Environmental Impact Assessment for the Reconstruction of Guraidhoo Harbour

Thaa Atoll, Maldives

Proposed by:

Ministry of Housing & Infrastructure
Government of Maldives

December, 2015

MEECO

PROJECT SYNOPSIS

Name of the Project: Environmental Impact Assessment for the Reconstruction of Guraidhoo Harbour, Thaa atoll, Maldives
Project Proponent: Ministry of Housing and Infrastructure
Project Contractor: Not awarded yet
Project Value: MRF 30 million
Expected Duration: 1 year
EIA Consultant: Ahmed Saleem
EIA Date: December 2015

WEIGHTS AND MEASURES USED IN THE REPORT

1 metric tonne = 2,204 pounds (lbs.)
1 kilogramme (kg) =2.2 lbs.
1 metre (m) = 3.28 feet (ft.)
1 millimetre (mm) = 0.03937 inches (”)
1 kilometre (km) = 0.62 mile
1 hectare (ha) = 2.471 acres

LIST OF ABBREVIATIONS

DIRAM	Detailed Island Risk Assessment in Maldives
DO	Dissolved Oxygen potential
EIA	Environment Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EPPA	Environmental Protection and Preservation Act
GHGs	Greenhouse gases
GPS	Global Positioning System
LIT	Line Intercept Transect
MEE	Ministry of Environment and Energy
MEECO	Maldives Energy and Environment Company
MMS	Maldives Meteorological Service
MoFA	Ministry of Fisheries and Agriculture
MoHI	Ministry of Housing and Infrastructure
MRC	Marine Research Centre
NTU	Nephelometric Turbidity Units
RIAM	Rapid Impact Assessment Matrix
TDS	Total Dissolved Solids
TOR	Terms Of Reference
UNDP	United Nations Development Programme
USD	United States Dollar

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ACKNOWLEDGEMENT

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PROPONENT'S DECLARATION

The proponent has elected to submit an Environmental Impact Assessment for the proposed reconstruction of the Th. Guraidhoo harbour in accordance with Environmental Protection and Preservation Act (Act No. 4/93) and the EIA Regulations (2012).

Ministry of Housing and Infrastructure

CONSULTANT'S DECLARATION

As the lead consultant of this EIA, I hereby, declare that the content in this EIA report is complete, true, and correct to the best of information that I had while compiling this EIA.

Ahmed Saleem

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މި އެންވަޔަރަންމަންޓަލް އިމްޕެކްޓް އެސެސްމަންޓް (އީ.އައި.އޭ) ރިޕޯޓަކީ ތ. ގުރައިދޫ ބަނދަރު މަރާމާތު ކުރުމުގެ މަޝްރޫއާއި ގުޅޭ ގޮތުން މިނިސްޓްރީ އޮފް ހައުސިންގ އެންޑް އިންފްރާސްޓްރަކްޗަރގެ އެދުމުގެ މަތިން މޯލްޑިވްސް އެނާޖީ އެންޑް އެންވަޔަރަންމަންޓަލް ކޮންސަލްޓަންސީ (މީކޯ) އިން ތައްޔާރުކުރިފައިވާ އެންވަޔަރަންމަންޓަލް އިމްޕެކްޓް އެސެސްމަންޓް ރިޕޯޓެކެވެ.

މި ރިޕޯޓަކީ ތައްޔާރުކުރެވިފައިވާނީ އެންވަޔަރަންމަންޓަލް ޕްރޮޓެކްޝަން އެޖެންސީ (އީ.ޕީ.އޭ) އާއި އެދިޔާރާއި ދެމެދު އެއްބަސްވެވިފައިވާ ޓާމްސް އޮފް ރިފަރަންސަށް ބިނާކޮށެވެ.

މި ރިޕޯޓުގެ މަޤްސަދަކީ އެންވަޔަރަންމަންޓަލް އިމްޕެކްޓް އެސެސްމެންޓް ގަވާއިދު 2012 ގައި ބަޔާން ކުރެވިފައިވާ ކަންތައްތަކާ ގުޅިގެން ކުރުމެވެ. އެ ގޮތުން މި ރިޕޯޓުގައި، ރާވިފައިވާ މަޝްރޫއުގެ ސަބަބުން ތިމާވެށްޓާއި އިޖްތިމާއީ އަދި އިޤްތިޞާދީ މާހައުލަށް ކޮންފަދަ އަސަރުތަކެއް ފޯރާނެ ކަމުގައި ދެނެގަތުން ބަޔާންކުރެވިފައިވާނެއެވެ.

ތ. ގުރައިދޫ ބަނދަރު މަރާމާތުގެ މަޝްރޫއުގެ ދަށުން ކުރުމަށް ހުށަހެޅިފައިވާ މައިގަނޑު މަސައްކަތްތައް ތިރީގައި ބަޔާން ކުރެވިފައި އޮތެވެ.

1. މިހާރުގެ ބަނދަރުގައި ހާއިލް ކޮށްފައިވާ ކަނޑުބޮޑު އަޅުކުރުމާއި ނަރުގެ ދެ ފައިކަރި އަޅުކުރުން.
2. ބަނދަރުގެ އެއްގަމުބޮޑު އަޅުކޮށް ބަނދަރުގެ ހުޅަނގުދެކުނު ބޮޑު އަޅުކުރުން.
3. މިހާރުގެ ބަނދަރުން ތިރަފުވެފައިވާ ބައި ފުންކުރުން.
4. ބަނދަރަށް 60 މީޓަރު އިތުރުކޮށް ބޮޑުކުރުން.
5. ބަނދަރު ފުންކުރުމާއި ބޮޑުކުރުމުން އުފެދޭ ވެލި އަޅައި ކެޔޮ ސަރަހައްދުން ބަނދަރުގެ ހުޅަނގުދެކުނު ފަރާތާއި އިންވެގެން ހިއްކުން.
6. އަލަށް ހިއްކާ ސަރަހައްދުގައި ރިވެޓްމަންޓް ޖެހުން.
7. ބަނދަރުގައި ނެރުބައްތި ޖެހުން.

ތ. ގުރައިދޫގެ ބަނދަރުތެރި ވަރަށް ބޮޑަށް ހަޑާލާފައި ބަނދަރުގެ ފުރިހަމަ ބޭނުން ނުހިފޭ ވަރަށް ހާލަތު ދަތިވެފައިކަން ފާހަގަ ކުރެވެއެވެ. އެހެން ކަމުން ރައްޔިތުންނަށް ކަލާއުކާ ބަނދަރަށް ވަދެ ނިކުމެ އުޅުމަށް ދަތިތަކާއި ކުރިމަތިވެއެވެ. އަދި ބަނދަރުގައި އަޅައިފާވާ ދޯނިތަކަށް ގެއްލުންވުމުގެ ފުރުސަތު ބޮޑުވެފައިވާކަން ފާހަގަ ކުރެވެއެވެ. މީގެ އިތުރުން ބަނދަރުގެ ބޮޑުމިނަކީ ރަށުގެ މިހާރުގެ އިގްތިސާދީ ހާލަތާއި ކުރިއަށް އޮތްތަނުގައި ތަފާތުކުރާ އިގްތިސާދީ ކުރިއެރުމަށް ބަލާއިރު، ކުޑަ ބަނދަރެއްކަން ފާހަގަކުރެވެއެވެ.

ތ. ގުރައިދޫ ބަނދަރަކީ ރަށުގެ އިގްތިސާދަށް ވަރަށް ބޮޑަށް މުސާހަމާކުރާ ތަނެކެވެ. އެގޮތުން މަސްވެރިކަމާއި ރަށުން މާލެ އުފުލާ ދަތުރުވެރިކަމާއި ފިހި ވެރިކަމު ބޭނުންކުރާ ބަނދަރަކީ މި ބަނދަރުގެ އިތުރުން، އެހެން އުޅަނދުފަހަރު އާއްމުކޮށް ބޭނުން ކުރާ ބަނދަރެއްގެ ގޮތުގައި ގުރައިދޫ ބަނދަރު ފާހަގަކުރެވިފައިވެއެވެ. އެހެންކަމުން ރާވިފައިވާ މަޝްރޫއުގެ ދަށުން ބަނދަރު މަރާމާތުކޮށް ބޮޑުކުރުމުން ބަނދަރާއި ބަނދަރުގެ ހިދުމަތް ލިބޭ އެހެން ރަށްރަށުގެ ދަތުރުވެރިންނާއި ވިޔަފާރިވެރިންނަށް ފައިދާ ކުރިއަށް ދާނެ ކަމަށް ގަބޫލު ކުރެވެއެވެ.

މަޝްރޫއުގެ ސަބަބުން ކުރިމަތިވެދާނެ ތިމާވެށީގެ މައްސަލަތައް ދެނެގަތުމަށް ކޮންސަލްޓަންޓުންގެ ޓީމުން ބަލާފައިވާ ގޮތުގައި ޖާގަ ބަލައިފި މަޝްރޫއުގެ މާހައުލު ދިރާސާ ކޮށްފައިވާނެއެވެ. އަދި ރަށުގެ ރައްޔިތުން ފާހަގަކުރާ މަޝްވަރާ ގެންދަމުން ދިޔަ ބައްދަލުވުމުގައި މި ރިޕޯޓް މަޝްރޫއުގެ ސަބަބުން ކުރިމަތިވެދާނެ ތިމާވެށީގެ އަސަރުތަކާއި އިޖްތިމާއީ އަދި އިޤްތިޞާދީ އަސަރުތަކުގެ މައްސަލަތައް ދިރާސާގައި އަލިއަޅުވާލާފައިވާނެއެވެ. ތިމާވެށީގެ އަސަރުތައް ދެނެގަތުމަށް ބޭނުންކުރެވިފައިވާ، ސައިންޓިފިކް ހަމަތަކާއި ކޮންސަލްޓަންޓުގެ ތަޖުރިބާއެވެ.

ދިރާސާއިން ހާމަވި ގޮތުގައި، މަޝްރޫއުގެ ކުޑަބޮޑު މިންވަރާއި މުއްދަތުގެ އަސަރުތަކުގެ ތިމާވެށީގެ ހާލަތަށް ބަދަލުއައުން، ހުނަރުވެރިކަމާ މަޝްރޫއުގެ ސަބަބުން ދިގުމުއްދަތަކަށް ދެމިގެންދާނެ އިއާދަނުކުރެވޭ ބޮޑެތި ގެއްލުންތަކެއް ތިމާވެށްޓަށް ކޮންސްޓްރަކްޝަން ހަރަކާތް ނުކުރެވޭ. އެހެން ނަމަވެސް ބަނދަރު މަރާމާތުކުރުމުގެ މަސައްކަތް ކުރިއަށްދާ ދުވަސްވަރު ކޮންމެވެސް ވަރެއްގެ ނުރައްކާ އަސަރުތަކެއް ތިމާވެށްޓާއި ރަށުގެ އިޤްތިޞާދީ އަދި އިޖްތިމާޢީ ވެއްޓަށް ކޮންސްޓްރަކްޝަން ހަރަކާތްތަކުގެވެ. މި ފަދަ ވަގުތީގޮތުން ކުރިމަތިވާނެ ނުރައްކާ އަސަރުތައް މި ރިޕޯޓުގައި ހުށަހަޅާފައިވާ ފިޔަވަޅުތައް އަޅައިގެން މަސައްކަތްކުރުމުން އެފަދަ ނުރައްކާ އަސަރުތައް ކުޑަކުރެވޭނެއެވެ. ދިރާސާއިން ފާހަގަ ކުރެވުނު ގޮތުގައި ބަނދަރު މަޝްރޫއުގެ ސަބަބުން ކުރިމަތިވާ ނުރައްކާ ތިމާވެށީގެ ގިނަ މައްސަލަތަކަކީ މަޝްރޫއު ތަރުތީބު ކުރަމުންދާ މަރުހަލާގައި މައިގަނޑު ގޮތެއްގައި ކުރިމަތިވާނެ ކަންކަމެވެ. ބަނދަރު ހަދާ ނިމުމުން ކުރިމަތިވި ކަންކަމުގެ އަސަރު މަދުވެގެން ފެތުރިގެންދާނެ ކަމަކުވެސް ބަނދަރު މަރާމާތުކުރި ނިމި ފުރަތަމަ ބޭނުން ހިފަންފެށުމުން ޖުމުލަ ގޮތެއްގައި ފާއިދާކުރުވާނެ ރަށަށް އިޤްތިޞާދީ އަދި އިޖްތިމާޢީގޮތުން ބޮޑެތި ފާއިދާތަކެއް ހަރަން އެކީ ބޯޓު ފައިދާތަކެއް ކުރާނެ ކަމަށެވެ.

މަޝްރޫޢުގެ ކުރިއަށް ގެންދިޔުމުގެ ސަބަބުން ކުރިމަތިވާނެ ބައެއް މައްސަލަތަކަކީ އިސްވެ ދެންނެވުނު ވިސްތާރަ ކަންކަމަށް ނުވެވި، ދިރާސާތަކުން ހާމަވާ ގޮތުގައި، ފަރުން ނަގާ ވެލި ނުނަގާ ގޮތުގައި ކުރިން ދިރާސާކުރެވުނު ތިމާވެށީގެ ކަންކަމުގައި ދެކުނު ފަރާތްތަކުގެ އެކަށީގެންވާ ކަމެއް ކަމުގައިވާ ބައިގަނޑުތައް، ތިމާވެށްޓާއި އަސަރުކުރާ ޖަނަވާރުތައް އަދި ގަސްގަހާގެހި ފަދަ ތަކެތީގެ ގުޅުން ގެއްލިދާނެ ކަމެވެ. މިކަމުގެ ސަބަބުން ހިނގުމުގެ އެކަށީގެންވާ މިންގަނޑުތަކާ ޚިލާފަށް ކުރިމަތިވާނެ ކަންކަން މި ރިޕޯޓުގައި ފާހަގަ ކޮށްފައިވެއެވެ.

މިގޮތުން މަޝްރޫއުގެ ހަރަކާތްތަކުގެ އެކަށީގެންވާ މޮނިޓަރިންގް ޕްރޮގްރާމެއް ކުރިއަށް ގެންދިޔުމާއި، މަޝްރޫއުގެ މަސައްކަތްތަކުން ކުރިމަތިވާ ތިމާވެށީގެ ނުރައްކާ އަސަރުތަކާ ރިޕޯޓުގައި ބަޔާންކޮށްފައިވާ ފިޔަވަޅުތައް އަޅައިގެން މަޝްރޫއު އެކަށީގެންވާ ގޮތުގައި ކުރިއަށް ގެންދެވިދާނެ ކަމަށް ދިރާސާއިން ފާހަގަ ކުރެވިފައިވެއެވެ.

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2. NON-TECHNICAL SUMMARY

The Ministry of Housing and Infrastructure requested the services of Maldives Energy and Environmental Company (MEECO) to provide an Environmental Impact Study (EIA) for the re-construction of harbour at Guraidhoo Island, Thaa Atoll.

The assessment addresses specific key issues stated in the Terms of Reference (TOR) as agreed between EPA and the Proponent following the Scoping Meeting held on the matter.

This EIA report was prepared for the fulfilment of the requirements of the Environmental Impact Assessment Regulations, 2012 with the purpose of conducting an assessment of possible impacts on biophysical and human environment arising from proposed development project.

The project is proposed by Ministry of Housing and Infrastructure, Maldives.

The proposed harbour reconstruction project include the following components;

1. Reconstruction of improved breakwaters for harbour basin and entrance channel;
2. Reconstruction of improved main quay wall and a side quay wall;
3. Maintenance dredging of the harbour;
4. Extension of the harbour basin;
5. Reclamation of small area of land by dredge sediment disposal;
6. Construction of revetments on a 14m section for the newly reclaimed land;
7. Installation of navigational lights.

The present harbour facility at the Guraidhoo Island is greatly damaged and is not serving its intended function of providing safe access to the island and safe mooring of vessels. Additionally, the size of the harbour is identified as inadequate for the present need and expected economic growth of the island.

The harbour forms a key part in many livelihood activities of the island and is frequently used by passenger and cargo vessels as well as vessels travelling to and from Laamu atoll. Hence, the improvement of harbour facility will greatly benefit the island community while also enabling future economic development at the island.

The proposed project is not expected to cause any long term major irreversible environmental impacts, though few temporary impacts during the construction phase is expected. These impacts can be successfully mitigated by following the measures recommended in this EIA. The construction phase of the project is also expected to present several negative socio-cultural and economic impacts, which can also be mitigated by following measures presented in this EIA. Overall, the project is expected to yield major positive impacts in socio-cultural and economic sector when the new harbour comes into operation.

Based on the results of the assessments, this EIA study concludes that with the proposed mitigation in place, the project is justifiable, would be environmentally acceptable and could proceed in compliance with the relevant environmental legislations and regulations. In this EIA, the consultants have proposed an Environmental management plan to ensure that the construction phase of the project does not cause major unexpected impacts on the environment as well as to ensure that the proposed measures are working effectively to safeguard the environment.

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3. INTRODUCTION

3.1 BACKGROUND

The Ministry of Housing and Infrastructure (MoHI) (hereafter referred as the 'Proponent') requested the services of the Maldives Energy and Environmental Company (MEECO) to undertake the Environmental Impact Assessment (EIA) for the reconstruction of the existing harbour at Guraidhoo Island, Thaa atoll.

MEECO prepared this document in accordance with the EIA Regulations (2012) and Regulation on Dredging and Reclamation (Regulation 2013/R-15) (Copy of the dredging permit is attached in Annex 3). This EIA provides a focused assessment of the proposed harbor reconstruction project in terms of existing environmental conditions, potential environmental impacts to the surrounding near shore marine environment and shorelines and social-economic impacts as detailed in the Terms of Reference (ToR) for undertaking EIA for this project (ToR is attached in Annex 1).

In 1999, a harbour was built at Th. Guraidhoo to facilitate easy access to the island and safe mooring of vessels. However, the existing structures of the harbour have seriously damaged over the last 16 years, therefore not serving their intended function to the full potential. Additionally, the size of the harbour have been identified as inadequate for the current situation due to increasing number of vessels using the harbour more frequently than before.

In order to reconstruct the existing harbour, the Proponent intends to carry-out six major tasks. They are; (1) construct new breakwaters for the harbour basin and entrance channel (2) construct new quay walls (3) maintenance dredging of shallow areas within the harbour basin and entrance to maintain an average depth of 3 meters from mean sea level (4) dredge the area next to the existing southwestern side quay wall to a depth of 3m from mean sea level for extending the harbour basin by 60m (5) reclaim a small area of land by disposing dredge material (6) construct revetments on a small section of the dredge material disposal site and (7) Installation of navigation lights. These improvements to the harbour is expected to resolve the issues faced by harbour users while ensuring the size of the harbour is adequate for the present and future use.

3.2 PURPOSE OF EIA

Given the potentially adverse environmental impacts associated with dredging and the other works in the marine environment for the proposed project at Th. Guraidhoo, the proponent has requested MEECO the preparation and submission of an Environmental Impact Assessment (EIA) report to EPA to comply with the Environmental Protection and Preservation Act (4/93) and EIA Regulations 2012.

The objective of the EIA study is:

a) To provide an assessment of the potential environmental effects of the proposal and to determine which of these, if any are likely to result in a significant effect on the environment and to propose ways and means of avoiding, mitigating and or compensating the perceived negatives effects of the project;
b) To provide necessary information to EPA applicable to the proposed development; and
c) To assess how the proposals have been developed to achieve a satisfactory level of environmental performance in line with the EIA Regulations

3.3 SCOPE OF THE EIA

This EIA is concerned with the proposed reconstruction of the existing harbour at Guraidhoo Island. The details of the EIA scope are provided in the ToR attached in Annex 1.

4. ADMINISTRATIVE AND REGULATORY FRAMEWORK

This section highlights relevant government stakeholders, their roles and reviews relevant legal framework applicable to the proposed project.

4.1 MINISTRY OF ENVIRONMENT, ENERGY AND WATER

The Ministry of Environment and Energy (MEE) is key Ministry in the government mandated with the protection of the environment. Environmental responsibilities assigned to MEE includes formulating environmental policies, coordinating, preservation and management of the environment throughout the country, and enforcing Environmental Protection and Preservation Act (EPPA) (04/93). Under Article 5(a) of EPPA, Environmental Impact Assessment is mandatory for projects that may cause potential harm to the environment. The EIA report has to be submitted to the EPA for approval before commencement of a project. As per this legislation, any project that has any undesirable impact on the environment can be terminated without compensation by MEE.

4.2 ENVIRONMENT PROTECTION AGENCY

EPA is the key regulatory body on environment, which is an autonomous body formed under the umbrella of MEE. It is mandated with implementing the EIA process in the Maldives, implementing the Environment Act and subsequent regulations on behalf of MEE, regulating water and sanitation, biodiversity conservation, waste management and coastal zone management. Also, it is responsible for developing environmental standards and guidelines in the country.

4.3 MINISTRY OF FISHERIES AND AGRICULTURE

The MoFA is mandated to ensure sustainable management of the nation's marine and terrestrial resources. The Ministry enforces fisheries and agriculture laws and regulations relating to the sustainable management of these marine and terrestrial resources. Regulations relating to protected marine animals are formulated under the Fisheries Law of the Maldives by the MoFA. All uninhabited islands and their ecological components are also management by the MoFA under agriculture laws.

Protected marine species include turtles, dolphins, black corals, the napoleon wrasse, sharks and rays, lobsters, sea cucumber, giant clams, and corals. Separate regulatory clause and notifications exist for all such species. Corals are the base of reef systems and their health and vitality is critical for the sustainable development of fisheries and tourism. Hence much importance has always been afforded for the protection of corals in the Maldives. Specific regulatory measures combined with well thought out education and awareness campaigns have almost phased out coral mining activities in the Maldives.

The Marine Research Centre (MRC) under the MoFA, through assistance from Climate Change Trust Fund formulated an innovative approach to coral reef monitoring. Given the government's policy on research and monitoring is to be trimmed down but delegate this responsibility to private sectors, the proposal is to entrust the coral reef monitoring to resorts. A web-enabled database will be created to entre, compile and disseminate the information. Tourist resorts are encouraged to take part in this activity by committing resources and its staff.

A major priority are of the Ministry is fishery management. This has become more important with third party certification of Maldives pole-and-line tuna fishery.

4.4 LEGAL FRAMEWORKS

Four regulations pertaining to the proposed project have been reviewed and the project's conformity to these have been assessed.

a) EIA Regulations 2012
b) Regulations on cutting down of Trees
c) Regulation on Dredging and Reclamation
d) Regulation and Waste Management

4.4.1 EIA regulation 2012

The most important governing law as far as the environmental impact assessment is concerned is Environment Protection and Preservation Act (Law No. 4/93) (EPPA).

EPPA mandates all development projects in the Maldives to undertake an Environmental Impact Assessment prior to undertaking any such project.

Further the EPPA states an impact assessment study shall be submitted to the relevant Government authority before implementing any development project that may have a potential impact on the environment.

It goes on to say that the relevant Authority of Government shall formulate the guidelines for environmental impact assessment and shall determine the projects that need such assessment as mentioned in above.

The law also gives power to the relevant Government authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation.

According to the EPPA waste disposal, oil and poisonous substances any type of waste, oil, poisonous gases or any substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives.

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

Under the provisions of EPPA the Government of Maldives has formulated and gazetted Environmental Impact Assessment Regulations (2012) detailing the EIA process and the EIA preparation.

In addition to EIA regulations, other relevant regulation will be followed in development and implementation of the proposed project. These regulations include ban on coral mining. Coral mining from house reef and atoll rim reef has been banned since 1990. Sand mining from any island has also been banned since March 2000.

The EPPA, EIA Regulations and other relevant regulations will be duly taken into consideration in preparing the EIA report and in the implementation of the project.

4.4.2 Regulation on cutting down trees

Cutting down and relocating of mature trees is regulated in Maldives under the by-law on cutting down, uprooting, digging out and export of trees and palms from one island to another. In the preamble of the law, made in pursuant to Law No. 4/93, it states the purpose of the law is to educate citizens and developers

about the importance of trees including sound management to maintain trees and provide standards for the preservation of trees in the Maldives.

Under the law certain tree are prohibited to remove from island. They include:

- The coastal vegetation growing around the islands extending to about 15m into the island
- All trees and palms growing in mangroves and wetlands spreading to 15m of land area
- All trees in Government protected areas
- Trees that are being protected by the Government in order to protect species of animal / organisms that inhabit on such trees
- Trees / palms those are unusual in nature.

The law states that prior permission must be obtained for removal and/or relocation of 10 or more trees or palms. For indiscriminate removal and land clearances and EIA Decision Note is required. The size of the trees and palms that are allowed to be relocated should have more than 15feet from lowest point to the crown spread for palms and 8 feet from the lowest point to the trunk to tip of the highest branch for trees other than palms.

The law also states that cutting down and uprooting of the trees shall be made under supervision of the island / atoll offices (in the current context Atoll / Island Councils).

4.4.3 Regulation on dredging and reclamation

Regulation on Reclamation and Dredging of Islands Lagoons (Regulation 2013/R-15) came into effect in April 2013. The regulation requires having permission of EPA on projects requiring alternation of the island, either by reclamation or dredging. Specifically the regulation requires producing scaled-maps of the island before and after the proposed intervention. Special provisions have been made on protected and sensitive area restricting changes to the environment of the islands.

Since any EIA submission shall be made only after successful clearance of the dredging and reclamation permit, the proponent has obtained clearance from EPA in advance as per this Regulation. A copy of the permit is given in Annex 3.

4.4.4 Regulation on waste management

Waste management Regulation (No. 2013/R-58) is more recent coming into effect on 6 February 2014. The regulation was gazetted on 05 August 2013. The regulation provides set of comprehensive guidelines on collecting, storing, transporting and managing waste. In the preamble its states the objective of the regulation is in line with the Article 22 of the Constitution which requires that development activities designed for achieving socioeconomic targets should ensure that environment and its constituent living component is not compromised and that resources are utilized effectively.

The regulation talks of the responsibilities of collection, transport, treating and storage of waste. It also talks of management centres and landfill sites and managing hazardous waste. Various sectors and entities (including tourist resorts) encouraged having their own waste management plans consistent with the Regulation.

EPA is the implementing agency of environmental law and the implementing agency of the EIA regulation.

4.5 SUMMARY

In summary, the EIA report has not identified any particular law or regulation that the project could contravene with the way it has been planned to be executed. It is concluded that the proposed project can proceed fully in compliance with the relevant laws, regulations, government polices pertaining to the protection and conservation of the environment.

5. PROJECT DESCRIPTION

5.1 PROPONENT OF THE PROJECT

The project is proposed by Ministry of housing and Infrastructure (MoHI) of the Government of Maldives with the aim of improving transportation system at the project island. The MoHI is the government institution responsible for infrastructure development and, formulation and implementation of relevant policies and priorities with regard to national infrastructure development.

Contact detail of the proponent is stated below,

Ministry of Housing and Infrastructure,
Ameenee Magu, Maafannu, Male', 20392,
Republic of Maldives,
Tel: + (960)3004300, Fax: + (960)3004301
Email: mohamed.muizzu@housing.gov.mv

5.2 STUDY AREA

The proposed project will be undertaken in the island of Guraidhoo which is roughly centered at $2^0$19' 21.73" N, 73^0 18' 58.57" E and situated on the eastern side of Thaa atoll (Figure 1). The island was once joined to a small uninhabited island situated to the east of Guraidhoo by reclamation of land on a small lagoon in between the two islands. The total land area of the island after joining with the uninhabited island is approximately 38 hectares. A land reclamation project is currently being undertaken in the island which will result in extension of land area by 45 hectares.

The island is approximately 23.4 km away from the nearest airport, situated at Th. Thimarafushi, and about 3.7 km away from the only operational tourist resort (Maalifushi by Como) in the Thaa atoll. The island is situated in the same reef system as Th. Thimarafushi, Maalifushi and Th. Gaadhiffushi which stretches about 25 km along the south-eastern rim of the Thaa atoll. No other inhabited island exist within this reef system but it has 17 more small uninhabited islands.

No protected areas exist within the Thaa atoll but few environmentally sensitive areas are located on the western and southern side of the atoll. None of these environmentally sensitive areas are located in close proximity to the project island, with the closest being approximately 26km away.

The main focus of the proposed project will be on the existing harbour of the island. This harbour was constructed in 1999 to facilitate easy access to the island and safe mooring of vessels.

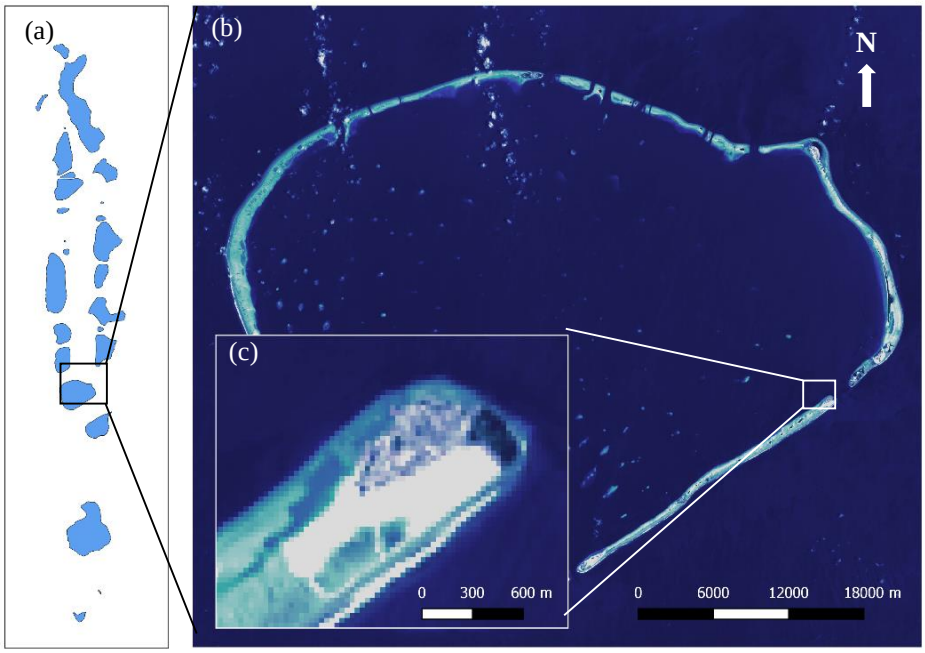

Figure 1. Overview of the study area (a) location of Thaa atoll in Maldives (b) satellite image of Thaa atoll and location of Guraidhoo (c) close up of Th. Guraidhoo (Imagery source: United States Geological Survey, Landsat 8 satellite, photo taken on 03rd October)

5.3 DESCRIPTION OF THE PROJECT SITE

The project's focus is the existing harbour located on the north western side of the island, approximately at $2^0$19' 39.77" N, 73^0 19' 11.99" E. The existing harbour basin measures 229m in length and 91m in width. The entrance channel of the harbour measures 24m in width with a 62m and 24m breakwater built on western and eastern side respectively.

Figure 2 Location of the existing harbour

The structures of the existing harbour are seriously damaged and have lost their structural integrity (Figure 3). As a result, the present condition of the harbour at Guraidhoo undermines the intended function for which it was initially built.

The existing breakwaters for the harbour and the entrance channel have had the most damage over the years, hence not serving its intended purpose of keeping the harbour area calm in rough sea conditions. There are several large cracks formed at the existing breakwater for harbour basin. The cracks are expected to have been formed due to the loose placement of the previous breakwater material or due to large empty space between the materials used. The large cracks cause the concrete bags used for the core of the structure to be taken away during strong wave action and these large cracks develop overtime causing the complete structure to crumble. The same process is expected to have caused the entrance channel breakwaters to completely crumbled providing little or no protection at all for the channel during rough seasons. These conditions are not favourable when accessing the harbour and presents a high possibility of damage to moored vessels inside the harbour.

The quay walls of the harbour have also developed cracks at various sections and the damage is expected to have been caused by drawing of sand beneath the quay wall. This process have destabilized the quay wall and causing it to tilt. This process is generally observed when the base of quay walls are constructed to the level of habour basin's depth or if an adequate part of the base is not submerged into the sediment. In such case, loose sediments are drawn into the harbour from the landward side which creates empty spaces/channels beneath and adjacent to the quay wall leading to instability of the structure.

The depth of harbour basin and the entrance channel is also expected to have become shallower over the years due to deposition of sediment that has been carried into the harbour through wave action and currents.

During the field surveys, large amounts of waste were observed floating within the harbour basin and most of it were seen aggregated on the north eastern corner of harbour. Aggregation of the wastes at this end was expected during the survey since the current was observed to be travelling in north eastern direction. The most likely source of the waste are harbour users indicating an existing operational impact from the harbour.

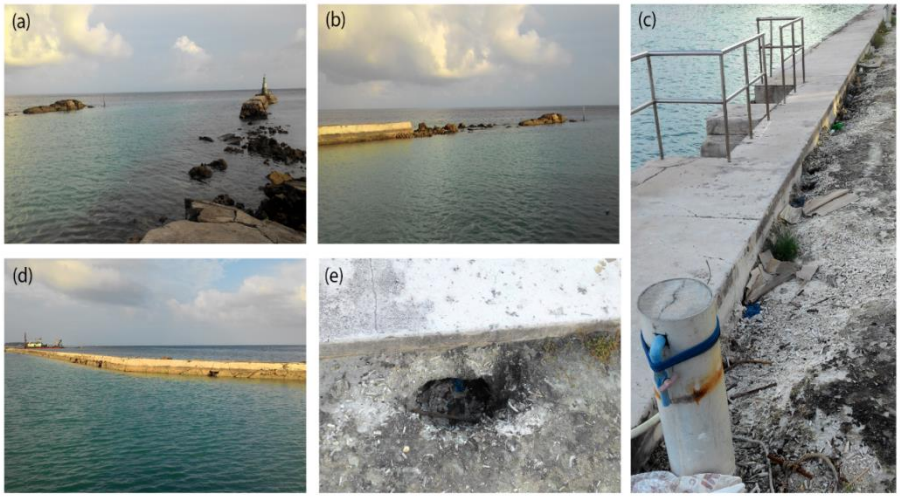

Figure 3. Existing condition of the harbour (a) completely damaged breakwaters on either side of the entrance channel (b) western side breakwater of the entrance channel (c) the main quay wall of the harbour (d) existing breakwater for the harbour basin with large cracks (e) a large whole formed adjacent to the main quay wall.

5.4 THE PROJECT

The proposed 'Th. Guraidhoo harbor reconstruction' project will carry out seven major activities to reconstruct the existing harbor of the island. A detailed drawing of the proposed project (Figure 4) and the descriptions of major activities are provided below.

Figure 4. Proposed harbour design for Th. Guraidhoo.

5.4.1 Reconstruction of breakwaters

The proposed project plans to reconstruct the existing breakwaters of the harbour and the entrance by constructing improved breakwaters. The eastern side breakwater of the entrance channel will be extended by 52m under this project.

The new breakwaters will be built using rock boulders. Concrete waste removed from the existing breakwaters and quay walls are proposed to be used as the core of the new structures. At the completion of the project, the breakwater for the harbour basin will measure 250m in length and the new western and eastern side breakwaters of the entrance channel will measure 62m and 76m respectively.

5.4.2 Reconstruction of quay walls

Under the proposed project, the existing main quay wall and southwestern side quay wall will be removed and replaced by an improved concrete quay wall. The new main quay will measure 290m in length while the southwestern side quay walls of the harbor will be 86m in length (Figure 4). A 5m x 290m concrete pavement will also be built immediately adjacent to the main quay wall (Figure 4)

5.4.3 Maintenance dredging

The proposed project will carry out dredging to deepen the shallower areas of the current harbour basin to 3m from mean sea level (msl). The dredged material from the existing harbor basin is expected to be

unconsolidated sand as the area would have been dredged to a depth of 3m during the initial harbour development.

5.4.4 Extension of harbor

The project proposes to add further 60m to the length of harbor basin from the current quay wall on the southwestern side (Figure 4). The area that requires dredging has an average depth of 0.5m below msl. Hence it is estimated that 14,493 m^3 of sand will have to be excavated to achieve a uniform depth of 3m from msl for the entire harbor basin.

5.4.5 Dredge material disposal (land reclamation)

The proposed filling area of the dredged material is located adjacent to the new side quay wall on the southwestern side of the harbor (figure 4). The area proposed for filling has an average depth of 0.5 m from msl. The resultant land reclaimed from the dredge material will be leveled to the current average land height of the island.

5.4.6 Construction of revetments

Revetments, measuring 14m in length, are proposed to be built on a small section of the reclaimed land near the seaward end of the southwestern quay wall. The location of revetments are shown in figure 4. Rock boulders and concrete waste generated from the removal of existing structures are proposed to be used for constructing the revetments. These structures will prevent erosion of areas that are most likely to be hit by strong waves.

5.4.7 Installation of navigation lights

Installation of navigation light at the end of both breakwaters of the entrance channel will be carried out during the project

5.5 PROJECT WORK METHODOLOGY

The general construction methodologies widely used in the Maldives for harbour dredging and, breakwater construction and quay wall construction will be applied in this project. The construction of the proposed breakwater extension and the maintenance dredging activities will be carried out in a manner that would minimize the impacts during the construction phase. At project commencement, the maintenance dredging of the most inner section of the harbour basin will be carried out. The dredge material will be collected onto trucks on a barge, which will transport the material to the designated fill site on the southwestern side of the harbour. A sand bund wall will then be created along the fill site boundary with the initial dredge material followed by filling in of inside the fill area. The maintenance dredging will then be moved to the other end of the harbour with the same machinery and methods. The maintenance dredging of the harbour entrance will be carried out with the placement of a silt screen at the mouth of entrance channel. The harbour breakwater reconstruction will follow, with dismantling of the existing breakwater. Placement of rock boulders on the footprint of the existing harbour will be carried out immediately after removal of existing structures to prevent sediment escape. The entire harbour breakwater, including for the extension area will be built during this process. Entrance channel breakwater reconstruction and elongation will also be carried out following the aforementioned method. Harbour extension dredging will commence once the breakwater reconstruction and maintenance dredging work is completed. The dredge material will be transferred to the adjacent fill site using a lorry. The revetment will then be constructed at the newly reclaimed fill site. The

task of building of main quay wall and the southwestern side quay wall will be begin after the extension dredging is over. Construction of the pavement adjacent to the main quay wall and installation of navigation lights will be carried out together as the last task of the project.

5.6 JUSTIFICATION OF THE PROJECT

The existing harbour at Guraidhoo is very important for the island's residents as it plays important roles in supporting the island community's livelihood activities. However, the harbour at its present state do not provide enough safety for the users and the size of the harbour has been identified by the residents as inadequate for the present and expected future need.

The island is known for fishing and production of value added fish products through local processing techniques. Currently the island has six large fishing vessels (80 – 100ft) based in the island that frequently use the harbour for mooring and access. Hence, ensuring safety for the moored fishing vessels and ease to maneuver the vessels in and out of the harbour is recognized as an important priority. Additionally, there is an ice plant facility developed in the vicinity of harbour for providing ice to fishing vessels. The island council members noted that fishing vessels in the region did visit the harbour to buy ice when the facility was in operation for two years. However, at the moment, no fishing vessels visit the island to buy as the facility is no longer in operation. It is expected that more fishing vessels in the region will start to use the harbour very frequently when the operation of facility is re-established. Hence improving the harbour and extending the size is important to accommodate expected increase in number of harbour users.

Furthermore, the existing harbour is very regularly used by passenger vessels and vessels transporting goods. According to the council members consulted for this EIA, the harbour is also used by vessels travelling to and from Laamu atoll as a safe location to stop by during rough sea conditions. Currently, 3 cargo vessels (1 from Guraidhoo and 2 from other islands) and 4 passenger boats use the harbour very frequently. The 2 cargo vessels from other islands use the harbour at least once a week while each passenger vessel makes one trip per week between Male' and Guraidhoo. There is also an atoll ferry that use the harbour and a daily ferry that carries people working at Maalifushi resort to and from Guraidhoo. According to the council members, a common complaint received from the harbour users, especially from the large cargo and fishing vessels, is the small size of the entrance channel and the lack of adequate protection provided by the existing entrance channel breakwaters.

Therefore, in addition to improving safety of the frequent harbour users and developing a harbour of an adequate size, improvement of harbour entrance design and structure is also important for the harbour users. The reconstruction of breakwaters using rock boulders is expected to result in more durable structures that can withstand strong waves while elongation of the eastern side harbour entrance breakwater will provide more protection for the vessels from waves and strong currents when entering the harbour. The new improvements for the entrance channel breakwaters are also expected to shield the harbour basin from the strong currents, hence resulting in relatively calmer conditions inside the harbour than the surrounding waters.

5.7 INPUTS AND OUTPUTS

The key inputs required for the project implementation are; machinery, cement, rock boulders, electricity, fuel, water, workers, accommodation for workers and other materials required for construction works and maintenance and servicing of the machinery.

The contractor will be responsible for sourcing and transfer of equipment and workers to and from Guraidhoo. The machinery carried to the island should be in good condition to avoid delays during the project due to breakdowns of machinery. The contractor should also take the responsibility of arranging adequate accommodation for the workers.

Electricity and water required for the project site can be obtained from the island. The contractor will fulfill the necessary mechanisms established at the island for connecting electricity and water to the project site. The raw materials required for the project, such as cement and rock boulders, and fuel and lubricants required for operation of machinery will be sourced and transferred to the island by the contractor. The contractor is required to store fuel barrels and any type of oil (e.g. lubricants) at a safe location that ensure safety of humans and environment.

A detailed list of inputs required for the implementation of the proposed project and their descriptions are provided in the Table 1 below.

Table 1. Project inputs and their description

Input	Description
Workers	Skilled and licensed workers should be employed to operate the machinery in order to run the operation smoothly and to ensure safety for the workers and the locals
Accommodation	Workers will need adequate accommodation with basic facilities
Excavator	Excavator will be used to mechanically dredge the areas that needs deepening inside the harbour and to dredge the extension area of the harbour. The excavator will also have to be used for spreading and leveling the dredge waste at the disposal sites
Barge	A barge will be used to base the excavator when accessing areas that cannot be reached by only the excavator
Crane	A crane is expected to be used for lifting heavy concrete blocks when removing the existing breakwaters and the quay walls.
Dump truck	Dump trucks will be used to transport the dredge waste from the dredge site to the disposal area
Concrete mixer	This will be used to produce concrete mix that is required for reconstruction of new structures
Rock boulders	To be used for construction of the new breakwaters and the revetment
Cement	Cement will be a major raw material for the construction of the habour. Cement will be required to construct the quay walls and the pavement adjacent to the main quay wall
Fuel and lubricants	Fuel and lubricants will be required for the operation of machinery.
Electricity	Electricity required for the construction purposes are to be sourced from the island.
Water	Water needed for construction and other purposes will be obtained from the island

The main outputs of the proposed project are the structures of the harbour and waste that will be generated throughout the project.

There are four types of wastes that is expected to be generated at the construction phase of the project. They are dredge waste, concrete waste from dismantled structures of the existing harbour, general solid waste and hazardous waste such as oil, lubricants, chemicals, batteries etc. Among these, dredge waste and concrete waste will be generated in large quantities while the quantity of other two types of waste is expected to be very low.

The two main types of wastes generated from the project are planned to be used during the project. The dredge waste generated from maintenance dredging and extension of harbour will be used for reclaiming a small area of land on southwestern side of the harbour. The concrete waste generated during the project are to be used as the core of new breakwaters and for construction of revetments at the reclaimed land.

The key structures of that will be built under the proposed project and expected forms of waste are listed and described in the table 2 below.

Table 2. Expected outputs and their description

Output	Description
Dredge material	An estimated 28,600.91 m^{-3} of dredge material is expected to be produced from maintenance dredging and harbour extension dredging
Concrete waste	Significant amount of concrete waste will be generated from dismantling of existing breakwater structures and the main and side quay wall
Hazardous waste	The expected form of hazardous waste from the project are used lubricant oils of the machinery and equipment
Solid waste	Some amounts of solid waste is expected be generated from daily activities of the workers as well as from construction activities
Extended harbour	The harbour will be extended by 60m to the southwest from the location of present side quay wall
New quay walls and adjacent pavement	The final harbour will have a new main quay wall built in place of the present quay wall along with new main quay wall for the extended area of the harbour. A pavement measuring 5m in width will be built along the 290m stretch of the new main quay wall. In addition, a new side quay wall will measuring 86m will be built on southwestern side
New breakwaters	A total length of 250m harbour breakwater will be built under this project, which includes replacing existing breakwater structures and extending it to the newly extended area. The entrance channel breakwaters will also be replaced and the eastern side extended by 52m
Reclaimed land	Approximately xx m^2 of land will be reclaimed adjacent to the new southwestern side quay wall by disposing dredge material
Revetments	Revetments measuring 14m will be constructed on a small section of the newly reclaimed land
Entrance channel navigation lights	New navigation lights will be placed at the ends of entrance channel breakwaters

5.8 PROJECT SCHEDULE

The project is expected to take approximately one year to complete. The table below indicates the tentative durations for all the expected stages of work.

Table 3. Major tasks and their expected durations

Description	Duration (Days)
Preliminary works	7
Mobilization	14
Site setup	15
Survey	7
Dredging (for maintenance and extension) and filling	60
Quay wall construction	60
Breakwater construction	60
Revetment construction	45
Pavement construction	30
Installation of navigation lights	7
Out survey	7
Site clearance	14
Demobilization	14

5.9 PROJECT BOUNDARY AND ENVIRONMENTAL IMPACT ZONE

The major impacts from the proposed project are anticipated in the immediate marine environment at the project site. Therefore, basing on experience from such projects and expert opinion, an expected environmental impact zone is identified for conducting baseline surveys and to study the extent of expected environmental impacts.

The proposed project will be carried out at an area of approximately 990 m^2 as indicated by yellow polygon in the figure 5. The implementation of the proposed project is expected to have some impacts inside the project area as well as immediate surrounding marine environment covering an area of 1681 m^2 (indicated by red polygon in figure 5).

The figure below shows the project boundary and the identified area where environmental impacts are expected to occur.

Figure 5. Proposed poject boundary and expected impact boundary

6. SURVEY METHODOLOGIES

6.1 CLIMATE

Climate data for the specific location of Guraidhoo is not available. Therefore, long term climatic data acquired from the closest location, L. Kahdhoo airport, were used to assess and predict the conditions at Guraidhoo. The Maldives Meteorological Service (MMS) have a weather monitoring station based at L. Kahdhoo airport where they have been recording weather data since 1992. It is assumed that the data obtained from L. Kahdhoo station will provide a reasonably good overview of the climatic conditions at Guraidhoo. The climatic factors assessed from the available historical data are temperature and rainfall. Reference to published literature and information from MMS were used to describe the general pattern and speed of wind, tides and waves prevalent across the country and, to predict likely occurrence of natural disasters.

6.2 MARINE ENVIRONMENT

The figure 6 below shows the locations where benthic cover and water quality assessments were undertaken.

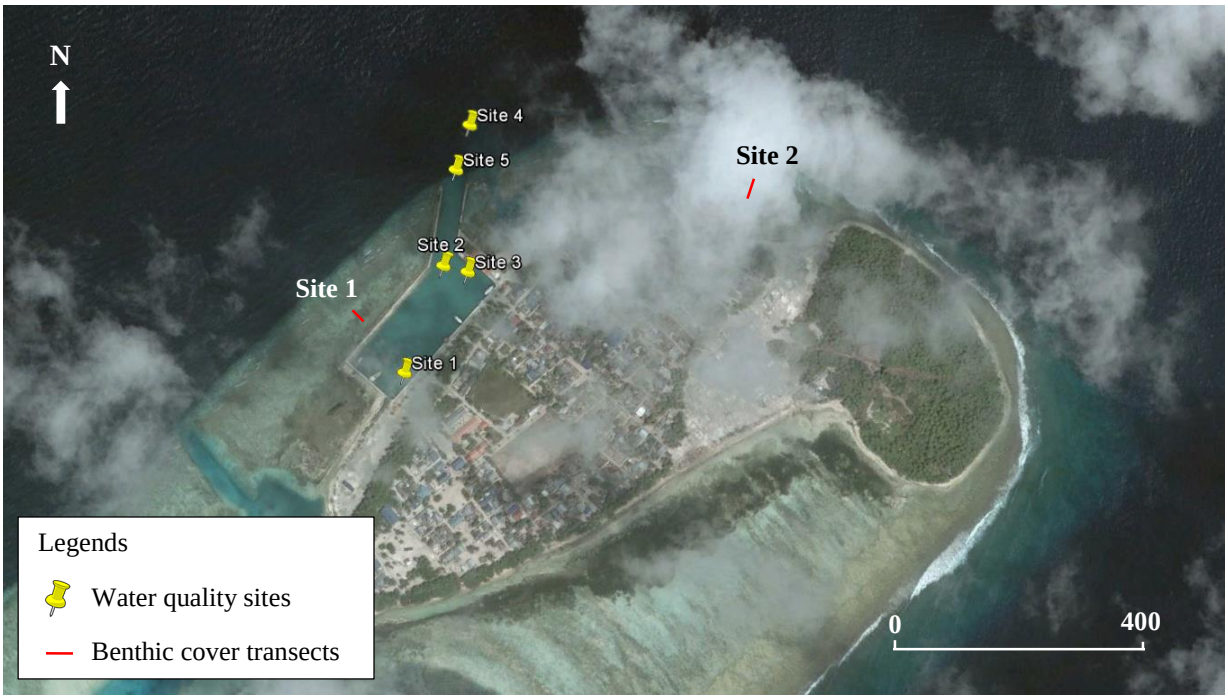

Figure 6. Location of marine surveys

6.2.1 Bathymetry

Bathymetric survey was carried out for the entrance and harbour basin, proposed filling site, reef area adjacent to the harbour and for an alternative filling site proposed by the island council. The bathymetry was studied using dinghy mounted GPS and HI-TARGET SONARMITE for the areas deep enough to access by boat and, using a handled depth recorder and GPS for the shallower areas.

6.2.2 Benthic cover

The benthic cover for the area was studied using Line Intercept Transect (LIT) method. Two transects measuring 20m in length were used for the study. One transect was placed outside the harbour, perpendicular to the harbour breakwater, moving towards the reef edge. Similarly, the other transect was placed perpendicular to the shoreline leading towards the reef edge. The location of transects are shown in the Figure 6. The benthic cover classes used for the assessment are; live coral, dead coral, rubble, sea grass and fine sand.

6.2.3 Fish abundance

The abundance of various fish species at the survey site were studied qualitatively, hence arriving at a relative abundance category for the species present at the site. This was done by videoing the area with an underwater camera and later assessing the species and number of fish observed at the site. Qualitative categories were then assigned to the species to describe their relative abundance. The categories used for the study are; abundant, common and rare.

6.2.4 Water quality

For this EIA, in situ water quality assessments were carried out at different locations. A HORIBA U-52 Multiwater Quality Checker was used to analyze the quality of water. The instrument, which has been span calibrated using standard grade reagents, uses voltammetric methods to analyze conductivity, Dissolved Oxygen (DO) and Total suspended Solids (Turbidity) of water samples. All the parameters were measured and logged in real time on field which preserves the chemical constituents in equilibrium with their natural physio-chemical environment, thus giving a more accurate picture of the quality and status of water samples. This technique is more reliable than wet laboratory chemical analyses which would require numerous pre-processing steps to alleviate the effect of reduced and oxidized material. The GPS locations where water quality assessments were done are shown in Figure 6.

6.2.5 Near-shore current

The direction and velocity of surface current inside and outside of the harbour basin were assessed using a Garmin foretrex301 GPS tracker. This device was left on the surface of water and let to drift along with the current for some time. The tracker records its GPS location and time at set intervals. These information are then used in a software to deduce the velocity and the direction of current.

6.3 TERRESTRIAL ENVIRONMENT

No extensive studies were carried out to assess the terrestrial flora and fauna of the island since the proposed project is not expected to have an impact on the terrestrial environment. However, name and number of trees present near the harbour extension area were recorded as they will have to be removed for the harbour extension.

6.4 SOCIO-ECONOMIC SETTING

The socio-economic setting of the island was studied using several sources. This includes published reports such as Preliminary results of 2014 census, 2006 Census report. Socio-economic information were also obtained from the island council through a questionnaire and through direct consultation with council

members. Additionally, observation made during the visit to the island were used to describe the socio-economic setting of the island.

6.5 IMPACT ASSESSMENT

Following data analysis, literature review and stakeholder consultations, a system called Rapid Impact Assessment Matrix (RIAM) was used to organize the EIA. RIAM methodology as described in detail by Jensen et al (1998) brings together the individual multi-disciplinary parts of an EIA in a transparent and semi quantitative manner. It keeps transparent control of the components in a distinct semi quantitative manner allowing direct comparison of different problems, and above all it allows a holistic and coherent anticipation of problems. This methodology has been found be effective for EIA involving coastal development projects.

The process of defining the components, which are of importance in evaluating the possible changes due development, is called scoping. In the RIAM these components are considered in a holistic manner and fall into four groups. These groups represent the issues relating to the Physical/Chemical environment (P/C); those relating to Biological/Ecological (B/E) concerns; human issues defined as Social/Cultural (S/C); and issues dealing with the Economic/Operational (E/O) aspects of development.

In the RIAM analyses, all problems are analyzed according to five characteristic criteria. Two criteria relate to properties that are of singular importance to the condition, and three criteria to properties that are of value to the situation. The first type of criteria is: the importance of the condition, which is assessed against the spatial boundaries or human interests it will affect; and the magnitude, which is defined as a measure of the scale of benefit/dis-benefit of an impact of a condition.

For the importance of condition (I) the scale is defined as:

4 = important to national/international interests
3 = important to regional/national interests
2 = important to areas immediately outside the local condition
1 = important only to the local condition
0 = no importance

For the magnitude of a change or effect (M) the scale is defined as:

+3 = major positive benefit
+2 = significant improvement in status quo
+1 = improvement in status quo
0 = no change/status quo
-1 = negative change to status quo
-2 = significant negative dis-benefit or change
-3 = major dis-benefit or change

Criteria that are of value to the situation are defined as permanence, reversibility and cumulative properties. Permanence defines whether a condition is temporary or permanent, e.g. an embankment is a permanent condition even if it may one day be breached or abandoned, whilst a coffer dam is a temporary condition, as it will be removed.

Reversibility defines whether the condition can be changed and is a measure of the control over the effect of the condition.

Cumulative property is a measure of whether the effect will have a single direct impact or whether there will be an accumulated effect over time, or a synergistic effect with other conditions.

Table 4. The scale used for the criteria that are of value to the situation

Score	Permanent (P)	Reversible (R)	Cumulative (C)
1	No change / not applicable	No change / not applicable	No change / not applicable
2	Temporary	Reversible	Non-cumulative / single
3	No change	Irreversible	Cumulative / of indirect effect / synergistic

Table 5. Range bands used for RIAM

Environmental classification (ES)	Value of the class	Value of the class (numerical)	Description of the class
72 to 108	E	5	Extremely positive impact
36 to 71	D	4	Significantly positive impact
19 to 35	C	3	Moderately positive impact
10 to 18	B	2	Less positive impact
1 to 9	A	1	Reduced positive impact
0	N	0	No alteration
-1 to -9	-A	-1	Reduced negative impact
-10 to -18	-B	-2	Less negative impact
-19 to -35	-C	-3	Moderately negative impact
-36 to -71	-D	-4	Significantly negative impact
-72 to -108	-E	-5	Extremely negative impact

The assessment of the different problems that have been selected for evaluation by the scoping process gives a value ascribed (by the consultants) to each of these criteria. By the use of a simple formula a score (the environmental score) for the individual components was calculated:

ES = I*M*(P+R+C)

To use the evaluation system described, a matrix of cells showing the criteria used, set against each defined component, is produced for each project option. From the formulae given above each ES number is calculated and recorded. To provide a more certain system of assessment, the individual ES scores are banded together into ranges where they can be compared. The ranges cover impacts from a major positive change/impact (+5/E) to similarly negative effect (-5/-E). Conditions that have neither importance nor magnitude will score a zero and be banded together (0/N); and any condition in this band is either of no importance or represents the status quo, or a non-applicable situation.

7. EXISTING CONDITIONS

This section outlines the existing environment of the proposed project area with reference to surveys carried out during the EIA study while also making use of other available sources to describe the environmental and socio-economic setting as comprehensively as possible.

7.1 METEOROLOGY AND CLIMATE

7.1.1 Temperature

Analysis of 21 years (1992 – 2012) of records show that daily average temperatures of Kadhdhoo does not go above 33.2°C. The mean daily maximum temperature for Kadhdhoo has been found to be at 31.2°C while the mean minimum temperature is 25°C (Figure 7).

In relative terms, the period from March to May with an average daily high temperature above 31°C are the hottest period of the year while the hottest month of the year is April reaching a mean temperature peak of above 32°C (Figure 8).

The cool periods lasts from October/November to January with an average daily high temperature below 30ºC. The coldest day of the year is around mid-December, with an average low of 26°C and high of 30ºC. The sea surface temperature in the Indian Ocean in July 2014 is recorded to be around 29-30°C.

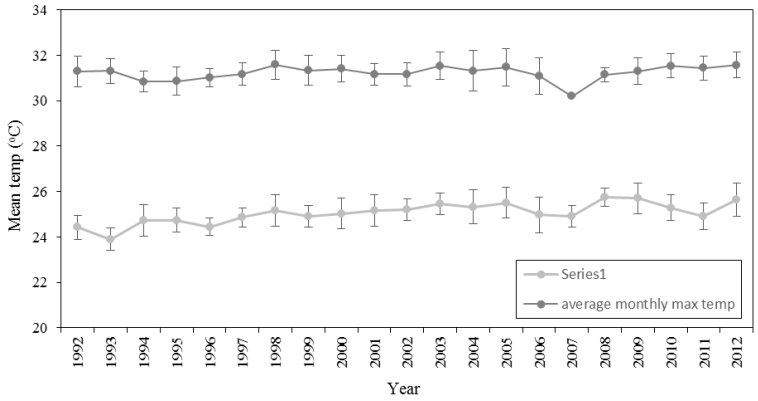

Figure 7. Variations in mean yearly temperature in Kadhdhoo (1992-2012)

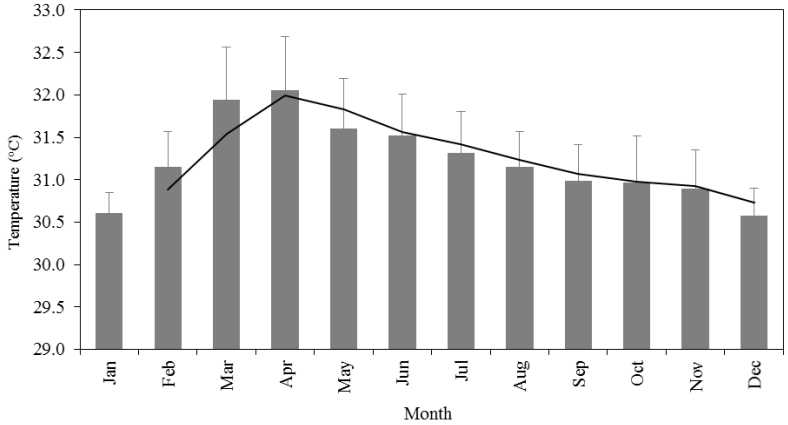

Figure 8. Average monthly maximum temperature based on 21 years of data (1992-2012).

7.1.2 Rainfall

Maldives rainfall is mainly determined by the two seasons: the northeast monsoon and the southwest monsoon. The southwest monsoon prevailing from May to November is the rainy season and the northeast monsoon from January to March is the dry season.

Analysis of the rainfall data for the past 22 years (1992-2013) shows high variability from year to year with an average yearly mean of 2216.3 mm as shown in the Figure 9.

Average monthly rainfall analysis show a general increase in rainfall as the year progressed from January to December. February and March are the driest months while the month of October is the wettest month. Last four months of the year from September through to December, the average rainfall is significantly higher than the rest of the months except in the month of May.

Figure 9. Yearly total rainfall data for the period 1992-2013 (the dark grey line shows the yearly mean rainfall for the 22 years).

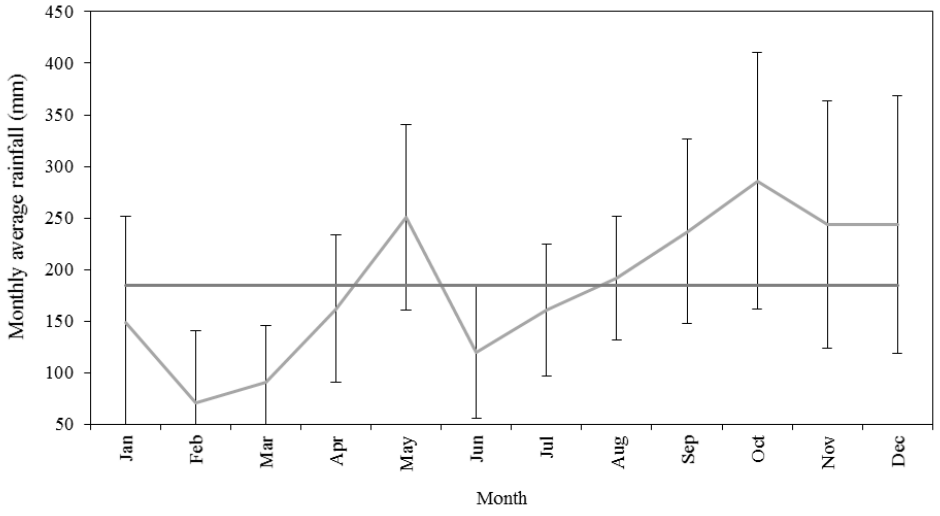

Figure 10. Average rainfall for the twelve months of the year for Kadhdhoo Island (1992-2013). (The solid dark gray line indicates monthly average).

The average monthly rainfall of 185 mm is expected based on totals annual rainfall figures obtained for the 22 year period. The lowest mean rainfall occurs in February (70 mm), while the highest mean rainfall is expected in October with 286 mm. As Figure 10 shows for almost the first half of the year (except May) the mean monthly rainfall is below the yearly average for a month, whereas the last 5 month spanning from August through to December the average monthly rainfall is higher than yearly average for a month taken for the 22 year period.

7.1.3 Wind

The climate of the Maldives can be divided into two monsoon periods marked by strong seasonal reversals in wind direction that are confined to a narrow range of wind angles. Summary wind data since 1964 (Figure 11) indicate that the Maldives experience west to northwest winds (2250–3150) from April to November during the Hulhangu monsoon with a mean wind speed of 5.1 m s-1. In contrast the Iruvai monsoon, from December to March, is characterized by winds from the east-northeast (450–900) with a mean wind speed of 4.9 m s-1. Wind strength is most variable during the crossover between northeast and westerly monsoons with mean wind speed falling to 3.5 m s-1 in March (Department of Meteorology, 1995).

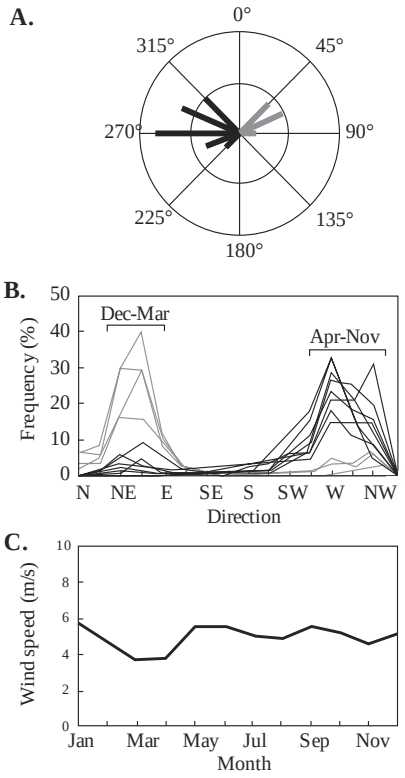

Figure 11. Summary of wind data for the Maldives showing A) 30-year mean percent frequency wind direction B) 30-year mean monthly percent frequency wind direction; C) 30-year mean monthly wind speed. Climate data from Government of Maldives, Department of Meteoro1ogy, (1995) adapted from Kench et al; (2010).

Strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to October. During stormy conditions gusts of up to 50-60 knots have been recorded at Kadhdhoo (data from Maldives Meteorological Services).

7.2 TIDES

Tides experienced in Maldives are mixed and semidiurnal/diurnal. Typical spring and neap tidal ranges are approximately 1.0m and 0.3m, respectively. Maximum spring tidal range in the southern atolls is approximately 1.1m. There is also a 0.2m seasonal fluctuation in regional mean sea level, with an increase of about 0.1m during February to April and a decrease of 0.1m during September to November. Like in most other atolls, semidiurnal tides are experienced in Laamu Atoll is two high tides and two low tides a day. The tide varies from place to place, depending on the location and on the shape and depth of the basin, channels and reefs and also time of the year. Tidal variations in Maldives are presented in Table 5. In the Maldives, tides may have significantly important influence on the formation, development, and sediment movement process around the island.

Table 6. Tidal variations in Maldives with respect to mean sea level

Tide Level	Referred to MSL
highest astronomical tide (HAT)	+0.64
mean higher high water (MHHW)	+0.34
mean lower high water (MLHW)	+0.14
mean sea level (MSL)	0.00
mean higher low water (MHLW)	-0.16
mean lower low water (MHLW)	-0.36
lowest astronomical tide (LAT)	-0.56

7.3 CURRENTS

Currents which affect the sea area around the Maldives are caused by one or more of the following system:

- Oceanic currents.
- Tidal currents.
- Wind-induced currents.
- Wave-induced currents.

The oceanic currents flowing across the Maldives are notorious for their strength. The exposure of the Maldives to the vast Indian Ocean ensures that an immense body of water is constantly flowing across the plateau on which the atolls are built. Currents in the channels near Male have been recorded at 4 knots or more. Inside an atoll, current speeds are more settled. Oceanographic currents are driven by two monsoonal winds, namely the westerly and north easterly wind. The westerly flowing current tend to dominate from January to March while the easterly currents dominate from May to November. The changes in current flow patterns occur in April and December. The current velocities are about 0.5m/s, only in may values may increase to 0.8m/s.

The surface current readings taken during this study found currents travelling in ENE direction with an average speed of 0.25 ± 0.096 ms^{-1} inside the harbour. The surface current outside the harbour also travelled in the same direction and had a relatively similar speed of 0.27 ± 0.172 ms^{-1}. The map below show the location and drift track created by the device used for measuring the current.

Figure 12. The location of current measurement and its track

7.4 HAZARD VULNERABILITY

In 2009, through DIRAM Project by UNDP (2006), the natural vulnerability of the islands and atolls of the country to potential hazards have been modelled to understand the risk factors of the country. The disaster risk scenario for Maldives can be described as moderate in general. Despite this, Maldives is among the most severely affected countries hit by the Asian tsunami on December 2004. The report identified the existing vulnerabilities and identified mitigation measures with costing. The report had identified children, women and low income households as the most vulnerable.

Natural hazards that may occur at the project location can be broadly classified into geological and meteorological hazards. Based on the different types of hazards identified in DIRAM, the following hazards have been predicted to be particularly relevant to the project site in relation to the project components:

- Wind storms and cyclones;
- Swell waves and wind waves;
- Wind storms;
- Flooding due to heavy rainfall/storms;
- Tsunami.

DIRAM report has stated that major natural hazards in the Maldives are strictly controlled by the geophysical and climatic settings and show quite different patterns in their distribution, as shown in Figure 13.

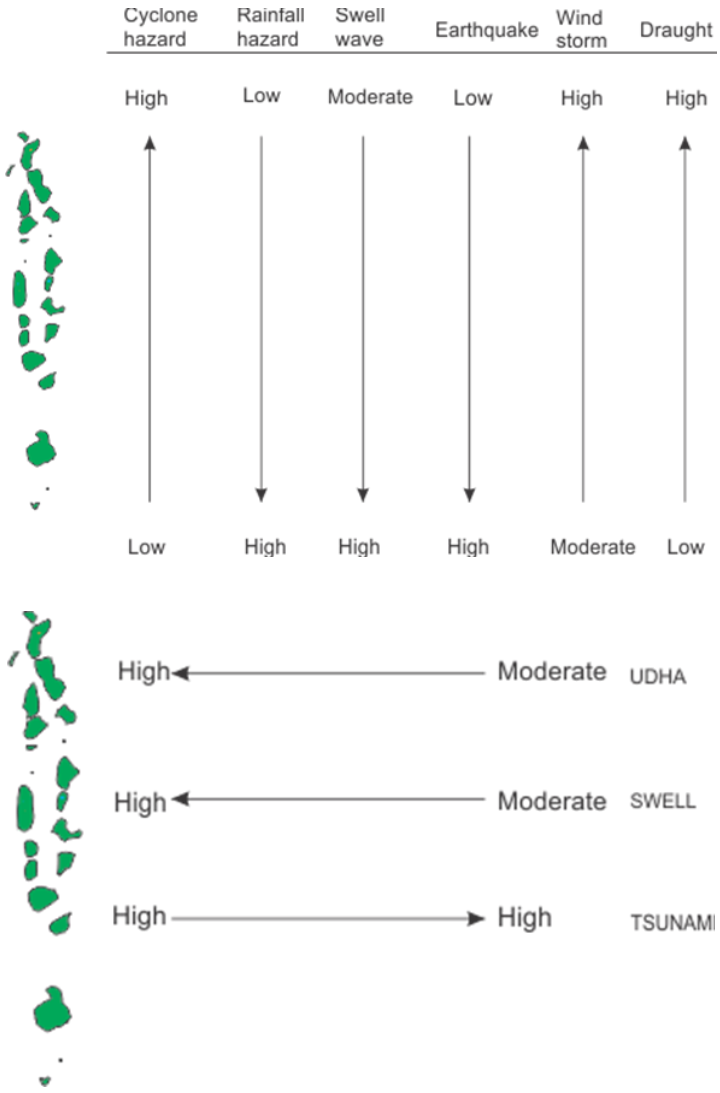

Figure 13. Major natural hazards distribution pattern in the Maldives. (A) Latitudinal variations of major natural hazards. (B) Longitudinal variations of major natural hazards across the Maldives (Adapted from UNDP, 2008)

Hazards, frequencies, and damage potential for the Maldives is summarized in Table 6 (UNDP, 2005).

Table 7. Hazards, frequencies and damage potential for the Maldives

Hazard	Tsunami	Swell waves or storm surges	Rainfall flooding	Strong winds
frequency	Once in 200 years	-	Once in 1 year	Several times a year
Potential damage	Very high	high	moderate	low

The project island is relatively at very low risk of cyclone and draught hazard, though risk of other hazards such as swell waves, rainfall and wind is expected to range between moderate to high.

7.5 MARINE ENVIRONMENT

7.5.1 Bathymetry

The bathymetric map produced from the survey is attached in the Annex 2 of this report. The key findings from the bathemetric survey are summarize in the table 7 below. The main finding that will have the biggest impact on the proposed project is the production of excess dredge material. At present, the average depth of the harbour area is 2.5m below msl. Approximately, 20,600 m^3 of excess dredge materials are expected after filling the proposed area. Moreover, even after filling the alternative site proposed by the island council, an excess of 14,600 m^3 of dredge material is expected.

Table 8. Key findings from the bathymetric survey for the proposed project

Description	Quantity (m^3)
Dredge material from maintenance dredging	16272.67
Dredge material from harbour extension	12328.24
Total dredge material	28600.91
Fill quantity required for proposed site	8000.00
Excess after filling proposed site	20600.91
Fill quantity required for alternative site	6000.00
Excess after filling proposed and alternative site	**14600.91**

7.5.2 Benthic cover

Benthic cover at the two surveyed sites are considerably different from each other (Figure 14). However, rubble and sea grass is observed to be the two most dominant cover types at both the sites, despite the large difference observed for these two cover types at the two sites. The site outside the harbour (site 1) is mostly dominated by rubble, making 73% of the areal cover followed by sea grass (15%) while the other site had sea grass (51%) as the most dominant cover followed by rubble (32%). Live corals were not recorded at the transect 2 but a small percentage of live coral cover (10%) are observed at the transect 1.

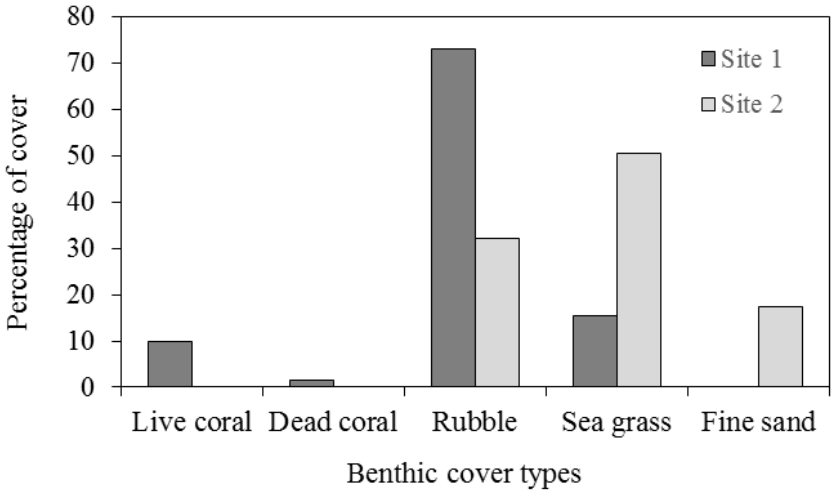

Figure 14. Percentage of benthic cover at survey sites

7.5.3 Fish abundance

The species of fish observed during the survey and their relative abundance are provided in the Table 8 below. Overall, the species belonging to Acanthuridae family are very common at the site. During the survey *Acanthurus auranticavus* were mainly observed feeding in schools. The butterfly fishes (Chaetodontidae) were not common but four species were seen at the site, which makes them the second highest in number of species observed for a single family. Species belonging to the family Labridae were fairly common at the site. Additionally, an interesting observation of a Napoleon wrasse (*Cheilinus undulatus*), a species belonging to Labridae family, was made outside the survey period.

Table 9. Fish abundance at the reef area adjacent to the harbour

Family, *species*	**Relative abundance**	**General description of the family**
Acanthuridae		
Acanthurus auranticavus	Abundant	Very common across Maldivian reefs, with 30 species from this family known to be occur in Maldives. Most species mainly feed on algae while some supplement this with various planktons
Acanthurus lineatus	Common	
Acanthurus leucosternon	Rare	
Acanthurus triostegus	Rare	
Acanthurus blochi	Rare	
Naso brevirostris	Rare	
Ctenochaetus striatus	Rare	
Chaetodontidae		Butterfly fishes – Fairly common across Maldives. 32 species out of about 120 species are seen in Maldives. Diet include filamentous algae, small invertebrates, plankton, and coral.
Chaetodon collare	Rare	
Chaetodon meyeri	Rare	
Chaetodon triangulum	Rare	
Chaetodon trifasciatus	Rare	
Balistidae		17 species are known to exist in Maldives. Diet includes snail, sea urchin and other invertebrates.
Balistapus undulatus	Rare	
Sufflamen bursa	Rare	
Melichthys indicus	Common	
Labridae		Wrasses – Species of this family present in Maldives occur very commonly at reefs.
Thalassoma hardwicke	Common	
Gomphosus caeruleus	Rare	
Thalassoma amblycephalum	Common	
Scaridae		Family of parrotfishes. 23 species of scarids are known to occur in Maldives. Feeds on algae by scraping from corals. Also eat sea grass, coral polyps and invertebrates.
Scarus frenatus	Rare	
Scarus ghobban	Rare	
Serranidae		A very large family with more than 400 species. Groupers are the most common in Maldives. Mainly carnivorous
Cephalapholis argus	Common	
Nemipteridae		Out of 64, only 3 species found in Maldives. Feed on worms and small invertebrates
Scolopsis bilineata	Rare	
Zanclidae		A family with only one species which is fairly common in the Maldives. Feed on coral polyp and small invertebrates
Zanclus cornutus	Rare	

7.5.4 Water quality

The water quality test results indicate a high level of turbidity at the sites (sites 1 to 3) within in the harbour basin (Table 9). The highest turbidity level of 9.3 Nephelometric Turbidity Units (NTU) was observed at the site near the area where harbour entrance connects with the harbour basin. The site 4 and 5 showed a low turbidity level of 0 and 0.6 NTU respectively.

Table 10. Water quality test results from 6 locations near proposed project area.

Name	Salinity (ppt)	pH	Turbidity (NTU)	Dissolved Oxygen (mgL^{-1})	Conductivity ($mScm^{-1}$)	Temperature (^0C)	TDS (mgL^{-1})
Site 1	32.7	8.44	4.7	15.00	50.0	27.92	30.5
Site 2	32.3	8.46	9.3	13.06	50.7	27.92	30.4
Site 3	33.4	8.43	6.7	12.54	50.8	27.80	30.5
Site 4	32.9	8.51	0.0	16.52	50.2	28.88	30.2
Site 5	30.2	8.47	0.6	15.25	48.6	28.51	30.2

7.6 TERRESTRIAL ENVIRONMENT

The trees that will have to be removed to carry out harbuor extension and building of quay walls are listed below**.** The main trees that will have to be uprooted and relocated are the *Cocos nucifera.*

Table 11. Trees present at the harbour extension area.

Local name	Scientific name	number
Ruh	*Cocos nucifera*	18
Dhiggaa	*Hibiscus tiliaceus*	1
Hirun'dhu	*Thespesia populnea*	6
Boashi	*Tournefortia argentea*	1
Uni	*Guettarda speciosa*	1
Kuredhi / keredhi	*Pemphis acidula*	1
Kaani / Kauni	*Cordia subcordata*	1

7.7 SOCIO-ECONOMIC SETTING

7.7.1 Population

According to the preliminary results of the 2014 census, the resident population of the island is 1,248 people (figure 15) comprising 634 males and 614 females. There are further 69 foreigners working in the island. The island council estimates the registered population of the island to be around 2050 people. This suggests that about 61% of the registered population currently resides in the island. The island's resident population is higher than the atoll's capital, Veymandoo, and also has the highest resident population in the atoll with a 13.85% share of total atoll population. An average annual population growth rate of 1.1 was observed for the island between the 2006 and 2014 census. The population density of the island is 34 people per hectare (newly reclaimed land area excluded for the calculation as the project is not yet completed).

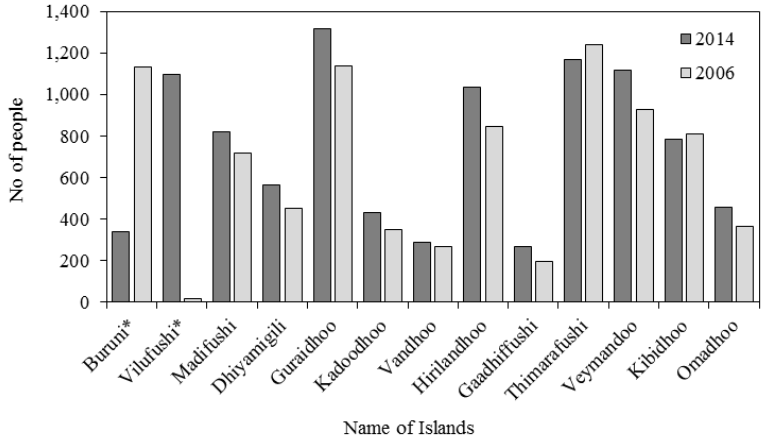

Figure 15. Population of the Thaa atoll, (Source: Preliminary results of 2014 census and 2006 census results, National Bureau of Statistics)

The population pyramid for Th. Guraidhoo, constructed from the published 2006 census figures, suggests that the majority of population is below 35 years of age (figure 16). The sex ratio is approximately 1:1 for the age groups between 1 year and 20 years while females greatly outnumber males in the age groups between 20 and 45 years.

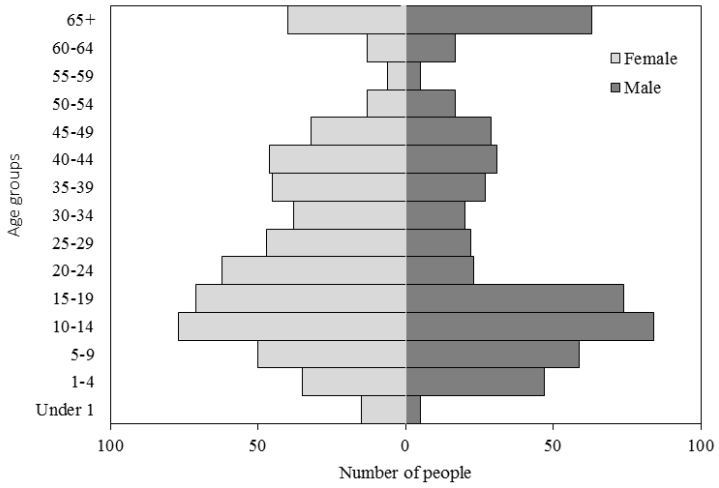

Figure 16. Population pyramid for Th. Guraidhoo

7.7.2 Economic activities

The livelihood of Guraidhoo people depend on a diverse range of activities. Public sector employment, fisheries related activities and employment in the tourism industry are the main sources of income for the residents of Guraidhoo. Additional sources of income for the island people include operation of small businesses such as retail shops, cafés and restaurants.

Government institutions present in the island are; Island council office, Post office, Police station, Health Centre, School and Fenaka Co ltd. These government institutions play an important role in providing basic services as well as provide employment opportunities for the residents of the island.

Fishing and fisheries related activities are an important source of income for the residents of Guraidhoo. At present, 6 fishing vessels, measuring approximately 80-100ft in length, operate from the island. An average of 18-20 fishermen work in each of these vessels. The most common type of fishery practiced by the fishermen of Guraidhoo are pole and line fishery and handline yellowfin tuna fishery. An ice plant facility is present in the island to provide ice for the fishing vessels. The ice plant facility is currently not in operation but the island council expects the facility to become operational very soon. The facility is now leased out to a private company for 15 years under the condition that it operates in the island for 11 years. In addition to providing ice for local fishing vessels and vessels from other islands, the facility also provides employment opportunities.

Residents of Th. Guraidhoo are also involved in value addition to fish through local processing techniques. Currently there are 14 people involved in this business. The value added products produced in the island are; salted fish (by 2 processors), smoked/dried fish (by 12 processors) and fish paste (Rihaakuru). Fish paste production is mainly undertaken by women.

The development of Th. Maalifushi as a resort island has brought many employment opportunities for the residents of Guraidhoo. Working in Maalifushi resort is very convenient for the people since there is daily ferry service between the island and the resort. According to the council members consulted for this EIA, the resort is currently providing employment opportunities for more than 100 individuals from Guraidhoo.

8. STAKEHOLDER CONSULTATION

The stakeholder consultation with the island council was conducted on 12th November 2015 at the Th. Guraidhoo council office. The island council assured the consultants that they have consulted the general public regarding the harbour reconstruction project. These consultations were carried out by calling a general meeting where public express their views on the proposed development. Additionally, the council members noted that they have consulted individual senior members of the public regarding the development. Basing on the aforementioned consultations, following are the main concerns raised by the island council.

1. The council has plans to develop a cargo loading and unloading area at the proposed fill site.
2. The council expressed their interest in moving the jetty at harbour, to the northeastern side, so it aligns with the main road of the island.
3. The council proposed an alternative fill area, on the northeastern side of the island. According to the council members, the proposed alternative area is known for erosion and was also filled during the initial harbour construction work. However, the fill materials have since eroded, reaching the edge of the waste disposal site and the batch of coconut palm trees present near the shore.
4. Waste management is a pressing issue for the island and accommodation of any large amounts of wastes from the proposed project will be difficult.
5. The council members noted that MoHI have committed to start a waste management project after the completion of dredging and reclamation work currently being carried out at the island.
6. The council members noted receiving of complaints from frequent harbour users (large passenger vessels that travel to and from Male', cargo vessels, fishing vessels that stop at Guraidhoo to pick up ice) about difficulties caused by the size of entrance channel and condition of the harbour.
7. Council members highlighted that they have communicated to the ice facility, upon receiving instructions from MoHI, to relocate the inlet and outlet pipes of the facility.

In addition to this, the council members provided an overview of the present socio-economic setting of the island and average vessel traffic at the harbour. These information are used throughout this EIA report to describe many aspects of the island and to form a basis socio-cultural and economic impacts on the island.

9. POTENTIAL IMPACTS AND MITIGATION OPTIONS

9.1 INTRODUCTION

Developmental projects involving coastal development and coastal modification in island environments are considered to generate a various levels of environmental impacts, some of which can be felt on the immediate environment and some impacts can be cumulative. Marine environment is directly affected from changes in hydrodynamics due to coastal modification from dredging and reclamation projects as coral reefs are very vulnerable to immediate changes that will be sustained from most of the development activities. Therefore, during the scoping, designing of the project activities and field surveys, consideration must be given to minimize the impacts felt on the environment. This Chapter describes in detail the potential environmental impacts and measures proposed to mitigate the impacts arising from harbour reconstruction works both during construction and operation phases of the proposed project.

9.2 UNCERTAINTY

Environmental impact prediction itself involves a certain degree of uncertainty, as the predicted impacts may vary according to weather, ecological conditions and social conditions in the atoll or island. Furthermore, limited time allocated for conducting the EIA studies does not permit collecting adequate primary data on the existing environment of the project location. Data on environmental aspects such as currents, waves, and sediment transport regimes may require at least one full year of data collection to make informed judgments. Given the time and budgetary constraints, the impact predictions to a large extent had to be based on short term primary data and secondary information obtained from literature review and conducting interviews with the locals. However, the level of uncertainty, in the proposed project is considered to be low, as the project scope is small and experience from harbour construction work carried out in many islands and resorts in the Maldives is readily available.

9.3 POTENTIAL IMPACT ASSESSMENT MATRIX

As this is a coastal development project, majority of the impacts of the project are expected during the construction stage. This phase includes mobilization of machinery and vehicles, workforce, reconstruction of breakwaters and quay wall, maintenance dredging of the harbour, extension of harbour, installation of navigation lights and land reclamation by dredge waste disposal.

This Section of the report identifies the potential environmental impacts and possible issues that could arise from construction and operational phase. Their identification as potential impacts does not mean that they would necessarily occur or that they could not be successfully mitigated.

The assessment of environmental impacts (positive and negative) had been carried out during EIA process and the resulting RIAM matrix is given in Table 11.

Table 12. Impacts assessment for the construction phase

		I	M	P	R	C	ES	RS
PC1	Coastal morphology	1	2	3	1	1	10	B
PC2	Water quality	2	-2	2	2	2	-24	-C
PC3	Air quality	1	-1	2	1	1	-4	-A
PC5	Hydrodynamics	1	0	1	1	2	0	N
PC6	Hazardous waste	1	-1	2	2	2	-6	-A
BE1	Coral reef	1	-2	2	2	2	-12	-B
BE2	Sea grass beds	1	-1	3	3	2	-8	-A
BE3	Coastal vegetation	1	-1	3	2	1	-6	-A
BE4	Eutrophication	1	0	1	1	1	0	N
SC1	Aesthetic and cultural value	1	-3	2	2	2	-18	-B
SC2	Income	1	-1	2	2	2	-6	-A
SC3	Employment	1	-1	2	2	2	-6	-A
SC4	Public health and safety	1	-3	2	2	2	-18	-B
SC5	Solid waste management	2	-3	3	2	2	-42	-D
EO1	Infrastructure	3	-3	2	2	2	-54	-D
EO2	Transportation	3	-2	2	2	2	-36	-D
EO3	Navigation	2	-2	2	2	2	-36	-D
EO4	Fisheries activities	1	-2	2	2	2	-24	-C

Table 13. Impact assessment for the harbour operation after reconstruction

		I	M	P	R	C	ES	RS
PC1	Coastal morphology	1	0	1	1	1	0	N
PC2	Water quality	2	2	3	1	3	28	C
PC3	Air quality	1	0	0	1	1	0	N
PC5	Hydrodynamics	1	0	1	1	1	0	N
PC6	Hazardous waste	1	0	1	1	1	0	N
BE1	Coral reef	1	0	1	1	1	0	N
BE2	Sea grass beds	1	0	1	1	1	0	N
BE3	Coastal vegetation	1	0	1	1	1	0	N
BE4	Eutrophication	1	0	1	1	1	0	N
SC1	Aesthetic and cultural value	1	3	3	1	2	18	B
SC2	Income	1	2	3	1	2	12	B
SC3	Employment	1	2	3	1	2	12	B
SC4	Public health and safety	1	2	3	1	2	12	B
SC5	Solid waste management	2	-1	1	1	1	-5	-A
EO1	Infrastructure	3	3	3	1	3	63	D
EO2	Transportation	3	3	3	1	3	63	D
EO3	Navigation	3	3	3	1	3	63	D
EO4	Fisheries activities	2	3	3	1	3	42	D

Range of values (RS) given in the table in alphabetic are as follows:

E = Major positive change;
D = significant positive change;
C = moderate positive impact;
B = positive impact;
A = slight positive impact;
N = no change/Status quo/not applicable;
-A = slight negative impact;
-B = negative impact;
-C = moderate negative impact;
-D = significant negative impact; and
-E = major negative impact.

Table 14. Class totals for major categories of impacts during reconstruction

	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	0	1	0	2	1	0	1	0	0	0
BE	0	0	0	1	2	1	0	0	0	0	0
SC	0	1	0	2	2	0	0	0	0	0	0
EO	0	3	1	0	0	0	0	0	0	0	0
Total	0	4	2	3	6	2	0	0	0	0	0

Table 15. Class totals for major categories of impacts during harbour operation after reconstruction

	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	0	0	0	0	4	0	0	1	0	0
BE	0	0	0	0	0	4	0	0	0	0	0
SC	0	0	0	0	0	0	0	4	0	0	0
EO	0	0	0	0	0	0	0	0	0	4	0
Total	0	0	0	0	1	8	0	4	1	4	0

The assessment of impacts by RIAM matrix indicate that no major negative impact (-E = 0) is expected to occur during the construction phase of the proposed project and during harbour operation after reconstruction. However, harbour reconstruction phase has series of negative impacts (-A = 6, -B = 3, -C = 2, -D = 4) ranging from slightly negative to significantly negative situations. Many of these impacts can be effectively mitigated during the construction phase and while others will be improved when the harbour comes into operation. This is evident from the positive dominant matrix resulted (N = 9, B = 4, C = 1, D = 4) for the operational phase of the harbour.

The following sub sections explain the main negative and positive impacts expected from the construction phase and harbour operation in more detail. Additionally, mitigation measures are proposed for the expected negative impacts to reduce the anticipated damages from the proposed project.

9.4 POTENTIAL IMPACTS AND MITIGATION OPTIONS

9.4.1 Impact on water quality

The water quality at the project site is expected to deteriorate immediately with the commencement of dredging works, however for a temporary period of time. The toothed-bucket action of the excavator on the sea floor head will disturb the substrate and place sediments into suspension. In addition, movement of the bucket while lifting the sediments out of the water will also place sediments into suspension. The maintenance dredging inside the harbour and entrance channel is likely to cause high a level of disturbance to the bottom sediments as the area was previously dredged and basin's bottom is expected to have fine sediments accumulated since then. Even though the impact on water quality is temporary and localized, it could cause irreversible damage to the nearby coral reef ecosystem if not contained properly during the dredging operation. The presence of loose sediments in water can obstruct penetration of light, resulting in reduced primary production by the photosynthetic organisms. If high level of turbidity persist for a prolonged time in the coral reef waters, reduced primary production may trigger a wave of negative effects up the food chain causing eventual loss of coral reef ecosystem integrity near the site. Additionally, if large amounts of suspended sediments inside the harbour is to escape into the surrounding coral reef, sedimentation of these suspended particles on corals may lead to death of corals and/or reduced fitness. The severity of the aforementioned impacts will amplify if the dredging work is carried out during rough conditions of south-west monsoon. Hence it is crucial that suspended sediments are contained within the harbour basin during the maintenance dredging.

The impact on water quality and the effect that it will have on the surrounding marine environment during the harbour extension dredging will also be very similar to that of maintenance dredging. However, one aspect that differ from the maintenance dredging is the absence of an easy containment boundary for the proposed extension area and the fill site. This makes the process more likely to allow sediment escape into the surrounding marine environment which will increase the severity of the impacts. Therefore, enacting proper containment structures before dredging and filling must be of high importance for the harbour extension dredging operation.

With present knowledge of the environment and experience from similar projects, the consultant propose to implement the following plan of actions and mitigation measures when carrying out the project. Implementing these methods will greatly reduce the impacts of dredging and filling operation on the sea water quality and the surrounding marine environment.

Mitigation options

1. Carryout the maintenance dredging phase without removal of the existing harbour breakwaters or
2. If removal and reconstruction of the habour breakwaters are scheduled as the initial stage, then carryout the maintenance dredging after successful reconstruction of the structures.
3. Build containment structures for the fill area before filling, either by building a bund wall using sand or sand bags. This bund wall should also function as a proper turbid water containment structure for harbour extension dredging works.
4. Dredging and filling are to be carried out during calmer conditions at the dredge area.

5. Use silt screens when dredging the entrance channel to prevent sediment escape into surrounding reef environment.

Careful implementation of the aforementioned measures will reduce the impact on water quality and its expected negative effects on the nearby ecosystem during the construction phase of the project. The water quality of the harbour is expected to improve after the construction phase and resulting in normal conditions for during the operation of harbour. Water quality is not expected to deteriorate to levels detrimental to the coral reef ecosystem during the operation of harbour.

9.4.2 Impacts coral reef

The coral reef system near the harbour is expected to be negatively impacted during the construction phase of the proposed project. However, the main impact is not expected to be caused by direct destruction of corals but by the indirect impacts caused by the deterioration of water quality and resulting sedimentation. Although, if the breakwater re-construction operations are not carefully conducted, corals adjacent to the breakwater may have to endure direct impacts. As the new breakwaters are proposed to be built on the exiting breakwater footprint with small extensions, no major destruction of corals are expected.

Mitigation options

1. The loss of water quality and escape of sediments into the coral reef can be mitigated by implementing the measures proposed in sub-section *9.4.1*.
2. Use the existing footprint of the breakwaters to reduce the direct impact of coral destruction during the breakwater reconstruction
3. Careful placement of rock boulders and operation of the equipment.

No negative impact can be identified for the coral reef system from the operation of the harbour.

9.4.3 Impact on sea grass beds

The proposed harbour extension and fill area and the alternative fill area proposed by the island council are sea grass beds. During the proposed project, loss of the sea grass bed(s) is inevitable, though this is identified as a reduced negative impact due to the fact that the sea grass beds are not known to play a significant role in maintenance of coral reef systems in the Maldives. Additionally, the coverage of sea grass bed for the proposed area is very low while there are small patches of sea grass adjacent to the harbour breakwater that could provide the same function, if there are any, for the coral reef system adjacent to the proposed area.

Mitigation options

Therefore, the loss of small areas of sea grass cover is identified as a minor environmental cost which is inevitable to achieve the long term socio-cultural and economic benefits of the proposed project.

9.4.4 Impacts on air quality

The emission of greenhouse gases (GHGs), mainly carbon dioxide, from the use of machinery are expected to slightly contribute to loss of air-quality. However, this is will be very minor as only handful of machinery will be used for the implementation of proposed project. Additionally, no alternative equipment that does not emit GHGs are used in Maldives or for major construction works elsewhere.

Mitigation options

1. Use of fuel efficient machinery and/or use of equipment in good condition
2. Properly service the equipment at required intervals during the project period.
3. Minimized idle time for the vehicles and machineries.

Since this impact only occurs during construction phase, it will not have any (positive or negative) during the operational phase of the harbour.

9.4.5 Impacts on coastal vegetation

The coastal vegetation will not be significantly impacted from the proposed project since the project only effect a small area of the coastal vegetation near harbour extension and fill area. Furthermore, at completion of the proposed project, the function of the coastal vegetation as natural erosion control measures will be lost due to reconstruction of quay wall or reclamation of land in fill area. However, since there are large palm trees forming the coastal vegetation patch that will be effect by the project, the regulation on cutting down trees will have to be followed.

Mitigation options

1. Relocate the large trees to a location designated by island council before the construction activities.

No impacts on coastal vegetation is expected to occur during the operational phase of the harbour.

9.4.6 Impacts on aesthetic and cultural values

The construction phase of the proposed project will have temporary negative impacts on the aesthetic look of the island. This is expected as major reconstruction of harbour will be carried out during the project by removal of the structures and building new ones. Additionally, the operation of machinery and marking of the construction boundary will temporarily deteriorate the appearance of the harbour. The operation of machinery and other construction works such as placement of rock boulders will create noise pollution at the island.

Mitigation options

1. Mark a clear site boundary in a way that blocks the view of construction operation being carried out.
2. Avoid carrying out any construction work during night time, especially work that are expected to create loud noises, such as movement and placement of rock boulders.
3. Do not carry out any work that create loud noise during the prayer times.

However, due to the new structures and absence of construction machinery, the aesthetic look of the harbour will improve significantly after the completion of the proposed project. The operation of the harbour is not expected to have any negative impacts on the aesthetic and cultural values of the island.

9.4.7 Impacts on income and employment

Some negative impacts on income and employment are expected during the construction phase of the proposed project. The livelihood activities of Guraidhoo depends heavily on the usage of the harbour as

explained under economic activities in socio-economic setting of the island (sub-section 7.6.2) and elsewhere in this report. Hence, the main impact on income and employment will arise from the difficulty of accessing the harbour during the construction phase.

Mitigation options

1. An area of the harbour always has to be designated for daily users of the harbour. In order to achieve this, the reconstruction has to be carried out in a manner that leaves one area without any major construction activities that may pose risks for the harbour users. The proposed way to do so, is by first deepening the area on the northeastern side of the harbour channel while allowing the other end to be used by the vessels. The harbour extension and maintenance dredging can then be carried out later, when the northeastern side's deepening and other works are completed and available for vessels to use.

Once the project is completed and the harbour is fully operational, the income and employment of the island is expected to greatly improve due to the improved harbour facility. This is because, the main difficulties caused by the existing harbour conditions will be eliminated by the new harbour while also resulting in a larger habour that will pave way for future expansions of economic activity at the island.

9.4.8 Impacts on public health and safety

Public health and safety is an important factor that needs to be ensured during and after the proposed project. The operation of large machinery and other conditions caused during the construction phase will pose major threats to public and workers if rules and regulation are not adhered to and best practices not employed.

Therefore it is recommended that, along with observance of rules and regulations, the precautionary measures proposed below should be followed

Mitigation options

1. Workers safety instructions shall be clearly made visible at the project site
2. Site accessibility shall be carefully controlled, instruction signs placed at the construction site to avoid unauthorized access.
3. Mark the construction boundary as proposed in 9.4.6.
4. Protective gears shall be made available to the workers.
5. First aid kit shall be available at the workers camp.
6. Only certified workers shall be allowed to operate machineries and vehicles.
7. Do not smoke or use naked flames near fuel storage, while refilling the machinery or when handling flammable oil.
8. All marine based machineries such as excavators shall have fire extinguishers.

The operation of harbour is not expected to pose any negative threats to the public health and safety.

9.4.9 Impacts on waste management

Waste management at the island is already major issue, hence any production of waste during the proposed project will further burden the existing system and create negative impacts. The solid waste disposal area designated by the island council is situated very close to the shore on the north eastern side of the island.

This area is presently an erosion zone, hence wastes are being carried away into the marine environment by waves. Additionally, proper disposal of hazardous waste cannot be carried out at the island.

One of the major type of wastes that will be generated from the proposed project is concrete waste, which is proposed to be used as core of new breakwaters and for the revetments. However, it should be noted that exact amount of concrete waste that will be generated and the amount that will be used for the habour reconstruction is not yet known. Therefore, in case of excess concrete waste after using for construction, a proper management plan for the excess waste has to be identified. The waste disposal site at the island will not be able to accommodate any amounts of concrete waste. Hence, disposing of these waste generated from the project to the present disposal site at the island is not recommended.

Even though, hazardous waste and solid waste generated from the proposed site is expected to be minor in quantity, they can have undesirable negative impacts on the island when disposed with concrete waste.

Mitigation options

1. Segregate the waste and store them safely at the project site
2. Storage of used lubricant oil must be at a location away from shoreline and habour to prevent accidental spills into marine environment.
3. Any hazardous waste produced during the project (e.g. lubricants, used batteries etc) should be stored inside a closed container at the project site
4. Excess concrete waste should be placed at one place.
5. Transfer all the wastes to a proper disposal site, preferably to Thilafushi, especially to fully comply with the Waste Management regulation in regard to hazardous waste.
6. If there is logistical possibilities, transfer some waste from the project island's disposal area to the proper disposal site when transferring the project waste.

The operation of the harbour is expected to present an issue for waste management of the island. It is expected that waste build up inside the harbour basin will occur during the operation of the harbour, as observed during the field survey.

9.4.10 Impacts on infrastructure

The proposed project is expected to have significant negative impacts on the infrastructure during the construction phase. The most impacts on infrastructure will be felt by the existing structures of the harbour as it will be removed and reconstructed, though this is going to be temporary. The new structures will improve the harbour facility, hence an overall benefit on infrastructure is expected from the proposed project.

However, an immediate significant impact on infrastructure that will have to be dealt with for successful implementation of the project is the relocation of ice facility's pump station and the inlet and outlet pipes. These components of the island's ice plant is located on the footprint of the proposed project, hence needing relocation. The MoHI have already communicated the need to relocate the pipelines, though relocation of pump station is not mentioned (letter attached in Annex 5). According to the council members consulted for the EIA, the council have informed the private company who operate the facility to carry out the relocation of pipelines.

Mitigation options

1. It is critical that island council and the proponent (MoHI), solve this issue before carrying out the project by discussions with the ice plant's operator to avert stakeholder conflicts from the proposed project.

No impacts on the infrastructure are expected during the operational phase of the project, rather infrastructure is expected to be in a much better shape after the construction phase is over.

9.4.11 Impacts on navigation and transportation

The construction phase of the harbour will have significant negative impacts on navigation and the transportation. These impacts arise from the difficulties that the frequent harbour users will have to endure because of the presence of the machinery and the closure of access to some parts of the harbour.

Mitigation options

1. Allocate an area for the harbour users, as proposed under subsection 9.4.7, to reduce the burden on harbour users during the construction phase.

The impacts on navigation and transportation will be significantly positive due to improved conditions when the new harbour comes into operation

9.4.12 Impacts on fisheries activities

The fisheries activities will face significant negative impacts during the construction phase as access to the harbour will be limited during this period. However, similar to the negative impacts on navigation and transportation and, on income and navigation, the impacts can be reduced by allocation of space for the harbour users during construction.

Mitigation options

1. Allocate an area for the harbour users, as proposed under subsection 9.4.7, to reduce the burden on harbour users during the construction phase.

The fishery sector is expected to benefit hugely from the operation of new and improved harbour facility at the island.

9.5 SUMMARY

In summary, the construction phase of the proposed project will present difficulties for the frequent harbour users but the improvement of the harbour facility after the completion of the project is expected to generate substantial long term social-cultural and economic benefits for the island. The difficulties arising from the construction phase can be reduced by implementing the measures proposed in this EIA.

The expected negative environmental impacts are mostly temporary which can be successfully mitigated by following the proposed actions. An impact that cannot be mitigated is the loss of sea grass beds, however it is considered as a minor damage since no cumulative effect which will result in loss of integrity of the immediate ecosystem is anticipated.

10. ALTERNATIVES

10.1 NO DEVELOPMENT OPTION

The no development option means that the harbour reconstruction project at the Th. Guraidhoo will not be carried out. The implication of this is that no impacts (positive and negative) arising either from the construction phase of the proposed project or the operational phase of the improved harbour will occur. In such a case, the islands already damaged harbour may degenerate beyond conditions acceptable for safe access and mooring of vessels. Additionally, the residents of the island is set to lose the expected major socio-cultural and economic benefits if the harbour reconstruction project is not carried out.

However, on the positive side no environmental impact, though almost always identified as temporary and easy to mitigate, will not occur during the construction phase of the project.

Since the short and long term socio-cultural and economic benefits outweigh the short term negative impacts on the environment, choosing not to go forward with the proposed project is not considered as a reasonable option.

10.2 DEVELOPMENT OPTIONS

This section explore alternative development options for the proposed project and assess their feasibility and effectiveness against proposed methods.

10.2.1 Use of tetrapods for breakwaters

The proposed project can use tetrapods for reconstruction of breakwater structures instead of rock boulders, both of which are expect to have the same cost for the project. Their effectiveness in high energy wave environments have been proven locally. The use of tetrapods will not introduce any new environmental impact from that is expected with use of rock boulders. However, tetrapod construction is expected to extend the construction phase of the project as it needs to be built at the site, using different raw materials and machinery. In addition, construction of tetrapods are also expected to generate more waste than the proposed method. Therefore, choosing rock boulders over tetrapods to reconstruct the harbour is identified as a more appropriate option.

10.2.2 Dredging method

A bucket excavator is proposed to be used for the maintenance and harbour extension dredging works of the project. An alternative option for dredging would be use of a cutter suction dredger which may be more suitable in terms of controlling the sediment. However, use of a cutter suction dredger over bucket dredger would incur additional costs. Furthermore, the limited working space for the dredger and the small area required for dredging could cause significant logistical and operational difficulties for the cutter suction dredger. On these basis, a bucket excavator is considered as the most suitable option to be used in dredging works**.**

10.2.3 Filling the alternative site

The proposed project have only identified one site for filling the dredge waste. The analysis of the bathymetry results indicate that an excess of 20600.91 m^3 of dredge waste will be generated after filling the proposed site.

The consultation with island council revealed that the area they want to fill is a different site on the north eastern side of the island (Indicated on the bathymetry map in Annex 2). Choosing to fill the alternative site along with proposed site is expected to reduce the amount of excess dredge material. Furthermore, filling this site will provide protection for the existing waste disposal area of the island. However, the filling work should only be carried out if proper erosion control measures can be constructed during project as the alternative fill area is already known for erosion.

Filling this area with excess dredge waste is not expected to have any immediate negative impacts on the environment except the ones identified in the sub-section 9.4.1, 9.4.2 and 9.4.3.

The expected negative impact of sediment escape into the coral reef and loss of water quality at the reef can be mitigated by building bund walls before filling the area, as recommended for the proposed fill site. Though, basing on the historical evidence, it is not acceptable to leave the fill material without proper erosion control for this site. Therefore, either sand bags or similar concrete structures will have to be constructed to avoid further erosion and impacts that it might have on the adjacent coral reef. Filling the alternative area and provision of erosion control will have significant positive impact on the environment as it will reduce the amount of waste that is carried out into the sea while also safeguarding the shoreline from further erosion.

Furthermore, dredge waste of 14,600.91 m^3 is expected in excess even if the alternative site is chosen to be filled. The proposed method to manage the excess dredge material is placing the excess on an accessible area, preferably on a small area of the newly reclaimed land. This method is proposed because it will have no impact on any environmental factors, such as on vegetation. The fine waste then can be used by the residents for construction purposes. The island council should make necessary arrangements, rules and regulations if necessary, to allow the dredge waste (sand) to be used by residents.

11. ENVIRONMENTAL MONITORING PLAN

Environmental monitoring is essential to ensure that post-construction and operational impacts are known and eliminated in a timely manner. Dealing with impacts earlier would save money and also help planning and operationalize the process.

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project are included in the monitoring plan. These include water quality (turbidity, TDS and BOD), sediment deposition on corals.

The environmental monitoring plan (EMP) presented here is in outline form. It should be detailed and completed when the final dredging action plan has been determined. The purpose of the EMP is to monitor or control the environmental effects of the dredging process. It should be based on compliance, verification, feedback, and know-how. It is therefore suggested that the environmental consultants are recruited for proper implementation of the EMP during the construction and operational phase. In the case of the proposed dredging works, environmental monitoring is particularly necessary to ensure that suspended sediments generated during excavation and during disposal of the dredged materials, do not adversely affect the health of the coral reef ecosystem.

Since the project works is related to the dredging of marine sediments, building of coastal structures and to some extent creation of land in the marine environment, environmental monitoring is particularly necessary to ensure that these activities do not adversely affect the health of the coastal ecosystems in vicinity of the project environment. In addition to undertaking the EMP outlined in the report, good project planning, preparations, are important to avoid delays during the construction phase. Unnecessary delays in project implementation has the potential to create serious negative perception of the project causing not only environmental damages but also financial losses. The following measures shall be ensured prior to the onset of the construction phase;

1. Use of appropriate dredging equipment for the dredging;
2. Clear demarcation of the dredging to ensure dredging does not go beyond what is required;
3. Adequate materials supplied to the site so at avoid delays;
4. Ensuring skilled labour availability for the operation of the dredger and operating other machineries; and
5. Good workmanship applied in all project related activities.

Table 15 and 16 below show the details of the proposed monitoring aspects including the monitoring parameters, indicators, baseline, proposed methods, frequency and estimated costs.

Table 16. Monitoring of the marine environment

Parameter / Method	Frequency of Monitoring	Purpose	Estimated cost (USD)
Benthic cover by major life forms (live, dead, rock rubble and sand). Method shall include, visual inspection of the selected sites, photography and line intercept transect to assess the life-form cover.	Monitoring shall be conducted at least once during construction, post construction on the reef area on the outside of the existing harbour breakwater and reef area adjacent to the entrance channel breakwaters. Operational phase monitoring shall be conducted one year after the operation begins. Benthic cover of the reef area on either side of harbour entrance need to be monitored every two weeks during the dredging phase, by taking random photographs of the benthos.	Indicative of the changes in the live coral cover	1500 / trip
Fish population / visual census	Visual fish census will have to be carried out along with benthic reef monitoring surveys except when the photographic survey are carried out during the dredging phase.	To assess broad scale change in the ecological status of the coral reefs (increase / decrease of herbivores, etc.)	

Table 17. Monitoring of the seawater quality, waste audit and equipment maintenance

Type	Parameters	Locations	Frequency	Estimated cost (USD)
In situ monitoring / sampling and testing from a laboratory	Dissolved oxygen (DO) Total Dissolved Solids (TDS)	Sediment levels in the water column shall be monitored daily by the contractor at the reef area on either side of the harbour entrance. Samples from at least 3 locations shall be tested for TDS and DO.	Daily records shall be kept in order to demonstrate compliance. Daily summary reports shall be prepared and be made available to the proponent. Water monitoring will also need to be	5000

			carried out after six from completion and after a year, coinciding with reef monitoring program	
Waste management	All waste generated shall be documented and logs maintained. Any waste sent to the disposal site will have to be measured (its quantity or volume) and accounted for through proper audits. Project site shall be kept clean at all times with waste bins placed at locations easily accessible to workers.	Construction site	Logs updated daily	-
Equipment and vehicle maintenance	Equipment and vehicles shall be regularly maintained to avoid unnecessary breakdown to avoid delays and accidental leaks.	Construction site	Frequency determined by the engineers	-

11.1 MONITORING COSTS

The proponent's commitment to undertake the proposed mitigation measures and to undertake the monitoring is given in Annex 4.

11.2 REPORTING

The proponent must make necessary arrangements to carry out the aforementioned monitoring plan. The results of the monitoring activities carried out by a qualified person shall be communicated to the proponent and EPA, in a clear report format as per the table 18 below.

Type	Responsible person	Recipient (MoHI)	Frequency
TDS, DO	A qualified person designated by contractor	MoHI	Every day during the construction phase
Photographs of the reef	A qualified person designated by contractor	MoHI	Every day during the construction phase

Reef monitoring report (along with water quality results available up to the date of submission)	A qualified person designated by contractor	MoHI & EPA	(2 reports) Once every six months after completion of the project until a year.
Waste management report	A qualified person designated by contractor	MoHI & EPA	After completion of the project
Final report	A qualified person identified by contractor	MoHI	After completion of all the monitoring stated in Table 16 and 17.

12. CONCLUSIONS AND RECOMMENDATIONS

This EIA has been undertaken to assess the proposed project, evaluate various alternatives, and to determine potential impacts and respective mitigation measures. The EIA was carried out in a participatory manner where views collected from stakeholders have been incorporated in to the EIA where appropriate.

The reconstruction of the harbour at Th. Guraidhoo is identified as justifiable as the existing structures are greatly damaged, hence not serving the intended function for which it was initially built. Reconstruction of the structures are required to ensure safety of vessels when accessing and moored at the harbour. It is found that all the project components proposed for the project are needed to improve the condition of the harbour facility.

The harbour forms a key part in many livelihood activities of the island and is frequently used by passenger and cargo vessels. The improvement of harbour facility will greatly benefit the island community while also enabling future economic development at the island.

However, the consultant highlights the importance of improving and taking adequate measures, as required by the engineering standards, to maintain the structural integrity of the new structures for a prolonged time. The report by Kench (2010) provides a good overview of the many design limitations in the coastal infrastructure developments of the Maldives with applicable improvement options. Among them, measures of particular importance to the proposed project are improving the structural integrity of the breakwaters and the quay walls. The breakwater structures should be built on the existing hard-bottom footprint to stabilize the structure while placing the boulders as packed as possible. The quay wall construction should pay particular attention to the cause of present condition of the harbour. Hence the base of the new quay wall should be placed deep enough, or should be supported by steel structures or anchored to the land at appropriate intervals and have toe protection to stabilize the structure. Additionally, geotextile cloth on the landward side of the quay wall needs to be placed to block sediment movement into the harbour basin. The main objective of recommending these measures to increase the structural integrity of the structure is to avoid any major construction work in the future that would put additional stress on the environment.

This EIA also recommends the proponent and the relevant parties at the island to make necessary arrangements to dispose waste generated by the harbour users and to develop and implement a harbour waste management plan during the operational phase. The suggested measures to achieve this is by placing bins at easily accessible locations near the harbour. A mechanism to transfer the waste to the disposal site will also need to be included in the management plan. In addition, any waste carried into the harbour basin will have to be cleaned on regular intervals and disposed. Keeping the harbour clean at all times is important for the island to maintain aesthetic value of the harbour.

The EIA suggest to make use of the excess dredge material produced from the proposed project to re-fill the alternative site proposed by the Island council. The proposed alternative fill site was previously filled under the initial harbour construction project, though all the materials have since been washed away. The erosion zone having already reached the waste disposal site located close to the shore, is washing away the waste into the marine environment. Hence, this EIA recommends filling the area as well as stresses on the importance of enacting proper erosion control structures under the this project. This is to ensure that no significant negative environmental impact occur from sediment escape and sedimentation on nearby coral reef. Inclusion of this recommended adjustment to the proposed project have great potential to improve the

environmental condition of the island while stabilizing the shoreline. The consultant, hence, recommends the proponent to follow required procedure to include the aforementioned component into the project, with necessary clearances from EPA.

This EIA found no evidence of any major significant negative environmental impact or change that are of importance at national/international level. However, the project is expected to generate some temporary negative environmental and socio-economic impacts during the construction phase of the project. These negative impacts can be effectively mitigated by implementing the measures proposed in this EIA. Overall, the most of the impacts are expected to be short-lived and only significant during the construction phase of the project. On the other hand, the socio-economic factors will greatly improve during the operational phase of the harbour as a result of the improved facility.

Based on the results of the assessments, the EIA study concludes that with proposed mitigation in place, the project would be environmentally acceptable and is in compliance with the relevant environmental legislations and regulations. With implementation of the recommended environmental mitigation measures, no unacceptable adverse residual impacts from the project are anticipated. This EIA recommends a comprehensive Environmental Management Plan (EMP) to assess the effectiveness of proposed mitigation measures and to safeguard the environment from any unanticipated impact. The monitoring programme will be implemented to check the implementation of mitigation measures and environmental compliance and to take necessary precautionary measures in the event of an unforeseen environmental impact. The monitoring programme will also be associated with a proper reporting mechanism to inform relevant government agencies.

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14. ANNEXES

Annex 1. Terms Of Reference (TOR)

"Dhivehin" – Always Maldivian, Forever Independent

Environmental Protection Agency EPA

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EPA/ToR/2015/139

Terms of Reference for Environmental Impact Assessment for Harbour Reconstruction at Guraidhoo, Thaa Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on 11 August 2015 for undertaking the EIA of the proposed harbour reconstruction at ***Guraidhoo Island, Thaa Atoll***. This ToR is based on the draft ToR submitted by the consultant on 29th September 2015. While every attempt has been made to ensure that this TOR addresses all of the major issues associated with development proposal, they are not necessarily exhaustive. They should not be interpreted as excluding from consideration matters deemed to be significant but not incorporated in them, or matters currently unforeseen, that emerge as important or significant from environmental studies, or otherwise, during the course of preparation of the EIA report.

1. **Introduction and rationale**
   Describe the purpose of the project and if applicable, the background information of the project and the tasks already completed. Objectives of the development activities should be specific and if possible quantified. Define the arrangements required for the environmental assessment including how work carried out under this contract is link other activities that are carried out or that is being carried out within the project boundary. Identify the donors and the institutional arrangements relevant to this project.

2. **Study Area**
   Submit a scaled plan with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size. The study area should include adjacent or remote areas, such as relevant developments and nearby environmentally sensitive sites (e.g. coral reef, sea grass, mangroves, marine protected areas, special birds site, sensitive species nursery and feeding grounds). Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.

3. **Scope of Work**
   Identify the number of the tasks of the project including preparation, construction and decommissioning phase.

Task 1. Description of the proposed project – Provide a full description and justification of the relevant parts of the dredging works, using maps at appropriate scales where necessary. Information on the following activities should be provided where appropriate:

- Location of the harbour/channel on scaled map

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- Design parameters of the harbour/channel (size, depth, profile of channel)
- Design parameters of the supporting coastal infrastructure and reclamations
- Justification for the location of harbor/channel
- Methods for dredging and dredge disposal at appropriate site(s),
- Clearing dredged material from temporary site(s)

- Project management (include scheduling and duration of the project [component wise scheduling] and life span of facilities; communication of construction details, progress, target dates, labour requirement, local labour availability, housing of temporary labor construction/operation/closure of labour camps. Emergency plan in case of spills [diesel, grease, oil etc.] access to site, safety, equipment and material storage, fuel management),
- In addition, an emergency plan to mitigate negative impacts on the environment from events such as unavailability of breakwater material in time for construction.

Dredging/Excavation

- Location and size of harbour basin, reef entrance and other dredge area(s) on a scaled map,
- Justification for the selection of the location, depth and size of dredge area(s),
- Equipment used for dredging and justification, including equipment capacity and description of positioning system (where appropriate), depth control system and operational control procedures,
- Exact method and process(es) of dredging/excavation (e.g. details of the use of sand beds or use of barge mounted excavation)
- Dredged material disposal/usage details, e.g. for land reclamation, beach replenishment or coastal protection works,

The EIA report should investigate possibilities for alternatives

- Alternative methods/equipment for dredging
- Alternative borrow area locations: have these been considered and if so, give arguments why these alternatives have not been selected, and

Dredge material disposal

- Design of the disposal/reclamation area(s), including justification(s) (from a socio-economic and environmental perspective) for the choice of design criteria,
- Quantity, quality and characteristics of dredged material,
- Method and equipment for transport (including distance) of fill material and hydraulic filling,
- Justification and location of temporary stockpile(s) if required,
- Location and design of the containment measures,
- Description of safety measures during the construction phase and justification and design of drainage measures if required.

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The EIA should investigate possibilities for alternative:

- Alternative disposal sites.
- Alternative containment measures.

Coastal Structures

- Locations and designs of the seawall and quay wall
- Locations and designs of additional coastal protection measures (if required)
- Method and equipment used for construction of coastal structures

Extra Works

- Any extra civil works deemed necessary by the community should be included in this EIA including but not limited to:
  - Location of the roads to be levelled and reason for levelling
  - Construction of any new roads to access the harbour
  - Dredging and reclamations specifications for boat yard areas
  - Vegetation clearings other than from harbour foot print

Task 2. Description of the Environment

Assemble, evaluate and present the environmental baseline study/data regarding the study area and timing of the study (e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they will be usefully applied to future monitoring. The report should outline detailed methodology of data collection utilized.

The baseline data will be collected before construction and from at least two benchmarks. All sampling/survey locations shall be geo referenced including but not limited to water sampling points, reef transects/photo quadrats, vegetation tansects, soli profiles, and manata tows sites for monitoring data comparison. Information may be divided into the categories shown below:

Climate

- Temperature, rainfall, wind and waves
- Natural Hazard Risks including storm surges

Geology and geomorphology

- Island geomorphology including presence of beach rocks and any special characteristics (use maps)
- Bathymetry of the required sites (all dredging and fill locations) (use maps)
- Seasonal patterns of coastal erosion and accretion,
- Shoreline (high tide line and low tide line) and vegetation line (use maps), and
- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during construction

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Hydrography/hydrodynamics (use maps)

- Tidal ranges and tidal currents
- Wave climate and wave induced currents
- Wind induced (seasonal) currents
- Sea water quality measuring the following parameters;
  - pH
  - Salinity
  - Turbidity
  - Total Suspended Solids (TSS)

Note: Sea water quality should be tested from all project sites and from at least one control site for data comparison purpose.

Ecology

- Identify marine protected areas (MPAs) and sensitive sites such as breeding or nursery grounds for protected or endangered sites (e.g. coral reefs, spawning fish sites, nurseries for crustaceans or specific sites for marine mammals, sharks and turtles). Include description of commercial species with potential to become nuisance or vector
- Benthic and fish community monitoring around the island
- Landscape integrity, and

Socio-economic environment

- Demography: total population, sex ratio, density, growth and pressure on land and marine resources;
- Income situation and distribution
- Economic activities of both men and women (e.g. fisheries, home gardening, fish processing, employment in industry, government)
- Seasonal changes in activities
- Land use planning, natural resource use and zoning of activities at sea
- Accessibility and (public) transport to other island
- Services quality and accessibility (water supply, waste/water disposal, energy supply, social services like health and education)
- Community issues/concerns with respect to the project

Hazard vulnerability

- Vulnerability of area to flooding and storm surge

Absence of facilities in the country to carry out the water quality tests will not exempt the proponent from the obligation to provide necessary data. The report should outline the detailed methodology of data collection utilized to describe the existing environment.

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Task 3. Legislative and regulatory considerations

Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. The report should clearly identify the different articles and clauses that apply to the said project and should state how the project meets these requirements.

Task 4. Potential impacts (environment and socio-cultural) of proposed project, including all stages

The EIA report should identify all the impacts, directs and indirect, during and after construction, and evaluate the magnitude and significance of each. Particular attention shall be given to impacts associated with the following

Impacts on the natural environment

- Changes in flow velocities/directions, resulting in changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology
- Loss of marine bottom habitat, both in the borrow area as well as due to enlargement of the island, resulting in loss of bottom life, which may impact fish stocks and species diversity and density of crabs, shellfish etc.
- Sediment dispersal in water column (turbidity at the dredging site [overflow], the reclamation areas and related to shore protection activities), possibly resulting in changes in visibility smothering of coral reefs and benthic communities and affecting fish and shellfish etc.
- Impacts of noise, vibration and disturbance
- Impacts on ground water table and quality (leaching of salts in the deposited sediments and change in ground water quality)
- Impacts on unique or threatened habitats or species (coral reefs, sea turtles etc.)
- Impacts on landscape integrity/scenery, and
- Impacts on the environment should the project be held up due to unforeseen circumstances

Impacts on the Socio-economic environment

- Benefits and impacts of the works in fishing activities
- Impacts of the dredging and reclamation works on resource users (adjacent businesses, nearby resorts and dive sites)
- Impact on employment and income, potential for local people to have (temporary) job opportunities (and what kind) in the execution of the works
- Impacts of the reclamation works (diminished) access to groundwater and risks of covering up hazardous materials
- Level of protection against hazards like sea level rise, storm surges, etc.
- Employment and economic opportunities and diversification

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- Increased demands on natural resources and services (domestic water supply, waste water disposal, treatment systems, solid waste disposal systems, energy supply, etc.)
- Social destabilization of the island community, and
- Monitoring of socio-economic and demographic development

Construction related hazards and risks

- Pollution of the natural environment (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste)
- Risk of accidents and pollution on workers and local population, and
- Impacts on social values, norms and belief due to presence of workers of dredging company on local population

The method used to identify the significance of the impacts shall be outlined. One or more of the following methods must be utilized in determining impacts; checklists, matrices, overlays, networks, expert systems and professional judgment. Justification must be provided to the selected methodologies. The report should outline the uncertainties in impact prediction and also outline all positive and negative/short and long term impacts. Identify impacts that are cumulative and unavoidable.

Task 5. Alternatives to proposed project

Describe alternatives including the "no action option" should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". This should include alternative location of harbour, breakwater technologies, dredge disposal sites and dredging methods etc. environmental, social and economic factors should be taken into consideration. Alternative protective measures to be taken till the rock boulders are been brought. The report should highlight how the location was determined. All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

Task 6. Mitigation and management of negative impacts

Identify possible measures to prevent or reduce significant negative impacts to acceptable level. These will include both environmental and socio-economic mitigation measures. Mitigation measures to avoid or compensate habitat destruction. E.g. temporal sediment control structures, coastal protection structures to reduce erosion, coral reconstruction, temporary docking jetty and MPA replacement areas. Measures for both construction and operation phases shall be identified. Cost the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An Environmental Management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

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Task 7. Development of monitoring plan

Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for coastal modification, beach morphology, sediment movement around the island. Ecological monitoring will be submitted to the EPA to evaluate the damages during construction and after project completion in accordance to the EIA regulations 2012. The baseline study describe in task 2 of section 2 of this TOR is required for data comparison detail of the monitoring program including the physical and biological parameters for monitoring, cost commitment from responsible person to conduct monitoring in the form of a commitment letter, detailed reporting scheduling, costs and method of undertaking the monitoring program must be provided. Monitoring is required in;

- Coastal erosion around the island
- Water quality assessment (seawater quality)
- Marine ecosystems monitoring (coral reef, seagrass and fish and invertebrates communities), and
- Socio-economic monitoring for project success or improvement requirements

Task 8. Stakeholder consultation

Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders. Consultation shall be undertaken with Guraidhoo council and the general public of Guraidhoo. The EIA report should include evidence of consultation, including names of those consulted and their contact details. The EIA report should include the methodology of consultation with justification, details of the date, time and place of the consultation and the summary outcomes. The report should include evidence that EIA report has been submitted to atoll council prior to submission to EPA.

4. Presentation

The EIA 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 EIA Regulations 2012.

5. Timeframe for submitting the EIA report

The developer must submit the completed EIA report within 3 months from the date of this TOR.

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5/10/2015

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Annex 2. Bathymetric map of the proposed project area

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Key Plan

Notes :

_UNITS IN METERS
_ELIVATION ARE REFERRED TO MSL
_MATERIAL FROM MAINTENANCE DREDGING HARBOUR _16272.67CU.M
_EXTENSION DREDGE VOLUME _12328.24CU.M
_TOTAL DREDGE MATERIAL _28600.91CU.M

_PROPOSED FILL AREA VOLUME – 8000 CU.M
_ALTERNATIVE FILL AREA VOLUME _6000 CU.M
_TOTAL FILL AREA VOLUME _14000CU.M

LEGEND

	EDGE OF EXSITING ROAD
	SHORE LINE
	BUILDING
	EXSISTING HARBOUR WALL
	EXTENSION DREDGE AREA
	–4m TO –35m CONTOURS
	–35m TO –40m CONTOURS

SCALE :	1:5000
SURVEYED BY :	DINAL (SURVEYOR)
DATE OF SURVEY :	12-13/11/2015
DRAWN BY :	DINAL (DRAUGHTSMAN)
CHECKED BY :	HASHIKA (SLNIOR SURVEYOR / LNGINLLR)
DATE OF SUBMIT :	25/11/2015

LOCATION
GURAIDHOO
THA ATOLL

PROJECT : TH.GURAIDHOO HARBOR RECONSTRUCTION

DRAWING TITLE : DRAWING OF GURAIDHOO JETTY & PROPOSED AREA

DRAWING No : 2015/015

SHEET No : 015

REV	DESCRICTION	BY	DATE

Annex 3. Initial dredging and reclamation permit

بسم الله الرحمن الرحيم

"Dhivehin" – Always Maldivian, Forever Independent

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Environmental Protection Agency EPA

203-PROREC/138/2015/153 ނަންބަރު:

މިނިސްޓަރ އޮފް ހައުސިންގ އެންޑް އިންފްރާސްޓްރަކްޗަރ ޑރ. މުޙައްމަދު މުއިއްޒު،
ފުރަތަމަ ސަލާމަތުން ދަންނަވަމެވެ.

ތ. ގުރައިދޫ ބަނދަރު ހެދުމުގެ މަޝްރޫޢު – ފަޅުފޮޅުމާއި ބިންހިއްކުމުގެ ހުއްދަ

ސަބްޖެކްޓުގައި ދެންނެވިފައިވާ މަޝްރޫޢާއި ގުޅޭގޮތުން، އެ މިނިސްޓްރީން 8 ޖޫން 2015 ގައި ހުށަހަޅުއްވާފައިވާ ދިވެހިރާއްޖޭގެ ރަށްރަށުގައި ބިންހިއްކުމާއި ފަޅުފޮޅުމަށް ހުއްދައަށް އެދޭ ފޯމު ލިބިފައިވާ ކަމުގައި ދަންނަވަމެވެ.

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3. ޗާޓު ސަރަހައްދު 1 ފޮޅުމުން ލިބޭ ގާތްގަނޑަކަށް 20836 ކިއުބިކް މީޓަރުގެ ވެލި އާއި ޗާޓު ސަރަހައްދު 2 ފޮޅުމުން ލިބޭ ގާތްގަނޑަކަށް 12285 ކިއުބިކް މީޓަރުގެ ވެލި ބަނދަރުގެ ހުޅަނގުން ހިއްކުމަށް ހަމަޖެހިފައިވާ ސަރަހައްދުގެ ބިންހިއްކުމުގެ މަސައްކަތްކުރުން.

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14 ޖޫން 2015

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Website: www.epa.gov.mv

އެންވަޔަރަންމަންޓަލް ޕްރޮޓެކްޝަން އޭޖެންސީ
ގްރީން ބިލްޑިންގ، 3 ވަނަ ފަންގިފިލާ، ހަނދުވަރީހިނގުން
މާލެ، ދިވެހިރާއްޖެ، 20392

203-PRODEC/138/2015/153

Annex 4. Commitment letter from the proponent

بسم الله الرحمن الرحيم

Ministry of Housing and Infrastructure
Male', Republic of Maldives.

ހިއްސާކުރުމާއި ބިނާކުރުމުގެ ވަޒާރާ
ދިވެހިރާއްޖެ.

Date: 08th December 2015

No: 138-PIS2/203/2015/294

Environmental Protection Agency
Ministry of Environment and Energy,
Ameenee Magu, Maafannu, Male', 20392,
Maldives.

Sub: EIA to the Proposed Construction of Harbour in Th.Guraidhoo:

As the proponent of the project, we guarantee that we have read the report and to the best of our knowledge all non-technical information provided here are accurate and complete. Also we confirm our commitment to finance and implement all construction mitigation and the monitoring program as specified in the report.

Signature:

Name: Aishath Bariyya

Designation: Engineer

Ameenee Magu, Maafannu, Male', 20392, Republic of Maldives. ދިވެހިރާއްޖެ، ފާރުގަނޑު، ފާ ހ، 20392، ދ.ފ.ބ.
+(960) 300 4 300 +(960) 300 4 301 secretariat@housing.gov.mv
www.housing.gov.mv www.facebook.com/housing.gov.mv www.twitter.com/HousingGovMv

Annex 5. Letter from MoHI to Th. Guraidhoo council regarding the relocation of ice plants pipelines

[illegible]

Ministry of Housing and Infrastructure
Male', Republic of Maldives.

[illegible]: 138-PIS1/386/2015/7

[illegible]

[illegible]

[illegible] 386/138/2015/9 (26 [illegible] 2015) [illegible]

[illegible]

[illegible]

[illegible]

28 [illegible] 1346 [illegible]

04 [illegible] 2015 [illegible]

[illegible]

[illegible]

guraidhoo council - ice plant cable

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

+(960) 300 4 300 | +(960) 300 4 301 | secretariat@housing.gov.mv

www.housing.gov.mv | www.facebook.com/housing.gov.mv | www.twitter.com/HousingGovMv

Annex 6. List of People consulted

Hussain Ahad	Th. Guraidhoo council president	7429448
Ibrahim Ali	Th. Guraidhoo council member	9555503 / 7537808
Hussain Ishan	Th. Guraidhoo council member	9765699

Annex 7. EIA report sent to Island Council by email.

============ Forwarded Message ============
From : shafiya.naeem@meeco.com.mv
To : "guraidhoo-council"
Date : Wed, 02 Dec 2015 22:37:13 +0500
Subject : Guraidhoo Harbour Reconstruction Project EIA
============ Forward Message ============

ތ. ގުރައިދޫ ބަނދަރު ހެދުމުގެ މަޝްރޫޢުގެ އީ.އައި.އޭ. ރިޕޯޓް މި އީމެއިލާއި އެކު ފޮނުވީމެވެ. ވީމާ، މި ރިޕޯޓް ރިވިއު ކައުންސިލުން ލިބިފައިވާ މި ކޮމެންޓްތަކެއް ވީ އެންމެ އަވަސް ފުރުސަތެއްގައި ފޮނުއްވައިދެއްވުން އެދެމެވެ.

ޝުކުރިއްޔާ،
ޝާފިޔާ

Regards,

Shafiya Naeem
Technical Director

MEECO

Aakakaage, Galolhu, Alikilegefaanu Magu, Male', 20129, Maldives.
Mobile: +(960) 797 1586 | Tel: +(960) 301 0855 | Fax: +(960) 301 0844 | http://www.meeco.com.mv/

Please consider the environment before printing this email

PDF Th.Guraidhoo_30...

[No reply received after a week from submission to the council]

Annex 8. CVs of contributing Authors

Curriculum Vitae

Mohamed Shimal

Permanent Address:	Malas, H.Dh Vaikaradhoo, Republic of Maldives
Present Address:	M.Nicosia, 1st Floor, Male', Republic of Maldives
ID card No:	A229368
Contact No:	9639049
Email:	m11.shimal@gmail.com

Education

2012 – 2014	**Bachelor of Environmental Science (Wildlife conservation and biology),** Charles Darwin University, Darwin, Northern Territory, Australia.
2007 – 2009	**Advanced Level Edexcel and Higher Secondary Certificate (HSC) Examinations,** Center for Higher Secondary Education (CHSE), Male', Republic of Maldives.
2004 – 2006	**Cambridge GCE O-level, IGCSE and, Secondary School Certificate (SSC) Examinations,** H.Dh Atoll School, H.Dh Vaikaradhoo, Republic of Maldives.

Employment History

Mar 2014 – present	• **Senior Research Officer** at Reef fisheries unit of Marine Research Centre. *Responsible for monitoring and assessing of reef fisheries in the Maldives and conduct relevant research for sustainable management of reef fisheries in the Maldives.*
Jan 2010 – Dec 2012	• **Assistant administrative officer** at Civil and Electrical Engineering Department of Maldives Ports Limited.

Professional Development and Leadership

2015	• Completed 2 months training on 'Sustainable use of fisheries resources through diversification of fisheries-based livelihood in island countries', offered by Japan International Cooperation Agency, in Okinawa, Japan.
2015	• Assisted Catlin Seaview Survey survey team from University of Queensland, Australia in facilitating their coral reef research in Maldives.
Nov 2013 – Nov 2014	• Served one term as a Student Representative in the Charles Darwin University Student Association's committee.
2012	• Completed 100 hours of voluntary work in Mangrove Blue Carbon research project conducted by Le Bai at Charles Darwin University's Research Institute of Environment and Livelihood.

Skills and Experience

- Working knowledge of ArcGIS, QGis, eCognition, ENVI classic and AutoCAD.
- Terrestrial and marine environmental surveying.
- Diving (PADI open-water license).
- Successfully completed an independent research project in species level mapping of mangroves using remote sensing as part of the Bachelor of Environmental Science course

References

Dr. Carla Eisemberg
Research Associate, Wildlife Ecology
Research Institute for the Environment and Livelihoods
School of Environment, Charles Darwin University
Darwin, Northern Territory, Australia
Email: carla.eisemberg@cdu.edu.au
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Le Bai
Institute for Applied Ecology New Zealand
School of Applied Science
WL Block, 110A
31-33 Symonds Street
Auckland City, New Zealand
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Cathy Jones
President
Charles Darwin University Student Association
Charles Darwin University
Darwin, Northern Territory, Australia
Email: cdusa@cdu.edu.au
Ph: +61426610749

Ali Hammadh

Address:
Ma.Glassge, Nikagas Magu, Male', Maldives• +960 7433241 • zoogya@gmail.com

Personal statement

Motivated, resilience and self-sufficient individual eager to work and progress in the environmental management and impact assessment field..

Key Skills

- Proficiency in all areas of Microsoft Office, including, Excel, Word and PowerPoint
- Communication skills, both written and verbal.
- Sample collecting and handling skills combined with the knowledge of using analytical instruments such as UV-Vis spectrometers, Handheld XFR spectrometers, IR spectrometers, Voltammeters and HPLC.
- Interdisciplinary knowledge of environmental water quality management and familiarity with Australian water quality standards.
- Knowledge of data regression and map building using ArcGIS software

Employment History

Townsville Atmospherically deposited Dust Metal Study

(August 2014 – December 2014)

Responsibilities

- Open up a dialogue between NQCC (North Queensland Conservation Council)
- Arrange Accommodation and finances.
- Do preliminary desktop research on history of laws and regulation, previous similar studies.
- Gather information about regulatory bodies and stakeholders.
- Open up a dialogue between Townsville port and meteorological centres to gather data.
- Take notes and keep up to date records of project with respect to Professor Mark P. Taylors
- Update Professor on the progress of tasks assigned to team members.
- Stake out sampling sites to be confirmed by professor.
- Fieldwork. (Collecting samples/transporting them to laboratories/inventory check)
- Regress raw data into tables and graphs. Responsible for the results section of the report.
- Media day with ABC network. Answer their questions and assist them in providing information

Media report:
http://mobile.abc.net.au/news/2014-12-05/high-toxin-levels-in-townsville-playgrounds-alarms-researchers/5946730?pfm=sm&section=qld

Laboratory Demonstrator At MQ University Study Labs

(June 2014 – July 2014)

Responsibilities:

- Introduction of teaching laboratory to year 12 students from Kilara High School and North Sydney Boys High School students
- Demonstrate general sample handling and preservation when collecting and testing water samples
- Explain the chemistry and process of determining dissolved oxygen and orthophosphates in water using the calorimetric method of phosphomolybdic acid reduction
- Explain the use, advantages and disadvantages of external standardisation method in testing for orthophosphates in water and explain the workings and use of UV-Vis spectrometers.
- Guide and manage a group of 20 students during the experiment.
- Help students with calculation and maintain the spectrophotometers.

Note Taker for Unit: PHYS 159

(August 2012 – December 2012)

Responsibilities:

- Upload concise clear notes to the disability student's portal after attending weekly lectures.
- Include diagrams and upload notes routinely on time with adequate depth and detail in report format.
- Review existing notes with other note takers to develop a general standard
- Meet with special needs students to discuss the quality of notes and discuss ways of refining and improving notes uploaded

Ministry Of Tourism

(February 2011 – March 2011)

Responsibilities:

- Maintaining and organising the ministries filing system
- Prepare meeting rooms and take notes during meetings
- Drafting letters.
- Inputting gathered information about islands into database

Education

Macquarie University
(January 2012 – December 2014)

Award: Bachelor of Environment
Major: Chemistry
Environmental Management

- GPA 3.3

CHSE
(June 2008 – June 2010)

Four Edexcel Subjects
- Chemistry Grade A
- Physics Grade A
- Biology Grade B
- Maths Grade B

Majeediyya School
(2004 – 2007)

Six Cambridge GCE Subjects
- Chemistry Grade A
- Physics Grade A
- Biology Grade A
- Computer Studies Grade A
- English as a Second Language Grade A
- English Language Grade A

Jammaluddin School
(2000 - 2007)

Achievements

2014 – Bachelor of Environment Majoring in Chemistry and Environmental Management
2012 – Robert Menzies College Deans Award for Academic Achievement
2011 – Australian Development Scholarship
2010 – CHSE Certificate of Merit (achieving passes in elective subjects with distinctions)
2008 – National Top Ten Award

Hobbies & Interests

- Sea
- Diving
- Fishing
- Sports

References

Attachments include:

- A welcoming letter from senior lecturer at Macquarie University Mr Ian Jamie
- Academic Transcripts/certificates

Shafiya Naeem
Neutrino; Sikka Goalhi; Malè 20082; Maldives
Phone: +(960) 771-1586 (M); +(960) 332-2242 (W); Fax: +(960) 332-2509
Email: shafiyanaeem@gmail.com; snaeem@mrc.gov.mv

Education

University of Tasmania, Launceston, Tasmania (2002 – 2005)
Bachelor of Aquaculture with upper second class Honours

Science Education Centre, Malè, Maldives. (1998 – 2000)
London GCE A Level Examinations

Aminiya School, Malè, Maldives (1993 – 1997)
London GCE O Level Examinations

Employment

Marine Research Centre; Ministry of Fisheries, Agriculture and Marine Resources
H. White Waves, Malè, Maldives
Senior Research Officer (February 2008 –)
Aquaculture Research Officer (February 2006 – February 2008)

- OIE focal point for aquatic animal health monitoring
- Management of mariculture research projects undertaken by Marine Research Centre
- Community mobilisation and sensitisation activities to promote commercial aquaculture in the country
- Administration of the Pearl Culture Project undertaken by the Marine Research Centre in collaboration with the United Nations Development Programme
- Provide technical advice on aquaculture and on the import of aquatic animals into the country to policy makers in order to facilitate the development/refinement of guidelines

Project Officer Trainee (September 2001 – February 2002)

- Assisted in the Pearl Culture Project undertaken by the Marine Research Centre in collaboration with the United Nations Development Programme
- Participated in all other mariculture activities undertaken by the Research Centre
- Organised workshops on the use of pearl oysters, and the importance of mariculture of pearl oysters in the Maldives
- Participated in the annual fishermen's day celebrations as a member of the Fishermen's day Advanced Team.

Ministry of Fisheries, Agriculture and Marine Resources; Ghazee Building, Ameer Ahmed Magu, Malè, Maldives
Fisheries Extension Officer Trainee (August 2000 – September 2001)

- Assisted in surveys, studies and research undertaken by the Fisheries Development and Extension Section of the Ministry of Fisheries, Agriculture and Marine Resources
- Developed training materials, manuals and modules for fisher folk, on fish processing and Seafood Technology, as well as Fisheries Economics and Financial Management
- Conducted quality control checks on yellow fin tuna fishing vessels to ensure quality export products
- Coordinated training/extension courses on Fisheries Economics and Financial Management of Small Fishing businesses as well as on fish product quality management in fishing communities
- Worked with the Fishermen's day Advanced team in organising the hosting of the annual Fishermen's day events

Conferences, Training Programmes and Seminars Attended

Regional consultative workshop on "Best practices to supporting and improving livelihoods of small-scale fisheries and aquaculture households"
Asia Pacific Fisheries Commission, Manila, Philippines (October 2009)

Training course on fish disease diagnostics
UNESCO-MIRCEN for Marine Biotechnology, Karnataka Veterinary, Animal and Fisheries Sciences University, College of Fisheries, Mangalore, India (July-August 2009)

The 10th International symposium on Genetics in Aquaculture "Roles of Aquaculture Genetics in Addressing Global Food Crisis"
Faculty of Fisheries, Kasetsart University; Bangkok, Thailand (June 2009)

Second Regional Workshop on Lessons Learned in Post-tsunami Sustainable Livelihoods and Coastal Ecosystem Management
Asian Institute of Technology; Bangkok, Thailand (February 2008)

Regional Study Tour Exchange Programme on Grouper and Seaweed Farming Techniques as Post-Tsunami Relief and Reconstruction for Sustainable Coastal Development
USAID; Bali, Indonesia (June 2007)

UNEP Environmental Impact Assessment Training
United Nations Environment Programme in collaboration with Ministry of Environment, Energy and Water; Male', Maldives (September 2006)

Aquafin CRC Conference
Cooperate Research Centre; Tasmania, Australia (July 2005)

Bioinformatics Course
The Australian National Genomic Information Service; University of Tasmania, Australia (June 2005)

International Training Course for Fisheries Extension Officers in Extension Methodology and Coastal Fisheries Management
Training Department, SEAFDEC; Bangkok, Thailand (June – July 2001)

Socioeconomic Coral Reef Monitoring Training Programme
Global Coral Reef Monitoring Network in Collaboration with IOC-UNESCO/UNEP/IUCN; Vaavu Atoll, Maldives (January 2001)

Experience

- Conducted interviews with victims of 2004 tsunami in the Maldives, in association with the Pacific Tsunami Museum and the University of New South Wales (April 2009)
- PADI Open Water Divers (November 2008)
- Led the investigation team during the mass fish mortality to determine the cause of the mass fish kill that occurred in the Maldives (September 2007 – January 2008)
- Practical experience in the aquaculture of groupers, pearl oysters and anemone fish, seahorses, live feeds for aquaculture, etc (2003 – current)
- Molecular identification of some groups of bacteria colonising the southern bluefin tuna (2005)
- Biochemical identification of bacterial flora of southern bluefin tuna (2005)
- Practical demonstrator for third year Aquatic Animal Health, and Physiology of Aquatic Organisms practical courses at the University of Tasmania (2005)
- Casual employment at the University of Tasmania as a research assistant working on amoeba, a parasite causing losses in salmon aquaculture in Tasmania (January – March 2005)
- Volunteered in research on the aquaculture of seahorses and salmonids, including general husbandry and maintenance of the fish stock as well as immunology of salmonids. (2003 – 2005).
- Volunteered in the TasSTAR peer-tutoring programme organised by the University of Tasmania at the Newstead College (March – November 2004).

Referees

PROFESSIONAL

Mohamed Shiham Adam, PhD

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Marine Research Centre
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Hassan Shakeel, MSc

Senior Biologist,
Marine Research Centre
H. White Waves
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ACADEMIC

Assoc. Prof. John Purser

Head of Department of Seafood Quality and Safety,
National Centre for Marine Conservation and Resource Sustainability
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Launceston, Tasmania, Australia 7250
Phone: + (61) 3-6324-3820
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Dr. Chris Burke

Degree Coordinator,

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Monaragala,
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dinalshalika@gmail.com
+94773764203 /
+94555682479/+967685313

PERSONAL INFORMATIONS

- **Full Name :** ManamendraPatambandige DinalShalika Priyaruwan.
- **Birthday :** 11th June 1987
- **Gender :** Male
- **Current Position :** Surveyor.
- **Nationality:** Sinhalese
- **Country:** Sri Lanka
- **National Identity Card No.:** 871633592V
- **Passport No.**: N 5548430
- **Marital Status:** Married

Objective:

To provide the best to the employer from my abilities, while updating the knowledge and the quality of the carrier within the profession.

ACADEMIC QUALIFICATIONS

*Now following Civil HND.

***NCT Civil at technical college, Bandarawela**
(2008-2011)

- *Which included following theory subjects:*

*Land surveying.
*Construction surveying.
*Mathematics.
*Drawing.
*Geology.
*Building servicers.
*Construction Management.
*Irrigation Construction.
*Highway Construction.
*Structure.
*Quantity surveying.

Nishshanka Central College.Badalkumbura.
(1993 – 2007)

*General certificate of education Advanced Level – 2007
Biology – S Physics – S Chemistry – S

*General certificate of education Ordinary Level – 2003
A - 2 (Including Science) B -2 C – 6

TECHNICAL SKILLS

*Platform : Drawing
*Subjects : 3d max(max 6,max 7,max 9)\Maya/Auto Cad,civil 3d/Computer -hardware/Ulead studio.

WORKING EXPERIENC E

1). OCT 2015-UP to now :Working as a Land surveyor at MEECO.

* Preliminary hydrographic survey for EIA study of **Th-Guraidhoo**
* Tree & TOPO graphical survey for a construction requirement of **Hibalhidhoo** island.

2).May 2015- Up to now :Worked As a Land Surveyor At SAMMANEE ASSOCIATE. & March 2014 –2015 Sep :As a Land Surveyor. Worked At SGCC (Southern Group Civil Construction) pvt ltd.

3). April 2012 – February 2014: As a Technical Surveyor. Worked in CML-MTD

*Thoppuwa-Dankotuwa- Naththandiya-Madampe.

5). JAN 2011 – April 2012 : As a Technical officer. Worked in CML-MTD Construction Ltd**.**

(Widening, Improving and Asphalt Overlaying)

*Dayatakirula Project(Helagama to Okkampitiya).

* Galle fort access Road (Southern expressway).

* RDA Project (Urapola – Wathuragama and Yakkala – Radawana Road).

* A-32 Road Project,(Mannar)

* Uva 5 Project Badulla.

PERSONAL REFEREES

G.T.J Pathirana,
Passara Road,
Uva pelwatta.
(Syrveyor CML-MTD).
+94773381046

H.H.H. Gunarathna,
19/21 5th lane Ambagaha
landa watta, Gampaha
Road, Yakkala.
+94773762925
+94332237108
+9607949301.
Surveyor MEECO
(Surveyor & propertied SAMMANEE ASSOCIATE)

I declare that the information furnished here are true and correct to the best of my knowledge.

Shalika M.P.D. 18/11/2015