Environmental Impact Assessment Report
Harbor Expansion works at Kulhudhuffushi

Client:
Ministry of Housing and Infrastructure

Consultant:
Hussein Zahir

April 2016

PADECO

RIKAN PRIVATE LIMITED

ENVIRONMENT IMPACT ASSESSMENT REPORT

KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT

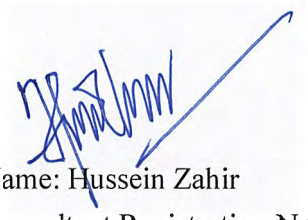
Client
Ministry of Housing and Infrastructure

Consultant
Hussein Zahir

April 2016

Consultants Declaration

I certify that to best of my knowledge that the assessment of environmental impact components through evaluation of primary data specific to the site, secondary data that can be applied for these components, the interpretation and statements made in Environmental Impact Assessment report for Kulhudhuffushi harbor expansion are true, complete and correct.



Name: Hussein Zahir
Consultant Registration Number: 04-07

Date: 23 March 2016

Proponents Declaration

Re: EIA for Harbour Development and Expansion Project at Kulhudhuffushi

As the proponent of the proposed project we guarantee that we have read the report and to the best of our knowledge, all information relevant to this project in terms of project description, project construction works and operational aspects provided here are accurate and complete. Also we hereby confirm our commitment to finance and implement Environmental Management Plan (EMP) as specified in the report.

Signature:

Name: Fathimath Shaana Farooq

Designation: Director General

On behalf of: Ministry of Housing and Infrastructure

Date: 29 March 2016

APPROVED

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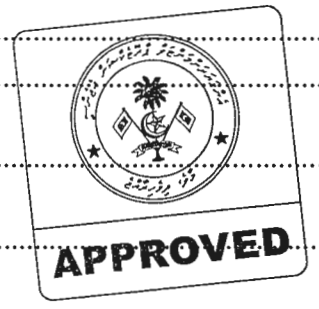
APPROVED



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بسم الله الرحمن الرحيم

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

ހިޔަސްދާރ ގޭގެ ހަދަހައި ބަދަސްތަކާ ބިނާކުރުމުގެ ވަޒާރާ
ދ.ކ.ފ. ދިވެހިރާއްޖެ.

Date: 29th March 2016

No: 138-PIS2/203/2016/80

Environmental Protection Agency
Ministry of Environment and Energy,
Green Building, Maafannu, Male',
Maldives.

Sub: EIA to the Proposed Project of Hdh. Kulhudhuffushi Harbor:

As the proponent of the project, we confirm our commitment to finance and implement all construction mitigation and the monitoring program as specified in the report.

Signature:

Name: Fathimath Shaana Farooq

Designation: Director General

APPROVED

Ameenee Magu, Maafannu, Male', 20392, Republic of Maldives.
ދ.ކ.ފ. ދިވެހިރާއްޖެ. 20392، ދާރުލްއަމާ، ދ.ކ.ފ. ދިވެހިރާއްޖެ.
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List of Appendices

1 Non-technical Summary

This Environmental Impact Assessment Report is prepared for the proposed harbor expansion project to meet the requirement of Maldives EIA regulation and ADBs Safeguards Policy Statement. With financial assistance from ADB this project is an initiative by the Government of Maldives (GoM) to expand harbor capacity in Kulhudhuffushi, Ha Dhaal atoll, with a view to improving maritime access and connectivity and fostering urban and regional development in Kulhudhuffushi and the Northern region.

The Consultant prepared the scope of EIA with support from ADB's environmental Safeguards officer assigned to this project. The final ToR for the project was issued by the EPA on 27th December 2015.

The proposed project consists of three components, reclamation, passenger/cargo harbor and a waterfront Small Craft Zone area including a separation wall. These structure and facilities are located in an artificially created shoreline and shallow lagoon between Kulhudhuffushi port (south end) and existing harbor (north end).

The proposed works under this project includes the following components:

1. Area 1 Reclamation
2. Area 2 Reclamation
3. Waterfront and Small Craft Zone Area with a Harbor separation wall
4. Passenger/Cargo Harbor

These structure and facilities are located in an artificially created shoreline and shallow lagoon between Kulhudhuffushi port (south end) and existing harbor (north end). In addition to dredging, reclamation, quay-wall and other civil works on basic infrastructure, operational port infrastructure (sometimes referred to as infrastructure-plus) includes facilities necessary for the safe operation of the harbor. Depending on the type, size, and use of the harbor, the scope and type of operational port infrastructure can vary widely. The main requirements for the passenger-cargo harbor in terms of operational port infrastructure are:

- Navigation lights
- Timber jetty
- Harbor pavement, drainage and apron lights
- Small passenger terminal
- Harbor markets
- Building for business and commerce activities

The duration of the project in terms of construction period is estimated as 18 months. An independent contractor will carry out construction of the harbor expansion works where workforce is considered as mix of both locals and expatriates.

Baseline environmental data for environmental components that are likely to affect were collected during field visits to the site on November 2015 and January 2016. These included information on changes to the shoreline of the proposed development area, shoreline profiles, bathymetry of the proposed dredging and reclamation areas, seawater quality at project impact areas and a control site, status of coral reef adjacent to impact area that included status of the coral community, fish community. In addition assessment of sea grass community that would be almost entirely affected was also carried out. In addition to this socio economic profile of the island community was also assessed that included concerns and community need with regard to expansion of the harbor facility.

Significant environmental components of the project that are likely to affect because of the implementation of various activities are, deterioration of seawater quality, damage to coral community through direct impact of dredging and reclamation, indirect impacts such as effects of sedimentation and turbidity. Average coral cover both at residual impact area and control site was 20%. Coral community diversity was not high. Diversity and abundance of fish community was normal and similar to marine habitats in the Maldives. The project impact area was screened through field assessment and literature review for presence of any nationally and internationally protected species or habits. Only one individual of Hawksbill sea turtle was encountered during the field survey. No protected species other than a single turtle were found in the project area and residual boundary.

Impact on sea grass community from dredging and reclamation is expected to be the highest since the proposed location for harbor basin will impact sea grass community. Approximately 2 hectares of sea grass area in the shallow lagoon will be thus affected. It is noted that this sea grass patch is a remnant of a large sea grass bed in the same location prior to reclamation works in 2010. There is another sea grass area in the shallow lagoon on the northern side of the existing harbor, which will not be affected by proposed expansion works.

The severity of impacts through application of Leopold matrix based on major impact areas varies from minor to moderate based on the size and time frame associated with the project construction phase. Major impact areas identified are coral reef, seawater quality and sea grass bed. Environmental mitigation measures on reducing identified impacts are addressed in the report. These include construction of a bund wall around the proposed

dredging for harbor basin. Alternatively silt screen can also be placed so that sediments from dredging and reclamation can be confined to the impact area ensuring impact reduction in project adjacent and residual impact areas. Since none of the impact areas are identified as critical or endangered habits at local or national level, no measures to compensate for loss of these habitats were suggested. Post construction phase of the project is likely to cause only minor impacts to the seawater quality and waste management. Mitigation measures proposed through application of local standards and use of available facilities will further minimize these impacts. Appropriate environmental monitoring program and activities are scheduled to ensure compliance to environmental mitigation measures and monitoring. An institutional arrangement has been proposed for environmental compliance and grievance redresses associated with the project that involve all relevant stakeholders.

Evaluation of project environmental components, impacts of the project on these components and their magnitude have indicated that the impacts are minor and manageable. Hence it can be concluded that the project is feasible with very limited impacts on natural environment. The positive benefits of the project from a socio economic perspective far over weighs the negative impacts. With the environmental impact mitigation measures proposed, environmental monitoring appropriately carried out through the proposed institutional arrangement further impacts that are not foreseen or addressed in this report can be managed.

ސާދާ ހުލާސާ

މިޕްރޮޖެކްޓަކީ އޭޝިއަން ޑިވެލޮޕްމަންޓް ބޭންކު (އޭ.ޑީ.ބީ) ގެ އެހީގައި ދިވެހި ސަރުކާރުން، ކުޅުދުއްފުށީގެ ބަނދަރު ބޮޑުކޮށް ތަރައްޤީކުރުމުގެ ޕްރޮޖެކްޓްތަކެވެ. ޕްރޮޖެކްޓް ހިންގަނީ މިނިސްޓްރީ އޮފް ހައުސިންގ އެންޑް އިންފްރާސްޓްރަކްޗަރގެ ބެލުމުގެ ދަށުންނެވެ.

ބަނދަރު ބޮޑުކުރުމަށް ކަނޑައަޅާފައިވާ ސަރަހައްދަކީ ކުޅުދުއްފުށީ ރީޖަނަލް ޕޯޓް އާއި މިހާރުގެ ބަނދަރާއި ދެމެދުގައިވާ، ގާތްގަނޑަކަށް 800 މީޓަރުގެ ތިލަފުށިގައެވެ. މިއީ 2010 ވަނަ އަހަރު އަޅަން ކުޅުދުއްފުށީގައި ހިއްކާފައިވާ ބިމުގެ ގޮނޑުދޮށާއި ގާތް އައްސޭރިއެވެ.

ބަނދަރު ބޮޑުކުރުމުގައި ހިމެނިފައިވަނީ:

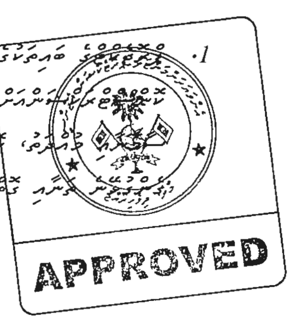
1. މުދާ އުފުލާ/ޕެސެންޖަރުންގެ ބަނދަރު
2. ކޫދުކިޔަވަރު ކުރާ ސާވާނުގެނުކުރުމާއި، ކޫދަން އުޅުމުގެ ސަރަހައްދު
3. ހިމާ ސަރަހައްދު؛ 1. ރީޖަނަލް ޕޯޓްއާއި، ޕެސެންޖަރ/ކާރގޯ ބަނދަރާއި ދެމެދު؛ 2. ކޫދުކިޔަވަރު ކުރާ ސަރަހައްދާއި މިހާރުގެ ބަނދަރާއި ދެމެދު
4. ބަނދަރުތެރޭގެ ބޭސިން، އަނބުރާލާ ބޭސި
5. ބަނދަރު (މުދާ އުފުލާ/ޕެސެންޖަރ ބަނދަރުގެ ވާޖަރު
6. މުދާ އުފުލާ ބަނދަރުގެ ނެރު

މި ޕްރޮޖެކްޓްގެ ބައިތައް ޑިޒައިން ކޮށްފައިވަނީ ޖަޕާނުގެ ކޮންސަލްޓަންސީކުންފުންޏެއްކަމަށްވާ ޕަޑޭކޯ (PADECO) އިންނެވެ. މުޅި ޕްރޮޖެކްޓްގެ އަންދާޒާ އަގަކީ އަށް މިލިއަން އެމެރިކާ ޑޮލަރެވެ (US$ 8,000,000). މި ޕްރޮޖެކްޓްގެ ކޮންސްޓްރަކްޝަންގެ މުއްދަތަކީ ގާތްގަނޑަކަށް 2 އަހަރެވެ.

މިޕްރޮޖެކްޓްގެ ތިމާވެށީގެ ދިރާސާކުރުމުގެ ކުރިން ޕްރޮޖެކްޓްގެ ބައިތަކުގެ މަޢުލޫމާތު ބަލާ، ޕްރޮޖެކްޓްގެ ތިމާވެށީގެ ކޮންސަލްޓަންޓުން ތައްޔާރުކޮށްފައިވާ، އެންވަޔަރަމަންޓަލް ޕްރޮޓެކްޝަން އޭޖެންސީ (އީ.ޕީ.އޭ) އާއި، އޭ.ޑީ.ބީގެ މިންގަނޑު ޕްރޮޖެކްޓްތަކުގެ ތިމާވެށީގެ މިންގަނޑުތަކާ ފެތޭގޮތަށް ތައްޔާރުކޮށްފައިވާ ޓާމްސް އޮފް ރެފަރެންސް އެއްގެ މަތިންނެވެ. މި ޓާމްސް އޮފް ރެފަރެންސް އީ.ޕީ.އޭ އިން ފާސްކޮށްފައިވަނީ 26 ޑިސެމްބަރ 2015 ގައެވެ.

މިރިޕޯޓުގައި މައިގަނޑު ގޮތެއްގައި ބަލާފައިވަނީ

1. ޕްރޮޖެކްޓްގެ ބައިތަކުގެ ތަފްސީލު، (މީގެ ތެރޭގައި ޕްރޮޖެކްޓްގެ ބައިތައް ކުރިއަށް ގެންދިއުމަށް ރޭވިފައިވާ ގޮތް)، ޕްރޮޖެކްޓްގެ ކޮންސްޓްރަކްޝަނަށް ބޭނުންވާ ސާމާނާއި ތަކެތީގެ އަދަދާއި މިތަކެތި ހޯދާނެ ގޮތްތައް، ބިނާކުރުމާއި، ބަނދަރު ކޮންމެހެން ބޭނުންކުރާނެ މިންވަރު، ކޮންސްޓްރަކްޝަން މަސައްކަތް ކުރާނެ މުއްދަތުގެ އަދަދާއި، އުޅުން ދިމާވާގޮތް، ކޮންސްޓްރަކްޝަން ސާމާނު ތަކެތި ބެހެއްޓޭނެ ގޮތް، އަދިވެސް ކޮންސްޓްރަކްޝަން މަސައްކަތާއި ގުޅޭ އެހެނިހެން ބައިތައް



2. ޕްރޮޖެކްޓުގެ އިޤްތިޞާދީ އަސަރު: މިގޮތުން މިޕްރޮޖެކްޓުގެ އެކިއެކި ބައިތައް ހިނގާ ތިމާވެށީގެ ބައިތަކާއި، އެބައިތައް ހިނގާ ގޮތުގައި، ގޮތުގެ ބައިތަކާއި، ޕްރޮސެސްތައް ބަދަލުވެދާނެއެވެ. ޕްރޮޖެކްޓުގެ ބައިތަކާއި ގުޅުން ހުރި ގޮތާއި ބައިތައް ޕްރޮޖެކްޓުގެ ތަފްސީލާއި ބެހޭ ނަމްބަރުތައް ތަފާތު ގޮތްތަކަށް ބަލާލެވިދާނެއެވެ.

3. ތިމާވެށީގެ ބައިތައް: ޕްރޮޖެކްޓުގެ އެކިއެކި ބައިތަކުން ތިމާވެށީގެ އެކިއެކި ބައިތަކަށް ކުރާނެ އަސަރު ދިރާސާކުރުމުގެ ގޮތުން ޕްރޮޖެކްޓް ހިނގުމަށް ކަނޑައެޅިފައިވާ ސަރަހައްދުގެ ބައިތަކަށް ބަލާލެވިފައިވެއެވެ. މިގޮތުން ޕްރޮޖެކްޓުގެ ސަރަހައްދުގެ ވަގު ކުއާލިޓީ، އަޑުގެ ކުއާލިޓީ، ފަޅުގެ އެއްވަރު، ފެނުގެއަޑިއާއި ހުރިގޮތް، ރީފު ފަޅުގެ ހާލަތު، ފަރުގެ ހާލަތު، މަޑުފަޅުގެ ހާލަތު، އިކޮލޮޖީ ހާލަތު ހިމެނިފައިވާނެއެވެ.

4. ތިމާވެށީގެ މިހާރުގެ ހާލަތު (ޕްރޮޖެކްޓް ނުކުރި) ބަލައި ތިމާވެއްޓަށް ކުރާނެ/ކުރެވޭނެ އެއްވެސް ނެގެޓިވް އަސަރުތަކަށް ބަލާލެވިފައިވެއެވެ. މިގޮތުން ބަނދަރު ހުޅުމަށްޓަކައި ވަޅުލުން ކުރުމުގެ ސަރަޙައްދު އެކުގެ ނެގެޓިވް އަސަރުކުރުވާނެކަމަށް ފާހަގަކުރެވުނު ފަރުގެ މާހައުލުގެ ބައިތަކެވެ. ފަޅުކޮނުމުގެ ނަތީޖާ ހިމެނޭފަދަ ތަކެތި އަދި ކަނޑުގެ ވެއްޓަށް ސަރަހައްދު ފަރުގެ ގޮތުގެ ތަކެއްޗަށް، އެހެނިހެން ސަރަހައްދުތަކަށް އަސަރު ކުރެވޭނެއެވެ. މިގޮތުން ކަނޑުގެ ވެއްޓާއި ހިމެނޭ މަސްދުނޑު ސަރަހައްދު ދިރުމުގެ ތަނަވަސްކަމާއި ދެމެހެއްޓުމަށް ޓަކައި ފަރުގެ ތަނުތަނުގެ ސަރަހައްދު އެކަށީގެންވާ ދިރުންތަކަށްވެސް އަސަރުކުރާނެއެވެ.

5. މަޝްވަރާ ފާހަގަކުރެވުނު ކަންތައްތައް ނުވަތަ އެކަންތައްތަކުން ތިމާވެށްޓަށް ކުރާނެ އަސަރު ކުޑަކުރުމަށް ގެންދާނެ މިންވަރުގައި ފާހަގަކުރެވިފައިވެއެވެ. އަސަރުތައް ކުޑަކުރުމަށް ގެންދާނެ ހަރަކާތްތަކާއި އިތުރުން، ތިމާވެށީގެ ބައިތަކަށް ކުރާއަސަރު ކުޑަކުރުމަށް ގެންދާނެ ކުޑަކުރުން ގެންދާނެ ގޮތް މޮނިޓަރިންގ ޕްރޮޖެކްޓުގެ މުއްދަތުގައި ހިމެނިފައިވާނެއެވެ.

މަޝްވަރާ ބާއްވާފައިވާ ތިމާވެށްޓަށް ކުރާ އަސަރު ކުޑަކުރުމަށް ގެންދާނެ ހަރަކާތްތަކާ ގުޅޭ ޕްރޮޖެކްޓުގެ ބައިތައް ކުރިއަށްގެންދިޔަގޮތް ޕްރޮޖެކްޓާއި ކުރިން ގެންދިޔުމުގައި އެންމެ ރަނގަޅު ކަމަށްފެނެއެވެ. މިގޮތުން ޕްރޮޖެކްޓުގެ ތިމާވެށީގެ ބައިތަކުގެ އިތުރުން މި ޕްރޮޖެކްޓުގެ ސަރަހައްދު އިޖްތިމާޢީ އަދި އިޤްތިޞާދީ އެކަށައެޅިފައިވާ ރަނގަޅު ރައްޔިތުންގެ އެކި ހިސާބުތަކަށް ފާހަގަކުރެވެއެވެ. މިގޮތުން މި ޕްރޮޖެކްޓުގެ ސަރަހައްދު ރައްޔިތުން އިޖްތިމާޢީ ހާލަތު ރަނގަޅުކުރުމަށް ބޭނުންވެއެވެ.

ވީމާ، މި ޕްރޮޖެކްޓް ކުރިއަށް ގެންދިޔުމުގައި އެންމެ ރަނގަޅު ކަމަށް ފެނެއެވެ. މިއާއިއެކު ޕްރޮޖެކްޓުގެ ތިމާވެށީގެ މޮނިޓަރިންގ ޕްލޭން އާއި އެއްގޮތަށް ކުރިއަށް ގެންދިޔުމަށް މަޝްވަރާކުރަމެވެ.

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2 Introduction

This project is an initiative by the Government of Maldives (GoM) to expand harbor capacity in Kulhudhuffushi, Ha Dhaal atoll, with a view to improving maritime access and connectivity and fostering urban and regional development in Kulhudhuffushi and the Northern region. This project is funded under TA-8829 MLD as the Asian Development Bank (ADB) finances Kulhudhuffushi Harbor Expansion Project. The Ministry of Housing and Infrastructure (MHI) is the Implementing Agency (IA), and the Ministry of Finance and Treasury (MoFT) is the Executing Agency (EA).

The project preparatory technical assistance (PPTA) for this project is being undertaken by PADECO in association with local Consultants Riyan. The tasks of Consultant's Team through their Terms of Reference (ToR) specific to technical feasibility for project design include the identification and specification of key components and their civil works, the incorporation of climate change adaptation measures into project design especially coastal structures with viable engineering options taking into account international best practice and the recommendations from other project components such as the environmental and social assessments, and the economic and financial analyses.

A major milestone of this PPTA is to ensure environmental safeguards policy of ADB is inherent to project preparatory works, construction and operation works. In addressing the project's environmental and social impact, the methodology and process of assessment was carried out in accordance to the ADB's Safeguard Policy Statement (SPS) and GoM's policies on environment and social safeguards.

The total construction and maintenance cost of the project is USD 7,941,673 including contingencies. To this, an additional cost of USD 1,000,000 is added to cater for the cost of the project management consultant (PMC) and unforeseen mitigation costs. The total cost of the project is estimated to be USD 8,941,673.

2.1 Purpose of the report and need for the EIA

In accordance to ADB's Safeguard Policy Statement (SPS) this project has been classified as Category A project. Hence, the projected environmental impacts have been screened through a Rapid Environmental Assessment (REA) screening available from ADB; which affirmed the requirement for a category A EIA.

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In addition to ADB's Safeguard Policy Statement requiring a Category (A) EIA, environmental regulations of Maldives also require projects similar to this nature to prepare an EIA report and environmental decision made through a Decision Note (DN) issued by EPA. Developers of such projects are required to carry out EIA studies under the Environmental Act of Maldives. The developer is required to obtain approval of EPA prior to the implementation of any development activities related to this project.

A Scoping Application to EIA with a draft ToR was prepared by the Consultant with support from ADB's environmental Safeguards officer assigned to this project. The final ToR for the project was issues by the EPA on 27th December 2015. A copy of the ToR is given in Appendix 1.

This document presents the findings of EIA for the Kulhudhuffushi Harbor Expansion Project through field assessments of various environmental components as required by the ToR by EIA consultant, stakeholder consultations by EIA consultant as well as information and feedback from relevant stakeholders during various fact finding trips made by the project team.

2.2 Report structure

This report is with reference to the ToR issues by EPA in compliance with EIA Regulation 2012 under Environmental Protection and Preservation Act of Maldives (Law No. 4/93). Several amendments to the EIA Regulation 2012 are made of which particular relevance to this project was amendment of November 2015. As part of this Amendment, application for permit of dredging and reclamation works shall be submitted together with EIAs to the Environment Protection Agency.

Specific structure of this EIA report also has to comply with this report structure guideline given in Appendix (Baa), Schedule 1. The report also includes specific information and assessments required by ADB's environmental safeguards that are applicable and included in the ToR.

A summary of the main contents of this EIA is outlined below;

1. A Non technical summary of the report both in Dhivehi (in local script) and in English. This shall cover a summarized description of the project, its rationale and justification. All major components of the project, identification of all significant environmental impacts associated with the project, mitigation measures proposed for significant environmental impacts

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2. Introduction
3. Legal and Policy Framework
4. Project Description: A description of the overall project proposal including justification, main project inputs and outputs, project schedule etc.;
5. Methodology
6. Existing Environment: An assessment of the existing environmental status of the proposed development site and surrounding environment;
7. Potential Environmental Impacts: Prediction of potential environmental impacts and evaluation of the magnitudes of environmental implications that will be associated with the proposed developments;
8. Mitigation Measures: Identification and assessment of the ways in which negative impacts on the environment of the project site be appropriately managed and minimized
9. Environmental Management Plan
10. Stakeholder Consultation
11. Conclusion and Recommendations

In addition, the following sections are included in the report

12. Climate Change Assessment
13. Institutional Arranges

3 Project Setting

This chapter describes national relevant laws and regulations relevant to this project as well as international agreements that are pertinent to the construction and operation of the project.

3.1 National policies and guidelines

3.1.1 Environmental Protection and Preservation Act (Law 4/93)

Environmental protection Act that came soon after ratification of Convention of Biological Diversity (CBD) in 1993 has a framework law to managing all environmental issues. Under this Law the most significance component is preparation of environmental impact assessment for all development projects that could have a significant impact on natural environment. Clause 5a states that an impact assessment study shall be submitted to the Ministry of Environment, Energy and Water before implementing any development project that may have a potentially detrimental impact on the environment. Therefore, Clause 5 is of specific relevance to this EIA. The EIA Regulations, which came into force in May 2012, has been developed by the powers vested by the above umbrella law. This EIA has also been prepared as per this regulation.

3.1.2 The National Solid Waste Management Policy

The National Solid Waste Management Policy (NSWMP) was developed in 2008 in order to address solid waste management issues in the Maldives and thereby create a healthier environment. This policy was developed through participatory consultations with island communities and extensive research that led to a set of strategic and governance principles that reflected the universally accepted practices. This includes establishing a governance structure for solid waste management which will distribute and establish clearly delineated roles and responsibilities for solid waste management at island, regional and national levels. This imposes all waste producers have a duty to manage the waste they produce. Waste will be managed and disposed as close as possible to the place of their generation.

Development of a waste management system to accommodate the specific requirements of special wastes based on verifiable facts and known effective strategies that are financially viable is also part of the strategy. Financial incentives and disincentives will be pursued to support good waste management practices. Goods that are harmful to the environment or cause public nuisances and unacceptable waste activities will be discouraged. The community participation and awareness about good waste management practices will be

maximized through this policy. In order to achieve this, a Solid Waste Management Regulation was developed and became effective in 2010.

3.1.3 Solid Waste Management Regulation

The Solid Waste Management Regulation, which is pertinent to the proposed project, was drafted by the Ministry of Housing and Environment in 2010 with the aim of implementing the National Solid Waste Management Policy formulated in 2008. The administrating authority for the regulation has been identified as the Environmental Protection Agency at the national level and island/city councils at the provincial level. Implementation of the Solid Waste Management Regulation will aid to protect the environment through:

- Minimizing the impact of waste on the environment including, in particular the impact of waste so far as it directly affects human health;
- Establishing an integrated framework for minimizing and managing waste in a sustainable manner; and
- Put in place uniform measures to seek to reduce the amount of waste that is generated, and where waste is generated, to ensure that waste is reused, recycled and recovered in an environmentally sound manner before being safely treated and disposed.

Parts II, III, IV and V of the Regulation provide detailed clauses on the following in the respective order:

- Part II – Waste management measures: this part highlights detailed clauses on waste management standards and plans, declaration of priority wastes, extended producer responsibility, prohibition of unauthorized disposal of waste, littering, collection containers in public places, waste collection at sea and waste collection facilities at ports, reduction, reuse, recycling and recovery of waste, waste management activities list and restrictions on provision of waste management services.
- Part III – Waste Management Licenses: this part gives detailed clauses on waste management licenses, license periods and licensing requirements, standards to be observed by licensees, bundling of services and transferring or surrender of license, waste management license fees and how to charge the relevant fees, financial securities and the license register.
- Part IV – Transportation of waste: this part gives detailed clauses on duties of persons transporting waste and duties of receivers of waste, export and trans-

boundary transportation of hazardous waste, transportation of waste from one island to another and accidents at sea.

- Part V – Monitoring, Inspection, Auditing and Enforcement: this part gives detailed clauses on duty to furnish information and duty to report, notice from the Administrating Authority requiring a review of activities carried out under a license, revocation of a license, defrayal of Administrating Authority costs, register of fines and administrative actions, Inspectors, establishment of a national waste information system and National waste management status reports.

The regulation was gazette in August 2013, and became effective in January 2014 under authority of the Environmental Protection Agency.

3.1.4 Solid Waste Management Regulation

The guideline suggests specific values of the maximum concentration that can be tolerated for each parameter potentially present in the wastewater. The values must not be exceeded when treated wastewater is released into surface water, ground water or into deep sea. According to this guideline, these values should be used in line with Environmental Impact Assessments and Clean Production Protocols to finalize the license for the discharge of specific wastewater.

The guideline covers combined domestic and industrial water requirements for deep sea discharge. According to this, no trade effluents will be accepted for discharge into deep sea outfall unless:

- The industry has proven to government that it is following best international Clean Production practice
- An Environmental Impact Assessment has been submitted, and
- The trade effluent complies with the following conditions:
- The effluents should have a pH in the range 5 – 9.5;
- Temperature no more than 44 Degree Celsius;
- Total Suspended Solids up to 150mg/l.

Frequent monitoring of the receiving body is required on a regular basis to ensure the parameters above mentioned are within acceptable levels.

The project developer and contractor shall follow this guideline in the handling and disposal of effluents from the operation of batching plants and other sources of wastewater

from construction and operation of the project.

3.1.5 Third National Environment Action Plans (2009 – 2013)

The proposed project is expected to provide a learning experience in terms of effectiveness of the use of EIA as a planning instrument and appropriate monitoring for which specific focus is laid in Objective 24.1 of NEAP 3 (Ministry of Housing, Transport and Environment, 2009).

3.1.6 National Biodiversity Strategy and Action Plan (NBSAP)

In implementing the proposed project activities, due care has to be taken to ensure that the national biodiversity strategies are adhered to. To adhere, surveys were undertaken as part of the EIA to find out if biological resources of value and protected nature are affected by implementing any component of the proposed project.

3.1.7 Guidelines for Land-use Planning

This guideline outlines the relevant elements of land allocation and how it should be allocated in inhabited islands. The entire regulation is referenced.

3.1.8 Dredging and Reclamation Regulation

Dredging and permit can be given.

Clause 7 discusses the types of situations in which dredging and reclamation can be undertaken.

Clause 11 outlines the criteria's to be utilized during dredging and reclamation.

Clause 13 outlines the details of conditions to be met in a borrow area. This includes, minimum buffer zone between the reef line, shore lines and also buffer zones around reef.

Clause 14 outlines the dredged soil disposal methods and its use.

Clause 15 outlines the maximum area for dredging. Clause 16 outlines the maximum area for reclamation.

3.2 ADB's Safeguard Policies

The operational policies of ADB includes 3 Safeguard Policy Statements: the involuntary Resettlement policy (1995), the policy on indigenous people (1998) and the environment policy (2002). Safeguard policies are generally understood to be operational policies that seek to avoid, minimize, or mitigate adverse environmental and social impacts, including protecting the rights of those likely to be affected or marginalized by the development process. All 3 safeguard policies involve a structured process of impact assessment, planning, and mitigation to address the adverse effects of projects throughout the project cycle. The safeguard policies require that (i) impacts are identified and assessed early in the project cycle; (ii) plans to avoid, minimize, mitigate, or compensate for the potential adverse impacts are developed and implemented; and (iii) affected people are informed and consulted during project preparation and implementation. The policies apply to all ADB-financed projects, including private sector operations, and to all project components.

Due to the nature and extent of this project and applying safeguard standards, the project has been classified as a category A project. Category A refers to proposed projects if it is likely to have a significant adverse environmental impact that are irreversible, diverse or unprecedented. These impacts may affect an area larger than the site for facilities subjected to physical work. In this case an environmental impact assessment is required.

3.3 International conventions and agreements

Maldives has signed and ratified several international conventions that is relevant to protection and preservation of the environment. This include protection of biodiversity, climate change mitigation and adaptation and environmental pollution. The following table (Table 1) provides a list of relevant environmental governance oriented international conventions. The GoM has ratified UNFCCC and associated protocols, and convention concerning protection of the world cultural and natural heritage, convention on biological diversity and convention of Law of the sea. In addition Maldives is also party to IMO Marine Pollution (MARPOL) convention. The GoM has certain obligations under ratification of these conventions and local legal and regulatory instruments has to incorporate relevant components of these conventions into national environmental management. Several regulations has already been formulated to address these.

Table 1 International Conventions of relevance to this project GoM has signed and ratifies

Convention/Agreement	Date of Ratification/ Accession (a) Acceptance (A)
Vienna Convention for the Protection of the Ozone Layer Vienna, 22 March 1985.	26 Apr 1988 (a)
Montreal Protocol on Substances that Deplete the Ozone Layer *Montreal, 16 September 1987*	16 May 1989
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer *London, 29 June 1990.*	31 Jul 1993 (a)
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer *Copenhagen, 25 November 1992.*	27 Sep 2001 (A)
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer adopted by the Ninth Meeting of the Parties *Montreal, 17 September 1997.*	27 Sep 2001 (A)
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer *Beijing, 3 December 1999.*	3 Sep 2002 (a)
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal *Basel, 22 March 1989.*	28 Apr 1992 (a)
United Nations Framework Convention on Climate Change *New York, 9 May 1992.*	9 Nov 1992
Kyoto Protocol to the United Nations Framework Convention on Climate Change *Kyoto, 11 December 1997.*	28 Mar 2002
Convention on biological diversity *Rio de Janeiro, 5 June 1992.*	9 Nov 1992
Cartagena Protocol on Biosafety to the Convention on Biological Diversity *Montreal, 29 January 2000.*	3 Sep 2002 (a)
Convention Concerning the Protection of the World Cultural and Natural Heritage, *23 November 1972*	22 May 1986
Stockholm Convention on Persistent Organic Pollutants *Stockholm, 22 May 2001*	17 Oct 2006 (a)
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, Rotterdam 10 Sep 1998	17 Oct 2006 (a)
United Nations Framework Convention on Law of the Sea	7 Sep 2000

4 Project Description

4.1 Project Proponent

The project proponent is the Government of Maldives (GoM). The Ministry of Housing and Infrastructure (MHI) is the Implementing Agency (IA), and the Ministry of Finance and Treasury (MoFT) is the Executing Agency (EA). Project beneficiary is Kulhudhuffushi Council.

4.2 The Project

The proposed project consists of three components; reclamation, passenger/cargo harbor and a waterfront Small Craft Zone area including a separation wall. These structures and facilities are located in an artificially created shoreline and shallow lagoon between Kulhudhuffushi port (south end) and existing harbor (north end).

The proposed works under this project includes the following components:

5. Area 1 Reclamation
6. Area 2 Reclamation
7. Waterfront and Small Craft Zone Area with a Harbor separation wall
8. Passenger/Cargo Harbor

These structure and facilities are located in an artificially created shoreline and shallow lagoon between Kulhudhuffushi port (south end) and existing harbor (north end). The concept design for these facilities are shown in Figure 1 and Appendix 2a.

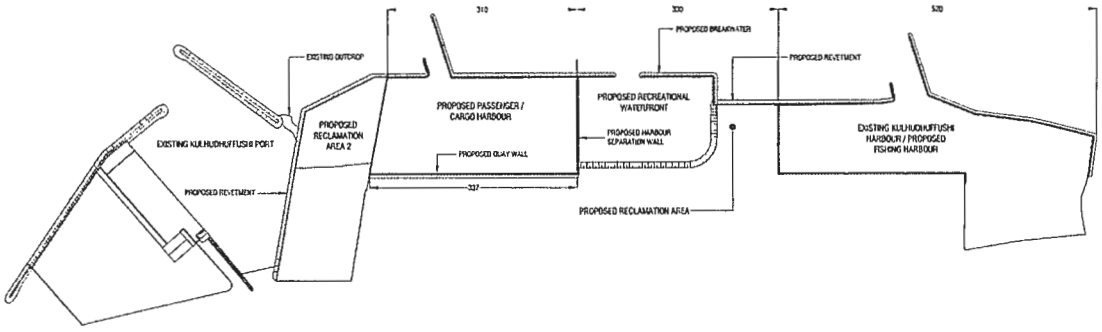


Figure 1 Concept design for the proposed harbors and associated civil works at Kulhuduffushi (A3 paper size of the concept design layout is given in Appendix 2a).

4.3 Reclamation areas

Reclamation: Area 1 The area will be approximately 100m by 50m when completed and extends the existing reclaimed land adjacent to the southern quay wall of the existing Kulhudhuffushi Harbor by approximately 50m (Appendix 2b). The required volume of reclamation material is estimated to be just less than 15,000 m^3.

Reclamation: Area 2 The Area 2 outline shown in Appendix 2c is taken from MHI's LUP (Appendix 3). The estimated size of this area is 123m by 270m. The majority of this area has already been reclaimed in earlier work and only the seaward portion of approximately 25,000 m^3 remains to be completed. Erosion has occurred along the western edge of the reclamation and along the southern edge at the interface with the regional port. Reshaping of the reclamation into an apparently stable beach profile has occurred due to the action of waves passing through the Regional Port, principally from a south-westerly direction

Google Earth Arial Photo and Level Contours included in Figure 2 and Appendix 4, show that the intersection of the beach profile with the finished level of Area 2 (approximately RL 1.6 m MSL) is very close to the edge of the proposed Area 2 reclamation. To ensure that this edge is not eroded over time or washed out due to a one off event of greater intensity, a revetment has been included.

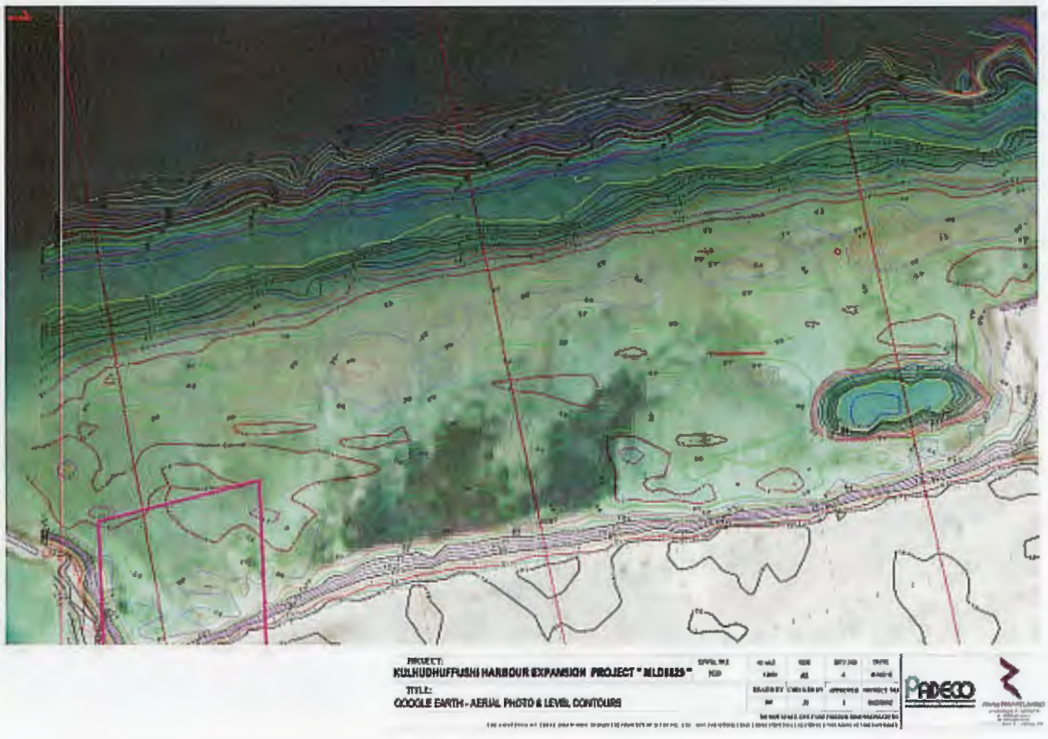


Figure 2 Bathymetric contour of the proposed Area 2 development

4.4 Waterfront and small craft zone area

The immediate and short-term intended purpose of this development is to provide a waterfront zone for small and personal craft as the centerpiece of the overall development. Important in the consideration of options is to minimize capital cost (the do-minimum option) and maximize flexibility for future low cost development of the area into a boat harbor and protection of the land developments from sea water inundation.

The natural sea bed level is approximately RL -1 m MSL, which is adequate for the intended purpose and no dredging cost will be incurred. Three options are considered as follows:

Option 1: Protected by breakwater and suitable for mooring small personal crafts, then larger ones if the area is later converted into a separate harbor. A beach profile is provided around the interior perimeter along a short revetment to prevent undermining of the seaward revetment protecting Area 1. Refer to in Appendix 2d.

Option 2: A shortened breakwater is provided, with shore protection provided by a revetment around the interior perimeter and on the seaward side of the reclaimed region of Area 1. Refer to Drawing in Appendix 2e.

Option 3: As in Option 2, a shortened breakwater is provided; however, a quay wall replaces the revetment along the interior perimeter. Refer to Drawing in Appendix 2f.

Option 1 is preferred as it meets MHI's needs in the immediate term and is the least costly for future redevelopment into a separate harbor or extension of the proposed Passenger-cargo harbor. If the breakwater in Option 1 was constructed to a depth suitable for future dredging, as shown in Section B-B in Appendix 2g, the cost would be higher than the cost of Option 2. Option 3 is the highest cost option irrespective of the breakwater adopted, due to the relatively high cost of the quay walls.

Using the Section B-B breakwater design shown in Appendix 2g, the cost of Option 1 and Option 2 will be similar, with Option 1 also having the immediate and long term advantages mentioned above. Section B-B shows how the breakwater could be modified in the event that future development requires dredging behind it.

4.5 Harbor separation wall:

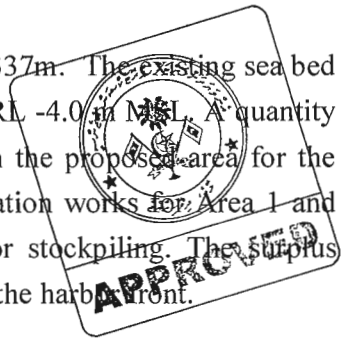
The harbor separation wall provides a physical barrier from the inherent dangers at the adjacent passenger-cargo harbor and to prevent sand migrating into the dredged harbor from the waterfront and small craft zone area. Three options were considered:

- Option 1: Sand bund with armor protection on both sides
- Option 2: Quay wall with sand beach on the waterfront mooring side
- Option 3: Precast concrete box caisson, sand-filled with in-situ concrete topping.

Option 3 is preferred as it requires the least capital outlay and offers the greatest flexibility in terms of future development. Removal of this structure would be less costly than either of the alternatives, presenting less of a hurdle to future expansion of the proposed passenger-cargo harbor.

4.6 Passenger/cargo harbor

The size of then proposed passenger/cargo harbor is 158m by 337m. The existing sea bed level is fairly uniformly RL -1.0 m MSL and will be dredged to RL -4.0 m MSL. A quantity of just over 150,000 m^3 of sandy material will be dredged from the proposed area for the harbor basin. Approximately 40,000 m^3 will be used for reclamation works for Area 1 and Area 2, leaving approximately 110,000 m^3 surplus material for stockpiling. The surplus material will be stockpiled in the large reclaimed land adjacent to the harbor front.



The largest vessels to use the harbor will be approximately 30 m in length, with a draft of up to 3 m. However, it may be possible that vessels with a draft up to 3.4 m or even 3.5 m to use the harbor subject to a proper evaluation of the minimum under-keel clearance (UKC). The calculation of a 'safe' UKC not only depends on the harbor's draft, tide, current, and weather conditions, but also on the vessel's trim and list characteristics and motions when approaching and using the harbor. In the absence of compulsory pilotage in Kulhudhuffushi local harbor, the Consultant recommends an evaluation of the minimum UKC to be undertaken in the early weeks of harbor operations, in line with the siltation rate and the frequency of maintenance dredging.

The quay wall will comprise a higher version of the ubiquitous "L" precast concrete wall used for the 3 m deep harbors (Figure 3). Recent practice in harbor's construction in the Maldives relies almost exclusively on this method, the KPL regional port being one notable exception where a steel sheet pile wall, with in-situ reinforced concrete capping was used. The greater height of this wall may explain the basis for this choice.

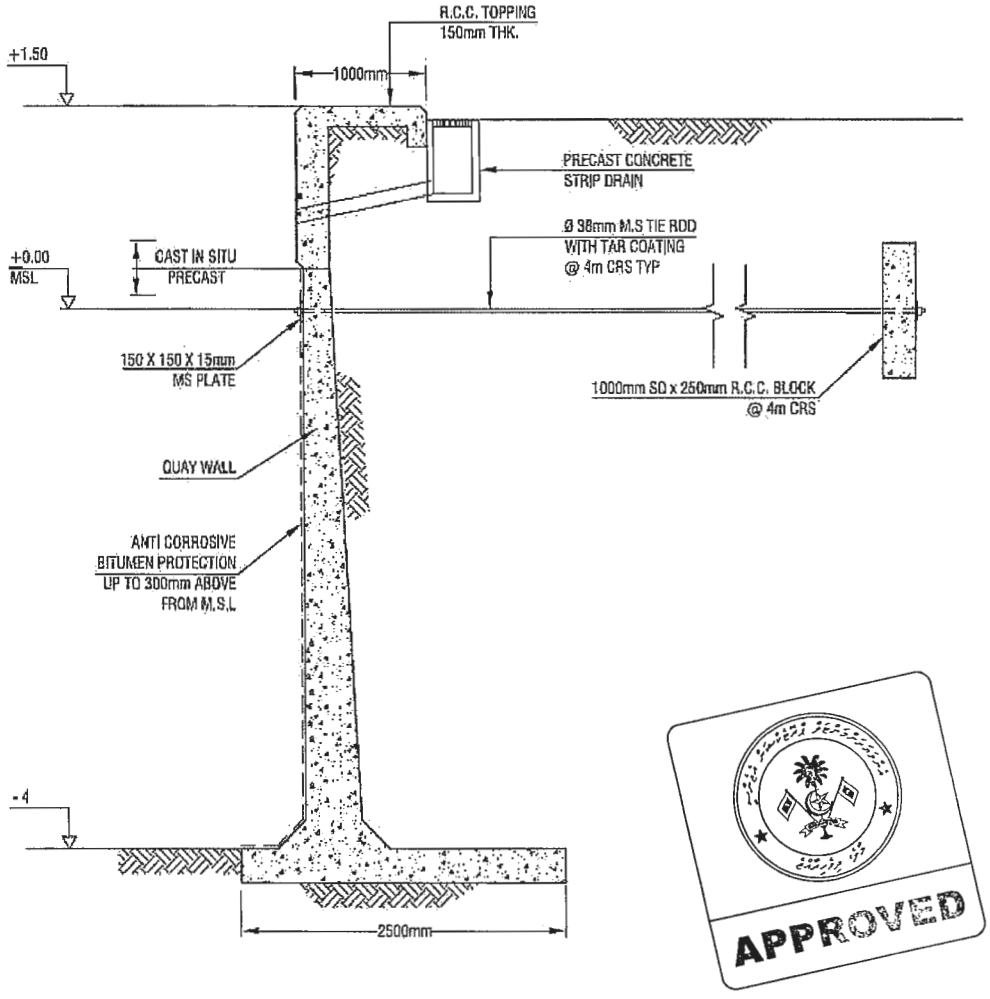


Figure 3 Typical cross section of a quay wall

4.7 Operational port infrastructure

In addition to dredging, reclamation, quay-wall and other civil works on basic infrastructure, operational port infrastructure (sometimes referred to as infrastructure-plus) includes facilities necessary for the safe operation of the harbor. Depending on the type, size, and use of the harbor, the scope and type of operational port infrastructure can vary widely. For this project, the main requirements for the passenger-cargo harbor in terms of operational port infrastructure are as follows:

Navigation lights

The standard approach for the provision of navigation lighting in other recent projects includes a solar Sealite SL-60 unit mounted on the breakwaters either side of the entrance. They are suitable for illuminating hazards and come with 256 International Association of Lighthouse Authorities (IALA) flash patterns.

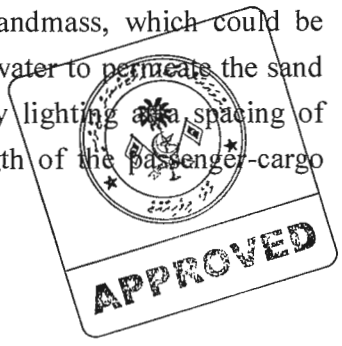
Timber jetty

The existing harbor has a concrete quay wall length of approximately 300 m, which has proven to be inadequate on some days, especially when visiting vessels moor there for several days at a time. A total of seven timber jetty finger piers are proposed perpendicular to the harbor separation wall, at a 15 m spacing to provide more berth space for convenient cargo unloading and passenger access to shore. Detailed design for the timber jetty will be prepared at a later stage of the project. The proposed material for jetty is of imported marine quality hardwood.

Harbor pavement, drainage, and apron lights

Consistent with other similar projects conducted by MHI, an allowance for a 6m wide paved apron is included for the length of the passenger-cargo harbor. An allowance for a continuous strip drain in the vicinity of the quay wall is included in the cost estimate.

It would be impractical to provide drainage for the entire landmass, which could be drained to the sea. Local custom is to allow the majority surface water to percolate the sand rather than be collected and drained to the sea. Roadway/ Quay lighting at a spacing of approximately 15m is included in the cost estimate for the length of the passenger-cargo harbor.



Bunkering and supply

Bunkering and supply facilities provide fuels to ships and vessels for their own use and range from large tank bunkering stations to small bunker barges. For the passenger-cargo harbor, and given the small scale of ships and ship operations, there does not appear to be a need for a bunkering station or a bunker barge at this stage. Further, if required, an existing gas/petrol station adjacent to the port, could store and supply marine diesel for ships using the harbor.

Ships also take on fresh water from bunkering facilities and occasionally require electricity supply. Rather than make provisions for supply at the harbor, these needs can be met by the existing suppliers in Kulhudhuffushi.

Fire and emergencies

In ports, the scope of firefighting and emergency services normally includes fire prevention and response to accidents and emergencies both in the harbor and on-board ships. As such, the response capability should include a wide range of services including attending fires, dangerous goods incidents, chemical leaks, and oil spills.

In Kulhudhuffushi, there is already a fire station just outside the harbor area (adjacent to the gas station), which is also responsible for attending fire and emergencies in the port. The extent to which such a facility has the necessary capacity and capability to deal with major port emergencies, such as a fire explosion or an oil spill is unknown; however, it is likely that further training and capacity building along with adequate equipment would be required once the new expansion becomes fully operational.

Port superstructure and ancillary facilities

Port superstructure refers to port buildings, warehouses, and equipment and may also include a range of other ancillary facilities. In most port and harbors, a distinction is made between essential and non-essential ancillary facilities depending on the regulatory requirements in place and on the needs of the port users and community.

For the purpose of this report, we have listed the cost relevant superstructure and ancillary facilities based on our professional judgment, the preliminary feedback from economic and social surveys, and the requests of both MHI and ADB.

The extent to which some or all of those superstructures and ancillary facilities will be included in the detailed and final design will depend on the outcomes from the final project

scoping which will take place during ADB's final Fact-finding mission, currently scheduled on 28 February – 06 March 2016; as well as further investigation and detail design during the PMC's work.

Passenger terminal

A building with a footprint of 14m x 14m is proposed in front of proposed passenger/cargo harbor. The location of this building is shown as illustrated in Appendix 2h. Details of this building will be made at a later stage of the project. It is anticipated that such a size building would be sufficient to house the passenger terminal and also provide space for the following:

- seating area
- passenger terminal/ atm (automated teller machine)
- prayer room
- one ticketing office
- 2 administrative offices
- amenities

Amenities include washing area for prayers, male and female toilets. Toilets and waste water from washing area will be connected to existing sewerage network of the island. Other waste generated from terminal related activities will be disposed at island based waste disposal facility.

Harbor markets

The harbor markets will comprise separate fishing and vegetable markets to support the local fishing and produce trading industries. Currently fish processing is conducted in temporary and very modest circumstances. Similarly, produce and vegetable trade takes place in an open area near the hospital, without appropriate shade or areas to congregate.

The 15m x 10m fish market would include an ice plant, enabling fishermen to keep their catch fresh. For the vegetable market, a 15m x 10m open structure is proposed to provide covered space for the market with room to congregate. The location of both these facilities are shown in illustrated in Appendix 2i. Both these structures are currently shown as locations, however, detailed design will be prepared at a later stage of the project.

Buildings for commerce and business activities

Additional buildings could be justified to complement the development of the harbor. The cost estimate includes for an additional building with a footprint of 14m x 11m to house the following:

- General store
- 2 food and beverage outlets
- 2 retail outlets
- 2 business offices
- Amenities

4.8 Need for the Project

Kulhudhuffushi is a major population center in the north of the Maldives and is currently being developed as an urban center under the GoM's development plans. The total registered local population is 8,011 according to Census 2014 (National Bureau of Statistics). Kulhudhuffushi is home to major state institutions, both civil service and public enterprises, the regional hospital, and the northern regional secondary school, and a future airport. As a center for the entire north of Maldives the overall population of the region is estimated as 45,000.

The 50 bed hospital, which is earmarked for expansion, provides general medical services, specialist care, surgery (minor), emergency services, dental services, and services of the intensive care. Existing education facilities in the form of a preschool, two primary schools, one secondary and higher secondary school, and a vocational training center; are all designed to cater for students from Kulhudhuffushi and nearby islands. There is also a small branch campus of the national university. A project to build a new air strip and airport facilities in Kulhudhuffushi has been recently approved, and will replace the existing airport in neighboring Hanimaadhoo island.

The main transport infrastructure in Kulhudhuffushi are the regional port and the local harbor. Furthermore, a regional airport project was recently approved by the GOM. In addition to this, an on-going road development project has been recently completed, which includes the provision of asphalt road surface and the necessary drainage for the main roads of the island.

Commercial shipping services connecting Kulhudhuffushi to the rest of the Maldives include weekly services to-from Malé; public ferry services to-from smaller islands in the Northern atolls, and several non-regular cargo/passenger services. In addition,

Kulhudhuffushi is currently accessed from Malé and elsewhere via Hanimaadhoo airport followed by approximately a half- hour transfer by speedboat.

With consideration to all the above, and often considerable congestion of the existing harbor, the government aims to improve the local maritime transport condition at Kulhudhuffushi. The ideal of a separate passenger/cargo dedicated harbor will facilitate better condition and is expected to ease current and future congestion. Allocating existing harbor as a dedicated fishing harbor will also help overcome the current congestion.

4.9 Location and Extent of Site Boundaries

The project location is between KPL and existing cargo/passenger harbor annexed to section of the harbor dedicated to fishing vessel. The specific area for development is also peripheral to recently reclaimed land (reclamation completed in 2010). Adjacent to boundary on the proposed project area are KPL on the south and existing harbor on the north side (Figure 4).

Figure 4 Project impact boundary showing area in general as residual impact boundary

4.10 Construction phase and schedule for implementation

The construction phase of the project is expected to be approximately 18 months.

4.11 Mobilization

Mobilization of construction workforce to the site will be within two month of construction contract awarding date.

4.12 Inputs (description of the project in terms of raw materials, processes, equipment and work force)

4.12.1 Workforce

A combined foreign and local labor work-force of a maximum of 50 is anticipated. Depending on the work methodology it is possible and likely that this will be halved by any experienced contractor. Based on current industry norms and practices with the exception of a few local workers, the majority of workers are expected to be expatriate.

4.12.2 Power and water supply during construction phase

Kulhudhuffushi being an urban center has a centrally connected grid and reticulated water and sewerage. Hence electricity, water and sewerage requirement for the project construction workforce will be using these services. Based on size of the construction workforce it is expected that the local utility services such as electricity, water and sewerage system be sufficient for the entire duration of the construction and beyond. Bottled water will be used predominantly for drinking.

4.12.3 Construction methods

- **Duration of dredging work**

The dredging work is anticipated to take a total of 28 weeks and will be carried out as per schedule given in Table 2 below.

Table 2. Proposed schedule for dredging work

Activities	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8-17	Month 18
Mobilization									
Rock sourcing									
Dredging/reclamation									
Disposal of sand									
Revetment/quay wall									
Demobilization									

- **Method and equipment used for dredging**

Dredging will be undertaken using an excavator. Excavated material will be moved to proposed reclamation sites using trucks and lorries. Excess sand and sediment from dredging

work after filling proposed reclamation site, back filling works associated with the quay wall, bedding for revetments and breakwaters will be stock piled in a designated area (specific location not yet allocated). Estimated volume of dredged material is 144550m^3. Total workforce for the subcomponent is 15-20 workers. Various types of inputs and outputs of the project are given in Table 3.

Table 3 Estimated Inputs for the construction and operational phase of harbor development

Phase	Input resource(s)	Source/Type	How to manage workers, acquire, dispose materials and waste
Construction phase	Construction workers, construction camp	• 50 foreign/local workers during peak construction period	Workers sourced from contractor's current workforce and supplemented with local and foreign new recruitment where required. Pre-fabricated Building (work force accommodation) . Sufficient land adjacent to site for camp.
	Construction material (e.g. rock boulders, sediments, for reclamation, concrete structure etc.	• Rock boulders for armor rock, geotextile, aggregate, cement, river sand • reclamation fill material	• Sourced from neighboring countries depending on where available (e.g. India, Sri Lanka, Bangladesh) • From dredged areas of proposed harbor basin
	Waste management	• Construction related waste, workforce borne domestic type waste • Waste from vehicles/machinery	• Local waste disposal site • Local waste site/transported to Thilafushi
	Water supply	• Reticulated water sourced from local utility service provider MWSC. • Bottled drinking water available locally	• Through commercial user arrangement with the service provider • Locally purchased
	Electricity/Energy	Local utility services company to provide power	Through commercial user arrangement with the service provider
	Fuel storage	No large quantities of fuel are expected to be stored by the Contractor	Under commercial terms with local supplier

Phase	Input resource(s)	Source/Type	How to manage workers, acquire, dispose materials and waste
Operational phase	Water supply	• Reticulated water sourced from local utility service provider MWSC.	• Through commercial user arrangement with the service provider
	Electricity/Energy	Local utility services company to provide power	Through commercial user arrangement with the service provider
	Fuel storage	Diesel, petrol	Under commercial terms with local supplier
	Waste management	Waste from passenger and cargo vessels, such as solid waste, sewage, engine waste oil, etc.	Solid waste disposed at local waste management site No sewage or effluent containment and disposal systems installed on vessels. When in harbor waste disposed directly to the harbor basin. Not yet regulated under waste management regulation

4.12.4 Outputs (project components)

4.12.4.1 Detailed designs

Detailed design of various components of the project will be prepared once the concept for various components are approved by MHI and ADB.

4.12.4.2 Key structures

Description of key structures as described in sections 4.2 to 4.7.

taken on the same locations in order to have an understanding of the impact of beach sediment movement in the area for proposed development. This area is not part of the natural shoreline (reclaimed shoreline in 2010) and therefore should not be taken as natural shoreline changes. This location where beach profiles were taken will be entirely modified. Adjacent areas of the shoreline is heavily modified through various coastal structures, hence no profiles were taken on either side of the harbor as the project works will not have any impact on the shoreline on either side.

Table 4 Location (GPS referenced) of beach profiles

Beach Profiles	Bench mark position (GPS coodinates)
Profile 1	6°37'22.0"N; 73°03'51.5"E
Profile 2	6°37'19.3"N; 73°03'52.4"E
Profile 3	6°37'15.7"N; 73°03'52.9"E
Profile 4	6°37'12.3"N; 73°03'53.2"E
Profile 5	6°37'09.2"N; 73°03'53.8"E
Profile 6	6°37'06.0"N; 73°03'55.0"E
Profile 7	6°37'02.9"N 73°03'56.3"E

5.1.3 Wave and tide

Wave and tide data were used for the purpose of understanding general wave and tide condition from available secondary data that can be applied. This include national tide monitoring data available from National Meteorological Centre. Other relevant data on tides and waves were used where applicable.

5.1.4 Surface Currents

Current data at reef was collected using drogue method. A precision GPS was attached to a drogue and line feature data was collected at point intervals of 30 seconds. The current speed (surface current) was calculated as a function of distance travelled by drogue per unit time (m/s). The speed measurement was made as meters per second. The final output of drogue data is made using MatLab routine. Drogue data was collected from west side reef slope and reef flat in the general area for proposed development.

5.1.5 Shoreline changes

The island morphology or historical changes were analyzed using images obtained from the Google Earth image archives (images from 2006, 2010 and 2014). Shoreline on all the images were traced. The image for the year 2006 was used as a base year image. The movement or the changes of the shoreline line was determined with respect to this baseline. Change in the area enclosed by the vegetation line was used to determine the net change in the area of the island enclosed by the vegetation.

5.1.6 Sediment characteristics

Sediment characteristics of the impact area was assessed by sampling upper surface of the sea bottom from the proposed area for development. 12 sediment samples from three transects perpendicular to the beach from beach to 150m off shore location were taken and analyzed for grain size. The location of sediment samples are given in Figure 5.

5.2 Marine Survey

A 200 meter long and 5 meter belt transect area was chosen at each survey site. An underwater camera with housing was used to take a series of photographs for assessing reef benthic community at 2 sites, 2 depths (5 and 10 meter depths). Several photo quadrats (1m by 1m) were taken along 200 by 5 meter belt transect at each site at these two depths 40 randomly selected photo quadrats were used to assess reef benthic community by determining percentage of various benthic substrate (categories) using standard benthic categories for coral reef benthic substrate sampling as described by English et. Al., 1997. As a subset of benthic community, corals were grouped into their taxonomic level as general. Where identification enabled, coral were also identified to species level, with specific reference to Endangered Species as classified by IUCN Red list.

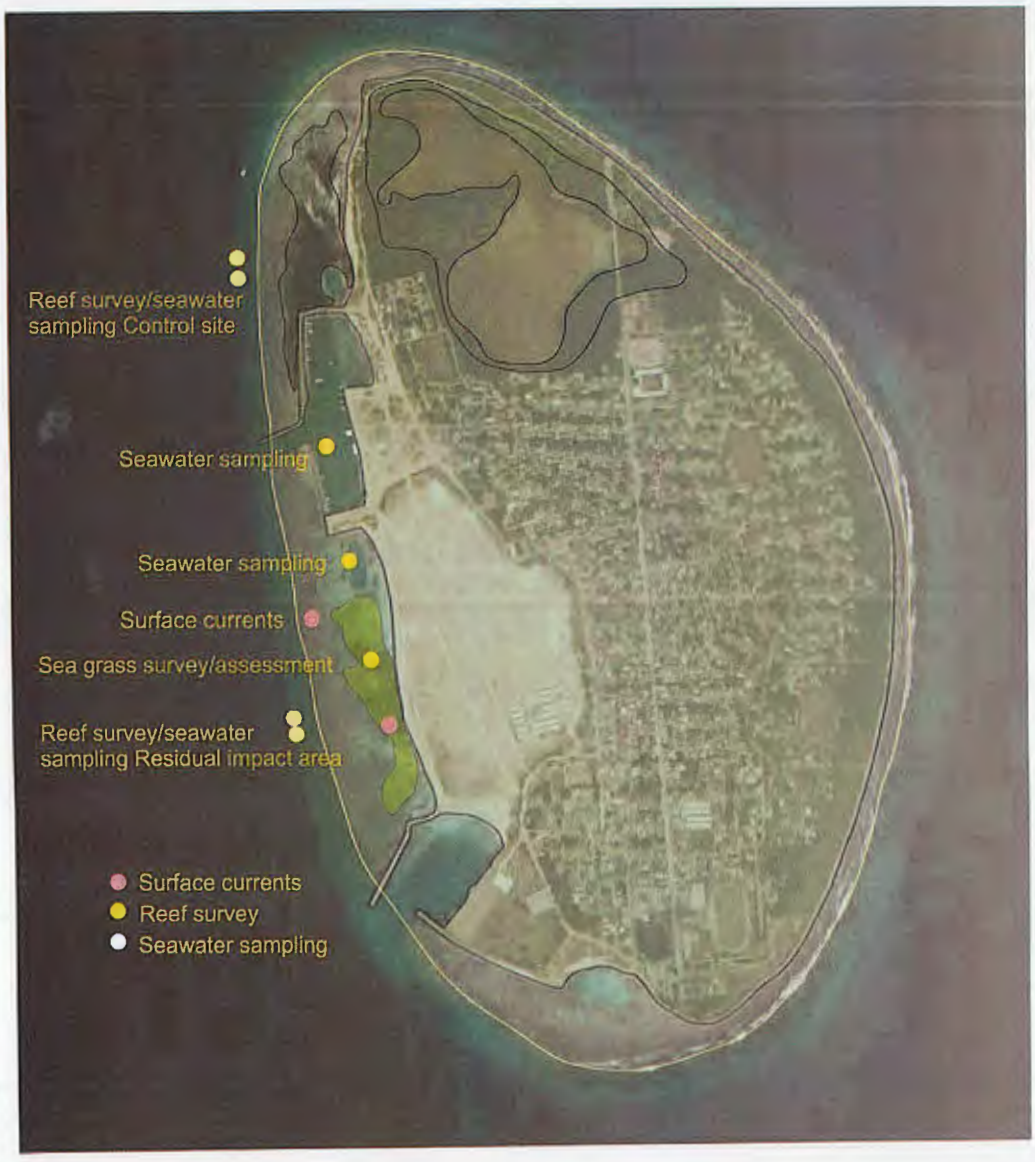


Figure 5. Reef survey (R- quantitative, Q- qualitative), seawater sampling (SW) and sediment sampling locations

The ecological setting of sites R1 and R2 will act as a baseline for future reef monitoring (Figure 5 and Table 5) for location and GPS coordinates of survey sites. Coral Point Count with Excel extension (CPCe) was used to assess the benthic cover.

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Table 5 GPS coordinates of the survey, water sampling locations

Survey locations	GPS coordinates
Reef 2/seawater (control)	6°37'44.4"N; 73°03'41.0"E
Reef 1/seawater (Residual impact area)	6°37'10.2"N; 73°03'45.5"E
Seawater (exisitng harbour basin)	6°37'29.6"N; 73°03'47.2"E
Seawater (nearshorel lagoon)	6°37'18.2"N; 73°03'48.7"E
Sea grass (impact area)	6°37'10.2"N; 73°03'50.6"E

Assessment of the selected fish community was also carried out at the same sites and same transects which would also be considered as the reef benthic baseline assessment sites for future monitoring of the impact of the project. Fish abundance surveys were based on visual fish census techniques described in English et. al., (1997). The 200 by 5 meter long belt transect area was used to estimate the diversity and abundance of coral reef fish and significant invertebrates that are commonly associated with the reef environment of Maldives. Special reference was given to estimating the numbers of lobsters, giant clams and sea cucumbers as they are at various levels of protection for conservation and management locally. In addition to this selected mega fauna such as sharks, napoleon wrasse, and sea turtle were focus of the assessment. All surveys were carried out by SCUBA.

In addition, qualitative assessment of the shallow lagoon (predominantly a sea grass meadow) were also made to document the extent and nature of the sea grass community. Major categories of sea grass were identified to their species level. Presence of sea grass associated benthic fauna especially invertebrates were assessed. It is expected that this area will be effected as a result of proposed coastal modification through dredging and reclamation. Locations of various surveys including reef survey sites are shown in Figure 5.

5.3 Water quality analysis

In order to assess the sea water quality, seawater samples taken from 4 locations (Figure 5 and Table 5 sample location). Samples were tested by the Water Quality Assurance laboratory of MWSC. Samples were also tested for their physical parameters using a multi probe water instrument (Hanna Instrument, HI9828). Samples were analyzed for specific parameters given in TOR.

5.4 Socioeconomic condition

Socio economic profile of the project area was assessed and presented through available secondary data on population and major economic activities with particular emphasis on local

and regional maritime transport. In addition to this, information available from Poverty and Social Assessment study that included in the project design component consultancy work has also be used.

6 Existing environment

6.1.1 General setting

The Maldives archipelago is a long double chain of coral atolls formed over the Lacadives-Chagos ridge that runs 1 deg north to 9 deg south along the longitude 73 deg. Maldives is among the only four independent states that comprises entirely of low lying small islands. The 26 geographic atolls that form the country cover an area of 21,373 km^2 over 100,000 km^2 with some 1,200 islands (Naseer and Hatcher, 2004). The land area of all the islands sum up to approximately 300 km^2 with a total coastline length of 644 km. The Maldivian atolls are quite diverse in their shape and size, ranging from circular to elliptical to oval with areas ranging from of 5.4 km^2 to 4219.48 km^2. Channels, which run from east to west, separate these atolls.

Similar to the atolls, the characteristics of the Maldivian islands also greatly vary from the North to the South of the archipelago. While fringing reefs in the northern atolls are more distinct and discontinuous with smaller islands and numerous patch reefs in the shallower lagoon, the atolls in the south host a large number of continuous reefs of considerable length along its perimeter, with several reefs hosting large islands. The lagoons of the southern atolls are deeper and host fewer patch reefs. The shapes of the islands are also influenced by the climate. Maldives is governed by the Indian Ocean Monsoon climate. As a result Maldives experiences a wet season (the southwest monsoon) and a dry season (the northeast monsoon) annually. The strong reversals in the wind regime as a result of monsoon change bring about short term changes in island shorelines by transferring the sand along the shorelines of the islands.

Although Maldives is not in a seismically active zone, the Carlsberg Ridge which is a seismically active zone, runs along 800 km west of Maldives. This ridge is a slow spreading divergent boundary between the African and the Indian plates. The zig-zag pattern observed at the boundary is associated with the transform faults where the plates are moving horizontally past each other. The earthquake of magnitude 7.5 at the Carlsberg Ridge, in 2003 was experienced by the Maldives. Figure 6 below shows the location of the ridge and the associated transform faults.

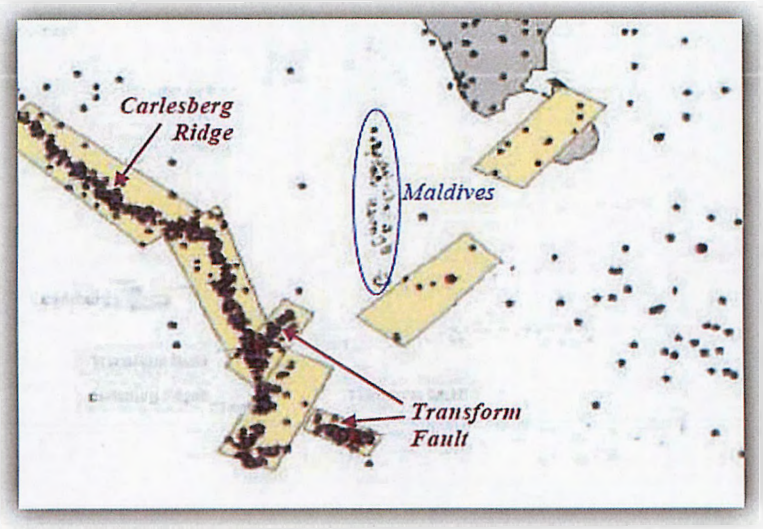


Figure 6 Location of Carlsberg ridge near the Maldives

6.2 Geographic location and general setting of Kulhudhuffushi

Kulhudhuffushi is located on the eastern side peripheral reef of Thiladhummathi Atoll, at geographic coordinates of N6° 37' 24" and E73° 04' 10" (Official Atlas of Maldives, MPND), (Figure 7). For administrative purposes the atoll is also referred to as Haa Dhaal atoll, the second northern most atoll of Maldives. It is the administrative focal island of Haa Dhaal atoll. The distance between Kulhudhuffushi and Male (capital of Maldives) is approximately 275km. It has an area of approximately 235 hectares with an addition of 35 hectares from reclamation of the shallow lagoon on the western side shoreline in 2010. Neighboring inhabited islands on separate peripheral reefs are Nolhivaram and Kumundhoo on the north and south respectively.

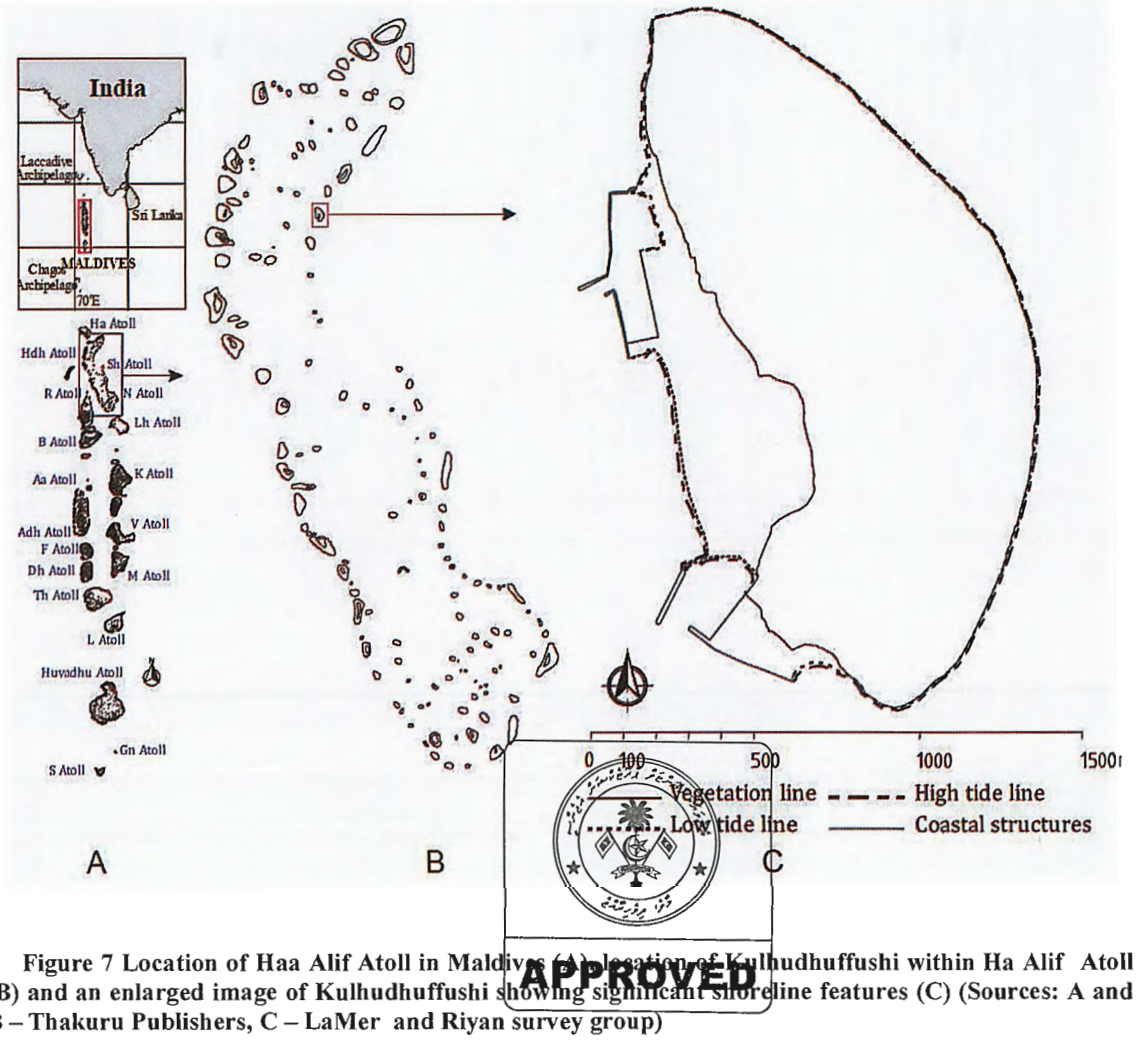


Figure 7 Location of Haa Alif Atoll in Maldives (A), location of Kulhudhuffushi within Ha Alif Atoll (B) and an enlarged image of Kulhudhuffushi showing significant shoreline features (C) (Sources: A and B – Thakuru Publishers, C – LaMer and Riyan survey group)

As typical of many islands in the north of Maldives, the reef is exclusive to the island. The Reef is almost oval in shape, maximum length and width (visible extend) are 2.87km and 1.78km respectively. Length and width of the island are 2.53km and 0.9km respectively. It also has significantly large wetlands (mangrove fringe) on north and south ends with a combined area of 33.46 hectares. The island at its geographic setting is exposed to the north east monsoon from the ocean side (east) with strong winds, waves and occasional storms (tropical storm scale) originating from Indian Ocean cyclone belt (UNDP, 2006).

6.3 Ambient air quality

Ambient air quality in the Maldives is generally good with sources of emission in low density. The main sources of emission that negatively influence air quality are open burning of waste, exhaust fumes from road and sea transport vehicles and diesel based production of electricity. Harmful components that may deteriorate air quality as a result of these sources include, CO_2, CO, NO_x, particulate matter. Road vehicles and sea vehicles are not in high density at project site. Emissions from such sources is likely to be low. With the nature of

geographic setting of islands in general including their small sizes, elevation and proximity to the ocean, it is unlikely that air quality will be a significant issue.

6.4 Ambient noise

Ambient noise at daytime at the proposed location and vicinity are already above resident level (<55 dBA) at the proposed harbor expansion area. It is important to note that the area is already adjacent to a functional domestic scale harbor where noise level may attain to a light commercial sites associated noise levels (70dBA). This is not a continuous level of noise as harbor activities are not intense. Currently cargo vessels unload their cargo and transport it to off site locations through road vehicles. Such activities are mainly limited to daytime hours. Sensitive receptors to noise in the vicinity of the harbor are local residents living nearby. The distance from residing plots and harbor area is in excess of 300 meters. With several cottage and semi commercial activities already on going in the same area as the proposed project site, it is unlikely that noise sourced from the project both during construction and operation phase of the project be significant.

6.5 Shoreline survey

Satellite and aerial images of the island from 1969 to 2011 show significant changes to the shoreline on the north end but minimal change to the south (MEE 2013). This change is somewhat altered due to construction of port and its coastal structures completed in 2005. The most significant changes to the shoreline came from the excavation works and subsequent surplus dredge spoil associated with local harbor in 2009 and due to large reclamation project that added approximately 28 hectares to the western shoreline.

Changes to the shoreline using Google based imagery from 2006 to 2014 are shown in Figure 8. The added land and its artificial shoreline remain exposed to wave energy and sediment movement. Stabilization of the reclaimed shoreline since 2010 has led to changes and this change has been surveyed in 2013. Subjected portion of the shoreline that will be almost entirely modified has been surveyed as part of the EIA which include shoreline profiles. Comparison of these profiles to 2013 survey including profiles are shown in Figures 13-19.

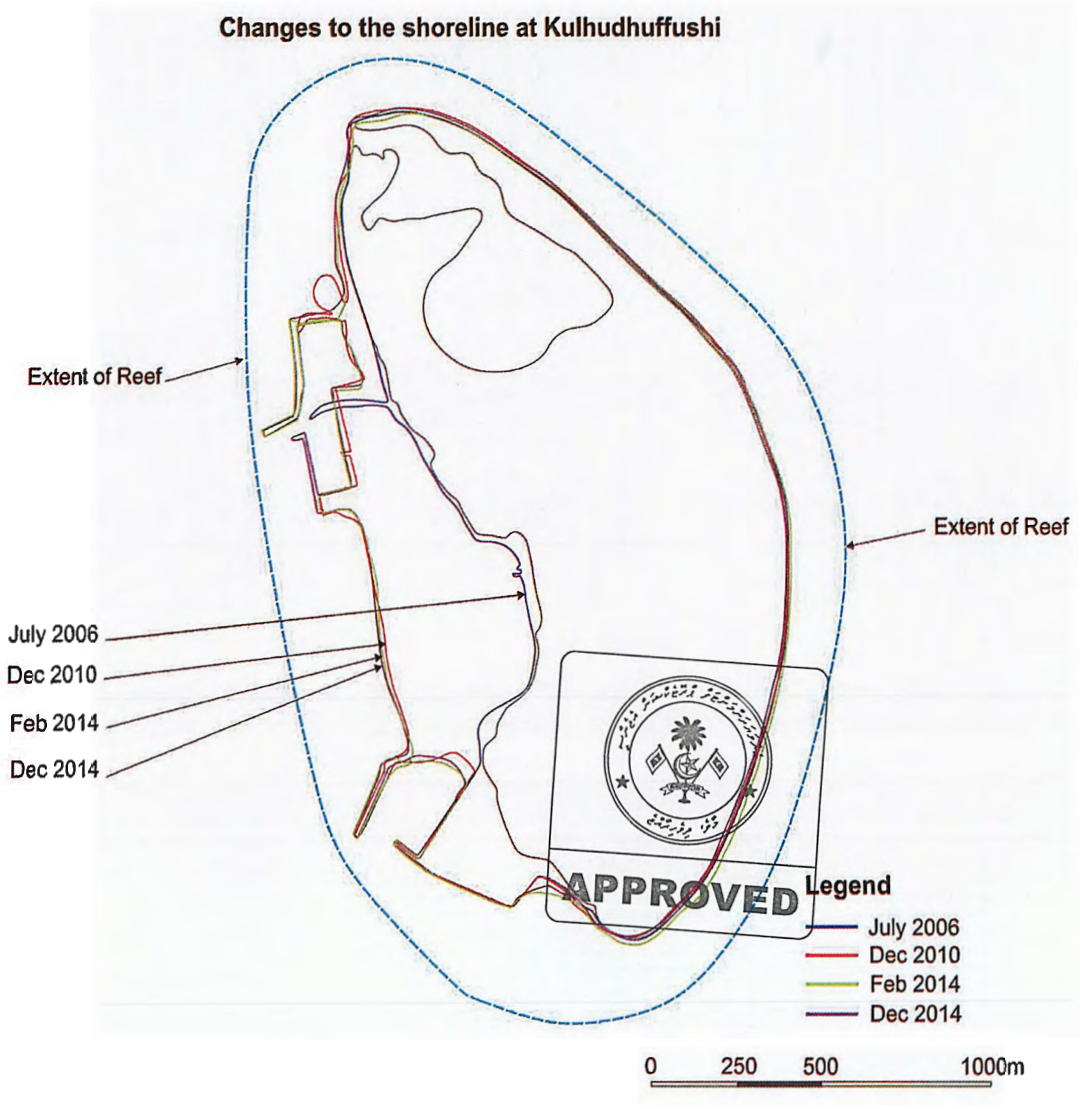


Figure 8 Results of shoreline survey compared (EIA based)

6.6 Climatology and oceanography

6.6.1 Temperature

The Meteorological station at Haa Dhaal Hanimaadhoo records temperature on an hourly basis. Data on mean daily temperature was obtained from the station for the period of May 2008 to December 2012. The whole data set was analyzed to obtain a frequency distribution of daily mean temperature for the given period. Results of this analysis are shown in Figure 9, which shows that temperature in the region was most commonly at temperatures between 28°C and 29°C. The lowest recorded temperature was at 24.2°C while the highest recorded temperature was at 32.5°C.

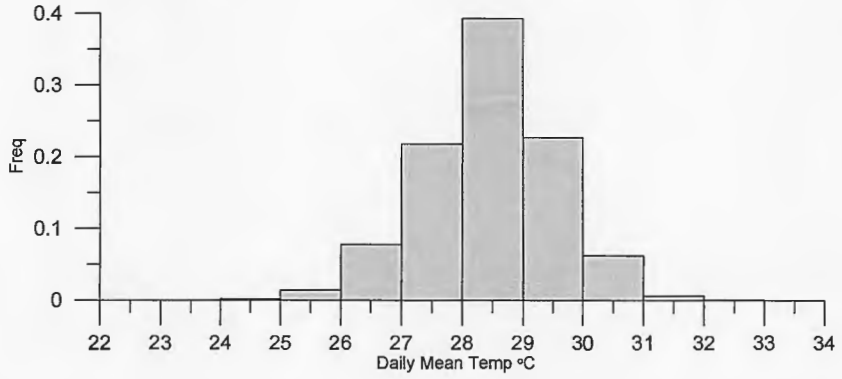


Figure 9. Frequency distribution of daily mean temperature recorded at Haa Dhaal Hanimaadhoo station (May 2008 – December 2012)

6.6.2 Rainfall Characteristics

No site specific rainfall data are available, hence rainfall data for the analysis of the existing environment at Kulhudhuffushi was used as a proxy from the Meteorological station at Hanimaadhoo. Figure 10 shows a frequency distribution plot of daily rainfall measurements recorded for the region, for the period between May 2008 and December 2012.

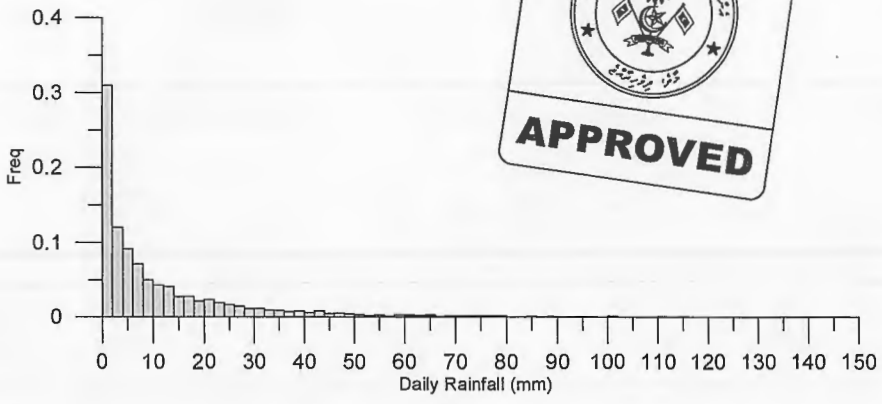


Figure 10. Frequency distribution of daily mean rainfall recorded at HDh. Hanimaadhoo station (May 2008 – December 2012)

Daily rainfall exceeding 50mm can be classified as heavy rain, and as evident from the above figure, this is a rare instance for the region. Most commonly recorded rainfall for the region is between 0 to 2mm daily, which is seen to occur for about 30% of the year.

Figure 11 shows a plot of average annual rainfall for the region, between the years of 1998 and 2012. The average annual rainfall was obtained from the daily rainfall recorded for the

region. The highest average annual rainfall was recorded for 2004 at 2209.3mm, while the lowest was recorded at 2002 at 1346.5mm.

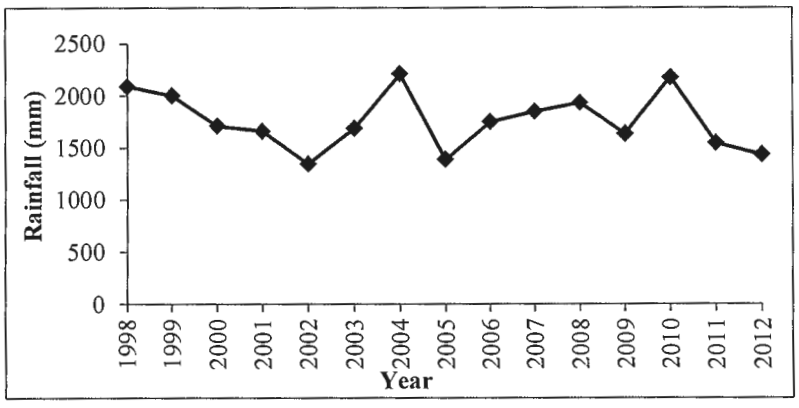


Figure 11 Average yearly rainfall for the 15-year period between 1998 and 2012

6.6.3 Wind climate

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

The SW monsoon lasts between May and September while the NE monsoon lasts between December and February. The period between March and April is the transition period from the NE monsoon to SW monsoon known locally as the *Hulhangu Halha*, while the transition period from SW monsoon to NE monsoon is known as *Iruvai Halha*. *Iruvai halha* lasts from October to November (Table 6). The SW monsoon is generally rough and wetter than the NE

monsoon. Storms and gales are infrequent in this part of the world and cyclones do not reach as far south as the Maldivian archipelago (Ministry of Construction and Public Works, 1999).

Table 6 The four seasons experienced in the Maldives

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

Since there were no site-specific wind data, wind regime around the island was assumed to be similar to that at the closest meteorological station, which is at Haa Dhaal Hanimaadhoo, approximately 30 km north of Kulhudhuffushi. An analysis of the wind climate was done using hourly wind data between the period of May 2008 to December 2012 from Hanimaadhoo meteorological station. In this analysis, wind rose diagram based on wind speed and direction and the frequency of speeds and direction was produced.

Wind rose plot (Figure 12) shows that winds from the western quadrant are dominant reaching speeds as high as 30 knots. Winds from the northern and eastern quadrant are less prevalent and with comparatively low speeds. Wind speeds above 18 knots were found to be a rare occurrence, and the instances when it does occur, wind direction was from the western quadrant (Table 7), thus indicating that this was during the SW monsoon, when winds are generally stronger.

Table 7 Hourly wind data from Hanimaadhoo Meteorological station

				Wind Speed (Knots)														
Wind Direction		Freq	Cum. Freq	>0 - 2	>2 - 4	>4 - 6	>6 - 8	>8 - 10	>10 - 12	>12 - 14	>14 - 16	>16 - 18	>18 - 20	>20 - 22	>22 - 24	>24 - 26	>26 - 28	>28 - 30
22.5	NNE	3.9%	3.9%	0.005%	2.784%	0.964%	0.119%	0.020%	0.005%	0.008%								
45	NE	3.8%	7.7%		0.961%	1.777%	0.821%	0.211%	0.033%	0.015%	0.005%	0.003%						
67.5	ENE	5.1%	12.8%		0.882%	2.339%	1.111%	0.486%	0.191%	0.074%	0.015%	0.005%						
90	E	5.1%	17.9%		1.154%	2.146%	0.905%	0.511%	0.211%	0.104%	0.018%	0.003%						
112.5	ESE	1.1%	19.0%		0.501%	0.534%	0.069%	0.013%										
135	SE	1.0%	20.0%		0.440%	0.422%	0.086%	0.036%		0.003%	0.003%							
157.5	SSE	0.8%	20.8%		0.285%	0.346%	0.114%	0.041%	0.020%	0.003%								
180	S	1.1%	21.9%		0.338%	0.460%	0.168%	0.066%	0.028%	0.005%			0.003%					
202.5	SSW	2.2%	24.1%		0.702%	0.913%	0.358%	0.163%	0.064%	0.013%	0.005%							
225	SW	4.1%	28.2%		0.519%	1.312%	0.994%	0.661%	0.297%	0.226%	0.051%	0.010%	0.005%					
247.5	WSW	10.9%	39.0%		1.147%	3.216%	2.278%	1.996%	1.200%	0.653%	0.264%	0.074%	0.036%	0.005%	0.005%			
270	W	25.2%	64.2%		2.464%	6.349%	5.133%	4.884%	3.165%	2.153%	0.572%	0.211%	0.117%	0.043%	0.041%	0.013%	0.008%	0.003%
292.5	WNW	15.3%	79.5%		2.087%	4.131%	3.351%	2.520%	1.599%	1.078%	0.249%	0.117%	0.066%	0.033%	0.025%	0.008%	0.008%	0.003%
315	NW	9.2%	88.7%		2.174%	3.882%	1.775%	0.859%	0.305%	0.153%	0.046%	0.028%	0.008%	0.003%				
337.5	NNW	5.6%	94.3%		1.752%	2.771%	0.658%	0.287%	0.107%	0.043%	0.005%	0.013%						
360	N	5.7%	100.0%		2.303%	2.733%	0.481%	0.114%	0.023%	0.013%								
Cumulative %				0.005%	20.49%	34.30%	18.42%	12.87%	7.249%	4.543%	1.233%	0.463%	0.234%	0.084%	0.071%	0.020%	0.015%	0.005%

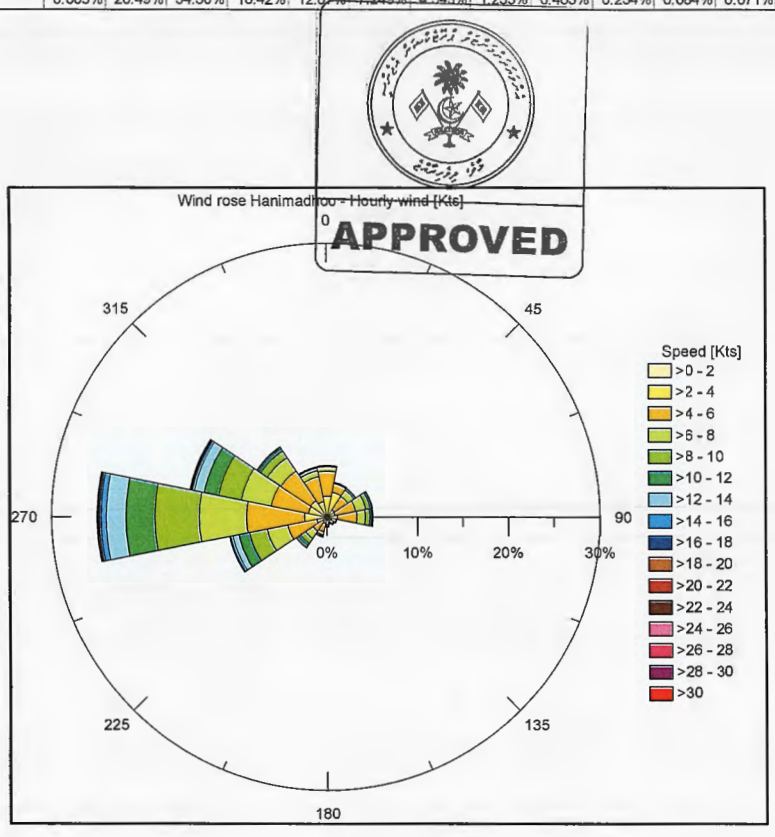


Figure 12 Wind rose plot for Hanimaadhoo Meteorological station, based on hourly wind data for the period of May 2008 to December 2012

6.6.4 Tide

Tides in the Maldives are usually characterized as a mixed tide. It contains two main cycles (diurnal and semi-diurnal tides) per day (Figure 13). Harmonic analysis of the tides represents the period of oscillation of the celestial forcing that gives rise to the respective harmonic.

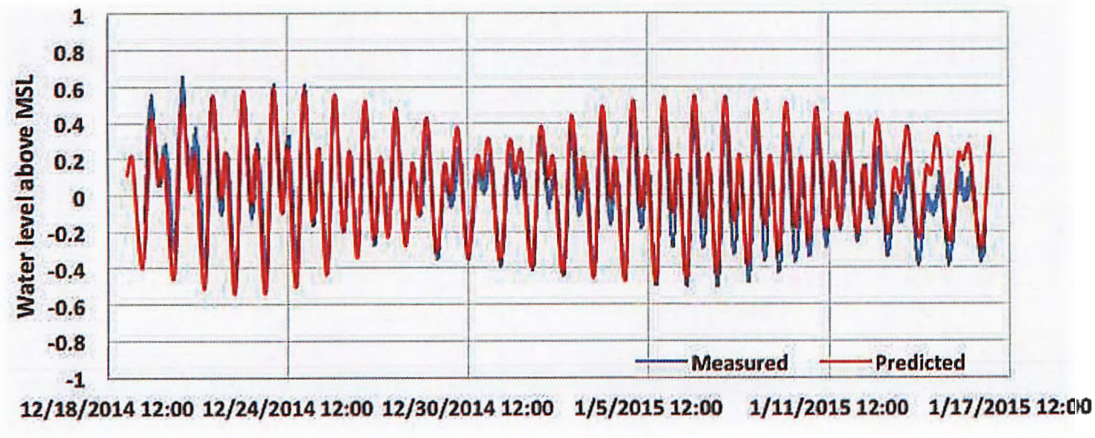


Figure 13Observed tide at nearby location to Kulhudhuffushi and predicted tide for Hanimaadhoo Station

6.6.5 Wave

The dynamics of wave is an important factor to consider in construction of any offshore structures such as water bungalows, harbors, jetties etc. Waves play a significant role in the modification of the beach environment and the surrounding. Types of waves and current influence to the shoreline is shown in Figure 14.

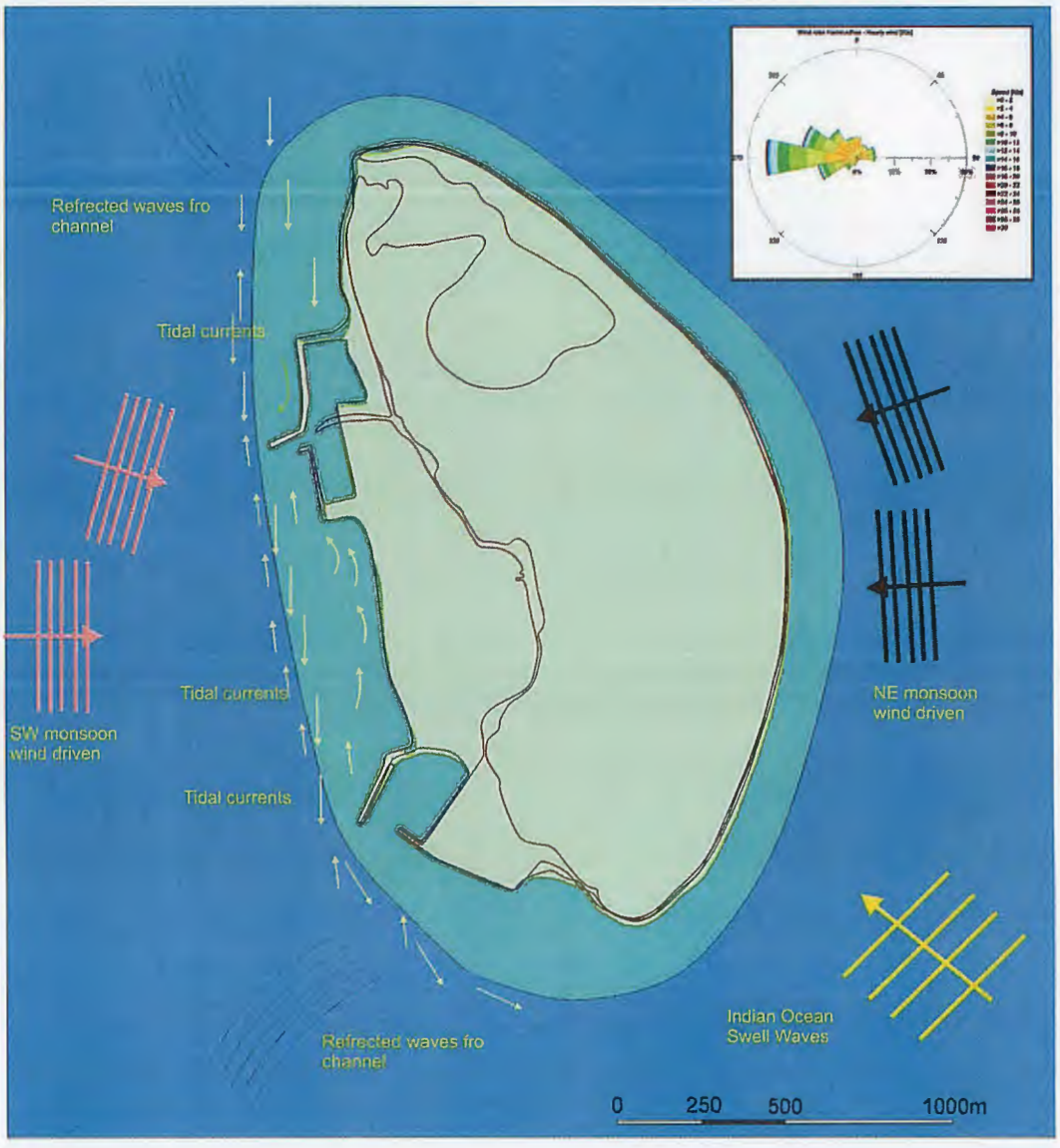


Figure 14 Refraction and shoaling of waves from the atoll channel openings dominating the waves on the eastern side

6.6.6 **Current**

Currents play an important role in the movement of the sediment dynamics. The current regimes around the island are mostly governed by the wind, swell and tide. Since there is no local data about the current regime at the location, a GPS tracked drogue was tracked to determine the current regime at the time of field visit. Recorded drogue tracks at western side reef slope and near shore lagoon during the field survey indicated that the currents are slow. Currents are mainly along the reef and along the shoreline with an average speed of 0.2m/s and 0.09m/s respectively both flowing from north to south. The current governed by the wind waves and refracted swells waves from relatively wide channels on either end of the reef. Tidal and wave induced current often increase to speed of 0.3-05m/s during ebb (receding

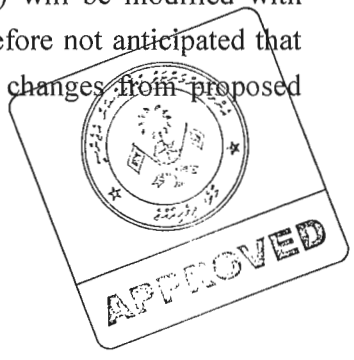
tide) and flow (incoming tide) especially in channels. However, the magnitude of the current is weak during the time of survey.

6.7 Beach environment

Beach profiles from 7 locations were taken along the shoreline (artificially created) where the developments are proposed. Specific locations of the beach profiles are given in Appendix 5.

The existing beach is shaped after a large reclamation work that filled majority of shallow lagoon between regional harbor (KPL) and existing passenger/cargo and fishery harbor. Significant change to the shoreline has been observed when compared with 2013 survey (3 years after reclamation) and that of 2016 (EIA report survey). With groyne effect between two harbors, shoreline appear to be changing with wind generated wave action. Beach profiles compared between 2013 and 2016 for the 7 locations are shown in Figure 15 to Figure 21. The northern end of the beach based on the profiles show a significant decrease in level of beach with respect to MSL (Figure 15). Same profile also indicates that this part of the beach has eroded significantly. This may be a seasonal pattern as beach movement is influenced by monsoonal wind and associated near-shore hydrodynamic influence.

Similar pattern is observed in the entire northern part of the beach (Figure 16 and Figure 17). The central part of the beach appear to accrete due to sediment movement (profile 04 and 05). Similar to northern end of beach the southern end of beach also have eroded compared to 2013 (Figure 20 and Figure 21). It is however noted that this change will be stopped due to development of proposed structure on the entire stretch of this artificially created beach. With this change the entire shoreline on the western side (almost 2km) will be modified with terminal groynes, revetments and breakwater constructed. It is therefore not anticipated that natural shoreline on either side of the harbor will change due to changes from proposed activities associated with this project.



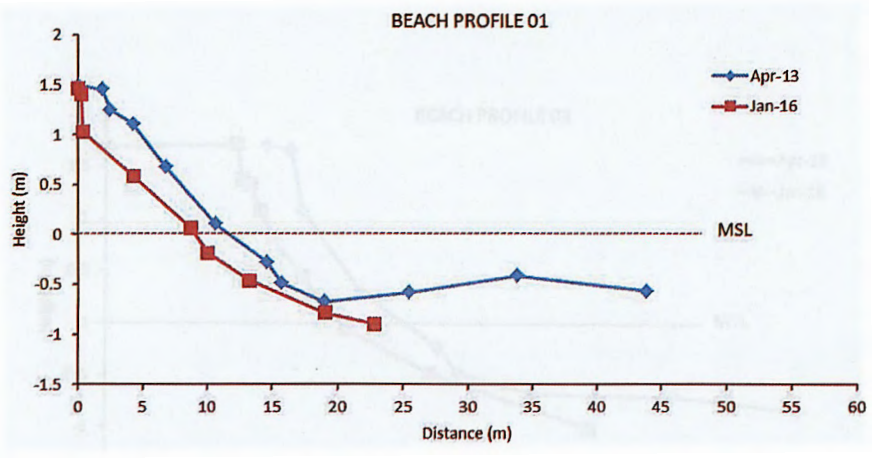


Figure 15 Beach profiles compared 2013 and 2016 (EIA field survey) on the north end of the beach (see Appendix beach profile)

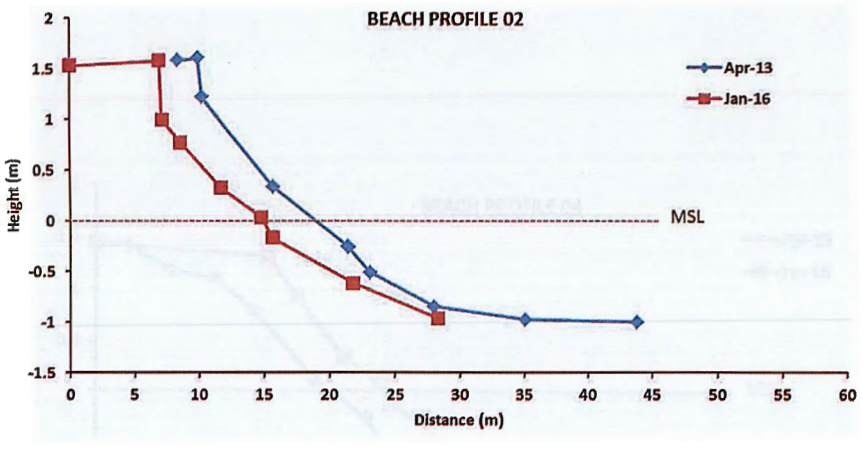


Figure 16 Beach profiles compared 2013 and 2016 (EIA field survey) on the north end of the beach (see Appendix beach profile)

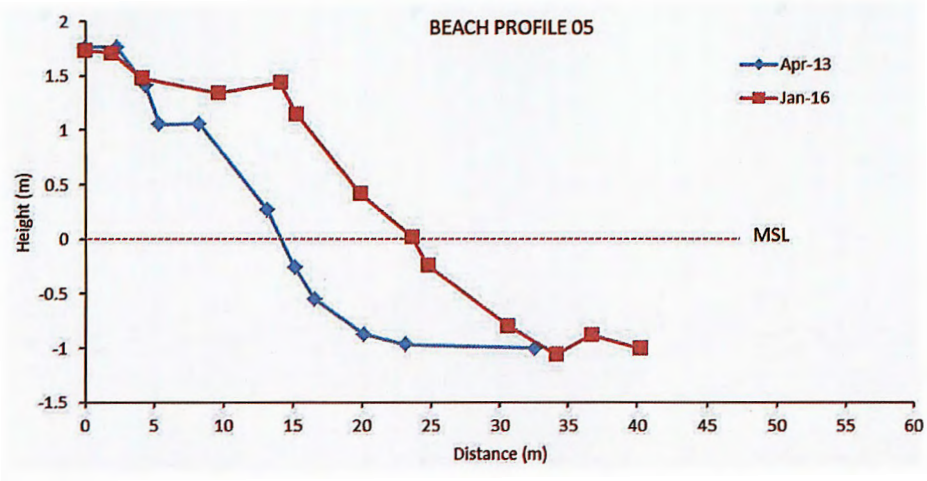


Figure 19 Beach profiles compared 2013 and 2016 (EIA field survey) on south-central part of beach (see Appendix beach profile)

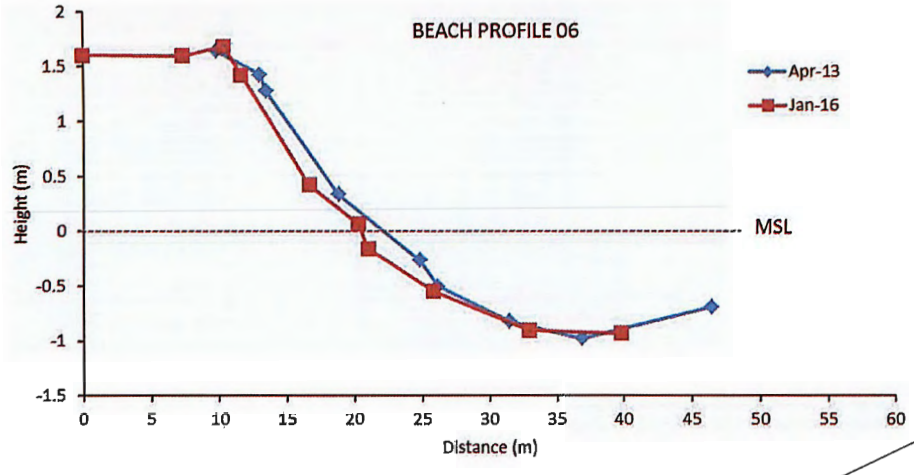


Figure 20 Beach profiles compared 2013 and 2016 (EIA field survey) on south of beach (see Appendix beach profile)

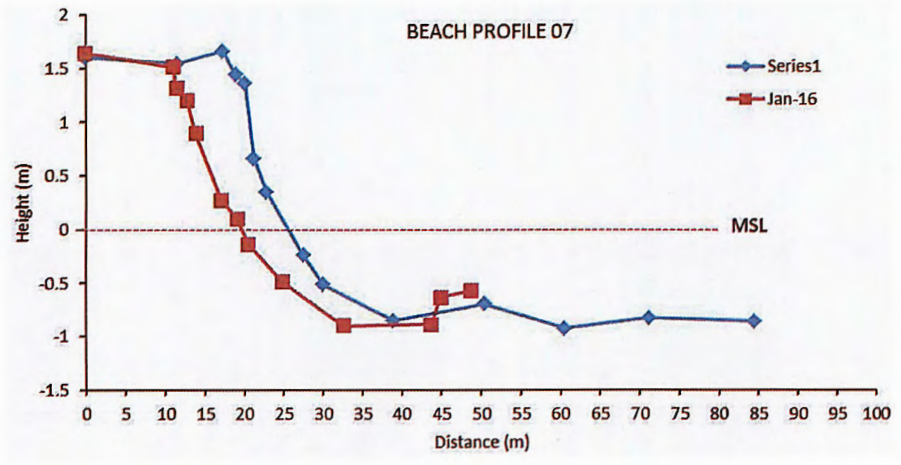


Figure 21 Beach profiles compared 2013 and 2016 (EIA field survey) on south extent of beach (see Appendix beach profile)

6.8 Sediment characteristics

Natural sediments of Maldives are entirely marine based and calcareous origin since the atolls of Maldives are developed on a oceanic ridge toped with calcium carbonate accreted over several thousand years. Shoreline sediments are thus driven from the reef through physical (wave action) and biological (grazing and erosion) breakdown of calcium carbonate based organisms. Sediments are often characterized by their exposure to environmental forcing, habitat types. Fine sediments where they are present are often settled in and trapped in calm enclosed habitats. According to United States Geological Survey (USGS) sediments are characterized as shown in Table 8.

Understanding characteristics of sediments at the proposed project area is important since majority of the civil works associated with the project involves dredging and reclamation. This is particularly important with regard to impact of sediments on adjacent and nearby habitat which may be impacted due to sedimentation and turbidity. Fine sediments especially silt and clay may impact benthic habitats such as coral reefs and sea grass beds.

Sediment samples were taken from 3 transects across the shore area proposed for dredging. Each transect consists of samples from beach, near-shore, mid-shore and fore-shore within a distance of 150m from beach to fore-shore sample. Core samples were taken from surface to a depth of 20cm using an improvised corer fabricated from a PVC pipe. Sieve analysis of samples indicated that over 80% of the samples consist of sand classified as 0.0626 to 2 mm size. Silt and clay (<0.625mm) was 3% and gravel (> 2mm) was 13%. Beach

sediments at all 3 transects were predominantly sand (>99%). Silt and clay was highest in near shore samples which ranged between 5-10%. A descriptive summary of characteristics of sediment samples are given in Table 9. Graphical description of the samples from sieve analysis is given in Appendix (sieve analysis data).

Sediments were not sampled for their organic contents, presence of heavy metals as it is not specifically required by ToR. Natural sediments are of entirely coral reef calcium carbonate based and hence natural background level of heavy metals would be virtually nil.

Table 8 Sediment classification table (Source: USGS)

Sediment Sizes		
Descrption	**Classification**	**Size (mm)**
Gravel	Boulders	>256
	Cobbles	64-256
	Pebbles	2-64
Sand	Sand	0.0625-2
Silt	Silt	0.002-0.0625
Clay	Clay	<0.002

Table 9 General description of various sediment types with respect to sampling zones

Sample position	North shoreline (transect 1)	Mid shoreline (transect 2)	South shoreline (Transect 3)
Beach	Moderately well sorted medium size sand that is skewed towards coarser grain size	Moderately well sorted medium size sand that is skewed towards coarse grain size	Moderately well sorted medium sand skewed towards fine size
Nearshore	Poorly sorted medium size sand that is skewed towards finer grain size	Poorly sorted medium size sand that is skewed towards finer grain size	Well sorted fine sand that has near symmetrical distribution
Mid shore	Poorly sorted granule that is very much skewed towards coaser grain size	Poorly sorted coarse sand that is strongly skewed towards finer grain size	Poorly sorted very coarse sand that is skewed towards coarser size
Foreshore	Poorly sorted pebble that is very much skewed towards coaser grain size	Very poorly sorted granule that is skewed towards coase grain size	Poorly sorted coarse sand that is skewed towards finer grain size

6.9 Coastal features at project site

Coastal features at the project site was assessed along the three transects from where sediment samples were analyzed, starting from reclaimed land across the lagoon to the extent of reef slope. General morphological and benthic substrate features are thus shown in Figure

22. The extent of sea bottom from beach toe to lower extent of reef slope (30m) below mean sea level is approximately 330 meters long. Shallow sandy lagoon width ranges from roughly 120 to 140m with an approximate depth of 1m below MSL. The southern part of the shallow lagoon from near shore towards reef crest is covered by sea grass which extends to 90 meters from low tide extent of beach. This area is predominantly sandy with very little amount of fine sand (silt and clay sizes) as shown in section 6.8. Width of reef crest is approximately 60 meters which is highly consolidated due to cementing of this area through wave breaking continuously in this portion of reef. Wave energy during field visit in January was minimal due to reduced wave action as a result of NE monsoon where wind direction is from east and north east making this area as leeward side of wind. However, wave energy during SW monsoon will be more intense as predominant wind blows from west especially when the wind is strong during stormy weather. Reef crest has minimal coral community.

Beyond reef crest the upper reef slope and lower reef slope plunges to the atoll basin to a depth of 30-40 meters. The width of upper and lower slope combined is approximately 80 meters. Coral community (biotic substrate as approximately 20%) with other non biotic substrate such as rock, rubble and sand characterize reef bottom. This portion of the reef is also well consolidated. Beyond reef slope the sea bottom is sandy.

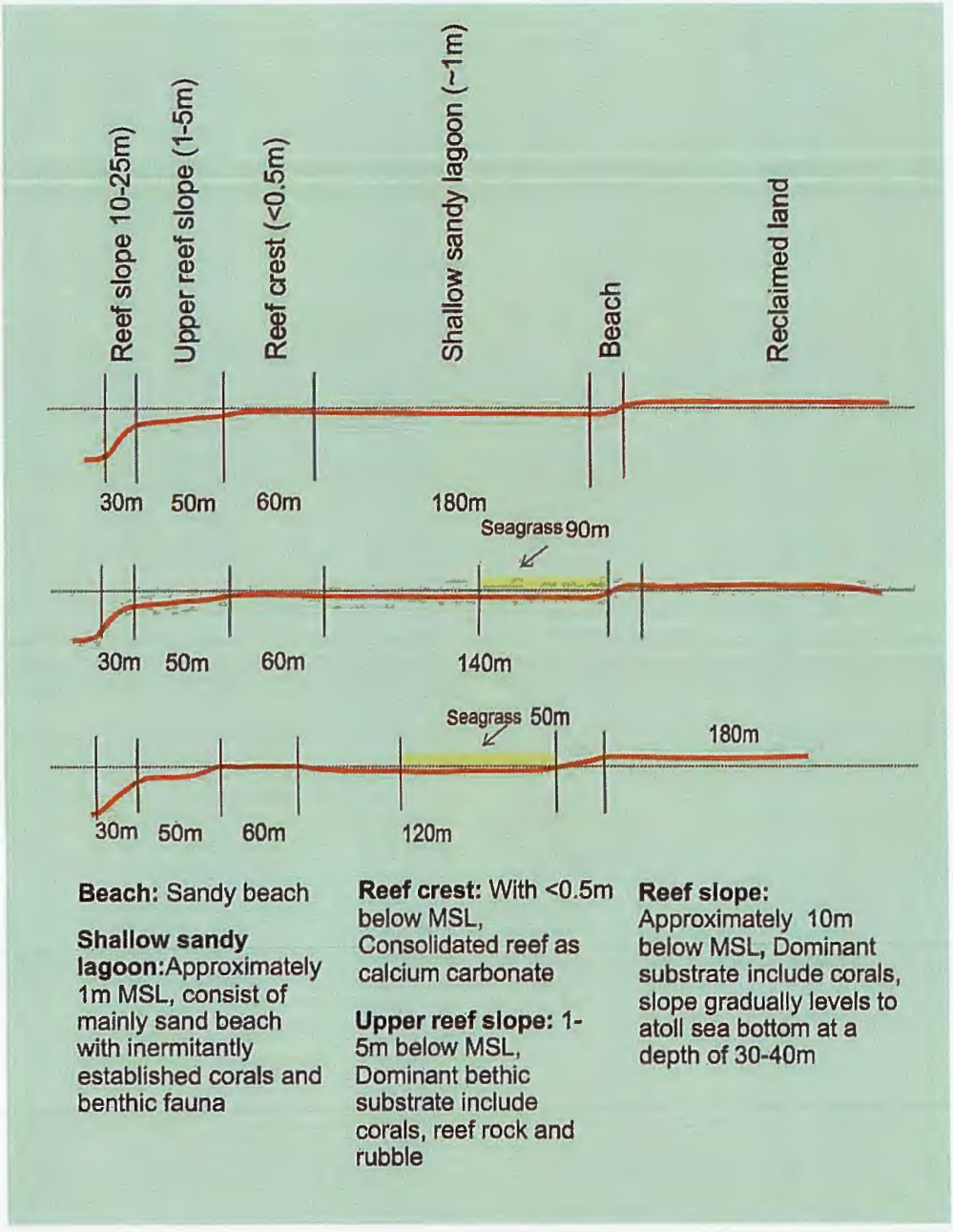


Figure 22 Three transects showing general characteristic of the sea bottom showing all major and significant features

6.10 **Fauna**

Assessment of fauna focuses on marine environment as the project impact is anticipated on nearby reef and associated habitats. Reef surveys were carried out at 2 sites of the western reef (see Figure 5). The site R1 is located at the southern end of west side reef, while R2 is located at the northern end of the west side reef. R1 represents a site that may have residual impacts due to excavation and reclamation works while R2 represents an undisturbed reef site

located some 500m north of the residual impact area and is also referred as the control site. Qualitative assessment of adjacent lagoon which is dominated by sea grass was also carried out.

6.11 Reef survey

Baseline Survey location R1

This site is located along the shoreline of recently reclaimed land. Hence this site was chosen as a representative site of baseline conditions for reef health (coral cover and abundance of fish) that has undergone recent disturbance. Surveys were carried out at two depths, 5m and 10m, following standard protocols. At 5m coral cover as indicator of reef health that maybe affected due to sedimentation was approximately 20% (Figure 23). Abiotic benthic substrate that include rock, rubble and sand was over 60%. Composition of algae (does not include macro algae) was approximately 10%.

Total number of coral general in the Maldives is estimated as 62. At 5m depth at survey location R1 only 7 coral general was encountered which is less than 11% of the total generic diversity of corals (Figure 24). Massive growth form attaining coral groups (slow growing corals)such as porites and favites are more dominant (over 60% of live coral composition) compared with branching (fast growing corals) coral groups such as acropora and pocillopora (less than 20%).

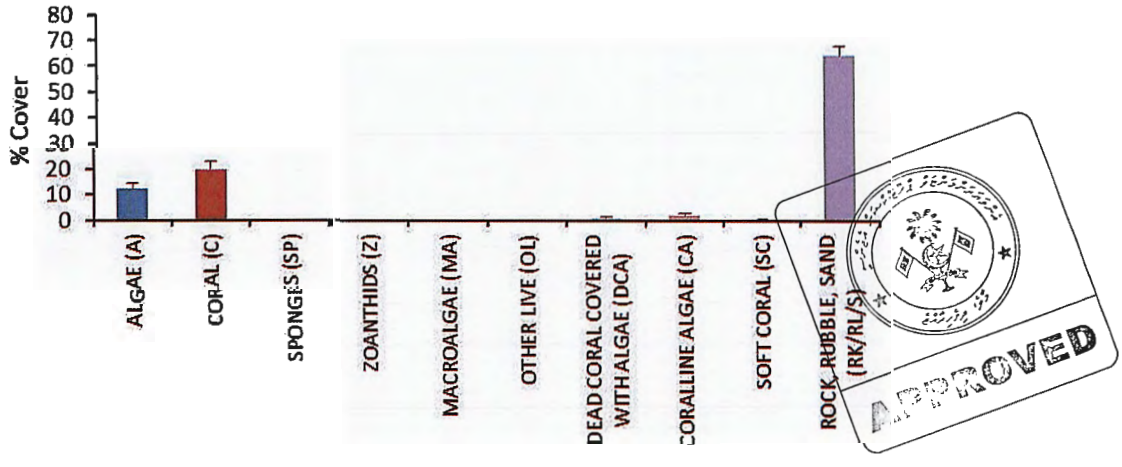


Figure 23 Reef benthic community structure at the upper reef slope (5m) at baseline survey location R1. Values are mean (n = 40), error bars are standard error (SE) of mean.

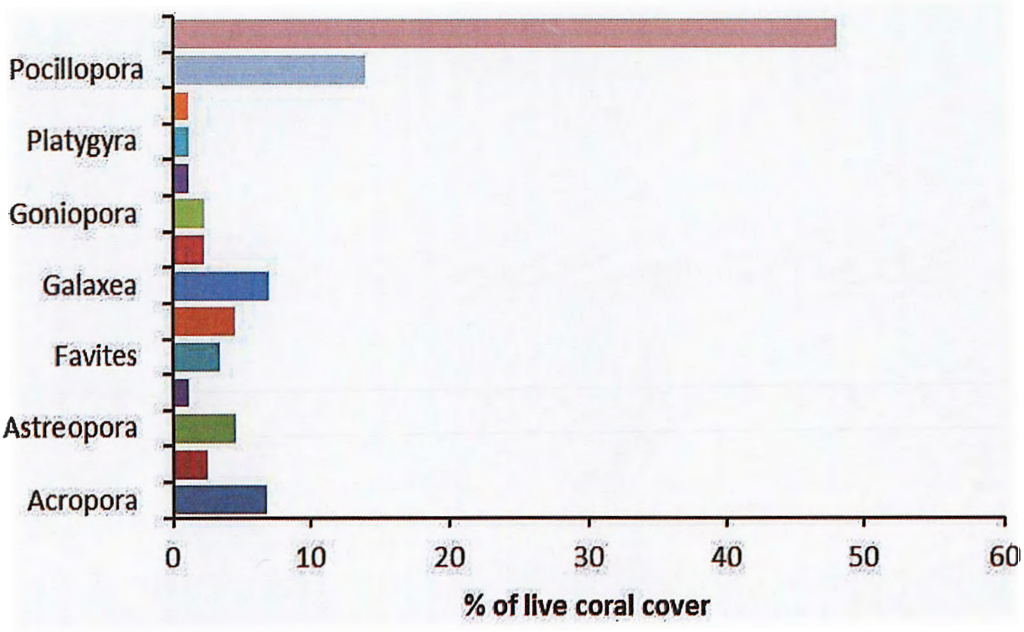


Figure 24 Coral genera (diversity) at R1 5m

At 10m, coral cover was also approximately 20% (Figure 25). Abiotic benthic substrate that include rock, rubble and sand was over 60%. Composition of algae (does not include macro algae) was approximately 10%. There was no significant difference in reef substrate between two depth surveyed including coral cover.

At 10m depth 12 coral general was encountered which is less than 20% of the total generic diversity of corals (Figure 26). Acropora was the dominant coral general accounting for over 50% of live coral cover followed by porites.

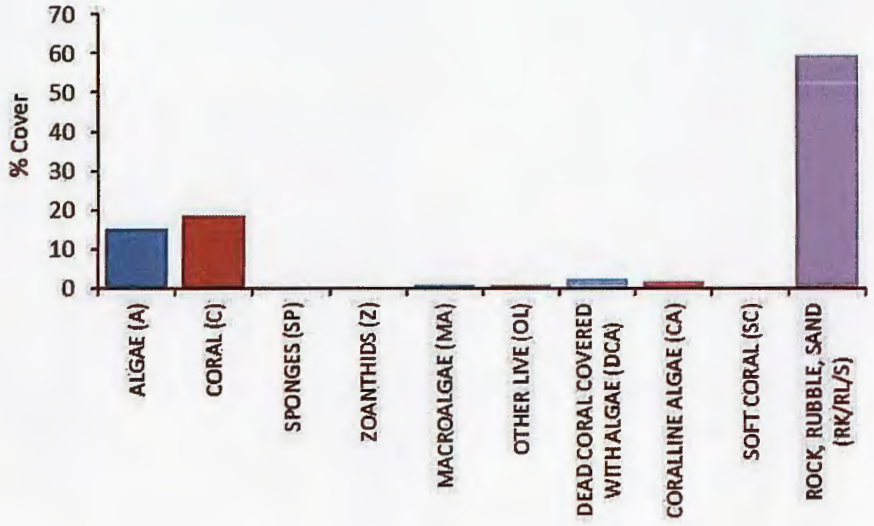


Figure 25 Reef benthic community structure at the reef slope (10m) at baseline survey location R1. Values are mean (n = 40), error bars are standard error (SE) of mean

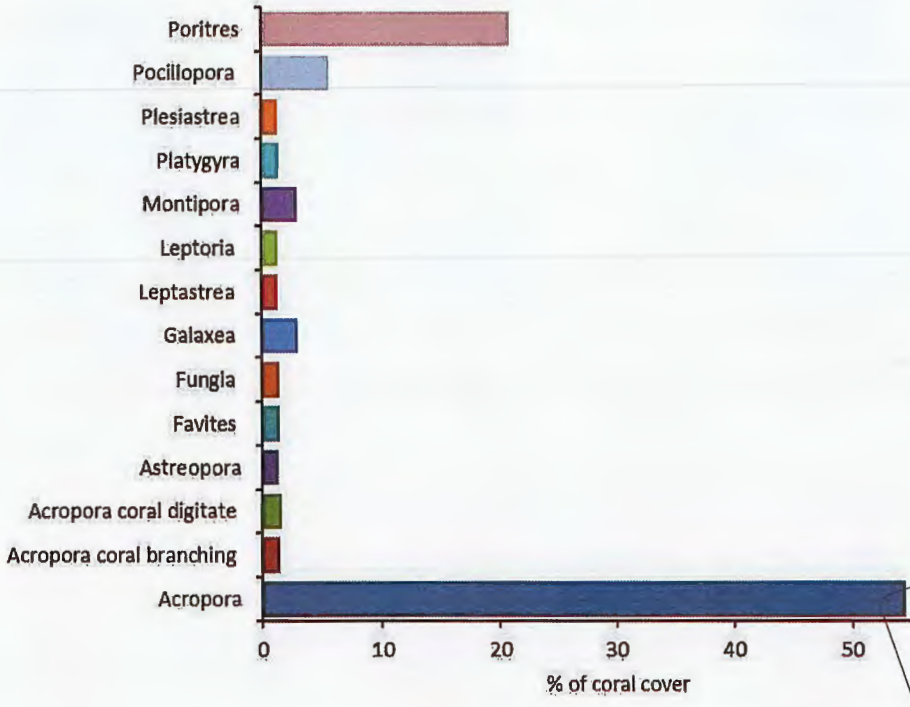


Figure 26 Coral genera (diversity) at R1 10m

Baseline Survey location R2

This site was chosen as a control site to compare with potential residual impacts from dredging activities that may affect benthic coral community. At 5m, coral cover was 15% (Figure 27). Abiotic benthic substrate that include rock, rubble and sand was over 40%. Composition of algae (does not include macro algae) was approximately 15%. Coralline algae as important reef cementing biotic organism was significantly high (over 25%) which is also a good substrate and indicator for coral settlement.

With respect to live coral composition, 12 coral general was encountered which is less than 20% of the total generic diversity of corals (Figure 28). Massive growth form attaining coral porites are most dominant (over 35% of live coral composition) followed by branching (fast growing corals) coral groups such as acropora and pocillopora (over 35%). Among acroporids, table shape acroporid (*Acopora hyacinthus*) accounted for 15% of live coral cover.

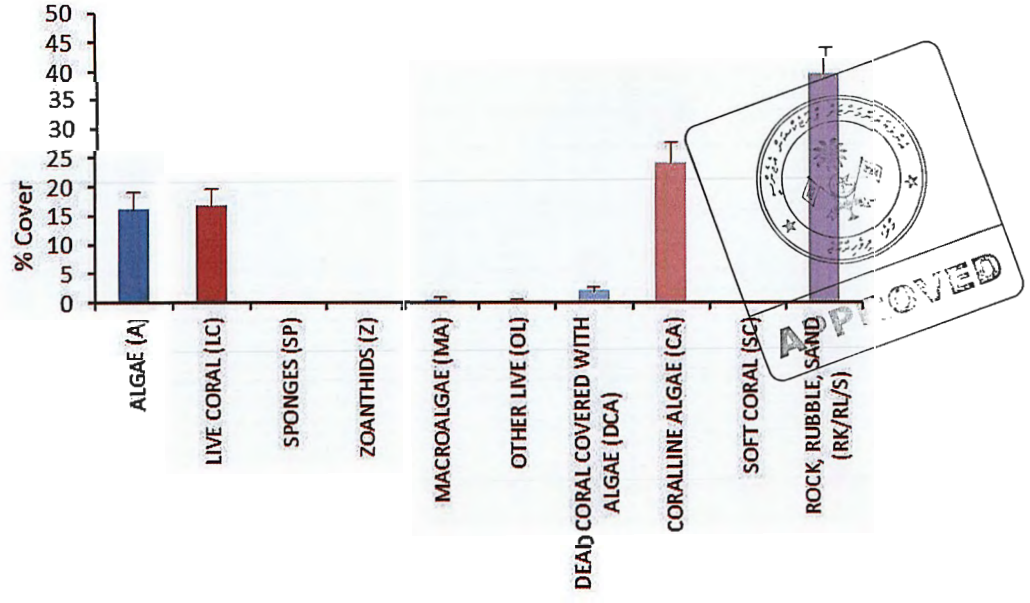


Figure 27 Reef benthic community structure at the upper reef slope (5m) at baseline survey location R2. Values are mean (n = 40), error bars are standard error (SE) of mean

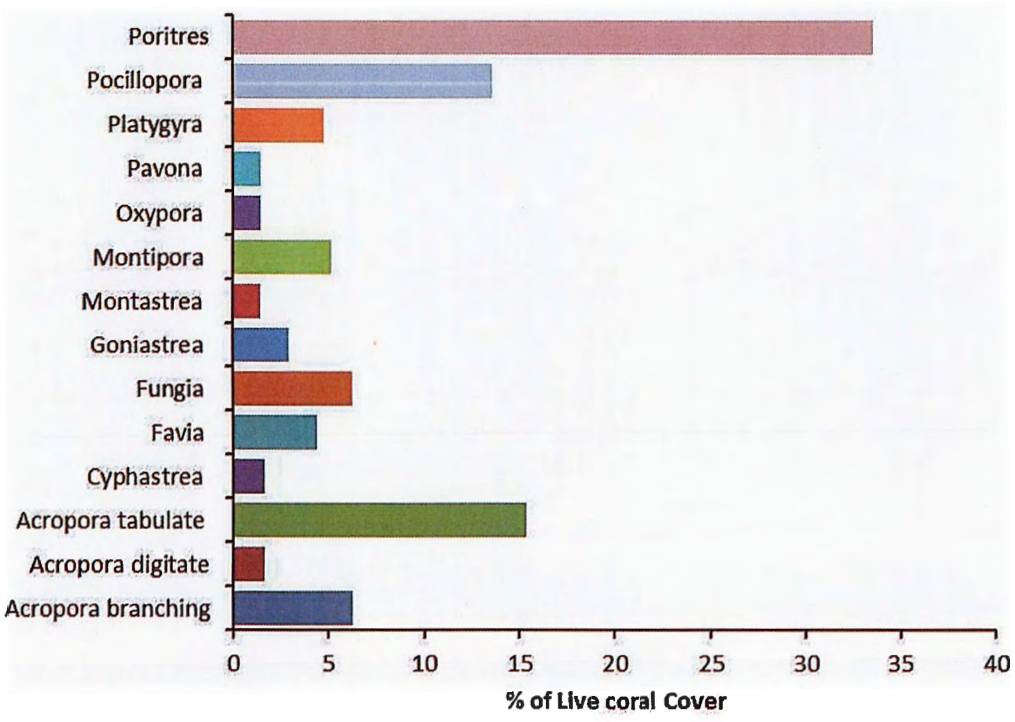


Figure 28 Coral genera encountered at 5m depth at baseline survey location R2, as percentage of total coral cover

At 10m, coral cover was also approximately 15% (Figure 29). Abiotic benthic substrate that include rock, rubble and sand was over 60%. Composition of algae was low (less than 5%). There was no significant difference in reef substrate between two depths surveyed including coral cover.

At 10m depth at survey location R2, only 9 coral general was encountered which is 14% of the total generic diversity of corals (Figure30). Similar to other reef surveyed locations, acropora and porites were most dominant coral general accounting for over 70% of live coral cover. Solitary coral (free living genera fungids) were significantly high accounting for over 15% of live coral community.

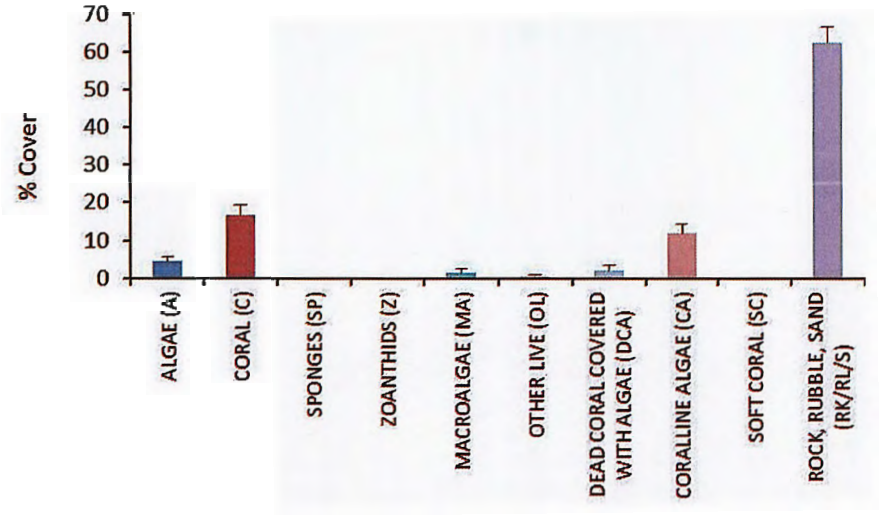


Figure 29 Reef benthic community structure at the reef slope (10m) at baseline survey location R2. Values are mean (n = 40), error bars are standard error (SE) of mean

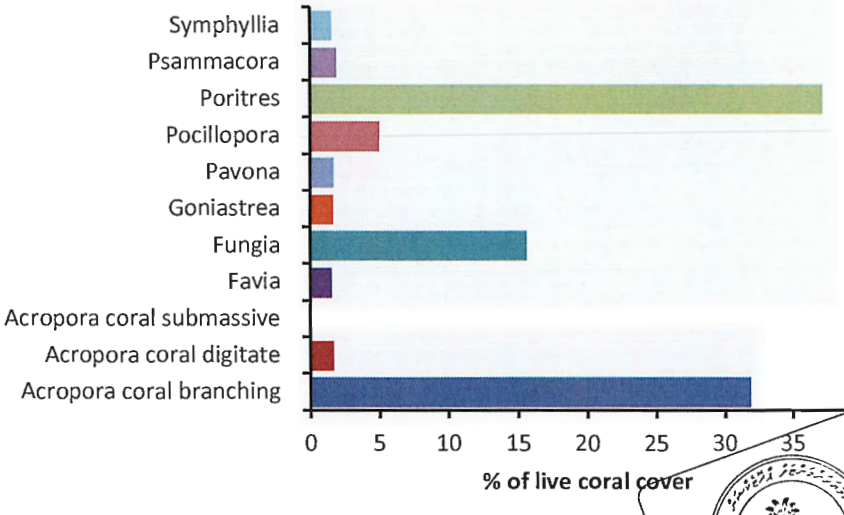


Figure 30 Coral genera encountered at 10m depth at baseline survey location R2, as percentage of total coral cover

Based on this data it can be concluded that the reef benthic community (coral community) is not highly diverse. Only 20% (maximum) of the coral general diversity were recorded. The number of coral species recorded in the Maldives is 230 (Picheon and Benzoni, 2007). It is estimated that the number of coral species at the reef sites would be less than 30.

No IUCN listed (Red List) as critically endangered (CE) or endangered corals were encountered within the survey area. These include *Acropora rudis* and *Stylopora pistillata* respectively. Both are reported (Corals of the World, Veron 2000) to occur in Maldivian reefs.

6.11.1 Reef fish community

Assessment on species and abundance of common fish were carried out at the two reef sampling locations where coral and other benthic community characteristics were assessed. This is to establish baseline data on fish community for the required environmental monitoring of these sites during construction and operation phase. Table 10 shows abundance of major trophic groups of fish and other fauna at all survey sites combined.

Commercially important food fishes present at both sites include, *Aphareous viridiscence, Lutjanus gibbus, Lutjanus bohar, Lutjanus kashmera* and *Lutjanus monostigma.*

Table 10 Abundance of fish and their trophic levels at two reef community sampling locations. L1 is impact/residual impact site, L2 is control site

Family	Species	Functional group	Abundance	Presence (location)
Herbivores				
Acanthuridae	*Naso brevirostris*	Browsers	C	L1, L2
	Acanthurus leucosternon	Grazers/detrivores	C	L1, L2
	Acanthurus lineatus	Grazers/ detrivores	A	L1, L2
	Acanthurus dussumieri	Grazers/ detrivores	C	L1, L2
	Naso lituratus	Browsers	C	L1, L2
	Naso hexacanthus	Browsers	C	L1, L2
	Zebrasoma scopas	Grazers/ detrivores	R	L1, L2
Pomacentridae	*Chromis viridis*	Grazers	A	L1, L2
	C. atripectoralis	Grazers	C	L1, L2
	C. ternatensis	Grazers	C	L1, L2
	Dascyllus aruanus		C	L1, L2
Pomacanthidae	*Centropyge multispinis*	Grazers/ detrivores	R	L1, L2
	P. xanthometopon	Grazers/ detrivores	R	L1, L2
	Pygoplites diacanthus	Grazers/ detrivores	C	L1, L2
	Aolemichthys xanthurus	Grazers/ detrivores	R	L1, L2
Chaetodontidae	*Chaetodon collare*	Browsers	C	L1, L2
	Chaetodon trifascialis	Browsers	R	L1, L2
	Chaetodon melannotus	Browsers	C	L1, L2
	Chaetodon guttatissimus	Browsers	C	L1, L2
	Chaetodon kleinii	Browsers	C	L1, L2
	Forcipiger longirostris	Browsers	C	L1, L2

Family	Species	Functional group	Abundance	Presence (location)
Labridae	*Cetoscarus bicolor*	Browsers	C	L1, L2
	Hipposcarus hairid	Browsers	C	L1
	Scarus festivus	Scrapers/excavator	C	L1
Balistidae				
	Odonus niger	Grazers/ detrivores	C	L1, L2
	Melichthys indicus	Grazers/ detrivores	C	L1, L2
Carnivores				
Lutjanidae	*Aphareous viridiscence*	Predator	(O)	
	Lutjanus gibbus	Predator	(C)	L1, L2
	Lutjanus bohar	Predator	(O)	L1, L2
	Lutjanus kashmera	Predator	(A)	L1, L2
	Lutjanus monostigma	Predator	C	L1, L2
Lethrinidae	*Gnathodentex aurolineatus*	Predator	(A)	L1, L2
	Monotaxis grandoculis	Predator	C	L1, L2
Bait species				
Bpadhi				
Caesionidae	*Caesio sp*		A	L1, L2
	Sprateloides delicatlus		A	L1, L2

Note: C = Common; O = Occasional; A=abundant

6.11.2 Sea grass community

Four out of 5 species that have been reported to occur in the Maldives were present at the small meadow (approximately 2 hectares). These include *Thallasia hemprichii* (abundant), *Holdule uninervis* (common) *Cymodocea rotundata* (common) and *Syringodium isoetifolium* (occasional) in their establishment. Photographic representation of sea grass meadow is given in Appendix 6.

Other associated fauna present are Black sea cucumber (*Actinopyga miliaris*), Impatient sea cucumber (*Holothuria impatiens*) and few numbers of giant clam (*Tridacna maxima*).

6.11.3 Significant fauna

Significant fish fauna such as sharks, manta rays, Napoleon wrasse were not encountered during the baseline environmental data collection at field. Of the 5 species of sea turtles that are reported to occur in the Maldives only a hawksbill turtle was seen during the survey. Sea turtles are the most common and locally abundant species of turtles. Only one individual spiny lobster (*Penulirus versicolor*) was present in the vicinity of the transect belt at 10 meter depth of the control site. Few numbers (< 30) of Maxima clam (*Tridacna maxima*) and 9 of Fluted giant clam (*Tridacna scuamosa)* were recorded at both sites and depth combined.

Following table (Table 12) provides marine protected species that are often associated with reef areas and open ocean.

Table 11 List of marine protected species in the Maldives.

Species	Locally protected	IUCN Red List category
Napoleon wrasse	yes	E
Turtles (five species)	yes	E and CE
Whale shark	yes	E
Giant Clam (2 species)	yes	LC
Whale and dolphins (all species)	yes	NA
Lobsters (5 species)	yes	NA
Sharks	yes	NA
Triton shell	yes	V

IBAT for business, an integrated Biodiversity assessment tool was used by ADB to generate a proximity report for Kulhudhuffushi area in January 2016 to identify biodiversity features and species which are located within 50km radius. Main focus of the assessment was based on IUCN red list of threatened species that included, corals, fishes, mammals and invertebrates. Significant organisms that are likely to be associated with the site are corals and fishes. Non of the species that are classified as Endangered or Critically Endangered were encountered at the project location. The IBAT assessment report is given in Appendix 7.

6.11.4 Seawater quality

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

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

increasing sediment load in the water column causing discoloration of the impact area for a prolonged period.

It is worthwhile to note here that there is no direct input source of nutrients in the coastal waters as a result of the proposed activities but rather a potential release of nutrients associated with dredging or excavation (harbor entrance channel dredging, harbor basin dredging, reclamation sites). Therefore the purpose of the assessment of water quality is to establish a baseline for the seawater quality, taken as a standard to compare with any future water quality assessments. A list of parameters tested and their values for the 4 locations are given in Table 12 (test results from MWSC) and Tables 13 and (in-situ water testing done using Hanna HI9828 probe).

Table 12 Water test results from MWSC Laboratory

Parameters		Harbor out side (residual impact area)	Harbor inside	Reef control	Beach/near shore
Salinity (ppt)		34.31	34.31	32.46	33.44
Biological Oxygen demand (mg/L)		1	1	1	1
Total Dissolved solids (mg/L)		26100	25100	24800	25500
Total Suspended solids (mg/L)		<5	<5	<5	7
Turbidity(NTU)		0.105	1.53	0.315	1.78
Total coliforms (CFU/100ml)		>201	>201	>201	>201
Fecal coliforms (CFU/100ml)		35	66	0	18

Table 13 Sea water quality parameters tested and their results (Hanna HI9828 water test probe)

Parameters	Nearshore lagoon		Fishery /commercial harbour		Reeef Survey location R1		Reef Survey locationR 2(control)	
	Mean	STDV	Mean	STDV	Mean	STDV	Mean	STDV
Temperature (¡C)	29.88	0	28.82	0.02	28.45	0.08	28.54	0.04
pH	8.17	0	8.28	0.11	8.32	0.12	8.31	0.11
Dissolved Oxygen (mg/l)	3.58	0.01	3.75	0.24	4.36	0.12	4.82	0.08
Conductivity (µS/cm)	51282	19.32	51614.17	108.58	51259.29	90.25	51308	118.4
Total Dissolved Solids (g/l)	25.64	0.01	25.81	0.05	25.63	0.05	25.66	0.06
Salinity (ppt)	33.53	0.01	33.81	0.08	33.56	0.07	33.59	0.09

6.12 Social Economic environment

6.12.1 Demography

According to National Census 2014 by National Bureau of Statistics, the population of Kulhudhuffushi is 8,224 of which 3712 are males and 4299 are females (excluding expatriate immigrants). Based on the size of the island (235 hectares) the population density is 35 per hectare. Male to female sex ratio is 1: 1.2. According to the census population is increasing at

a rate of 1.68%, which is average, compared to some other atolls in Maldives. Kulhudhuffushi population contributed to 2.4% of the total population of Maldives during this period. Population data of Kulhudhuffushi from 2006 to 2014 (Census 2014).

The population of Kulhudhuffushi highly depends on the migration of people from islands of Haa Dhaal and the neighboring atolls of Haa Alif and Shaviyani.

6.12.2 Access to social services and Amenities

Education: Kulhudhuffushi is one of the few islands where higher secondary and tertiary education is offered in Maldives. As of November 2015, according to island council, there are 2808 students and 245 teachers in the island. Jalaaludhin School, the only secondary and higher secondary school serving in the island is also the largest education center in the Atoll. Started in 1998, it currently serves more than 1000 students. The two primary schools of Kulhudhuffushi include Afeefuddin School and Haa Dhaal Atoll Education Center. There are also 2 preschools in the island managed by the government as well as private parties. From 2012 onwards Maldives National University campus in Kulhudhuffushi is offering degree courses in the island which gave opportunities for many students who complete their secondary and higher secondary in the island, to pursue higher education.

According to 2014 census, the majority of the people who have attained education over the age of 6 has obtained primary education (47%). However, there is a huge decrease in the number of persons attending secondary education and even more for primary education. The percent of population who have received secondary education is 12% with 10% completing GCE Level examinations. Added to this, 6% completed certificate level education, only 0.3% of this population completed GCE A 'Level examinations. 0.5% of the population have attained Diploma level, Degree and Masters Level.

Electricity: Electricity is provided to the island by the government owned company, Fenaka Corporation Pvt. Ltd. Electricity is provided for 24 hours. The quality of service provided by them is good. However, the generators used to provide electricity are old and as a consequence, the service providers face difficulties in maintaining and managing the generators.

Waste management: waste management service is provided by the Island Council through an island waste management center. With the increasing population and the developments coming to the island, managing waste has become one of the biggest challenges faced by the island community. Although, a waste management center is

established on the island, there is no proper equipment in the center to manage waste. Organic wastes including food and plant litter are usually burnt in the open. Other wastes such as recyclable waste and hazardous waste collected through local facility are sent to Thilafushi, a waste disposal site near Male regarded as a national level waste disposal and management site. The community with their limited awareness about the importance of waste management is challenged by the lack of locally appropriate infrastructure for waste management which is constrained by lack of technical and financial resources.

Water supply and sewerage: Kulhudhuffushi is one of the few islands in the country that enjoys utility services such as water supply and sewerage services with household connections. Before these services, the residents were using ground water and rain water for drinking and septic tank system. The desalinated water supply and sewerage system is operated by Malé Water and Sewerage Company.

Communication: Telecommunication services to the island are provided by Dhiraagu and Ooredhoo. Landline telephone communication service to the island, provided by Dhiraagu, is the only landline telephone communication service provider in the island. "Ooredhoo" along with Dhiraagu provides mobile communication services. Almost everyone of the working population have a mobile phone. Meanwhile, internet services are provided by Dhiraagu and Infocom Private Limited.

Transport: Modes of transport used on the island include bicycles, motor cycles, cars, lorries and pick-ups. Earlier there were many bicycles on the island and many have used it as an ideal form of transportation. However, with the construction of the Harbor on the island, there has been a sudden boost in the number of vehicles - notably motor cycles. Now it is the main and preferred mode of transportation in the island. According to the island council, currently there are 2256 vehicles registered on the island.

Kulhudhuffushi also acts as a key regional maritime connection and cargo interchange point for the Haa Dhaal atoll and other Northern atolls in general. At present, Kulhudhuffushi also acts as a major passenger and cargo hub in the Northern region of the country. There are regular scheduled boats/ferries carrying both cargo and passengers. Improved accessibility through the passenger harbor project would widen the already existing local sea transport system.

Health services: The first Health Center of Kulhudhuffushi officially started its services on May 12, 1973. Since its establishment, many developments have taken place in the health sector of the island. New infrastructure has been built and a variety of services are offered. Because of the geographical isolation of the island and rapidly increasing population, the government upgraded the health center to a 50 bed regional hospital on June 11, 2001. The

hospital operates daily 24 hours with 2 general practitioners, 4 specialists, 1 radiographer and 36 nurses. Medical tests like blood tests and urine tests can be done in the hospital.

Although, the hospital has been upgraded and it provides a better service compared to the many other islands in Maldives, it still lacks many facilities and services. Many people travel to Malé to receive better services. Apart from the hospital there are two private clinics, a branch of eye care, one STO pharmacy, 3 private pharmacies and one drug rehabilitation and detoxification center on the island.

The health condition of people in Kulhudhuffushi is generally good compared to other atolls in Maldives. Most commonly reported diseases are acute respiratory infections, viral fever and diarrhea. Other diseases rarely reported on the island include dengue fever, typhoid and scrub typhus.

6.13 **Climate change and other Environmental Vulnerabilities**

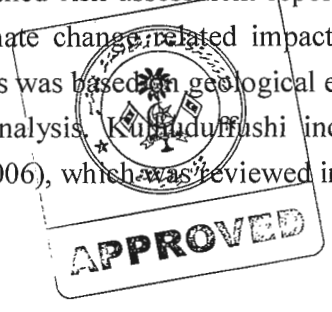
Maldives is a coral atoll based archipelagic island nation, which are exposed to natural forces of the surrounding seas. The average elevation of the islands where varying density of people live is 1.5m above Mean Sea Level (MSL). The most important natural asset are coral reef that protect the islands acting as a sea defense somewhat mitigating wave action especially during severe storms. Coral reefs also provide nature based goods and services both to the economy, culture and social well being. Global environmental issues, particularly climate change associated impacts, are well realized locally and accepted internationally. Maldives is highly vocal in advocating its physical, economic and social vulnerability to climate since climate change has been accepted as a global threat. In this regard Government of Maldives was among the first small island nation that signed UN Framework Convention on Climate Change (UNFCCC) in 2001. International Panel on Climate Change (IPCC) has been active on environmental threats associated with climate change on various ecosystems and populations inhabiting and depending on these ecosystems. According to all IPCC assessment reports, Small Island Developing states (SIDS) like Maldives are the ones that will be hit first and hardest by the global climate change. SIDS have contributed the least to climate change, yet they are among the least equipped financially and technically to respond to adapt and mitigate climate change impacts. Additionally, these islands are in a special risk of being inundated as sea level rise, land loss and beach erosion continue to increase under a changing climate.

First National Communication of the Maldives to the UNFCCC in 2001 reported the vulnerability of Maldives to climate challenges. Based on the findings of the First National

Communication, and at the request of the UNFCCC, the Maldives prepared its National Adaptation Program of Action (NAPA) in 2007. NAPA acknowledges the impact of climate change and identifies the vulnerabilities of a small nation that is composed of multitudes of islands in extreme low elevations. The climatic hazards identified include rise of sea level and increasing intensity and frequency of extreme events such as wind gusts, precipitation and storm surges under cyclonic events. The considerable investments made to develop the country's infrastructure in the areas of tourism, fisheries, human health, water resources, agriculture and food security and coral reef ecosystems are highly vulnerable to sea level rise and storm conditions. The first two priority adaptation actions identified in Maldives NAPA are: (a) Integration of Future Climate Change Scenarios in the Safer Island Strategy to Adapt to Sea Level Rise and Extreme Weather Risks Associated with Climate Change and (b) Coastal Protection of Safer Islands to Reduce the Risk from Sea Induced Flooding and Predicted Sea Level Rise.

Several environmental management policy strategies have been developed locally to advocate internationally on climate change vulnerability issues. These include national environmental action Plans (3), and most recently, Maldives Climate Change Policy Framework (MCCPF) in 2015. MCCPF identified strategic polices for responding to climate change impacts over the next 10 years (2014–2024). This Policy defines five thematic goals and strategies that the Government and the people of Maldives have prioritized for implementation to ensure that safety and resilience are achieved. Policy goal 3 of the MCCPF states: Strengthen adaptation actions and opportunities and build climate resilient infrastructure and communities to address current and future vulnerabilities. Maldives has also prepared and submitted its most climate change strategy on national climate change mitigation to UNFCC Conference of Parties (COP21) in 2105 as Intended National Determined Contribution in an effort to reduce carbon emissions in the context of economic growth and sustainable development.

Vulnerability to extreme environmental events was hard felt in 2004 tsunami associated flooding and damage to several islands causing human loss and damage to critical infrastructures, though not related to climate change. Post tsunami efforts to understand vulnerability of Maldives with specific focus on selected islands prepared Disaster Risk Profile for Maldives in 2006 with assistance from the United Nations Development Program (UNDP). This detailed risk assessment report identifies where risks from multiple hazards are, including climate change related impacts. The probability of hazards across different regions of Maldives was based on geological evidence, historical data and projections derived from theoretical analysis. Kulhudhuffushi included among Detailed Disaster Risk Profile Island (DIRAM, 2006), which was reviewed in 2013 (MEE 2013).



6.13.1 Climate Change Considerations for Kulhudhuffushi Harbor Expansion Project

The shorelines of isalnds of Maldives are continuously shaped and defined by the actions of tides, storm waves, and extreme water level events such as storm surges and tsunamis. In the absence of human development, the effect of these events on the shore is simply part of the natural process by which the shores and coastal environment respond to the forces of nature. It is when human development occurs in the coastal zone that these natural processes lead to problems.

Kulhudhufushi is located on the eastern rim of Thiladhunmathi Atoll (see Figure 7). An existing small fishery harbour at Kulhudhufushi is planned to be expanded to accommodate larger vessels to advance the economy of this populated island. This calls for adaptation engagement as identified by Maldives NAPA in order to alleviate the climate change hazards that are widely recognized. The 2006 UNDP disaster risk assessment report identifies notable hazards to Maldives as windstorm, heavy rain flooding, swells waves and udha (gravity wave flooding), storm surges, tsunami, earthquakes and climate change.

When undertaking a vulnerability assessment of various assets in the coastal zone to climate change impacts, the success of the exercise will ultimately hinge on the accuracy of the climate change projections and the quality of critical data sets necessary to analyze the projected impacts. Much literature counsel that climate change adaptation is highly context specific, so generic adaptation actions cannot be adopted without appropriate site-specific investigation. However, it must be noted at this onset that there are just limited data derived through site measurements and or site investigations specific to Kulhudhufushi for determining the various parameters required in a harbor design. Of the multiple hazards identified, only those that need serious consideration in the design of the harbor and those that are aggravated by a changing climate (exposure) are discussed here and the information is based mainly on the UNDP disaster risk assessment reports (DIRAM 2006 and DIRAM 2013).

Sea Level Rise

Sea level rise refers to the increase in mean sea level over time. Historically, sea level has been rising around the globe for thousands of years since the end of the last ice age. However, during the last century, tide gauge and satellite recorded measurements indicate an acceleration of sea level rise relative to the past rate. Thus, there is high confidence that the

warming atmosphere associated with global climate change is expected to accelerate both the thermal expansion of seawater and the melting of glaciers and ice sheets and will lead to increasing rates of sea level rise (Parris et al., 2012). As a result of the rise in sea levels, a variety of impacts may be expected in Maldives.

In IPCC's 2001 assessment of global warming, it projected that global mean sea level is expected to rise between 9 and 88 cm by 2100, with a best estimate of 50 cm (IPCC, 2001b).

The 2006 UNDP disaster risk assessment report for Maldives provides sea level rise projections by HadCM2 model for three periods and for IS92a (medium) and IS92e (high) emission scenarios as given in the table below (Table 15).

Table 14 HadCM2 SLR Projections

Model/ Methodology	Projections by Year				Remarks
Sea level rise projections for Maldives by HadCM2 (HadCM2 is a coupled atmosphere-ocean general circulation model (GCM) developed at the Hadley Centre)	Scenario	2025	2050	2100	1. Estimated that by 2025, ≈15% of Maldives will be inundated 2. Area of inundation will increase to 31 % by 2050. 3. Projected that the island will be completely inundated by 2100 in high emission scenario
	HadCM2 (IS92a – medium emission scenario)	9.3 cm	19.9 cm	48.9 cm	
	HadCM2 (IS92e – high emission scenario)	19.7 cm	39.7 cm	94.1 cm	

There is a wide range of estimates for future sea level rise in peer reviewed scientific literature. However, because of the range of uncertainty in future global climate change and the difficulties in generating probabilistic projections of sea level rise, the estimates are intended to represent potential future conditions associated with different scenarios of ocean warming and ice sheet melting, or loss.

Tropical Cyclonic Winds

Besides heavy rains and strong winds during monsoons, hazardous weather events, which regularly affect Maldives, are tropical storms or 'tropical cyclones', and severe local storms (thunder storms/ thunder squalls). The people of Maldives popularly refer to such severe local storms as 'freak storms' (Maniku, 1990).

Tropical cyclones that hit Maldives at times are destructive due to associated strong winds that exceed a speed of 150 km/hr, with rainfall of above 30 to 40 centimeters in 24 hours and storm tides that often exceed 4 to 5 meters. Cyclonic winds can cause a sudden rise in sea-level along the coast, leading to a storm surge. The combined effect of surge and tide called the 'storm tide' can cause catastrophe damages to coastal infrastructure.

Maldives is also affected by severe local storms- thunder storms/ thunder squalls. Hazards associated with thunderstorms are strong winds, often exceeding a speed of 100 km/hr, heavy rainfall, lightning and hail; they also give rise to tornadoes in some regions. In general, thunderstorms are more frequent in the equatorial region than elsewhere, and land areas are more frequently hit by thunderstorms as compared to open oceans. However, thunderstorms close to the equator are less violent when compared with those in the tropical regions and beyond. Maldives being close to the equator, thunderstorms are quite frequent but less violent here. Nonetheless, strong winds generated by severe local storms generate large wind-driven waves, which are hazardous for coastal structures.

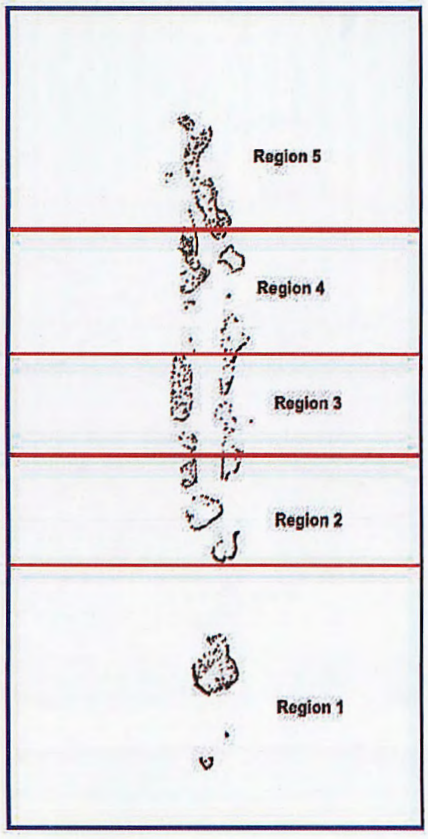


Figure 31 Cyclone hazard zones of Maldives

The 2006 UNDP disaster risk assessment report for Maldives classifies cyclone hazard zones of Maldives into 5 regions according to 500-year return period wind speed of each region. It notes that frequency of wind speeds decrease from north to south (Region 1 is not affected by any cyclonic storm). See Figure 31.

Using the wind speeds of 21 cyclonic disturbances recorded during 1877 to 2004, the probabilities and return periods of wind speeds have been evaluated according to the method described by Chu and Wang (1998).

The return period of a cyclonic storm with a wind speed of 34 knots will be about 23 years. For deep depressions with wind speeds 28-33 knots, the return period varies between 10 -20 years. From the return period analysis it has also been found that very severe cyclonic storms with surface winds having a speed of 65 knots are expected to recurrence in 135 years in Maldives (Note: 1 knot = 1.852 km/hr).

The probable maximum wind speed (PMWS) estimated for Maldives by cyclone hazard zoning as shown in Figure 31 is reproduced below in Table16. The harbor expansion project of Kulhudhufushi island falls in Zone 5.

Table 15 PMWS of Maldives

Hazard Zone	Probable Maximum Wind Speed (knots)
1	0.0
2	55.9
3	69.6
4	84.2
5	96.8

As said above, Maldives is affected by severe local storms which are locally known as 'freak storms'. From an analysis of local storm data it was seen that these affect almost all the islands of Maldives. During 1958 to 1988, these events affected 92 islands. The report mentions that 'freak storms' affected the islands throughout the year with peak seasons during May – July but due to incomplete data, hazard zones have not been drawn for the local storms.

Storm Surges

The 2006 UNDP disaster risk assessment report for Maldives has computed probable maximum winds and probable maximum pressure drops for different return periods. For the 500 year return period, it was computed to be 30 hectopascal (hPa), for a 100 year return period, it was 20 hectopascal. (Note: 100 hPa = 75 mm Hg). Considering analogous surge nomograms and basic storm parameters (historical), the storm surge estimated for Maldive islands is shown in Table 17. (Note: Height of average astronomical tide is added to that of storm surge to obtain the height of the storm tide). The storm tide data indicates that the probable maximum storm tide in northeastern islands of Maldives can be about 2.3 meters, which can inundate most of the northern islands.

Table 16 Estimates of Storm Tide

Hazard Zone	Pressure drop hPa	Storm Surge Height (m)	Average Tide height (m)	Storm Tide (m)
1	-	-	-	0.00
2	15	0.45	0.93	1.38
3	15	0.60	0.93	1.53
4	30	0.99	0.98	1.97
5	30	1.32	0.98	2.30

Return Period (Years)	Pressure drop hPa	Storm Surge Height (m)	Average Tide height (m)	Storm Tide (m)
100	20	0.84	0.98	1.82
500	30	1.32	0.98	2.30

Probable Maximum Precipitation (PMP)

Probable maximum precipitation for 24 hours is an important parameter for designing drainage systems and for many other purposes of planning. The design of drainage should consider PMP values, the catchment area of drains and characteristics of the catchment area to avoid local flooding. To estimate the PMP in Maldives, the 2006 UNDP disaster risk assessment report fits a theoretical distribution to the extreme daily rainfall for three stations using Gumbel's Type I extreme value distribution function. The function has been used to estimate the probabilities and the return period of rainfall for 50, 100, 200 and 500-years. The derived data of PMP for different return periods for three stations in Maldives are given in Table 18 below.

Table 17 Estimates of Probable Maximum Precipitation (mm)

Station	Return Period			
	50 years	100 years	200 years	500 years
Hanimaadhoo	141.5	151.8	162.1	175.6
Hulhule	187.4	203.6	219.8	241.1
Gan	218.1	238.1	258.1	284.4

6.13.2 Adaptation Considerations in the Design of Coastal Defense Structures

Within the context of climate change, the term 'adaptation' is frequently used. The IPCC defines adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007). As described in Burton et al (2006) adaptation can be either proactive or reactive. It can be distinguished based on the form of the action: Proactive if the actions aims to reduce future risks, reactive if they alleviate impacts once they have occurred.

The harbour expansion project can benefit from adaptation planning through proactive adaptation measures that can moderate the risks of future sea level rise (SLR), and storm surge perceived as the larger threats to coastal infrastructures of Maldives. Although easily said, the challenge is how to be proactive in adapting to climate change. Intervention options are site specific, depending on the local conditions such as geology, geomorphology, shoreline stability, exposure and sediment movement. The choice may also be affected by the availability and cost of materials such as sand sources for ongoing nourishment, suitable rock

for revetment construction, construction access, etc., funding, timeframes and adjacent development and land use.

This extract from an ADB report aptly points to the difficulties of adaptation planning: '*Planned adaptation in response to or in anticipation of this impact can mitigate or prevent some harmful effects of climate change, and draw benefits from the more positive consequences. But there is a dearth of consistent, comprehensive information about the most recent developments in adaptation technologies and a lack of access to institutions and agencies that can facilitate technical and knowledge transfer. Adaptation practitioners are thus held back from developing a robust portfolio of hard and soft adaptation technologies*'.

Planning and designing for adaptation in a coastal environment is a complicated matter that require plenty of field data to predict the risks and outcomes of planned options. One may simply think of an adaptation by design would mean increasing the elevation of coastal defenses by an amount equal to the sea-level rise. But this requires an appropriate balance to be struck between safety and required strength and serviceability over the life of the structure and over initial and maintenance costs. This balance can only be achieved using realistic estimates of future climatic design loads which is also very complex.

The only comprehensive scientific report specific to Maldives that provides a fairly detailed analysis of risk assessment under a future climate is the 2006 UNDP report. The salient design input criteria necessary for consideration are summarized in the previous section (Section 6.12.1). In the dearth of other comprehensive literature, it is proposed that the climate projections given there be used to determine climate change allowance for sea level rise and storm surge heights in the design of coastal structures for Kulhudhuffushi Harbor Expansion Project.

While there are obviously many challenges to projecting future sea level rise, even a seemingly small increase in sea level can have a dramatic impact on many coastal environments. The UNDP report (DIRAM) provides sea level rise estimates under medium and high emission scenarios. The medium emissions scenario may be considered appropriate as there exists uncertainties in projecting how rapidly and how much global temperature will increase during the 21st century. Importantly, local (or relative) changes in sea level depart from the global mean trend due to regional variations in oceanic level change and geological uplift/subsidence. It could be possible that SLR for the Maldivian region could be higher or even lower than global average SLR.

Design life means the minimum duration a structure is expected to last. The longer is the design life; the higher is the cost of a project. Therefore, in choosing the design life for a structure, it makes sense to consider a design life that generates an economical project without sacrificing the required function. For example, there is little point designing a protection seawall for the ambient sea level predicted for 2100 if the proposed protection structure will only have a 30 year working life.

The return period or recurrence interval concept is widely used by policy makers and planners to assess the risks associated with extreme events and to develop suitable management strategies. Design water level decisions are usually addressed using the traditional risk-based approach of a "design return period" as is common in any hydraulic engineering. For example, the "100-year storm surge level" is the surge elevation with a 1%-annual risk of exceedance, which is to say that in each year, there is a 1% chance that a storm surge of this magnitude (or greater) will occur. However, some coastal designs may justify a lower return period (e.g., 25- year or 50-year) in certain areas - balancing the greater risks affiliated with such design with engineering and economic considerations.

It is likely under a changed future climate where frequencies of extremes are increased that a 1 in 50 year event could become a 1 in 20 year event by 2050. It is proposed that sizing is achieved by doubling the return periods to account for climate change rather than using a lower recurrence period.

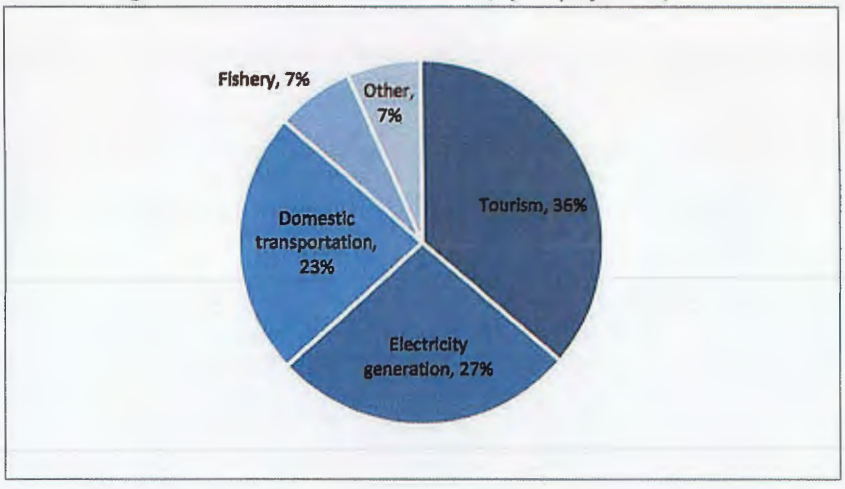
Owing to the fact that sea level rise is additional to other coastal hazards created by storm surges, cyclonic winds, etc., sea level rise planning allowances must be considered along with coastal planning and management instruments that address those other coastal inundation hazards. It is important to note that the allowances only relate to inundation, and not erosion of soft shorelines, or impacts associated with this erosion.

6.14 Green House Gas (GHG) Emissions

Maldives is one of the most vulnarable countries at risk from the effects of climate change among Small Island Developing Nations (SIDS). Human induced emmission such as CO_2 is the largest contributer to GHSs that has been proved to be the causal factor of long term climate change. With lack of natural resources, Maldives dependency on fossile fuel as the primary source of energy is high. In this regard Maldives emmision as per capita has been regarded high. According to World Bank, CO_2 per capita emmission was 3.3 tons in 2010. Comparative per capita as island nations are, 7.8 (Sychelles), 3.2 (Mauritius) and 0.6 (Sri Lanka). With high depencency on fossile fuel, this figure is on the increase. Although per capita CO_2 emmissions are relatively high, own contribution to GHG emissions as proportion of global emmissions is minimal.

Total GHG emissions in the Maldives in 2009 stood at 1.1 million tonnes of CO_2e (UNDP Risø Centre and Ministry of Environment and Energy, 2014), or 0.003% of global emissions, up from an estimated 0.7 million tonnes of CO_2e in 2005 (World Bank, 2015a). It is estimated that emissions will reach 2 million tonnes of CO_2e by 2020 (UNDP Risø Centre and Ministry of Environment and Energy, 2014). According to Maldives Energy and Supply demand study of Maldives Energy Authority the total emmisons is estimated as 1.23 million tonnes of CO_2e.

The main emitting sectors are: tourism, energy, domestic transportation and fisheries; together accounting for 93% of Maldives' domestic emissions (Andrei Marcu ett.al., 2015). Figure 32 shows the share of each sector in national GHG emissions.



Data source: UNDP Risø Centre and Ministry of Environment and Energy, 2014.

Figure 32 GHG emission by sector

6.14.1 GHG Emissions from Kulhudhuffushi Maritime Transport

CO_2 as the primary component of GHG emission as a conservative estimate was calculated based on available data. The following varailables were used for this esimation;

- Total number of marine vessels for Maldives (National Census, 2014)
- Number of vessels at Ha Dhaal atoll (National Census, 2014)
- Number of vessels at Kulhudhuffushi (vessel registry at Transport Authority)

- Total national CO_2e emmisions from transport vessels (Maldives energy supply and demand survey 2010-2012, Maldives energy Authority)

The following table (Table 19) provides figures used for the calculation.

Table 18 Attributes used for emissions calculation for maritime transport vessels at Kulhuduffuashi

Description	Quantity
Total number of registered vessels	12074
Vessels Haa Dhaal	555
Vessels at kulhudhuffushi	138
Total emmisions (tonnes CO_2e)	1,229,615
Emmissions from vessels (fishing, cargo and others (tonnes CO_2e)	141,131

Based on the data it is conservatively estimated that 12074 vessels will emmit 141, 131 tonnes of CO_2e. Emission from atoll scale at Haa Dhaal atoll is thus estimated as 6482 tonnes of CO_2e (11% of total maritime (excluding tourism sector) emissions). For Kulhdhuffushi it is estimated that emissions would be approximately 1613 tonnes CO_2e 1% of national total. Emissons were estimated based on figures from National energy supply and demand survey estimates for year 2012. This is regarded as insignificant as proportion of national emission from maritime transport.

Without mitigation policies, emissions will increase steadily as the economy develops further, the population grows, and consumption patterns change. Inorder to address mitigation at national level as part of global initiative, Maldives has already commited to reducing GHG emissions through Intended Nationaly Determined Contribution (INDC) officially communicated with UNFCCC in 2015. In this regard a 10% reduction for GHG emission by 2030 as Bussiness as Usual (BAU) has been pledged. This pledge can be scaled up. These actions and undertakings could be scaled-up to 24% in a conditional manner, in the context of sustainable development, supported and enabled by availability of financial resources, technology transfer and capacity building. With over 99% of enery requirement met by import of fossile fuel this is highly challenging. Energy from renewable sources are mainly from solar, ammounting to less than 0.2 %. Primary area of emmison reduction fouses on solar based electricity where it aims to provide minimum 30% of daytime electricity from that source. Innovative technologies for marine transport vessels to reduce GMG emmissions can assit reduction in GHG emmisions in this rector.

7 Stakeholder consultation

7.1 EIA scoping

As an important part of the EIA formulation, under EIA regulation of Maldives a scoping application for developing a ToR based on project brief (scoping application form) was submitted to EPA on 20th of December 2015. A draft ToR for preparation of EIA was submitted to EPA along with scoping application form.

EIA scoping meeting was held on 27th of December with representatives of various stakeholders of the project. This included representatives from EPA, representatives from MHI, representatives from Kulhudhuffushi Council and representative from project design consultants. During the scoping meeting, information with regard to project was briefed by MHI and representative from design consultants. Based on this discussion, issues raised by various stakeholders, scope of EIA was finalized based on draft ToR submitted to EIA. EPA issued ToR for the EIA report on 27th December 2015.

7.2 Meeting with MHI and concept design team

EIA consultant was a member of the concept design team. Hence throughout the concept design at various stages of design related consultations and discussion EIA consultant has been involved. In this regard consultant met with relevant stakeholders of the project both at meeting and was engaged in discussion to understand the components that are likely to have impacts on the environment in assisting various components of this report.

7.3 Meetings with local stakeholders

As part of socio economic assessment exercise for this project the socio economic consulting team met with various stakeholders of the project. Consultation with local stakeholders was carried out using a mixed-method consisting of both quantitative and qualitative data collection techniques, depending on the requirements of the information. The public consultation process was held from 20-22 November 2015 and the second consultation was held from 23-26 December 2015 in Kulhudhuffushi. The first consultations were held with fishermen and fish processors in Kulhudhuffushi. The second consultation was held for members of the community from youth groups to women's groups, NGOs, Women's Development Committee, School administration and teachers, Bank officials, entrepreneurs, business owners and members from Kulhudhuffushi Island Council. All efforts were taken to select most suitable, impartial and knowledgeable members from each group that were

chosen for the consultation process. The total number of people that attended these consultations were 51, of the 7 was women.

7.3.1 Meetings with Public (Kulhuduffushi)

EIA consultant's made a field visit to independently meet local public. Island Council facilitated to invite general public (or interested/concerned stakeholder of the island) through a Public Announcement system used by the council to make announcements to the Public. Meeting with interested parties were held on 13th of January 2016. Only 27 representatives or individuals, who showed interest in hearing about the project, raise concern or issues with regard to the project attended the meeting. No women attended the meeting. List of people met and their stakes are given in Appendix 8.

EIA consultant gave an introduction; the following is a brief of the introduction to the project.

The people who attended the meeting were briefed how the EIA work is related to the project where the government of Maldives has initiated to secure a loan from ADB, for the proposed harbor expansion works and certain studies have to be made and approved to enable this. EIA team is from the design contractor side and was there to do a survey of the port and consult with the relevant community stakeholders as part of an EIA report. As part of EIA, the consultant informed that community concerns, social needs and requirements have to be incorporated within the reports. In this regard, they have been informed that a separate Poverty and Social Assessment study is already ongoing and shall be part of overall design consultancy outputs. Consultant is therefore seeking their views and concerns on various aspects of the project concept designs shared with them. Several concerns were raised with regard to various aspects of harbor design. Consultant affirmed that their concern will be informed to the project implementing agency (MHI) and design consulting team and feedback on their concerns will be reflected in final EIA report.

Based on the project component brief on preliminary design, some people who attended the meeting seemed dissatisfied with previous engagements because of lack of appropriate considerations in the concept. The following are some of the questions and statements, which were more relevant to the discussion. The responses to the questions raised are from project design consulting team and MHI (Table 20)

Table 19 Concerns shown by Public during Consultations

Concern	Response/Action taken/Recommendation
Proper means of water flow in and out of the harbor will be needed; have they been	Already considered in the concept design and details of the circulation and flushing related

incorporated into the design? They were concerned that enough means of circulation to clear the harbor may not be given.	aspects of the harbor will be done once funding is approved
During stormy weather, they already experience difficulties during entry and exit to the harbor. How has the design been implemented to cater for that?	Design has already given due consideration to these by talking to local stakeholders such as fishermen and boat operators.
Some questions to find the lengths, areas and depths of the designed harbor. Also how high the harbor walls will be above high tide. In addition, there were questions based on the slope, width of the wall at the top and base. Generally, the people present were better able to understand when measurements were based on linear dimensions rather than slopes and angles. (It may be more appropriate to include these dimensions when presenting to the public, in future.)	Depth is considered adequate for similar nature harbor. Typical local harbor depths are -3m below MSL. Passenger/ cargo harbor as an expansion to the current harbor is designed for 14 m below MSL. More appropriate and detailed drawing of the various structures will be developed later. These will be shared with the local stakeholders. Structure designs have already given considerations to the design proposed on review of various reports and harbor works and their environmental factors associated with such structure.
Some commented that outer wall side of harbor wall (currently a revetment) is never used; can future extensions include means to utilize the space	Not considered based on local norms for similar nature harbor. Harbor is designed with forecasted vessel usage considered.
Some felt that the entry is very narrow, and that the current design will bring in swells during the stormy weather	Entrance channel is based on local harbor user consultation outputs and existing design aspects, sizes of the vessels. No modification is considered. Minor changes may come in detail design stage.
Some commented that whatever the design, there were certain parties who influence how the project gets built. Will there be proper quality control to ensure that what is designed and what gets built.	Agreed. Yes there will be proper quality controls to ensure the build contractor follows design specifications.
Some were concerned that waves may get bigger in future.	This concern is inherent as part of the design requirement. Hence an allowance of 0.2meters has been considered in the overall height of the

	breakwaters.
Comments about the current design, some feel that the harbor access channel walls and basin adjoining points are too sharply defined corners. This need to be revised to avoid difficulty in maneuvering larger sized boats.	Noted. Detailed design will look into such aspects.
Issues with regard to orientation of harbor entrance channels were also raised. It was suggested that it should be more inclined to the existing orientation that what the current design shows.	Noted. Detailed design will look into such aspects.
Questioned whether harbor entrance breakwater wall will be extended right to the edge of the reef.	Not considered as this was not seen necessary through consultation outputs.
Some commented that rather than having recreational spaces, why not make the port bigger.	Recreational area is a community requirement with future development plans associated with the newly reclaimed areas. The government has already committed.
Will there be any repair or upgrading work done to the existing harbor while new development is taking place	Not budgeted in this project.
Can vessels utilize the outer harbor wall after new development?	Yes, if there is a requirement.
Should have better means of loading and unloading cargo.	Some aspects of this are already included in the design especially during harbor operation phase.
Some of those present wants to have the drawings so they can study them later.	

7.3.2 Findings of stakeholder consultations

In general, there was a consensus among all the participants of the consultations that the development and expansion of the harbor would bring in economic development to the island and region. As other islands depend on Kulhudhuffushi as a business hub, the scale of business will increase when people gain confidence on the investments and a reliable transport system between inter-islands in the region is the key to this confidence. There were also concerns that Kulhudhuffushi Port is Limited and is not being operated to its full capacity.

In all stakeholder consultations the participants stated that they were aware of the harbor expansion and redevelopment project by the Ministry of Housing and Infrastructure. There

was huge media coverage of the project since the promise of the harbor expansion was a promise made during an election campaign of the current Government according to the local people.

At the beginning of each consultative meeting, an overall brief of the project was provided to various groups. Impacts, both negative and positive, that are common with any infrastructure development program acquiring land were discussed with the stakeholders. People interacted with interest to learn about the project and shared their views as well.

Additional public consultations will be carried out as part of environmental monitoring and management aspect of the project as part of continued involvement of the relevant stakeholders. This is particularly important during project detailed design stages to ensure that their concerns particularly direct users of the harbor to ensure their concerns and recommendations identified in section 7.3.1. Detailed design and engineering aspects of the harbor will also be shared with the Council in addition to the community, and regular progress of the project development will be shared.

8 Environmental Impacts

8.1 Impact Identification

Various methods are available to categorize impacts and identify the magnitude and significance of the impact, such as checklists, matrices, expert opinion, modeling etc. Impacts on the environment from various activities of the project construction work (constructional impacts) and operation of the harbor (operational impacts) have been identified through interviews with the project management team, field data collection surveys and based on past experience in similar development projects. Data collected during field surveys can be used to predict outcomes of various operational and construction activities on the various related environmental components. This data can also be used as a baseline for future monitoring of the environment.

Possible impacts arising from the construction and operation works are categorized into reversible and permanent (irreversible) impacts. The impacts identified are also described according to their location, extent (magnitude) and characteristics. Reversible and irreversible impacts are further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken. Below are the impact categories) (Table 21).

Table 20 Impact prediction categories

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

The concept of the Leopold Matrix (Leopold et. al., 1971) has been used to classify the magnitude and importance of possible impacts, which may arise during the construction, and operational stage of the project. This is one of the best-known matrix methodology used for identifying the impact of a project on the environment. It is a two dimensional matrix which

cross-references between the activities which are foreseen to have potential impacts on the environment and the existing conditions (environmental and social) which could be affected.

The matrix has the actions, which may cause an impact on the horizontal axis and the environmental conditions, which may be impacted on the vertical axis. While the original Leopold matrix lists 100 such actions and 88 environmental conditions, not all are applicable to all projects. Hence the matrix used in the current assessment is a modified matrix customized to this project.

Each action that is significant is evaluated in terms of magnitude of effects on the environmental condition and importance of this impact. Value in upper left hand corner of the block indicates magnitude of interaction and that in the bottom right hand corner of the block indicates importance. All significant actions, their magnitude of impact and importance of impact (which specifies whether the impact is short term or long term) are further described in the text.

The proposed project involves the construction of coastal structures that are likely to have impact on near-shore, marine environment especially direct impact areas. The severity of impacts is predicted by reviewing the design plans and construction methodologies. Mitigation measures are formulated in light of the baseline status of existing environment, information of the project impact areas identified with respect to construction activities methodologies proposed.

8.2 Limitation or uncertainty of impact prediction

Uncertainty of impact prediction are mainly due to lack of long term data (shoreline, local currents and wave climate), inherent complexity of ecosystem (reef and shoreline environment) and limited previous monitoring programs with consistent methodologies that are locally applicable which can be used to accurately predict outcomes associated with this project to that of similar previous projects and their impacts.

The impacts are predicted by reviewing the survey data collected during the field visits and information and predictions for environmental impacts of similar natured projects in Maldives. These include various environmental impact assessment reports for harbor and coastal development projects in the Maldives. Data collected during the field visit is limited in terms of number of days to a week or few more, which limits the overall understanding of even the short term environmental conditions (wave condition, currents, and littoral movement).

The time limitation of EIA field data collection and report preparation is also a hindrance to properly understanding the environmental factors dictating the conditions of the habitat.

8.3 Impact Analysis

An analysis of impacts due to the project was done using Leopold matrix (Table 22). Magnitude and importance of an impact is given a numerical value from 1-10, 1 being the lowest and 10 the highest. Importance of impact is judged based on existing environment data, methods used and past experience with similar projects.

The matrix showed that impacts on marine habitat due to dredging, reclamation and construction breakwater are anticipated to be moderate, while impacts on seawater quality due to excavation and disposal of excavated material are anticipated to be minor to moderate. Both marine habitat and water quality impacts aspect are direct and indirect.

Direct negative impacts on marine habitats are alteration of lagoon bottom by dredging leading to habitat loss to benthic and burrowing organisms. Approximately 8 hectares of shallow area will be modified by dredging for harbor basin and reclamations (2 areas) combined. Though this shallow area as a significant coral component has less than 1% coral cover, it occupied approximately 2 hectares of sea grass. It is anticipated that most of this sea grass area will be destroyed due to dredging. Indirect impacts to the reef as residual impacts are from increased turbidity due to dredging. Dispersal of sediment plume may have residual impacts to the nearby coral community. Fish may exhibit avoidance behavior due to disturbance but alternation of the habitat may lead to loss of feeding or foraging areas. Benthic organisms in the lagoon other than corals will also be affected due to habitat loss and alternation.

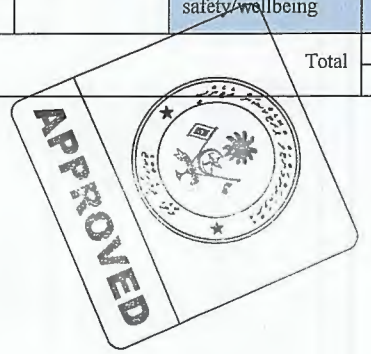
Deterioration of water quality from dredging, reclamation and breakwater construction is likely to be short term and limited to the construction period. Water quality deterioration through increased turbidity and nutrient release due to disturbance is likely to affect coral community and other organisms. Coral and many other organisms including sea grass require optimal sunlight to their photosynthetic feeding. Unnecessary level of nutrient may also negatively affect organisms when regular threshold is disturbed.

Positive impacts due to the project are expected to be a safer docking area for vessels and easier unloading of fish by the fishing vessels. Furthermore, development of the harbor front area would open up the area for business facilities and income opportunities. Moreover, construction of the harbor facility on the western side of the island also provides a coastal protection feature to the beach that has been naturalized with the reclamation works in 2010.

Thus erosion issue associated with the entire shoreline between KPL and existing harbor will be permanently interrupted.

Table 21 Leopold matrix for Harbor development and expansion works

				Constructional Activities					Operational Activities				Total
				Dredging	Sedimentation	Operation of heavy machinery	Fuel / hazardous material	Solid waste generation	Safer docking and easier unloading	Increased land area	Income opportunities	Passenger harbor/terminal and recreational harbor	
Environmental /Social Condition	Physical	Water	Seawater	7	7		1	1					16
				5	5		1	1					12
			Coastal Zone									+5	+5
												+5	+5
		Air	Air Quality			5			1				6
						4							4
			Odors										
			Noise	7		10							17
				4		3							7
	Biological	Ecosystems	Quality	10	4			1					15
				10	2			1					13
	Social	Social	Employment								+6		+6
											+10		+10
			Health/ safety/wellbeing	0			3		+8	+10		+18	+33
							3		+10	+10		+10	+27
			Total	24	11	16	4	2	+8	+10	+6	+10	
				19	7	7	4	2	+10	+10	+10	+20	



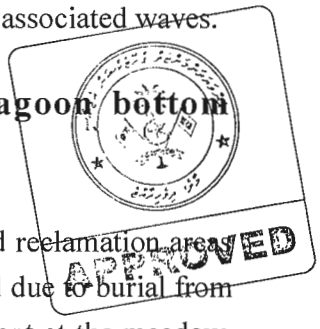
8.4 Construction Phase Impacts

In any development project major direct impacts to the environment (either short term or long term) occur mainly during the construction phase. Potential direct or indirect impacts on the social and natural environment from the proposed works include:

- Changes to hydrodynamic pattern
- Direct loss of habitat and disturbance to the lagoon bottom and reef flat area by dredging works
- Indirect impact on reef environment due to sedimentation
- Impacts due to noise
- Occupational health and safety hazards for construction workers and local public

8.4.1 Changes in hydrodynamic pattern

The construction of harbor and associated civil structure at the proposed location (west side shoreline adjacent to reclaimed area) is likely to cause minor changes to the existing hydrodynamic pattern at the western side of the island. The wave induced currents will be minimal to the shoreline at the location of the development. Because of the harbor and associated infrastructures (including entrance channel side wall breakwaters) current flow along the reef will be restricted. It is therefore likely that reef sediment transport will be restricted between this newly built entrance wall and existing wall creating a groyne effect. During SW monsoon the littoral movement will be from west to east, hence western side of the breakwater and harbor revetment is envisaged to accumulate sediments. It is unlikely that this modification will bring any significant change to shorelines beyond the two coastal structures (harbors) on either end of proposed new harbor that is considered as an expansion. Western side of the harbor will be sheltered from NE monsoonal wind and associated waves.



8.4.2 Direct loss of habitat and disturbance to the lagoon bottom and reef flat area due to dredging works

The most significant benthic community both at proposed dredging and reclamation areas is sea grass. Approximately 2 hectares of sea grass will be directly affected due to burial from reclamation and removal from dredging. 4 species of sea grass were present at the meadow, dominated by *Thallasia hemprichii*. The impact on this sea grass area and associated organisms cannot be avoided, especially non sessile benthic organisms. Fish and other fast moving organism will have a change to avoid and move to no impact areas. Live coral cover

within the impact area was estimated to be approximately 1%. Therefore impacts on live coral will be insignificant. Impact of habitat loss is irreversible at the basin and entrance location and is unavoidable.

8.4.3 Indirect impact on reef environment due to sedimentation

Coral cover at the reef area (residual impact area and control site) in the vicinity of harbor was 20% with mostly massive and branching corals. Hence construction of the facility at the site and associated dredging is anticipated to have uncertain impacts on the marine environment of the area, with unknown loss or impacts on the marine fauna.

8.4.4 Indirect impacts due to sedimentation.

The sediment plume due to the dredging works is expected to spread along the western reef, into the atoll basin. The currents along the reef are expected to transport the sediments into the atoll basin, depending on the direction of tidal current at the time of dredging. Hence impacts on seawater quality is anticipated to be moderate as it is not direct. The sediments which are transported to the west of the island are expected to impact the deeper lagoon area. Live coral cover at the northern side (control site) of the harbor facility is approximately 20%, and therefore impacts on live coral cover in the area due to sedimentation are also envisaged to be minor.

8.4.5 Impacts of noise, vibration and other disturbances

The residential area on the northern side of the island is 240m from the project area (newly built residential houses). Thick vegetation belt separates the project area and residential area. Hence impacts due to noise and air pollution are expected to be minor. Agricultural land is approximately 100m away from the project site and is also separated by thick vegetation.

8.4.6 Impacts on sensitive habitats and protected species

No protected areas are located within the vicinity of the project impact areas. No IUCN critically endangered or endangered marine species or locally protected species were found in the project area except a single encounter with a hawksbill turtle (*Erytmochelyes imbricate*) during field surveys. Hawksbill turtle is the most common species among the 5 marine protected turtle species that are found in Maldives waters. Hence visual sighting of sea turtles at reefs are a common occurrence. There is no documented evidence or anecdotal information on turtle nesting at proposed development area specifically or Kuhudhuffushi beach at large.

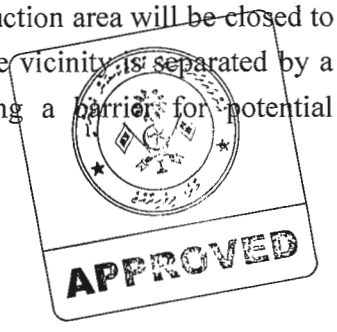
Sea grass, though a globally significant ecosystem providing ecosystem functions and socioeconomic benefits to communities, locally sea grass are not considered important. There are no documented reports of any significant subsistent level of fishing by the local community associated with sea grass bed. Such areas are often popular where they occur in large meadows as shore fishing areas by surrounding nets. Significantly large sea grass area existed in the area that was reclaimed in 2010. The existing sea grass meadow is merely a remnant of the large meadow. Hence removal of approximately 2ha of sea grass in the project impact area has insignificant environmental implications within Maldives.

8.4.7 Socioeconomic impacts

No negative socio economic impact is envisaged from the proposed development as dependency on natural resources from the habitats that is likely to be affected directly was not identified through the consultation process. Project would bring social and economic benefits from the project in terms of better and improved harbor facility. Associated harbor infrastructure such as passenger terminal will be favored by visitors. Harbor expansion will also help to improve trade and other associated benefits.

8.4.8 Occupational health and safety hazards for construction workers and local public

Occupational health hazards are not expected as high. Only a small amount of workers will be engaged in the project construction activities. Construction workers will be provided with appropriate protective gears such as clothes, footwear and head gear. Where dust from vehicles are concerned, masks to cover nose and mouth will be provided. Hearing protective devices will be provided to those staff and workers who has to work for long hours in loud areas. Potential hazards on public is not expected since the construction area will be closed to the general public. In addition proximity to residential area in the vicinity is separated by a large reclaimed area that is currently not developed providing a barrier for potential interaction with public and construction works area.



8.5 Operational phase Impacts

8.5.1 Water quality

Operation of the harbor has the potential to pollute the water within harbor and vicinity. Water pollution could occur as a result of discharges or accidental release of different types

of (solid, liquid, hazardous) substances from vessels. This may result from harbor activities such as vessel loading and unloading, handling, and storage activities.

The harbor expansion project will reduce the burden of existing harbor traffic in the north harbor and also accommodate future requirements. The expansion also enables segregation of harbor activities (e.g. a separate passenger /cargo harbor basin, a recreational activity area and fishing harbor). Harbor activities will be limited to distribution of imported goods and local produce. Mitigation measures include the contractor strictly observing the relevant provisions of the National Waste Management Regulation. There are no proper waste management facilities at the project site except for a waste collection facility in the island. The regulation encourages all waste producers to use the facility in compliance with relevant components of the regulation.

The potential impact on water quality is therefore considered insignificant. With proper control and management, spills can be avoided and contingency in case of a spill can prevent the impact of spills.

8.5.2 **Air quality**

Dust from operation of vehicles and emissions from boat engines are the likely sources that would impact air quality from the operation of expanded port. Dust from land-based operation is already a significant factor that may influence air quality negatively as the harbor front is not paved. Dust from the unpaved road surface will remain as a source of particulate matter event after completion of the civil works associated with the project. With the existing harbor front activity and new expansion related work with potential increase in vehicle activities, it is likely that dust from such activities will increase but the extent of this is difficult to estimate.

The maneuvering of boats and handling of cargo from land-based vehicles will result in air emissions from (mainly diesel) engines. Emissions from burning of fuels may impact air quality (increased concentrations of sulfur and nitrogen oxides). Annex VI of the MARPOL Convention, ratified by Maldives, aims to prevent air pollution from ships and therefore sets limits on sulfur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances. In the absence of national air quality standards, such international obligations shall be mainstreamed into national laws. Irrespective of availability of national air quality standards as of now, harbor management shall give consideration to implementing the MARPOL regulations.

The impact of emissions from these sources on nearby sensitive receptors (community settlement area is 200m) is minimal or negligible as the operation of the harbor with the

expansion works cannot be considered large scale or intensive. At locations of intense vessel and machinery movement in the port, the impact on occupational health needs to be maintained to acceptable levels.

8.5.3 **Noise**

Sources of noise include cargo handling and vehicle movements as a result of cargo loading and unloading at the new harbor front and recreational activities. There is already some level of noise from existing harbor and construction in the newly reclaimed area. Incremental noise from new harbor is not likely to be significant since current activity noise impact on sensitive receptors (e.g. nearby residential areas) is not likely significant. With new land use plans on the reclaimed land, it is likely that the distance between sensitive receptors and the new harbor will reduce. Currently residential area from harbor is approximately 200m. Increase in noise levels may vary depending on the type, duration and intensity of work. It is not expected to exceed maximum allowable noise for similar industries. Therefore, impact from noise is considered manageable and not significant.

9 Alternatives

When Alternatives proposed for harbor expansion works are considered, there are a few alternative options for this type of projects. The geography and environmental setting allows certain tested and socially and economically accepted harbor infrastructures throughout Maldives when it comes to their design, location and materials used. The following sections look at the said aspects of the project as alternatives that have been considered with respect to the proposed design. Based on these alternatives and their impact consideration from environmental and economic perspective the preferred options are discussed.

9.1 Considered alternatives

9.1.1 Design

Proposed design:	See appendix 2
Alternative design:	None proposed, design was based on widely used and accepted concept for small scale harbors.

9.1.2 Location of harbor and other civil structures

Proposed location:	See appendix 2
Alternative location:	Non proposed, since the design and location of the harbor was decided based on existing set up (as expansion of an existing facility) with consultation between MHI and stakeholders of Kulhudhuffushi.

9.1.3 Location and orientation of entrance channel

Proposed location:	See appendix 2 (additional entrance designed based on existing entrance at Kulhudhuffushi
Alternative location:	According to the concept design the location and orientation of the entrance channel is at the southern outer corner of new passenger/ cargo harbor. Alternative option is to move the entrance channel to north corner or center of the outer extent of harbor.

9.1.4 Construction materials and methods

Materials

Proposed methods:	Rock boulders for revetments and breakwater and concrete quay walls
Alternatives:	Coral rock based/sand and cement based bags for quay wall , revetments and breakwater. Steel sheet piles for quay walls is also another alternative

9.1.5 Method of dredging and reclamation

Proposed methods:	The proposed method dredging is by using excavators
Alternative :	Cutter suction dredger

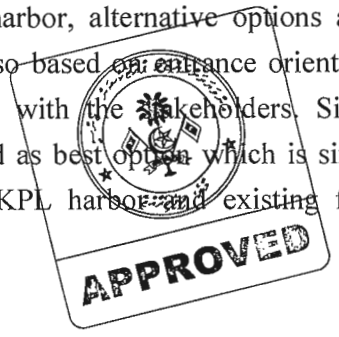
9.2 Considered options

9.2.1 Design

Proposed design is preferred in the absence of an alternative. It should be noted that the proposed design is based on environmental variables such as wind, waves and proximity to the reef etc. The design (shape) is considered in respect to existing harbor and the area available for expansion works. This design is therefore considered practical and functional with the associated expansion. It can also be justified in terms of finance available for this expansion works.

9.2.2 Location of harbor and entrance channel

There is no alternative location thus proposed location is considered. The near shore areas for locating harbor is not infinite since suitable shoreline adjacent to existing harbor is limited. As the project is expansion of the existing harbor, alternative options are also limited. Harbor entrance channel and orientation was also based on entrance orientation of the current harbor which was decided in consultation with the stakeholders. Similarly, entrance channel orientation setting its width was agreed as best option which is similar to already existing entrance channel orientation both at KPL harbor and existing fisheries harbor.



9.2.3 Materials and methods

The considered material for revetment are rock boulders. Rock boulders has proven best available and favored option for construction of revetments and breakwater recently replacing coral based rocks that are less durable. While being the cheaper option, the geo-bag option will also function well as a protection structure, however, this is not opted.

The proposed method of dredging is by using an excavator. The alternative is to use a dredger. However, using a dredger is not chosen as the proposed burrow area is the harbor basin for the proposed harbor expansion. Due to the proximity of the two proposed areas for reclamation to the proposed harbor basin there is thus no requirement for a dredger. Large size excavator can also attain the required depth of the harbor basin which is -4m below MSL. The scale of the project (extend and duration excavation works) is also a factor in favor of opting for an excavator instead of a dredger.

9.3 The no-project scenario

The "no project scenario" for the project is also considered. If this option is selected, the flooding issues due to storm surge and swell waves and absence of a natural ridge system on the western side of the island would remain unresolved. While there will be environmental impacts due to the project, it is not considered feasible to leave the issue of flooding unaddressed, due to the risk posed on the island community.

10 Environmental Management Plan

An environmental management plan is an implementation plan that consists of mitigation measures, monitoring program and institutional setup to be adopted during construction and operation of harbor expansion works to minimize adverse environmental and social impacts. This plan also includes actions that can be taken to implement mitigation measures. Budgetary estimates for environmental mitigation measures, monitoring program during construction and operation phases are also given.

10.1 Mitigation measures: Construction Phase

The environmental impacts associated with the construction phase result from dredging, reclamation, construction of breakwaters, construction of quay walls and transportation of construction material and construction of workforce camp. The impacts will be mainly on the marine and socio-economic environments. The mitigation measures for each of the activities, which are exerting impacts on the environment, are presented in the following sections.

Dredging, reclamation and construction of breakwater: Dredging of the harbor basin would generate sandy materials of varying sizes, causing disturbance to the bottom sediments, impacting seawater quality, air and noise pollution, etc. The dredged material will be used in reclamation. The construction of breakwaters will require import of granite rock. The measures proposed to be adopted for mitigation of the impacts are:

- Interaction with local communities and community leaders will be held so that they are made aware of the construction.
- The construction zones would be demarcated along with display / signboards restricting movement of locals, limited to the construction period, in and around the construction limits.
- Mitigation measures like provision of silt screens and creation of bund wall from initial dredged material will be adopted. The dredging and reclamation works will be limited mostly to day time and where possible to low tide. Work at low tide will ensure fine sediments are not readily washed off to residual impact areas.
- Reclamation and dredging operational area be limited to bare minimum so that the impacted zone is minimal.

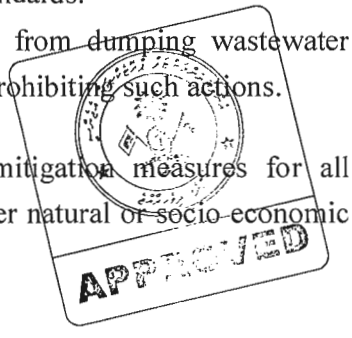
- Diesel driven engines of workboats, barges and dredgers will be well-maintained and meet emission norms of diesel vehicles.
- Seawater quality monitoring program will be initiated with special emphasis on turbidity and will follow the schedule given in the monitoring program.
- Extreme precaution will be taken to avoid spillage or leakage of diesel, oils and lubes from construction related vehicles. To reduce the impacts from spills or leaks occurring during operation and maintenance of these vehicles will be done only at designated and surfaces in the construction yard. Spills / leaks, if any, will be recovered and disposed according to local standards.
- The worker camps will be located close to the harbor within the reclaimed land.
- The camps will be adequately equipped with all the necessary facilities / amenities such as water supply, power supply, wastewater collection, solid waste collection and sanitation.
- The domestic wastes generated from the camps will be disposed at local waste disposal site.

10.2 **Mitigation measures: Operation Phase**

Harbor expansion works aim to provide a dedicated harbor area for cargo and passengers. The cargo to and from harbor would be general trade cargo from Male and local produce to and from nearby islands. Therefore the general cargo to be handled is clean and no significant impact is expected. Some level of solid waste from general cargo will be produced. Liquid waste sourced from ships is likely to cause some impact. These include deterioration of water quality resulting from waste water from ships, sewage waste, ship based bilge water oil and waste oil spills. The following measures are proposed to mitigate impacts from discharge that are of ship based;

- Operational facilities such as passenger terminal amenities will be connected to local sewerage disposal system.
- Oily wastes which are generated from the mechanical areas of the port will be collected and disposed appropriately according to local standards.
- Ships / vessels calling at harbor would be discouraged from dumping wastewater during berthing periods since there is no local regulation prohibiting such actions.

The following table (Table 23) provides environmental mitigation measures for all relevant components identified that may have an impact on either natural or socio economic



environment. It is provided as an indication of the duration and magnitude of impacts and specific institutional responsibility for both construction and operation phase of the project.

Table 22. Possible environmental impacts and mitigation measures for harbor expansion and operation phase

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
CONSTRUCTION PHASE (Temporary impacts)	Littering on terrestrial and marine environment	Littering, accidental disposal and spillage of any construction wastes should be avoided by pre-planning ways of their transportation and unloading at site. Careful planning of the work activities can also reduce the amount of waste generated.	Lagoon	During construction	Minor to moderate, short term impact	Contractor, MHI)	N/A (no additional cost)
		During piling works at the over water structures, all construction related waste will be collected and sent to the waste management site. Burnable waste will be sent to local disposal site	Lagoon	During construction/operational phases	Minor	Contractor, MHI	Included in the initial cost of project
		Development implementation of a waste disposal management strategy during the construction stage	Land/Lagoon/Reef	During construction	Moderate	Contractor, MHI	Included in the initial cost of project
	Damage to reef by unloading works	Awareness raising of project managers on environmentally friendly practices to minimize negative impacts on all aspects of construction	Temporary access area and land	During construction	Minor, short term impact	Contractor, MHI	N/A

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
		Remaining material and machinery demobilized after completion of dredging works	On land	During construction	Minor	Contractor, MHI r	N/A (may cost more for the material unloading process)
	Sedimentation and siltation on the reef and lagoon	Operation of heavy machinery only in the low tide (dredging and piling works) Clearly mark needed areas for dredging and reclamation	Lagoon	During construction	Major to moderate, short term impact	Contractor, MHI)	Cost of heavy machinery increase of 20% Silt curtain cost unit rate is $46.00, total length required is 680m therefore cost is $31,280.00
	Physical damage to marine flora and fauna	Avoid operation of heavy machinery out of construction area or boundary	Lagoon / reef	During construction	Minor to moderate	Contractor, MHI	N/A

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
	Seawater contamination,	Oil /chemical handling and management procedures will be made known to all relevant staff, appropriate supervision,	Reef flat area/ lagoon	During construction/operational phase	Moderate impact	Contractor, MHI	N/A (included in the initial project cost)
	Air pollution	Heavy machinery used dredging and reclamation works operated Minimized	Air	Construction phase	Minor/short termed	Contractor, MHI.	N/A (may increase labor cost)
	Noise pollution	Avoid use of heavy machinery during night hours	At construction site	Construction phase	Minor/short term	Contractor	N/A (same as above)

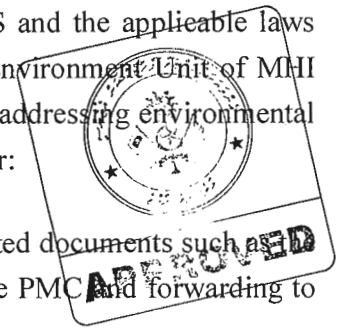
Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
OPERATIONAL PHASE (permanent impacts)	Solid waste generated at harbor	All waste generated from harbor related activities with appropriate guideline Solid waste sorted at service outlets and sorted at the waste processing area Reuse and recycle waste where possible	On land	Operational phase	Minor if proper waste management plans are in place, long term throughout the operation of the complex	Harbor management unit	N/A (included in the initial project cost)
	Damage to the reef by boat land recreational activity	Harbor entrance channel clearly marked Marked access and recess from recreational harbor with appropriate buoys	Lagoon, reef	Operational phase	Minor/long term	Harbor management	USD 100-150 (cost of making markers and buoys)

Phase	Possible Impacts	Mitigation measures	Location	Time frame	Impact intensity	Institutional responsibility	Estimated cost (USD)
							N/A (included in the staff training program)
	Air pollution from boat operation	Engine running of the vessels when in harbor is minimized	Air	Operational phase	Minor if properly managed, long term	Harbor management	N/A

10.3 Institutional arrangements

Effective implementation and supervision of the environmental mitigation measures and monitoring activities identified in this document can only be achieved through a suitable institutional mechanism involving stakeholders of the project. A broad institutional mechanism for environment safeguards associated with the project, roles and responsibilities of various agencies and parties for implementing environment safeguards are provided below.

Project Management Unit (PMU): The Project Director (PD) under the PMU is responsible for the overall compliance of the project with the SPS and the applicable laws and rules under the EPA. The Environmental officers under the Environment Unit of MHI will be responsible for processing the environmental clearance and addressing environmental concerns under the project as needed. The PD will be responsible for:



- Reviewing and approving all environment safeguard related documents such as the EIA report, safeguard monitoring reports prepared by the PMC and forwarding to ADB for disclosure on the ADB website.
- Conducting monthly site visits.
- Timely endorsement and signing of key documents and forwarding to the respective agencies required for processing of environmental clearance and other environment safeguard related permits and licenses.
- Award the civil works contract only after the environmental clearance has been received from EPA.
- Ensure all contractors obtain permits, licenses etc. for activities such as dredging and others before the implementation of the respective construction activity.
- Taking proactive and timely measures to address any environment safeguard related challenges and significant grievances (during construction stage).

Project Management Consultant (PMC). The Environment Specialist under the PMU will monitor implementation of the EMP and monitoring plan by the contractor. Specific responsibilities of the Environmental Specialist are:

- Review the detailed design of the harbor and ensure it includes the least impacts on local environment and follows recommendations made in the EIA report.
- Conduct an initial training on implementation of the EMP requirements for the contractor including providing guidance on format of monitoring checklists/reports to be maintained by the contractor.
- Provide job training for contract workers as needed during project construction.

- Conduct monthly site visits to the construction site.
- Review test results for testing seawater quality and air quality.
- Review the EMP implementation records of the contractor and crosscheck with the project site conditions.
- Ensure contractors secure necessary permits and clearances on a timely basis.
- Prepare monthly monitoring reports based on site visits and submit it to the PD for review and approval.
- Based on the monthly monitoring reports, prepare semi-annual safeguards monitoring reports and submit it to the PD for review and approval and further submission to ADB for disclosure on the ADB website.
- Advise the contractor on how to address non-compliances.
- Report the occurrence of any unanticipated impacts to the PD and recommend mitigation measures and need for the EIA report to be updated.
- Accordingly, advise the contractor on how to address the unanticipated impact.
- Facilitate the functioning of grievance redress mechanism and ensure that all complaints are resolved on a timely basis.

Contractor. The Contractor is the principal agent to implement the EMP during the pre- and during construction stage. Specifically, the contractor will:

- Appoint a qualified environment focal person to implement the EMP and monitoring plan.
- Obtain necessary environmental license(s), permits etc. from relevant agencies as prior to commencement of civil works contracts.
- Implement all mitigation measures in the EMP and activities in the Monitoring Plan.
- Submit monthly self-monitoring reports to the PMU.
- Ensure that all workers, site agents, including site supervisors and management participate in training sessions delivered by PMU.
- Ensure compliance with environmental statutory requirements and contractual obligations.
- Participate in resolving issues as a member of the GRC.
- Respond promptly to grievances raised by the local community or any stakeholder and implement environmental corrective actions or additional environmental mitigation measures as necessary.
- Based on the results of EMP monitoring, cooperate with the PIU to implement environmental corrective actions and corrective action plans, as necessary.

Implementation arrangements for environmental impact mitigation and monitoring to ensure both local and ADB environmental specific environmental safeguards are met are given in Figure 33.

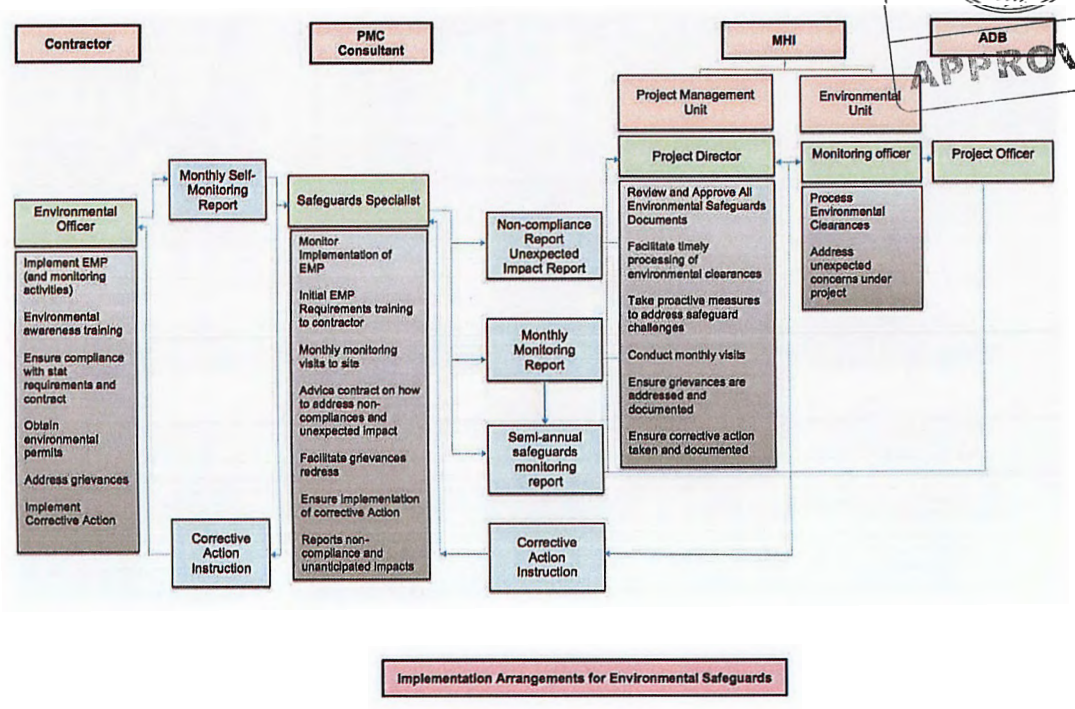


Figure 33 Institutional setup for environmental management of the project

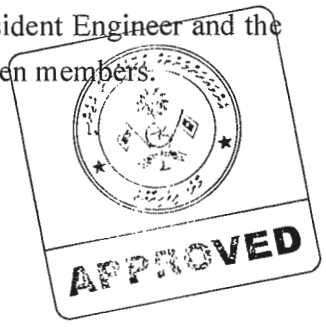
10.4 Grievance Redress Mechanism

GRC will be established at two-levels, one at the project site level and another at PMU level, to receive, evaluate and facilitate the resolution of displaced person's concerns, complaints and grievances. The GRC is aimed to provide a trusted way to voice and resolve concerns linked to the project, and to be an effective way to address displaced person's concerns without allowing it to escalate resulting in delays in project implementation. The GRC will aim to provide a time-bound and transparent mechanism to voice and resolve social and environmental concerns linked to the project. The response time prescribed for the GRCs would be four weeks. The GRC is not intended to bypass the government's inbuilt redress process, nor the provisions of the statute, but rather it is intended to address displaced

person's concerns and complaints promptly, making it readily accessible to all segments of the displaced persons and is scaled to the risks and impacts of the project.

First Level of GRC: The project site level GRCs will function on site where the harbor expansion is being implemented. The GRC will be chaired by the Resident Engineer and the members will comprise of the following as members, including 2 women members.

- Island Council representative
- NGO representative / Person of standing from the community
- NGO representative / Person of standing from the community
- Contractor representative



Second Level GRC: Project Steering Committee

- Senior Official, MoFT
- Senior Official, MHI
- Senior Official, MED

The primary level of actions to address project related grievances are through grievance redress committee at site (First level of GRC). Complaints from local individuals and community representatives can be filed to the committee through the project management site office. A formal complaint logbook can be placed at the site office. Minor complaints can be resolved immediately where possible by the site supervisor or engineer. If a complaint cannot be resolved, then the matter has to be discussed at first level grievance committee no later than 3 days of the logged complaint. If a solution for the complaint can be agreed, it shall be implemented and rectified to a satisfactory level within 7 days from a decision made from the committee meeting. If no further compliant from a specific does not recur it shall be assumed that the specific issue is resolved. All complaints and resolutions for those complaints shall be appropriately logged for relevant reporting and documentations.

If any complaints cannot be resolved on site and no suitable remedial measures are reached, then such issues can be brought to attention of second level grievance committee (Project Steering Committee). Such issues shall be informed to the committee within 7 days of meeting of the committee (first level) where a decision cannot be made. The time frame for addressing issues in such instances are difficult to estimate and thus may vary. Where timely decision can be made by steering committee, it shall be communicated to the site level committee and to establish good communication between relevant stakeholders of the complaint. The mechanism for resolving complaints showing various responsible representatives and time frames are shown in Figure 34.

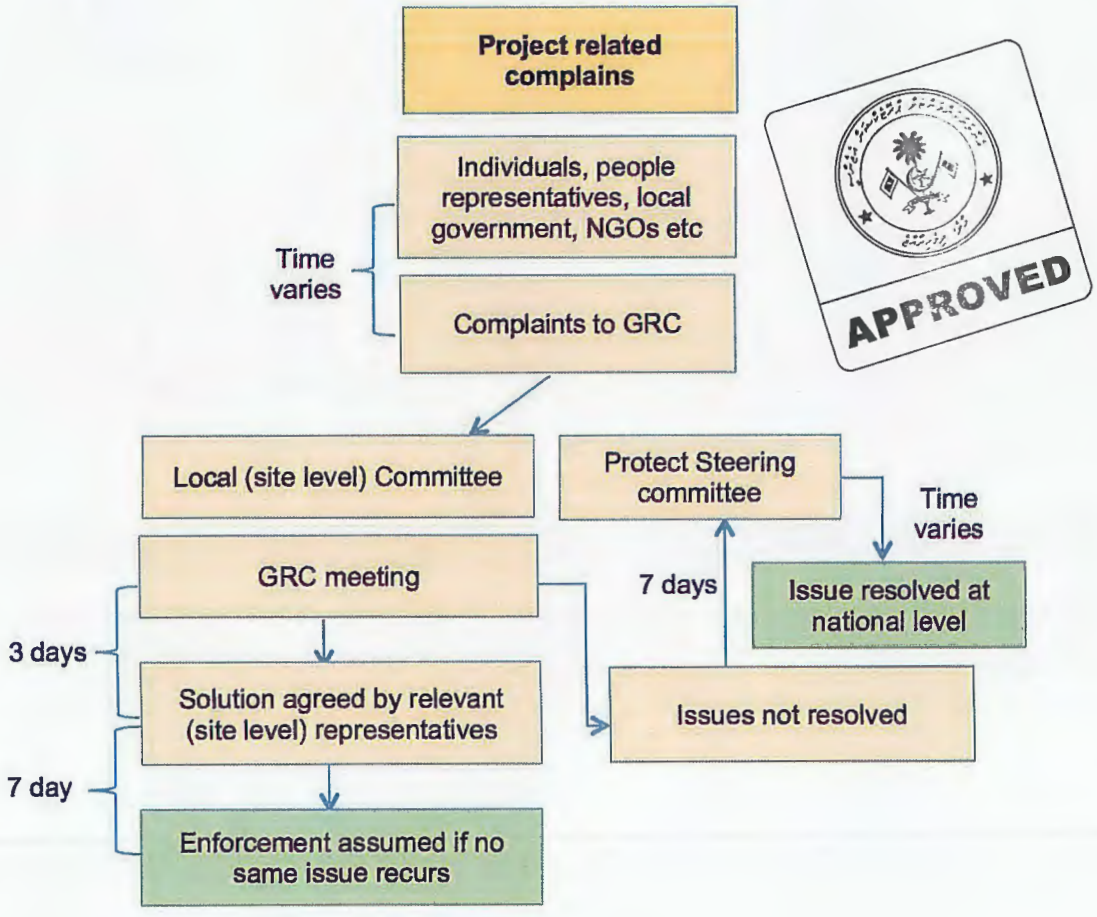


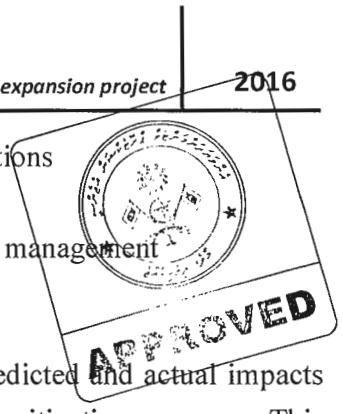
Figure 34

10.5 Monitoring Program

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

- Compare predicted and actual impacts
- Assess the effectiveness of mitigation measures
- Obtain information about responses of receptors to impacts
- Enforce and ensure legal standards and requirements set with project approval approvals
- Prevent and take remedial measures for negative environmental issues resulting from inaccurate predictions

- Minimize errors in future assessments and impact predictions
- Make future assessments more efficient
- Provide information environmentally responsible project management
- Improve EIA and monitoring process



Impact and mitigation monitoring is carried out to compare predicted and actual impacts occurring from project activities to determine the efficiency of the mitigation measures. This type of monitoring is targeted at assessing project related impacts on the natural, social and economic sectors as well as impacts on natural resources and dependent communities that are likely to be affected due to implementation of the project. Impact monitoring is supported by an expectation that at some level anthropogenic impacts become unacceptable and action will be taken to either prevent further impacts or re-mediate affected systems and community. Monitoring environmental mitigation identified for significant environmental impacts aims to compare predicted and actual (residual) impacts so that effectiveness of mitigation measures can be determined.

Monitoring works during the construction and operational phase will be carried out according to Table 24. Cost for the monitoring (data collection) activities will be covered by the project Management Contractor. Commitment to carryout and finance environmental mitigation and monitoring work shall be provided by Project proponent (MHI). Letter of commitment is given in the Proponent's declaration at the beginning of the report, (page xiii).

The EIA monitoring report structure provided in the EIA Regulations 2012 (2012/R-27) shall be used for the monitoring report preparation. Environmental monitoring reports shall be submitted every six months to EPA for the duration of construction phase with data collected as scheduled on environmental attributes as proposed in monitoring program (See Table 24). Environmental monitoring report during operation stage of the project shall be submitted to EPA on an yearly basis with data collected as scheduled on environmental attributes as proposed in the monitoring program during operation (see Table 24).

Environment Safeguard Monitoring: The Environmental Specialist from the PMC will prepare monthly environmental monitoring reports based on monthly site visits for review and approval by the PD. Based on the monthly reports he/she will prepare a consolidated Semi-Annual Safeguards Monitoring report with inputs from the Social Development Specialist of the PMC on social safeguards. The Semi-Annual Safeguards Monitoring Report will be submitted to the PD for review and approval and further submission to ADB for disclosure on the ADB website.

Table 23 Monitoring program for of the project

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring
Construction phase			
Reef benthos (coral and other benthic cover)	Photo quadrate method at 250 by 5 meter belt transect areas at baseline project impact area and control site	Every 3 months	Rate per field survey USD 800.00
Reef fish community, diversity and abundance	Visual Census of reef fish diversity and abundance at baseline data collection locations	Every 3 months	Rate per field survey USD 800.00
Seawater (seawater tested for contaminants or increased in nutrients due to dredging, reclamation and harbor protection related works),	Water sampled from baseline sampling locations. Water samples tested by a Nationally accredited laboratory Following parameters are to be tested; **Physical properties:** Salinity, pH, Electrical conductivity, Dissolved oxygen, Turbidity **Chemical properties:** Biological Oxygen Demand, Chemical Oxygen Demand, Nitrite, Nitrate, Phosphate, Sulfates **Biological properties:** Total coliforms, fecal coliforms **Metals including heavy metals:** Iron, Copper, Tin, Zinc, Magnesium, Mercury,	Every 1 months	Rate per test set USD 1000.00
Sedimentation rates	Set up sediment traps on baseline data collected as project impact area and control site	Every 2 weeks for the entire duration of dredging and reclamation works, 3 months post dredging and reclamation	USD 500.00 per cycle

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring
Operation phase			
Reef benthos (coral and other benthic cover)	Photo quadrate method at 250 by 5 meter belt transect areas at baseline project impact area and control site	Every 6 months after construction phase is completed (total 2 years)	USD 800.00
Reef fish community, diversity and abundance	Visual Census of reef fish diversity and abundance at baseline data collection locations	Every 6 months after construction phase is completed (total 2 years)	USD 700.00
Sediment quality	Sediment sampling at harbor basins (2) are core samples and analyzed for physic-chemical properties and heavy metals by a Nationally accredited laboratory to include: pH, organic matter, nutrients, Iron, Copper, Tin, Zinc, Magnesium, Mercury	Quarterly for 2 years	USD 300.00
Seawater (seawater tested for contaminants or increased in nutrients due to waste from vessels, fuel and waste oils,	Water sampled from baseline sampling locations. Water samples tested by a Nationally accredited laboratory Following parameters are to be tested; **Physical properties:** Salinity, pH, Electrical conductivity, Dissolved oxygen, Turbidity **Chemical properties:** Biological Oxygen Demand, Chemical Oxygen Demand, Nitrite, Nitrate, Phosphate, Sulfates **Biological properties:** Total coliforms, fecal coliforms **Metals including heavy metals:** Iron, Copper, Tin, Zinc, Magnesium, Mercury,	Quarterly for 2 years	USD 1000.00

10.6 **Monitoring reporting and format**

Monitoring reporting and format will follow the schedule and report structure shown in Environmental Impact Assessment Guidelines by EPA.

11 Conclusion

The findings of Environmental Impact Assessment show that the impacts of the harbor expansion on marine habitat are anticipated to be moderate while the impacts on seawater quality due to excavation and disposal of excavated material are anticipated to be minor to moderate due to the low cover of live coral in the area and currents within the area. On the other hand, the project will have positive impacts against erosion, providing safer mooring and docking for fishing, cargo, and passenger vessels and small crafts, and generating environmental and socio economic benefits.

To mitigate against significant impacts on sensitive environmental receptors, an Environmental Management Plan and Monitoring Program for both the construction and operational stages of the project has been prepared. These environmental mitigation measures and monitoring plans were prepared with allocation of adequate funds for their effective implementation. Furthermore, a Grievance Redress Mechanism (GRM) has been formulated including through the establishment of a joint grievance redress committee to address both social and environmental grievances that may arise during all project phases.

To make the harbor expansion works and its operation a viable undertaking, environmental considerations identified through assessment of sensitive receptors of the environment need to be incorporated in implementation strategies. The Environment Act and EIA regulation of Maldives provide a good framework on how to effectively manage the country's environment and natural resources. The EIA has examined potential environmental impacts of the project construction and operation through examination of environmental components that would be affected. The EIA also meets the requirements of the Government and, in principle, complies with ADB's Environmental Assessment Requirements.

Acknowledgements

I would like to acknowledge all who were involved in materializing this report. In this regard I would like to thank assistance from the project design team for their inputs on project description, work methodology and scheduling of the project. I would also like to thank relevant staff from ADB who assisted in compilation of relevant sections of the report with regard to climate change and environmentally sensitive areas. Thanks are also due to people who have assisted in the field in various aspects of baseline environmental data collection.

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Appendices

Appendix 1 Terms of Reference

203-EIARES/138/2015/297

Terms of Reference for Environmental Impact Assessmentfor Harbour Expansion Works at Kulhudhuffushi, HaaDhaal atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on 27 December 2015 for undertaking the EIA of the proposed harbour extension works at *Kulhudhuffushi, HaaDhaal.* 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/activity 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 linkedwith other activities that are carried out or that are on going within the project boundary. Identify the project financing and institutional arrangements relevant to execution of the project.

2. **Study area** – Submit a minimumA3 size scaled plan with indications of all the proposed infrastructures and components of the project. Specify the 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 nesting or roosting sites, ecologically and economically sensitive species (nursery and feeding grounds).Relevant developments in the within the project boundary and adjacent areas shall be addressed including residential commercial areas in addition to significant indigenous and cultural areas.

3. **Scope of work**– Identify and quantify tasks of the project including project preparation, construction, operation and decommissioning (if applicable) phases.

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

- Location of the harbour basin extension and related structures on an A3 scaled map

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- Design parameters of the harbour and related components subject to construction (size, depth of the basin, quay walls, revetments, breakwaters and harbour entrance or access channel etc.)
- Justification for the harbour extension works,
- Locations and designs of any additional coastal protection measures related to the harbour works,
- Method and equipment used for construction of various components associated with project
- Measures to followed to ensure environmental safeguards during various stages of project development,
- 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 labour, construction/operation/closure of labour camps, emergency plan in case of spills (diesel, grease, oil)access to site, safety, equipment and material storage, fuel management and emergency plan in case of spills).

Dredging/Excavation

- Location and size of burrow areas (s) on a scaled map;
- Justification for the selection of the location, depth and size of burrow area(s);
- Equipment and methods used for dredging of the harbour basin, access channels and land reclamation.
- Location of disposal of excess excavated materials. Its use and justification.

Task 2. Description of the environment – Assemble, evaluate and present the environmental baseline information/data regarding environmental resources within the study area where impacts are considered. Methodology used to collect baseline data including data sources, data gaps or deficiencies shall be described..As such all baseline data must be presented in such a way that they can be used and referenced to future monitoring requirement identified through an environmental management plan. As much as possible all baseline environmental information shall be presented in maps, figures and tables.

All sampling/survey locations shall be geo referenced including water quality sampling locations, reef coral reef health assessment sites, and other relevant environmentally sensitive components assessed. The baseline environmental information shall include;

Climate

- General climatology relevant to the site including rainfall, wind, waves and air quality,

Geology and geomorphology

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- Island geomorphology(shoreline and vegetation line) including presence of beach rocks and any special characteristics (use maps);
- Bathymetry of the project impact sites including area proposed for dredging, reclamation and other relevant areas where appropriate (use maps);
- Identification of erosion and accretion pattern at the project direct impact and residual impact area.
- Characteristics of seabed and reef sediments

Hydrography/hydrodynamics (use maps)

- General description of tides and currents using site specific data where available,
- Seawater quality at the project site specific to physical parameters: temperature, pH, salinity, turbidity, Total Dissolved Solids, Total Suspended Solids and Dissolved Oxygen, BOD_5 COD, Faecal and total coliforms

Air quality and Noise levels

- Brief description of ambient air quality and noise level in the project area. A qualitative description maybe provided (instead of quantitative data collection) since the currently are no issues of air pollution or noise. The existing conditions of low population, existence of small scale commercial activities occasionally etc. maybe provided to justify lack of air and noise issues

Ecology

- Description of the marine environment to include characteristics of the seabed including benthic and fish community at the project impact area and vicinity
- Provide a general list of floral and faunal species in the project area and clearly identify species that are classified as "critically endangered" (CR) or "endangered" (EN) under IUCN or under special protection status under the Government of Maldives may be presented separately in a tabular format
- If there are any CR or EN or species under national protection, further background information on the habitat range, seasonal behavior/activities such as migration, breeding etc. needs to be provided and determined whether the project area is "critical habitat" according to the IFC Performance standard 6 guidelines[1] for such species
-

Socio-economic environment

- Demography: total population, sex ratio, density, growth
- Pressure on land use and marine resources dependency,
- Land use planning, natural resource use and zoning of activities at sea;
- Accessibility such as land and marine transport system at the island,
- Infrastructure facilities such as health, education, water supply, sewerage, electricity status

[1] http://www.ifc.org/wps/wcm/connect/bff0a28049a790d6b835faa8c6a8312a/PS6_English_2012.pdf?MOD=AJPERES

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- Boats and other seagoing vessels at the island and pattern of vessels that use existing harbour
- Structure or sites that are of historical, and cultural significance

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. Include permits and approvals in the EIA document.

Project approval from the following institutions shall be included:

- Approval from the Housing and Infrastructure;

Task 4. Potential impacts (environmental and socio-cultural) of proposed project: The EIA report should identify all the impacts, direct and indirect, during construction and operation stages, and evaluate the magnitude and significance of each. Recommendations for further updates and revisions of impacts analysis during the detailed design stage maybe provided if necessary. Particular attention shall be given to impacts associated with the following:

Impacts on the natural environment

- Impacts of project location on people and natural resources
- Changes in current flow velocities/directions, that may result in changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology due to construction of the harbor;
- Loss of marine habitat, and related ecosystem impacts and impacts on any IUCN CR or EN or national protected species
- Sedimentation impacts to direct impact area and nearby marine habitats,
- Impacts of noise, vibration and disturbance during the construction and long term impacts during operation of the harbor;

Impacts on the socio-economic environment

- Benefits and impacts of the project on marine based and other relevant economic activities;
- Impacts on employment and income, potential for local people to have (temporary) job opportunities (and what kind) in the execution of the proposed project works;
- Level of coastal protection from the project design and implementation against hazards such as sea level rise, storm surges, etc.
- Social destabilization of the island community

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Construction related hazards and risks

- Pollution of the natural environment (e.g. spills, pollution from construction related waste) during construction and operation;
- Risk of accidents and pollution on workers and local community during construction and operation,
- General occupation health and safety related risks within construction camps and
- Impacts on social and economic values, norms and belief due project outputs and health related issues such as STD, HIV, AIDS etc. during construction.

Cumulative and induced impacts – Cumulative impacts of the project in addition to recent, ongoing and planned development projects in the project area must be identified and measures recommended to mitigate and minimize the impacts. Induced environmental impacts that may occur in future as a result of the project must be identified and recommendations provided to mitigate and minimize the impacts.

The methods 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, technologies, materials, designs, timing, etc. environmental, social and economic factors should be taken into consideration. The report should highlight how the location was determined. All alternatives must be compared with locally accepted standards of similar nature. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

Task 6. Climate Change Assessment – Climate change related risks for the sustainability of the project must be identified in reference to past climate related events as well as future projected climate scenarios in the country. In relation to the extent of risks identified appropriate mitigation measures must be incorporated in project design. If no risks were identified during the project design life, clear justification needs to be provided. If any risks were identified, the measures taken in project design including cost estimates for the additional measures, if any, need to be clearly presented. Overall, the project must clearly demonstrate that proper due diligence done on climate risks have been carried out

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and addressed. Recommendations for steps to be taken during detailed design maybe recommended if necessary.

Quantitative estimates on greenhouse gas emissions must be made in relation to future boat/ferry traffic during project operation. This maybe based on the traffic projections carried out as part of the project economic analysis. A comparison must be made between baseline GHG emissions based on existing boat/ferry traffic and future projected traffic over the project life to understand the additional quantity of GHG that will be generated as a result of the project.

Task 7. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures. Mitigation measures to avoid or compensate habitat destruction, e.g. sediment control structures, coastal protection structures to reduce erosion, coral reconstruction, and temporary jetty and replacement of marine protected or environmentally sensitive areas. If any IUCN CR or EN or national protected species are going to be impacted, mitigation measures must be provided to avoid, mitigate or compensate for the impacts to ensure there will be no "net loss" of biodiversityMeasures for both construction and operation phase shall be identified including 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 (EMP) in matrix format will be prepared summarizing the impacts, mitigation measures, location, monitoring method and indicators, costs and responsible parties for implementing and monitoring the mitigation measures. This EMP will be updated during the detailed design and attached to the bidding documents during recruitment of the civil works contractor.

Task 8. Environmental Monitoring Plan– Identify issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for all relevant components of the project. Details of the monitoring program during construction and operation stages including the physical and biological parameters for monitoring, cost commitment from the developer to carryout monitoring in the form of a commitment letter, detailed reporting scheduling, costs and methods of undertaking the monitoring program including monitoring indicators and targets, must be provided.

Task 9. Stakeholder consultation– – Identify appropriate mechanisms for providing information on the agricultural project to relevant stakeholders, government authorities. In this respect consultation shall be undertaken with the following stakeholders and any other relevant stakeholders identified during the preparation of the EIA report:

- Council kulhudhufushi
- Relevant stakeholders of Kulhudhufushi
- Ministry of Housing and Infrastructure

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Consultations must be carried out during project preparation with local people in the project area and local or international environmental NGOs existing in the country. Consultations must be targeted at informing the stakeholders on the project, listening to their views and addressing any concerns they may have if relevant for the project. The EIA report should include a list of people/groups consulted, clearly showing the numbers of men and women consulted, their contact details and summary of the major outcomes. Photos of the consultations maybe provided as appendixes.

Task 10. Institutional arrangements and Grievance Redress Mechanism–Describe the project organizational set up for implementing the project clearly showing positions/people that will be responsible for environment safeguards. Provide a flow chart with description of key responsibilities with respect to environment safeguards for each agency. This must include the Executing Agency, Project Management Consultants, Contractor, Local Council, EPA etc.

Propose a mechanism for the project to address grievances or complaints that maybe raised during project implementation by the local community or any other party. Provide a flow chart to clearly demonstrate how the mechanism will work.

Presentation- The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It shall contain the findings, conclusions and recommended actions including specifying measures to be taken during preparation of the detailed design supported by summaries of the data collected and citations f or any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2012 and related amendments

Timeframe for submitting the EIA report – The developer must submit the completed EIA report within 6 months from the date of this Term of Reference.

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27 December 2015

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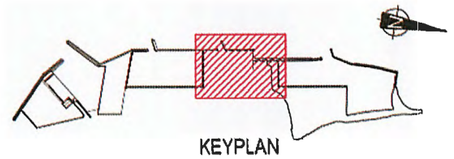
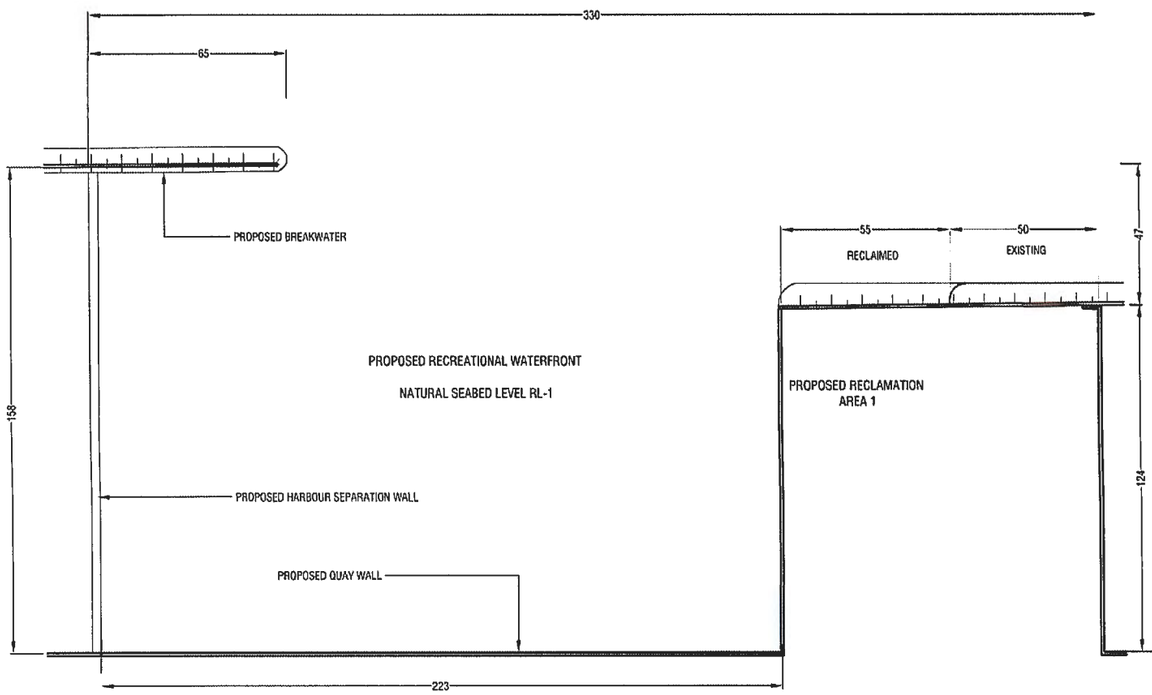
Appendix 2 Project Design related drawings





NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. All LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT:	DWG. NO:	SCALE	SIZE	REV. NO	DATE
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	0080	1:1500	A3	A	18 DEC 15
TITLE:		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
PROPOSED RECREATIONAL WATERFRONT (OPTION - 3)		AM	JD	II	RI/2015/102

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DO NOT SCALE. ONLY USE FIGURED DIMENSIONS GIVEN

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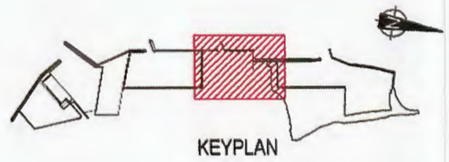
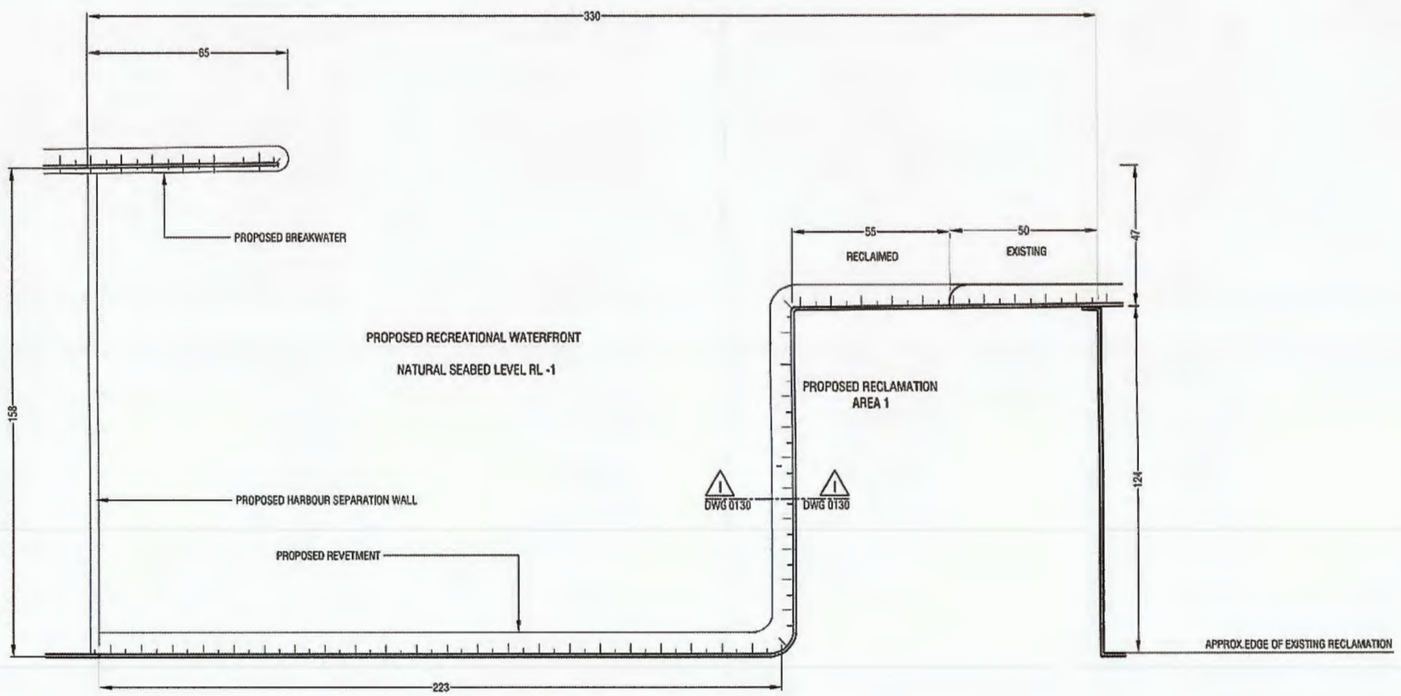
Appendix 2e





NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. All LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT:	DWG. NO:	SCALE	SIZE	REV. NO	DATE
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	0070	1:1500	A3	A	18 DEC 15
TITLE:		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
PROPOSED RECREATIONAL WATERFRONT (OPTION - 2)		AM	JO	IS	RI/2015/102

DO NOT SCALE. ONLY USE FIGURED DIMENSIONS GIVEN

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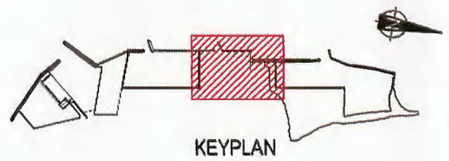
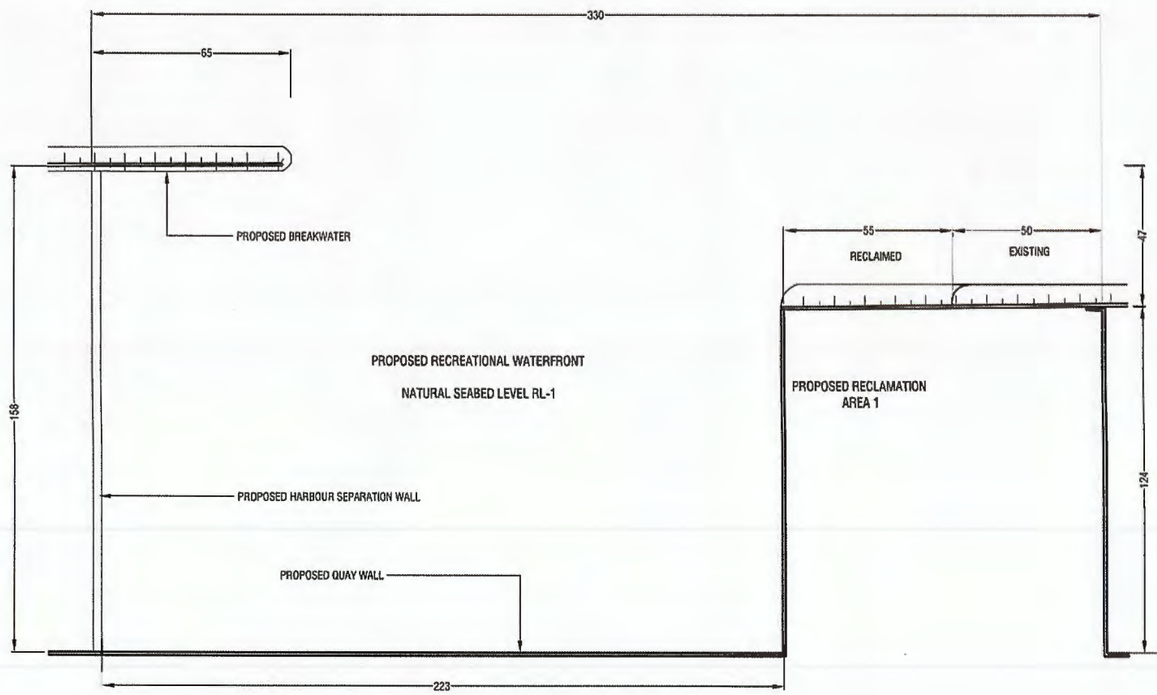
Appendix 2f





NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. All LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT:	DWG. NO:	SCALE	SIZE	REV. NO	DATE
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	0080	1:1500	A3	A	18 DEC 15
TITLE: PROPOSED RECREATIONAL WATERFRONT (OPTION - 3)		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
		AM	JO	II	R/2015/192

DO NOT SCALE. ONLY USE FIGURED DIMENSIONS GIVEN

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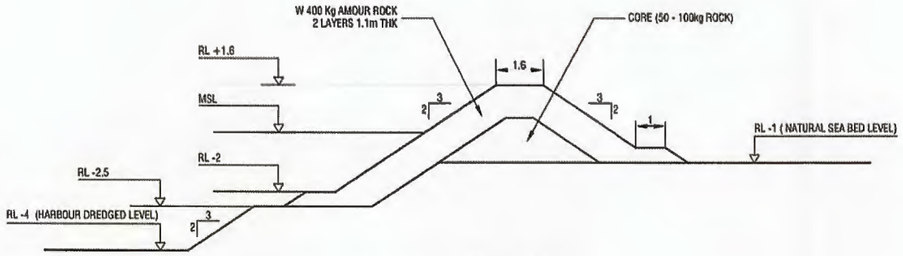
Appendix 2g



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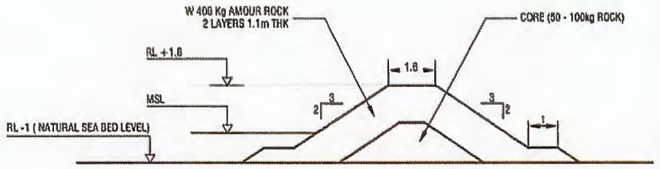
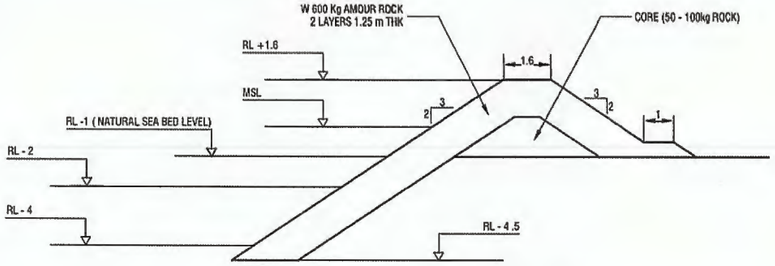
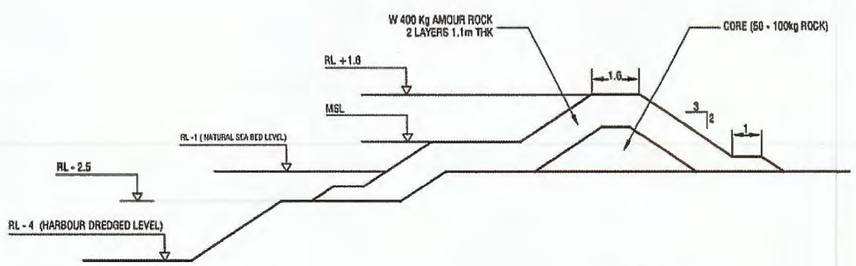
REF. DWG 0090



SECTION B-B
REF. DWG 0060



SECTION C-C
REF. DWG 0060



SECTION B-B (MODIFIED)
REF. DWG 0060

NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. All LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT:	DWG. NO:	SCALE	SIZE	REV. NO	DATE
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	0120	1:150	A3	A	16 DEC 15
TITLE: BREAKWATER SECTIONS		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
		AM	JD	II	RI/2015/192

DO NOT SCALE, ONLY USE FIGURED DIMENSIONS GIVEN

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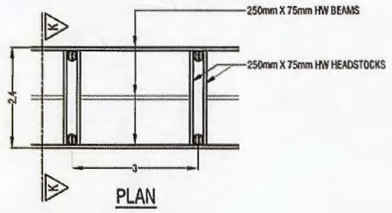
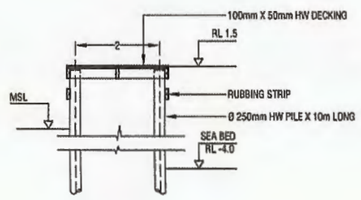
TIMBER JETTY

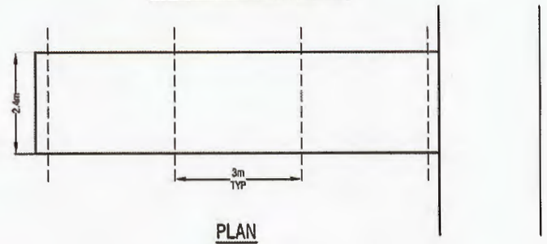


PLAN

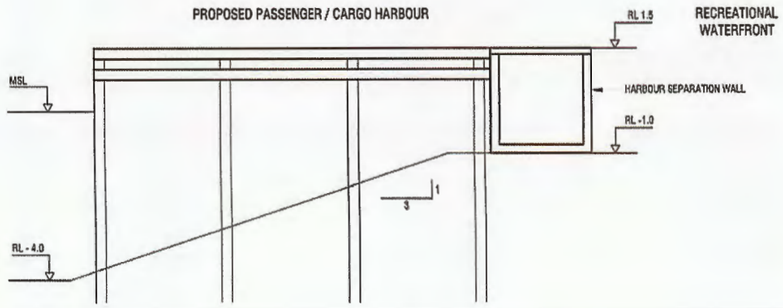


SECTION K-K

TIMBER FINGER JETTY



PLAN



ELEVATION

NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. All LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT:	DWG. NO:	SCALE	SIZE	REV. NO	DATE
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	0100	1:100	A3	A	18 DEC 15
TITLE:		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
TIMBER JETTY		AM	JO	II	RI/2015/192

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Appendix 3 Land Use Plan of Kulhudhuffushi

Appendix 2h

PROJECT: KULHUDHUFFUSHI HARBOR EXPANSION PROJECT " MLD8829 "	DWG. NO: 0140	SCALE	SIZE	REV. NO	DATE
		1:3000	A3	B	15 FEB 18
TITLE: ANCILLARY FACILITIES		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
		AM	JO	II	RI/2015/102

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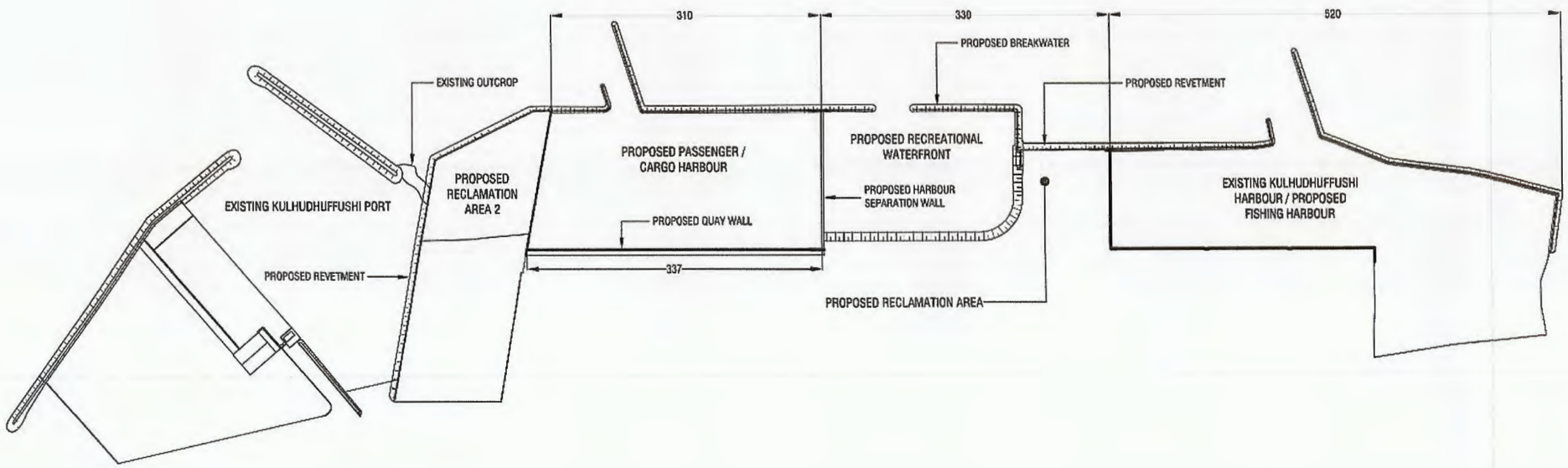
Appendix 2a General layout of harbor expansion works



NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. All LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT:	DWG. NO:	SCALE	SIZE	REV. NO	DATE
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	0050	1:5000	A3	A	18 DEC 15
TITLE:		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
GENERAL ARRANGEMENT		AM	JD	II	RI/2015/192

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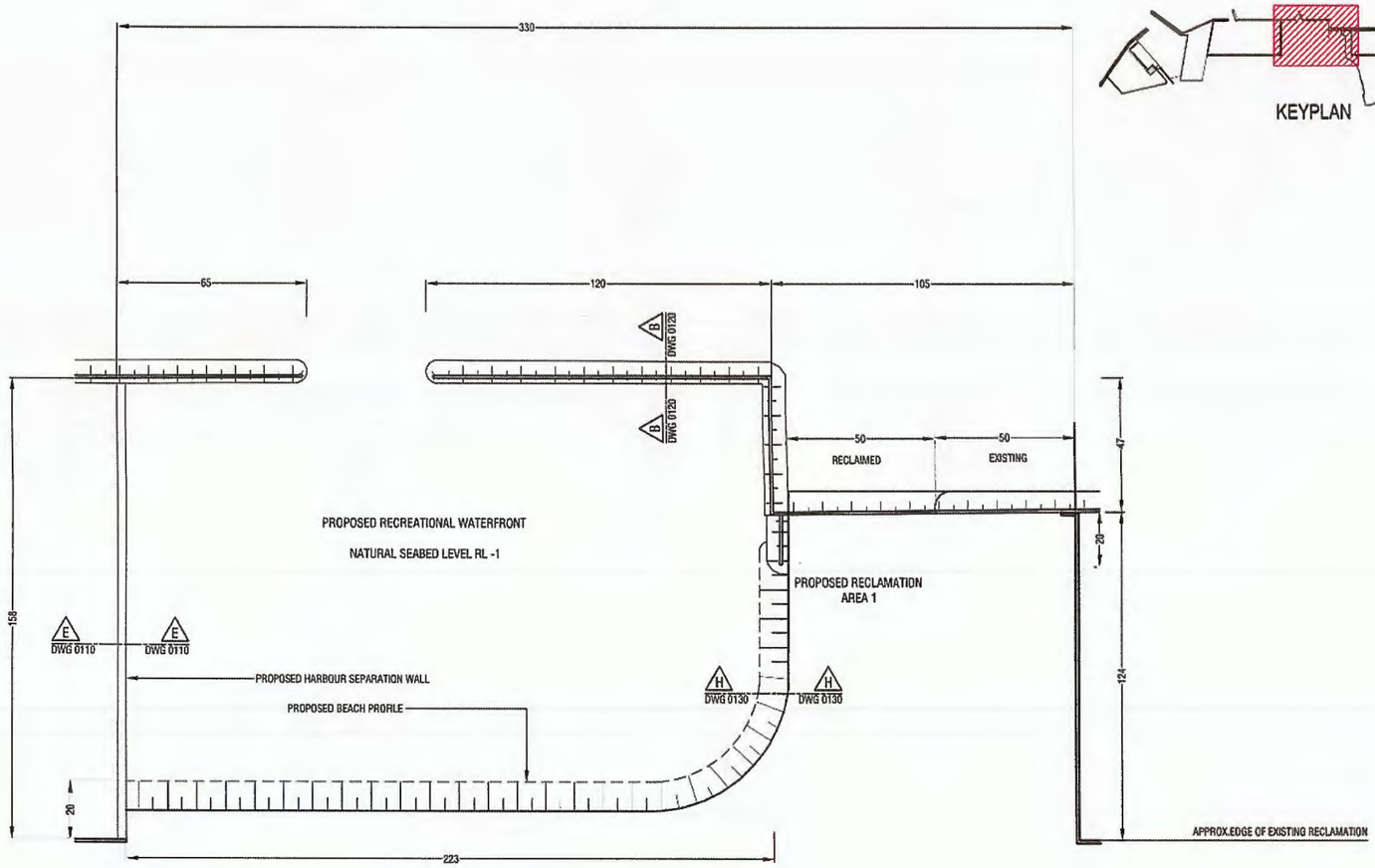
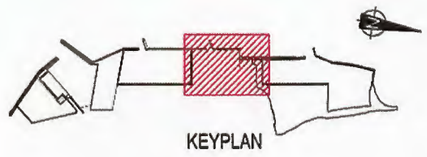
Appendix 2b&d





NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. All LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT:	DWG. NO:	SCALE	SIZE	REV. NO	DATE
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	0060	1:1500	A3	A	18 DEC 15
TITLE:		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
PROPOSED RECREATIONAL WATERFRONT (OPTION - 1)		AM	JD	II	R/2015/102

DO NOT SCALE. ONLY USE FIGURED DIMENSIONS GIVEN

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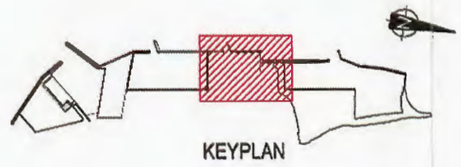
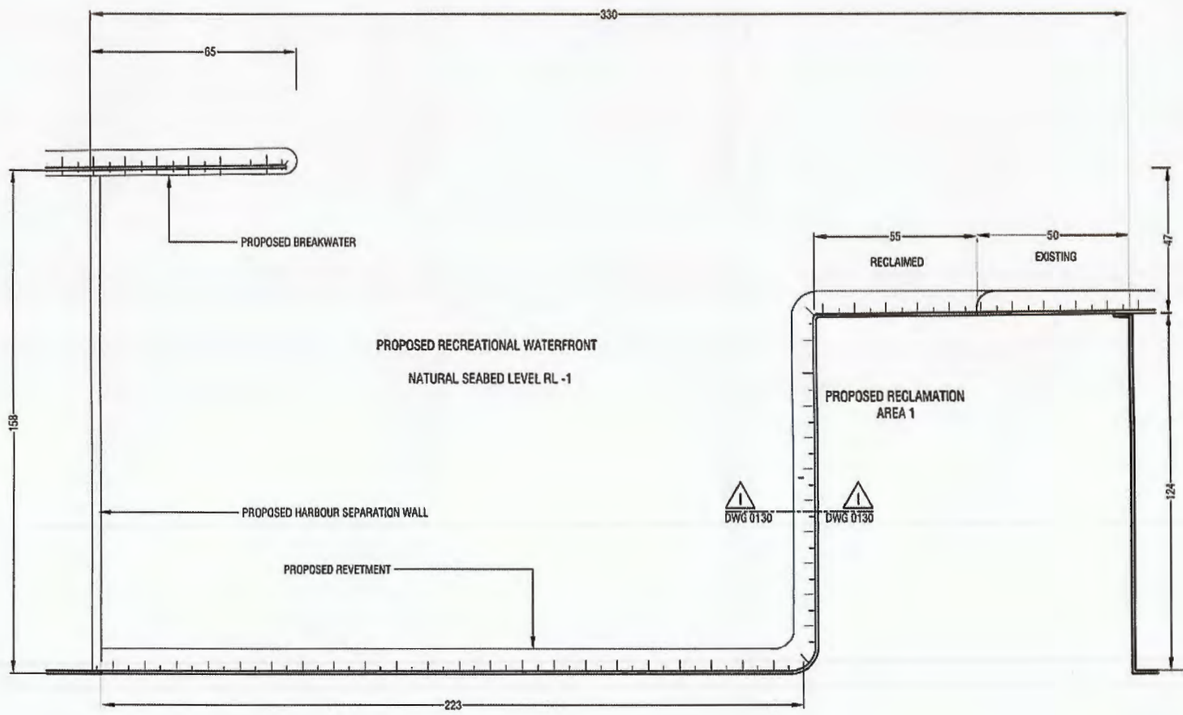
Appendix 2c





NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. All LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT:	DWG. NO:	SCALE	SIZE	REV. NO	DATE
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	0070	1:1600	A3	A	18 DEC 15
TITLE:		DRAWN BY	CHECKED BY	APPROVED	PROJECT. NO
PROPOSED RECREATIONAL WATERFRONT (OPTION - 2)		AM	JD	II	RI/2015/182

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MINISTRY OF HOUSING AND INFRASTRUCTURE
AMEENEE MAGU, MAAFANNU 20392, MALE', REPUBLIC OF MALDIVES
TEL: 3004300 FAX: 3004301 email: planning@housing.gov.mv

TITLE: HDH.KULHUDHUFFUSHI LAND USE PLAN

PROJECT: HDH.KULHUDHUFFUSHI LAND USE PLAN

DRAWN BY: NAA

CHECKED BY: ZS

SURVEYED BY:

SCALE:

DATE: 19 March 2015

Appendix 4 Bathymetry of the proposed harbor expansion and breakwaters

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T1

T2

T3

36

30

28

27

4

16

3

14

5B

29A.1

BREAKWATER

26

2C

13

20

18
A

21

5A

7

1A

5

19

1A

1B

6

1

2

1A

1B

8B

17

2A

2B

34

12

19

1A

1B

9

10

18

1A

8C

18

29.3

15

25

38

39

40

29.16

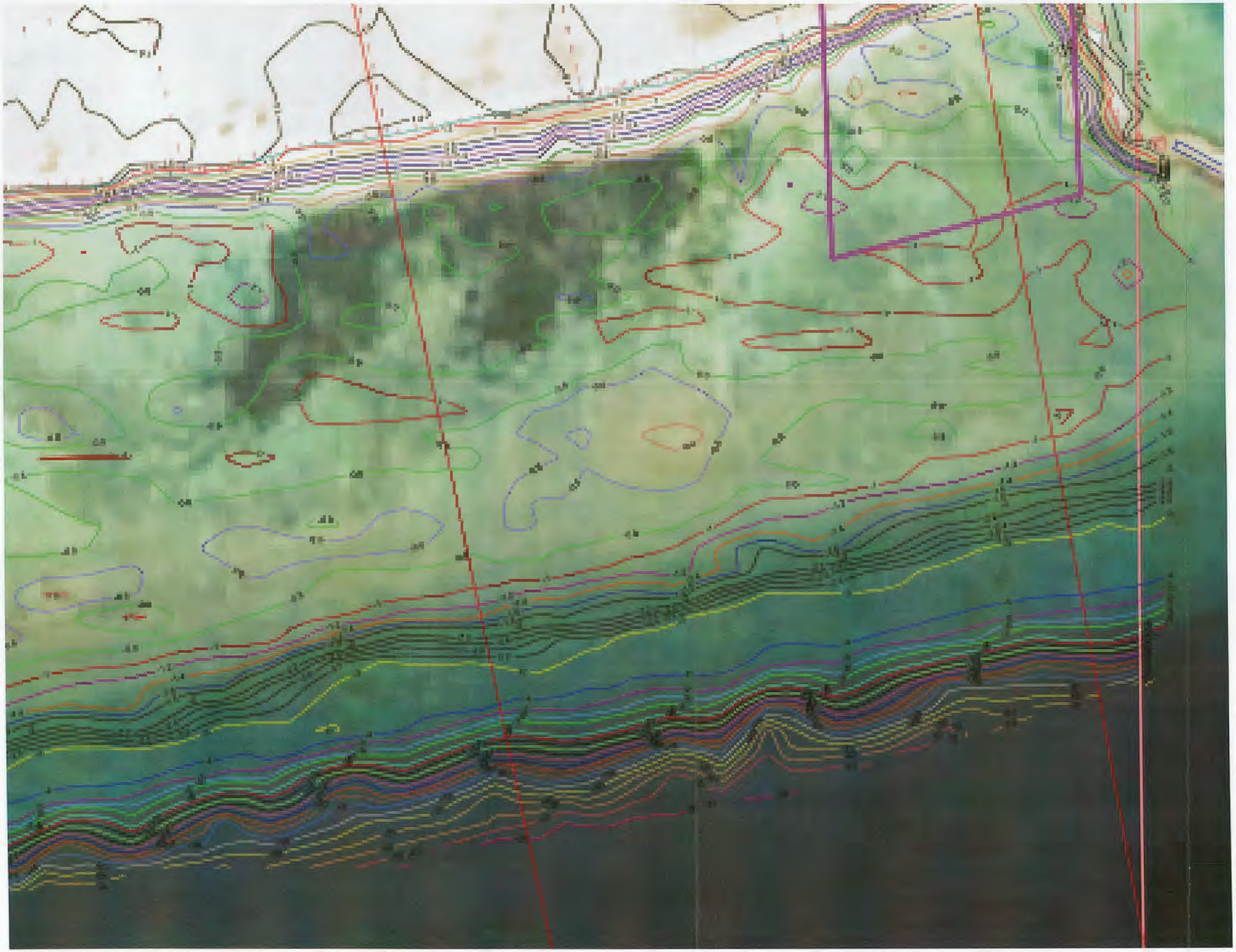
28

29.8

29.7

SCALE 1:2000

NORTH



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Appendix 5 Beach profile locations

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BEACH PROFILE - 01

BEACH PROFILE - 02

BEACH PROFILE - 03

BEACH PROFILE - 04

BEACH PROFILE - 05

BEACH PROFILE - 06

BEACH PROFILE - 07

Appendix 6 Sea grass pictures

Sea grass community








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Appendix 7 IBAT document

Protected Areas and Key Biodiversity Areas

The following sites are found within the selected buffer distances:

Features within 10 km

There are no features within 10 km.

Features within 25 km

There are no features within 25 km.

Features within 50 km

Priority Sites for Biodiversity		
Key Biodiversity Area	Haa Alifu Atoll migratory birds/congregations	6,000 ha

IUCN RED LIST OF THREATENED SPECIES

Given suitable habitat, the following species are potentially found close to the area of interest:

Taxonomic group	Scientific Name	Common Name	IUCN Red List category
Birds		Jouanin's Petrel	NT
Birds		Pallid Harrier	NT
Birds		Swinhoe's Storm-petrel	NT
Birds		Eurasian Curlew	NT
Corals			VU
Corals			VU
Corals			VU
Corals			VU
Corals			NT
Corals			DD
Corals			NT
Corals			NT
Corals			VU
Corals			DD
Corals		Branch Coral	NT
Corals		Staghorn Coral	NT
Corals			NT
Corals			VU
Corals			VU
Corals		Finger Coral	NT
Corals		Brush Coral	NT
Corals			DD
Corals			DD
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			DD
Corals			VU
Corals			VU
Corals			DD
Corals			DD
Corals			EN
Corals			NT
Corals			NT
Corals			DD
Corals			NT

Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals			VU
Corals			NT
Corals			VU
Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals		Common Mushroom Coral	NT
Corals			VU
Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals		Blue Coral	VU
Corals			NT
Corals			NT
Corals			VU

Corals		Catch Bowl Coral	NT
Corals			NT
Corals			NT
Corals			VU
Corals			VU
Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			VU
Corals			NT
Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals			VU
Corals			VU
Corals			VU
Corals		Lettuce Coral	VU
Corals			NT
Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			DD
Corals			VU
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals			NT
Corals		Smooth Cauliflower Coral	NT
Corals			VU

Corals			NT
Corals		Organ Pipe Coral	NT
Corals			VU
Corals			VU
Corals			VU
Fishes		Redmouth Grouper	DD
Fishes		Reticulate Eagle Ray	EN
Fishes		Pelagic Thresher	VU
Fishes		Bigeye Thresher Shark	VU
Fishes		Common Thresher Shark	VU
Fishes		White-dashes Wrasse	DD
Fishes		Indian Mottled Eel	NT
Fishes		Shortfin Eel	NT
Fishes		Green Humphead Parrotfish	VU
Fishes		Silky Shark	NT
Fishes		Pondicherry Shark	CR
Fishes		Oceanic Whitetip Shark	VU
Fishes		Hardnose Shark	NT
Fishes		Blacktip Reef Shark	NT
Fishes		Great White Shark	VU
Fishes		Longnose Gulper Shark	DD
Fishes		Taiwan Gulper Shark	NT
Fishes		Golden Hind	DD
Fishes		Darkfin Hind	DD
Fishes		Yellow Butterflyfish	DD
Fishes		Bluelashed Butterflyfish	DD
Fishes		Triangulate Butterflyfish	NT
Fishes		Exquisite wrasse	DD
Fishes		Rosy-scales Fairy Wrasse	DD
Fishes		Brown-marbled Grouper	NT
Fishes		Queensland Groper	VU
Fishes		One-blotch Grouper	DD
Fishes		Camouflage Grouper	NT
Fishes		Greasy Grouper	DD
Fishes		Slender Hammerhead	NT
Fishes			DD
Fishes		Masked Grouper	DD
Fishes		Quagga Catshark	DD
Fishes		Eightbar Grouper	DD
Fishes		Black Marlin	DD

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Fishes		Shortfin Mako	VU
Fishes		Longfin Mako	VU
Fishes		Striped Marlin	NT
Fishes		Reef Manta Ray	VU
Fishes		Giant Manta Ray	VU
Fishes		Megamouth Shark	DD
Fishes		Greater Guinean Mobula	DD
Fishes		Tawny Nurse Shark	VU
Fishes		Sharptooth Lemon Shark	VU
Fishes		Small-tooth Sand Tiger Shark	VU
Fishes		Bigeye Sand Tiger	DD
Fishes		Squaretail Leopardgrouper	VU
Fishes		Blacksaddled Coral Grouper	VU
Fishes		Roving Coralgrouper	NT
Fishes		Blue Shark	NT
Fishes			DD
Fishes		Crocodile Shark	NT
Fishes		Whale Shark	VU
Fishes		Narrow-barred Spanish Mackerel	NT
Fishes		Squat-headed Hammerhead Shark	EN
Fishes		Smooth Hammerhead	VU
Fishes		Leopard Shark	VU
Fishes		Black-blotched Stingray	VU
Fishes		Shortbill Spearfish	DD
Fishes		Blackvent Filefish	DD
Fishes		Yellowfin Tuna	NT
Fishes		Bigeye Tuna	VU
Fishes		Longtail Tuna	DD
Fishes		Whitetip Reef Shark	NT
Fishes		Porcupine Ray	VU
Fishes			DD
Mammals		Bryde's Whale	DD
Mammals		Blue Whale	EN
Mammals		Pygmy Killer Whale	DD
Mammals		Short-finned Pilot Whale	DD
Mammals		Indo-pacific Beaked Whale	DD
Mammals		Pygmy Sperm Whale	DD
Mammals		Dwarf Sperm Whale	DD
Mammals		Blainville's Beaked Whale	DD
Mammals		Ginkgo-toothed Beaked Whale	DD

Mammals		Killer Whale	DD
Mammals		Sperm Whale	VU
Mammals		False Killer Whale	DD
Mammals		Spinner Dolphin	DD
Other invertebrates		Harry Blackfish	VU
Other invertebrates			DD
Other invertebrates		Tigerfish	DD
Other invertebrates		Chalky Cucumber	DD
Other invertebrates			DD
Other invertebrates			DD
Other invertebrates			DD
Other invertebrates			DD
Other invertebrates			VU
Other invertebrates			DD
Other invertebrates		Bottleneck Sea Cucumber	DD
Other invertebrates		Golden Sandfish	EN
Other invertebrates		Black Teatfish	EN
Other invertebrates		Golden Sandfish	EN
Other invertebrates			DD
Other invertebrates			DD
Other invertebrates		Amberfish	DD
Snails and Slugs			DD

About IBAT

The Integrated Biodiversity Assessment Tool (IBAT) provides key decision-makers with access to critical information on biodiversity priority sites to inform risk management and decision-making processes that address potential biodiversity impacts. Developed through a partnership of BirdLife International, Conservation International, International Union for Conservation of Nature (IUCN) and United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), the vision of IBAT is that decisions affecting critical natural habitats are informed by the best scientific information and in turn decision makers will support the quest to collect and enhance the underlying datasets and maintain that scientific information.

Appendix 8 List of people met and related pictures

List of community members who turned up for the meeting 13 Jan 2016 Kulhudhuffushi

Name	Profession/trade	Contact
Abdul Raheem Mohamed	-	7865030
Ibrahim Rashid	-	7856770
Abdulla Adam	-	7613252
Mohamed Hassan	-	9933575
Amjad Moosa	-	7824746
Ibrahim Adam	-	7727176
Assad	-	7835444
Abdulla Thaufeeq	-	7741826
Abdulla Adam	-	7924016
Mohamed Ibrahim	Boat owner	7778821
Hassan Gasim	-	7584342
Mohamed Moosa	Boat captain	7678074
Adam Mohamed	Boat owner	9913500
Hassan Ali	Boat owner	7909305
Ibrahim Ahmed	Boat owner	7896445
Abdul Latheef	-	9886617
Hassan Moosa	Boat crew	7918475
Arif Ali		9904040
Ali Hassan		9914584
Mohamed Hussain	Boat captain	9733511
Abdul Salaam Abd. Rasheed		9922500
Mohamed Iqbaal	Boat owner	7742363
Jaleel Ali		7717702
Zakariya Adam	Boat owner	7739577
Ahmed Hassan		7793322
Abul Salaam		9115339
Abdul Rahman Usman	Contractor	9851164
Mohamed Ali	Fisherman	
Ibrahim Niyaz	Fisherman	
Adam Ibrahim	Fish Processor	
Ali Ismail	Fish Processor	
AbdulLatheef	Fishing Vessel Owner	
Habeeba Ali	Bank of Maldives	
Shaheedha Ali	Jalaaludheen School	
Niyaz Moosa	Taxi driver	
Ahmed Adam	Construction	
Ali Abdul Raheem	Security services	

Hussain Ali	Businessman
Hussain Yamin	Businessman
Mohamd Ali	Businessman
Hussain Ali	
Hassan Habeeb	HA. Hoarafushi
Noorul Hudha Mohamed	H.Dh. Nellaidhoo
Mohamed Mausoom	H.Dh Makunudhoo
Mohamed Adhuham	Airport Ferry Association agent
Shaheedha Ahmed	President ACSC
Aminath Afreena	Member of ACSC
Ibrahim Naeem –	Member ACSC
Mohamed Umar	Information Secretary ACSC
Saudha Ahmed	Secretary ACSC
Ahmed Abdulla	Member Zigzag
Azeez	Zigzag

Community Consultation

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Appendix 9 Reef Pictures

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
FEN Building 5th Floor, Machangoalhi, Ameeneemagu, Male', Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

بسم الله الرحمن الرحيم

MWSC

WATER QUALITY TEST REPORT

Test Report No: 300706/2016/01

Customer Informations : ***Land & Marine Environmental Resources Group Pvt. Ltd***
H. Azum 3rd Floor,
Ameenee Magu,
Male'
Rep. of Maldives

Date: 24/01/2016

Sample Description / Location~	Kulhudhuffushi				TEST METHOD	UNIT
	Harbour-Outside	Harbour-inside	Reef Control	Beach		
Sample Type~	Sea water					
Sampled Date~	16/1/2016					
Sample Received Date	17/1/2016					
Test Requisition Form No.	900162774					
Sample No.	821320	821321	821322	821323		
Date of Analysis	17/1/2016 -22/1/2016					
PARAMETER	ANALYSIS RESULT					
Physical Appearance	Clear	Clear	Clear	Clear	Visual	-
Salinity	34.31	34.31	32.46	33.44	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 22nd edition)	‰
Biological Oxygen Demand (BOD)	1	1	1	1	HACH Method 8043	mg/L
Total Dissolved Solids (TDS)	26100	25100	24800	25500	Electrometry	mg/L
Total Suspended Solids (TSS)	<5 (LoQ 5mg/L)	6	<5 (LoQ 5mg/L)	7	Method 8006 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Turbidity	0.105	1.53	0.315	1.780	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Coliform, Total	>201	>201	>201	>201	Colilert®-18/Quanti-Tray®	CFU/100mL
Coliform, Faecal	35	66	0	18	Colilert®-18/Quanti-Tray®	CFU/100mL

Keys:

UNITS: **mg/L:** Milligrams per litre, **NTU:** Nephelometric Turbidity Unit, **‰:** Parts per thousand, **CFU:** Colony Forming Unit

LoQ: Limit of Quantification

Checked by:	Approved by:
Afnan Farooq Laboratory Executive	Mohamed Eyman Senior Technical Officer

APPROVED

Notes:

Sampling Authority: Sampling was not done by MWSC Laboratory

This test report is ONLY FOR THE SAMPLES TESTED.

~ Information Supplied by the customer

**********END OF THE REPORT**********

Appendix 11 Existing harbor front plate

Existing Harbor Front








APPROVED