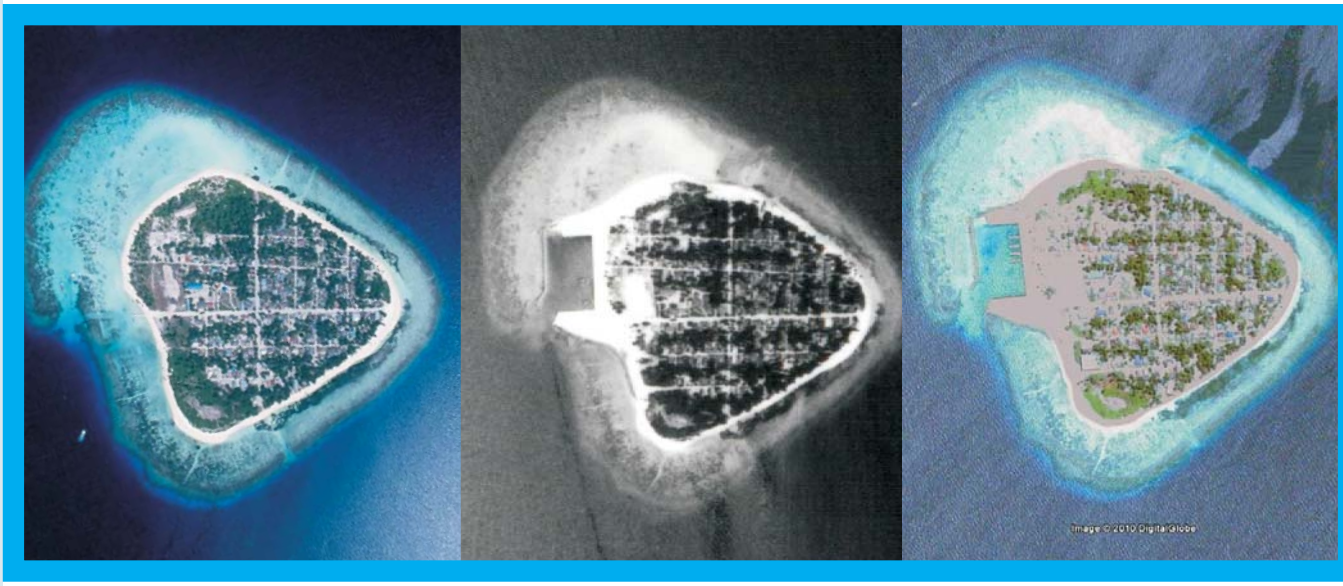
MINISTRY OF HOUSING, TRANSPORT AND ENVIRONMENT

EIA report for Restoration of Ga Dhevadhoo Harbour under

Construction of Harbours for Tsunami Victims Project



August 2010

AL- HABSHI CONSULTANTS OFFICE
P .O. Box 27154, Safat 13132, Kuwait.
Tel: (965) 2430103/2433131 Fax: (965) 2431136

RIYAN PTE LTD
3RD FLOOR, H. COLEEZIUM
AMEENEE MAGU, MALE' 20054
REP OF MALDIVES

La Mer GROUP
Land and Marine Environmental Resources Group Pvt Ltd, Maldives

Declaration of the Consultant

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

Name: Hussein Zahir
Consultant Registration Number: 04-07

Signature:
Company Name: Land and Marine Environment Resources Group Pvt Ltd

Date: 19 August 2010

`

Table of Content

`

`

`

List of Tables

`

Table of Figures.

`

`

List of Appendices

`

EXECUTIVE SUMMARY

1. This Environmental Impact Assessment (EIA) report is to fulfill the regulatory requirements under the Environmental Protection and Preservation Act of Maldives prior to the proposed harbor restoration at Ga Dhevadhoo in Ga Atoll.
2. Ga Dhevadhoo harbor restoration project is part of the Construction of Harbors for Tsunami Victims Project. This restoration project involves repair of harbors at 10 islands. The project is funded by a joint loan taken from Islamic Development Bank (IDB), the Saudi Government and Organization of the Petroleum Exporting Countries (OPEC) by the government of Maldives. The design consultancy was awarded to Alhabshi Consultants Office, a Kuwaiti Company in association with Riyan Pvt Ltd (a Maldivian company). The Agreement for consultancy was signed on 6th November 2008 between the Government of Maldives and Alhabshi Consultant.
3. Project proponent of the proposed harbor restoration project is Ministry of Housing, Transport and Environment. The project was bided as a design and consultancy project. The main design consulting company Alhabhsi Consultants is assigned to carry out the design works, preparing tender documents, carrying out EIAs and construction phase supervision consultant.
4. The proposed development project involves renovation and restoration of Ga Dhevadhoo harbor. Under the proposed project, new quay wall (concrete sheet piles, L section) and breakwaters (armor rocks) will be constructed at the existing foot prints. The harbor basin will also undergo maintenance dredging to -3MSL (where necessary). Since the proposed project is only a restoration project, basin size will not be increased. The concept plan is formulated in light of the new third generation harbor concept which is focused at functionality of the harbor. In this regard harbor usage components such as passenger embarking/disembarking, loading unloading area, fish landing, water and fuel recharging and mooring area will be demarcated.
5. Ga Dhevadhoo is located at Ga atoll, 400km from Male'. It is just about 28km from Kaadedhoo Airport. Nearest inhabited island is Ga Nilandhoo (24km at eastern side) and GDh Thinadhoo (26km at the western side of Dhevadhoo). In terms of geographic coordinates, it is located at 00° 33' 26" N and 73° 14' 32" E. Nearest islands are Hagadhoo approximately 4.5km south west and Funamudua approximately 5km west of Dhevadhoo.
6. The existing harbor facility is located at the western side of the island, while access to the harbor is via an entrance channel south western side of harbor. The project boundaries are the harbor front area, either side breakwaters, eastern side seawall and entrance area). Under the proposed project maintenance dredging will be done at the basin and entrance area

`

where necessary and this activity will generate sediment plumes west wards. Dredged material removed during the maintenance dredging works will be reused for construction.

7. The existing harbor footprint will not be changed due to the proposed project, breakwaters and quay wall will be constructed at existing foot print area (apart from small section of breakwater at the southern side of the harbor for protection of entrance channel). Therefore the existing design of the harbor will remain as it is. The length of the harbor after completion of renovation works will be 149.2m and width 95m. The length of entrance channel is approximately 63m, while width is 40m.
8. The harbor will have a total length of 190m of breakwater at the western side. The breakwater will be constructed of armor stones and remains of existing breakwater as core The side quay will have a total length of 190m of type 2 design quay wall, while the main quay will have a length of 149.2m.
9. Approximately 1500m^3 of dredged material will be generated by the maintenance dredging works. This sand will be reused during construction stage, thereby avoiding the need for disposal.
10. Existing environment was examined to identify significant environmental components that would be affected and to establish a baseline condition of the site. Available and relevant literature on environmental impacts associated with similar projects was evaluated to identify possible impacts. Oceanographic data and information on local hydrodynamics were qualitatively assessed to determine the current pattern around the island which was based on monsoonal wind patterns, wind generated waves, tidal flushing, geographic setting, the topography of the lagoon and shape of the shoreline.
11. The reef flat area in front of harbor was dominated by tabulate life forms of Acropora and massive life forms of Porites. Large table corals and branching coral colonies were abundant at the area. Numerous small table coral colonies were observed behind the reef flat area dominating the rocky back reef towards the lagoon. The reef slope area was dominated by large table corals and branching forms of acropora. Live coral cover at the reef flat area is approximately 45%, from which 30% is estimated to be Acroporids. Large porties bommies were mainly observed just off the crust area at the reef slope. Other live coral generas observed are Pocillopora, Pavona, Echinopora, Goniastrea, Psammacora and Favites.
12. It is important to note that the most significant impact associated with the project would be impact on the marine environment from sedimentation. Dredging and excavation often carry a heavy load of sediments increasing sediment load in the water column causing discoloration due to suspended sediments of the impact area for a prolonged period. Since the project is a restoration project, the extent of sediment plum will be limited at the harbor basin area.
13. Since the proposed project is restoration project, environmental impacts associated with the proposed project are considered minor. The significant environmental components that are likely to be affected are the coral community at harbor front area.

`

14. Mitigation measures are provided in the report for impacts that were categorized minor to moderate. Impact mitigation measures and monitoring is carried out to compare predicted and actual impacts occurring from project activities to determine the efficiency of the mitigation measures. It has to be noted that environmental monitoring has not been done since the completion of harbor, and extent of changes to habitat, live coral cover and shoreline is not known. Even though the project is not envisaged to cause impacts to shoreline (since construction will be done at existing footprint), it is important to monitor shoreline changes.
15. One of the main issues highlighted by most of the participants of the meeting held at Dhevadhoo as part of stakeholder consultation was the issue of repeated surveys and no action. The community strongly feels that the restoration project would only ease the accessibility issue but will not resolve the issue of accommodating all the vessels used by the community especially the fishing fleet. The participants of the meeting stated that the harbor facility is in need for expansion (800x300ft).
16. The participants stated that due to location of Dhevadhoo many trade vessels and Safaris use Dhevadhoo harbor as a transit point, therefore the harbor is always crowded. Also during fishing season the harbor is used by fishing vessels from other atoll as well. Due to this reason the community feels very strongly that the harbor needs to be expanded. Since resorts are opening near the island, additional usage of harbor is envisaged therefore burden on harbor will increase.
17. Overall the IDC and harbor committee was in favor of the project and very little issues apart from extension of harbor were raised during the stakeholder meeting
18. With due consideration to main environmental components identified and the magnitude of impacts on these components from the proposed developments, the consultant concludes that the project components and designs are feasible and appropriate mitigation measures are given to correct and minimize unfavorable environmental consequences. Furthermore, the public and community consultation responses were in favor of the project due to the socio-economic benefits foreseen to the community from a functional harbor.

`

1. INTRODUCTION

Ga Dhevadhoo harbor restoration project is part of the Construction of Harbors for Tsunami Victims Project. This restoration project involves repair of harbors at 10 islands. The project is funded by a joint loan taken from Islamic Development Bank (IDB), the Saudi Government and Organization of the Petroleum Exporting Countries (OPEC) by the government of Maldives. The design consultancy was awarded to Alhabshi Consultants Office, a Kuwaiti Company in association with Riyan Pvt Ltd (a Maldivian company). The Agreement for consultancy was signed on 6th November 2008 between the Government of Maldives and Alhabshi Consultant.

a) Purpose of the Report and Need for the EIA

This EIA covers the environmental reporting requirements in preparation for harbor restoration project as stipulated by the environmental regulations of Maldives. Coastal developments such as repair of harbors that are likely to a have a significant impacts to the environment are required to submit an EIA or IEE report by Environmental Act of Maldives. Article 5 (a) of the Environmental Protection and Preservation Act of Maldives (Law No. 4/93) provides for an impact assessment study to be submitted to the Ministry of Housing, Transport and Environment (MHTE) before implementation of any activity that may have a significant impact on the environment. The Environmental Impact Assessment Regulation of Maldives (EIA Regulations, MEEW, 2007) provides a list of development proposals requiring environmental impact assessment reports which are outlined in Schedule D where EIAs are mandatory for harbor development projects or renovation works.

Therefore, in accordance with the above requirements and procedures to follow under the EIA regulations, a scoping meeting to discuss the renovation or restoration proposal and determine the Terms of Reference (TOR) for the EIA report was held between the Client (MHTE), LaMer Group Pvt Ltd as the EIA Consultant, representative of design consultant (Alhabshi consultants), Ministry of Home Affairs and representatives from Environment Protection Agency (EPA) as the Regulator on 31st March 2010. This report provides the results of the field work carried out on Ga Dhevadhoo in August 2009 and associated public and community consultations that followed based on the TOR approved by EPA.

b) Structure of the Report

The structure of this report follows the Terms of Reference (TOR) discussed in the presence of the developer, the EIA consultant, representative from Ministry of Housing, Transport and Environment (MHTE), Ministry of Home Affairs and representatives of Environmental Protection Agency (EPA) as the EIA regulatory body. Upon submission of a draft TOR by the EIA consultant it was approved by the EPA on 6th April 2010, based on discussions between the consultant, the client and the other stakeholders. The approved Terms of Reference (TOR) for this report is attached in Appendix 1 of this document.

`

2. PROJECT SETTING

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

- Ministry of Housing, Transport and Environment
- Ministry of Home Affairs

a) Environment Protection and Preservation Act of Maldives

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

- Guidelines and advice on environmental protection shall be provided by the concerned government authorities.
- Formulating policies, rules and regulations for protection and conservation of the environment in areas that do not already have a designated government authority already carrying out such functions shall be carried out by MEEW (now known as MHTE).
- Identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation.
- An EIA shall be submitted to MHTE before implementing any developing project that may have a potential impact on the environment.
- Projects that have any undesirable impact on the environment can be terminated without compensation.
- Disposal of waste, oil, poisonous substances and other harmful substances within the territory of the Maldives is prohibited. Waste shall be disposed only in the areas designated for the purpose by the government.

`

- Hazardous / Toxic or Nuclear Wastes shall not be disposed anywhere within the territory of the country. Permission should be obtained for any trans-boundary movement of such wastes through the territory of Maldives.
- The Penalty for Breaking the Law and Damaging the Environment are specified.
- The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment.

The proposed harbor restoration project at Ga Dhevadhoo will fully abide by the Environmental Preservation and Protection Act. Disposal of oil, chemicals and other hazardous materials will be strictly controlled and managed. Such materials will not be disposed at inappropriate locations in the local or the regional vicinity, but will be transported to a designated waste disposal site, in Ga. Atoll or any other government approved disposal site. In any event, hazardous wastes such as oils and chemicals not allowed disposal at site, will be transported to Thilafushi for appropriate disposal.

b) Second National Environmental Action Plan (NEAP II)

The aim of NEAP II (MHAHE, 1999) is to provide the necessary guidance for the protection and preservation of the environment of the Maldives and to sustainably manage its resources for the collective benefit and enjoyment of present and future generations.

The main strategies of NEAP II are:

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

`

- Adhering to international and regional environmental conventions and agreements and
- Implementation of commitments embodied in such conventions.

NEAP II specifies priority actions in the following areas:

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

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

c) National Biodiversity Strategy and Action Plan (NBSAP)

The goals of the National Biodiversity Strategy and Action Plan (MHAHE, 2002) are:

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

`

d) Protected Areas and Sensitive Areas

Under Article 4 of the Environment Protection and Preservation Act, the Ministry of Environment (now MHTE) is vested with the responsibility of identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation. At present there are no rules and regulations made available to the public on designation and protection of habitats and heritage areas.

Since the proposed project is a renovation work, only the existing foot print areas is assigned as site boundary. Therefore only the project area will be affected.

e) Cutting down, uprooting, digging out and export of trees and palms from one island to another

Pursuant to law number 4/93 (Environment Protection and Preservation Act of Maldives), the Ministry of Environment, Energy and Water (now MHTE) has passed a by-law with the purpose of educating developers on the importance of trees. This includes best management practices for maintaining trees and provides standards for preservation of trees in the Maldives and set down rules and regulations to be adhered to prior to commencing of felling, uprooting, digging up and exporting of trees and palms from one island to another in Maldives.

The by-law states that the cutting down, uprooting, digging up and exports of trees and palms from one island to another can only be done if it is absolutely necessary and there is no other alternative.

It further states that for every tree or palm removed in the Maldives two more should be planted and grown on the island. The by-law prohibits the removal of the following tree types:

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

`

- Trees/palms that are abnormal in structure

Since the project is a renovation work at an existing functioning facility no impact is envisaged on the vegetation.

`

3. PROJECT DESCRIPTION

a) Project Proponent

Project proponent of the proposed harbor restoration project is Ministry of Housing, Transport and Environment. The project was bided as a design and consultancy project. The main design consulting company Alhabhsi Consultants is assigned to carry out the design works, preparing tender documents, carrying out EIAs and construction phase supervision consultant.

b) The Project

The proposed development project involves renovation and restoration of Ga Dhevadhoo harbor. During the December 2004 Indian Ocean Tsunami, Ga Dhevadhoo harbor facility received extensive damages. These include damage to harbor protection walls, side walls and quay walls. Under the proposed project, new quay wall (concrete sheet piles, L section) and breakwaters (armor rocks) will be constructed at the existing foot prints (See Appendix 2 for site plan). The harbor basin will also undergo maintenance dredging to -3MSL (where necessary). Since the proposed project is only a restoration project, basin size will not be increased. The concept plan is formulated in light of the new third generation harbor concept which is focused at functionality of the harbor. In this regard harbor usage components such as passenger embarking/disembarking, loading unloading area, fish landing, water and fuel recharging and mooring area will be demarcated.

At present a contractor for the project is yet to be assigned therefore some aspects of the project details such as work methodologies (casting of concrete elements) is assumed to be similar to other harbor projects carried out in Maldives (concrete elements precast in Thilafushi or Hulhumale and transported to site, this is mainly to scarcity of land for pre-casting these structures).

c) Need for the Project

During the December 2004 Indian Ocean Tsunami, extensive infrastructure damages were received throughout the Maldives. The Government of Maldives reported that the tsunami damaged or destroyed 36 jetties totaling to 1,600m in length, 4,200m of quay wall, 15,000m of harbor sea walls, 375,000m^3 of basin dredging, and 145,000m^3 of entrance dredging[1].

[1] Maldives Post Tsunami Environmental Assessment Report; UNEP, 2005)

`

Due to the tsunami event Ga Dhevadhoo harbor received a number of damages at varying magnitude. In contrast to most other harbours, quay wall at Dhevadhoo harbor was in relatively good condition, although some areas of the breakwaters suffered extensive damages (major portion of breakwaters are intact).

Ga Dhevadhoo population is predominantly involved in fisheries industry, and a number of fishing vessels uses the harbor (this includes vessels from other islands as well) and is directly related to the social wellbeing of the island community. At present due to entrance channel protection, accessing harbor at SW monsoon rough periods is very difficult.

d) Location and Extent of Site Boundaries

Ga Dhevadhoo is located at Ga atoll, 400km from Male'. It is just about 28km from Kaadedhoo Airport. Nearest inhabited island is Ga Nilandhoo (24km at eastern side) and GDh Thinadhoo (26km at the western side of Dhevadhoo). In terms of geographic coordinates, it is located at 00° 33' 26" N and 73° 14' 32" E. Nearest islands are Hagadhoo approximately 4.5km south west and Funamudua approximately 5km west of Dhevadhoo.

The existing harbor facility is located at the western side of the island, while access to the harbor is via an entrance channel south western of harbor. The project boundaries are the harbor front area, either side breakwaters, eastern side seawall and entrance area). Under the proposed project maintenance dredging will be done at the basin and entrance area where necessary and this activity will generate sediment plumes west wards. Dredged material removed during the maintenance dredging works will be reused for construction.

Figure 1 Existing location of the harbor and possible sediment plume projection associated with dredging works.

`

e) Construction Phase and Schedule for Implementation

The harbor restoration construction stage at Ga Dhevadhoo is estimated to last 12 months. Below are the major sub components of the restoration works. Table 1 provides the expected work program and work schedule for the project.

- Mobilization, material unloading
- Setting outwork (breakwaters, entrance breakwater heads)
- Excavation of harbor basin (maintenance dredging)
- Excavation of entrance channel (where necessary)
- Disposal of dredged material
- Construction of quay wall
- Construction of harbor walls, entrance walls and revetments

`

Table 1 Construction schedule for Ga Dhevadhoo (since contractor is not assigned, construction schedule of similar project is assumed, Construction schedule of N. Kendhikulhudhoo)

No.	Details	Months											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Mobilization and material unloading												
2	Setout work												
3	Maintenance dredgding (basin)												
4	Maintenance dredgding (enterance)												
5	Construction of quay walls												
6	Construction of breakwaters and revetments												
7	Disposal of surplus dredged material												

`

f) Major Inputs

i) Mobilization and material unloading

All material for the proposed project will be transported to the site on landing crafts and barges. Materials for harbor restoration works will be unloaded at the harbor front area. Temporary construction yard and storage site can be set up in the vicinity of the harbor facility (reclaimed land at harbor front area). No vegetation will be cleared for any construction purpose at Ga Dhevadhoo.

ii) Workforce

The total workforce for the project is estimated at 30-35 workers (since contractor is not assigned yet this figure is taken from work force used in similar projects, example harbor development project at N. Kendhikulhudhoo). All workers will be accommodated in existing residential houses. Food and other facilities will be met by existing facilities on the island. No additional temporary sheds or accommodation units will be constructed. A container based office unit will be located at the project site as the site office. Major concrete works necessary for the construction works (assumed to be only capping beam sections) will be carried out at the empty land at harbor (area demarcated by IDC during the meeting at held at Ga Dhevadhoo).

iii) Heavy machinery and power generation

The project construction works is not yet contracted, therefore machinery used for similar project is assumed. Machinery to be used for the proposed project is excavators (2 units), cranes, wheel loader and trucks (3 units). Excavators will also be used for demolition works, construction of harbor protection walls and entrance channel walls. Power for the project site will be met by the island's existing power house and portable generator. All fuel for the project will be stored in barrels (diesel for excavators, cranes and trucks).

`

g) Construction methods

i) Demolition works

The existing quay walls (where necessary) and breakwaters will be demolished using excavators. The demolished materials will be used as core for the breakwaters. Since the existing quay wall and breakwaters are constructed with coral rock and cement this material would be ideal as core material. Instead of removal the breakwater debris will be aligned and shaped for core of new breakwater (where possible, if not debris will be transported to necessary areas for breakwater core), thus reducing amount of debris for disposal and reuse of dredged spoil.

ii) Excavation method

Since the project only involves maintenance dredging, excavators on barge will be used. In-survey for the design phase has already been carried out therefore areas where deepening is necessary is already identified. All dredged material will be transported to harbor front area after filling up of barge and unloaded for temporary stockpiling. The finish design depth of the harbor basin will be -3MSL (areas shallower than -3MLS will be deepened to design depth) while entrance channel will be -4MSL.

Since the project involves maintenance dredging and no additional entrance or entrance reorientation work is involved, blasting will not be required at any stage of the construction works.

iii) Construction of wharf and harbor protection structure

It is assumed that concrete elements for the quay wall will be caste off site and transported when required (since contractor is not assigned yet details of this component is not clear, therefore method used in similar projects are assumed). If concrete elements are caste off site only minor concrete works will be required at site (casting of capping beam, which will be done in-situ). Since removal of existing quay wall and disposal will be costly, the new quay wall will be set adjacent to existing one (See Appendix 4 for breakwater details). The space between the existing and new quay wall will be filled with sand (sediment from maintenance dredging works). The element toe area will be deepened and leveled. After placing the elements, the toe area will be refilled. After placing the concrete element, tie rods will be used to fix and anchor the L section to anchor slabs (anchor slabs tie rods will be drilled through the existing quay wall structure). After placing the concrete elements the quay wall will be joined together with a capping beam.

`

The sections of quay wall that is either subsided or with significant structural damage will be demolished and removed; these would be used as core for breakwaters.

The side quays will be of type 2 quay wall design. The type 2 design of quay wall comprises geo-textile bags and a concrete capping beam (see Appendix 4 for quay wall details). The geo-textile bags will be filled with dredged material.

The breakwater will be constructed using armor rock while the existing coral rock remains of breakwater will be used as core material (type 2 breakwater). If coral rock debris is not enough for core, geotextile bags filled with dredged material will be used. The breakwater will extend 65m south of harbor to protect the entrance channel. The breakwater structure will not be enclosed, instead open on both sides (south and northern side allowing maximum flushing).

h) Major Outputs

i) Harbor design

The existing harbor footprint will not be changed due to the proposed project, breakwaters and quay wall will be constructed at existing foot print. Therefore the existing design of the harbor will remain as it is. The length of the harbor after completion of renovation works will be 149.2m and width 95m. The length of entrance channel is approximately 63m, while width is 40m. The depth of basin is at average -3.6MSL, areas where design depth is not met will be deepened to -3MSL. Depth of entrance channel will be -4MSL.

The harbor will have a total length of 190m of breakwater at the western side. The breakwater will be constructed of armor stones and remains of existing breakwater as core (See Appendix 4 for breakwater detail). The side quay wall will have a total length of 190m of type 2 design quay wall, while the main quay will have a length of 149.2m (See appendix 2 for site plan).

`

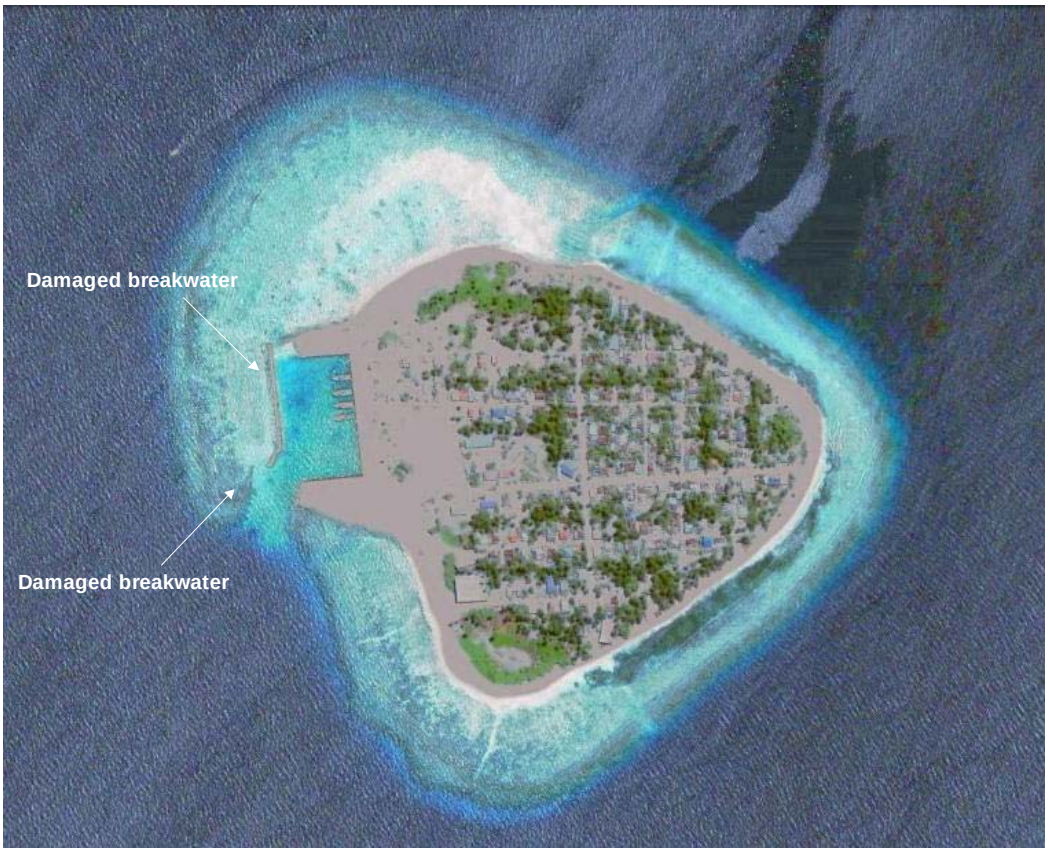


Figure 2 Damaged breakwater areas, the breakwater at entrance head area was entirely destroyed and submerged

ii) Dredge material

Dredge material removed from the harbor basin (maintenance dredging works) and entrance will be initially stockpiled near harbor area since this of the material will be required during construction works. Dredged materil will be used for back filling the area in between the existing quay wall and new quay wall and for filling the geo textile bags of breakwaters and side quays. Approximately 1,500m^3 of dredge material will be removed from the harbor basin and entrance channel.

i) Risks Associated with the Project

Only minor risk are envisaged due to the proposed project since dredging works are very limited. The main works will be the restoration of breakwaters and quay walls. Seawater degradation and sedimentation impacts are envisaged. Since the existing footprints will be used no additional impacts are envisaged on the shoreline or littoral movement.

`

4. Methodology

The approach to data collection and compilation of this report includes;

- Consultation and discussion with the design consultants and engineers with regard to design and work methodology that would be used to implement the proposed activities
- Examination of proposed project activities,
- Examination of the existing environment to identify significant environmental components that would be affected,
- Consultation with major stakeholders to exchange information on the project and to follow the procedures required for the report, and
- Evaluation of available and relevant literature on environmental impacts associated with similar projects.

Information on existing environment was collected during the field visit to the project site during September 2009. General information on the existing environment was based on available secondary data, such as climatic data for Huvadhu atoll in general (National Meteorological Centre at GDh Kaadedhoo) because no site specific data was available. Due to the general uniformity of the climatic data along Maldives, climatic data from GDh Kaadedhoo were considered applicable to the site given the lack of availability of site specific data and also the short time available for the preparation of the report to collect such data.

Since nearest tide station is at Addu, limited tide data collected at GDh Lonudhuhutta for a coastal modification study by LaMer Pvt (EIA for coastal modification of GDh Londhuhutta, 2008) was used.

Oceanographic data and information used to determine the current pattern around the island was also based on monsoonal wind patterns, wind generated waves, tidal flushing, geographic setting, the topography of the lagoon and shape of the shoreline.

Beach profiles were taken using a digital level. Initially the beach toe of the island was mapped using precision GPS. Afterwards profile areas were selected based on possible impact areas due to the proposed project. Four profiles were taken to establish as baseline data. All beach profiles are aligned perpendicular to the beach. Location of beach profiles and GPS coordinates are given in Figure 3.

An underwater camera with housing was used to take a series of photographs for assessing reef benthic community, since only harbor area will be impacted qualitative assessment was made. Snorkelling surveys were done at the harbor front area to assess the reef condition. Major

`

benthic categories and live coral cover was visually estimated. Live coral cover was also assessed for dominant generas and types.

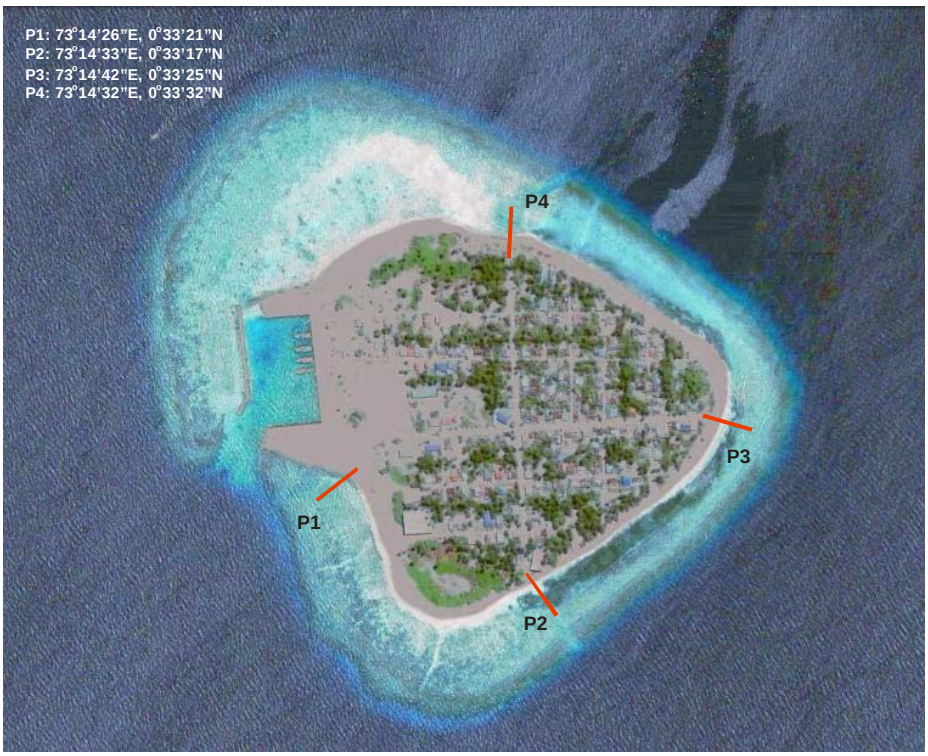


Figure 3 Location of beach profiles and GPS coordinates

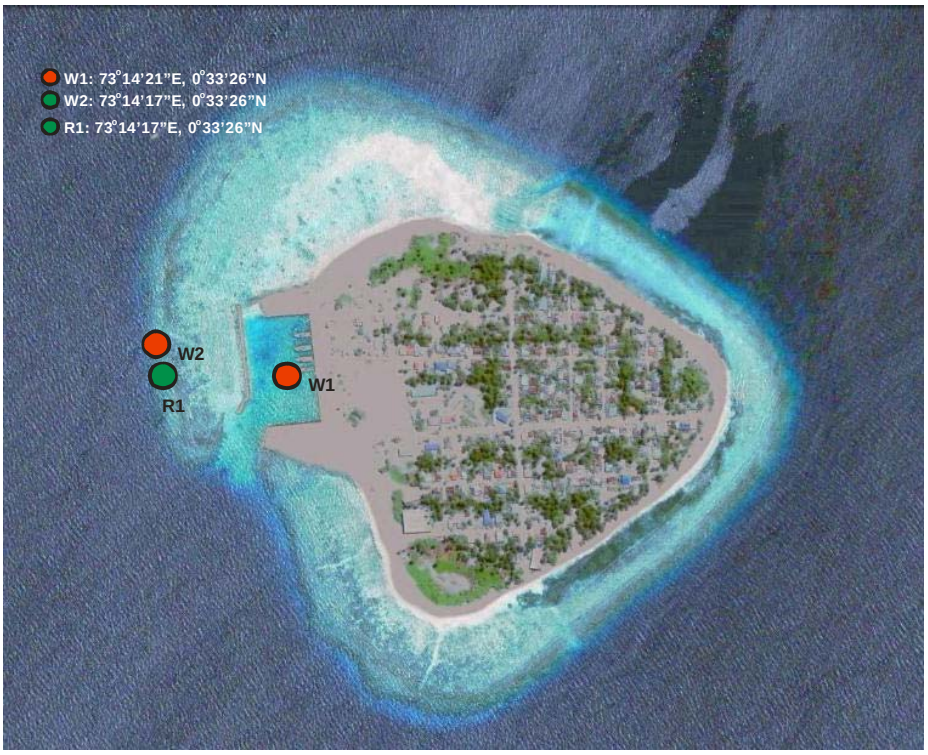


Figure 4 Reef survey and water samplings locations and GPS coordinates

`

5. Public Consultation

As part of the public consultation process for this project, relevant stakeholders from the public and private sector were consulted and discussions were exchanged based on the proposed project activities. The need justifications and approval of the proposed activities from the perspective of relevant institutions were inclusive of this consultative process. The consultative process is based on meetings and discussions with representatives of relevant stakeholders. Perceptions of the community in the vicinity of the proposed project site based on specific focus groups such as island officials, boat owners and fishermen were also included in this consultative process. List of people met in this consultative process is given in Appendix 5.

a) Institutional Arrangements

Ga Dhevadhoo is administratively located in Ga Atoll. As with all other atolls of the Maldives, the island community governed through the Ministry of Home Affairs and Central South Province Office. Day-to-day administrative and management of the island community needs together with routine reporting to relevant ministries or other institutions in Male' is managed by the Island Councilor and with support from the Island Office administrative staff.

The Ga Dhevadhoo Harbor reconstruction Project is being carried out under the Tsunami Restoration Project. The project is implemented by Construction and Infrastructure Department of Ministry of Housing, Transport and Environment. The design and supervision consultants are Alhabshi consultants of Kuwait and Riyan Pvt Ltd. Contractor for the restoration works is not yet appointed. A site office will be established at the project area, where information about the project and progress of the project will be available to the community if needed.

b) Community consultations and stakeholder meetings

Consultation with the former Island Development Committee (IDC) was held during the site visits made to the island during the initial survey trips by the EIA consultants and representative of design consultant (Alhabshi consultants). Members of the island development committee, boat owners and fishermen were informed about the process of EIA and the government regulations on Environmental Protection. The IDC, Deputy Island Chief of Ga Dhevadhoo were also consulted on the design aspects of the harbor. The participants of the meeting were informed that the project is a restoration project therefore existing footprint of the harbor will remain as it is now. Although it is named as a restoration project quay walls, side quays and breakwaters will be new. Also maintenance dredging works will be done at deepen areas of the harbor and entrance channel where necessary. The members of the IDC have been informed about the inevitable environmental impacts of such a development. In addition to the physical

`

data used for the design and location of the harbor members of the island community were consulted on existing issues in relation to the harbor.

One of the main issues highlighted by most of the participants of the meetings was the issue of repeated surveys and no action. The community strongly feels that the restoration project would only ease the accessibility issue but will not resolve the issue of accommodating all the vessels used by the community especially the fishing fleet. The participants of the meeting stated that the harbor facility is in need for expansion (800x300ft).

The participants stated that due to location of Dhevadhoo many trade vessels and Safaris use Dhevadhoo harbor as a transit point, therefore the harbor is always crowded. Also during fishing season the harbor is used by fishing vessels from other atoll as well. Due to this reason the community feels very strongly that the harbor needs to be expanded. Since resorts are opening near the island, additional usage of harbor is envisaged therefore burden on harbor will increase.

The community has a concept of harbor, which was shared with the design and EIA consultants. In this design major changes were increase of length of harbor and breakwater extension to protect the entrance. The participants of the meeting were informed about the nature of the project, but also were informed that these requests will be passed on to the ministry.

Overall the IDC and harbor committee was in favor of the project and very little issues apart from extension of harbor were raised during the meeting.

c) Consultation with MHTE

After the field visit to the project islands (10 islands), a meeting was held at MHTE to brief the Construction and Infrastructure Department (CID) of MHTE about the field work and initial findings of the trips. The consultants informed CID the issues raised by the island communities and finds of the team. In regard to Ga Dhevadhoo, the issue of harbor expansion and entrance channel protection was raised.

The personnel from CID stated they don't have any issue in extension of breakwater for protecting the entrance channel. As for extension of the harbor the personnel from CID requested a costing so that they can make an assessment.

d) Outcome of the consultation meetings

Major outcome of the consultation meetings is issue of breakwater and harbor extension.

- In regard to the breakwater extension at the southern side, the final concept prepared had this component incorporated as the community requested.

`

- In regards to the harbor expansion it was decided that since the project is funded by a loan and is a restoration project, available funds will not be sufficient for the expansion therefore existing size of the harbor will be maintained.

`

6. Existing Environment

a) General Setting

The Maldives archipelago consists of a double chain of coral atolls, 80 – 120km wide stretching 860km from latitude 7° 6' 30" N to 0° 41' 48" S and longitude 72° 32' 30 E to 73° 45' 54" E (Ministry of Construction and Public Works, 1999). The double chain of the Maldivian atolls lies on the parallel submarine ridges in the central part of Indian Ocean known as Lacadive-Chagos ridge. The archipelago comprises 25 natural atolls (Naseer, 2004) grouped into 20 administrative units (see Figure 5). The atolls are separated by east-west running deeper channels. The atolls vary in shape from circular and oval to elliptical. The atolls contain 1190 islands, of which only 198 are inhabited. The total reef area of Maldives is 4,493.85km^2 while the total land area is 227.45km^2 (Naseer, 2004). Approximately 80% of Maldivian land area is less than 1m above mean sea level.

The characteristics of reefs and coral islands of the Maldives vary considerably from north to south. The atolls to the north are broad banks discontinuously fringed by reefs with small coral islands and with numerous patch reefs and faros (the word faros is derived from the Maldivian word "*faru*") in the lagoon. To the south the depth of atoll lagoon increases, faros and patch reefs are rare in the lagoon, the continuity of the atoll rim is greater and a large proportion of the perimeter of the atolls is occupied by islands (Woodroffe, 1992). The islands have shallow reef flats on their seaward side, some with shingle ramparts at the seaward limit of the reef flat. The islands and the shingle ramparts owe their origin to the deposition of shingle or coral debris during storms. A number of islands can be found on a single reef. These islands may be separated by shallow passages that run across the reef flat. The width of some of these passages could be less 100m while some passages are over a few hundred meters wide.

`

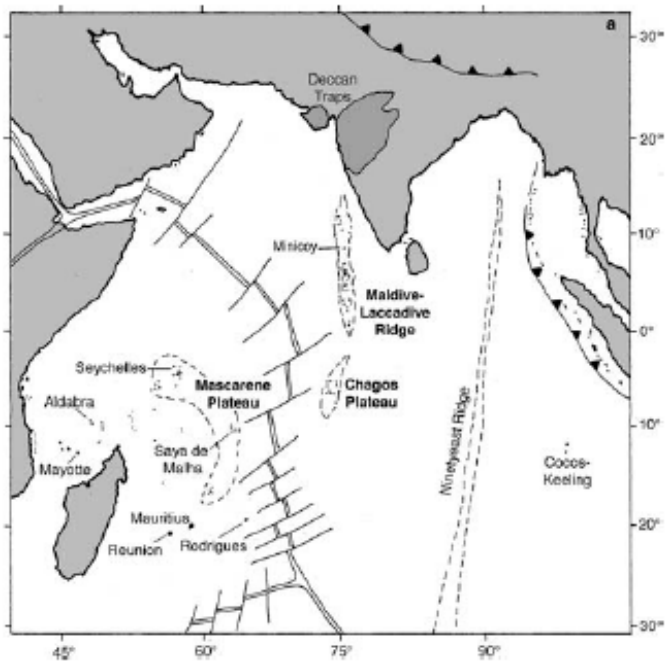


Figure 5 Geographic location of Maldives in Indian Ocean

b) Geographical location and general setting of Ga Dhevadhoo

Ga Dhevadhoo is located at Ga atoll, 400km south of Male'. It is just about 28km from Kaadedhoo Airport. Nearest inhabited island is Ga Nilandhoo (24km at eastern side) and GDh Thinadhoo (26km at the western side of Dhevadhoo). In terms of geographic coordinates, it is located at 00° 33' 26" N and 73° 14' 32" E. Nearest islands are Hagadhoo approximately 4.5km south west and Funamudua approximately 5km west of Dhevadhoo. The reef system is approximately 900m long and 840m wide resembling a triangular shape.

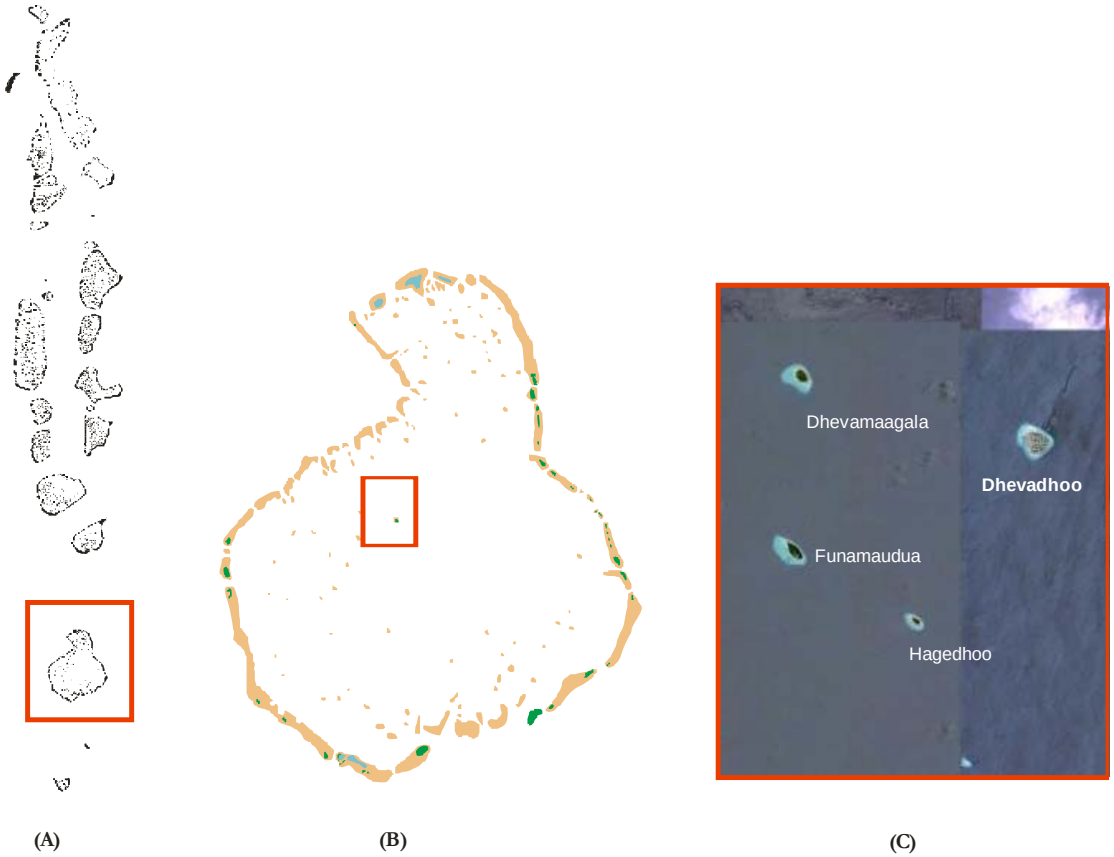


Figure 6 Geographic location of Huvadhu atoll in Maldives chain of atolls (A), Map of Huvadhoo Atoll (B) and geographic area near Dhevadhoo and location of Dhevadhoo (C)

c) Climate and Oceanography

i) Wind climate

Wind climate in the Maldives is dominated by the Indian monsoon climate South West (SW) monsoon and North East (NE) monsoon. The Indian monsoon system is one of the major climate systems of the world, impacting large portions of both Africa and Asia (Overpeck et, al., 1996). The monsoon climate is driven by the atmospheric pressure differences that arise as a result of rapid warming or cooling of the Tibetan Plateau relative to the Indian Ocean (Hastenrath 1991; Fein and Stephens 1987). During the summer of northern hemisphere the Tibetan Plateau warms rapidly relative to the Indian Ocean which results in an atmospheric pressure gradient (Low pressure over Asia and high pressure over the Indian Ocean) between the Asian landmass and the Indian ocean, which drives the prevailing wind from south to westerly directions. The period during which prevailing winds are from south to westerly direction is known as the SW monsoon. In the winter of northern hemisphere the continent cools relative to the ocean. This reverses the pressure gradient (low pressure over the Indian

`

Ocean high pressure over the Asian landmass) and the prevailing winds become northeasterly. The period during which prevailing winds are from northeasterly directions is known as NE monsoon. The transitions from NE to SW monsoon and vice versa are distinctly different from SW or NE monsoon. During these transition periods the wind becomes more variable.

The SW monsoon lasts between May and September while the NE monsoon lasts between December and February. The period between March and April is the transition period from the NE monsoon to SW monsoon known locally as the Hulhangu Halha, while the transition period from SW monsoon to NE monsoon is known as Iruvai Halha. Iruvaihalha lasts from October to November (Table 2). The SW monsoon is generally rough and wetter than the NE monsoon. Storms and gales are infrequent in this part of the world and cyclones do not reach as far south as the Maldivian archipelago (Ministry of Construction and Public Works, 1999).

Table 2 The four seasons experienced in the Maldives

Season	Month
NE-Monsoon	December January February
Transition Period 1	March April
SW-Monsoon	May June July August September
Transition Period 2	October November

Summary wind data for the period between may 2005 and June 2007 affirms the strong winds are mainly from westerly direction and least common from north to east quadrant (Figure 7). The summary data also shows that over 75% of the time wind speed is between 3m/s and 6m/s (Table 3). Wind speeds greater than 7m/s occurs only 4.6% of the time and winds at this speed are confined to between SSE and NW directions.

The measure of symmetry (skewness) of the wind speed distribution from the four main quadrants (N-E, E-S, S-W and W-N) show that winds between S-W has a fairly symmetrical distribution (Figure 8). This indicates that the percentage of occurrence of wind speed at low to high speeds is evenly distributed around the mean wind speed. Winds from N-E quadrant show

`

a highly skewed distribution, indicating that the percentage of occurrence of lower speed winds is greater from the quadrant between N-E.

The wind data for the period between May 2005 and June 2007 from Kadedhooo also shows that the average wind speed is highest during Iruvai Halha and during SW monsoon (Table 4). The yearly averaged wind speed was found to be 3.02m/s. Yearly maximum wind speed was 7.72m/s.

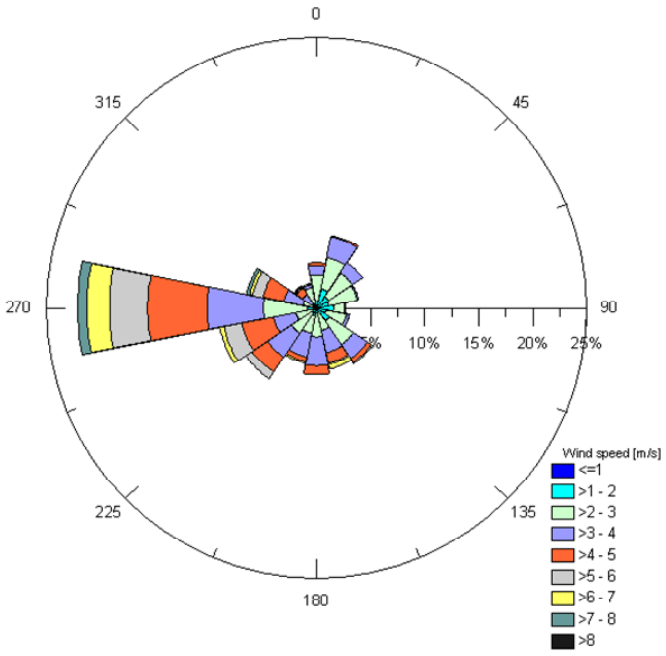


Figure 7 Summary wind data indicating the wind speed, direction and percentage of occurrence of wind from different directions (wind data between May 2005 and July 2007)

Table 3 Summary statistics of wind data from Huvadhu Atoll

		Wind Speed (m/s)							
		<=1	*>1 - 2*	*>2 - 3*	*>3 - 4*	*>4 - 5*	*>5 - 6*	*>6 - 7*	*>7 - 8*	*>8*
Direction	**Total % count**	**Percent count**								
N	**4.2%**		0.6%	2.5%	0.8%	0.3%				
NNE	**6.9%**		1.8%	3.0%	2.0%	0.1%				
NE	**5.1%**		1.3%	2.7%	1.1%					
ENE	**3.9%**		1.1%	2.7%	0.1%					
E	**2.7%**		1.5%	1.0%	0.1%					
ESE	**3.1%**		0.8%	2.0%	0.3%					
SE	**6.2%**		1.4%	2.7%	1.5%	0.4%	0.1%			
SSE	**5.8%**		0.4%	1.7%	2.1%	1.0%	0.1%	0.4%		
S	**6.2%**		0.4%	2.3%	2.7%	0.8%				
SSW	**5.2%**		0.7%	1.7%	2.3%	0.4%		0.1%		
SW	**7.9%**		0.4%	2.4%	2.7%	1.7%	0.7%			
WSW	**9.2%**		0.3%	1.7%	2.1%	3.0%	1.7%	0.4%		
W	**22.1%**		0.8%	4.1%	5.2%	5.5%	3.5%	2.1%	0.8%	
WNW	**6.6%**		0.3%	1.0%	1.8%	2.0%	1.0%	0.3%	0.3%	
NW	**2.5%**			0.4%	1.1%	0.7%	0.1%	0.1%		
NNW	**2.4%**		0.4%	1.5%	0.3%		0.1%			
Total % count			***12.4%***	***33.2%***	***26.3%***	***15.9%***	***7.5%***	***3.5%***	***1.1%***	

`

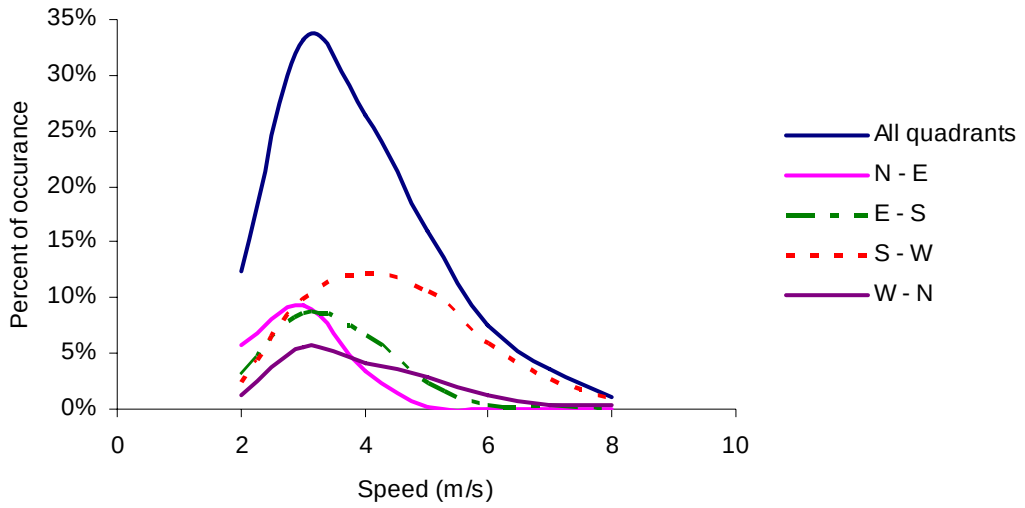


Figure 8 Frequency of occurrence of wind speed from the four main cardinal quadrants

Table 4 Statistics of wind data from Huvadhu Atoll

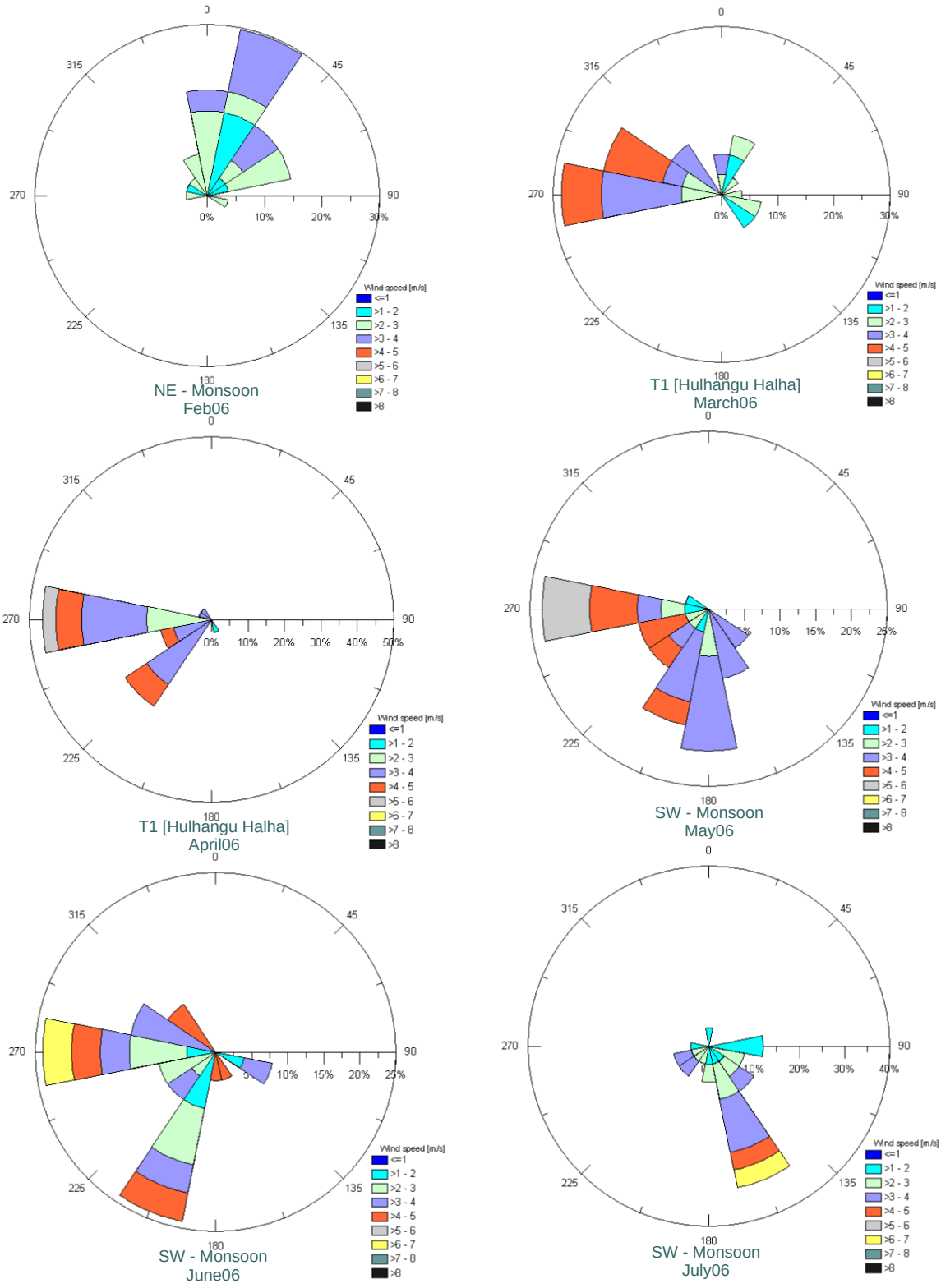
Quadrant	Skewness
N - E	1.16
E - S	0.92
S - W	0.10
W - N	0.74

Period	Average Wind Speed (m/s)	Max Wind Speed (m/s)
NE monsoon	2.73	6.69
Hulhangu Halha	2.81	6.17
SW monsoon	3.08	7.72
Iruvai Halha	3.47	7.72
Yearly Average	3.02	7.72

Monthly wind rose plots for the 12 months between February 2006 and January 2007 (Figure 9) evidently shows how distinctly different are the wind patterns for the four periods NE, Hulhangu Halha, SW and Iruvaihalha. The first month of Hulhangu Halha, March is marked with variable winds while during the second month of this period the winds become predominantly westerly. It is also noted that although the winds are variable stronger winds prevail from westerly directions during Hulhangu Halha. During the first two months of SW monsoon, May and June, winds prevail from Southerly to Westerly directions. There are no winds from the Northeasterly quadrant. During the months of July and August winds prevail from Southeasterly directions. During the final month of SW monsoon, September, winds remain variable between Southwesterly and Northwesterly directions. Wind patterns during Iruvaihalha, October and November become distinctly different from the 5 months of SW

`

monsoon. During October to November the winds becomes highly variable but remains fairly strong in its speed. Variable wind directions were also recorded for the first month of NE monsoon (December) but stronger winds prevail from Northeasterly direction. The months of January and February clearly shows prevailing Northeasterly winds.



`

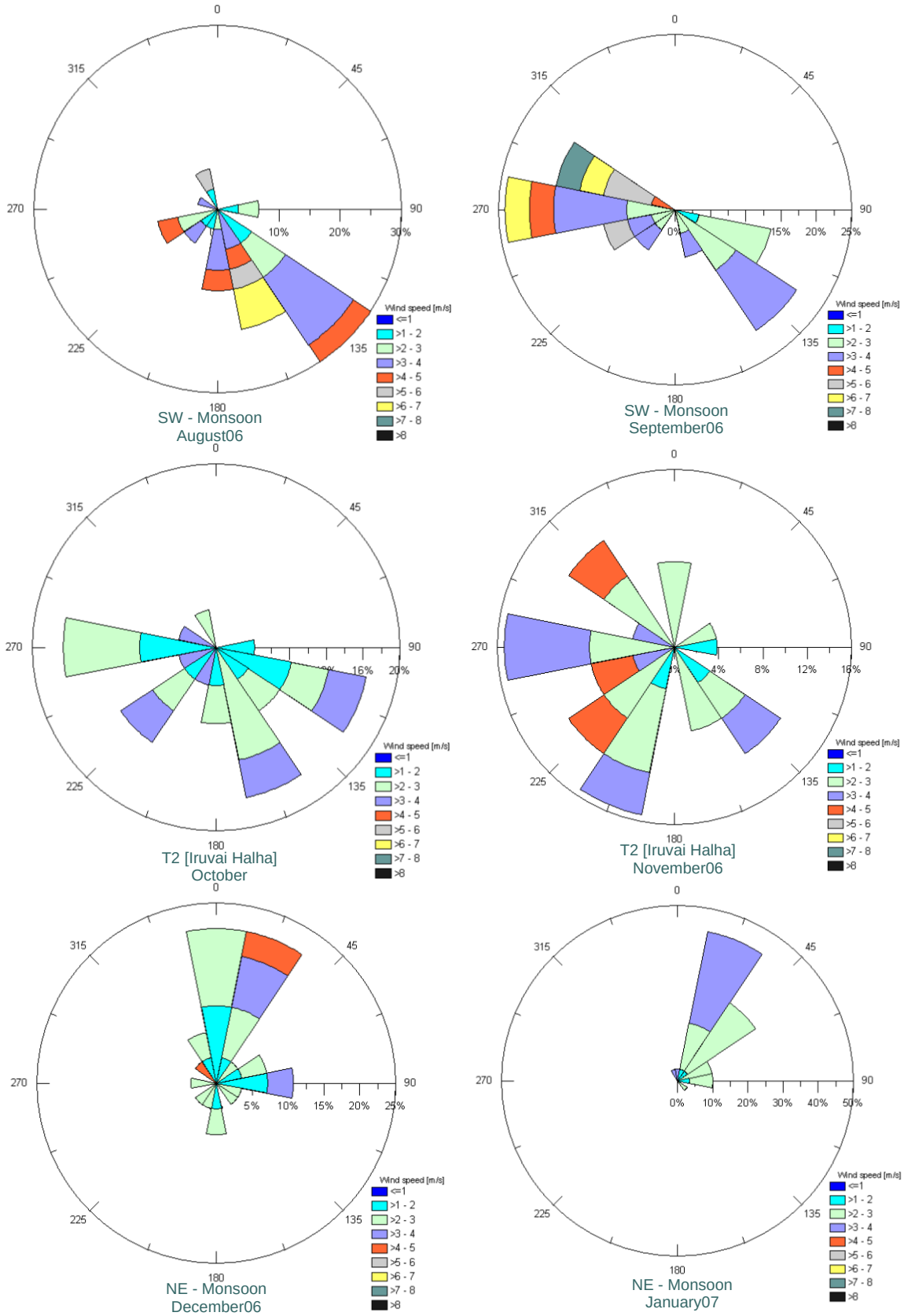


Figure 9 Wind rose plots for 12 months between Feb 06 and Jan 07

`

ii) Tide

Tide in the Maldives is characterized by sinusoidal oscillation containing two main cycles per day (semidiurnal tide) combined with a one cycle per day (diurnal tide). The combination of these two tides is referred as a mixed tide. Analyses of tides involve the study of harmonics which represents the period of oscillation of the celestial forcing that give rise to that harmonic. Therefore, harmonic analysis of the tides breaks down the complex tidal oscillations into a collection of simple sinusoids, which can be used to predict the tide at the site of tidal data collection.

There are no permanent tide stations established in Huvadhoo Atoll. The closest tide station is in Addu Atoll. A few months of tide data (between 2nd May 2007 and 5th June 2007) have been obtained at the island of Lonudhuhutta, which is a resort hotel under construction within Huvadhu Atoll at approximately 34km SW of Dhevadhoo. These tide records have been analysed to determine the main tidal constituents within Huvadhu Atoll. These analysis indicate that the tide in Huvadhu Atoll have a principle lunar semi diurnal constituent (M2) of period 12.4hrs and a Lunar declinational diurnal constituent (O1) of 25.5hrs (Figure 10). The periods 11.9hrs and 23.5hrs represents principal solar semidiurnal constituent (S2) and Luni-solar declinational diurnal constituent (K1) respectively. The period 14.2 days represents the spring-neap cycle of the tide.

Tidal records from Lonudhuhutta also show a difference in height of the two high waters or of the two low waters of each tidal day which is called diurnal inequality. The difference in the successive high or low tide changes with the declination of the Moon and, to a lesser extent, with the declination of the Sun. In general, the inequality tends to increase with increasing declination, either north or south, and to diminish as the Moon approaches the Equator.

The ratio between diurnal and semi diurnal tides [F = (K1 + O1)/(M2 + S2)] allows classification of the tide into four different categories (Table 5).

Table 5 Classification of tides

Ratio [F]	Classification
0.00 - 0.25	semidiurnal tides
0.25 - 1.50	mixed, dominantly semidiurnal tides
1.50 - 3.00	mixed, dominantly diurnal tides
> 3.00	diurnal tides

`

The principle tidal constituents for determined for the tide records from Lonudhuhutta gives 2.02 for the ratio [F] which categorizes the tide in Huvadhoo atoll as a mixed, dominantly diurnal tide.

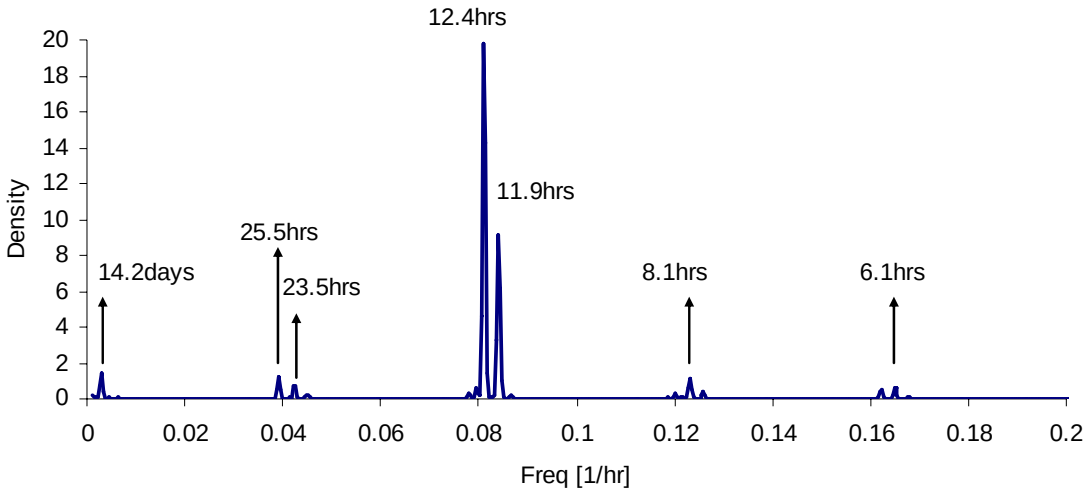


Figure 10 Spectral density analysis of tide data from Lonudhuhutta indicating the main tidal constituents

iii) Wave

The shape and location of Dhevadhoo and the knowledge of the offshore wave climate around the southern atolls of Maldives have been used to predict the general hydrodynamic conditions around the island. DHI (1999) described the general offshore wave conditions in the southern regions of Maldives (Table 6). It was reported that during NE monsoon the oceanic swells that approach the southern atolls of Maldives are generally from east – south. The longer period waves of the wave spectrum are from south – southwest directions while the shorter period waves are mainly from east – northeast directions. During the SW monsoon the waves are mainly from south. The longer period waves of the wave spectrum are from south – southwest while the shorter period waves are from southeast – south. It is therefore evident that the incident waves in the southern atolls of Maldives are predominantly from a southerly direction.

The local wind generated waves that are directly related to the wind climate in the region varies with the seasonal changes in the wind velocity. DHI (1999) reported that during the NE monsoon the wind is predominantly from NW – NE and the high speed winds are from west. During Hulhangu Halha (Transition Period 1) the wind varies to all directions but the high winds during this period are from west. Southwest monsoon is marked by winds from SE – SW and high speed winds from west. Iruvai Halha (Transition Period 2) also experiences westerly winds.

`

DHI (1999) reported that the high speed wind in the southern atolls of Maldives throughout the year is from west.

Table 6 Seasonal wind and wave climate around southern atolls of Maldives

Season	Month	Wind	Waves		
			Total	Long period	Short period
NE-Monsoon	December	Predominantly from NW-NE. High speeds from W	Predominantly from E-S. High waves from W	From S-SW	Mainly E-NE. High waves from W
	January				
	February				
Transition Period 1	March	From all directions. Mainly W. High speeds from W	Mainly from SE-S	From S-SW	Mainly from NE-SE
	April				
SW-Monsoon	May	Mainly from SE-SW High speeds from W	From SE-SW. Mainly S. High waves also from W	From S-SW	Mainly from SE-S. High waves from W
	June				
	July				
	August				
	September				
Transition Period 2	October	Predominantly from W High speeds from W	As SW-monsoon	From S-SW	From SE-W. Higher waves from W
	November				

Wave data reported in DHI (1999) shows that the highest waves reaching the southern Atolls of Maldives archipelago are from west direction (Figure 11). Waves of Hs 2.75m with wave periods (Tp) of 8s and 9s have been recorded from west direction. Swell waves with wave periods greater than 9s prevails from South and Southwest directions. Over 80% of the waves from south and southwest directions are long period swell waves.

The longer period swells (waves with periods between 15 and 21sec) come from SW direction. Over 37% of the waves from SW directions have Tp between 15s and 21s. Out of these very long period swells 19.15% of the waves have Hs of 0.25m, 11.5% have Hs of 0.75m, 4.33% have Hs of 1.25m, 1.38% have Hs of 1.75m and 0.31% have Hs of 2.25m.

DHI (1999) data also shows that 51.22% of the waves from SE direction consist of waves with Tp between 9s and 21s, while 48.78% of the waves have Tp between 3s and 7s. Waves from N, NE, E, NW and W are predominantly shorter period waves (Tp between 3s and 7s). 96.98% of

the waves from E direction, 99.6% of the waves from NE direction, 99.36% of waves from N direction, 95.74% of waves from NW direction and 75% of waves from W direction have Tp between 3s and 7s. These data evidently indicates that the local wind generated waves are predominantly confined to northern directions between West and East. The southern directions are predominantly dominated by longer period oceanic swells.

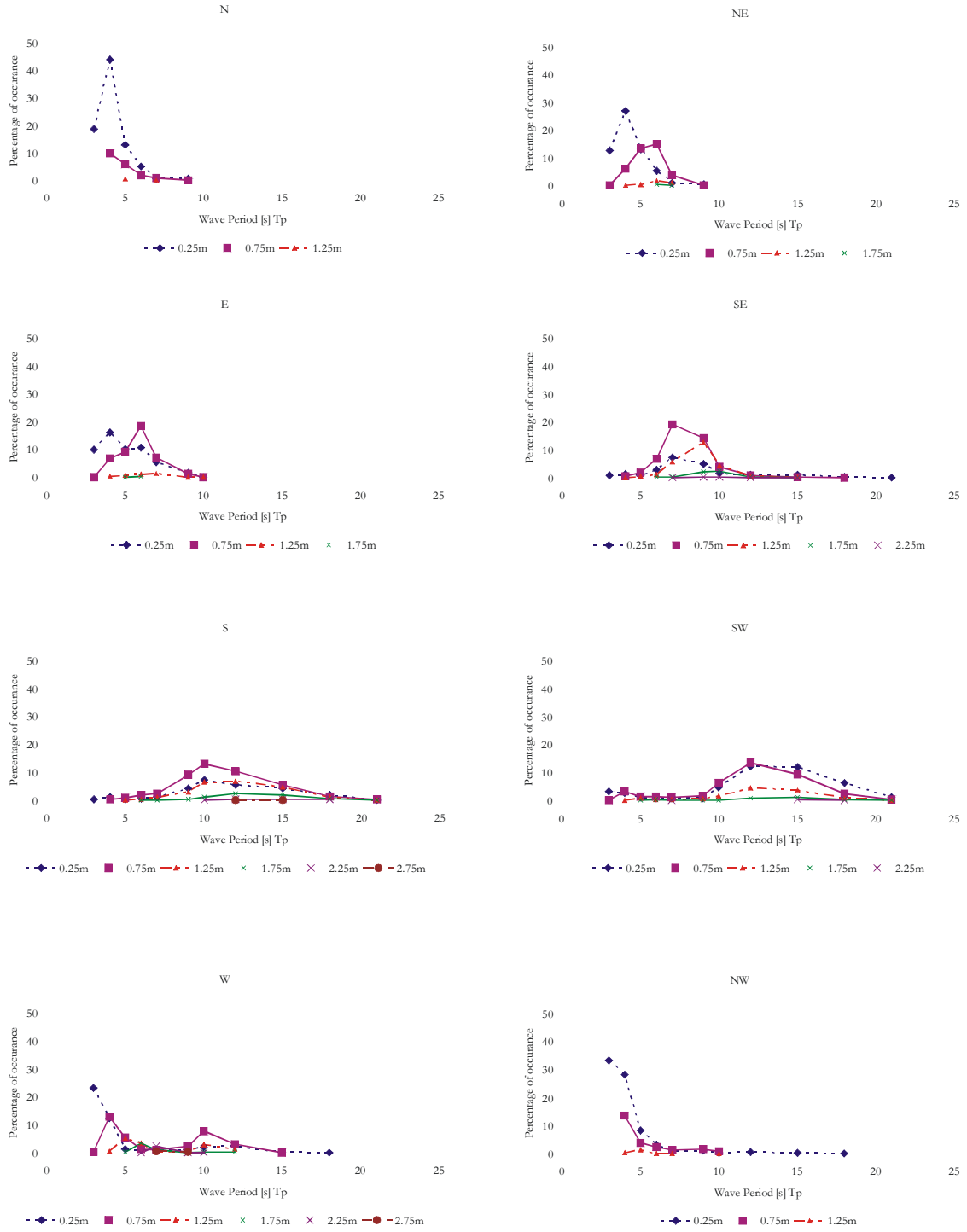


Figure 11 Wave height and period distribution in the southern parts of Maldives

`

Wave condition at Dhevadhoo reef system is dictated by refracted swells, NE and SW monsoonal wind generated waves. Since Huvadhu atoll is a very large atoll and due to location of Dhevadhoo in the atoll fetch lengths of wind waves at either season is large. Therefore during rough periods the inter atoll waters near Dhevadhoo is extremely rough. The entrance channel is oriented south western side, due to this reason (coupled with damaged entrance breakwater heads) the wind waves are received at almost up to the basin. During NE monsoon the harbor front area is sheltered and moderate wave impacts are envisaged.

Since the basin is open on both sides, maximum flushing is experienced. It has to be noted that due to circular shape of the island, alteration of shoreline has had little effect on the hydrodynamic condition of the lagoon.

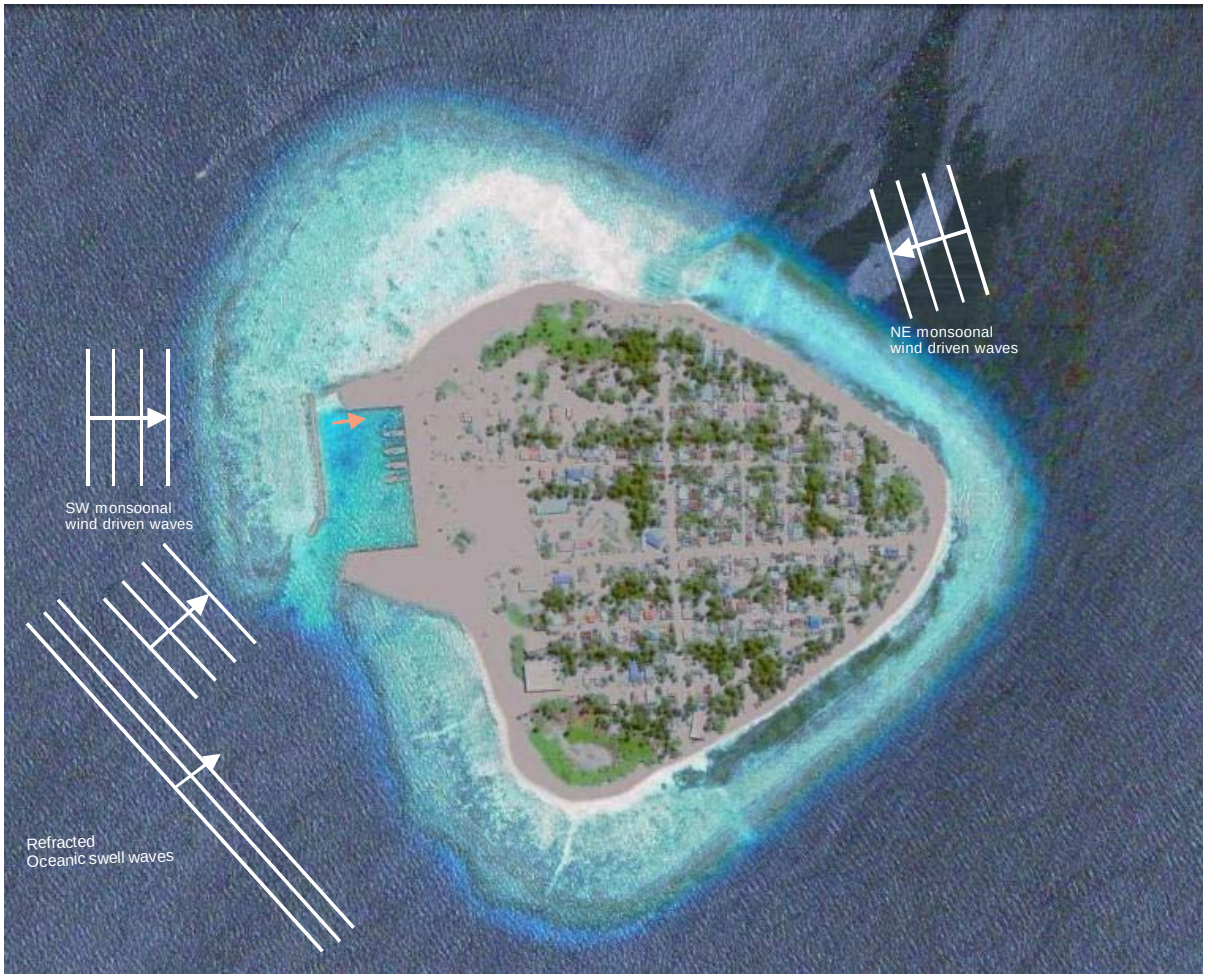


Figure 12 Assumed wave climate of the reef system

d) Beach Environment

The shore line of Ga Dhevadhoo has been modified at the western side during the initial construction of the harbor. Either sides of the harbor were reclaimed with the dredged material

`

from excavation works. 38m wide piece of land from northern side and 90m of land form southern side was reclaimed. The main purpose of this was to protect the side quays of the harbor. Generally rest of the shoreline is observed to be in good condition apart from seasonal accretion and erosion. The northern side of harbor (north of northern side quay) is observed with moderate erosion.

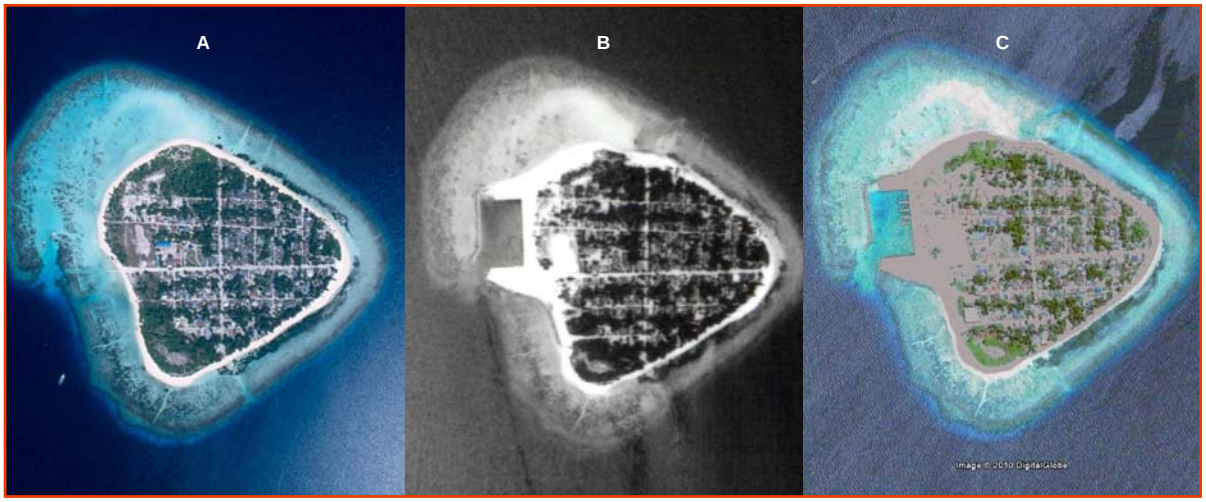


Figure 13 Time series aerial and satellite images of Dhevadhoo showing changes to the shoreline (Feb 2003 image A, Feb 2004 image B and Aug 2006 image C)

Beach profiles were taken at 4 locations as baseline for future monitoring program (Figures 14 to 17). The profile 1 is taken at the southern side of harbor at the reclaimed area, profile 2 is taken at the southern side of the island, profile 3 is taken at the eastern side of the island and profile 4 is taken at the northern side of the island. The near harbor area at the southern side of the harbor was observed to be rocky-shingle; this is perhaps due to fines being washed away after reclamation. The northern side of the harbor is also observed with erosion, although erosion is observed, extent of erosion is minor.

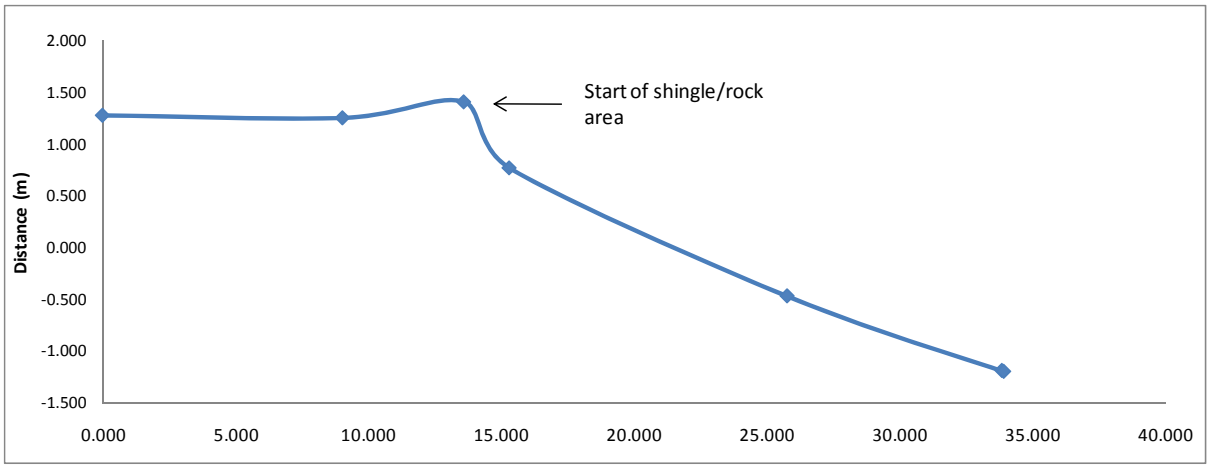


Figure 14 Beach profile 1

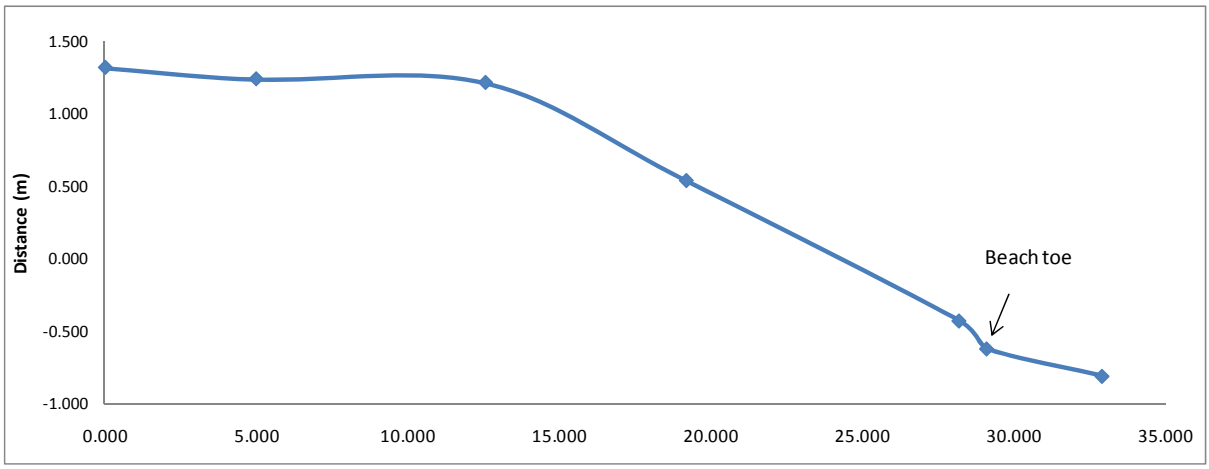


Figure 15 Beach profile 2

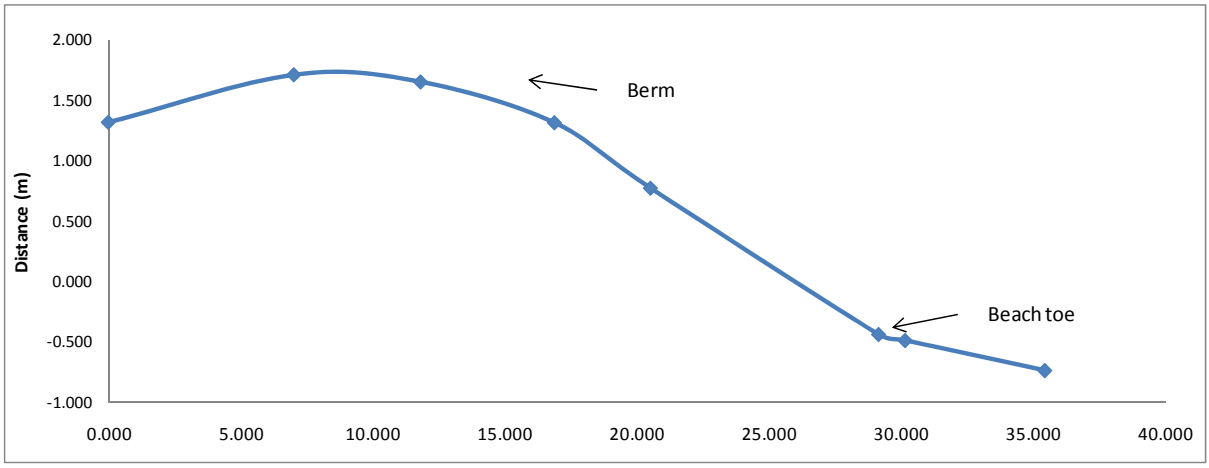


Figure 16 Beach profiles 3

`

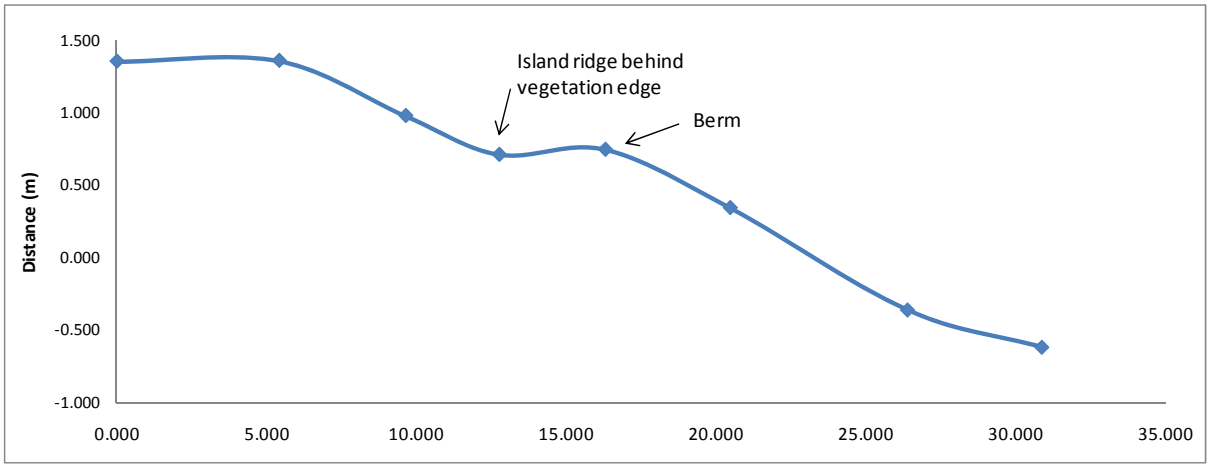


Figure 17 Beach profile 4

e) Marine Surveys

The status of the marine environment at the harbor construction site at Ga Dhevadhoo was carried out using standard marine survey methodologies to estimate the overall ecological condition of the reef. A brief description of the survey methods are given in Section 4.

The island of Ga Dhevadhoo is located at the central area of Huvadhu atoll. The reef hosting Dhevadhoo is approximately 900m long and 840m wide, resembling a triangular shape. The harbor basin is located at the lagoon area behind reef flat approximately 60m inside. The entrance channel is cut at the south western side of the harbor.

i) Coral community

The reef flat area in front of harbor was dominated by tabulate life forms of Acropora and massive life forms of Porites. Large table corals and branching coral colonies were abundant at the area. Numerous small table corals were observed behind the reef flat area dominating the rocky back reef towards the lagoon. The reef slope area was dominated by large table corals and branching forms of acropora. Live coral cover at the reef flat area is approximately 45%, from which 30% is estimated to be Acroporids. Large porties bommies were mainly observed just off the crust area at the reef slope. Other live coral generas observed are Pocillopora, Pavona, Echinopora, Goniastrea, Psammacora and Favites.

Fish life at the area was dominated by Acanthurids, Labrids and Pomacentrids. Three species of Chaetodontids was observed at the survey area these include *Chaetodon collare*, *Chaetodon trifasciatus* and *Chaetodon auriga*. Numerous bait fish (Atherinidae) was also observed at the area.

`

Figure 18 Reef slope area near the harbor front dominated by Porites massive forms and Acoporids

Figure 19 Back reef area behind the reef flat, with numerous acropora tabulate forms (left), few large acropora table corals where observed to be dead and covered in algae.

ii) Seawater quality

The condition or quality of coastal water is important for ecological functioning of the organisms living in the habitat, for health and safety reasons and also for visual and aesthetic impacts. The water quality is generally determined by the level of nutrients. There are several sources that can lead to increased nutrients in coastal waters, e.g. sedimentation and terrestrial storm water runoff. Sediment stirrup can also lead to release of nutrients within the sediments especially when there is large scale excavation and dredging involved.

The most important nutrients of concern in coastal waters are nitrates and phosphates. In excessive quantities these can cause rapid growth of phytoplankton and result in algal blooms. Visual quality of the water is also important, a beach environment is much more attractive when the water is clean and one can see the sea bottom. However, even clear water may sometimes be

`

polluted. Dredging and excavation often carry heavy load of sediments increasing sediment load in the water column causing discoloration of the of the impact area for a prolonged period.

Seawater sampling locations are provided in Figure 4. W1 is located at the harbor area while W2 is at the reef area at same location as the reef survey site R1. A list of parameters tested and their values are given in Table 7.

Table 7 Seawater quality parameter tested and their results at the sampling locations at Ga Dhevadhoo. Data analysis was carried out by the National Health Laboratory, Maldives Food and Drug Authority and using portable water test probe Hanna Multi-probe water test kit

Parameters	W1	W2
Physical appearance	Clear	Clear
Ammonia (mg/l)	0.6	0.65
pH	8.3	8.2
Turbidity (NTU)	1	1
Nitrite (mg/l)	0.00	0.00
Nitrate (mg/l)	0.44	0.88
Phosphate (mg/l)	0.28	0.17
Dissolved oxygen (mg/l)	6.1	6.0
Faecal coliforms (counts/100ml)	0	0
Total coliforms (counts/100ml)	0	0

f) Hazard vulnerability, area vulnerable to flooding and storm surges

Hazard vulnerability of Ga Dhevadhoo is assessed based on available literature and field data collection. The report prepared by the UNDP on disaster risk assessment of Maldives states that the Ga Dhevadhoo region falls into high risk category in terms of tsunami risk (Figure 20). Ga Dhevadhoo falls in to category 1, which is the lowest risk scale given in the risk assessment.

`

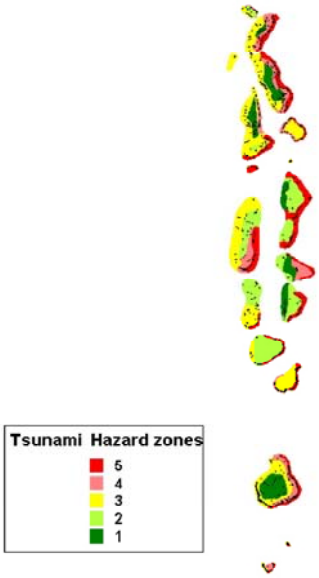


Figure 20 Tsunami hazard zones, category 5 is the highest risk zone while 1 is the lowest (figure derived from UNDP report on Disaster Risk Profile for Maldives November 2006)

Hazardous weather systems, other than general monsoons (heavy rain and strong winds) that affect Maldives are tropical storms (tropical cyclone) and severe local storms (thunderstorms/thunder squalls).Tropical cyclones are extreme weather events with positive and negative consequences. At times, these are very destructive due to associated strong winds (often exceeding 150 kmph), heavy rainfall (often exceeding 30 to 40 cm in 24 hours) and storm tides (often exceeding 4 to 5 meters). Strong winds can damage structures, houses, communication systems, roads, bridges and vegetation. Heavy rainfall can cause serious flooding. Storm surge is a sudden rise of sea level elevation along the coast caused by cyclonic winds. Sea level also rises twice daily due to astronomical reasons. The combined effect of surge and tide is knows as storm tide. Storm tides can cause catastrophes in low lying areas, flat coast and island territories such as Maldives.

The islands of Maldives are also affected by severe local storms (thunder storms/thunder squalls). Hazards associated with thunderstorms are strong winds (often exceeding 100kmph), heavy rainfall, lightning and hail. They give birth to tornadoes in some preferred regions (other than equatorial regions). In general thunderstorms are more frequent in equatorial regions compared to other areas (Figure 21). Land areas get more thunder storms compared to open ocean areas. However, thunderstorms close to the equator are less violent compared to those of other parts of tropics and extra-tropics. Maldives, being close to the equator, receive frequent thunderstorms but these are less violent. Strong winds generated by severe local storms consequently generate larger wind driven waves, which are hazardous to the islands of the Maldives.

`

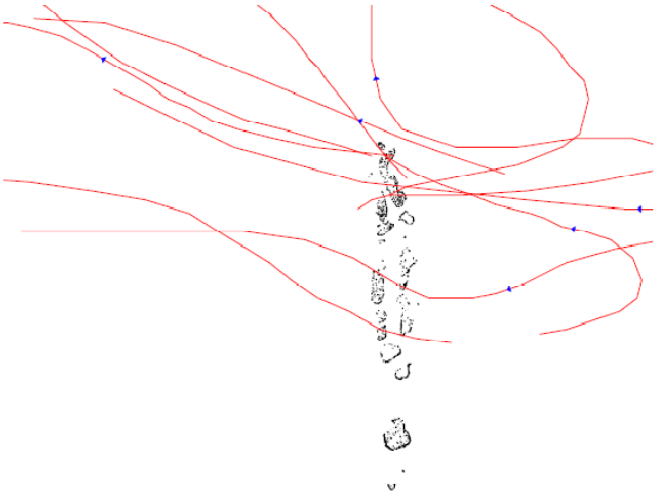


Figure 21 Track of severe storms affecting Maldives during 1877-2004

Ga Dhevadhoo falls into category 1, which is the lowest scale given in the risk assessment of cyclones or storms (see Figure 22). The major zones affecting are the mid and northern parts of the Maldives. During NE monsoon eastern side of the island receives transmitted swell waves coupled with wind waves.

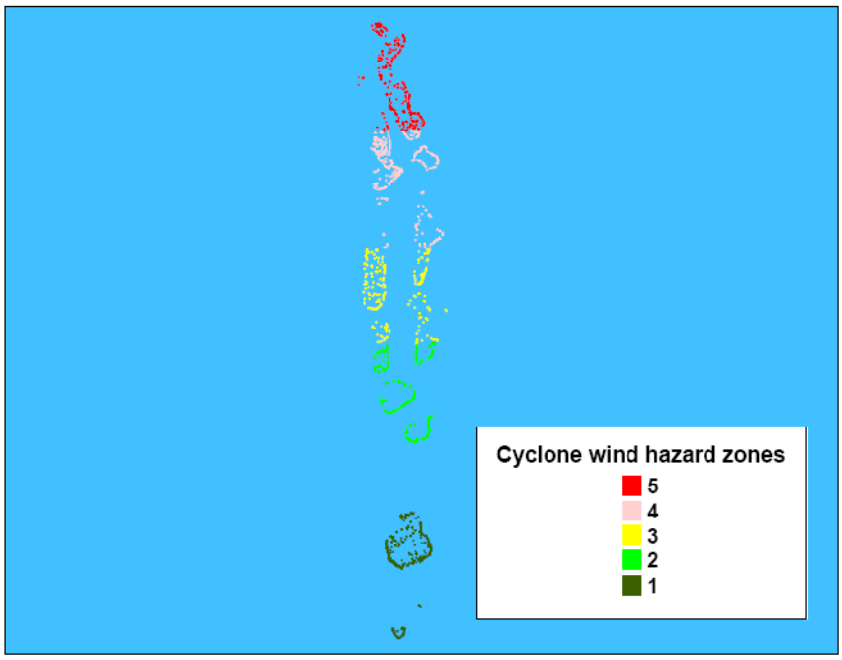


Figure 22 Cyclone Hazard Zoning (figure derived from UNDP report on Disaster Risk Profile for Maldives November 2006)

`

Bathymetry around Maldives shows that the ocean slope close to the east coast is steep compared to the same on the west coast. This led us to conclude that eastern islands of Maldives are vulnerable to higher surge hazard compared to western islands. Ga Dhevadhoo region falls into zone 1 (lowest risk zone) in the cyclone hazard zoning categories (Figure 23).

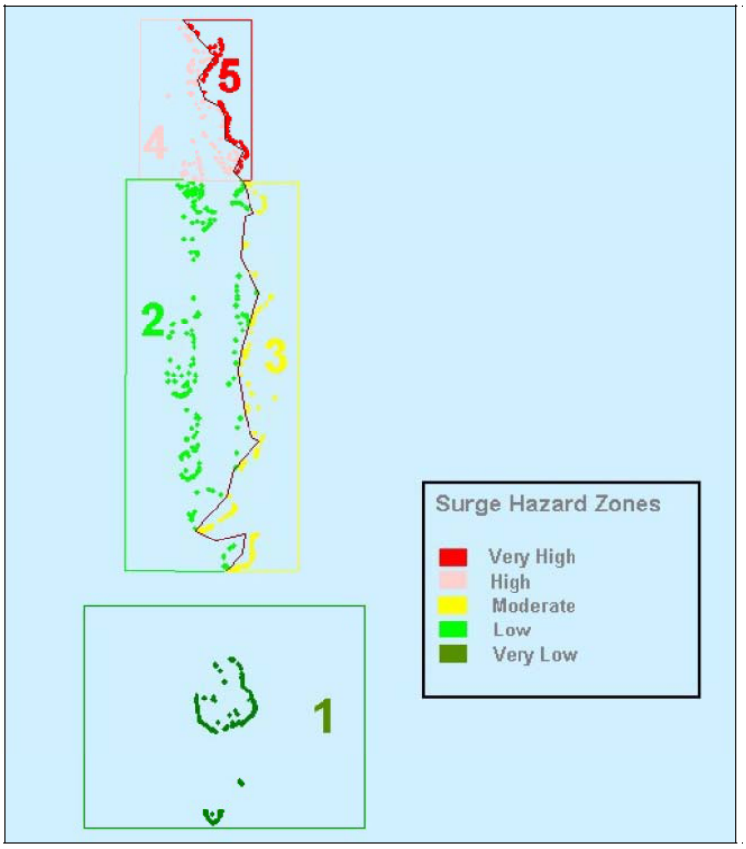


Figure 23 Surge Hazard Zones (figure derived from UNDP report on Disaster Risk Profile for Maldives November 2006)

g) Social Environment

Huvadhu atoll is the largest atoll in the Maldives chain of atolls, for administrative purposes the atoll is divided in to Gaafu alifu (Ga) and Gaafu dhaalu (Gdh) atoll. Ga atoll consists of more than 90 uninhabited islands and 10 inhabited islands. The capital island of Ga atoll is Villingili approximately 30km north east of Dhevadhoo. Dhevadhoo is approximately 28km east Kaadedhoo Airport. Nearest inhabited island is Ga Nilandhoo (24km at eastern side) and GDh Thinadhoo (26km at the western side of Dhevadhoo). In terms of geographic coordinates, it is located at 00° 33' 26" N and 73° 14' 32" E. Nearest islands are Hagadhoo approximately 4.5km south west and Funamudua approximately 5km west of Dhevadhoo. The population of Ga. Atoll is 12,413 (former Ministry of Atolls Administrations website), among them 6,037 are

`

women and 6,376 are men. Population of Ga Dhevadhoo is 1077 (source: Island Office fact sheet)

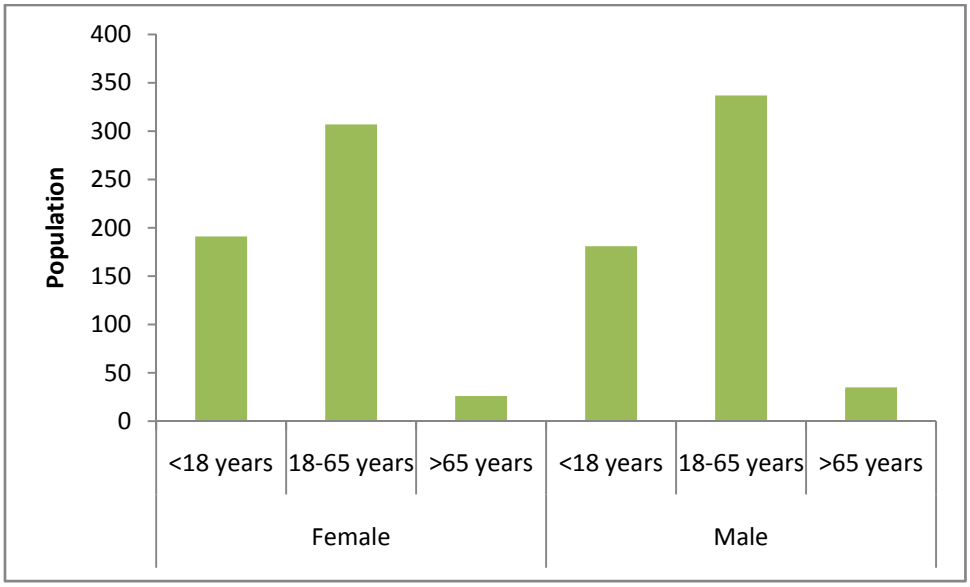


Figure 24 Population distribution of Ga Dhevadhoo (information derived from the island fact sheet, Ga Dhevadhoo Island Office)

The major economic activities of Ga Dhevadhoo are within the fisheries industry and boat building (MoAD, December 2007). Fishing is the main economic activity on the island with 6 mechanized fishing vessels of varying sizes registered to the island. In addition to this 5 other vessels are registered to the island. Two vessels are at present under construction (info: Island Office fact sheet)

No Major environmental issues are reported, except for issue of waste management.

h) Terrestrial Environment

The island vegetation of Ga Dhevadhoo is mostly dominated mature and young coconut palms. *Dhigga* (*Hibiscus tiliaceus*) is abundant throughout the island and *Hirundhu* (*Thespesia populnea*) and *Kaani* (*Cordia subcordata*) are occasional while *Nika* (*Fiscus benghalensis*) is rare on the island. The island of Ga Dhevadhoo has no swamp or wetland areas.

The entire harbor front area is reclaimed land and no natural vegetation is observed. The vegetation band near the harbor was planted after the harbor construction. During the proposed restoration project this band of vegetation will not be removed.

`

i) Built Environment

The harbor facility at Ga Dhevadhoo is located at the western side of the island, while the access to the harbor is via an entrance channel at the south western side of harbor.

i) Breakwaters

The existing breakwaters at the Ga Dhevadhoo harbor are badly damaged, with some areas totally destroyed (total length of breakwater 152m). The breakwaters are constructed with sand cement bags and coral rock. According to the IDC the breakwaters are routinely maintenaned during north east monsoon, therefore they are in relatively good condition. But during a SW rough period breakwater section constructed for protecting the entrance channel was entirely destroyed and submerged.

Figure 25 Breakwater at Ga Dhevadhoo harbor was constructed of sand cement bags. Breakwater sections are damaged at either side of entrance channel

ii) Quay walls

The quay wall at Dhevadhoo harbor is in relatively good condition compared to most harbors, although this may be the case some of the areas are subsided due sediment run off from under the structure. The quay wall is constructed with sand cement bags and concrete screed on top.

`

Observation of quay wall below the water line revealed that many bags missing and some areas caved in. This perhaps is due to sediment run off under the structure (due to turbulence created by propellers). Total length of quay wall inclusive of side quays is 330m.

Figure 26 Quay wall at Dhevadhoo is in relatively good condition on top side, primarily due to think concrete on top of sand cement structure

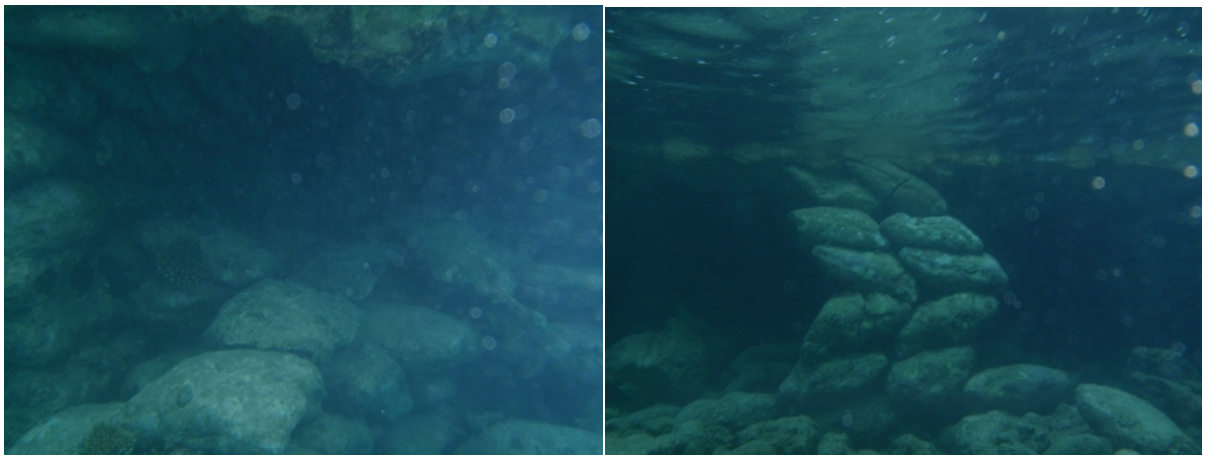


Figure 27 Near the northern corner of the harbor the sand cement bags were observed to be loose and detached, at some areas caved in.

`

Figure 28 Main quay wall, even though few cracks were observed structure appeared to be in good condition

iii) Harbor basin and entrance channel

Ga Dhevadhoo harbor basin is approximately 153m long and 93m wide. Both sides of the harbor is open (north and southern side), which facilitates maximum flushing. The basin is in relatively good condition due to this reason. The basin area near the breakwater is shallower than the design depth; this is due to sediment wash over during rough periods. The depth of basin near the breakwater is around 2.3 to 2.8m. Water flow is almost unidirectional at the harbor basin (north to south), which is probably the reason for good water quality of basin water. Entrance channel is also good condition with an average depth of -4MSL.

`

7. Environmental Impacts

Impacts on the environment from various activities of the restoration works have been identified through interviews with the Island Development Committee, field data collection and surveys and based on past experience in similar development projects. Possible impacts arising from the construction and operation works are categorized into reversible and permanent (irreversible) impacts. The impacts identified are also described according to their location, extent (magnitude) and characteristics. Reversible and irreversible impacts are further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken. Below are the impact categories (Table 8).

Table 8 Impact prediction categorized

Impact category	Description	Reversible/ irreversible	Cumulative impacts
Negligible	the impact has no significant risk to environment either short term or long term	Reversible	no
Minor	the impact is short term and cause very limited risk to the environment	Reversible	no
Moderate	Impacts give rise to some concern, may cause long term environmental problems but are likely short term and acceptable	Reversible	May or may not
Major-	impact is long term, large scale environmental risk	Reversible and Irreversible	Yes, mitigation measures has to be addressed

Since the project is a restoration project, additional impacts to the environment is thought to be limited, impacts envisaged is due to the maintenance dreading works limit (approximately 1500m^3 of material is expected to generated). The size of the harbor will remain relatively the same (apart from few adjustments), and built on existing footprint. No impact is envisaged on the terrestrial environment from the proposed project. The directly impacted area during the construction phase from dredging works is less than 1% of the total reef area of the reef system hosting Ga Dhevadhoo.

`

The severity of impacts is predicted by reviewing the design plans and construction methodologies and resources exposed to the impact. Mitigation measures are formulated in light of the information revealed by the project design engineers based on construction method of quay wall, excavation method and equipment or machinery used. Direct and indirect impact areas identified based on sediment plume based on dominant wind wave direction derived from wind data is given in Figure 1.

a) Limitation and uncertainty of impact prediction

Uncertainty of impact prediction are mainly due to the lack of long term data (shoreline, local currents and wave climate), Inherent complexity of ecosystem (reef environment, habitat and terrestrial environment although in a lesser extent) and lack of coordinated monitoring programs with inconsistent methodologies which can be used to predict outcomes or reliability of predictions of previous projects. It has to be noted that since the initial development of the harbor, monitoring of shoreline or reef habitat was carried out. Therefore changes to the shoreline can only be assessed using old aerials images.

It has to be noted that since the project is restoration project and construction done at existing footprint of the harbor, additional impacts are thought to minor.

b) Construction Impacts

Any development work involving excavation or dredging will have major impacts on reef and lagoon. The Impacts of excavation can range from smothering of live coral to kill of live coral. Potential direct or indirect impacts on the environment (on land and reef system) from the proposed works are limited to relatively small number of activities, these include:

- Maintenance dredging works at the harbor basin and entrance channel
- Impact of lagoon during construction of breakwaters

i) Schedule, logistics and loading and unloading construction materials

All construction materials will be transported to the site on cargo *dhonis* and barges and unloaded at the existing harbor basin. Material unloaded will be stored at the already bare area (harbor front). Initially heavy machinery will be brought to the island and once the maintenance dredging

`

component is completed, construction materials will be transported to the island. Impacts arising due to mobilization and unloading of materials include;

- Accidental spillage of construction materials (cement bags, rocks)
- Accidental oil spills (used for excavators and other heavy machinery)

Major concrete work will not be carried out at site, all "L" section concrete elements will be caste at Thilafushi or Hulhumale and transported to site. Armor stones will be brought to site once the harbor basin deepening works (maintenance dredging) are completed, armor stones will be temporarily stock piled on barges and moored at basin or stockpiled near harbor front area (exact methodology of work is not known yet since contractor is not assigned).

ii) Construction materials and solid waste

Transportation of construction materials such as cement, timber, plywood, sheet pile (concrete element), armor rocks and fuel for excavators and trucks to the site has the potential to aesthetically damage the marine environment especially the lagoon areas due to accidental spillage. Quite often construction waste finds their way into the marine environment during the course of their disposal unless necessary measures are taken to avoid this from happening.

Pollution of the lagoon and reef system can be caused by waterborne and windblown debris escaping from the construction site or from transportation vessels such as landing crafts and barges. Waste and residue arising from construction activities such as oil spills and other waste (used wooden moulds) may affect the marine environment. It has to be noted that since the existing basin is to be used for material unloading, any debris blown away or spilled will be contained inside the basin.

All solid waste generated during the construction stage will be sorted and disposed accordingly. All materials that can be burnt (packing material, timber, paper) will be disposed at Ga Dhevadhoo waste disposal sites. The materials that are categorized as hazardous waste such as used oil filters and luboil should be transported to government designated disposal site (Thilafushi).

iii) Impacts due to construction methods

Since excavators will be used for the maintenance dredging works, sedimentation is inevitable and this is an impact that will be unavoidable. But it has to be noted that the presence of breakwaters will limit the dispersal of sediments. Also it has to be noted that very little maintenance dredging will be required (only 1500m^3 of dredged spoil estimated).

`

Live coral at harbor front area is dominated by tabulate and branching forms of acroporids, while the back reef area is observed with numerous small colonies of table corals. Laminar forms are more prone to sedimentation impacts then encrusting or massive forms.

Fine sediments with rapid rate of deposition are detrimental to certain corals especially the tabulate forms of corals. Such sediments blocks the coral polyps from feeding and the lack of nutrition and other physiological stress such as respiration eventually starves and suffocated the corals leading to death. Finely deposited sediments are often difficult to get rid of even with strong currents.

Major environmental concerns associated with dredging and reclamation works are direct habitat loss, sedimentation and deterioration in water quality. High levels of sedimentation and silt from dredging activities is a major source of reef degradation. The consequences of excessive sedimentation on corals are well known and include:

- direct physical impacts like smothering of corals and other benthic reef organisms,
- reduces light penetration, which has a direct effect on zooxanthellae photosynthesis and thus the net productivity of corals. It also reduces coral growth, calcification rates and reproduction.
- dredged silt may form false bottoms, characterized by shifting unstable sediments
- silt suspension may increase nutrient release, leading to eutrophic blooms
- silt may act as sink or trap for many pollutants, which are absorbed onto the sediments

iv) Impact on vegetation

No impact on vegetation is envisaged due to the proposed project.

.

v) Coastal structures

Since the harbor protection structures and quay walls will be constructed at existing footprint, no additional impact to coastline is envisaged. It has to be noted that near harbor area, erosion is observed on either side of the harbor.

`

vi) Social impacts, noise and air pollution

Operation of heavy machinery and construction related equipment will contribute to noise pollution. Noise pollution during the dredging works will be mainly due to the operation of excavator and trucks. Construction noise at Ga Dhevadhoo will be dictated by the predominant wind direction (NE during NE monsoon and W to SW during SW monsoon). As the maintenance dredging works will be finished first, estimated time of completion within two months, this falls on early October 2010 (SW monsoon-NE transition). Therefore wind direction will be from western qaudrant. The infrastructures near harbor area are mostly commercial plots. Therefore these areas will be affected by noise pollution. Noise pollution is unavoidable. Dredging will be carried out during low tide; therefore noise level will not be sustained throughout the day. But it has to be noted that dredging has to be carried out during the night hours too (during low tide).

Restoration of harbor facility at Ga Dhevadhoo will have positive impacts in terms of easy and safe accessibility and wellbeing of community. At present due to damaged breakwaters at entrance area, during rough periods accessing the harbor basin is very difficult. Due to this reason the basin is also turbid. Also the subsided quay wall areas are a safety issue; therefore restoration of the harbor will ease the loading and unloading process of materials and goods. Also it has to be noted that the functional design of the harbor with usage zones will ease some of the problems experienced in existing harbor facilities such as unorganized mooring, unloading materials all over the area and difficulties of maneuvering vessel due to anchor ropes. The new design comprises of mooring rings and buoys which would reduce excessive anchor rope usage.

vii)Effects on Groundwater Quality

No impact is envisaged on ground water due to the proposed project.

c) Operational Impacts

Since the project is a restoration project, negative impacts in terms of operation impacts are not envisaged. Although this may be the case, positive impacts are envisaged

At present the island community and trade vessels from other islands face lots of difficulties in regard to harbor usage due to the bad condition of quay walls and entrance channel issue. During rough weather (especially during SW monsoon) the entrance area gets very rough and waves are transmitted inside the basin. The breakwater section extended towards at the southern side will reduce ease these issues and make the basin calm. Restoration of harbor will ensure safe harbor for vessels operated by the island community and trade vessels from other islands.

`

8. Mitigation Plan

There are a number of actions that can be taken to minimize the identified impacts. Those that are explored below emerged out of the discussions and consultations during this EIA and from the past experience of the consultant (Table 9). Mitigation measures are selected to reduce or eliminate the severity of any predicted adverse environmental effects and improve the overall environmental performance and acceptability of the project.

Mitigation measures are discussed for the construction and operational stage of the project. During the construction stage it is important to take measures to minimize sedimentation impacts on the reef environment. A construction method that has the least impact on terrestrial or marine environment has to be utilized.

`

Table 9 Mitigation measures proposed for the harbor restoration works at Ga Dhevadhoo

Possible Impacts	Mitigation measures	Location	Time frame (Phase)	Impact intensity	Institutional responsibility	Cost (MRF)
Littering on terrestrial and marine environment	Littering, accidental disposal and spillage of any construction wastes should be avoided by pre-planning ways of their transportation and disposal. Careful planning of the work activities can also reduce the amount of waste generated.	Reef flat, lagoon and land	During construction (12 months)	Minor, short term impact	MHTE/ contractor	N/A
	During construction of protection walls and break waters, all construction related waste collected stored at project site, and later disposed at atoll waste management site or at Thilafushi	Lagoon, reef flat	During construction (12 months)	Minor	MHTE/ contractor	N/A should be included in the project cost
Damage to reef by loading and unloading works	Awareness raising of project managers on environmentally friendly practices to minimize negative impacts. Conduct consultation meetings by Island Officials advising environmentally sound workmanship	Reef flat and reef slope lagoon	During construction (3 month, assumed timeline since contractor is not assigned detail work schedule is not available)	Minor, short term impact	MHTE/ contractor	N/A
	Careful planning to reduce time of the unloading process (not to time unloading during Fridays, when usually harbor is crowded).	Social	During construction (1 month)	Minor	MHTE/ contractor	N/A

`

Sedimentation and siltation on the reef and lagoon due to excavation works	Aligning the rubble of existing breakwater to form a temporary bund. The initial plan is to reuse these as core; therefore usage of these damaged sections will not have additional cost burdens.	Reef flat reef slope lagoon	During construction (2 months)	Major, short to midterm impact	Contractor, MHTE	N/A no additional cost
	Dredging works of the harbor basin and entrance will be carried out during the low tide (which would reduce the amount of fines released into the water column). Complete dredging works within the shortest time period as possible (reduce sustained sedimentation)	Reef flat and lagoon areas	During construction phase (2 months)	Moderate, short term.	Contractor, MHTE	N/A may increase the duration of the project, in turn increase cost of machinery
Loss of habitat, damage or death of coral at the entrance area, harbor protection walls	Avoid excavation works beyond the boundary of entrance, set out stakes marking the area for deepening at the entrance area	Reef flat, lagoon	During construction phase (12 months)	Minor to moderate, short termed. Since sediment plume will be directed towards the deep lagoon impact will be minor	Contractor, MHTE	N / A
	Construction of breakwaters done by excavators or cranes loaded on barge and construction work to be done inside basin					
	Completing the excavation works within the shortest time frame as possible	Air	Construction phase (12 months)	Minor/short termed	MHTE/contractor	N/A
Noise pollution	Completing the excavation and construction works as soon as possible, avoid work at night whenever possible	land	Construction phase (12 months)	Minor/short term	MHTE/contractor	N/A (may increase the cost of heavy machinery operation due to limit of operation time (timing the low tide window)

`

9. Alternatives

Since the project is a restoration project, location and size of basin and entrance channel will not change. Therefore alternatives are given for breakwater types, quay wall, and design.

a) Breakwater types

The existing breakwaters are constructed of sand cement bags and coral rock, the area near entrance was damaged during the tsunami event. The proposed breakwaters are rock breakwaters. Alternatives can be Gabion breakwaters. Considering both options in terms of environmental impacts no significant change is envisaged. It has to be noted that rock debris and sediment generated during the maintenance dredging works will be used as core (geo-textile filled with sediment).

b) Quay wall

The proposed type of quay wall is L section concrete elements. The elements will be placed adjacent to the existing quay wall since remove and demolition of breakwaters will be costly and disposal will have negative environmental impacts. The space between the existing quay wall and proposed quay wall will be filled with geo-textile bags (filled with sediment from maintenance dredging works). Alternative type of quay is geo-textile bag quay wall (as proposed for the side quays) and sheet piles.

Considering the options, all three methods are viable, but sheet pile type will require specialized machinery and vibrations caused by driving the piles may have negative impacts. Therefore a proposed quay wall types seems appropriate.

c) Design

The new design of the harbor is formulated by MHTE as functional harbor design (fishery harbor), where zones are demarcated for different usages of the harbor facility. Alternative is the existing harbor design, where zones are not demarcated. Considering the alternatives the old harbor design seems inappropriate due to many reasons. For example vessel mooring, loading/unloading and passenger areas are not demarcated, which creates problems like dust impacts or safety issues. Also due to unmanaged mooring practices vessels coming in for unloading or loading materials faces difficulty in accessing the quay wall. Whereas, the new design zones all uses to different areas of the

`

harbor thereby allowing organized usage of the harbor. In many harbors fish landing is done at almost all of the areas, this creates hygienic problems. It is important that support facilities needs to come along with the harbor, otherwise even if it is demarcated same issues as before would arise. For example if fish market, passenger terminal, fuel recharge facilities are not developed or constructed proper usage of the harbor cannot be achieved.

d) The no project scenario

If considering the no project scenario, the significant environmental impacts due to sedimentation and suspension of fine silt in the water column can be avoided. Since the sediment plume will reach western, southern and northern side of the reef (maintenance dredging at basin and entrance area), indirect impacts are possible. Indirect impacts include degradation of water quality, damage to live coral and slower rate of coral growth. But it has to be noted that only minor dredging works will be carried out therefore impacts are envisaged to be minor.

Considering socio-economic impacts due to no development is moderate to major, at present the community faces lots of difficulties due to entrance issue, damaged quay walls and safety issues (subsided quay wall). The island has been earmarked for harbor restoration for many years now; therefore no project scenario may have serious social implications. Also it has to be noted that Ga Dhevadhoo harbor is not only used by the island community but also used as a transit harbor by many trade vessel from other atolls. Therefore considering the overwhelming social impacts, "no project scenario" is not a feasible option.

`

10. Monitoring and Reporting

Monitoring is the systematic collection of information over a long period of time. It involves the measuring and recording of environmental variables associated with the development impacts. Monitoring is needed to;

- Compare predicted and actual impacts
- Test the efficiency of mitigation measures
- Obtain information about responses of receptors to impacts
- Enforce conditions and standards associated with approvals
- Prevent environmental problems resulting from inaccurate predictions
- Minimize errors in future assessments and impact predictions
- Make future assessments more efficient
- Provide ongoing management information
- Improve EIA and monitoring process

Impact and mitigation monitoring is carried out to compare predicted and actual impacts occurring from project activities to determine the efficiency of the mitigation measures. This type of monitoring is targeted at assessing human impacts on the natural environment. Impact monitoring is supported by an expectation that at some level anthropogenic impacts become unacceptable and action will be taken to either prevent further impacts or re-mediate affected systems. Mitigation monitoring aims to compare and predicted actual (residual) impacts so that effectiveness of mitigation measures can be determine.

The environmental monitoring proposed here is to determine the effectiveness of the mitigation measures and long term change to the benthic community (especially coral community) shoreline. The reef survey and beach profile sites established during the field surveys for EIA report preparation will be used for the monitoring program. All monitoring activities will be carried out under the supervision of an environmental monitoring and management consultant. The detail of the monitoring program is given in Table 10.

`

Table 10 monitoring program and cost for individual parameter

Parameter	Methodology	Sampling frequency	Estimated cost for monitoring
Coral and other benthic cover	Qualitative assessment ; snorkelling surveys assessing percentage of live coral	During construction works and after six month	Rate per field survey USD 100.00
Seawater quality	Water samples sent to Food and drug authority for analysis. Following parameters are to be tested; salinity, pH, turbidity, suspended solids, dissolved oxygen, Nitrite, Nitrate, Phosphate	Twice(during and after completion of project)	Rate per test set USD 100.00
Shoreline monitoring	Shoreline mapping by using high precision GPS (beach line, vegetation line to identify possible erosion problems)	During construction phase, every three months after completion and after 1 year	Rate per field survey USD 1000.00
	Beach profiles at established base line locations		

`

11. Conclusions

The long term environmental impacts associated with the proposed project are considered minor. This conclusion is based on the evaluation and various components of the proposed project, implementation methods discussed, finding of the existing environment and environmental components that are likely to be affected. The proposed project at Ga Dhevadhoo is a restoration project therefore magnitude and severity of impacts on reef and coastal habitats is minor. The new breakwaters and quay walls will be placed near or at existing footprint of the harbor, therefore additional lagoon and reef habitats will not have direct physical impacts. The main components of work that will have environmental impacts are maintenance dredging (very limited dredging which expected to generate only 1500m^3 of material).

During the meetings with IDC, harbor committee and island officials, all members of the meeting were in consent to the development, but stressed the need for harbor expansion due to overcrowding and increase of vessel sizes. Since the project is funded by a loan and is a restoration project, scope of design is limited to the harbor footprint. Although this may be the case socio economic justification for the project is the strongest, since the island desperately needs a good functioning harbor. The new design or functional design of the harbor is based on MHTE's new third generation fishery harbor concept. The new design assigns zones of harbor for various uses, which is very much needed. The various zones of harbor were agreed by IDC, harbor committee and island office personnel during the meetings held at the island.

The impacts identified in the report (water quality impacts and impacts of reef) can be minimized with the mitigation measures and environmental monitoring and this would ensure that unfavorable outcome of the design and modification to the harbor are identified early on so that appropriated remedial actions can be taken. The beach at Dhevadhoo is in relatively good condition even with the harbor structure. Erosion is only observed at areas where dredged material was disposed during initial harbor development (harbor sides). Since the proposed project involves construction at the existing footprint additional impacts are not envisaged, though this may be the case shoreline and beach monitoring is essential in identification of short and long term changes to the shoreline.

In conclusion, with due consideration environmental components the project is likely to effect the consultant concludes that the project components and designs are feasible and appropriate mitigation measures are given to correct and minimize unfavorable environmental consequences. Furthermore the public and community consultation responses were in favor of the project due to the socio-economic benefits

`

Appendices

`

Appendix 1 Terms of Reference (TOR)

Environmental Protection Agency
Male', Republic of Maldives

Terms of Reference for Environmental Impact Assessment

The following is the TOR based on the points discussed in the scoping meeting held on 31st March 2010 for undertaking the EIA of the proposed **Harbour re-construction works at Dhehvadhoo, Ga. Atoll, Maldives.**

1. Introduction - Identify the project to be assessed in the context of the executing arrangements for the environmental assessment. Description the rationale for the proposed development and its objectives

2. Study Area - Specify the boundaries of the study area for the assessment as well as any adjacent areas in the context of project site and residual areas that may have any impact from the project activities..

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

Task 1. Description of the Proposed Project - Provide a full description of the relevant parts of the project, using maps at appropriate scales where necessary. This is to include: size of the harbour, length of the quay wall, length of the breakwaters, proposed depth of the harbour basin. If the harbour basin depth or the size of the harbour is significantly changed, description of the excavation method, means and locations proposed for the disposal of excavated materials shall be described.

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

Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study areas, including the following:

a) Physical environment: geomorphology, meteorology (rainfall, wind, waves and tides), currents. Existing shoreline map including the location of the harbour basin, harbour area elevation with respect to the island, beach profiles (at least 4) in the vicinity of the harbour shall be provided. Bathymetry of the harbour basin and vicinity of the harbour shall be provided reflecting the existing and required depth of the harbour. Water quality of the harbour basin shall also be provided indicating general chemistry and bacterial characteristics.

b) Biological environment: Description of the marine environment in the vicinity of the harbour including lagoon, sea grass and reef areas where appropriate.

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

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

Characterize the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts.

All survey locations shall be referenced with Geographic Positioning System (GPS). All water samples shall be taken at a depth of 1m from mean sea level or mid water depth for shallow areas. The report should outline the detailed methodology of data collection utilized to describe the existing environment.

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

Task 3. Project Setting - Describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project.

Task 4. Determine the Potential Impacts of the Proposed Project-"Identify impacts related to the work in relation to their size, scale and duration. Distinguish between significant impacts that are positive and negative, direct and indirect (triggering), and short and long term. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making.

Task 5. Analysis of Alternatives to the Proposed Project- Describe the alternatives examined for the proposed project that would achieve the same objective including the no action alternative.

Task 6. Mitigation and Management of Negative Impacts- Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to dredge spoil disposal and dispersal/sedimentation control. Cost the mitigation measures, equipment and resources required to implement those measures.

Task 7- Stakeholder Consultation - Identify appropriate linkages and setups associated with the harbour reconstruction works. Identify the views of local stakeholders and affected groups with regard to harbour and associated components.

Task 8- Development of a Monitoring Plan- Identify areas and issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for dredging/disposal operations.

Presentation - The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and

citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2007.

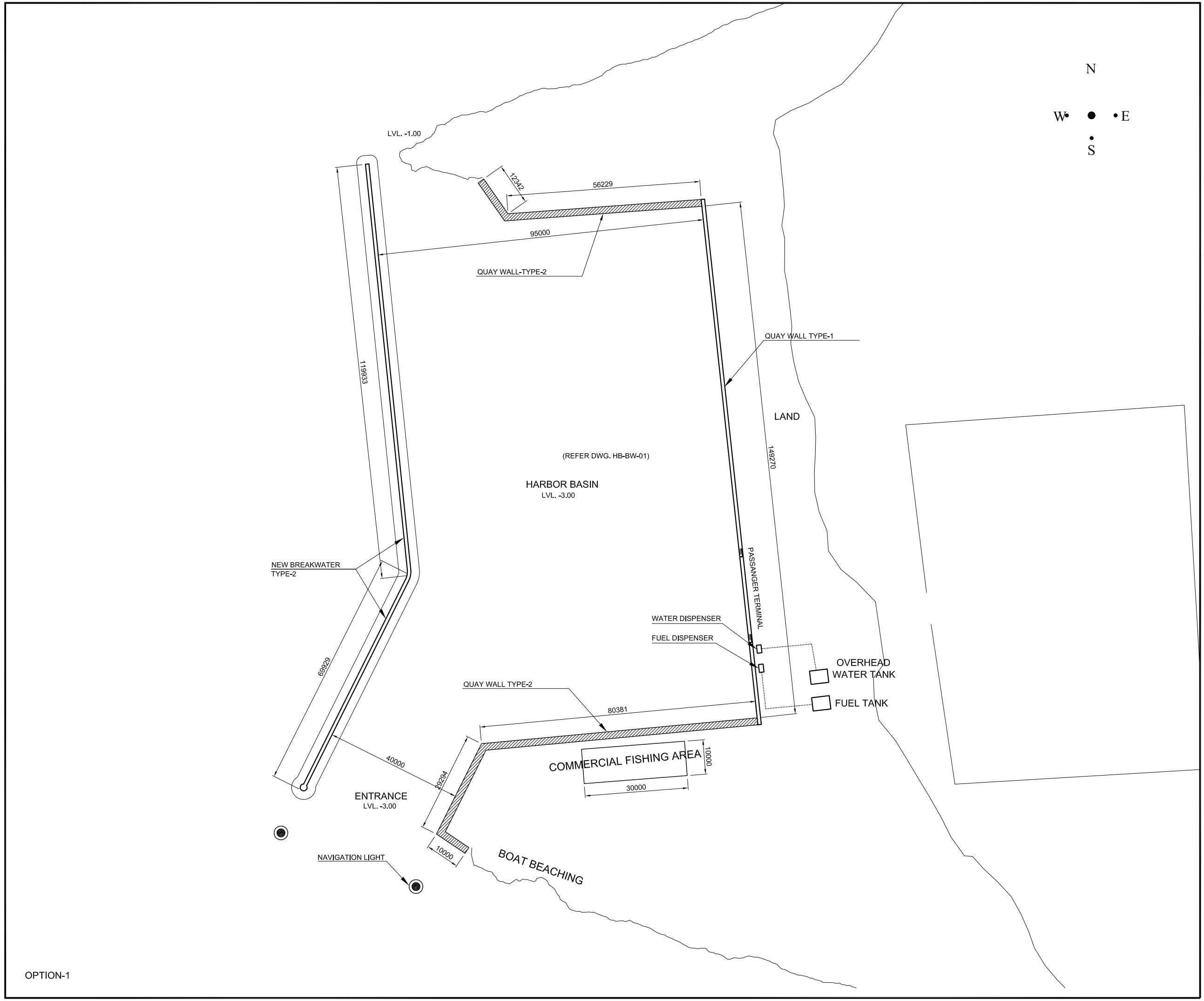
<u>Timeframe for submitting the EIA report</u> - The developer must submit the completed EIA report within 6 months from the date of this Term of Reference.

.....

6 April 2010

`

Appendix 2 Site Plan



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETER AND LEVELS ARE IN METERS, UNLESS OTHERWISE SHOWN.

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPRD.
..	..	..	..	..	..
-	..	..	..	..	..
-	-	-	-	-	-
-	-	-	-	-	-
A	04.02.'10	CONCEPT DESIGN SUBMITTAL	JP	SS	MA

REVISION

CLIENT

MINISTRY OF HOUSING, TRANSPORT AND ENVIRONMENT

REPUBLIC OF MALDIVES

CONSULTANT:

Al-Habshi Consultants Office

Tel.: 2430103 / 2433131 - Fax : 2431136

P.O.Box 27154 Safat 13132 - Kuwait

ASSOCIATES:

riyan Pte. Ltd.

3rd floor, h. coleezlum, ameenee magu

male' 20054, maldives.

PROJECT:

RECONSTRUCTION OF HARBORS FOR TSUNAMI VICTIMS PROJECT

DRAWING TITTLE:

GA.DHEVVADHOO ISLAND HARBOR DESIGN

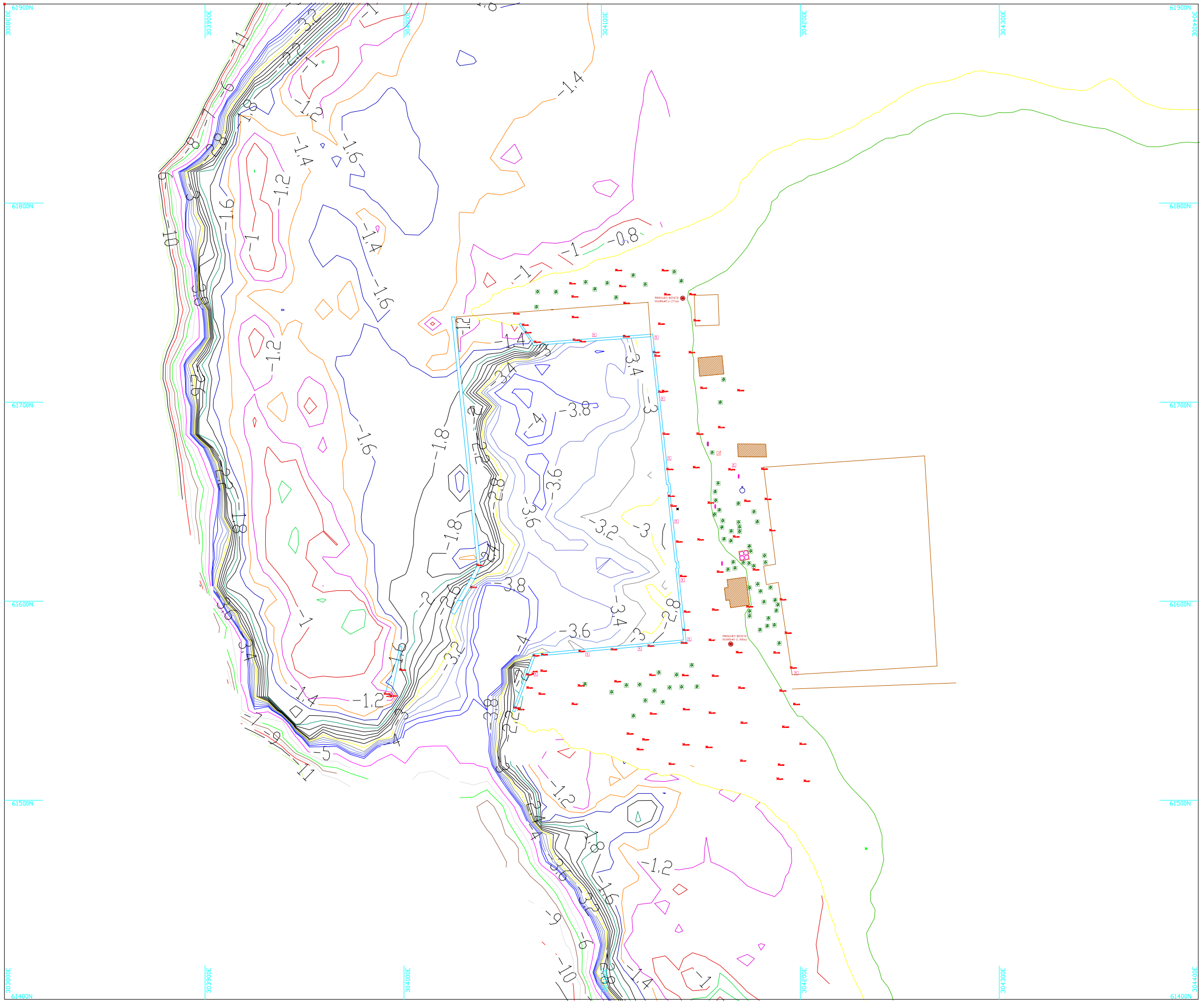
DESIGNED	DRAWN	CHECKED	APPROVED	SCALE	DATE
SS	JP	SS	MA	1 : 1000	04-02-10

PROJECT	SHEET	DRAWING
K505	1 OF 1	GAD-HB-02
REV	A	

`

Appendix 3 Bathymetry and shoreline map

BATHYMETRIC MAP OF GDH_DEHVADHOO HARBOUR AREA

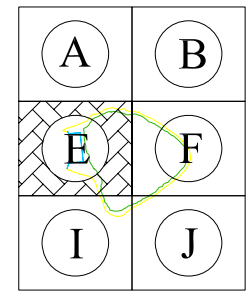


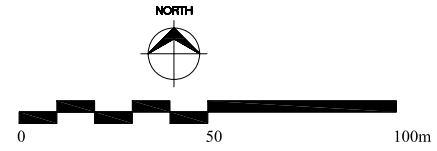
Map Legend :

- Benchmark
  PBM-1 = +1.368m(304165.0100E,61578.4900N)
  PBM-2 = +1.271m(304140.8850E,61752.1890N)
- Beach line (Toe of Beach)
- Edge of Vegetation
- Trees
- Plot and Buillding
- Distribution box
- Light Post
- +0.000 Habour Level Text
- - 4.00m Contour
- - 3.00m Contour
- - 2.00m Contour
- - 1.00m Contour

Contour Interval = 0.20m

Map index





Geodetic Parameter :

Zone : UTM Zone 43
Spheroid : WGS 1984
Vertical Datum : Mean Sea Level

Note: Dhivehi National Grid is derived from UTM Zone 43.
Local Grid has a false origin where the Northing has been shifted 100Km to South.

PROJECT: THE MALDIVES TSUNAMI RECONSTRUCTION PROJECT			
TITLE: BATHYMETRIC & TOPOGRAPHIC SURVEY - HABOUR, GDH_DEHVADHOO			
CLIENT: GOVERNMENT OF MALDIVES			
SURVEYED BY : MOHAMED AMEEQ	DRAWN BY : USMAN MOHAMED	DATE :	DWG No
SCALE : 1:1000	CHECKED : ISMAIL AABIDH	JANUARY 2009	02/02
IF IN DOUBT - ASK - DO NOT SCALE			

riyan Pte Ltd
3rd FLOOR, HUSNUFEIZUM, AMEENEE MAGU
MALE' 20-05, REPUBLIC OF MALDIVES
TEL: 3315685 FAX: 3315870, e-mail: info@riyan.com.mv

ALHABSHI

Surveyed on JANUARY 2009

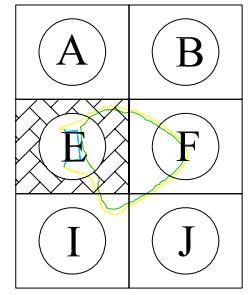
BATHYMETRIC MAP OF GDH_DEHVADHOO HARBOUR AREA

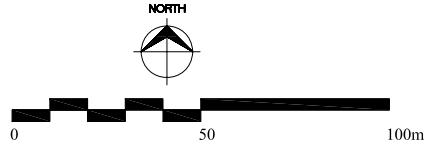
Map Legend :

- Benchmark
  PBM-1 = +1.368m(304165.0100E,61578.4900N)
  PBM-2 = +1.271m(304140.8850E,61752.1890N)
- Beach line (Toe of Beach)
- Edge of Vegetation
- Trees
- Plot and Buillding
- Distribution box
- Light Post
- +0.000 Habour Level Text
- - 4.00m Contour
- - 3.00m Contour
- - 2.00m Contour
- - 1.00m Contour

Contour Interval = 0.20m

Map index





Geodetic Parameter :

Zone : UTM Zone 43
Spheroid : WGS 1984
Vertical Datum : Mean Sea Level

Note: Dhivehi National Grid is derived from UTM Zone 43.
Local Grid has a false origin where the Northing has been shifted 100Km to South.

PROJECT: THE MALDIVES TSUNAMI RECONSTRUCTION PROJECT			
TITLE : BATHYMETRIC & TOPOGRAPHIC SURVEY - HABOUR, GDH_DEHVADHOO			
CLIENT : GOVERNMENT OF MALDIVES			
SURVEYED BY : MOHAMED AMEEQ	DRAWN BY : USMAN MOHAMED	DATE :	DWG No.
SCALE : 1:1000	CHECKED : ISMAIL AABIDH	JANUARY 2009	02/02
IF IN DOUBT - ASK - DO NOT SCALE			

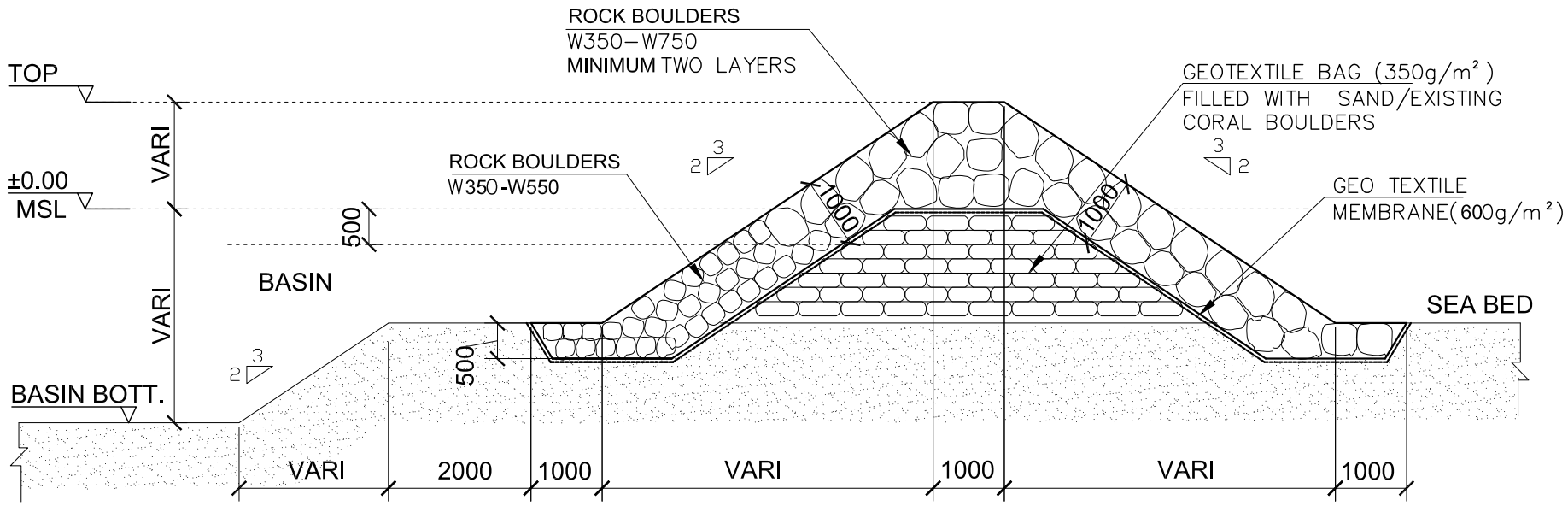
riyan Pte Ltd
3rd FLOOR, HUSNEEZIUM, AMEENEE MAGU
MALE' 20-09, REPUBLIC OF MALDIVES
TEL: 3315040 FAX: 3315076 e-mail: info@riyan.com.mv

ALHABSHI

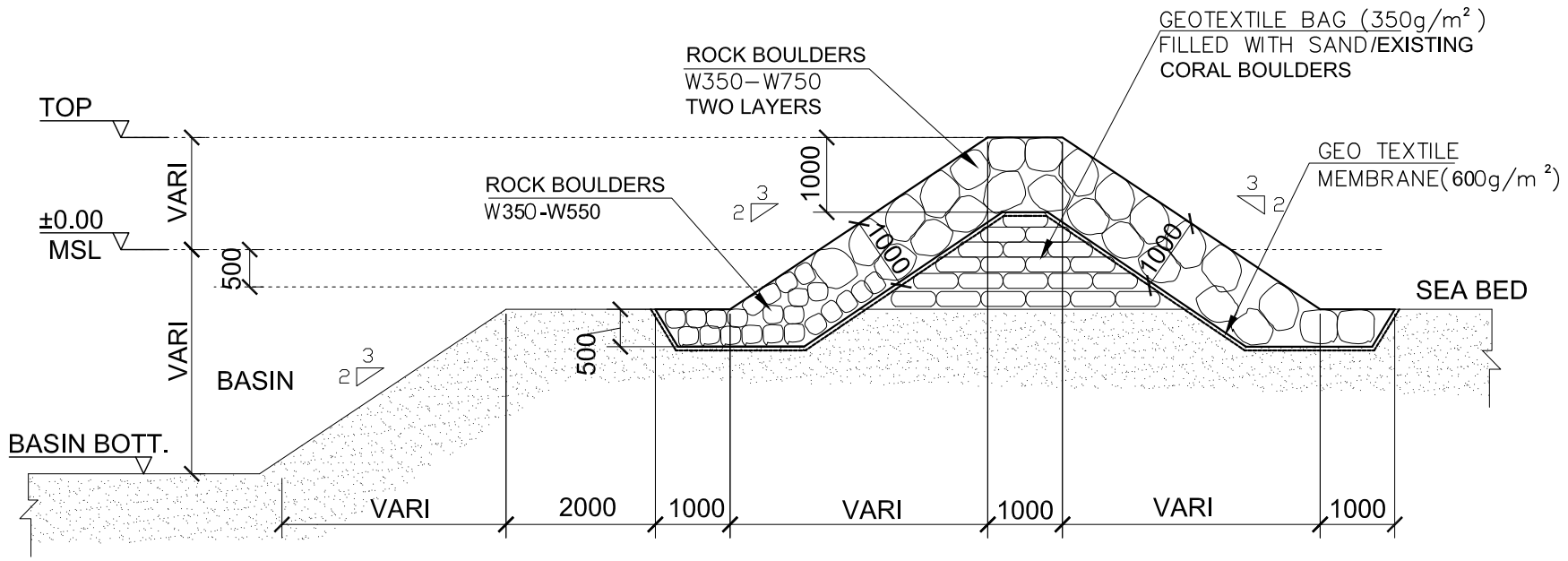
Surveyed on JANUARY 2009

`

Appendix 4 Breakwater and Quay Wall Design Details



BREAKWATER SECTION TYPE-1



BREAKWATER SECTION TYPE-2

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETER AND LEVELS ARE IN METERS, UNLESS OTHERWISE SHOWN.

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPRD.
..	..	..	..	..	..
..	..	..	..	..	..
-	-	-	-	-	-
-	-	-	-	-	-
A	03-02-'10	CONCEPT DESIGN SUBMITTAL	JP	SS	MA

REVISION

CLIENT

MINISTRY OF HOUSING, TRANSPORT AND ENVIRONMENT
REPUBLIC OF MALDIVES

CONSULTANT:

Al-Habshi Consultants Office
Tel.: 2430103 / 2433131 - Fax : 2431136
P.O.Box 27154 Safat 13132 - Kuwait

ASSOCIATES:

riyan Pte. Ltd.
3rd floor, h. coleezlum, ameenee magu
male' 20054, maldives.

PROJECT:

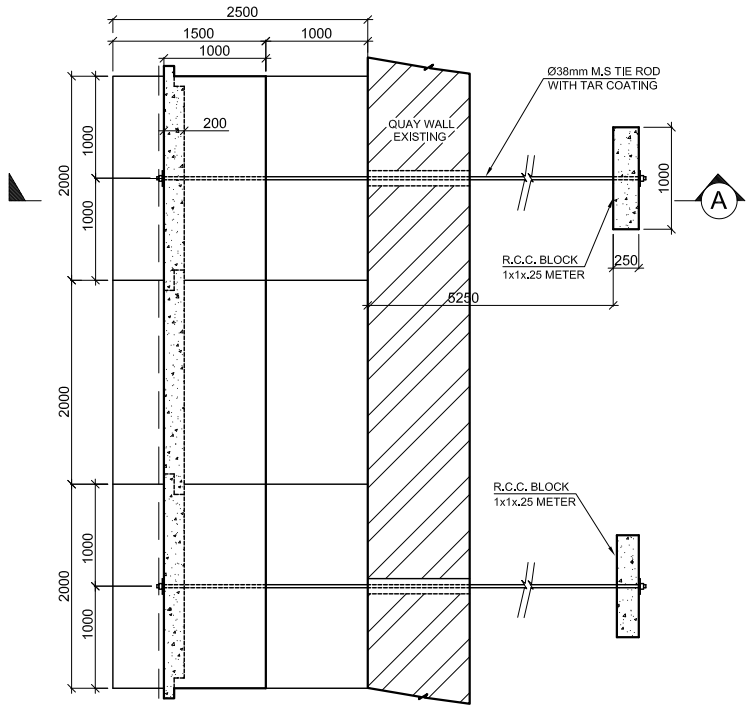
RECONSTRUCTION OF HARBORS FOR TSUNAMI VICTIMS PROJECT

DRAWING TITTLE:

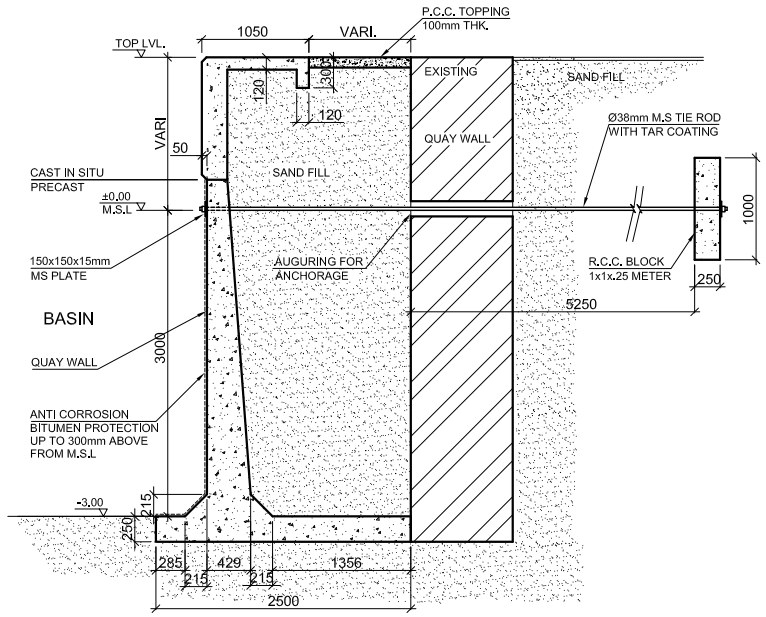
TYPICAL BREAK WATER DETAILS

DESIGNED	DRAWN	CHECKED	APPROVED	SCALE	DATE
SS	JP	SS	MA	1 : 100	03-02-10

PROJECT	SHEET	DRAWING
K505	1 OF 1	HB-BW-01
REV	A	



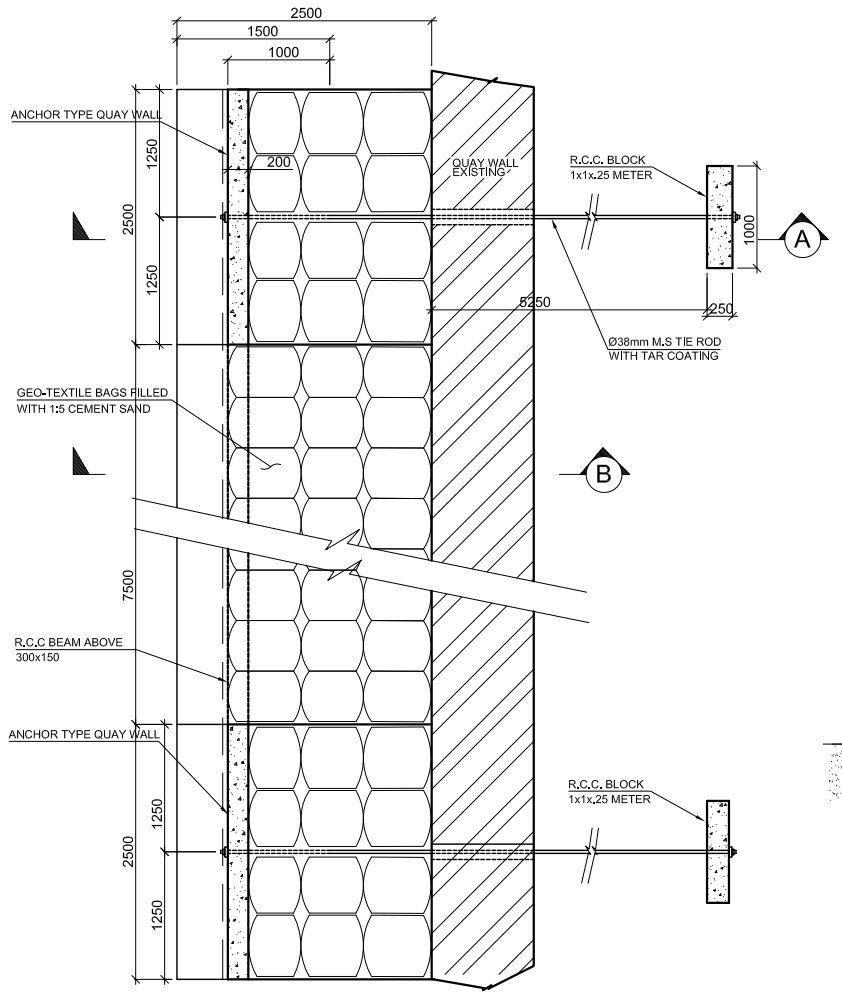
PLAN



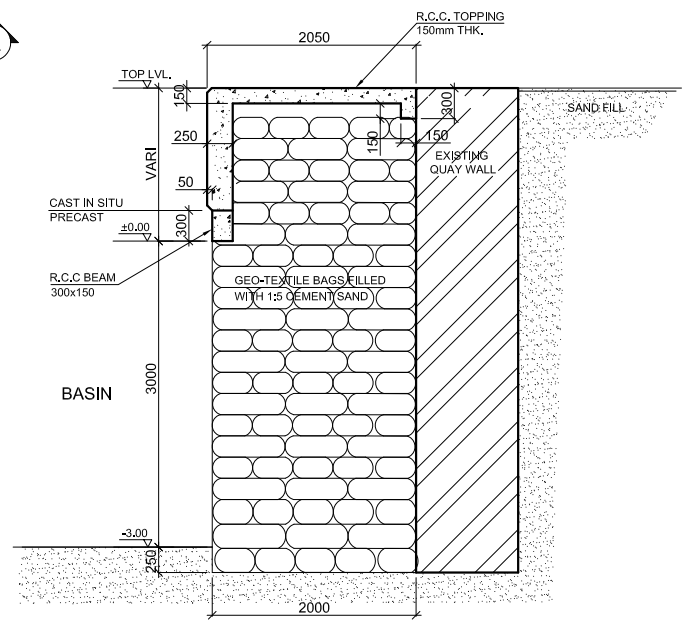
SECTION -X

DETAILS OF QUAY WALL-TYPE-1

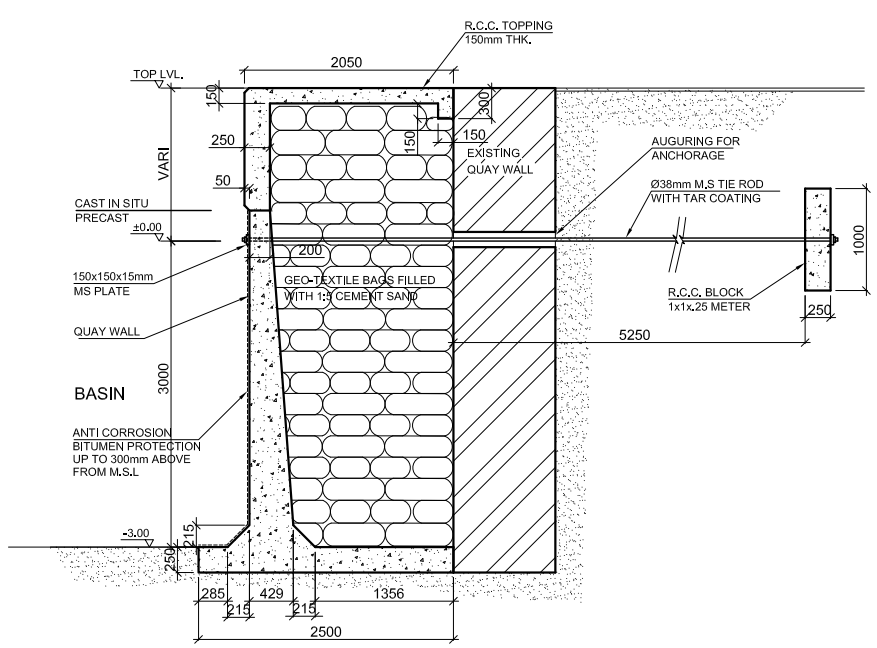
SCALE 1 : 50



PLAN



SECTION -B



SECTION -A

DETAILS OF QUAY WALL-TYPE-2

SCALE 1 : 50

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETER AND LEVELS ARE IN METERS, UNLESS OTHERWISE SHOWN.

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPRD.
..	..	..	..	..	..
..	..	..	..	..	..
-	-	-	-	-	-
-	-	-	-	-	-
A	03-02-'10	CONCEPT DESIGN SUBMITTAL	JP	SS	MA

REVISION

CLIENT

MINISTRY OF HOUSING, TRANSPORT AND ENVIRONMENT

REPUBLIC OF MALDIVES

CONSULTANT:

Al-Habshi Consultants Office

Tel.: 24301103 / 24331311 - Fax : 24311136

P.O.Box 27154 Safat 13132 - Kuwait

ASSOCIATES:

Pte. Ltd.

3rd floor, h. coleezlum, ameenee magu male' 20054, maldives.

PROJECT:

RECONSTRUCTION OF HARBORS FOR TSUNAMI VICTIMS PROJECT

DRAWING TITTLE:

TYPICAL QUAY WALL DETAILS

DESIGNED	DRAWN	CHECKED	APPROVED	SCALE	DATE
SS	JP	SS	MA	1 : 100	03-02-10

PROJECT	SHEET	DRAWING
K505	1 OF 1	HB-QW-01
REV	A	

`

Appendix 5 List of people met and minutes of meeting

ހުވަދު އަތޮޅު އުތުރުބުރީ ދެއްވަދޫ އޮފީސް

ދެއްވަދޫ

ދިވެހިރާއްޖެ

ގއ. ދެއްވަދޫ ބަނދަރު މަރާމާތު ކުރުމުގެ މަސައްކަތް ސަރުކާރު ކުރާ "ރިޔަން" ކޮންޓްރެކްޓަރސްގެ ޓީމުގެ ބައްދަލު ވުމުގެ ނަތީޖާ

15 ޖެނުއަރީ 2009 ބުރާސްފަތިދުވަހު ރޭ 9:00 ގައި ދެއްވަދޫ އޮފީހުގައި "ރިޔަން" ކޮންޓްރެކްޓަރސްގެ ޓީމުގެ ބައި ފަރާތްތަކާއި، ދެއްވަދޫ ބަނދަރު މަރާމާތު ކުރުމާއި ބެހޭ ކޮމިޓީ އާއި އެކު މަޝްވަރާ ބައްދަލު ވުމެއް ބޭއްވުނެވެ.

މިބައްދަލު ވުމުގައި 24 ބައި ފަރާތުން ބައިވެރި ވިއެވެ. މީގެ ތެރޭގައި މިރަށުގެ ވެރިން އިދާރާ ކޮމިޓީގެ މެންބަރުންނާއި އޮފީސްވެރިންނާއި، ކާރޭސެންޓަރާއި، މަސްވެރިން ހިމެނެއެވެ. "ރިޔަން" ކޮންޓްރެކްޓަރސްގެ ފަރާތުން ބައިވެރިވެވަޑައިގަތީ އެކޮންޓްރެކްޓަރސްގެ ކޮމިއުނިޓީ ކޯޑިނޭޓަރ/ޕްރޮޖެކްޓް އެންޖިނިއަރ އަދި ސައިޓް ސުޕަވައިޒަރ އެވެ.

މިބައްދަލުވުން ތައާރަފު ކުރީ ދެއްވަދޫ ބޭސިކް އެޑްމިނިސްޓްރޭޓަރ އެވެ. މިބައްދަލުވުން ތައާރަފު ކުރައްވަމުން 26 ޑިސެމްބަރު 2004 ދުވަހު ރާއްޖެއަށް ކުރިމަތިވި ސުނާމީ ކާރިސާއާ ގުޅިގެން މިރަށު ބަނދަރަށް އައިސް ލިބުނު ގެއްލުމާއި، ބަނދަރު ހަލާކު ވުމާއި ގުޅިގެން އެކަން ސަރުކާރަށް ސަމާލުކަމަށް ގެނައުމަށް ކުރެވުނު މަސައްކަތްތަކުގެ ތަފުސީލް 2005 އަދި 2006 ވަނަ އަހަރުގެ ތެރޭގައި މިރަށުން ވަޒީރުން ޒިޔާރަތް ކުރައްވާ ބަނދަރު މަރާމާތު ކުރުމަށް ކުރެވުނު މަސައްކަތާއި ބެހޭ ގޮތުން އަދި ހަމަޖެހިފައިވާ ކަންކަން ތިޔާ ފަރާތްތަކުގެ ސަމާލުކަމަށް ގެނުވުމާއެކު މިގޮތުން ސަރުކާރުން މިކަމަށް ހޭދަކުރި ކޮންމެ ރުފިޔާއެއް ހަމަ ޢަދުލުވެރިކަމާ އެކު ބޭނުންކުރުމަށް ސަރުކާރުގެ ކަމުގައި ބޭއްވުމަށް ތަފުސީލީ ގޮތުން ބަޔާން ކޮށްދިނެވެ.

"ރިޔަން" ކޮންޓްރެކްޓަރސްގެ ފަރާތުން މި ކުރާ މަސައްކަތުގެ ތަފްޞީލު އަދި މަސައްކަތްތައް ކުރުމަށް ހަމަޖެހިފައިވާ ގޮތާއި ބަނދަރުތަކުގެ މަރާމާތު ކުރުމަށް ތައްޔާރުކުރި މެޝިނަރީތަކާއި ކުރަން ހަމަޖެހިފައިވާ މުއްދަތު ކޮންކްރީޓުގެ ސާމްޕަލް ސަރުކާރަށް ފޮނުވުމާއި މިގޮތުން މި ކޮންޓްރެކްޓް ބަނދަރު ކުރުމާއި މަރާމާތު ކުރުމުގެ މަސައްކަތް ކުރުމަށް ސަރުކާރުން ހަވާލުކުރި ކަންކަމާއި ޓެކްނިކަލް ސުޕަވިޜަން ކުރުމަށް މިކޮންޓްރެކްޓުގެ މަސައްކަތަށް ބަނދަރުތަކުގައި ޖެހިގެން ކުރުމަށް ބޭނުންކުރާ ސާމާނު ކުރިން އެކަމުގައި ބޭނުން ކުރާނެ ގޮތް އާއި އެ ރަށުގެ ސަރުކާރުގެ ކަމުގައި ބޭނުން ހިފާނެ ގޮތުން ހުށަހެޅުނު ކަމުގައި، އަދި ރަށްރަށުގެ ރައްޔިތުން ވިސްނުން ހުރި ގޮތް ބެލުމަށް ފަހު ރަށްރަށުގެ ރައްޔިތުން މަޝްވަރާތަކުގެ ރިޕޯޓް ގައި ހިމަނަން ކަމަށް ވިދާޅުވިއެވެ. އަދި ސަރުކާރުން ބަނދަރު ތަކުގެ

ތަފްސީލު ކުރެހުންތަށް ކުރެހުމުން ބަލާލު ކޮންޓްރެކްޓަރ ކުވައިތުގެ އެމްބަސީއާއި ކޮންސަލްޓެންޓާއި ކަމާއި ، މިކަމާއި ގުޅޭ ތަފްސީލު ކުރެހުންތަށް ކުރެހުމާއި ބޭ ޓެންޑަރުކުރުމާއި ތަފާތުކުރުމާއި ކުރެވުނު ފްލޯރިން އެންވަޔަރަމެންޓަލް ކޮންސަލްޓެންޓާއި ބަލާލު ކޮންޓްރާ ކަމަށް ސަޕޯޓް ވިދާޅުވިއެވެ.

ބަނދަރު ފުރުގެ ބައި ފަރިން ދެއްކި ހިޔާލާއި މަޝްވަރާ :

- ސަރުކާރު ކޮށިތާއި ގުޅިގެން ބަނދަރު ތޮށިގެ އަށްވެ ފުރިހަމަ ބައިތަށް (ކަސްޓަމް ޖެޓީއާއި އެއްގަމު ފާޚާނާގެ ބައެއް) ހަރާކާ ވެފައިވާތީ ހެޔޮ ހުސްސުމު ބަނދަރު ތެރޭ ގޮތް ފުރިން ވަރަށް ބޮޑެތި ދޮނި ތަކާއި ކަރަމަތީން ޖެހެއެވެ.

- ސަރުކާރު ކޮށިތާއި ގުޅިގެން މަސްވާރު ކުރުމަށް ހަމަޖެހިފައިވާ ބަނދަރު ތަކެއް ބޮޑުކަމުން ދިގުން ހިފުނުފައިވާ މަސްދޯނިކާރު ބަނދަރުގެ ދޮރު ބޮޑު ކަނޑު ދިގު މުއްދަތަކަށް ދެމެހެއްޓެނިވި ގޮތަކަށް ބޮޑުވެގެން ވަރަށް ބޮޑު އަދި ކަރަށް ކަށެވެ. އަދި އެހާމް ބޮޑުންތެރި ދުރިއްމު ކަމަށްދީފައިވެ ޖެހެއެވެ. ސަރަހައްދު މިކަހަލަ ބޮޑެތި ކަންކަމަށް އިތުރު އިތުރު ކަރާ ފަރުތަކުން ކުރަދާ ކަމަކަށް ތަނެއް ކަމަށް ނުވާތީ މަޤާމު ކުރަނިވި ބަލަދާ ފުރަތަމަކަން ދިގު މުއްދަތަކަށް ދެމެހެއްޓެނިވި ގޮތަކަށް ހަރުދަނާ ބަނދަރެއް ބޭނުންވާކަން ފާހަގަކުރަމުން ގެންދެވެ.

- ބަނދަރު ބޮޑު ކުރަން ބޭނުންވާގޮތް : މިހާރު އޮތް ބަނދަރުގެ އުތުރު ފަރާތުން އިތުރަށް 300 ފޫޓް ދިގު ކުރުމާއި މިހާރު ހުރި ކަސްޓަމް ޖެޓީ ބަރާ ހުރެގެ ފަހަތުން 50 ފޫޓް ފުޅާ ކޮށް ފަރުކޮޅު ތިލަ ތަންތަނާއި ޖެޓީ ތިލަކޮށް ، ބަނދަރުގެ ފުންމިން ދެފު ދިޔަވަރުގެ 12 ފޫޓް ހުންނަވަރަށް ފުން ކުރުން .

- ބޮޑު ވާރުތު ދިގު މުއްދަތަކަށް ދެމެހެއްޓެނިވި ގޮތަކަށް ބޮޑުވެގެން ވަރަށް މުހިއްމު ކަމަކަށްވާތީ އެއްގަމު ފާޚާނާ ދި ހަރަކާ ޖެޓީއާއި ނަގުލައިސަކަރި ސިލިޓް ފައިބު ކަންވައި އަދި ކަސްޓަމް ޖެޓީއާއި ކަސްޓަމް ޖެޓީ ގެދޮރުވައިވާ ނަގުލައިސަކަރި ބަދަލު ޖަހައިގެން ހެދުން .

- ނަގުލައިސަކަރި ކަސްޓަމް ޖެޓީއާއި ގެދޮރުވައި ވާ ބައިގެ ބޭރު ހިސާ ޖަހާނުލާ ގޮތަށް ފާލަން ގައި ހުންނަ ނަގުލު ހަލާ ބައިސާ އެއް ހަމަހަމަވެ. މިފައި ކަމާގައި ހުންނަ ގާނޫނީ 200 ފޫޓެވެ. މިތަނުގައި 180 ފޫޓް ދިގުމިނަށް ހަދާން ޖަހާފައިވާ ޖެޓީއާއި ބައިވެރިވާ ހެލިކުރި ގައި ހަދާފައި ވާތަނެކެވެ. މިހާރު މިތަނުގައި ވައްޓާ ހަލާކުވެފައެވެ. މިހެން ފުރުގެ ސަރަހައްދު ބަނދަރު ބަހާ ގަދަވެ އެއްގަމު ވަރަށް ބޮޑެތި ގެއްލުން ވެއް ދިމާވެއެވެ.

- ނަގުލު ވައި ކަމަގެ އެއްގަމު ޖެޓީއާއި ގެދޮރުވައި ހިސާ ބައިގެ ބޮޑު ޖަހާނުލާ ހަދާ ދުރާރުން އެއްގަމާއި ވި ފާލަމުގައި ހިސާ ނަގުލު ފަރި ބައިޑިއާއި ހަމަހަމަވެ. މިފައި ކަލި ގައި ހިސާނީ ގަމު ގެދޮރުން 160 ފޫޓެވެ. މިހާރު މިތަނުގައި ހަދާފައިވާ 100 ފޫޓުގެ ޖެޓީއަކީ ބައިވެރިވާ އަމިއްލަ ހަދައިގެން ހަދާފައިވާ ތަނެކެވެ. މިތަން މިހާރުވަނީ ހަލާކުވެފައެވެ. މިހެންވުމުގެ ސަބަބުން އެއްގަމުގައި ހިސާ ފަސްގަނޑު ދުވި ނަގުލު ބޮޑުވަމުން ވަޔަބައިގެން ދިޔުން ބަލާގެ ސިމާވެއްޖެން ގެއްލުންތަކެއް ދިމާވަމުން ދެއެވެ.

- އެއްގަމުވާރުތު ހެރަސް ޖެޓީއާއި އަދި އެއްގަމު ޖެޓީއާއި ގުޅިގެން ނަގުލައިސަކަރި ބައިތައް ސިމެންތިގެ ކުރެއްވުން މިހާރު ހުރި ޖެހިލުން ބަދަލުކުރުމަށް އެކުލަވާލުމަށް ސިމެންތިގެ ކުރުން ބަލައިލުމަށް ކަމަށް ފެނެއެވެ.

- މިރަށް އަންނަ ޓޫރިސްޓުންގެ ގޮތުން އެހެނިހެން ރަށް ރަށުގެ ފަރަށް ގިނަ މަސްވެރި އުޅަނދު ދަތުރު ކުރޭ. މާލެ އާއި ސ.އަތޮޅާއި ދެމެދު ދަތުރުކުރާ ލޯންޗު އަދި ބޯޓު ފަހަރާއި، ބޭރު ދޯނިފަހަރާއި، ބޯޓު ތަކާއި މިރަށުގެ ބަނދަރަށް ވަދެ ނުކުތުމަށް އެކަށީގެންވާ ބަނދަރެއްގެ ބޭނުން ވަރަށް މުހިއްމު ކަމެކެވެ.

- ކުރިއަށް އޮތް ތާރީޚު މިރަށު ހަރަކާތް ބޮޑުވެގެން ދާނެ ކަމަށް ގަސްތުކުރެވިފައިވާތީ އެކި ސަރުކާރު ބޯޓު ފަހަރާއި، އަދި ފަހަރުތަކެއް މި ބަނދަރަށް ޖެހުމަށް ކުރީން ކަމަށް ފެންނަނީ އެފަރާތުން ތަކުން ބޭސް ބަދަލުވާނެ ގޮތަށް ބަނދަރު ބޮޑު ކުރުމަށްޓަކައެވެ. މިހުރިހާ ކަމަކާ ނަގާގޮތުން ސަރުކާރު ބޯޓު ފަހަރު ޖެހުމަށް ކުރުމެވެ.

- ރަށުގެ އުޅަނދު ފަހަރުގެ އިތުރަށް ބޯޓުން ރަށަށް ޖެހުމަށް ކުރާ ގެއްލުންތަކަކީ ބަނދަރުން ބޭރު ދިމާވާ ކަންތައްތަކުން ކުރަން ޖެހޭ ކަމަކަށް ވާއިރު މިކަން ކުރުމަށް ރަނގަޅު އެފަރާތް ހަކަތަ ފަދަ ފައިދާއެއް ހަމަޖެހޭނެ ގޮތަކާއި އެކު ބަނދަރަކަށް ވަދެ ނުކުތުމަށް ބަނދަރުގެ ބޮޑު ބޭނުމަކީ ކުރުވެފައި ނުވޭ. އެހެންވީމާ މިހާރު އޮތް ބަނދަރު އިތުރަށް ބޮޑު ކުރުމަކީ ނުހަނު މުހިއްމު ފަރާތެއް ދިމާވާ ކަމެއް ބޮޑަށް ހުރި ކަމެކެވެ.

- ބަނދަރުގެ ގޮވަ ބޮޑު ނުކުތް ބަނދަރު މަރާމާތު ކުރިއަށް ގެންދާ ފަސޭހަ ކަމަށް ނަތީޖާއި އެކު އިސްވެ ދެންނެވި ފަދައިން މިހާރު އޮތް ބަނދަރުގެ ދިގުމިނުން 300 ފޫޓު ، ފުޅާމިނުން 50 ފޫޓު ، އިތުރު ކުރުވާ ގޮތަށް މަރާމާތު ކުރުމަށް ހުށަހަޅަން އެދޭ ގޮތެވެ.

17 މުޙައްރަމް 1430

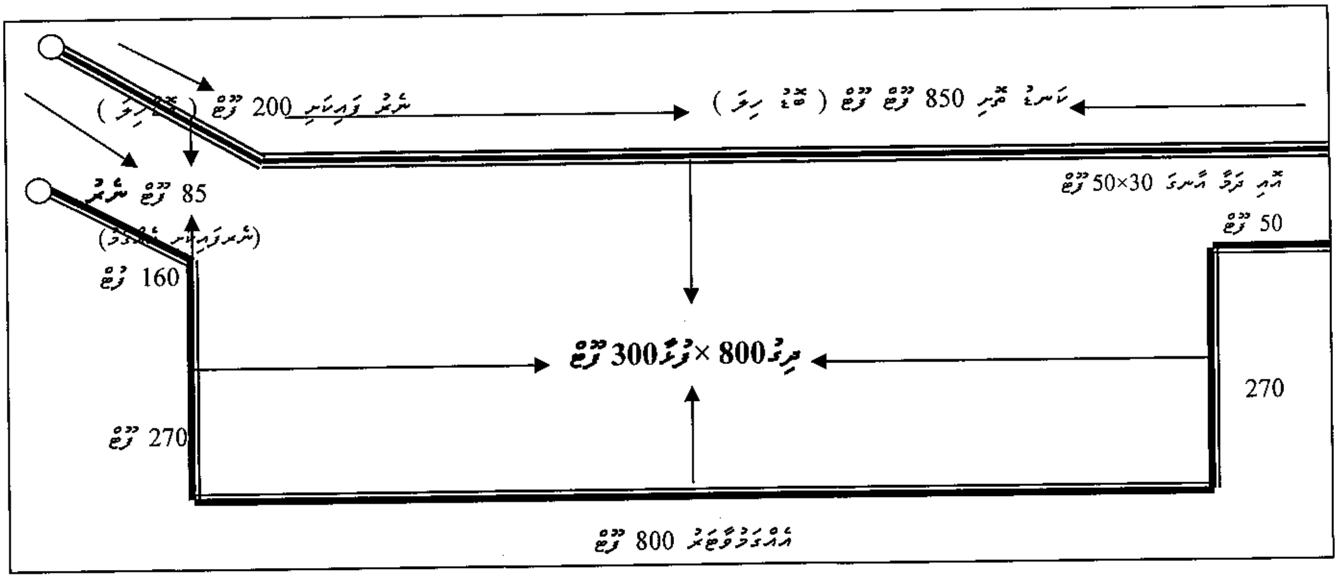
15 ޖަނަވަރީ 2009

W

S N

E

ކުރިމަގުގައި ފުޅާކުރާ ބަނދަރު ހުންނާނެ ގޮތް



بسم الله الرحمن الرحيم

ދިވެހިރާއްޖެ ތަރައްގީ ވަޒީފާ ދިނުމުގެ ސަރުކާރު

ދިވެހިރާއްޖެ ތަރައްގީ ވަޒީފާ ދިނުމުގެ ފަންނީ ކަންކަން ބަލަހައްޓާ ދާއިރާ

ފަލާ ތިމާރަދޫ.

ބަންދަރުގައި ބާއްވާފައިވާ ސަރުވޭ

ތަކެއްޗުގެ ނަން: ..... ދަނޑި ދަށްކުރާ ލޯންޗް .....

ބަންދަރުގެ ސަރުވޭ: ..... ފުދުން: 500 ފޫޓް ..... ފުދި: 250 ފޫޓް

ބަންދަރުގެ ފުދުން: (ބަންދަރުގެ ފުދުން 500 ފޫޓް، ދަނޑަށް ދާ ލޯންޗް 450 ފޫޓް، ކުރިއަށް ދާ 100 ފޫޓް) ދިގުކޮށް ދަނޑަށް ދާ ލޯންޗް ދަށްކުރާ ތަނުގެ ފުދުން

ބަންދަރުގައި ބާއްވާ ގޮތް: ✓ ފިލާ ގޮތުގައި ✗ ބަންދަރުގެ ތެރެ ✗ ބަންދަރުގެ ބޭރު ✗

ބަންދަރުގައި ބާއްވާ ގޮތް: (ބަންދަރުގެ ދަށުގެ ދަނޑަށް ދާ ލޯންޗް 100 ފޫޓް ދުރުގައި ހުންނަ ގޮތަށް)

ބަންދަރުގައި ބާއްވާ ގޮތް: 500 ފޫޓް (ދަނޑަށް ދާ ލޯންޗް ދަށްކުރާ ތަނުގެ ފުދުން 180 ފޫޓް ކަށަވަރުކުރަންވާނެ)

ބަންދަރުގައި ބާއްވާ ގޮތް:

ބަންދަރުގެ ތެރެ ✓ ބަންދަރުގެ ބޭރު ✓ ބަންދަރުގެ ތެރެ ✗ ބަންދަރުގެ ބޭރު ✗

ބަންދަރުގައި ބާއްވާ ގޮތް: ދަނޑަށް ދާ ލޯންޗް ދަށްކުރާ ތަނުގެ ފުދުން 500 ފޫޓް ދުރުގައި ދަށްކުރާ ތަނުގެ ފުދުން 30 ފޫޓް ދުރުގައި 180 ފޫޓް ދިގުގެ ގޮތުގައި ބަންދަރުގައި ބާއްވާ ގޮތް ކަށަވަރުކުރަންވާނެ

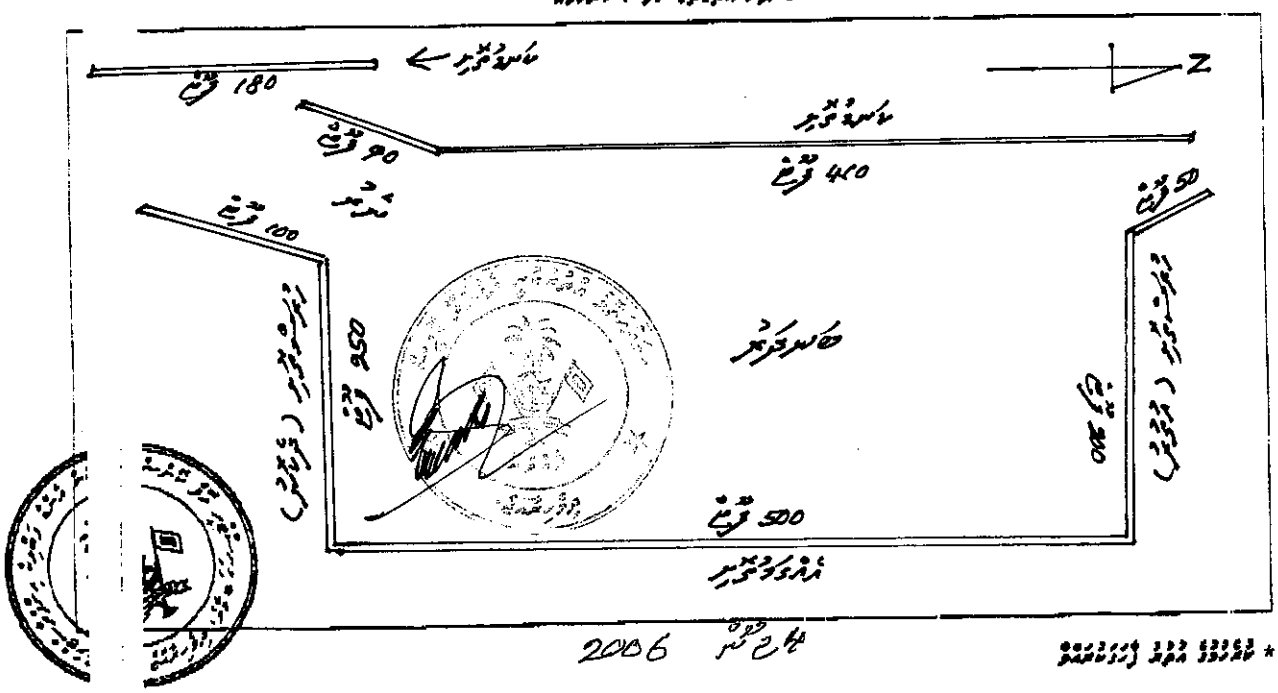
ބަންދަރުގެ ތެރެ ބާއްވާ ގޮތް: ދަނޑަށް ދާ ލޯންޗް 7 ފޫޓް

ބަންދަރުގެ ތެރެ: (ބަންދަރުގެ ތެރެ ބާއްވާ ގޮތް 7 ފޫޓް 6 ފޫޓް ދިގުގެ ގޮތުގައި)

ބަންދަރުގެ ފުދުން: 150 ފޫޓް ..... ބަންދަރުގެ ފުދި: 95 ފޫޓް

ބަންދަރުގެ ފުދުން ދަށްކުރާ ތަނުގެ ފުދުން: (ދަނޑަށް ދާ ލޯންޗް 10 ފޫޓް، ދަށްކުރާ ތަނުގެ ފުދުން 15 ފޫޓް 20

ބަންދަރުގެ ސަރުވޭ ފަދަ ގަޑި



2006 ކުރީ ދުވަސް

* ބަންދަރުގެ ސަރުވޭ ފުރިހަމަ ކުރި ދުވަސް

ދިވެހިރާއްޖެ ތަރައްގީ ވަޒީފާ ދިނުމުގެ ސަރުކާރު ފޯނު: 3323474 ފެކްސް: 3326300 ޕޯ.ބ: sn@dhivehinet.net.mv

بسم الله الرحمن الرحيم

ކުރިއަރާ ތަރައްޤީ ކުރެވޭ ގޮތުގެ ތަފްޞީލު

ފުރާނަގަރ

ދިވެހިރާއްޖެ

ބަންދަރު ބާލާނެ ގޮތް ބަޔާންކުރުން

ތަނުގެ ނަން : ގއ. ފުރާނަގަރ

ބަންދަރުގެ ސަބަބު : ދިގު 500 ފޫޓް ފުޅާ 250 ފޫޓް

ތަކެތި ލޯންކުރުމަށް ބޭނުންކުރާ ގޮތް:(ގައުދަކުން 500 ފޫޓް ތެރެ ހުންނަ 450 ފޫޓް ތަނަކަށް ތަކެތި ލޯ ގޮތުގައި ބަދަލުކުރެވޭނެ 100 ފޫޓް)

ކައުންސިލް ބިލްޑިންގ ☐ ސިޔާސީ ކުރިޔަށް ☐ ކައުންސިލް ބިލްޑިންގ ☐ ވިލާ ސެކްޝަންތަކަށް ☑

ގައުދަކުން ބަންދަރަށް ދާ ދަނޑި : (ގައުދަކުން 30 ވަނަހާ ފޫޓް ދުވަލު ތަކެތި ލޯ ދާ ދަނޑި ގައުދުގެ ދަރަނި ތަނުގައި 120 ފޫޓް ފުން ހުންނަ ހަދާ ފުވަރު)

ބަންދުގެ ތަނުގެ ދިގުމިނަށް: 500 ފޫޓް (ވިލާ ސެކްޝަންތަކަށް) 180 ފޫޓް (ކައުންސިލް ގެންގުވާ)

ބަންދުގެ ތަނުގެ ތަރައްޤީ ކުރެވޭ ގޮތް:

ގަދަ ތަނުގައި ☑ ވިލާ ސެކްޝަންތަކަށް ☑ ކައުންސިލް ބިލްޑިންގ ☐ ބެލެ ހިއްކާ ☐

ބަންދުގެ ފުރަތަމަ ފެންނަ ގޮތް: ވިލާ ސެކްޝަންތަކަށް ގެންގުވާނެ 500 ފޫޓް ތެރެއިން ދެ ފަރާތުން 30 ފޫޓް ތަނުގައި ދަށް ތަނުގައި 180 ފޫޓްގެ ފުވަރު ތަނުގައި ފުން ހުންނަ ފުވަރު

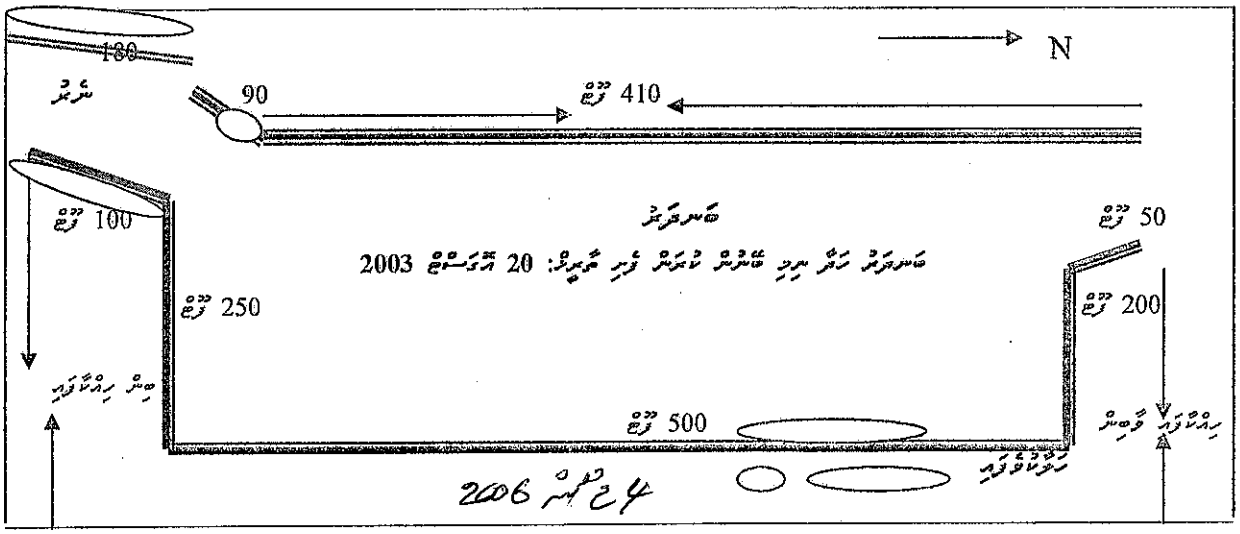
ތަނުގެ ދަށް ކަނޑާ ދާ ދަނޑި: ދަށް ތަނުގައި ހުންނަ ދަނޑި 7 ފޫޓް

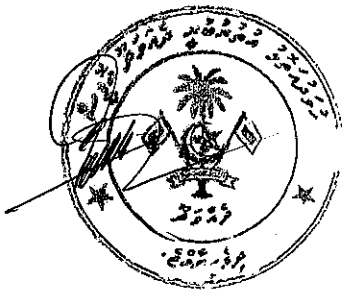
ބަންދަރުގެ ތެރެއަށް ދާ ދަނޑި : ބަންދަރުގެ ތެރެ ދާ ދަނޑި ބަންދަރުގެ ތެރެ ހުންނަ ގޮތުން ގަބޫލު ކުރާ ދަނޑި 7 ފޫޓް

ބަންދަރުގެ ތެރެ ދިގުމިނ : 150 ފޫޓް ތެރެއިން ފުޅާކުރާ ދަނޑި : 95 ފޫޓް

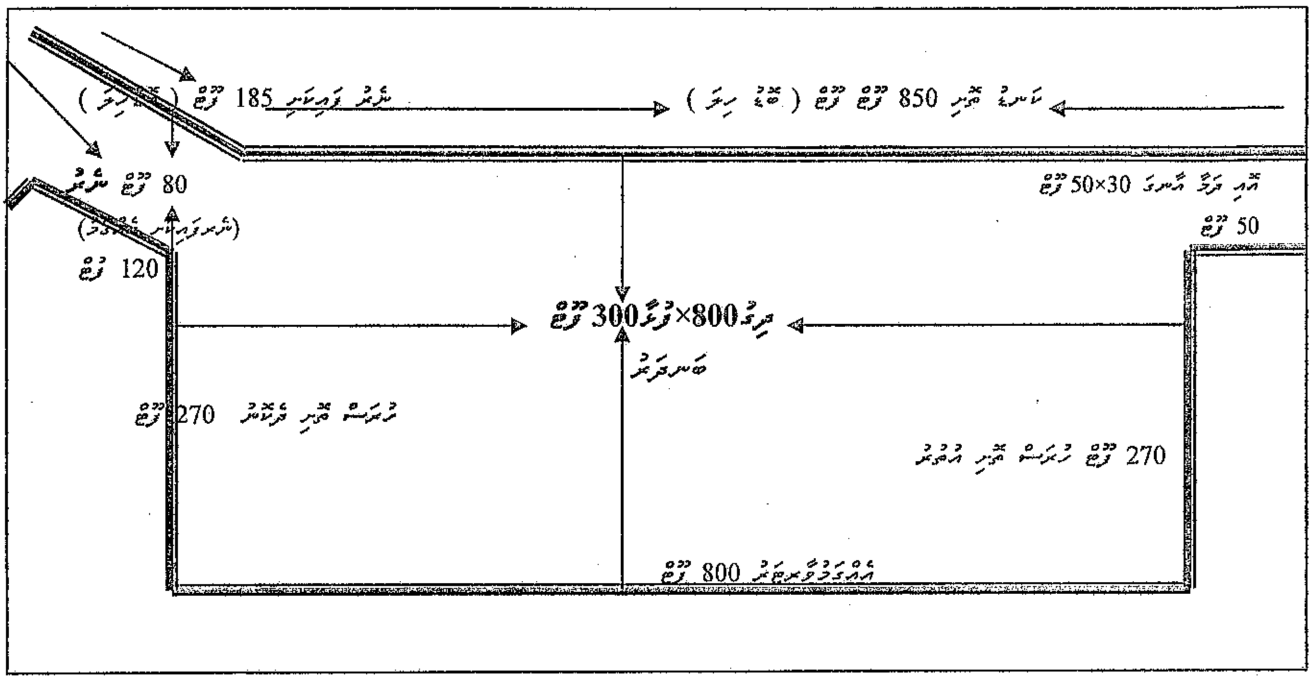
ބަންދަރުގެ ކަނޑާ ދާ ދަނޑި ބަންދުގެ ތެރެ ދާ ދަނޑި : ދެ ފަރާތުގެ ދަރަނި 10 ފޫޓް ތެރޭ ގަދަ ކުރާ ދަނޑި 15 ފޫޓް ދިގު 20 ފޫޓް ދަނޑި ތަނުގައި ދަށް ތަނުގައި ހުންނަ ދަނޑި ދެ ފަރާތުން ކަނޑާ ދާ ދަނޑި ދެ ފަރާތުން ކަނޑާ ދާ ދަނޑި ތަނުގައި ހުންނަ ދަނޑި ދެ ފަރާތުން ކަނޑާ ދާ ދަނޑި ތަނުގައި ހުންނަ ދަނޑި 5 ފޫޓް ކަނޑާ ދާ ދަނޑި 105 ފޫޓް. ކައުންސިލް ބިލްޑިންގ 3 ފަންގިފުޅުގެ ތަނުގައި 115 ފޫޓް 3 ފެނުގައި ދަށް ތަނުގައި ހުންނަ ދަނޑި ދެ ފަރާތުން ކަނޑާ ދާ ދަނޑި ތަނުގައި ބަންދަރުގެ ތަކެތި ލޯ ދާ ދަނޑި ދެ ފަރާތުން ކަނޑާ ދާ ދަނޑި.

ބަންދަރުގެ ތަނުގެ ގާތުގެ ކުރިމަގު ބަލައިގަތުން





ކުރިމަގުމައި ދެއްވާފަ ބަނދަރުގެ އަންދާޒާ ޗާޓު



- މިހާރު އޮތް ބަނދަރުގެ ހާލަތު ކުޑަ ސަބަބުންނާއި ބޯޓުން ކުރިމަތިލާން ޖެހިފައިވާކަމެވެ. ބަނދަރުގެ ދިގުމިނުގައި 500 ފޫޓު ފުޅާމިނުގައި 250 ފޫޓު ކަމަށްވާއި ދުރު ދިމާލަށް ފުންމިނުގައި 7 ފޫޓު ހުރުމުން ބަނދަރު ބޮޑުކަމާއި ޖާގަ ކުޑަކަމުން މިހާރު ބަނދަރުގެ ބޭނުން ކުރާ މަސްވެރި ބޯޓުތަކާއި ފަޅު ފަހަރާއި ބޯޓު ފަހަރު ވަރަށް ބޮޑަށް ދަތިވެއެވެ.

- ސުނާމީ ކާރިސާއި ގުޅިގެން ބަނދަރު ބޭރުގެ އެތެރު ފަރަށްވާ ބަރިތަށް (ކަނޑު ބޮއްޖެހި އެއްގަމު ވާރިތަރުގެ ބައެއް) ހަލާކު ވުމާއި ގުޅިގެން ހުރަގެ މާސްދު ބަނދަރު ތެޅޭ ގޮތަ ވެއްޓުން ވަރަށް ބޮޑުވި ދަތި ތަކެއް ކުރިމަތިވުން ޖެހެއެވެ.

- ބަނދަރު ބޮޑު ކުރަން ބޭނުންވާ ގޮތް: މިހާރު އޮތް ބަނދަރުގެ އުތުރު ފަރާތުން ނެގުމަށް ދެކުނުފަރާތުން އިތުރަށް 300 ފޫޓު ދިގު ކުރުމާއި މިހާރު ހުރި ކަނޑު ބޭރު ނަގާ ހުރަގު ފަރާތަށް 50 ފޫޓު ފުޅާ ކޮށް ފަރުކަޅި ދިގަ ތަނުގައި ބޭރު ދުވާއި ، ބަނދަރުގެ ފުންމިން ދުރު ދިމާލުގައި 11 ނުވަތަ 12 ފޫޓު ހުންނަގޮތަށް ފުން ކުރުން .

- ބޭރު ތޮށިތަރު ދިގު މުޅިދަތިތަކަށް ދެފުށުން ތެޅިއްޖެހިލާ ގޮތެއްގައި ބޭރުތުރުމަ ވަރަށް ދުރުތިލަވާގޮތަށް ކުރެވޭ އެއްގަމު ވާރިބަރު ދެ ހިރަށް ބޮއްޖެހި ނެރުފަޅުކަރު ސިމެންތި ފައިވާ ކަނޑުފައި އަދި ކަނޑު ބޮއްޖެހި ބޭރު ގުޅުފައިވާ ނެރުފަޅުކަރު ބޮޑު ހިލަ ޖަހައިގެން ހެދުން .

بسم الله الرحمن الرحيم

ދިވެހިރާއްޖެ ތަރުތީބުދަށް ތަރުވަރުގެ ތަފާތު

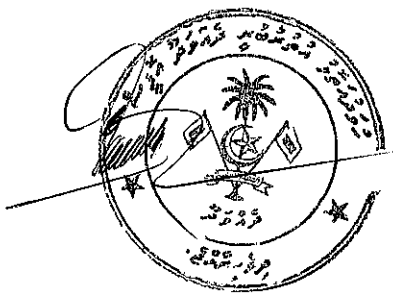
ތަރުވަރުގެ

ދިވެހިންގެ

ދިވެހިރާއްޖެ ސިވިލް ސަރވިހަށް ބަދަލުވެދާ

ނަންބަރު	ފުރިހަމަ ނަން ކުރިން ލިޔެވޭ ނަމުގެ ފަހުން	ތަރުވަ	ފ.ސ.ނ
01	ކާސިމް ހުސައިން	ކ	7622753
02	ދ ރ ކ	ކ	-
03	ހަސަނު ސާލިހު	ކ	7835540
04	ކ ތ ބ	ކ	7903038
05	ބ ދ ދ	ކ	7622707
06	ދ ވ ކ	ކ	7792087
07	ރ ބ ބ	ކ	-
08	ކ ދ ގ	ކ	9675270
09	ބ ކ ބ	ކ	7622409
10	ބ ރ ތ ކ	ކ	7904960
11	ދ ވ ސ ރ	ކ	7901965
12	ބ ށ ބ ގ	ކ	7797497
13	ގ ބ ބ	ކ	9999959
14	ތ ދ ބ	ކ	7901727
15	ކ ތ ބ 2	ކ	7903038

2009-01-15



`

Appendix 6 MHTE memo regarding commitment to mitigation measures and monitoring

بسم الله الرحمن الرحيم

ހިއްސާކުރާ ދާއިރާ، ޓްރާންސްޕޯޓް ހަ ވާތావරణ ތަރައްޤީ ވަޒާރާ

Ministry of Housing, Transport and Environment

ދަފްތަރު ޔާދު

OFFICE MEMO

From:	Engineering and Project Management Section		
To:	Environmental Protection Agency		
Copy:			
Subject:	Ha. Hoarafushi, Ha. Ihavandhoo, K. Dhiffushi, B. Goidhoo, B. Dharavandhoo, K. Kaashidhoo, AA. Mathiveri, Th. Hirilandhoo, Ga.Dhevvadhoo EIA		
Number:	(MEMO)138/203/2010/1035	Date:	6 July 2010

Ministry of Housing, Transport and Environment as the proponent of the IDB, OFID and Saudi Funded Harbour Projects at Ha. Hoarafushi, Ha. Ihavandhoo, K. Dhiffushi, B. Goidhoo, B. Dharavandhoo, K. Kaashidhoo, AA. Mathiveri, Th. Hirilandhoo, Ga.Dhevvadhoo, hereby confirm our commitment to carryout the environmental mitigation measures and monitoring program for the post-construction phase of the project.

Yours sincerely,

Shifaz Ali
Technical Advisor to the Minister

Ameenee Magu,
Maafannu,
Male', 20392,
Republic of Maldives.

Tel: +(960) 300 4 300 :ގުޅުން
Fax: +(960) 300 4 301 :ފެކްސް
Email: secretariat@mhte.gov.mv :ޕޯޓަލް
Website: www.mhte.gov.mv :ވެބްސައިޓް

ހަމީދީގަ،
ދ. ފަހަންނު،
ގދ، 20392،
ދިވެހިރާއްޖެ.

`

Appendix 7 References

Allison, W.R., (1996) 'Methods for surveying coral reef benthos'. Prepared for IMS, Zanzibar, 18 pp.

Coleman, Neville (2000). Marine Life of Maldives.

Defant, A. (1961). Physical oceanography, Volume 2, Pergamon Press, New York.

DHI (1999). Physical modelling on Navigation conditions and wave disturbance Maaneru site. Danish Hydraulic Institute.

Doodson, A. T. (1922). "The harmonic development of the tide-generating potential," Proceedings of the Royal Society, A, 100, 305.

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

Fernandes, L. (1989). Biases associated with the use of the manta tow, a rapid reef surveillance technique, with particular application to the crown-of-thorns starfish (Acanthaster planci), M.Sc. Dissertation, James Cook University, Townsville, 128pp.

Gischler, E. (2006). Sedimentation on Rasdhoo and Ga. Atolls, Maldives, Indian Ocean. Facies (2006) 52: 341–360.

Gourlay M.R., (1998). Coral cays: Products of wave action and geological processes in a biogenic environment. Proceedings of the 6th International Coral Reef Symposium, Australia. 2, 491 – 496.

IMO, International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). From the website http://www.imo.org/Conventions/contents.asp?doc_id=678andtopic_id=258

Kench, P. S .and Brander, R. (2005). Sensitivity of reef islands to seasonal climate oscillations: South Maalhosmadulu atoll, Maldives. Submitted to Coral Reefs.

Kench, P.S. and Cowell, P.J. 2001. The Morphological Response of Atoll Islands to Sea Level Rise. Part 2: Application of the Modified Shoreline Translation Model (STM). Challenges for the 21st Century in Coastal Sciences, Engineering and Environment, Journal of Coastal Research, Special Issue, 34: 645-656.

Kench, P.S. and McLean, F.R. (2004). Hydrodynamics and sediment transport fluxes of functional Hoa in an Indian Ocean Atoll. School of Geography and Environmental Science, The University of Auckland, New Zealand.

Kuiter R. H. (1998). Photo guide to Fishes of the Maldives

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

`

Malone, M. J., Baker, P. A., Burns, S. J. and Swart, P. K. (1990). Geochemistry of platform carbonate sediments, Leg 115, Site 716 (Maldives Archipelago, Indian Ocean). Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 115.

Maniku, H. A., 1990, "Changes in the topography of the Maldives", Forum of Writers on Environment, Male

Miller, I.R. and Muller, R. (1997). A quality control procedure for observer agreement of manta tow benthic cover estimates. In Proceedings of 8th International Coral Reef Symposium, Panama. Smithsonian Tropical Research Institute, Balboa, Republic of Panama, 2, 1475-1478

Ministry of Construction and Public Works (1999) Environmental/Technical Study for Dredging/Reclamation Works Under the Hulhumale Project, Maldives – Draft Final Stage 1 Report.

Moran, P.J. and De'ath, G. (1992). Suitability of the manta tow technique for estimating relative and absolute abundances of crown-of-thorns starfish (Acanthaster planci L.) and corals. Australian Journal of Marine and Freshwater Research 43:357-78.

Naseer, A. and Bruce, G. H. (2004). Inventory of the Maldives coral reefs using morphometrics generated from Landsat ETM+ imagery. Coral Reefs.

Naseer, A. and Bruce, G. H. (2004). Inventory of the Maldives coral reefs using morphometrics generated from Landsat ETM+ imagery. Coral Reefs.

Ohlhorst SL, Liddle WD, Taylor RJ and Taylor JM. (1988). Evaluation of reef census techniques. Proceedings of 6th International Coral reef Symposium. Australia. 2: 319-324

Pescares Italia Srl (2001). Environmental Impact Assessment Report for Regional Port Development Project in the Maldives. Prepared for Kuwait Fund for Arab Economic Development and Ministry of Transport and Civil Aviation.

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

Shore Protection Manual, (1994) US Government Printing Office, Washington, DC.

UNDP (2006). Developing a Disaster Risk Profile for Maldives. Volume 1: Main Report.

UNDP (2006). Developing a Disaster Risk Profile for Maldives. Volume 1: Main Report.

Veron, JEN (John Edward Norwood) (2000). Corals of the World

Woodroffe, C.D. (1992). Morphology and evolution of reef islands in the Maldives. Proc 7th Int Coral Reef Symp. 2: 1217 – 1226.