp.*) right

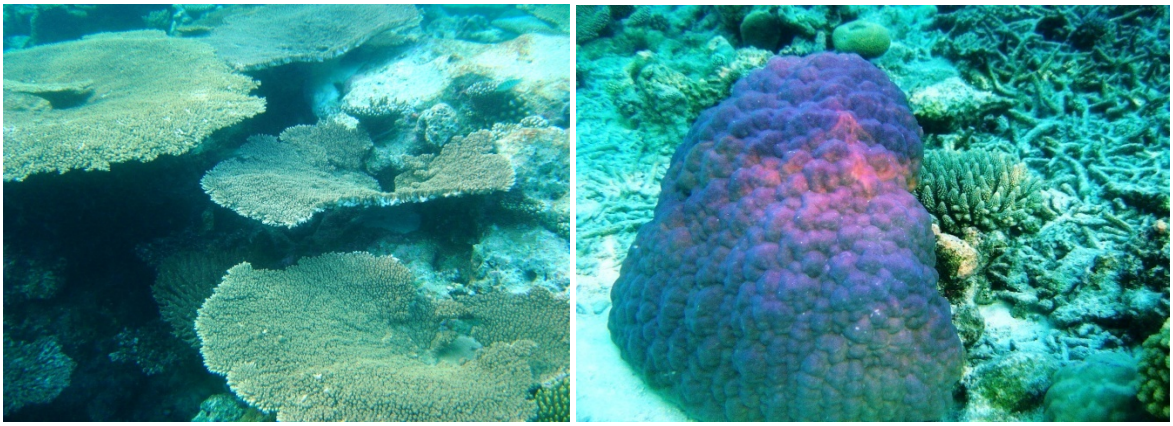


Plate 23 Table corals (*Acropora sp.*) left Massive coral (*Porites sp.*) right

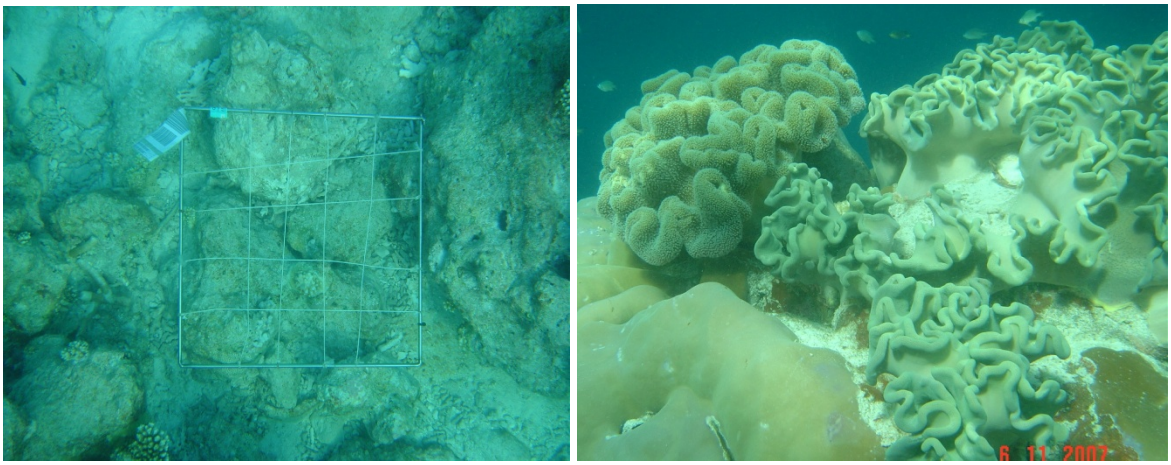


Plate 24 rock (left) soft coral (right)

4.5.2 Assessment fish communities

The result of 15 minutes swim for fish count along surveyed sites 1, 3 and 4, revealed that the abundance and diversity of fish is moderately good on the around the reef-edge and reef-slope. This may be due to the presence of a number of live coral colonies. Since most of the area was covered with rock and live coral, fishes associated with this type of environment were encountered. The dominant fish taxa observed in the surveyed area included butterfly fishes, wrasses, parrotfishes and damselfishes. The presence of *Acropora* coral colonies was associated with the occurrence of large number butterfly fishes at site 1. These fishes are an indicator of reef health. One medium sized Napoleon wrasse (*Cheilinus undulatus*) which is a protected species in the Maldives was also encountered at site 1. It is likely that the reef-flat is recovering from the 1998 severe coral bleaching event. Some of the conspicuous fish encountered are shown in Plate 25 – 27.

Table 3 fish survey results

Results of the fish encounter survey. Count given in number of individuals fishes encountered - Sites 1, 3 and 4.

Family	Species	Count S1	Count S3	Count S4
Acanthuridae	*Acanthurus leucosternon*	8	13	8
Acanthuridae	*Acanthurus lineatus*	-	3	-
Acanthuridae	*Acanthurus triostegus*	2	-	-
Acanthuridae	*Naso brevirostris*	1	-	-
Acanthuridae	*Naso lituratus*	1	1	-
Acanthuridae	*Naso unicornis*	2	-	-
Acanthuridae	*Naso vlamingi*	6	-	-
Acanthuridae	*Ctenochaetus* sp.	6	10	13
Balistidae	*Melichthys indicus*	-	-	1
Carrangidae	*Caranx melampygus*	2	-	-
Cirrhitidae	*Paracirrhitus forsteri*	1	2	-
Chaetodontidae	*Chaetodon auriga*	2	1	-
Chaetodontidae	*Chaetodon citrinellus*	1	8	2
Chaetodontidae	*Chaetodon falcula*	2	-	-
Chaetodontidae	*Chaetodon lunula*	1	-	-

Chaetodontidae	*Chaetodon guttatissimus*	1	-	-
Chaetodontidae	*Chaetodon meyeri*	2	-	1
Chaetodontidae	*Chaetodon triangulum*	11	1	2
Chaetodontidae	*Chaetodon trifasciatus*	5	8	4
Chaetodontidae	*Chaetodon trifascialis*	22	-	4
Chaetodontidae	*Chaetodon xanthocephalus*	2	-	-
Chaetodontidae	*Hemitaurichthys zoster*	5	-	5
Ephippidae	*Platex orbicularis*	1	-	-
Holocentridae	*Myripristis* sp.	1	4	-
Holocentridae	*Neoniphon* sp.	1	2	-
Labridae	*Bodianus axillaris*	-	1	-
Labridae	***Cheilinus undulatus***	1	-	-
Labridae	*Epibulus insidiator*	1	-	-
Labridae	*Helichoeres hortulanus*	2	1	2
Labridae	*Hemigymnus melapterus*	-	2	-
Labridae	*Labroides dimidiatus*	2	1	3
Labridae	*Gomphosus caeruleus*	2	2	1
Labridae	*Thalassoma amblycephalum*	-	-	3
Labridae	*Thalassoma lunare*	-	-	1
Labridae	*Thalassoma hardwicke*	13	4	3
Labridae	*Stethojulis*sp.	-	3	-
Lutjanidae	*Lutjanus bohar*	-	2	-
Lutjanidae	*Lutjanus fulvus*	-	1	-
Lutjanidae	*Lutjanus gibbus*	-	2	-
Lutjanidae	*Lutjanus kasmira*	2	-	-
Lutjanidae	*Lutjanus monostima*	-	6	-
Lutjanidae	*Caesio* sp.	sch > 30	sch > 30	-
Monacanthidae	*Oxymonacanthus longirostris*	-	2	-
Mullidae	*Parupeneus barberinus*	-	-	1
Mullidae	*Parupeneus bifasciatus*	1	-	-

Nemipteridae	*Scolopsis bilineatus*	-	1	2
Pomacanthidae	*Pygoplites diacanthus*	1	3	1
Pomacentridae	*Amblygltphidodon dickii*	5	-	-
Pomacentridae	*Chromis dimidiatus*	3	4	4
Pomacentridae	*Chromis ternatensis*	7	-	2
Pomacentridae	*Chromis viridis*	7	-	-
Pomacentridae	*Chromis* sp.	10	-	-
Pomacentridae	*Dascyllus aruanus*	-	4	-
Pomacentridae	*Pomacentrus indicus*	3	-	-
Pomacentridae	*Stegastes*sp.	-	-	4
Siganidae	*Siganus* sp.	2	-	-
Scaridae	*Cetoscarus bicolor*	1	-	2
Scaridae	*Scarus* sp1	2	1	3
Scaridae	*Scarus* sp2	3	-	3
Scombridae	*Gymnosarda unicolor*	1	-	-
Serranidae	*Cephalopholis argus*	1	-	-
Zanclidae	*Zanclus cornutus*	1	-	-

Plate 25 *Chaetodon trifascialis* (left) *Chaetodon triangulum* (right)

Plate 26 *Zenclus cornutus* (left) *Acanthurus triostegos* (right)

Plate 27 *Scarus sp.* (left) *Acanthurus lecosternon* (right)

4.5.3 Reef invertebrates

Only a few species of mollusks and echinoderms were encountered in these 3 sites (see Plate 28). This may be due to the nocturnal nature of mollusks and echinoderms. What was observed during the timed swims is presented in the table below.

Table 4 invertebrate survey results

Common name	Count S1	Count S3	Count S4
Giant clam	5	4	2
Sea cucumber	2	4	3
Starfish	6	5	6
Urchin	5	6	5

Plate 28 invertebrates in site 1, 3 and 4

4.5.4 The seagrass ecosystems

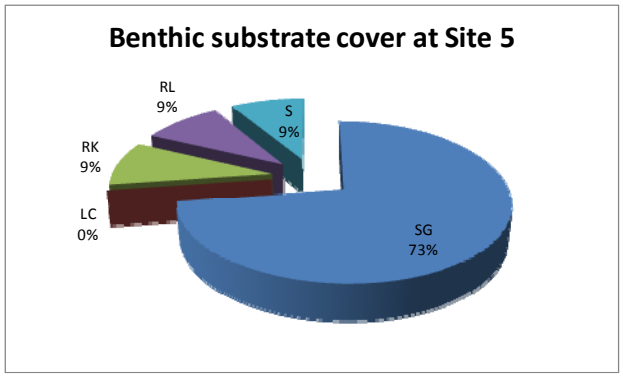
Seagrass beds are known to have high ecological value as they provide important food resources to a range of fish and invertebrates (King 1981; SunAqua 2002), both directly (grazing by fish and turtles) and indirectly (through detrital food chains, or provision of shelter to other associated flora and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

the presence of seagrass around an island has been linked to the eutrophication in coastal areas. The presence of seagrass in the reef-flat of many fishing island is an indicator of this.

Seagrass was observed almost all around Funadhoo. Only one species of seagrass (*Thalassia hemprichii*) was recorded on the seagrass bed. The density of the sea grass varied depending on the locality. The density of the sea grass is controlled by wave energy and strong current in some areas.

A quadrat survey and visual observation was conducted on these two sites (namely site 2 and site 5 which are located on the west and northeast side of the island). These two sites represent dense seagrass habitats of the island. The results of benthic categories cover are shown in Figure 12 benthic cover at site 5 and 2

. The seagrass cover was 51 and 72 percent respectively on sites 2 and 5.



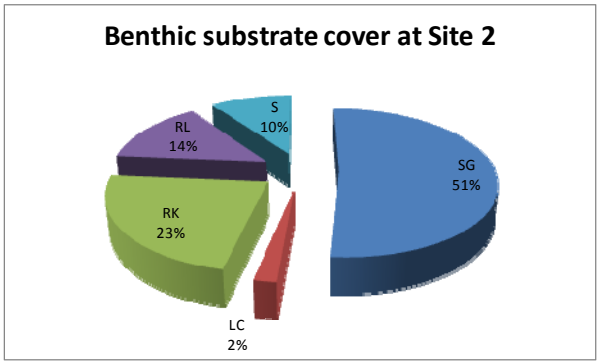


Figure 12 benthic cover at site 5 and 2

Bottom composition of site 2 and 5 – the seagrass areas. SG = seagrass, LC = live coral, RK = rock, RL = rubble, S = sand.

On average a large portion of the total shallow reef-flat was covered with seagrass. Withing these seagrass beds, other benthic substrates observed included rock, rubble and sand. Live coral species recorded were massive and encrusting life forms of *Porites, Psammacora and Pavona*.

A ten minute encounter survey was conducted for fish, molluscs and echinoderms at these two areas. A total of 20 species of fish belonging to 9 families were recorded on these two survey sites

Table 5 list of fish species in seagrass beds

Family	Species
Sygnathidae	*Corithoichthys haematopterus*
Gerreidae	*Gerres* sp.
Lethrinidae	*Lethrinus harak*
Labridae	*Helichoeres scapularis*
	Labroides dimediatus
	Cheilinus fasciatus
	Cheilio inermis
	Coris sp.
Acanthuridae	*Acanthurus triostegus*
	Zebrasoma scopus
Mullidae	*Parupeneus barberinus*
	Parupeneus bifasciatus
Pomacentridae	*Abudefduf biocellatus.*
	Abudefduf sp.
	Pomacentrus nagasakiensis
	Pomacentrus chrysurus
	Stegastes sp.
Balistidae	*Rhinecanthus aculeatus*
	Sufflamen sp.
Tetraodntidae	*Canthigaster benetti*

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

Only a few invertebrates were observed within the seagrass zone. This may be due to the timing of survey, since most of the molluscs and other echinoderms are nocturnal. Thick growth of sea grass also camouflages them making it hard to find. Some of the invertebrates observed at the seagrass area included String-of-beads sea cucumber (*Synapta sp*.), Money cowry (*Cyprea moneta*), and some bivalve species.

4.6 Bathymetry

Bathymetric surveys were conducted in around the island and concentrated in northern areas in accordance with the proposed development plan. The bathymetric surveys results are shown in Appendix 2. The bathymetry surveys showed that the lagoon on eastern side of the island is shallower than on western side. The average depth in eastern side lagoon is 0.6m during mean tide whereas the average depth of lagoon on western side is 0.8m during medium tide. Depth of western side lagoon increases more abruptly as moving further from the shore than on eastern side. The eastern side lagoon has a more uniform depth covering a larger area.

4.7 Currents

Both monsoonal and tidal currents were found around the island. Monsoonal water current around the island is northerly during SW monsoon with an average speed of 8m/m and southerly during NE monsoon an average speed of 5m/m. 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 was found to be predominantly northerly due to the narrower channel on northern side of the island and the longer reef system on south of Funadhoo reef system.

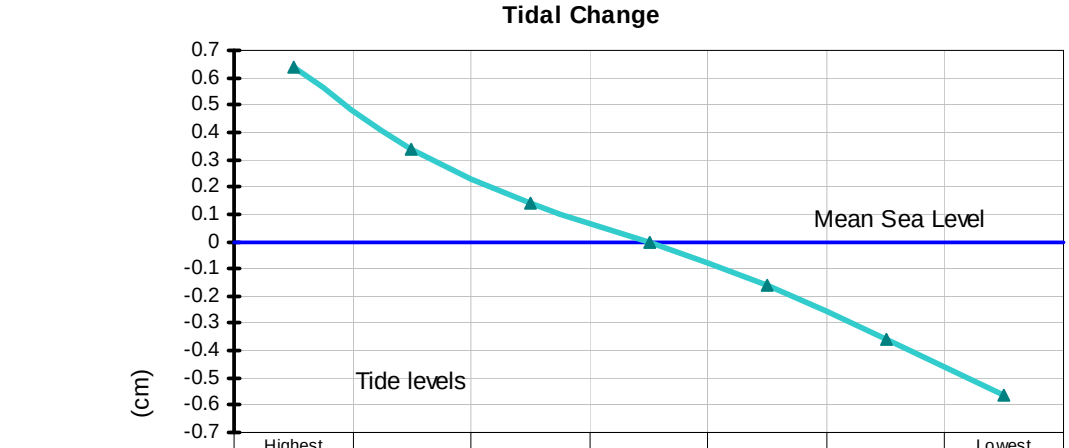
4.8 Waves

An extensive surf zone is found in eastern side especially in southeastern corner of the island where the reef system forms an extensive reef slope. The eastern side of the island is the windward side hence wave action is more on eastern side compared to western side. However, due to the large size of the atoll western side is also exposed to tremendous wave action especially during SW monsoon bad weather conditions. Eastern side of the island is very sheltered by the island itself during SW monsoon. However, eastern side of the island faces severs wave conditions during NE monsoon bad weather conditions.

4.9 Tides

Like most of the places 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 13 tidal change



	Highest Astronomical Tide	Mean Higher High Water	Mean Lower High Water	Mean Sea Level	Mean Higher Low Water	Mean Lower Low Water	Lowest Astronomical Tide
Reference to mean sea level	0.64	0.34	0.14	0.00	-0.16	-0.36	-0.56

Source: State of the Environment Maldives 2002 (UNEP)

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 Huvadhoo Atoll. The variation in tidal changes has a profound effect size of the beach area in the islands. In some of the islands surveyed in Huvadhoo Atoll, more than half of the beach is flooded during the highest tides. In Funadhoo for instant, approximately over 3% of the area of the beach is flooded during high tides.

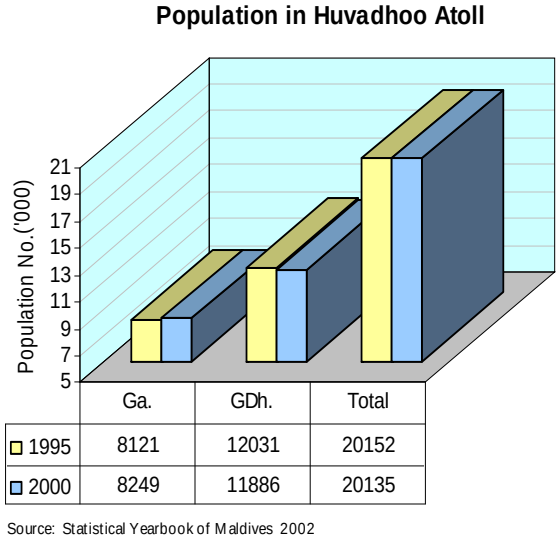
5. Socio-economic and population

Huvadhoo Atoll has the highest population of all the atolls in the country having little over 20,000 as recorded by the last census. However, it has remained very constant and the population density is relatively low compared to most of the atolls. The significance of large population is the impacts on the environment as a result of increased resource exploitation such as fisheries, developmental activities in the atoll such as land reclamation, harbour development and various other impacts from population pressures such as solid waste and sewage disposal.

These environmental issues related to population pressures, in the form of economic development in the atoll are found to be increasing, especially in the populated islands such as Gadhdhoo and Thinadhoo where for instant, much of the lagoon and wetland areas have been reclaimed for housing. Harbours have been developed without proper designs which have led to pollution in the harbours.

Figure 14 population of Huvadhoo Atoll

Population of the Atoll. The total population of Huvadhoo Atoll had slightly decreased during the last five years from 20,152 in the year 1995 to 20135 in the year 2000, while it has increased in North Huvadhoo Atoll from 8,121 to 8,249 in the same period. Population of N. Huvadhoo Atoll is less than that of S. Huvadhoo Atoll in the last census in 2000.



Source: Statistical Yearbook of Maldives 2002

As the tourism has been expanded throughout the whole country, development of tourist resorts have started in the atoll. Hadaha, and Mahadhoo in G.A. will be the closest two island to Funashoo, that will be developed as tourist resorts. Other islands in the atoll designated for development of tourist resorts are Funamauddu, Meradhoo, and Konotta in western side of the atoll and Lonudhuhutta in south of the atoll.

An existing domestic airport is found in Kaadedhdhoo, approximately 60km west of Funadhoo. A domestic airport is also proposed in north of the atoll in Vilingili, approximately 24km north of Funadhoo.

6. 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 ant atoll environment. Both qualitative and quantitative data were collected for this EIA study.

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

6.1 Marine environment assessment methods

6.1.1 Reef Aesthetic Survey – using Mata Tow Technique

This is a subjective attribute based on the observer's judgment and experience of the relative merits of a reef. This value judgment should incorporate coral cover, diversity of life forms, fish life, reef structure and general appeal. Observers should take care not to allow the present weather conditions to bias their judgment when assigning this category as poor visibility will impair this judgment. The following categories can be used to determine reef aesthetic.

1. Very poor
2. Poor
3. Average
4. Good
5. Very good
6. Excellent

Dominant benthic form

When determining percentage cover of hard coral during a manta tow survey the observer should note if a particular benthic form dominates an area. The dominant benthic form categories used to describe a reef are:

1. Hard coral - *Scleractinia* coral species
2. Soft coral - *Alcyonaria* species
3. Macro algae - Large, non-filamentous algae with a well-developed stems
4. Coralline/turf algae - All forms of encrusting algae and filamentous turf algae
5. Sand/Rubble - All unconsolidated substrate such as sand and broken fragments of coral and rock
6. Sponge - *Porifera* species

Dominant hard coral genus

If hard coral is the dominant benthic form in a zone, then it is broadly categorised as Acropora or non-Acropora. If hard coral is not dominant, or there appears to be equal dominance of Acropora and non-Acropora, then it is classified as 'no one coral genus dominant'.

A. *Acropora* genus

C. non-*Acropora* genus

N. No one coral genus dominant

Dominant hard coral form

There are eight coral life forms, which commonly dominate a reef slope. If there is no one dominant coral form, or if hard coral is not dominant, then it is recorded as 'no dominant form.

Live hard coral cover

Coral cover is determined from the median cover category estimate recorded by manta tow over the given reef zone.

Structural complexity

This is a subjective category designed to indicate the topography of the reef slope.

1. Uniform - a consistent, featureless area of reef, such as reef pavement, vertical drop-offs, flat, sandy, back reef areas or an area of staghorn coral.
2. Mixed - a variable reef slope that may be a solid edge interspersed with occasional grooves.
3. Complex - a very diverse slope that may consist of "spur and grooves," caves, holes, overhangs or bommies.

Fish abundance

This attribute is an estimate of the total fish abundance over the zone. The categories are subjective and rely on the observer's perception and experience.

1.Low
2.Moderate
3.High
4. Very high

Coral bleaching

Coral bleaching looks similar to scars caused by COTS, as the corals appear brilliant white. A close inspection of bleached coral will reveal that the polyps are still visible, although colourless. Bleaching should be recorded only if it is unambiguous. It is recorded as a percent cover category.

6.1.2 Manta Tow Survey

The manta tow technique is used to assess broad changes in the benthic communities of coral reefs where the unit of interest is often an entire reef, or large portion thereof. It enables visual assessment of large areas of reef within a short time and is highly recommended for determining the effects of large-scale disturbances such as those caused by coral bleaching, outbreaks of Acanthaster (crown-of-thorn starfish) and storm damage. The technique is useful for selecting sites that are representative of the large areas of the reef.

The technique involves towing of an observer, using a rope and a manta board, behind a small boat powered by an outboard motor. Tows are carried out at a constant speed around the perimeter of a reef and are broken into units of 2 minute duration. During each 2 minute tow, observations are made on several variables (e.g. percent cover of live coral, dead coral and soft coral). These are recorded onto data sheets as categories of integer values. Additional information can be collected, depending on the survey objectives, e.g. percent cover of sand and rubble, and the number of *Tridacnid clams, Diadema or Acanthaster*. However, Fernandes (1989), caution against recording data on too many variables, and the technique is not recommended for fish counts.

The method described in this manual is not useful in assessing the distribution and abundance of corals, but is also widely used for the study of *Acanthaster*. Details of *Acanthaster* assessment have been included because of the extensive destruction to many reefs in Indo-Pacific which have been caused by these starfish. The technique may also be used to assess other organisms of particular interest to a survey region. However, it should be noted that estimates of accuracy and precision of the technique have only been in relation to coral cover and *Acanthaster*

Background

In general, the manta tow technique has been used to investigate issues at broad level to assess the effects of *Acanthaster* on coral reefs in Micronesia, similar surveys have been conducted on the reefs within the Red Sea and the Great Barrier Reef The technique has also been used for more general, broad scale surveys of coral reef systems. While manta tow techniques have been used extensively since the early 1970's, the details of the method have varied between the different studies. Work by Moran et al. (1988, 1989) to assess the broad scale distribution and abundance of *Acanthaster* and their effect on the Great Barrier Reef has greatly refined the technique.

More recently, studies have focused on the precision of manta tow techniques for estimating coral cover and *Acanthaster* abundance. These studies have shown the technique to be particularly useful fro assessing broad changes in the distribution and abundance coral cover (especially live coral) and

Acnathater. For example, a typical manta tow survey (of approximately 50-60 tows) is capable of detecting a 20% change in the abundance of an outbreaking population of *Acanthaster.* The studies also show that, despite underestimating the number of *Acanthaster*, manta tow counts can be calibrated to predict estimates obtained from SCUBA swim. Hence, the combined information from a relatively large number of tows can give more accurate estimates of abundance when the spatial distribution of the target organism is highly variable (e.g. *Acanthater*), and the unit of interest is whole reef.

Advantages

- Large are of a reef can be surveyed in a relatively short time. This reduces the possibility of overlooking population changes or disturbances which can be variable in space and time (bleaching, storm damage, *Acanthaster*).
- It is relatively simple to perform after some training.
- It does not use expensive or specialized equipment which would require the observer to have special qualifications. (e.g. SCUBA apparatus).
- It can be performed in remote locations with minimal support.
- The observer can cover great distances without fatigue.

Disadvantages

- The survey may be conducted over inappropriate sections of the reef (e.g. large areas of sand or deep water) because the tow path is controlled by the driver who views the reef from above the water.
- If animals are not obvious they may be overlooked.
- The observer may have too much information to remember, particularly if many variables are being recorded.
- The method is not suitable for areas with poor visibility (less than 6m).

Logistics - Personnel

- Manta tow surveys are conducted by teams of one or more pairs of trained personnel. The duties of the teams are divided between the boat driver and the observer.
- Each series of manta tows is coordinated by a leader who is responsible for the safety of personnel and for ensuring that the technique is conducted in a standardized way, and for determining when conditions are appropriate for surveying.

Equipment

- A small boat with an outboard motor is used for towing observers. The boat should be fitted with towing bridle.
- A 17m tow rope connects the manta board to the boat. The rope should be braided and approximately 10mm in diameter (polyethene ski-rope is recommended). Two buoys

are placed on the rope, one at 6m from the manta board, and the other at 12m. These buoys allow the observer to estimate visibility in a standard manner.

- The dimensions of the manta board are 600 x 400 x 20 mm (length x breadth x thickness). It is recommended that the board be made from marine ply and painted white. Two indented handle grips are positioned towards each corner of the front of the board. A single hand hold is located centrally at the back of the board.
- A data sheet (A4 underwater paper is recommended) is held in position within a recess on the centre of the board. The data sheets should be preprinted to assist the observer record a set of biological variables and other significant observations.
- Diagrammatic representations of coral cover categories are attached to the board for observer reference. Any other list which may assist the observer may also be attached e.g. if survey will include *Acanthaster*, then categories used to record feeding scars and *Acanthaster* size should be provided.
- A pencil is attached with light twine to the board.
- The observer wear snorkeling equipment (mask, snorkel and fins) and preferably a full length dive suite or nylon ('stinger') suite.
- The driver should be protected from the sun and should have the following equipment in the boat:
- Waterproof watch for timing the duration of tows.
- An image of the reef sealed in plastic and attached with rubber bands to a plastic board. An aerial photograph of the reef is recommended however, a map or copy can be substituted if this is not available.
- A waterproof pen for marking the position of the tows.

Site Selection

- Whole (unbroken) reef perimeter are surveyed where possible. Shoals and ill-defined areas of reef, separated by deeper water, are not usually surveyed.
- Tows are begun from an easily identifiable point on the reef. This is particularly important when resurveys are intended. A GPS if available, can be very useful for relocating sites.
- For long sections of coastline with fringing reefs, allocate a section of the length as a reef.
- If there are two teams conducting the survey, the teams should start from the same point and then proceed in the opposite directions. Tows are continued until the boats meet again. In situation where the reef is not circular, teams should start in the opposite ends of the reef and proceed towards one another, repeating the tows until the boats meet. Hence, each reef will consist of consecutive tows which will vary in number according to the size of the reef to be surveyed.
- If it is possible to complete a survey in a single set of consecutive tows, marker buoys are left to denote where the next set of tows will begin.

General procedure

- The survey of the reef is broken into manta tows of 2 minute duration. At the end of each 2 minute tow, the boat is stopped to allow the observer to record the data on the printed sheet attached to the manta board. At this time, the driver marks the tow number and position of the boat on the aerial photograph. When the observer is ready to continue, he signals the driver to start another 2 minute tow. This procedure is repeated until the entire perimeter or length, of the reef has been surveyed.
- The observer is towed parallel to the reef crest so that the maximum amount of the reef can be seen, i.e. tow path should be close to the reef crest. The tow speed should be constant. During calm weather the speed should be between 3 to 5 km per hour (1 to 1.5 knots, the equivalent to a slow walk). Factors such as currents and sea conditions may vary the tow speed.
- Since the boat driver may not be able to position the boat on an ideal tow path, the observer may have to vary the search relative to their position on the reef slope. The width of search is variable, but a scan of a 10 to 12 m strip of the reef is recommended. The search path and width will also vary according to the visibility, reef gradient, distance from the substratum, and the distribution and density of the organisms being counted.
- The direction of the reef is determined by factors such as wind, currents and angle of sun. When weather conditions allow, it is advised to standardize the direction in which tows are conducted (e.g. clockwise on circular reef; north to south, or east to west, along a length of fringing reef) so that comparison of resurveyed reefs require less correction.
- Observations should be discontinued where visibility is less than 6m. This distance is determined using the buoys located along the tow rope. If the back of the boat can be seen, the visibility is judged to greater than 18m.
- Standard hand signals should be used between the observer and the boat driver to allow effective communication. For instance, observer should signal the driver to move closer to the reef when being towed over deep water.
- The maximum number of consecutive tows conducted by an observer is 15. Once a series of 15 tows have been completed, the observer and the driver (or a fresh observer) exchange roles. During this change over a briefing should occur. This includes discussions about general conditions, state of the reef and anything else of note seen by the observer during the tows.
- Observations are generally made from the surface. Manta towing below the surface may be necessary when the substratum is not clearly visible or closer inspection is required. Prolong diving should be avoided.

6.1.3 Coral Reef Fish Visual Census

Coral reef fish populations are assessed by visual census of the fishes along 50m transects. The transects are censused during day light hours using SCUBA and should be done in conjunction with Line Intercept Transect (LIT) method. The method used for the assessment and monitoring of fish is a combination of 2 techniques. The first detects differences in assemblages of reef fishes at different sites using abundance categories. It provides baseline data for zoning, management and monitoring of coral reefs. The second technique counts individual fish and estimates their total lengths in order to determine the standing stock and population size and structure of specific species (those that are favoured by fishermen). The method is one of the most common quantitative and qualitative sampling methods used in coral reef surveys.

Background

Fish communities are a major resource of coral reefs. They play an important role in coral reef ecosystem (e.g. the role of grazers controlling algal growth), and are commercially important for both fisheries, and more recently, tourism.

Visual census techniques have been used in coral reefs around the world to assess and monitor reef fish abundance and diversity. Combination of fish visual census and Line Intercept Transect are also used to examine the influence of substrate structure on reef fish community structure.

Advantages

- Visual census of fishes is one of the most quantitative and qualitative sampling methods used in coral reef surveys.
- It is rapid, non destructive and inexpensive.
- It utilizes a minimum of manpower and specialized equipment.
- It can be used to survey the same area through time.
- It has the potential to produce large databases rapidly for management and stock assessment purposes.

Disadvantages

- The observers must be very well-trained and experienced.
- There may be repulsion and / or attraction of fishes to the divers.
- Observer's error and bias occur in estimating numbers and sizes.
- There is low statistical power to detect change in rare species.
- The use of abundance categories reduces the power to detect small changes.
- The techniques are restricted to shallow depth due to decompression constraints.

Logistics -Personnel

- The fish survey team consists of 2 or 3 divers. The observer (fish counter) must be able to identify the fish species of the area.
- One diver is designated as the observer to reduce the bias.
- In areas of high fish abundance, the technique could be divided between the 2 divers: undertaking the census using abundance categories; while the other counts and estimates the lengths of specific 'target' species.

Equipment

- Small boat with outboard engine and safety equipment.
- SCUBA equipment.
- Pencil and slates, with prepared data sheets (preprinted A4 underwater paper is recommended). Prepare data sheets after a list of fish species from the area has been compiled.
- Fiberglass measuring tape – 50m long.
- Fish models or 'fiddle sticks' to practice estimating total lengths of fishes while diving.

Site selection

- Select the sites after a general survey of the reef slope so that the sites are representative of the reef. All sites should be similar with respect to physical characteristics, slope and coral cover.
- Where possible, the site for visual censuses of fishes should include those selected for collection of benthic lifeform data using LIT. This will provide the fish team with detailed description of the reef being censused.
- Select at least two sites (replicates) on the windward slope to estimate between the site variability within the one habitat. Each site within the habited (windward slope) must be similar to the other windward sites.
- If distinct windward and leeward habitat exist, select at least 1, preferably 2, sites in each zone. In regions where reversing monsoon winds prevail, selects sites from areas of the reef exposed to the different monsoons.
- The sites within habitats should be separated from each other by a reasonable distance (100 to 200m).
- Avoid variable habitats such as spur formation, which are likely to include sand and fissures.
- Record the exact positions of all replicates. If available, a GPS can be very useful for relocating the sites.

General procedure - Selection of species

- Reconnaissance dives at each must be done to list dominant species for inclusion on prepared data sheets before the actual census begins. This minimizes the time needed to write species names on the sheets, thereby improving observer's ability to record fishes continually.
- Select species to be censused using the following criteria:
- The species should be visually and numerically dominant, without cryptic behaviour.
- They should be easily identified underwater.
- They must be associated with reef-slope habitats.
- A core group of species appropriate for coral reef assessment should be made to:
- Quantitatively estimate density and size structure of species that are favoured (targeted) by fishermen (e.g. *Serranids, Ludjanids, Lethrinids, Haemulids, siganids*).
- Quantitatively estimate the abundance of 'indicator' species (e.g. Chaetodontids).
- Semi-quantitatively estimate the relative abundance of other species belonging to major trophic categories (planktivores, algal grazers, fish and coral feeders) such as *Pomacanthids, Acanthurids, Caesionids, Scarids, Siganids, Labrids, Mullids* and other species that are 'visually obvious'.
- With experience, observers may be able to count each fish encountered along the transect. Where this is possible, actual counts should be done since they give greater power to data analysis.
- Sample data sheets of species should be prepared for both abundance estimates, and for density and size estimates. These data sheets should be attached to the slate.

Laying of the transect

- At each site on the reef, lay at least 3 transect lines of 50m lengths at each of the two lengths (3-5m and 8-10m)
- The transect line should include the benthic lifeform transects (LIT) whenever both fish and benthic lifeforms are surveyed at the same reef.
- The fish transect and LIT are different lengths but may use the same transect line (tape) – 50m is the lengths for individual fish census, while for the LIT, a shorter transect length (20m) is used. Count the fish first using the same transect.
- The fish transect lines are straight and follow a depth contour.
- The replicate transect lines (at least 3) at each depth are located haphazardly and should not overlap. Each transect must be separated by 10 to 20m .
- The basic unit of data collection for fish visual census is 50m x 5m. Thus, 3 replicate provide a total census area of 750m2 at each depth.
- For greater safety work from the deeper transects to the shallow.

Census technique

- Wait for 5 to 15 minutes after laying the transect before counting, to allow the fishes to resume normal behaviour.
- Each transect is censused as a complete 50x5m belt. Transects should not be broken into smaller units as this will underestimate the abundance of more mobile species.
- The observer swims slowly along the transect (using the SCUBA), recording the fishes encountered within 2.5m either side of the transect, and 5m above, the transect Always verify the diver's ability to estimate 5m before beginning the census.
- If visibility is poor, it may be reduce the width of the transect belt to 2.5m wide, 2.5m above, the transect. This should be clearly noted on the data sheet.
- Count the actual number of 'target' species seen within the transect strip and estimate the size (in cm) of each of these fish.
- Count actual number of 'indicator' species.
- Estimate the abundances of 'visually obvious' species on a cumulative log 4, abundance scale from 1 to 8 (Russ 1985).

Logarithmic abundance categories used in estimates of abundance of numerically dominant fish species (Russ 1985).

Table 6 log 4 abundance category for fish count

Log 4 Abundance Category	Number of Fishes
1	1
2	2-4
3	5-16
4	17-64
5	65-256
6	257-1024
7	1025-4096
8	4097-16384

- Experienced observers can count actual numbers of 'visually obvious' species to provide superior data to the abundance categories. For species where fish are particularly numerous, however, abundance categories are the best estimate.
- Do not compromise getting a good overview of the community by trying to count all individual of some taxta, while not getting reliable estimates of abundance for others.
- One diver makes the census dive within the transect area while the other serves as a dive buddy swimming behind the observer and making general observations of the reef environment and the fish assemblages.
- In areas of high fish diversity and abundance, it is recommended that the tasks be separated. This can be done either by counting in 2 passes (different species each pass); or by having one diver concentrate on the 'target' species, while the second counts other species.

6.2 Bathymetry surveys

Bathymetry surveys were conducted by using GPS interfaced eco-sounder and position corrections made using total station surveying equipment. Data where 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 figure x.

6.3 Surface current surveys

Current direction and speed were estimated using floating drough system. 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.

6.4 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 17 beach profiles were taken around the island for assessing the beach slope profiles and amount of beach materials in different areas of the beach.

6.5 Vegetation surveys

Coastal vegetation were surveyed using line intercept transect method. A total of 39 transects of each 30m long were conducted on eastern coastal vegetation and a total of 9 transects of 30m each were also conducted in eastern side of the island. Qualitative visual observations of the coastal vegetation were also conducted.

Inside vegetation surveys were mainly conducted using qualitative methods to assess the overall status of the vegetation in terms of species and maturity of trees and quantitative surveys of sizes of the matured trees were conducted by measuring the girth of the large trees.

6.6 Soil surveys

Semi-quantitative assessment of soil of the island was conducted by taking soil profiles at various locations of the islands. Humus contents and depth of dark soil was assessed using visual assessment and taking measurement from the soil profiles.

6.7 Groundwater surveys

Groundwater surveys were conducted by taking samples from various locations of the island. The samples were taken to the National Health Laboratory and quantitatively analysed using laboratory equipments.

7. Public Consultation

Non-formal public consultations were conducted in the form of interviews with key personnel with respect to the proposed development. The people who were consulted included Ibrahim Mohamed from nearby Kondey island who looked after Funadhoo island until it is leased by the Government and general public from Kondey and Dhaandhoo. In general the key issue raised by the public on the proposed project was assurance of the start of the project and benefits from the project to the general public.

The public consultation revealed that the expectation of the public from the project is jobs and job opportunities from the project both in the construction and operation stage of the project. In the consultation the general public including fishermen and farmers, did not raise any conflicting issues in terms of economic, social or environmental.

The tourism in the area so far only involved a relatively few tourist who come for surfing. However, in the future tourism will be developed in the area. The consultation with the tourism operators revealed that the project is a bonus for future tourism operators in the area as the project can provide locally grown fresh vegetables, fruits and egg which area produced using environment friendly organic method.

The public consultation concluded that the public is looking forward for the start of the project construction and operation in order to maximize the benefits of the project to the atoll community.

8. Assessment of Direct and Indirect Environmental Impacts

8.1 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 rainforests of the underwater world.

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.

8.2 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 Funadhoo have been conducted to establish the historic and current status.

b. Negative and positive environmental impacts in construction and operation phase of the proposed project work. Extensive field surveys and assessment identified negative impacts that will result from the work activities of the proposed project.

c. Potential environmental impacts at the operational or post-construction phase of the proposed project. A rigorous 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 project work and operation of the island as an agriculture island, 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. Qualitative and quantitative data collected from filed work were analysed 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, for instance on, set standard 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.

This assessment identified and qualified 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 mitigating or a significant change to the proposal (category IV).

8.3 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 generally. Field surveys of the reef, beach, coastal and inland vegetation showed that there was no significant impact due to the tsunami. However, a negative impact due to the tsunami reported was increased salinity of ground water of the island. Other natural impact identified were significant beach erosion especially in the southern and southeastern areas of the beach. Major anthropogenic negative impacts included clearance of path through the vegetation.

8.4 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 vegetation from partial vegetation clearance for farming and on marine environment from harbour development. Negative impacts of proposed work activities on other attributes i.e. beach and coastal vegetation would be not significant in terms of nature, extent and magnitude as shown by the assessment of the proposed project work activities and existing environment.

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

8.4.1 Harbour development

The proposed harbour development of harbour, harbour quay-wall and harbour protection wall will impact mostly to the near shore and marine environment including the lagoon on eastern and northern areas of the island. Deepening a part of the lagoon to create the harbour basin, will remove habitat for burrowing organisms in the lagoon bottom. A part of the seagrass bed (approximately 1/4) will be permanently removed during excavation of the harbour basin. This impact is not likely to be ecologically significant as the seagrass in the proposed harbour area is not extensive to provide an ecologically significant habitat. Impact from harbour development will be felt within an area of 10,615 m² which is less than 4 % of the lagoon area and approximately 20 % of the seagrass bed in the lagoon eastern side of the island.

Harbour quay-wall construction will impact the near-shore environment due to deployment of heavy vehicles in the area. This impact will be to the near-shore habitat of the beach and the burrowing organisms in the area. This impact is not considered as significant as a relatively small area will be impacted due to this activity and the habitat in the area was not found ecologically significant as only approximately 200m (8%) of the near-shore environment will be impacted.

Harbour protection wall construction will impact the shallow lagoon environment and bottom of the lagoon where the harbour protection wall be laid. Approximately an area of 400m² of the lagoon bottom will be covered by the harbour protection wall. Bottom of the entire area has seagrass hence the seagrass bed will be impacted. This impact is not considered significant as the impact will be felt on only 2% f the seagrass bed in eastern side of the island. The seagrass in this area contains no significant habitats due to poor growth of seagrass in this area.

8.4.2 Navigation channel

Navigation channel deepening will impact the shallow lagoon and lagoon bottom in northern area of the island. Approximately 7,500m² (2%) of the lagoon bottom will be impacted due to excavation. This area of the lagoon bottom only contains sandy habitats and associated borrowing organisms. This impact is not considered as significant as it is a relatively small area and the area has no significant habitats.

8.4.3 Vegetation clearance

Development of proposed structures on land will impact the vegetation of the island in northern area of the island. Approximately 2776.60 m² of vegetation will permanently removed for the proposed development of structures and access roads. This impact is not considered to be a significant impact to the vegetation as there are no significant plants in terms of ecology or maturity and it is about 1.29% of the islands vegetation.

Vegetation clearance to get land for cultivation of vegetables and fruit and poultry farming will have a significant impact on the islands vegetation in terms of area of vegetation loss. Approximately 10,195m² of vegetation (4.73% of the island vegetation) from the island will be lost due vegetable and fruits cultivation. However, this impact is not considered as ecologically significant and most of the plants in the area are also very common and no old trees were found in the area.

8.4.4 Shore protection

The proposed eastern and southern side shore protection by filling in the eroding area with sand may impact certain shore organisms such as shore crabs and shore mollusks like periwinkles This impact maybe direct as the habitat will be lost. This impact will not be significant as the shore organisms found in this area are very common and has large populations and ability to recolonise in other areas. Approximately 20% of the eastern shoreline may be directly impacted due to the proposed shore protection measures.

The following table shores extent of direct physical impacts on various attribute of the island environment from various project activities.

Table 7 extent of physical impacts

Attribute impacted	Reef	Lagoon	Shore / beach	Vegetation
Work activity				
Harbour deepening	0	10,000m^2	0	0
Quay-wall	0	0	400m^2	0
Harbour protection wall	0	400m^2	0	0
Navigation Channel		7,500 m^2	0	0
Partial vegetation clearance	0	0	0	105,000 m^2
Total vegetation clearance	0	0	0	17,300 m^2
Shore protection (south)	0	2,500 m^2	1,700 m^2	0
Shore protection (southeast)	0	15,300 m^2	7,200 m^2	

8.5 Ecological Impacts in Construction Stage

Potential negative ecological impacts on the terrestrial and the marine 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 work 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 hours 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 may infauna and their habitats will be lost. However, it 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. 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 and filling lagoon bottom with sand may result 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 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 summary of nature and extent of impacts during the work activities of the proposed development work.

Table 8 extent and nature of impacts

Impact characteristic	Project work activities				
	Navigation channel deepening	Harbour development	Shore protection	Partial vegetation clearance	Complete vegetation clearance
Nature of impact	Cumulative	Cumulative	Cumulative	Cumulative	Cumulative
Magnitude of impact / Impact category	Category II Minor negative	Category II Minor negative	Category II Minor negative	Category II Minor negative	Category II Minor negative
Geographical range of impact & environmental attribute	7,500 m² of lagoon	10,000m² of lagoon	17,800 m² lagoon and shore	105,000 m² of inner vegetation	17,300 m² of inner vegetation
Duration of impact	Short-term	Short-term	Short-term	Short-term	Short-term
Reversibility	Reversible	Reversible	Reversible	Reversible	Reversible
Impact significance	Significant	Significant	Significant	Significant	Significant

The following figure shows extent of direct and indirect impacts on different attributes of the marine environment that would arise from the above activities in the proposed location (Figure 2

8.6 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 mooring area.

Propellers of the boats can disturb lagoon bottom and increase turbidity of the lagoon water as the boats come into the mooring area and leave from the mooring area. 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 increase of 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 mooring 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 mooring area

Periodic excavation to maintain the needed depth of the mooring area may not allow for the lagoon bottom organisms to establish after and thus benthic community may change. This change maybe decrease abundance and diversity

- Impact of the wake produced by the vessels on the beach

Vessels that come to the mooring area may produce wake that can lead to coastal modification over long-term. This may result in beach erosion depending on rate and extent of the use of the mooring area.

8.7 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 changes to species that is more resilient to changing environmental conditions due 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 the report.

8.8 Socio-economic impact

The proposed project will be investing Rf 20 million for infrastructure development including the proposed work activities. A significant amount of this will be distributed within the atoll community. In addition to this a significant amount of money per year will be spent as salary for the permanent employees. Also revenue for the Government from this project will be the lease rent of Rf 13 million over a period of 5 years.

One of the most important positive impacts of the proposed project will be both short-term and long-term positive socio-impacts to the atoll community. Direct positive short-term socio-economic impacts will be creation of jobs and job opportunities within the atoll during the project work activities. It is estimated that the proposed project work activities will create over 200 jobs directly related to the proposed work activities. In addition to this local people from the atoll and other regions will be trained for cultivation of vegetables and fruits in sustainable manner and permanent jobs will also be created in the island in long term. Agriculture sector in the atoll will be developed and expanded to meet the demand for agriculture products for the local people as well as for the upcoming tourist resort islands in the atoll as well as nearby atoll.

9. Mitigation measures

9.1 Mitigation Measures in Construction Stage

Early planning is the key to minimise the impacts on the marine and coastal environment from the proposed development in Funadhoo island. 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 it will not be difficult to mitigate and minimise the negative impact from the proposed development on the environment of the island.

In all development projects, it is essential to identify possible impacts to the natural environment and suggest best possible ways of minimising or overcoming those impacts. In this regard, there is a number of mitigation measures that are taken can be taken to minimise the impacts identified in the previous section of this report. Therefore, it is important to take the following mitigation measures to minimise the impacts form the proposed development in Funadhoo island.

1. Locations of the proposed structures are selected based on extensive field surveys and assessment of the terrestrial and the marine environment of the island.

2. Two locations most suitable for the proposed harbour development in terms of feasibility and least impact has been assessed in detail to select most appropriate location.

3. Navigation channel will be deepened in the area already partially opened and deeper than most areas and shortest possible location

4. The proposed development was analysed to decide the minimum area of harbour and navigation channel deepening.

5. Minimum area needed for harbour will be deepened

6. The harbour is located in the most sheltered and least beach dynamic location so that possible erosion due to the deepening of the harbour area will be avoided.

7. The proposed development in Funadhoo 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 sediment settling on the reef would be minimised. Therefore, the proposed work of channel

clearance and lagoon deepening will be conducted when the current direction is away from the reef.

8. Possible spreading of sediment plumes due to the excavation of lagoon will be controlled and minimised by use appropriate retention methods. Conventional method used for retention of sediment plume due to the lagoon excavation is by enclosing the area with bund wall prior to excavation.

9. 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.

10. The project manager, and the work force involved during the operation of the work will be briefed of environment friendly practices.

11. The work will be properly supervised and monitored to minimise negative effect on the environment.

12. The terrestrial and the marine environment will be monitored for potential impacts on the biological and ecological aspects of the environment.

13. 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.

14. Whenever heavy equipment and vessels are mobilized closer to the reef care will be taken to avoid accidents and damage to the reef

The following table summarizes the general measures that will be taken to minimize impacts during the main work activities of construction stage of the project.

Table 9 mitigation measures in construction stage

	Project Work Activities				
	Navigation channel deepening	**Harbour development**	**Shore protection**	**Partial vegetation clearance**	**Complete vegetation clearance**
Mitigation measures	Use silt screen or other appropriate methods e.g. bund walls to prevent spreading of sediment plumes	Use silt screen or other appropriate methods e.g. bund walls to prevent spreading of sediment plumes	Use silt screen or other appropriate methods e.g. bund walls to prevent spreading of sediment plumes	Avoid damage to other trees and relocate as many trees as possible to other location where there is no development	Relocate all the trees that are significant in age and species to other locations where there is development
	Use environmentally friendly materials and methods	Use environmentally friendly materials and methods	Use environmentally friendly materials and methods	Complete the work in shortest time period	Complete the work in shortest time period
	Complete the work in shortest time period	Complete the work in shortest time period	Complete the work in shortest time period	Use manual methods as much as possible	Use manual methods as much as possible
	Use manual methods as much as possible	Use manual methods as much as possible	Use manual methods as much as possible	Organize and inspect the work to minimize impacts	Organize and inspect the work to minimize impacts
	Organize and inspect the work to minimize impacts	Organize and inspect the work to minimize impacts	Organize and inspect the work to minimize impacts	Create awareness and brief the workforce how to minimize impacts	Create awareness and brief the workforce how to minimize impacts
	Create awareness and brief the workforce how to minimize impacts	Create awareness and brief the workforce how to minimize impacts	Create awareness and brief the workforce how to minimize impacts	Create awareness and brief the workforce how to minimize impacts	Create awareness and brief the workforce how to minimize impacts
	Minimize waste generation	Minimize waste generation	Minimize waste generation	Minimize waste generation	Minimize waste generation
	Erect signboards on environmental protection	Erect signboards on environmental protection	Erect signboards on environmental protection	Erect signboards on environmental protection	Erect signboards on environmental protection

9.2 Mitigation Measures in 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 channel through the lagoon and the mooring area. The following measures will be taken to minimise possible negative impacts arising from operation of the channel and the mooring area

- Maintenance deepening of the navigation channel and harbour area will be minimised as much as possible to avoid chronic impacts of turbidity increase in the lagoon water column and its possible ecological impacts. This will also minimise the cost of operation. Minimisation of maintenance deepening will also minimise possible alteration of lagoon bottom community.
- Possible wake produced by the vessels will be minimised by imposing speed limit so that wake is reduced. This is to avoid possible alteration of the beach line and beach erosion due to wake from the boats.
- Operation impacts of the channel and mooring area will minimised through consistent monitoring of impacts and taking appropriate measures based on monitoring data and analysis.

10. Evaluation of Alternatives

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

10.1 Alternative location for the harbour and access/navigation channel.

Northwestern side of the island was the next most appropriate location for a harbour development in terms of costs and feasibility of usage. Developing a harbour in this location will be less expensive and the impacts on the lagoon environment may be less as this location is deeper therefore less excavation compared to the proposed location as shown in the site plan. However, this location is more exposed to the WS monsoon waves and currents therefore more has to be invested in order to make the harbour usable. Locating harbour in other areas will need creating an access channel through the reef thus causing more damage to the environment as well as higher project cost.

10.1.1 Alternative for a harbour – a jetty construction

Option of a jetty was also evaluated for the access of the island. Cost and environmental impact of a jetty will be less compared to the proposed harbour. However, a jetty will not be feasible for the long-term operation of the proposed project given the scale and duration of the project. The operation of the proposed project is 20 years and it is a medium scale agriculture project thus a jetty was not considered in favour of a harbour as proposed.

10.1.2 Scale of the Project and allocation of land area for Farming and Land Structures

Land area needed for cultivation and poultry farming was evaluated based on the scale, duration, lease rent and investment of the project in order to make the project profitable. Less land area than proposed area of land for agriculture development was found to be not feasible for the project in terms of sustainability of the project.

10.1.3 Alternative coastal protection

The coastal erosion in south and southeastern side of the island can be left as it is thus negative impacts that may arising from sediment spreading in the lagoon water from the proposed coastal protection can be avoided. However, in long-term this may cause severe loss of vegetation in the area and damage to the island environment. If this alternative is opted, the materials excavated from the proposed harbour basin should be disposed elsewhere with an extra cost as well as impact where it will be disposed.

10.1.4 Alternative location (island) for the project

The project location (island) has been identified and allocated by high level consultation within the concerned Government agencies. These consultations involved technical as well as overall development policy currently being implemented. However, in terms of environmental impacts there maybe the project may be undertaken elsewhere with less negative environmental impacts. These alternative locations for the project can be inhabited islands of Konday or Dhiyadhoo where there is undeveloped land. If these locations are selected the need for coastal development such as harbour, and other development can be minimize and the impacts to the environment arising from these development may be minimized as well. However, overall development policy may not allow these alternative locations for the proposed development.

10.1.5 No development option

The no project development option can avoid all the negative impacts to the environment. However, no project development option can also have the risk of the island environment being neglected of environmental protection in long-term. For instance the coastal erosion can lead to loss of a significant amount of coconut palms and loss of land causing adverse natural environmental impacts in long-term. No project option will also result in loss of the socio-economic opportunities to the locals and to the country as a whole.

11. 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. the coastal zone irrespective of the options chosen because no method or option particularly guarantees a stable coastline. 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 minimising the impacts and in ensuring that appropriate precaution and care is employed.

11.1 Monitoring for 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 50m distance from one another to provide enough data to establish changes in coastline at designated locations and around the island.

2. Currents will be monitored using current meters or drogues.

3. 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

4. If available, periodic aerial photos may also be used to assess long-term changes to the hydrodynamic and littoral regimes.

11.1.1 Monitoring programme for the beach and coastal zone

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

Table 10 beach and coastal monitoring programme

Parameters / Method	Frequency of monitoring	Purpose
Beach/erosion & accretion 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
Sediment dynamics 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
Sediment dynamics Bathymetry	Every six months before and after project implementation	To monitor the effects of shoaling
Sediment dynamics Waves and tides	Once or twice a year	Understand effects on coastal environment including erosion & accretion

11.1.2 Monitoring programme for the terrestrial environment

Table 11 terrestrial environment monitoring programme

Parameters / Method	Frequency of monitoring	Purpose
Vegetation Transects and visual observations	Twice a year	Understand the changes to the vegetation and vegetation cover as percentage of the island
Fauna Visual observation	Every month	To monitor pests such as rats and insects that may cause impact to the vegetation
Groundwater – physical appearance, pH, salinity, phosphate, nitrate, sulphate Laboratory test of groundwater samples	Every three months	To take mitigation measures in case of increasing salinity due to water extraction, o deviation of phosphate, nitrate and sulphate from the natural (baseline)levels.

11.1.3 Marine environmental monitoring programme

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 mitigatory 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 resort redevelopment.

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.

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 12 marine environment monitoring programme

Methods / Parameter	Frequency of Monitoring	Purpose
Ambient Environmental Temperature,Salinity,Turbidity/light penetration, Currents	Twice 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
Coral reef 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
Marine Environmental Aesthetic 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
Fish populations Underwater Fish Census	Once after the work is completed And one every year thereafter	Quantitative assessment of fish population of selected species
Coral cover/recruitment Permanent Photo 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
Sedimentation Sediment traps deployment/collection	Twice a month during work and Once every 3 months thereafter	Quantitative assessment of sediment loading on the reef benthos.
Water quality 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 13 cost of monitoring

11.2 Breakdown of Monitoring Yearly Monitoring Cost

Activity	**Quantity**	**Cost USD**
Establishment of baseline environmental status for monitoring	1	5,000/-
Field work	24	3,000/-
Document preparation	4	3,000/-
Logistics (for 12 trips)	1	1,000/-
Travel and accommodation for a team of four (No. of trips)	12	20,000/-
Total		**32,000/-**

12. Conclusions

This environmental impact assessment study depicted that the proposed development project will cause a short-term significant impact to the marine and terrestrial environment of the island. The most significant long-term impact to the marine environment arising from the proposed will be felt on the lagoon environment on northeast of the island due to the proposed navigation channel and harbour development in this area. This impact will be the loss of the natural habitat for lagoon infauna of the lagoon environment due to excavation of the area to deepen to harbour the vessels. However, in terms of area this impact can be said insignificant as it will impact approximately 4% of the island lagoon. Short-term impacts of this development activity will be spreading of fine sediment in the lagoon water which will be minisized through appropriate mitigation measures. Coastal protection proposed will have a long-term positive impact as it will mitigate the negative impacts of coastal erosion occurring in southern and southeastern area of the island currently.

Most significant impact on the terrestrial environment will be felt on the island vegetation from the proposed vegetation clearance in the central area for farming activities. However, vegetation clearance is proposed in two levels to minimize the impacts. Partial clearance of the vegetation will remove only the bushes and leave the large trees intact. Total clearance will involve removal of large trees and these trees will be re-located as much as possible.

Socio-economic impact of the proposed project will be creation of job opportunities in the atoll and development of the agriculture industry in the country. The project will create enormous economic opportunities both in the construction and operation stage through creation of both short-term and permanent jobs and business opportunities especially for the locals. The project will also provide better dietary products for the locals and tourist resorts through production of fresh fruits and vegetables.

In terms of long-term benefits, the project will help to sustain the existing environment through consistent monitoring, evaluation and taking appropriate action to protect and preserve the ecology of the island.

13. Appendices

13.1 Appendix 1. Terms of reference

The EIA will be conducted in accordance with the instructions given in the EIA Regulation 2007. The format and structure of the EIA report will be, as given in "Schedule E" of the EIA Regulation 2007. As such a title page, non-technical summary and this TOR will be included in the EIA report in addition to the following project specific topics.

Project Setting

The proposed project will be implemented in the Maldives Environment and therefore, existing plans, policies, guidelines, regulations and laws of the country will be followed in addition to international conventions to which the country is a party. This EIA will specifically follow EIA regulations, 2007 passed under the national Environmental Protection and Preservation Act. In addition, regulations on agriculture development, utilization of marine and coastal resources of the country will be followed. The report will also review the circulars of Ministry of Fisheries, Agriculture and Marine Resources and other Government bodies in the context of the proposed agriculture development in Ga. Funadhoo.

Existing Environment

The proposed development project is located in the island of Funadhoo in North Huvadhoo Atoll at 0°33'42.85" N and 73°31'33.83"E. The nearest airport is Kaadedhoo airport approximately 60km west of Funadhoo.

The closest island to the project location is a very small uninhabited island named Funadhoo vilingili less than 1km north. The closest inhabited islands to the project location are Kondey (population 383)7km, Dhiyadhoo (population 229) 9km and Gemanafushi (population 1110) 13km south of the project location and Dhaandhoo (population 1563) 9km and Nilandhoo (population 847) 11km north of the project location. The closest resort island which is under development is Hadaha 10km southwest of the project location.

The project location, Funadhoo island is located on eastern rim of Huvadhoo Atoll within a separate coral reef system (within a separate Falhu). Any part of Funadhoo island or reef is not included in the list of sites requiring special protection.

The vegetated area of the island is approximately 21.556 hectares (215,560m²). The island is elongated oval shape and found to be stable in terms of erosion and accretion. The total area of coral reef system is approximately 106 hectares. The shallow lagoon area surrounding the island is approximately 27 hectares.

As the island is located on eastern rim of the atoll, eastern side of the island is windward side and this side faces open deep ocean. Western side of the island faces the atoll lagoon hence this side is leeward side. As usual the windward reef is structurally well developed and gets exposed during low tides thus provide shelter to the island. Eastern side reef is deeper and provide less protection to the island.

The lagoon on both sides of the island is similar size however, eastern side lagoon is shallower having less than 1m during mean tides whereas western side lagoon is deeper than 1m during mean tide.

Seagrass beds are found in the shallow lagoon areas on both sides of the island. Seagrass area on both sides covers approximately 10.02 hectares (100,236.29m^2). These segrass beds contain two species of seagrass. No unique feature is found within Funadhoo environment.

Eastern side of the island beach area mostly consisted of extensive beach rock, boulders, pebble and rubble. Approximately 40% of the coastline has exposed beach rock. Sandy beach though narrow is found all along western side of the island. Approximately 50% of the island has sandy beach. No serious net beach erosion is found in this island, however, severe seasonal erosion is found on eastern side and on southwestern side.

The coastal vegetation is thick and intact and consisted of mostly sea lettuce on western side and sea lettuce and screw pine on eastern side. The inside vegetation consists of mostly Sea hibiscus, screw pine and coconut palms in southern areas of the island. There are approximately 500 coconut palms in the island. The vegetation of the island can be said not matured as there are no large trees found except a few including Barringtonia. Less than 1% of the island is covered with mature tree. Although the vegetation is young the entire island is cover by vegetation. Tsunami impact to the island was found to be minimal as the shallow lagoon areas of the island are not extensive and the island has higher than average elevation.

There is partial entrance to the lagoon of the island through northern side of the island as this side of the reef has very sharp dropoff entrance to the lagoon by small speed boat is easy through this channel. However, it should be deepened and widen for safe and easy access to the island. As the island lagoon is very shallow there is no suitable area for anchoring. Therefore, a proper harbour will be constructed as described below.

Project Description and Development Activities

Ga. Funadhoo have been leased for 21 years to develop and operate the island as an agriculture island and to carry out agriculture related activities including poultry. Out of this period 1 year will be the duration for development of infrastructure needed for the project. Agricultural industry is one of the important sector that needs to be further developed in the country hence

Government gives priority for development of the sector. Thus a number of islands including Funadhoo have been leased for this purpose.

The island will be developed specifically for sustainable organic farming of fruits / vegetables and poultry / goat rearing. The island will be developed based on a concept that will result in the least possible negative impacts to the island and the surrounding environment.

Following are the main activities that will be carried out for the development of the island.

Development of a harbour

An adequate size of a harbour for the proposed project in terms of operations of the project activities will be developed. The dimensions of the proposed harbour are 100m by 75m (a water area of 10,615m2 and a key length of 100m). The minimum depth needed for the proposed harbour is 3m at mean tide. A habour of these dimensions will be developed in northeastern side of the island where it is most sheltered and closest to deep water so that entrance channel will be shortest.

As a part of harbour development an entrance channel of 100m by 25m will also be created connecting the habour and the deep water for the safe passage of vessels. This channel will be oriented northwest-southeast direction as in the existing entrance passage location and orientation.

Sheet piles with concrete capping will be used to construct the quay wall along the landward side of the harbor for safe berthing of the vessels. All retaining walls will be constructed using sand-cement bags.

Wave protection to the harbor will be provided by a tetra pod system constructed by sieved coral sand concrete from excavated sand from the harbor. Special precaution will be taken for sand-cement bag protection wall to minimise maintenance and maintenance impacts. Adequate water flow within the harbour will be provided by creating openings in the protection wall in south of the harbour.

Method for harbour and entrance channel deepening

Harbour area will be deepened by conventional method of excavation using an excavator. An excavator of bucket size 1m^3 and trucks to carry the excavated materials will be used in the habour development work in the development site.

Excavation area of harbour will be contained before start of excavation. Harbour protection structures i.e. the rear breakwater and side protection walls will be constructed before

excavation starts to minimise spreading of sediment and silt plumes to the marine environment.

Excavation of entrance channel will be contained by creating bund-wall to minimise spreading of sediment and silt to the marine environment. The bund wall will be removed after excavation of the entrance channel.

It is estimated that excavation of the proposed harbor area and entrance channel will generate approximately 45,547.38 m^3 of excavated materials containing mostly sand. The materials excavated from the entrance channel will be used for filling in the severely eroded area in north and the materials excavated from the harbor will be used to fill the adjacent area to the harbor. These materials will be transported using trucks along shoreline of the island.

Development of structures on land

All the structures will be constructed in northern area of the island. These structures will be constructed using conventional material of brick walls and corrugated iron roofing. A total of 2776.60 m^2 will be used as built-up area which is about 1.29% of the total land area.

A powerhouse to accommodate 2nos generators capacity of 35kVA and 50kVA and a desalination plant of capacity 25tons/day will be constructed using conventional methods material of concrete. The inlet for the desalination plant will be located southeast further away of the harbour. The outlet of the desalination plant will be located inside the harbor so that hypersaline water will be diluted inside the harbor and dispersed.

2nos fuel storage tanks of capacity 50tons each will be installed adjacent to the powerhouse. This tank will have concrete bund wall surrounding the fuel storage tank to prevent accidental spillage of fuel to the environment and seepage to the groundwater.

All the structures which will be constructed in the island will have a setback of a minimum 20m from the existing bushline.

Method of structures development on land

All land structures will be single storey and constructed using conventional materials and methods of construction in the Maldives, i.e. cement and sand and iron re-enforced concrete foundations using imported river-sand and aggregate.

Shore protection

The entire eastern side of the island faces severe seasonal erosion causing deterioration of coastal vegetation especially with observed increased frequency of sea-swells and tidal

flooding. Therefore measures need to be taken to protect eroding shoreline and coastal vegetation. The proposed method of shore protection is by filling the severely eroding areas with excavated material from the harbour and channel deepening. An area of approximately 14,000m on eastern side and 3,000m is proposed to be filled in southern area of the island.

Development of farming area

Farming area will consist of vegetables and fruit plantation area and poultry area. Vegetables and fruits plantation area will be located in the central area of the island. Two plots of land for green house and Nurseries (4,080m2 and 6,115m2 respectively) will be cleared fully from the existing trees and bushes in central area of the island. And two plots of land will be fenced for goat rearing (an area of 8,418m2) and poultry (an area of 20,228m2) in the south of the Nurseries and green house. Poultry will be used for production of organic eggs which has higher market value. The remaining available areas will be used for horticulture where bushes will be cleared and partially cleared.

Land clearance

Vegetation will be cleared in northern area of the island for construction of all the building structures. A total area of approximately 15,999.81m² of vegetation (less than 7.42% of the island vegetation) will be cleared in northern area of the island for development of land structures and access roads.

Vegetation will also be cleared in central area of the island for green house and nurseriers. A total area of approximately 10,195m² of vegetation (4.73% of the island vegetation) will be cleared in the central area of the island. Type of vegetation cleared will be mostly Sea hibiscus (Dhigga), Sea lettuce (Magoo) and Screw pine (Boakashikeyo) as these are the most common plants inside the island.

A minimum width of 20m wide coastal vegetation belt (Heylhi) around the island will be kept intact without any vegetation clearance except walkways leading to shore as shown in the site plan.

Method of land clearance

Two levels of vegetation clearance will be carried out. These are partial clearance mostly in the farming area and total clearance for construction of land structures. Partial clearance is clearing only the bushes and grass leaving the large trees. 48% of the vegetation will be partially cleared. Vegetation will be cleared using manual methods of using axe and other such conventional tools. No heavy equipment is need for vegetation clearance as there are not many

large trees. Coconut palms and other large tree which within the land use area will be kept and layout of structures will be adjusted to minimise cutting of large trees.

Waste management

Solid waste generated during the construction period will of two types i.e. construction wastes and organic waste from land and vegetation clearance. Construction waste will be minimal as there will be only few land structures built. Construction related waste will mostly include waste that can be reused i.e. iron from concrete re-enforcement, empty cement and gunny bags, waste timber pieces from roofing. These wastes will be reused as much as possible and taken to nearby islands for reuse on request.

Vegetable wastes from clearance of vegetation will be used to produce organic fertilisers that will be used for cultivation of vegetables and fruits.

Sewage will be managed using combination of biological method of underground reticulation system and septic tanks system. Sludge accumulated over the time will be used as to produce organic fertiliser.

Predicted negative impacts

Harbour development

The proposed harbour development including entrance channel, harbour quay-wall and harbour protection wall will impact mostly to the marine environment including the lagoon on eastern and northern areas of the island. Deepening a part of the lagoon will remove habitat for burrowing organisms in the lagoon bottom. A part of the seagrass bed (approximately 1/4) will be permanently removed during excavation of the harbour basin. This impact is not likely to be ecologically significant as the seagrass in the proposed harbour area is not extensive to provide an ecologically significant habitat. Impact from harbour development will be felt within an area of 10,615m2 which is less than 4 % of the lagoon area and approximately 20 % of the seagrass bed in the lagoon eastern side of the island.

Vegetation clearance

Development of proposed structures on land will impact the vegetation of the island in northern area of the island. Approximately 2776.60 m^2 m^2 of vegetation will permanently removed for the proposed development of structures and access roads. This impact is not considered to be a significant impact to the vegetation as there are no significant plants in terms of ecology or maturity and it is about 1.29% of the islands vegetation.

Vegetation clearance to get land for cultivation of vegetables and fruit and poultry farming will have a significant impact on the islands vegetation in terms of area of vegetation loss. Approximately 10,195m² of vegetation (4.73% of the island vegetation) from the island will be lost due vegetable and fruits cultivation. However, this impact is not considered as ecologically significant and most of the plants in the area are also very common and no old trees were found in the area.

Shore protection

The proposed eastern and southern side shore protection by filling in the eroding area with sand may impact certain shore organisms such as shore crabs and shore mollusks like periwinkles This impact maybe direct as the habitat will be lost. This impact will not be significant as the shore organisms found in this area are very common and has large populations and ability to recolonise in other areas. Approximately 20% of the eastern shoreline may be directly impacted due to the proposed shore protection measures.

Predicted positive impacts

Shore protection measures will protect the eastern side of the island and a significant percentage of the coastal vegetation of the island. Coastal vegetation plays an important role in protection of the island from erosion and salt spray into the island during certain periods of the monsoon. Positive impacts of the proposed other development activities relate to social and economic benefits to the locality by development of agriculture and diverse job opportunities especially to the nearby islands and the atoll population.

Mitigation of negative impacts

Negative impacts will be minimized and mitigated based on thorough assessment of the existing environment and development of a concept that have minimum environmental impacts. Location and design of harbour, land structures and farming areas are based on environmental surveys and consultation with locals familiar with the Funadhoo local environment. Construction period will be minimized minimize impacts on the environment. Methods for construction activities will be adopted to minimize impacts on environment. Minimum area for development of harbour, land structures and farming area considered to minimize negative impacts during development and operation of the proposed project. Monitoring of the existing environment and operation of the all the project activities will be conducted to identify and minimize and mitigate any negative impacts arising from the proposed project.

The EIA report for the development and operation of the proposed project at Ga. Funadhoo will provide the following in details.

-the title page giving tile of the EIA, location of the project, team responsible for the report, proponents names and signature and date the report is completed

-a non-technical and concise summery using non-technical language. This summery will include outline of the project and its location and will be focused primarily upon selection of alternative, key impacts and mitigation measures

-introduction providing background information on the project and its costs, the proponent and its previous experience with similar projects

-agreed terms of reference for the EIA

-project settings and how it conforms with the existing plans, policies, guidelines, regulations, laws and international conventions

-project description indicating project justification and rationale including duration of the project, proof of ownership of land, owner's consent to the project, components and size and scale of the project

-location map

-scaled A3 size site plan showing locations of all proposed infrastructure and setback of all building from the high water mark

-description of environmental conditions

-measures adopted to promote sustainable development during and both development and operation stage of the project

-capital investment and employment opportunities

-description of the natural, economic and human environment including a comprehensive site plan drawn to scale showing valued ecosystem components, low and high water marks

-aerial photographs of the site

-description of site characteristics including soil type

type of flora and fauna, habitats of ecological importance

-beach sediment dynamics and current regimes around the site

-socio-economic characteristics including population

-methodology of data collection

-public consultation including community, atoll and island office, summary of outcome of consultations and concerns identified.

-assessment of direct and indirect environmental impacts including impacts on biophysical, economic and human environment

-evaluation of alternatives including no development option

-preferred alternatives and mitigation measures

-environmental monitoring including parameters that will be monitored and monitoring methodologies and frequency and procedures for reporting to the authority

-conclusions including selection of preferred alternatives, mitigation measures and monitoring plan that will be undertaken

-declaration of the consultant that the information provided are true, complete and correct and

names and registration number of the EIA consultant and CV of unregistered consultants

13.2 Appendix 2. Additional technical information and baseline data

Eastern side coastal vegetation cover

7/11/2007

Transect 1

English name	Species	Transistion		Cover (cm)
Sea lettuce	*Scaveola taccada*	210	0	210
Screwpine	*Pendanus tectoris*	380	210	170
Cheese fruit	*Morinda citrifolia*	450	380	70
Screw pine	*Pendanus tectoris*	610	450	160
Sea hibiscus	*Hibiscus tilaceous*	690	610	80
Srewpine	*Pendanus tectoris*	780	690	90
Sea hibiscus	*Hibiscus tilaceous*	920	780	140
Nit pitcha	*Guettarda speciosa*	1070	920	150
Sea lettuce	*Scaveola taccada*	1440	1070	370
	Bare	1650	1440	210
Sea lettuce	*Scaveola taccada*	2060	1650	410
Sea hibiscus	*Hibiscus tilaceous*	2200	2060	140
Sea lettuce	*Scaveola taccada*	2790	2200	590
	Bare	2940	2790	150
Sea lettuce	*Scaveola taccada*	3000	2940	60
	Transect 2			
	Species			
Sea lettuce	*Scaveola taccada*	60	0	60
Coconut palm	*Cocos nucifera*	180	60	120
Sea lettuce	*Scaveola taccada*	560	180	380
Coconut palm	*Cocos nucifera*	770	560	210
Sea lettuce	*Scaveola taccada*	2000	770	1230
Tassel plant	*Suriana maritima*	2200	2000	200
Sea lettuce	*Scaveola taccada*	2410	2200	210
Ironwood	*Carpinus caroliniana*	2425	2410	15
Sea lettuce	*Scaveola taccada*	3000	2425	575
	Transect 3			
	Species			
Sea lettuce	*Scaveola taccada*	420	0	420
	Bare	670	420	250
Sea lettuce	*Scaveola taccada*	840	670	170
Coconut palm	*Cocos nucifera*	910	840	70
Tree heliotrope	*Tournefortia argentea*	1160	910	250
Ironwood	*Carpinus caroliniana*	1460	1160	300
Sea lettuce	*Scaveola taccada*	1540	1460	80

Coconut palm	*Cocos nucifera*	1740	1540	200
Ironwood	*Carpinus caroliniana*	1890	1740	150
Tassel pant	*Suriana maritima*	2180	1890	290
Tree heliotrope	*Tournefortia argentea*	2390	2180	210
Coconut palm	*Cocos nucifera*	2510	2390	120
Sea lettuce	*Scaveola taccada*	2830	2510	320
Ironwood	*Carpinus caroliniana*	3000	2830	170
	Transect 4			
Tassel plant	*Suriana maritima*	120	0	120
Tree heliotrope	*Tounefortia argentia*	370	120	250
Tassel plant	*Suriana maritima*	1210	370	840
Tassel plant	*Suriana maritima (dead)*	1590	1210	380
Tree heliotrope	*Tounefortia argentia*	2020	1590	430
Nit pitcha	*Guettaeda speciosa*	2390	2020	370
Ironwood	*Carpinus caroliniana*	2530	2390	140
Tassel plant	*Suriana maritima*	2650	2530	120
Coconut palm	*Cocos nucifera*	2870	2650	220
	Bare	3000	2870	130
	Transect 5			
Sea lettuce	*Scaveola taccada*	180	0	180
Coconut palm	*Cocos nucifera*	370	180	190
	Bare	450	370	80
Coconut palm	*Cocos nucifera*	750	450	300
Sea lettuce	*Scaveola taccada*	890	750	140
Coconut palm	*Cocos nucifera*	940	890	50
	Bare	1040	940	100
Coconut palm	*Cocos nucifera*	1210	1040	170
Sea lettuce	*Scaveola taccada*	1570	1210	360
	Bare	1810	1570	240
	Bare	1950	1810	140
Coconut palm	*Cocos nucifera*	2120	1950	170
Nit Pitcha	*Guettarda speciosa*	2270	2120	150
	Bare	2380	2270	110
Sea lettuce	*Scaveola taccada*	3000	2380	620
	Transect 6			
	Bare	40	0	40
Coconu palm	*Cocos nucifera*	170	40	130
	Bare	300	170	130
Sea lettuce	*Scaveola taccada*	1300	300	1000
Nit pitcha	*Guettarda speciosa*	1430	1300	130

Coconu palm	*Cocos nucifera*	1670	1430	240
	Bare	1790	1670	120
Nit pitcha	*Guettarda speciosa*	1980	1790	190
	Bare	2019	1980	39
Coconu palm	*Cocos nucifera*	2260	2019	241
Sea lettuce	*Scaveola taccada*	2460	2260	200
Nit pitcha	*Guettarda speciosa*	2650	2460	190
Sea lettuce	*Scaveola taccada*	3000	2650	350
	Transect 7			
Sea lettuce	*Scaveola taccada*	30	0	30
Nit pitcha	*Guettarda speciosa*	160	30	130
Sea lettuce	*Scaveola taccada*	310	160	150
Coconut palm	*Cocos nucifera*	450	310	140
Sea lettuce	*Scaveola taccada*	1010	450	560
Coconut palm	*Cocos nucifera*	1260	1010	250
Sea lettuce	*Scaveola taccada*	3000	1260	1740
	Transect 8			
Sea lettuce	*Scaveola taccada*	1470	0	1470
Nit pitcha	*Guettarda speciosa*	1710	1470	240
Sea lettuce	*Scaveola taccada*	3000	1710	1290
	Transect 9			
Sea lettuce	*Scaveola taccada*	730	0	730
Coconut palm	*Cocos nucifera*	930	730	200
Sea lettuce	*Scaveola taccada*	3000	930	2070
	Transect 10			
Sea lettuce	*Scaveola taccada*	3000	0	3000
	Transect 11			
Coconut palm	*Cocos nucifera*	150	0	150
Sea lettuce	*Scaveola taccada*	2380	150	2230
Coconut palm	*Cocos nucifera*	2930	2380	550
Sea lettuce	*Scaveola taccada*	3000	2930	70
	Transect 12			
Sea lettuce	*Scaveola taccada*	3000	0	3000
	Transect 13			
Sea lettuce	*Scaveola taccada*	1710	0	1710
Coconut palm	*Cocos nucifera*	1930	1710	220
Sea lettuce	*Scaveola taccada*	3000	1930	1070
	Transect 14			
Sea lettuce	*Scaveola taccada*	650	0	650
Ironwood	*Carpinus caroliniana*	1070	650	420
Sea lettuce	*Scaveola taccada*	3000	1070	1930
	Transect 15			

Sea lettuce	*Scaveola taccada*	2010	0	2010
	Bare	2260	2010	250
Sea lettuce	*Scaveola taccada*	3000	2260	740
	Transect 16			
Sea lettuce	*Scaveola taccada*	110	0	110
Ironwood	*Carpinus caroliniana*	960	110	850
Sea lettuce	*Scaveola taccada*	3000	960	2040
	Transect 17			
Sea lettuce	*Scaveola taccada*	3000	0	3000
	Transect 18			
Sea lettuce	*Scaveola taccada*	2880	0	2880
Coconut palm	*Cocos nucifera*	3000	2880	120
	Transect 19			
Coconut palm	*Cocos nucifera*	530	0	530
Sea lettuce	*Scaveola taccada*	2540	530	2010
Coconut palm	*Cocos nucifera*	2560	2540	20
Sea lettuce	*Scaveola taccada*	3000	2560	440
	Transect 20			
Sea lettuce	*Scaveola taccada*	200	0	200
Coconut palm	*Cocos nucifera*	790	200	590
	Bare	970	790	180
Sea lettuce	*Scaveola taccada*	1460	970	490
Coconut palm	*Cocos nucifera*	1820	1460	360
Sea lettuce	*Scaveola taccada*	2870	1820	1050
Coconut palm	*Cocos nucifera*	3000	2870	130
	Transect 21			
Coconut palm	*Cocos nucifera*	130	0	130
Sea lettuce	*Scaveola taccada*	400	130	270
Coconut palm	*Cocos nucifera*	610	400	210
	Bare	820	610	210
Coconut palm	*Cocos nucifera*	950	820	130
Sea lettuce	*Scaveola taccada*	1060	950	110
Coconut palm	*Cocos nucifera*	1850	1060	790
Ironwood	*Carpinus caroliniana*	2240	1850	390
Sea lettuce	*Scaveola taccada*	2500	2240	260
Coconut palm	*Cocos nucifera*	2700	2500	200
Sea lettuce	*Scaveola taccada*	3000	2700	300
	Transect 22			
Ironwood	*Carpinus caroliniana*	1900	0	1900
Coconut palm	*Cocos nucifera*	2130	1900	230
	Bare	2350	2130	220
Sea lettuce	*Scaveola taccada*	2540	2350	190

Ironwood	*Carpinus caroliniana*	3000	2540	460
	Transect 23			
Ironwood	*Carpinus caroliniana*	3000	0	3000
	Transect 24			
Ironwood	*Carpinus caroliniana*	340	0	340
	Bare	480	340	140
Coconut palm	*Cocos nucifera*	950	480	470
Sea lettuce	*Scaveola taccada*	1370	950	420
Ironwood	*Carpinus caroliniana*	1860	1370	490
Sea lettuce	*Scaveola taccada*	2680	1860	820
Ironwood	*Carpinus caroliniana*	3000	2680	320
	Transect 25			
Ironwood	*Carpinus caroliniana*	90	0	90
	Bare	240	90	150
Coconut palm	*Cocos nucifera*	550	240	310
	Bare	1120	550	570
Ironwood	*Carpinus caroliniana*	1470	1120	350
Sea lettuce	*Scaveola taccada*	3000	1470	1530
	Transect 26			
Ironwood	*Carpinus caroliniana*	640	0	640
Sea lettuce	*Scaveola taccada*	860	640	220
Screw pine	*Pendanus tectoris*	1030	860	170
Sea lettuce	*Scaveola taccada*	1770	1030	740
Nit pitcha	*Guettarda speciosa*	2170	1770	400
Tree heliotrope	*Tournefortia argentea*	2240	2170	70
Nit pitcha	*Guettarda speciosa*	2640	2240	400
Screw pine	*Pendanus tectoris*	2770	2640	130
Sea lettuce	*Scaveola taccada*	3000	2770	230
	Transect 27			
Sea lettuce	*Scaveola taccada*	320	0	320
Ironwood	*Carpinus caroliniana*	420	320	100
Sea lettuce	*Scaveola taccada*	700	420	280
Ironwood	*Carpinus caroliniana*	720	700	20
Sea lettuce	*Scaveola taccada*	930	720	210
Ironwood	*Carpinus caroliniana*	1100	930	170
Nit pitcha	*Guettarda speciosa*	1280	1100	180
Ironwood	*Carpinus caroliniana*	1820	1280	540
Tree heliotrope	*Tournefortia argentea*	1990	1820	170
Sea lettuce	*Scaveola taccada*	3000	1990	1010
	Transect 28			
Ironwood	*Carpinus caroliniana*	200	0	200

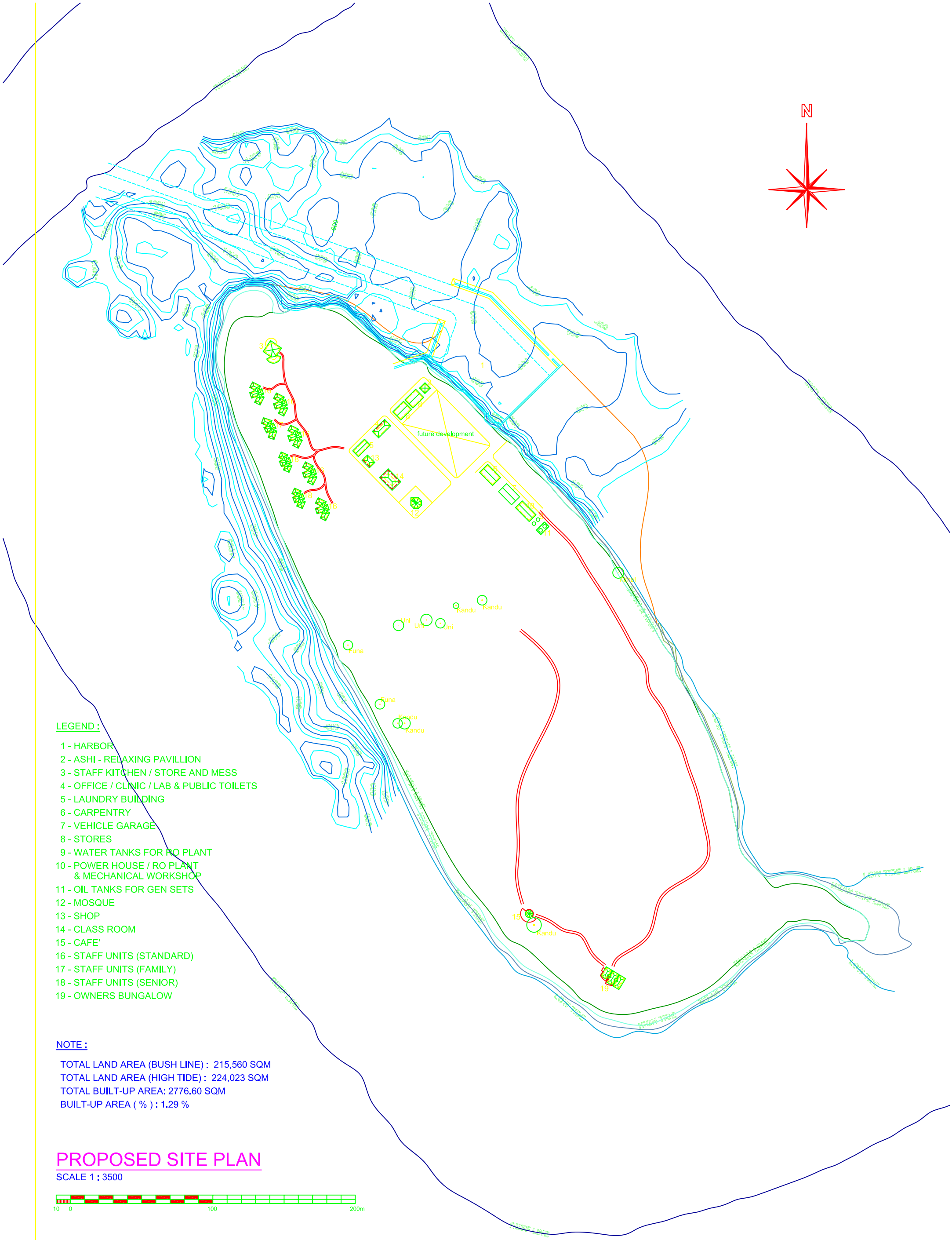
Sea lettuce	*Scaveola taccada*	700	200	500
Ironwood	*Carpinus caroliniana*	3000	700	2300
	Transect 29			
Sea lettuce	*Scaveola taccada*	400	0	400
Ironwood	*Carpinus caroliniana*	1540	400	1140
Sea lettuce	*Scaveola taccada*	1900	1540	360
Ironwood	*Carpinus caroliniana*	2610	1900	710
Sea lettuce	*Scaveola taccada*	2760	2610	150
Tree heliotrope	*Tournefotia argentea*	3000	2760	240
	Transect 30			
Sea lettuce	*Scaveola taccada*	3000	0	3000
	Transect 31			
Sea lettuce	*Scaveola taccada*	390	0	390
Tree heliotrope	*Tournefortia argentea*	810	390	420
Sea lettuce	*Scaveola taccada*	1000	810	190
Coconut palm	*Cocos nucifera*	1190	1000	190
Sea lettuce	*Scaveola taccada*	1620	1190	430
Tree heliotrope	*Tournefortia argentea*	1810	1620	190
Sea lettuce	*Scaveola taccada*	3000	1810	1190
	Transect 32			
Sea lettuce	*Scaveola taccada*	550	0	550
Tree heliotrope	*Tournefotia argentea*	660	550	110
Sea lettuce	*Scaveola taccada*	1740	660	1080
Tree heliotrope	*Tournefotia argentea*	1880	1740	140
Sea lettuce	*Scaveola taccada*	3000	1880	1120
	Transect 33			
Sea lettuce	*Scaveola taccada*	2250	0	2250
Nit pitcha	*Guettarda speciosa*	2470	2250	220
Sea lettuce	*Scaveola taccada*	2890	2470	420
Coconut palm	*Cocos nucifera*	3000	2890	110
	Transect 34			
Nit pitcha	*Guettarda speciosa*	270	0	270
	Bare	1020	270	750
Nit pitcha	*Guettarda speciosa*	1520	1020	500
Screw pine	*Pendanus tectoris*	2190	1520	670
	Bare	2450	2190	260
Screw pine	*Pendanus tectoris*	2630	2450	180
Sea lettuce	*Scaveola taccada*	2900	2630	270

Screw pine	*Pendanus tectoris*	3000	2900	100
	Transect 35			
Screw pine	*Pendanus tectoris*	520	0	520
Sea lettuce	*Scaveola taccada*	1500	520	980
Screw pine	*Pendanus tectoris*	2010	1500	510
Coconut palm	*Cocos nucifera*	2700	2010	690
Sea lettuce	*Scaveola taccada*	3000	2700	300
	Transect 36			
Nit pitcha	*Guettarda speciosa*	330	0	330
Sea lettuce	*Scaveola taccada*	930	330	600
Screw pine	*Pendanus tectoris*	1850	930	920
Sea lettuce	*Scaveola taccada*	1990	1850	140
Nit pitcha	*Guettarda speciosa*	2110	1990	120
Sea lettuce	*Scaveola taccada*	2500	2110	390
Nit pitcha	*Guettarda speciosa*	2600	2500	100
Sea lettuce	*Scaveola taccada*	2870	2600	270
Coconut palm	*Cocos nucifera*	3000	2870	130
	Transect 37			
Coconut palm	*Cocos nucifera*	150	0	150
Nit pitcha	*Guettarda speciosa*	200	150	50
Screw pine	*Pendanus tectoris*	610	200	410
Nit pitcha	*Guettarda speciosa*	1380	610	770
Coconut palm	*Cocos nucifera*	2640	1380	1260
Screw pine	*Pendanus tectoris*	3000	2640	360
	Transect 38			
Screw pine	*Penadanu tectoris*	490	0	490
Coconut palm	*Cocos nucifera*	1330	490	840
Nit pitcha	*Guettarda speciosa*	1720	1330	390
Sea lettuce	*Scaveola taccada*	1840	1720	120
Screw pine	*Penadanu tectoris*	2260	1840	420
Nit pitcha	*Guettarda speciosa*	2540	2260	280
	Bare	2870	2540	330
Tulip tree	*Thespesia populnea*	3000	2870	130
	Transect 39			
Tulip tree	*Thespesia populnea*	120	0	120
	Bare	710	120	590
Nit pitcha	*Guettarda speciosa*	1000	710	290
Screw pine	*Pandanus tectoris*	1360	1000	360
Balsa	*Hernandia nymphaeifolia*	2100	1360	740
Screw pine	*Pandanus tectoris*	3000	2100	900

Western side vegetation cover

	Transect 1			
English name	*Species*	Transition		Cover (cm)
Sea lettuce	*Scaveola taccada*	260	0	260
Crew pine	*Pendanus tectoris*	360	260	100
Coconut palm	*Cocos nucifera*	420	360	60
Sea lettuce	*Scaveola taccada*	1100	420	680
	Bare area	1270	1100	170
Screw pine	*Pendanus tectoris*	2130	1270	860
Sea lettuce	*Scaveola taccada*	2260	2130	130
Screw pine	*Pendanus tectoris*	2630	2260	370
Sea hibiscus	*Hibiscus tilaceous*	2850	2630	220
Sea lettuce	*Scaveola taccada*	3000	2850	150
	Transect 2			
Sea lettuce	*Scaveola taccada*	400	0	400
Coconut palm	*Cocos nucifera*	540	400	140
Sea lettuce	*Scaveola taccada*	1910	540	1370
Sea hibiscus	*Hibiscus tilaceous*	2330	1910	420
Sea lettuce	*Scaveola taccada*	2800	2330	470
Screw pine	*Pendanus tectoris*	2820	2800	20
Sea lettuce	*Scaveola taccada*	3000	2820	180
	Transect 3			
Sea lettuce	*Scaveola taccada*	120	0	120
Screw pine	*Pendanus tectoris*	460	120	340
Sea lettuce	*Scaveola taccada*	2930	460	2470
Sea hibiscus	*Hibiscus tilaceous*	3000	2930	70
	Transect 4			
Sea lettuce	*Scaveola taccada*	130	0	130
Sea hibiscus	*Hibiscus tilaceous*	820	130	690
Screw pine	*Pendanus tectoris*	1100	820	280
Nit pitcha	*Guettarda speciosa*	1730	1100	630
Sea lettuce	*Scaveola taccada*	1970	1730	240
Screw pine	*Pendanus tectoris*	2040	1970	70
Sea lettuce	*Scaveola taccada*	2720	2040	680
Nit pitcha	*Guettarda speciosa*	2900	2720	180
Screw pine	*Pendanus tectoris*	3000	2900	100
	Transect 5			
Screw pine	*Pendanus tectoris*	200	0	200
Nit pitcha	*Guettarda speciosa*	450	200	250
Sea lettuce	*Scaveola taccada*	750	450	300
Nit pitcha	*Guettarda speciosa*	1190	750	440

	Bare area	1410	1190	220
Screw pine	*Pendanus tectoris*	1710	1410	300
Sea lettuce	*Scaveola taccada*	2770	1710	1060
Nit pitcha	*Guettarda speciosa*	3000	2770	230
	Transect 6			
Screw pine	*Pendanus tectoris*	10	0	10
Nit pitcha	*Guettarda speciosa*	20	10	10
Sea lettuce	*Scaveola taccada*	160	20	140
Coconut palm	*Cocos nucifera*	310	160	150
Sea putat	*Barrintonia asiatica*	780	310	470
Nit pitcha	*Guettarda speciosa*	880	780	100
Screw pine	*Pendanus tectoris*	1080	880	200
Sea hibiscus	*Hibiscus tilaceous*	1530	1080	450
Screw pine	*Pendanus tectoris*	1820	1530	290
Nit pitcha	*Guettarda speciosa*	2010	1820	190
Screw pine	*Pendanus tectoris*	2250	2010	240
Sea hibiscus	*Hibiscus tilaceous*	2370	2250	120
Sea lettuce	*Scaveola taccada*	2550	2370	180
Screw pine	*Pendanus tectoris*	2720	2550	170
Nit pitcha	*Guettarda speciosa*	3000	2720	280
	Transect 7			
Sea lettuce	*Scaveola taccada*	1920	0	1920
Screw pine	*Pendanus tectoris*	2190	1920	270
Sea lettuce	*Scaveola taccada*	2590	2190	400
Screw pine	*Pendanus tectoris*	2920	2590	330
Sea hibiscus	*Hibiscus tilaceous*	3000	2920	80



LEGEND :

1 - HARBOR
2 - ASHI - RELAXING PAVILLION
3 - STAFF KITCHEN / STORE AND MESS
4 - OFFICE / CLINIC / LAB & PUBLIC TOILETS
5 - LAUNDRY BUILDING
6 - CARPENTRY
7 - VEHICLE GARAGE
8 - STORES
9 - WATER TANKS FOR RO PLANT
10 - POWER HOUSE / RO PLANT & MECHANICAL WORKSHOP
11 - OIL TANKS FOR GEN SETS
12 - MOSQUE
13 - SHOP
14 - CLASS ROOM
15 - CAFE'
16 - STAFF UNITS (STANDARD)
17 - STAFF UNITS (FAMILY)
18 - STAFF UNITS (SENIOR)
19 - OWNERS BUNGALOW

NOTE :

TOTAL LAND AREA (BUSH LINE) : 215,560 SQM
TOTAL LAND AREA (HIGH TIDE) : 224,023 SQM
TOTAL BUILT-UP AREA: 2776.60 SQM
BUILT-UP AREA (%) : 1.29 %

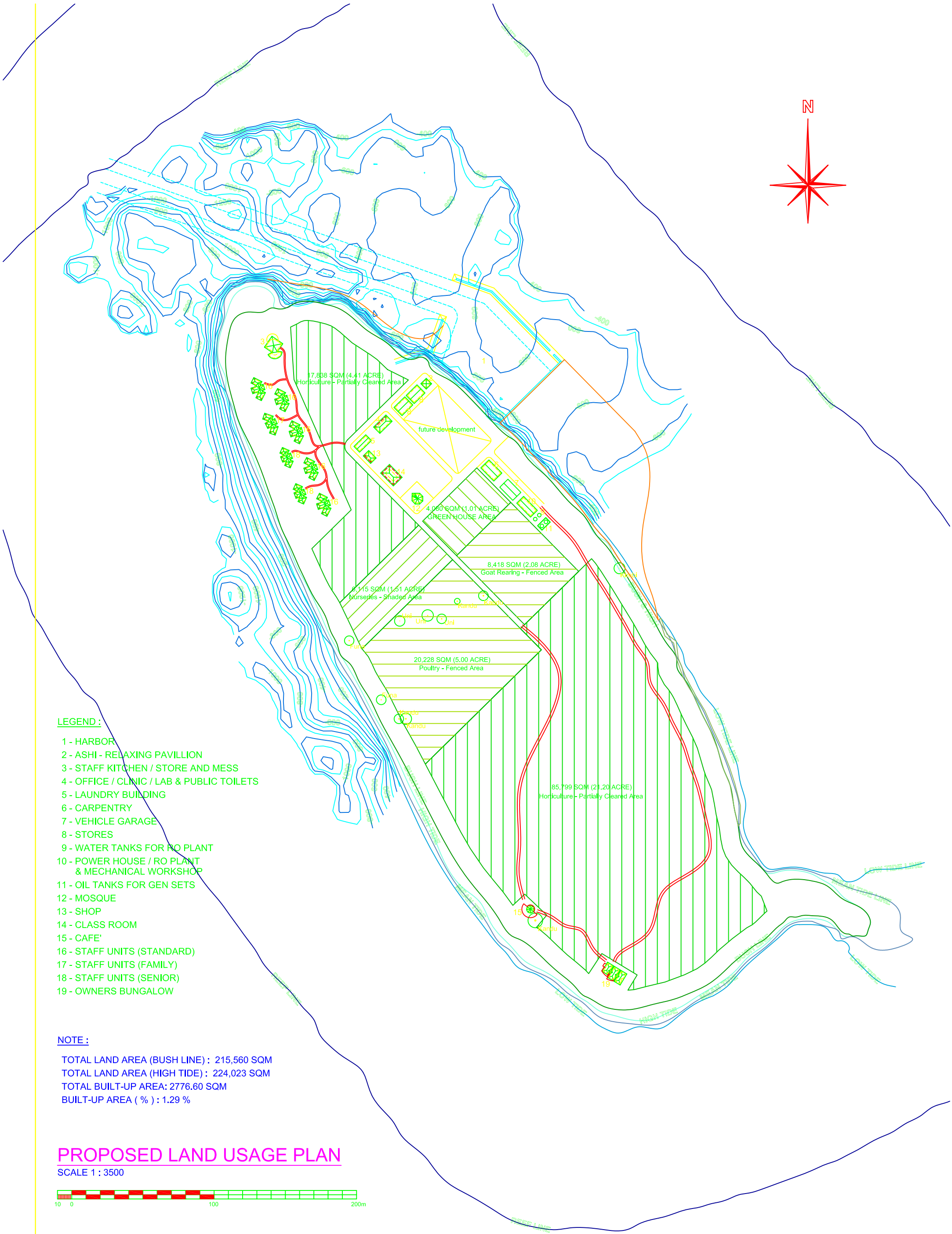
PROPOSED SITE PLAN

SCALE 1 : 3500

10 0 100 200m

CAD ASSOCIATES PRIVATE LIMITED
T O T A L + B U I L D I N G + S O L U T I O N S
M.SILVER STAR,HAVEEREE HINGUN 20-02 MALE',REPUBLIC OF MALDIVES
TEL:+960 3344654,FAX:+960 3344653,EMAIL:ecad.associates@gmail.com
w w w . e c a d a s s o c i a t e s . c o m

PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R	PROJECT. NO: EA - 117
			STRUC. DESIGN BY: -	DATE : DECEMBER 2007
TITLE: PROPOSED SITE PLAN	SCALE: AS GIVEN	CHECKED BY:	SURVEYED BY: H.R/H.S/M.M	SHEET NO: SV - 01
			DRAWN BY: H.R/H.S	



LEGEND :

1 - HARBOR
2 - ASHI - RELAXING PAVILLION
3 - STAFF KITCHEN / STORE AND MESS
4 - OFFICE / CLINIC / LAB & PUBLIC TOILETS
5 - LAUNDRY BUILDING
6 - CARPENTRY
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9 - WATER TANKS FOR RO PLANT
10 - POWER HOUSE / RO PLANT & MECHANICAL WORKSHOP
11 - OIL TANKS FOR GEN SETS
12 - MOSQUE
13 - SHOP
14 - CLASS ROOM
15 - CAFE'
16 - STAFF UNITS (STANDARD)
17 - STAFF UNITS (FAMILY)
18 - STAFF UNITS (SENIOR)
19 - OWNERS BUNGALOW

NOTE :

TOTAL LAND AREA (BUSH LINE) : 215,560 SQM
TOTAL LAND AREA (HIGH TIDE) : 224,023 SQM
TOTAL BUILT-UP AREA: 2776.60 SQM
BUILT-UP AREA (%) : 1.29 %

PROPOSED LAND USAGE PLAN

SCALE 1 : 3500

10 0 100 200m

eCAD ASSOCIATES PRIVATE LIMITED
TOTAL + BUILDING + SOLUTIONS
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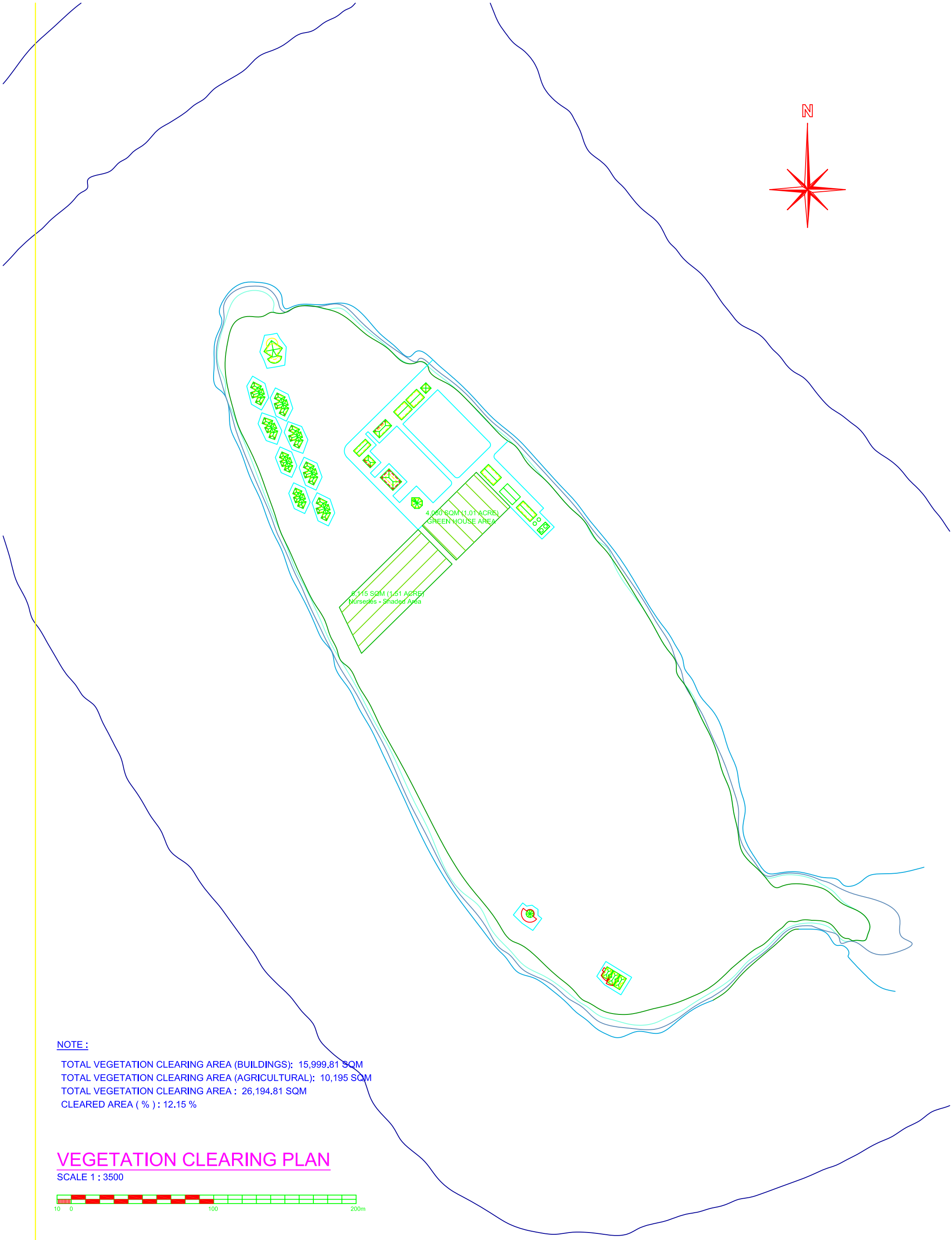
www.ecadassociates.com

PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R
			STRUC. DESIGN BY: -
TITLE: PROPOSED LAND USAGE PLAN	SCALE: AS GIVEN	CHECKED BY:	SURVEYED BY: H.R/H.S/M.M
			DRAWN BY: H.R/H.S
			PROJECT. NO: EA - 117
			DATE : DECEMBER 2007
			SHEET NO: SV - 02



NOTE :

TOTAL VEGETATION CLEARING AREA (BUILDINGS): 15,999.81 SQM
TOTAL VEGETATION CLEARING AREA (AGRICULTURAL): 10,195 SQM
TOTAL VEGETATION CLEARING AREA : 26,194.81 SQM
CLEARED AREA (%) : 12.15 %

VEGETATION CLEARING PLAN

SCALE 1 : 3500

10 0 100 200m

CAD ASSOCIATES PRIVATE LIMITED
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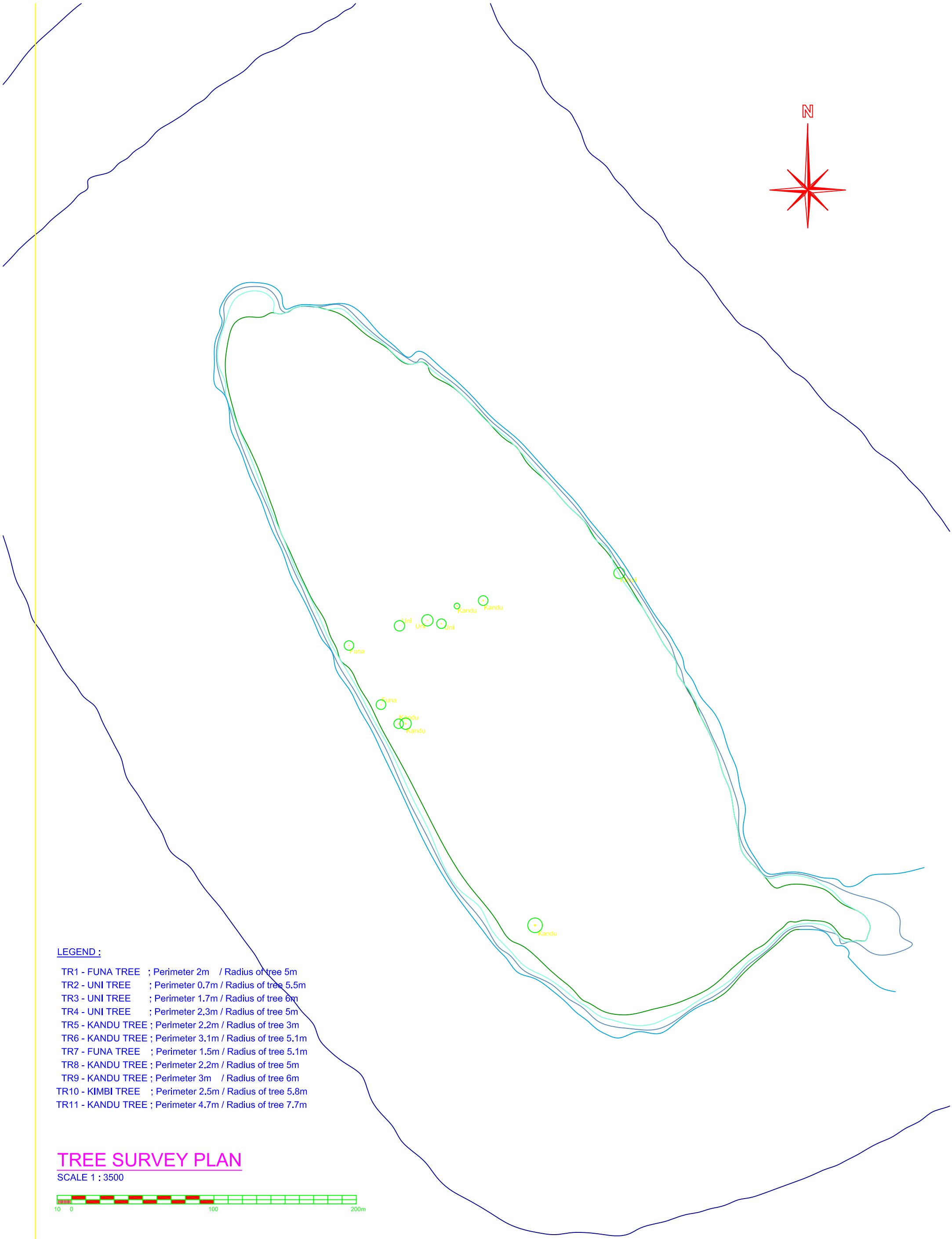
PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R STRUC. DESIGN BY: - SURVEYED BY: H.R/H.S/M.M DRAWN BY: H.R/H.S
TITLE: VEGETATION CLEARING PLAN	SCALE: AS GIVEN	CHECKED BY:	PROJECT. NO: EA - 117 DATE : DECEMBER 2007 SHEET NO: SV - 03



LEGEND :

TR1 - FUNA TREE ; Perimeter 2m / Radius of tree 5m
TR2 - UNI TREE ; Perimeter 0.7m / Radius of tree 5.5m
TR3 - UNI TREE ; Perimeter 1.7m / Radius of tree 6m
TR4 - UNI TREE ; Perimeter 2.3m / Radius of tree 5m
TR5 - KANDU TREE ; Perimeter 2.2m / Radius of tree 3m
TR6 - KANDU TREE ; Perimeter 3.1m / Radius of tree 5.1m
TR7 - FUNA TREE ; Perimeter 1.5m / Radius of tree 5.1m
TR8 - KANDU TREE ; Perimeter 2.2m / Radius of tree 5m
TR9 - KANDU TREE ; Perimeter 3m / Radius of tree 6m
TR10 - KIMBI TREE ; Perimeter 2.5m / Radius of tree 5.8m
TR11 - KANDU TREE ; Perimeter 4.7m / Radius of tree 7.7m

TREE SURVEY PLAN

SCALE 1 : 3500

10 0 100 200m

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w w w . e c a d a s s o c i a t e s . c o m

PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE: TREE SURVEY PLAN

CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES

AMENDMENTS

SCALE: AS GIVEN

CHECKED BY:

DESIGN BY: H.R

STRUC. DESIGN BY: -

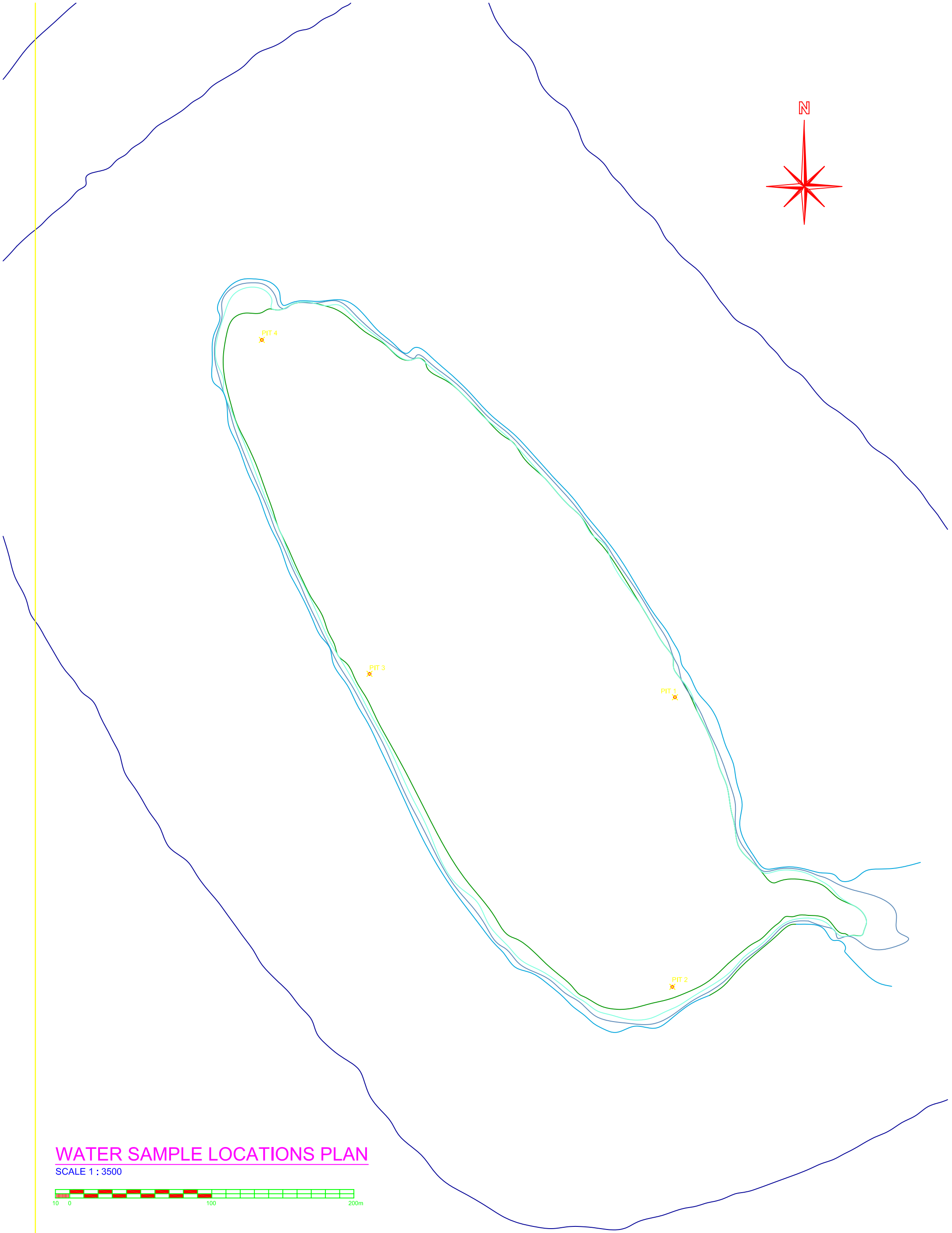
SURVEYED BY: H.R/H.S/M.M

DRAWN BY: H.R/H.S

PROJECT. NO: EA - 117

DATE : DECEMBER 2007

SHEET NO: SV - 04



WATER SAMPLE LOCATIONS PLAN

SCALE 1 : 3500

10 0 100 200m

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: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE: WATER SAMPLE LOCATIONS PLAN

CLIENT: Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

AMENDMENTS

SCALE: AS GIVEN

CHECKED BY:

DESIGN BY: H.R

STRUC. DESIGN BY: -

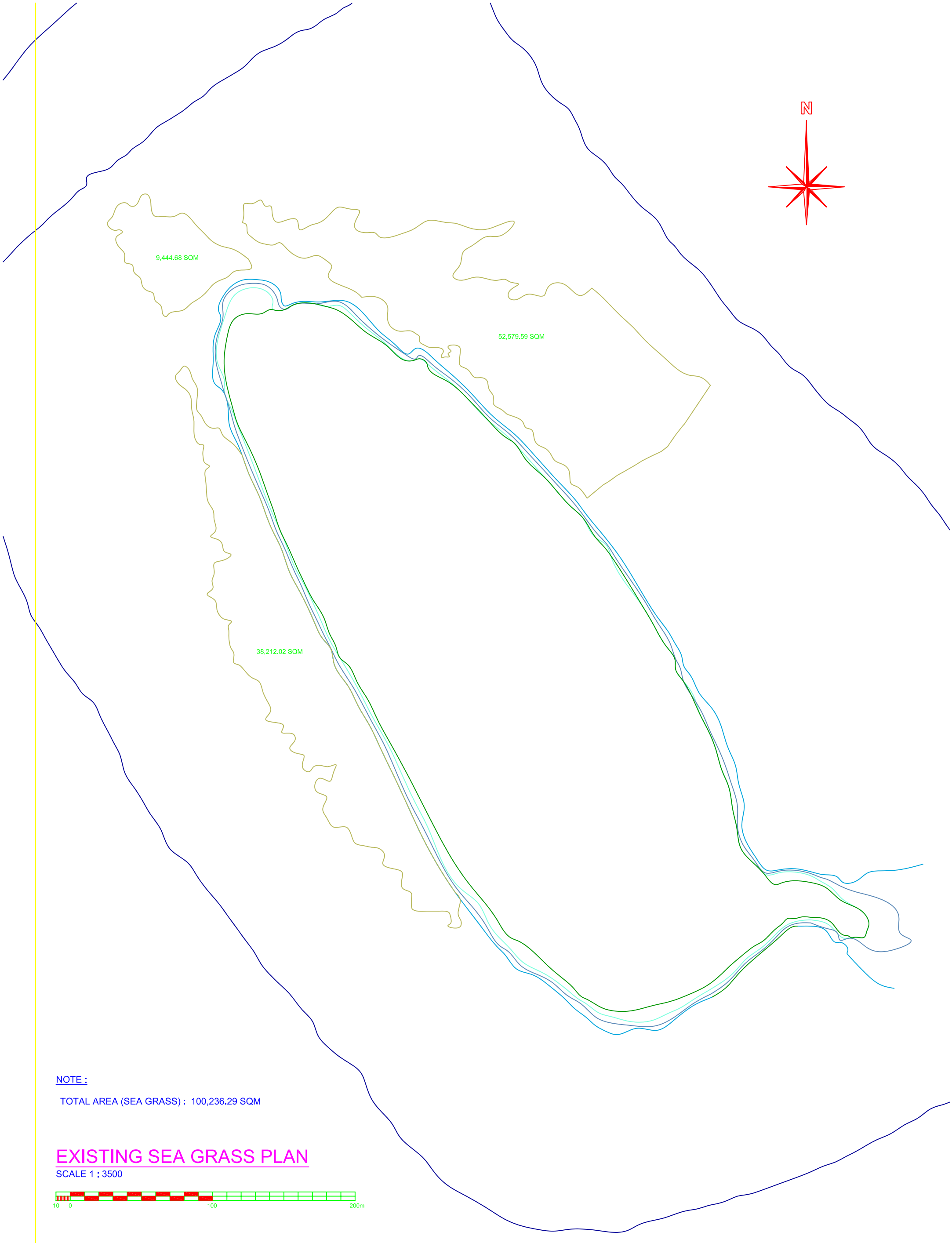
SURVEYED BY: H.R/H.S/M.M

DRAWN BY: H.R/H.S

PROJECT. NO: EA - 117

DATE : DECEMBER 2007

SHEET NO: SV - 05



NOTE :

TOTAL AREA (SEA GRASS) : 100,236.29 SQM

EXISTING SEA GRASS PLAN

SCALE 1 : 3500

10 0 100 200m

CAD ASSOCIATES PRIVATE LIMITED
TOTAL BUILDING SOLUTIONS
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TEL:+960 3344654,FAX:+960 3344653,EMAIL:ecad.associates@gmail.com
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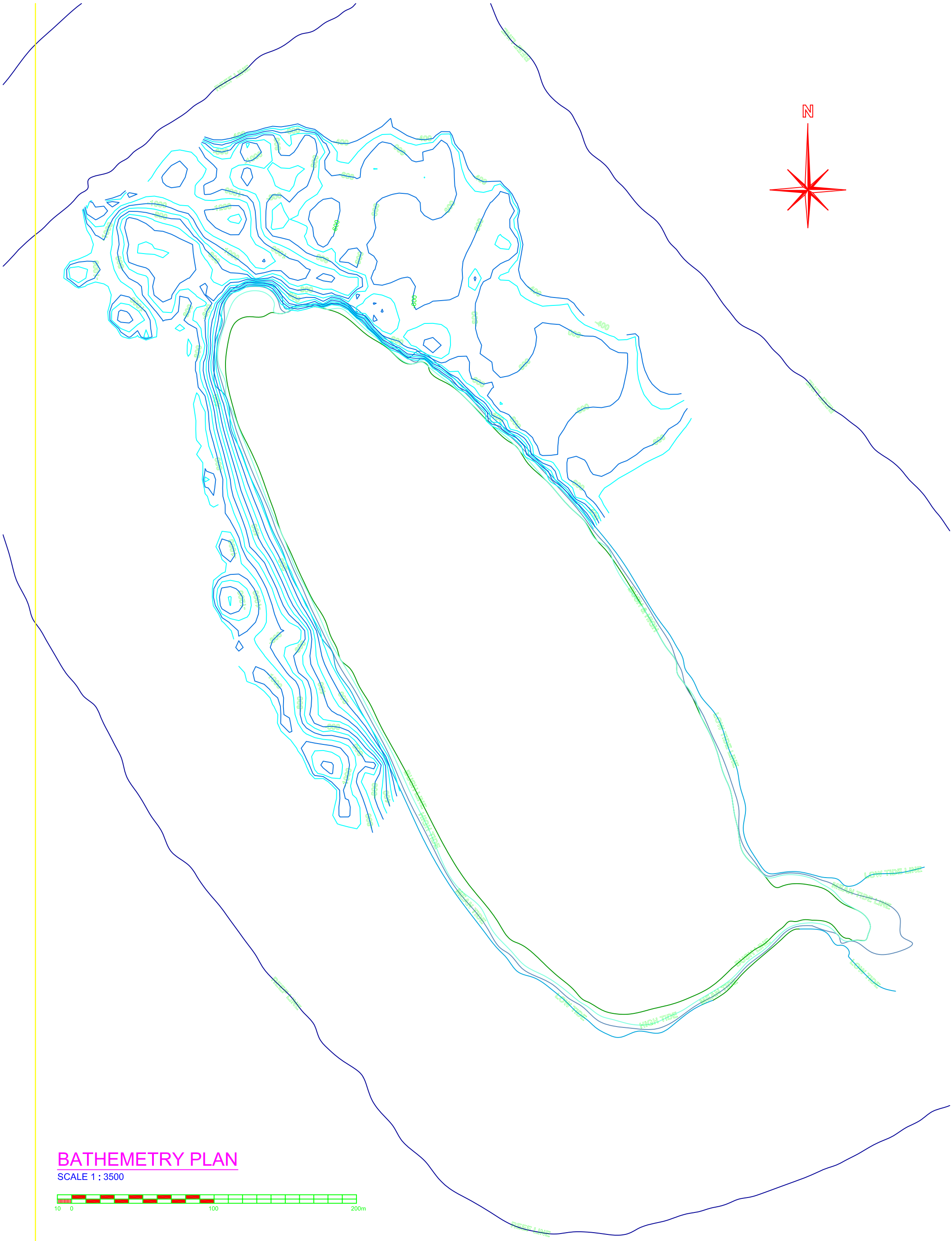
PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R
TITLE: EXISTING SEA GRASS PLAN			STRUC. DESIGN BY: -
	SCALE: AS GIVEN	CHECKED BY:	SURVEYED BY: H.R/H.S/M.M
			DRAWN BY: H.R/H.S
			PROJECT. NO: EA - 117
			DATE : DECEMBER 2007
			SHEET NO: SV - 06



BATHEMETRY PLAN

SCALE 1 : 3500

10 0 100 200m

CAD ASSOCIATES PRIVATE LIMITED
TOTAL BUILDING SOLUTIONS
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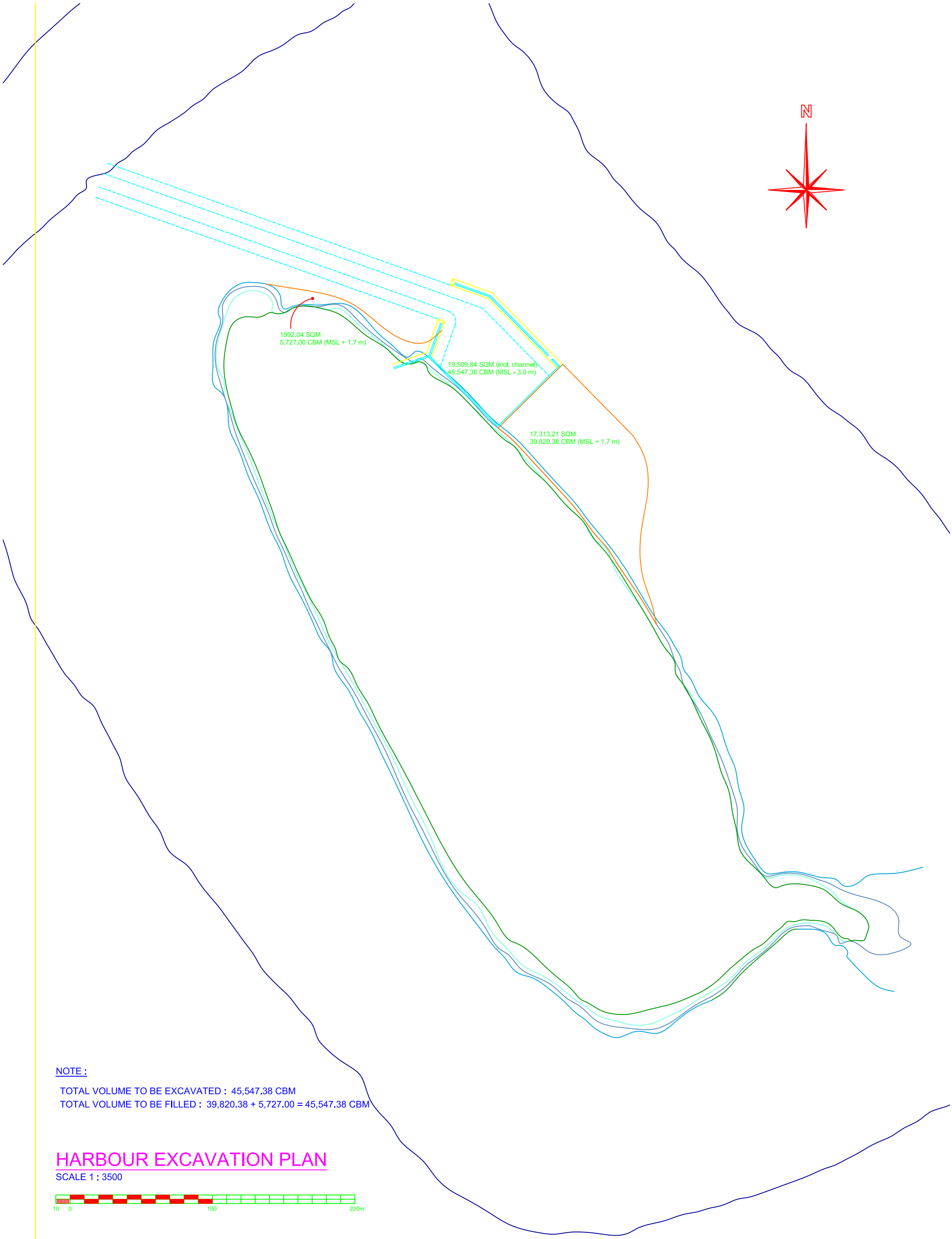
TEL:+960 3344654,FAX:+960 3344653,EMAIL:ecad.associates@gmail.com
www.ecadassociates.com

PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R STRUC. DESIGN BY: - SURVEYED BY: H.R/H.S/M.M DRAWN BY: H.R/H.S
TITLE: BATHEMETRY PLAN	SCALE: AS GIVEN	CHECKED BY:	PROJECT. NO: EA - 117 DATE : DECEMBER 2007 SHEET NO: SV - 07



NOTE :

TOTAL VOLUME TO BE EXCAVATED : 45,547.38 CBM

TOTAL VOLUME TO BE FILLED : 39,820.38 + 5,727.00 = 45,547.38 CBM

HARBOUR EXCAVATION PLAN

SCALE 1 : 3500

10 0 100 200m

CAD ASSOCIATES PRIVATE LIMITED

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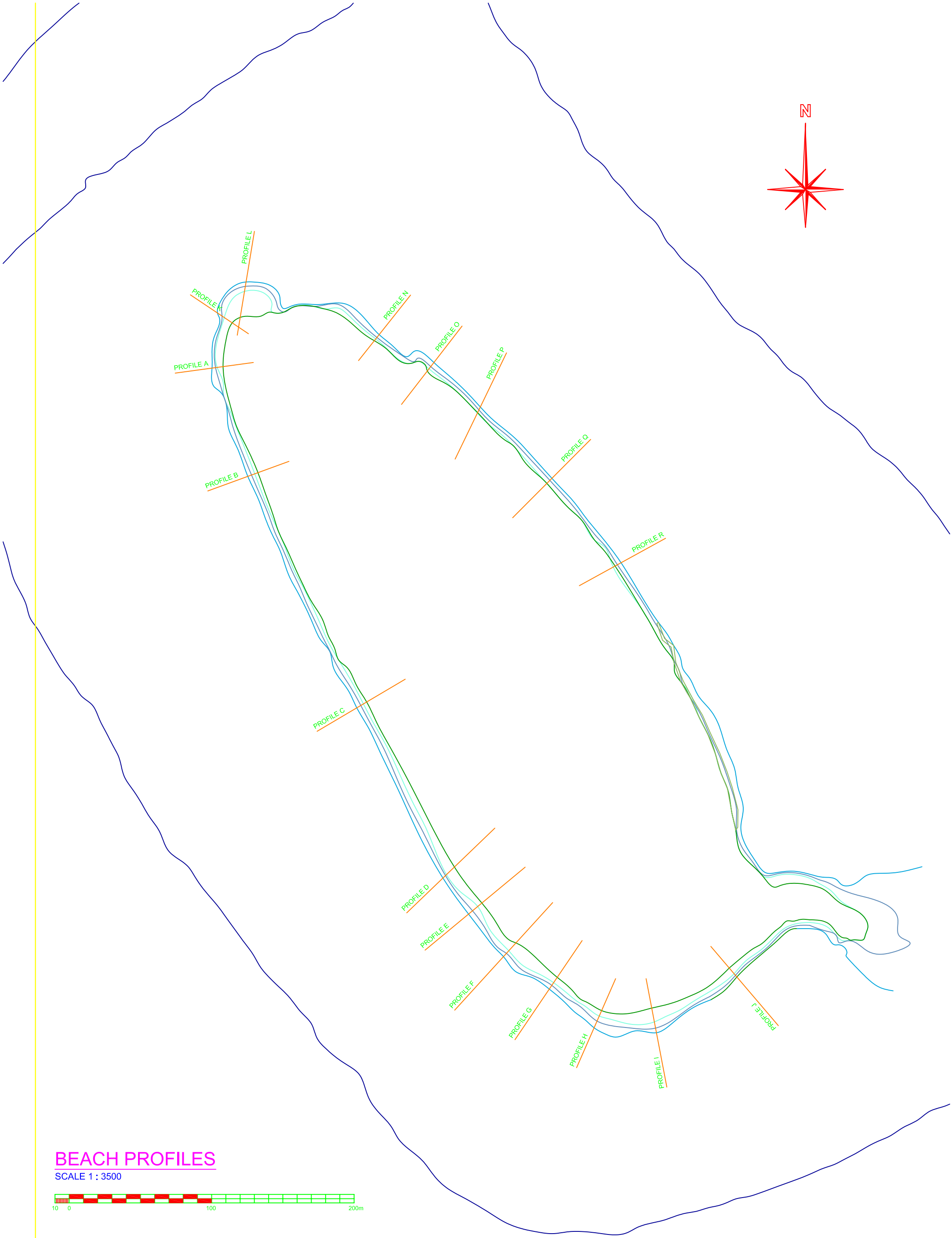
PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R
			STRUC. DESIGN BY: -
			SURVEYED BY: H.R/H.S/M.M
TITLE: HARBOUR EXCAVATION PLAN	SCALE: AS GIVEN	CHECKED BY:	DRAWN BY: H.R/H.S
			PROJECT. NO: EA - 117
			DATE : DECEMBER 2007
			SHEET NO: SV - 08



BEACH PROFILES

SCALE 1 : 3500

10 0 100 200m

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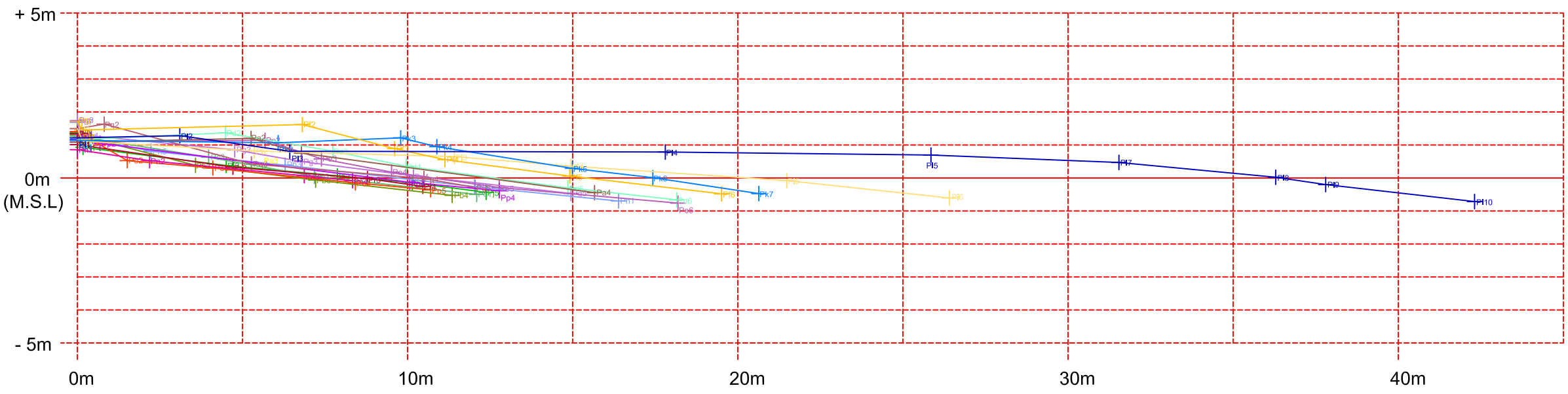
w w w . e c a d a s s o c i a t e s . c o m

PROJECT: GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT	CLIENT: Mr. AHMED ABDUL AZEEZ G. AIMA, MALE', MALDIVES	AMENDMENTS	DESIGN BY: H.R
			STRUC. DESIGN BY: -
			SURVEYED BY: H.R/H.S/M.M
TITLE: BEACH PROFILES	SCALE: AS GIVEN	CHECKED BY:	DRAWN BY: H.R/H.S
			PROJECT. NO: EA - 117
			DATE : DECEMBER 2007
			SHEET NO: SV - 09



PROFILE A
PROFILE B
PROFILE C
PROFILE D
PROFILE E
PROFILE F
PROFILE G
PROFILE H
PROFILE I
PROFILE J
PROFILE K
PROFILE L
PROFILE N
PROFILE O
PROFILE P
PROFILE Q
PROFILE R

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TOTAL + BUILDING + SOLUTIONS
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www.ecadassociates.com

PROJECT:
GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:
ALL BEACH PROFILES

CLIENT:
Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

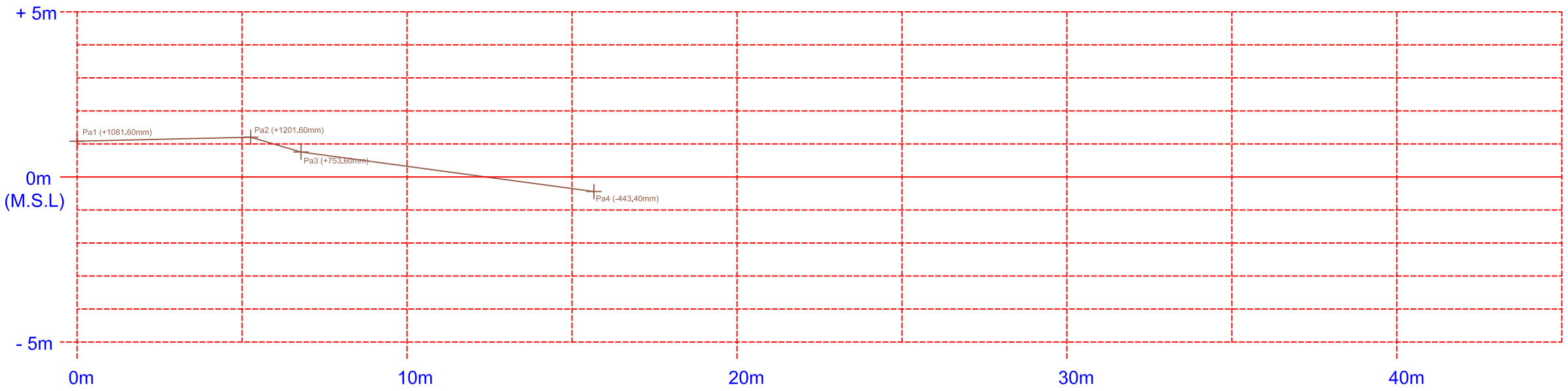
AMENDMENTS

CHECKED BY:

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

PROJECT. NO: EA - 117
DATE : DECEMBER 2007
SHEET NO: SV - 10

PROFILE A



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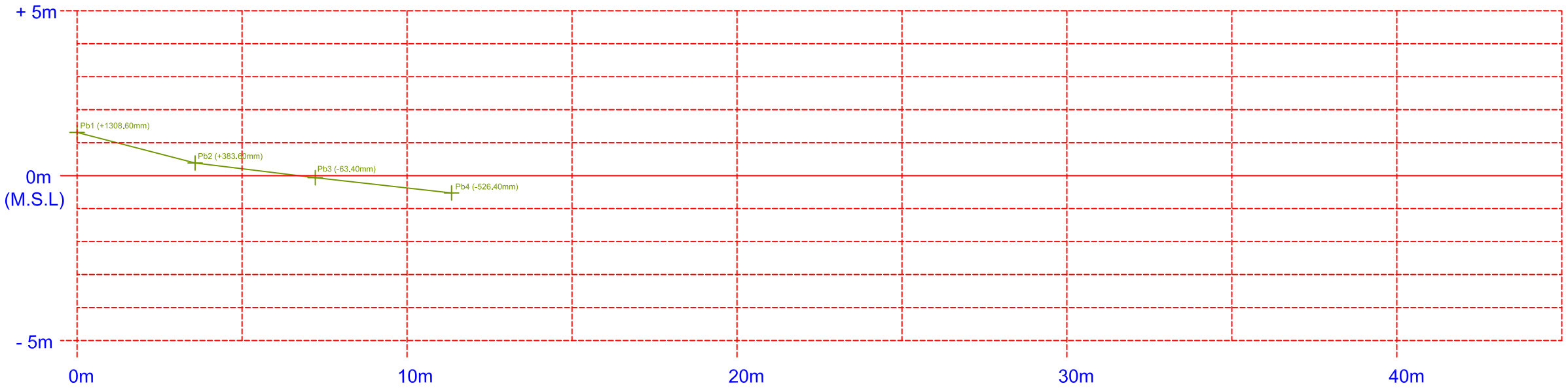

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PROJECT:
GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:
BEACH PROFILES A & B

CLIENT:
Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

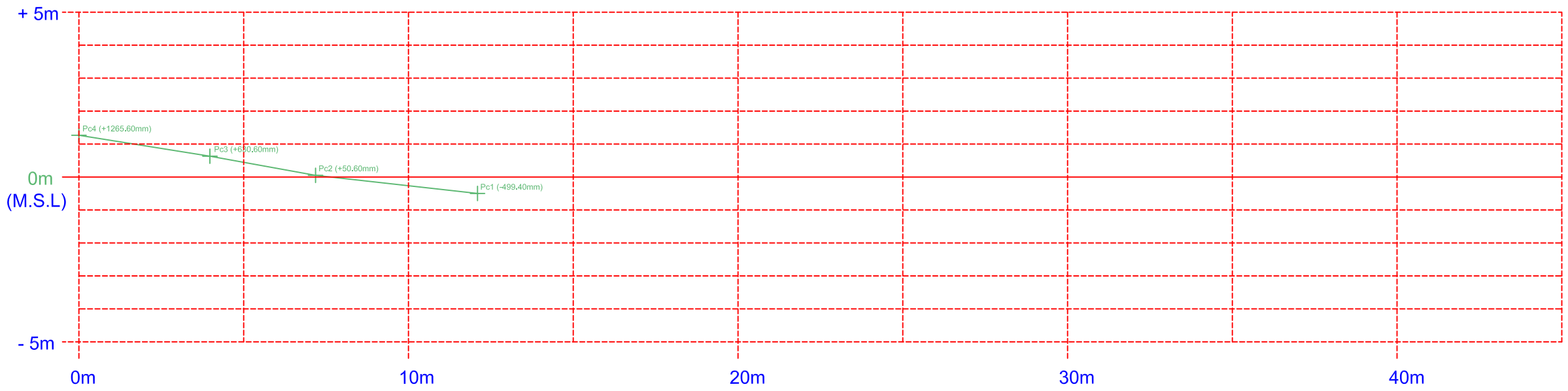
AMENDMENTS

CHECKED BY:

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

PROJECT. NO: EA - 117
DATE : DECEMBER 2007
SHEET NO: SV - 11

PROFILE C



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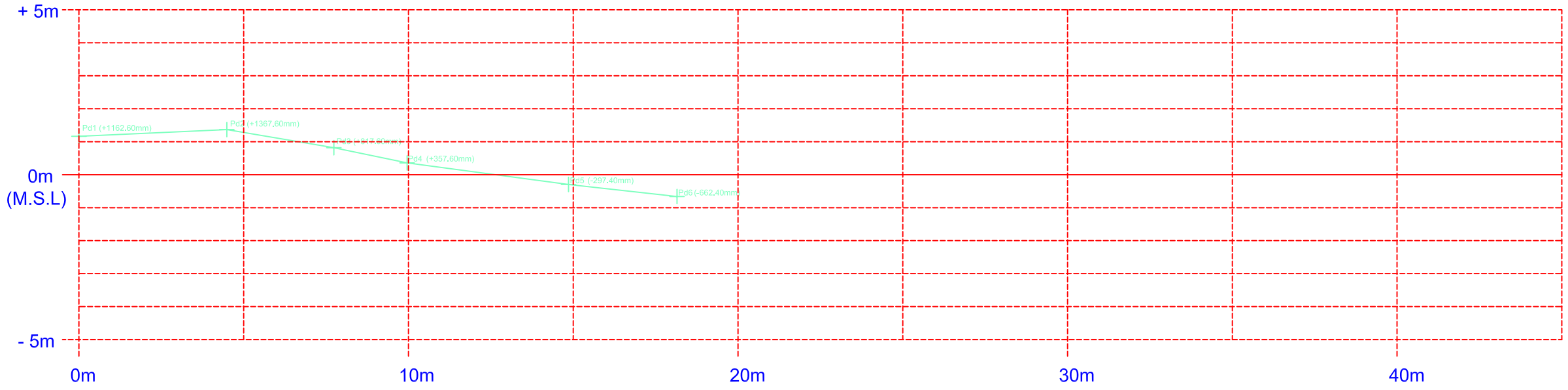

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PROJECT:
GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:
BEACH PROFILES C & D

CLIENT:
Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

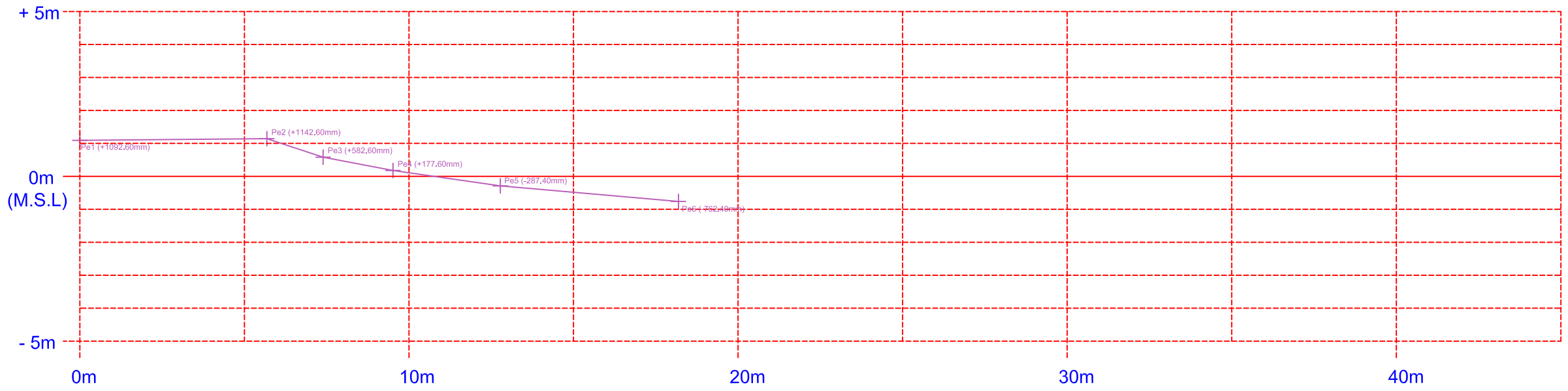
AMENDMENTS

CHECKED BY:

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

PROJECT. NO: EA - 117
DATE : DECEMBER 2007
SHEET NO: SV - 12

PROFILE E



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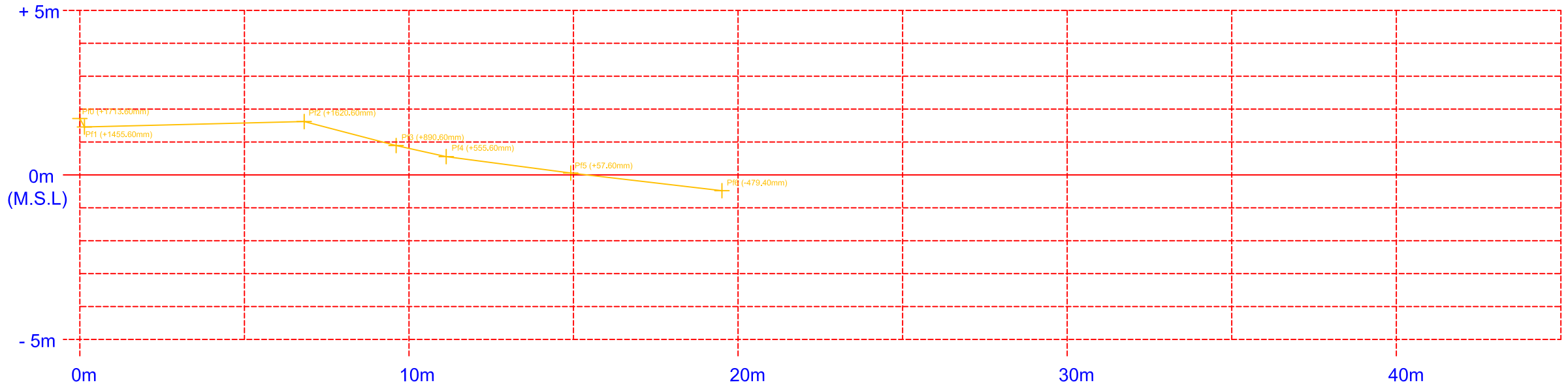

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w w w . e c a d a s s o c l a t e s . c o m

PROJECT:

GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:

BEACH PROFILES E & F

CLIENT:

Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

AMENDMENTS

CHECKED BY:

DESIGN BY: H.R

STRUC. DESIGN BY: -

SURVEYED BY: H.R/H.S/M.M

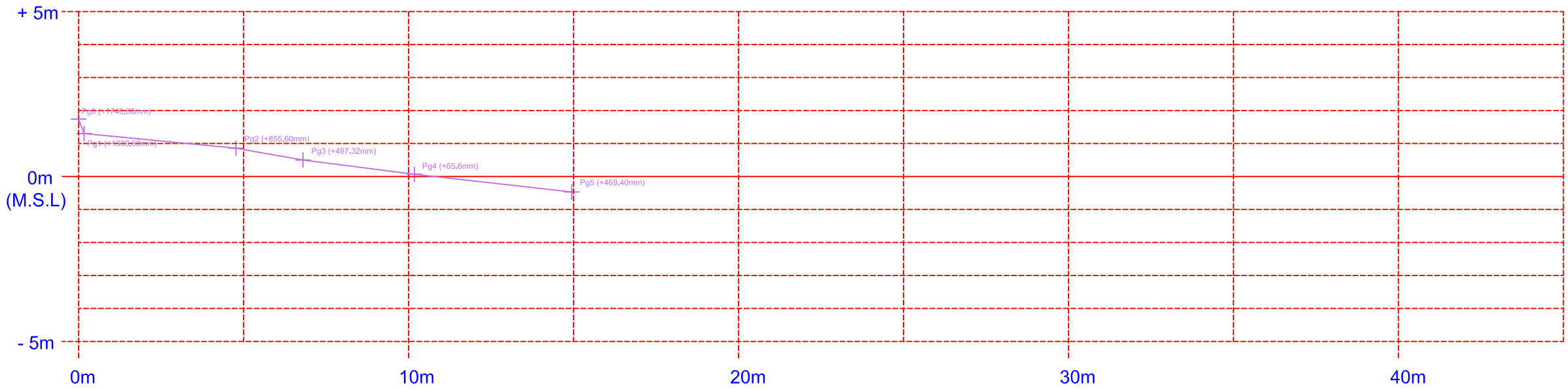
DRAWN BY: H.R/H.S

PROJECT. NO: EA - 117

DATE : DECEMBER 2007

SHEET NO: SV - 13

PROFILE G



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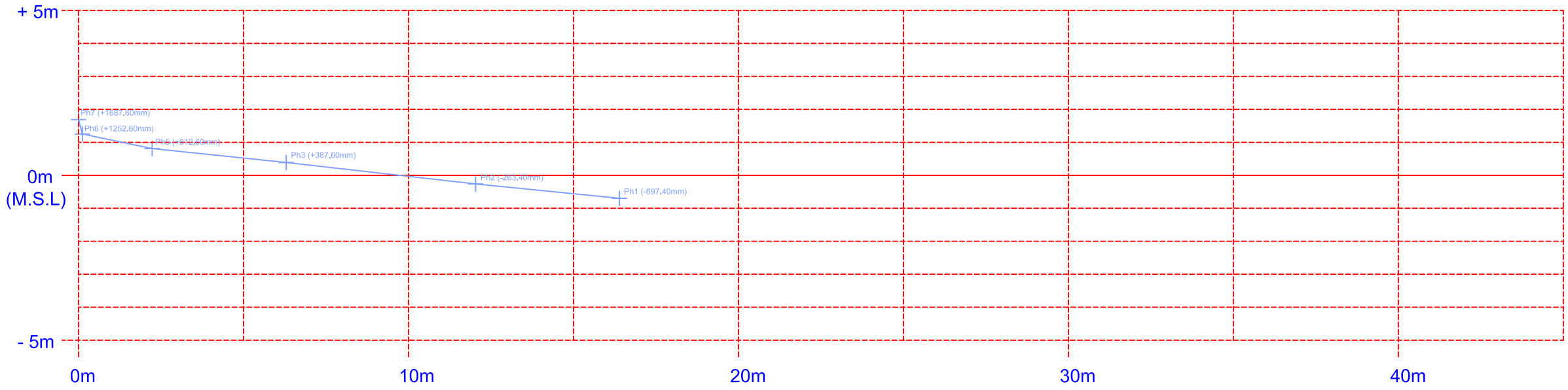

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TEL:+960 3344654,FAX:+960 3344653,EMAIL:ecad.assoclates@gmail.com

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PROJECT:

GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:

BEACH PROFILES G & H

CLIENT:

Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

AMENDMENTS

CHECKED BY:

DESIGN BY: H.R

STRUC. DESIGN BY: -

SURVEYED BY: H.R/H.S/M.M

DRAWN BY: H.R/H.S

PROJECT. NO: EA - 117

DATE : DECEMBER 2007

SHEET NO: SV - 14

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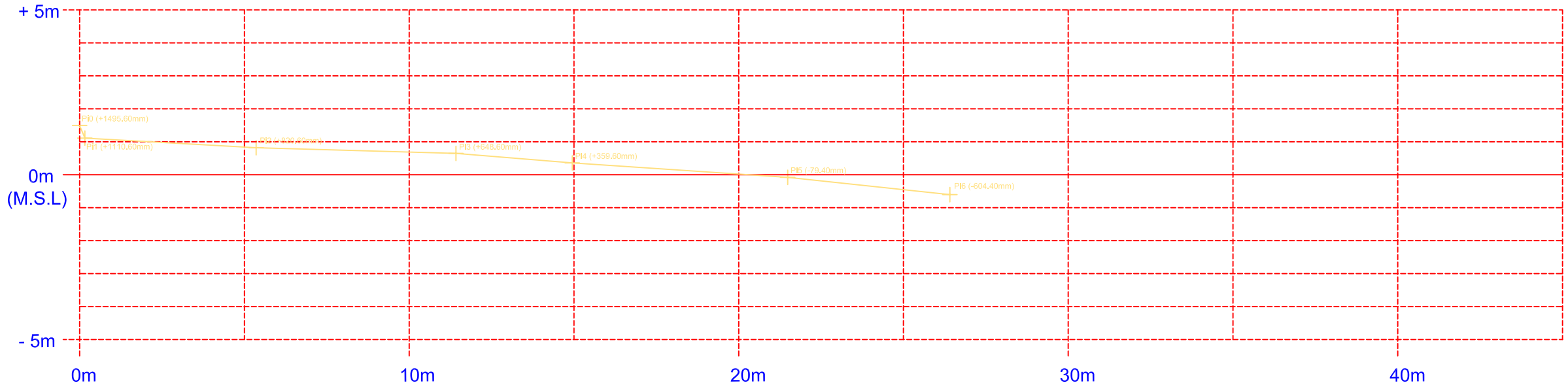

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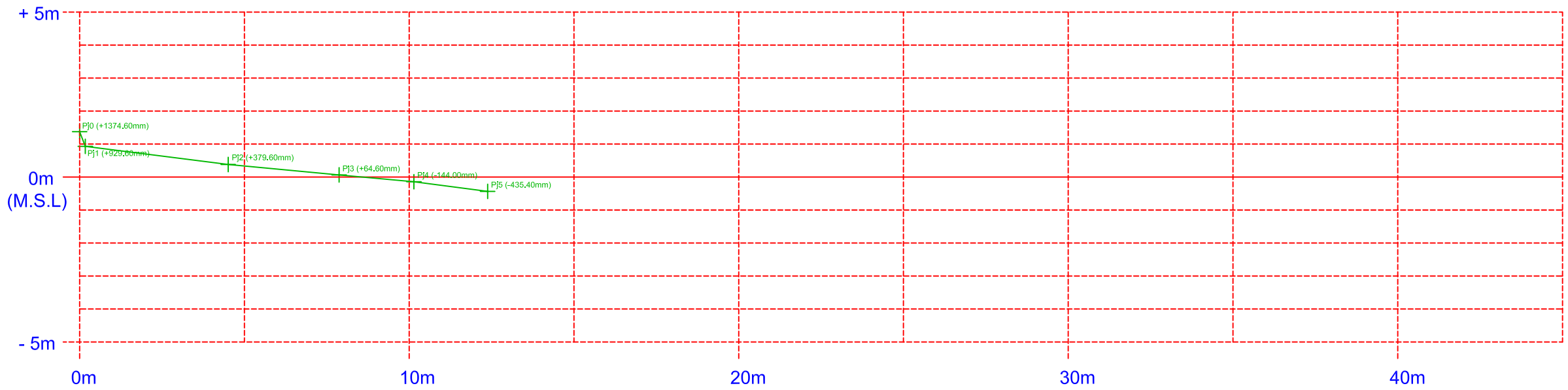

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PROJECT:

GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:

BEACH PROFILES I & J

CLIENT:

Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

AMENDMENTS

CHECKED BY:

DESIGN BY: H.R

STRUC. DESIGN BY: -

SURVEYED BY: H.R/H.S/M.M

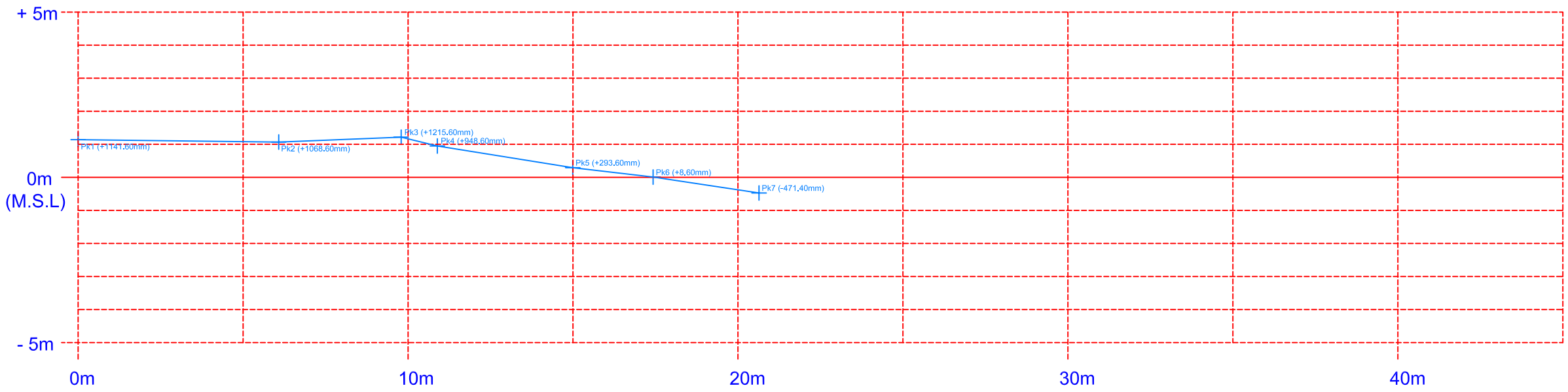
DRAWN BY: H.R/H.S

PROJECT. NO: EA - 117

DATE : DECEMBER 2007

SHEET NO: SV - 15

PROFILE K



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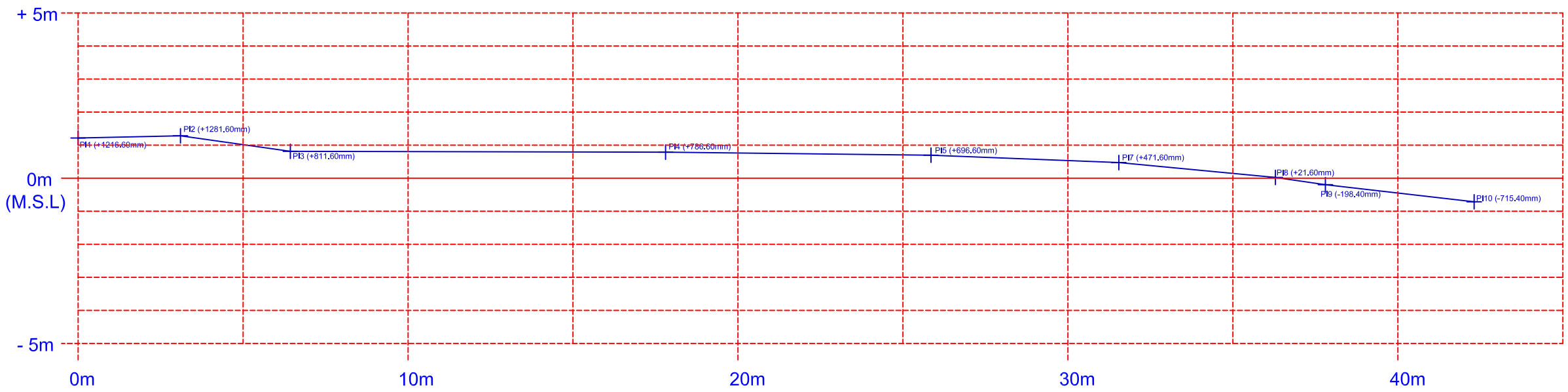

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PROJECT:

GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:

BEACH PROFILES K & L

CLIENT:

Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

AMENDMENTS

CHECKED BY:

DESIGN BY: H.R

STRUC. DESIGN BY: -

SURVEYED BY: H.R/H.S/M.M

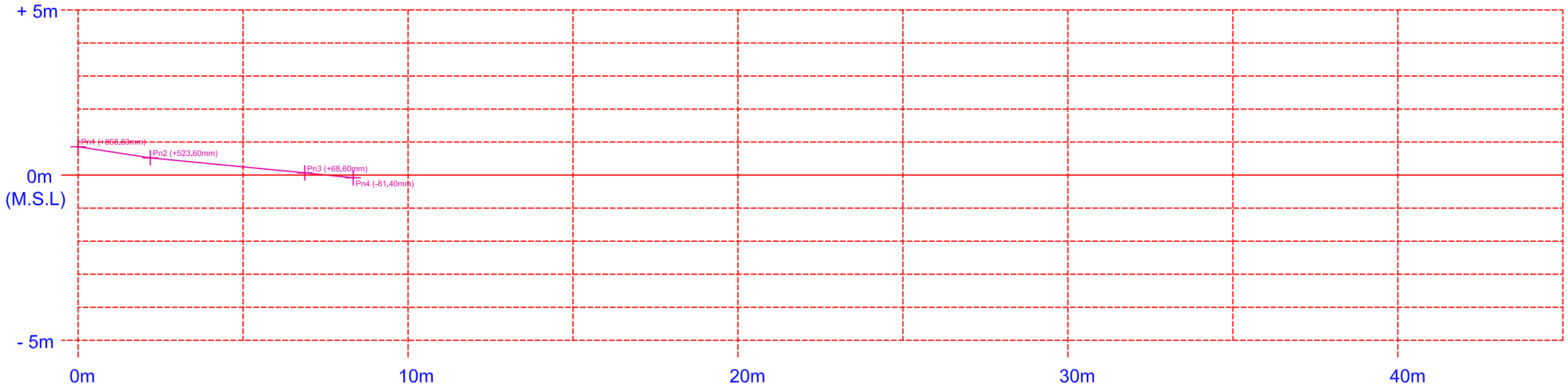
DRAWN BY: H.R/H.S

PROJECT. NO: EA - 117

DATE : DECEMBER 2007

SHEET NO: SV - 16

PROFILE N



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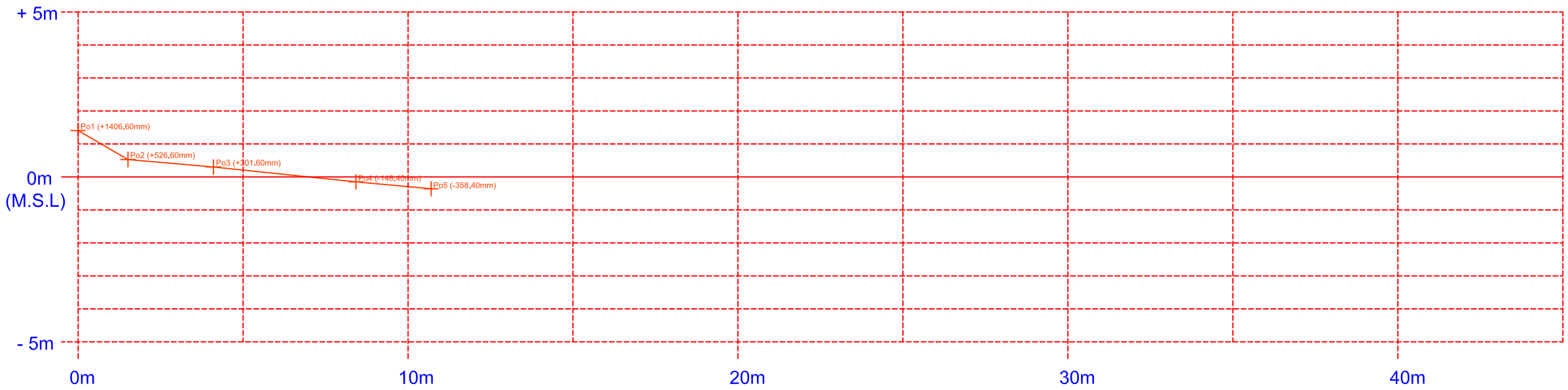

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PROJECT:
GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:
BEACH PROFILES N & O

CLIENT:
Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

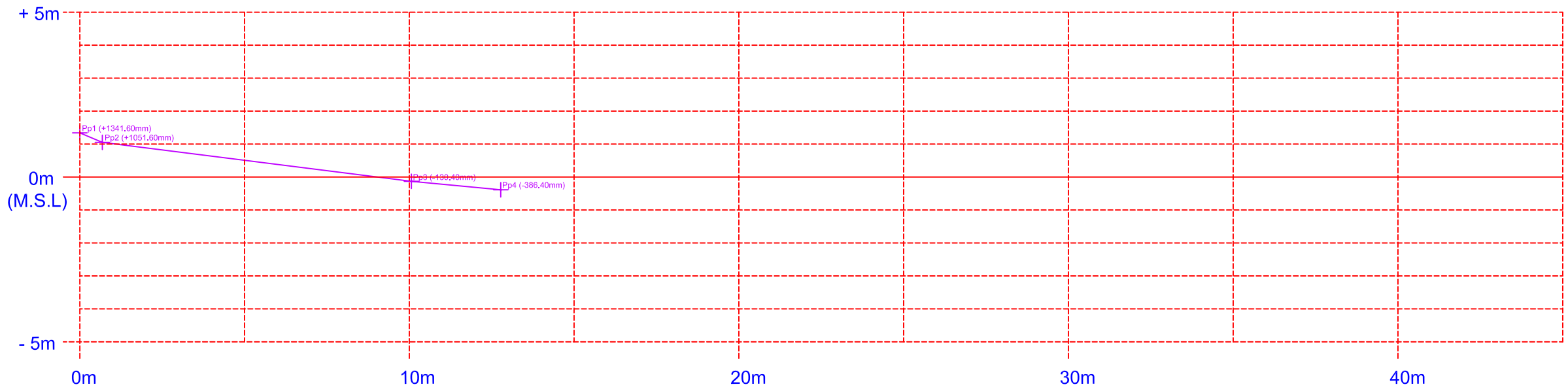
AMENDMENTS

CHECKED BY:

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

PROJECT. NO: EA - 117
DATE : DECEMBER 2007
SHEET NO: SV - 17

PROFILE P



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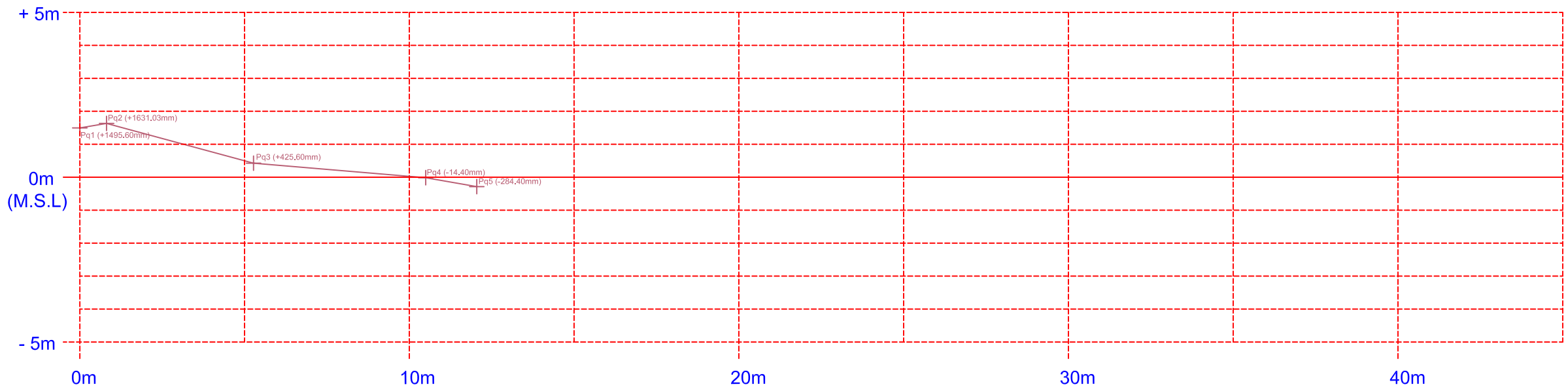

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PROJECT:
GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:
BEACH PROFILES P & Q

CLIENT:
Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

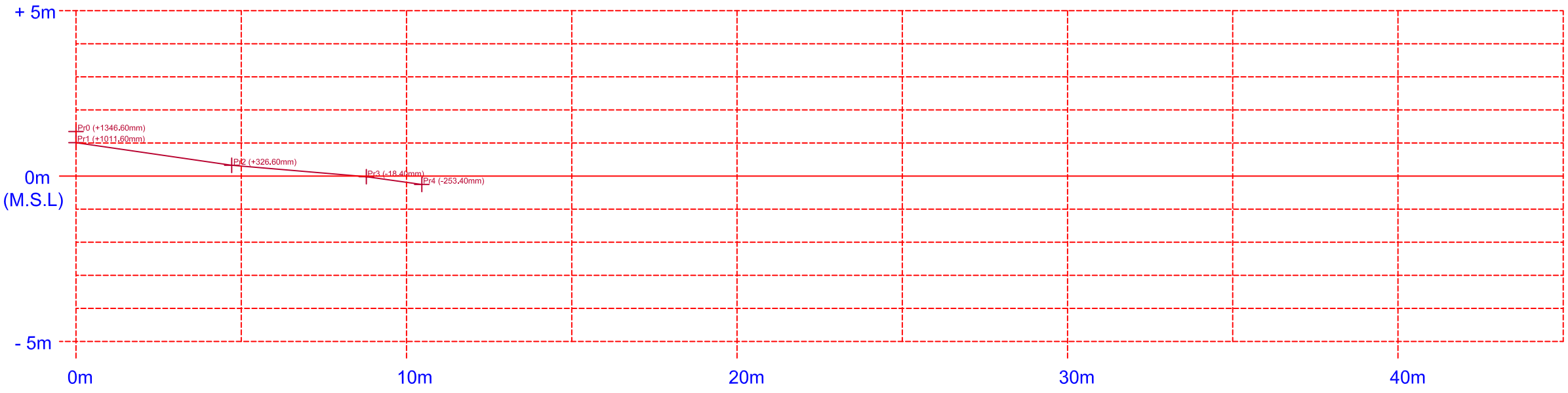
AMENDMENTS

CHECKED BY:

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

PROJECT. NO: EA - 117
DATE : DECEMBER 2007
SHEET NO: SV - 18

PROFILE R



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TOTAL + BUILDING + SOLUTIONS
M.SILVER STAR,HAVEEREE HINGUN 20-02 MALE',REPUBLIC OF MALDIVES
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www.ecadassoclates.com

PROJECT:
GA. FUNADHOO ISLAND FOR AGRICULTURAL DEVELOPMENT

TITLE:
BEACH PROFILES R

CLIENT:
Mr. AHMED ABDUL AZEEZ
G. AIMA, MALE', MALDIVES

SCALE: NOT TO SCALE

AMENDMENTS

CHECKED BY:

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

PROJECT. NO: EA - 117
DATE : DECEMBER 2007
SHEET NO: SV - 19

14. Sources of Information

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*,

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