Initial Environmental Examination

May 2016

MLD: Kulhuduffushi Harbor Expansion Project

Prepared by Ministry of Housing and Infrastructure, Government of Maldives for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of 4 April 2016)

Currency unit	–	Maldivian Rufiyaa (MVR)
MVR1.00	=	$0.06515
$1.00	=	MVR 15.35

ABBREVIATIONS

ADB	-	Asian Development Bank
CBD	-	Convention of Biological Diversity
DIRAM	-	Detailed Disaster Risk Profile Island
GoM	-	Government of Maldives
GHG	-	Green House Gas
GRM	-	Grievance Redress Mechanism
IEE	-	Initial Environmental Examination
IPCC	-	International Panel on Climate Change
MOFT	-	Ministry of Finance and Treasury
MHI	-	Ministry of Housing and Infrastructure
NAPA	-	National Adaptation program of Action
NSWMP	-	National Solid Waste Management Policy
PD	-	Project Director
PMC	-	Project Management Consultant
PMU	-	Project Management Unit
PPTA	-	Project Preparatory Technical Assistance
PMC	-	Project Management Consultant
PMWS	-	Probable maximum wind speed
REA	-	Rapid Environmental Assessment
SPS	-	Safeguards Policy Statement
TOR	-	Terms of Reference
UKC	-	Under-keel clearance
UNFCC	-	United Nations Framework Convention on Climate Change

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EXECUTIVE SUMMARY

1. This Initial Environmental Examination (IEE) Report is prepared for the proposed harbor expansion project to meet the requirement of the Asian Development Bank's (ADB) Safeguards Policy Statement (SPS), 2009. 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.

2. 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).

3. 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

4. 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.

5. Baseline environmental data for environmental components that are likely to be affected were collected during field visits to the site in 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 and 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.

6. Environmental components that are likely to be affected because of implementation of various activities under the project during construction and operation stage are: deterioration of seawater quality, damage to coral community and sea grass through direct impact of dredging and reclamation, indirect impacts such as effects of sedimentation and turbidity. Average coral cover both at indirect/residual impact area and control site was 20%. Coral community diversity was not high. Diversity and abundance of fish community was normal to similar marine habitats in the Maldives.

7. Impact on sea grass community from dredging and reclamation is expected 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 other sea grass area in the shallow lagoon on the northern side of the existing harbor, which will not be affected by proposed expansion works.

8. 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.

9. Impact of habitat loss is irreversible at the basin and entrance location and unavoidable. However, overall this will not have significant impacts since the habitat type is “modified habitat” according to the ADB SPS as the shallow lagoon area with the corals and sea grass in the project site is already highly disturbed from the land reclamation works that were carried out in 2010. No IUCN endangered or critically endangered species of corals, sea grass, fishes and other marine species are expected to be directly impacted by the project. The Hawksbill turtle a critically endangered species, one of which was sighted once in the control site on the reef slope is not expected to frequent the highly disturbed sea grass and corals in the Project direct impact area. Since none of the impact areas are identified as critical or endangered habitats no measures to compensate for loss of these habitats have been suggested.

10. Mitigation measure on reducing identified impacts have been proposed in the Environmental Management Plan (EMP). These include construction of a bund wall around the proposed dredging for harbor basin. Placing of silt screens so that sediments from dredging and reclamation can be confined to the impact area ensuring impact reduction in project adjacent and residual impact areas. Construction workers will be prohibited to harvest, fish or intentionally harm any marine fauna through appropriate clauses in the contract agreement.

11. An environmental monitoring program and activities will be implementedto ensure effectiveness and compliance with the EMPThe EMP will be updated during detailed design stage if necessary and various construction related sub-plans will be prepared by the contractor for approval by the Project Management Consultants (PMC) during pre-construction stage.

12. Key operation stage impacts are pollution of water quality in the harbour area due disposal of solid and liquid waste from the boats. This is also the key cumulative impact which will add onto the water pollution issues currently being faced in the existing fishing harbour north of the project site and the commercial port on the southern side. Mitigation measures include the boat operators and Island council (responsible for managing operation of the existing north harbor and project harbour) strictly observing the relevant provisions of the National Waste Management Regulation. A separate Capacity Development Technical Assistance support is being provided by ADB along with the project to build the capacity of Kulhudhufusshi Council on harbour operation and maintenance. This will include activities on waste management. With this CDTA it is expected that initiatives will be taken for finding solutions to address the problem of the direct release of waste/sewage water from boats into the sea water.

13. A climate change assessment carried out showed that key climate risks for harbors in the Maldives are: i) Sea level rise - estimates for Maldives by HadCM2 (IS92a - under a medium emissions scenario) project SLR of 19.9 cm and 48.9 cm by 2050 and 2100 respectively. Estimated that by 2050, ≈ 31% of Maldives will be inundated due to SLR; ii) Storm surges -

storm tide data indicates that the probable maximum storm tide in northeastern islands of Maldives can be about 1.82 meters, in the northern islands, corresponding to a 100-year recurrence period; and iii) Tropical cyclonic winds - the harbor expansion project of Kulhudhufushi island falls in a tropical zone where the probable maximum cyclonic wind speed will reach 96.8 knots according to a 500-year return period.

14. However given the small project scope and short design life of only 25 years, of the 3 risks identified, only the risk of sea level rise by 20cm was found to be relevant and applicable to the project. Accordingly the height of the breakwater was raised by 20cm. The estimated additional cost for this is $53,000 amounting to 0.65% of the total civil works cost of $8.11 million. Further adaptive maintenance management or incremental adaptation has been recommended to be implemented over successive short timescales (say every 5-10 years or so). This approach has the advantage to manage climate change uncertainty iteratively, based on gradually increasingly reliable climate change data whilst reducing the risk to commit to highly expensive investment which could tune out to be inadequate and jeopardize the economic viability of the project.

15. Based on data on Greenhouse Gas (GHG) emissions under different sectors including the Maritime transport sector in the Maldives it was conservatively estimated that the total of 12,074 marine vessels (2014 data) will emmit 141, 131 tonnes of CO_2e. Emissions 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. Based on this figure it can be safely assumed that the emissions with the additional traffic during the design life of the expanded harbour, will be far lower than 100,000 tons of CO_2e per annum. Thus further requirements for detailed quantification and monitoring as required by the ADB SPS is not triggered.

16. Institutional arrangements to ensure proper implementation of environment safeguards include: i) Overall management and coordination of environment safeguards by the Project Management Unit (PMU) under MOHI; ii) implementation of the EMP by the contractor; and iii) supervision and monitoring of EMP implementation by the Project Management Consultants (PMC). A mechanism has been proposed to address grievances of persons affected by the project during construction at the site level and project steering committee level..

17. This environmental assessment and the proposed EMP and Monitoring Program is found to be adequate to ensure that the project will not bring about any significant irreversible environmental impacts. The EMP will be reviewed and updated if necessary during preparation of the detailed design for the proposed Project Harbor. Hence it can be concluded that the project is feasible with insignificant impacts on natural environment. The positive benefits of the project from a socio economic perspective far over weigh the negative impacts.

ޚުލާޞާ

މިޕްރޮޖެކްޓަކީ އޭޝިއަން ޑިވެލޮޕްމަންޓް ބޭންކް (އޭ.ޑީ.ބީ) ގެ އެހީގައި ދިވެހި ސަރުކާރުން، ކުޑަދަތުރުފަތުރުގެ ބަނދަރު ބޭކާރު ތަރައްޤީކުރުމުގެ ޕްރޮޖެކްޓެކެވެ. ޕްރޮޖެކްޓް ހިންގަނީ މިނިސްޓްރީ އޮފް ހައުސިންގ އެންޑް އިންފްރާ ސްޓްރަކްޗަރގެ ދަށުންނެވެ.

ބަނދަރު ބޭކާރުކުރުމަށް ކަނޑައެޅިފައިވާ ސަރަހައްދުތަކަކީ ކުޑަދަތުރުފަތުރު ތިމާފަރާ ފުރާބަށް އާއި މިފަދަ ބަނދަރުތައް ދުވެލިގަދަވާ، ގޮތުގެ ބޭނުންކުރާ 800 މީހުންގެ ވިޔަފާރިގަދައެވެ. މިއީ 2010 ވަނަ އަހަރު ހިސާބު ކުޑަދަތުރުފަތުރުގައި ހިއްސާވާ ފަރުގެ ގޮސްނެތްތައް ގެތޯ އައްސަރިއެވެ.

ބަނދަރު ބޭކާރުކުރުމުގައި ހިމެނިފައިވަނީ:

1. މުދާ އުފުލާ/ފަސިންޖަރުންގެ ބަނދަރު
2. ދުރުކަނޑުވަރު ކޮޓޭ ސަލާމަތީގެ ލޮޅާ، ފުދޭން އަރުމުގެ ސަރަހައްދު
3. ހިއްކާ ސަރަހައްދު؛ 1. ތިމާފަރާ ފުރާބައްޗާއި، ފަސިންޖަރު/ކާރުގެ ބަނދަރުތައް ދެމެދު؛ 2. ދުރުކަނޑުވަރު ކޮޓޭ ސަރަހައްދުތައް މިހާރުގެ ބަނދަރުތައް ދެމެދު
4. ބަނދަރުތަކުގެ ބޭރުފޭރު، އަރިމަތި ބޭރު
5. ބަނދަރު (މުދާ އުފުލާ/ފަސިންޖަރު ބަނދަރުގެ ފާހަރު
6. މުދާ އުފުލާ ބަނދަރުގެ ނަރު

މި ޕްރޮޖެކްޓްގެ ބައިވެރެ ޖަޕާނީ ކޮންސަލްޓިންގ ފަރާތުގެ ކޮންސަލްޓެންޓުންނަކީ ފަޑެކޯ (PADECO) އިންނެވެ. މުޅި ޕްރޮޖެކްޓްގެ އަގަކީ އަށް މިލިއަން އެމެރިކާ ޑޮލަރެވެ (US$ 8,000,000). މި ޕްރޮޖެކްޓްގެ ކޮންސަލްޓަންސީގެ މުއްދަތަކީ ގާތްގަނޑަކަށް 2 އަހަރެވެ.

މިޕްރޮޖެކްޓުގެ ބިމާއިމެދު ތިޔެޕްބެއްޓަރު ކުރިމަތިވެދާނެ ޕްރޮޖެކްޓުގެ ބައިތަކުގެ މައްޗައް ބަލާ، ޕްރޮޖެކްޓުގެ ބިމާއިމެދު ކޮންސަލްޓޭޝަންތައް ބޭއްވުމަށްފަހު އިންވަޔަރަމަންޓަލް ޕްރޮޖެކްޓްތައް އެދުނުމުގެ (އީ.އައި.އޭ) އާއި، އޭ.ޑީ.ބީގެ މިޢަޔާރާ ޕްރޮޖެކްޓްބަލާގެ ބިމާއިމެދު މިންގަނޑުތަކަށް ފެތޭގޮތަށް ބައްލަވައިލުމަށްޓަކައި ބޭރުން އެއްގެ ތިރިކުރާނެ ގޮތް ބަލާފައެވެ. މި ބޭރުން އެއް ތިރިކުރާނެ ގޮތް ރިޕޯޓް އީ.އައި.އޭ އިން ފާސްކުރެވިފައިވަނީ 26 ޖަނަވަރީ 2015 ގައެވެ.

މިރިޕޯޓުގައި މައިގަނޑު ގޮތެއްގައި ބަލާފައިވަނީ

1. ޕްރޮޖެކްޓުގެ ބައިތަކުގެ ތަފްސީލު (މިގެ ތެރޭގައި ޕްރޮޖެކްޓުގެ ބައިތައް ކުރިއަށް ގެންދިއުމަށް ރޭވިފައިވާ ގޮތާއި، ޕްރޮޖެކްޓުގެ ކޮންސްޓްރަކްޝަން އަށް ބޭނުންވާ ސާމާނާއި ތަކެތީގެ އަދަދާއި މިވެސް ހުރިހާ ގޮތްތައް، ބިލިއަސްކުރާއި، ބަނދަރު ކޮންމަށް ބޭނުންކުރާނެ ސާމާނާ މުއްދަތު، ކޮންސްޓްރަކްޝަން މަސައްކަތް ކުރާނެ ދުވަހުގެ އަދަދާއި، އަދިމުން ތިޔެބާރުވަނާއި، ކޮންސްޓްރަކްޝަން ސާމާނު ގެންގުޅެން ވަނާއި ގޮތްތައް، އަދިވެސް ކޮންސްޓްރަކްޝަން މަސައްކަތާއި ގުޅޭ އެހެނިހެން ބައިތައް

2. ޕްރޮޖެކްޓުގެ އިދާރީބައިތައް: މިގޮތުން މިޕްރޮޖެކްޓުގެ އެކިއެކި ބައިތައް ހިމެނޭ ތިމާވެށީގެ ބައިތަކާއި، އެބައިތައް ހިމެނޭ ގާނޫނާއި، ގަވާއިދުތަކާއި، ޕޮލިސީތަކުން ބަލައިލެވިފައިވާނެއެވެ. ޕްރޮޖެކްޓުގެ ބައިތައް ގުޅުންހުރިގަވާއިދުތަކަށް ޕްރޮޖެކްޓުގެ ތިމާވެށިބައިތައް ބައްޓަންކުރެވިދާނެ ގޮތަށް ގޮތްތަކަށް ބަލާލެވިފައިވާނެއެވެ.

3. ތިމާވެށީގެ ބައިތައް: ޕްރޮޖެކްޓުގެ އެކިއެކި ބައިތަކުން ތިމާވެށީގެ އެކިއެކި ބައިތަކަށް ކުރާނެ އަސަރު ދެނެގަތުމުގެ ގޮތުން ޕްރޮޖެކްޓް ހިންގުމަށް ކަނޑައެޅިފައިވާ ސަރަހައްދުގެ ބައިތަކަށް ބަލާލެވިފައިވާނެއެވެ. މިގޮތުން ޕްރޮޖެކްޓުގެ ސަރަހައްދުގެ ފެނުގެ ކުއަލިޓީ، އަޑުގެ ކުއަލިޓީ، މޫދުގެ އާބާދީއާއި، ފެންގަދައަރާވުން ހުރިގޮތް، ބިމު މޫދުގެ ހާލަތު، ވަރުގެ ހާލަތު، މޫދުފަށުގެ ހާލަތު، އިޖުތިމާޢީ ހާލަތު ހިމެނިފައިވާނެއެވެ.

4. ތިމާވެށީގެ މިހާރުގެ ހާލަތު (ޕްރޮޖެކްޓް ނެތި) ބަލައި ތިމާވެއްޓަށް ކުރާނެ/ކުރާނެކަމަށް އަންދާޒާ ކުރެވޭ އަސަރުތަކަށް ބަލާލެވިފައިވާނެއެވެ. މިގޮތުން ބަނދަރު ހެދުމަށްބަލައި ފެނުފޮށް ކުރުމުގެ ސަރަހައްދުން އެތުރޭ ކުނިކަހާ އަސަރުކުރާނެކަމަށް ފާހަގަކުރެވޭ ފަރާތްތަކަށް ބަލާލެވިފައިވާނެއެވެ. ފެނުކޮންޓްރޯލް ކުރުމާ ހަމައަށް ފެރީގެ ސަރަހައްދު ބޮޑުކުރުމަށް ފަރާތްތަކުގެ ފިކުރު ސަރަހައްދު ފަރުގަނޑު ގެއްލިދާނެ، އެހެނިހެން ސާފުކުރުމަށް

އަސަރު ކުރާނެއެވެ. މީގެ އިތުރުން ޤަވާއިދުގައި ހިމެނޭ މައުލޫމާތުގެ ސަލާމަތުން މުޅި ފަރުދުގެ ޙައްޤުތަކާ ވާނެއެވެ. ފަރުދުންނަށް ނުގެއްލި އަދި ބަޔަކަށް ހިއްސާކުރުމުގެ ސަލާމަތުން އެސަރުކައްލުގައިވާ ދުރުންބަލަހައްޓާ އަސަރުކުރާނެއެވެ.

5. މަޢުލޫމާތު ފަރާތްތަކުން ކަންބޮޑުވާ ނުވަތަ އެކަށީގެންވާ ބިރުވެރިކަން ކުރާނީ އަސަރު ކުރެވޭނީ ގޮތެއް މިދުރުކުގައި ފާސްކުރެވޭއިރު އަސަރުވެ ކުރެވޭނީ ގޮތެއް ހިސާބުގެ އިތުރުން، މިޤަވާއިދުގެ ބައިތަކަށް ކުރާއަސަރު ކުދިކުރާނީ ގޮތެއް ބަލާނީ ގޮތުގެ ތަފުސީލުވެސް ފަރާތްތަކުގެ މަޢުލޫމާތުގެ ހިސާބުގައި ވެއްޖެއެވެ.

މަޢުލޫމާތު ބަލަހައްޓާ މީހުންގެ ކުރާ އަސަރު ކުރާނީ ގޮތެއް ހިސާބުގައި ގޮތަށް ފަރާތްތަކުގެ ބައިތައް ކުރުއަސްނާ މުޅި ފަރާތްތަކުގެ ކުރުމުގެ ދެނެގަތުމުގައި އަދި ރައްކާތެރިކަން ދޭނެއެވެ. މިގޮތުން ފަރާތްތަކުގެ މިޤަވާއިދުގެ ބައިތަކާ އިތުރުން މި ފަރާތްތަކުގެ ސަލާމަތުން ޢާއްމު ފަރާތްތަކުގެ މަޢުލޫމާތު ރައްކާތެރިކަން ދޭނެއެވެ. މިގޮތުން މި ފަރާތްތަކުގެ ސަލާމަތުން ރައްކާތެރިކަން ލިބިދޭނެއެވެ.

ވީމާ، މި ފަރާތްތައް ކުރާ ދެނެގަތުމުގައި އަދި ރަނގަޅު ކަމަށް ފެނެއެވެ. މިއާއެކު ފަރާތްތަކުގެ މިޤަވާއިދުގެ މަޢުލޫމާތު ފަރާތަ ޢާއި އެއްގޮތަށް ކުރާ ދެނެގަތުމުގައި މިއީ އެކަށީގެންވާ ގޮތެވެ.

I. INTRODUCTION

1. 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).

2. The project preparatory technical assistance (PPTA) for this project was undertaken by PADECO in association with local Consultants Riyan. The tasks of Consultant's Team through their Terms of Reference 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.

3. A major milestone of the PPTA was 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 Safeguard Policy Statement (SPS) and GoM's policies on environment and social safeguards.

4. 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 USD 8,941,673.

A. Purpose of the report and need for the IEE

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

6. The environmental regulations of Maldives 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.

7. A Scoping Application to EIA with a draft terms of reference was prepared and submitted to EPA. 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.

8. This document presents the findings of the IEE for the Kulhudhuffushi Harbor Expansion Project through field assessment of various environmental components, stakeholder consultations, information and feedback from relevant stakeholders during various fact finding trips made by the project team.

B. Report structure

9. This report is prepared in accordance with the ADB SPS requirements for an IEE report. Specific structure of this IEE report also has to comply with this report structure guideline given in Appendix (Baa), Schedule 1.

10. A summary of the main contents of this IEE is outlined below;

(i) 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 rational 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
(ii) Introduction
(iii) Legal and Policy Framework
(iv) Project Description: A description of the overall project proposal including justification, main project inputs and outputs, project schedule etc.;
(v) Methodology
(vi) Existing Environment: An assessment of the existing environmental status of the proposed development site and surrounding environment;
(vii) Potential Environmental Impacts: Prediction of potential environmental impacts and evaluation of the magnitudes of environmental implications that will be associated with the proposed developments;
(viii) Mitigation Measures: Identification and assessment of the ways in which negative impacts on the environment of the project site be appropriately managed and minimized
(ix) Environmental Management Plan
(x) Stakeholder Consultation
(xi) Conclusion and Recommendations

11. In addition the following sections are included in the report

(i) Climate Change Assessment
(ii) Institutional Arranges

II. PROJECT SETTING

12. 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.

A. National policies and guidelines

1. Environmental Protection and Preservation Act (Law 4/93)

13. Environmental protection Act came has a framework law to managing all environmental issues soon after ratification of Convention of Biological Diversity (CBD) in 1993. 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. The EIA Regulations, which came into force in May 2012, has been developed by the powers vested by the above umbrella law. This report has also been prepared as per this regulation.

2. The National Solid Waste Management Policy

14. 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 establish 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.

15. 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 maximized through this policy. In order to achieve this a Solid waste management regulation was developed and became effective in 2010.

3. Solid Waste Management Regulation

16. 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.

17. 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.

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

4. Solid Waste Management Regulation

19. 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.

20. 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.

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

22. 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.

5. Third National Environment Action Plans (2009 – 2013)

23. 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).

6. National Biodiversity Strategy and Action Plan (NBSAP)

24. 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 study to find out if biological resources of value and protected nature are affected by implementing any component of the proposed project.

7. Guidelines for Land-use Planning

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

8. Dredging and Reclamation Regulation

26. 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 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 dredge spoil disposal methods and its use.
- Clause 15 outlines the maximum area for dredging. Clause 16 outlines the maximum area for reclamation.

B. ADB's Safeguard Policies

27. The operational policies of ADB includes the Safeguard Policy Statement of 2009 which covers environment safeguards, involuntary resettlement , and indigenous people . 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. The policy under all 3 safeguard issues 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.

28. Due to the nature and small scale of this project and applying safeguard standards the project has been classified as category B project. Category B refers to proposed projects if it is likely to have a environmental impacts that are generally site-specific, largely reversible and readily addressed through mitigation measures. In this case an Initial Environmental Examination (IEE) required.

C. International conventions and agreements

29. 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) provide 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 obligation under ratification of these convention 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 April 1988 (a)
Montreal Protocol on Substances that Depletes 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 July 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	3 Sep 2002 (a)

Convention /Agreement	Date of ratification/ Accession (a) Acceptance (A)
Deplete the Ozone layer, *Beijing, 3 December 1999*	
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, *22 March 1989*	28 April 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 September 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 the Law of the Sea	7 Sep 2000
International Labor Organization	15 May 2009

III. PROJECT DESCRIPTION

A. Project Proponent

30. The project proponent is Government of Maldives. 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

B. The Project

31. 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).

32. The proposed works under this project includes the following components:

i. Area 1 Reclamation
ii. Area 2 Reclamation
iii. Waterfront and Small Craft Zone Area with a Harbor separation wall
iv. Passenger/Cargo Harbor

33. 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.

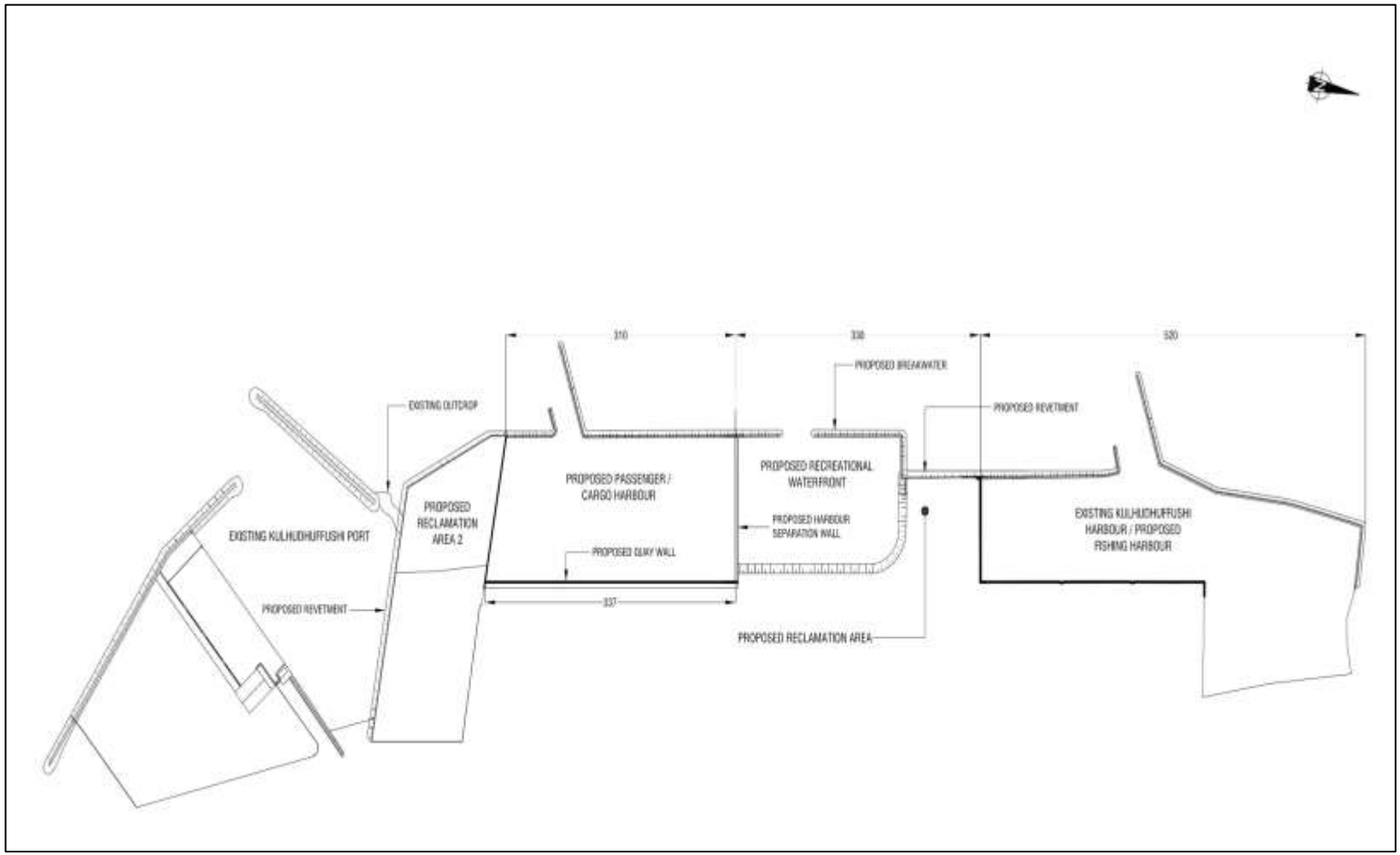

Figure 1: Concept design for the proposed harbors and associated civil works at Kulhuduffushi (A3 paper size of the concept design layout is given in Appendix 2a

C. Reclamation areas

34. **Reclamation: Area 1** The area will be approximately 100m by 50 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.

35. **Reclamation: Area 2** The Area 2 outline shown on 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

36. 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

D. Waterfront and small craft zone area

37. 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.

38. 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.

39. 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.

40. 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.

E. Harbor separation wall:

41. 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.

42. 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.

F. Passenger/cargo harbor

43. 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.

44. 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.

45. 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.

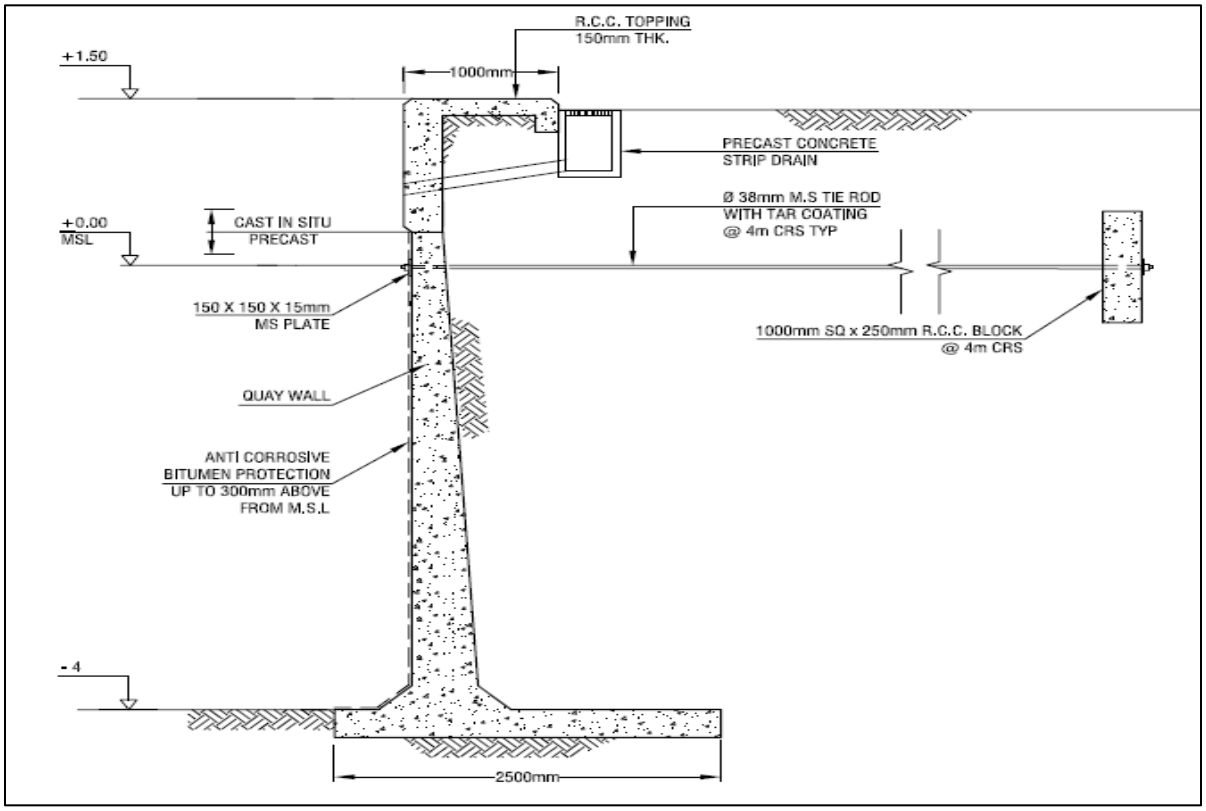

Figure 3 Typical cross section of a quay wall

G. Operational port infrastructure

46. 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:

1. Navigation lights

47. 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.

2. Timber jetty

48. 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.

3. Harbor pavement, drainage, and apron lights

49. 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.

50. 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 permeate 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

4. Bunkering and supply

51. 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.

52. 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.

5. Fire and emergencies

53. 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.

54. 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.

6. Port superstructure and ancillary facilities

55. 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.

56. For the purpose of this report, we have listed and 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.

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

7. Passenger terminal

58. 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 such a size building 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

59. 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

8. Harbor markets

60. 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.

61. 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.

9. Buildings for commerce and business activities

62. 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

H. Need for the Project

63. 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.

64. 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 a 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.

65. 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 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.

66. 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.

67. 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 to as a dedicated fishing harbor will also help to each the current congestion.

I. Location and Extent of Site Boundaries

68. 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

J. Construction phase and schedule for implementation

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

K. Mobilization

70. Mobilization of construction workforce to the site will be within two month of construction contract is awarded

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

1. Workforce

71. 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.

2. Power and water supply during construction phase

72. 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.

3. Construction material and methods

73. **Duration of Dredging Work.** The dredging work is anticipated to take a total 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									

74. **Method and equipment used for dredging.** Dredging will be undertaken using either an excavator or cutter suction dredger. The exact method and equipment will be finalized during the detailed design stage. If the excavator is used it will be mounted on sand filled gryones in the lagoon area. The excavator will not be kept full time inside the water. It will be brought back to the beach kept there when not carrying out excavation works. Based on earlier experience of

using both these equipment for dredging in the Maldives over many years, there has been no incident of fuel spills or water contamination from the equipment. 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
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

Phase	Input resource(s)	Source/Type	How to manage workers, acquire, dispose materials and waste
	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

75. **Handling and storage of construction materials.** As stated in the table above in addition to the dredged sand other types of construction material such as rock boulders for armor rock, geotextile, aggregate and cement will be required. These materials will be imported from neighbouring countries and transported into the island most likely using the existing KPL harbor. These materials will be stored in a storage space/facility that will be created for the project in the newly reclaimed land area adjacent to the project site.

4. Outputs (project components)

76. **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

77. **Key Structures.** Description of key structures as described in Section IV.

IV. METHODOLOGY

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

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

79. Information on existing environment was collected during the field visit to the project site from the 12^{h} January 2016 to 15th January 2015. Additional information for the project was collected from and through various filed visits to the site by the project design consultants in 2015 and early part of 2016. General information on the existing environment was based on available secondary data, such as climatic data from Hanimaadhoo Meteorological Centre (nearest meteorological information center to Kulhudhuffushi. Oceanographic data and information used to determine the current patterns around the island were also based on monsoonal wind patterns, wind generated waves, tidal flushing, geographic setting, the topography of the lagoon and shape of the shoreline. Wave and tide data collected from the project site during January 2016 site visit.

A. Physical Surveys

1. Shoreline survey

80. Shoreline survey was carried out using Topcon HiperII DGPS system with fixed error margin of ±15mm for horizontal coordinates. Initially three Permanent Survey Marks were established on the island, after which static survey method is used to attain GPS coordinates. The shoreline survey is done in Real Time Kinematic (RTK) mode using one DGPS as base and the other as a rover. Data is processed using Topcon Tools software.

2. Beach profiles

81. A total of 7 beach profiles were taken in the area proposed for development using an electronic level instrument. Locations where beach profiles were taken is shown in Table 4 and Appendix 5. The starting points of the profiles were fixed using Topcon HiperII GPS system (±10 millimeter accuracy). These data were compared with previous beach profiles 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 structure, hence no profiles were taken on either side of the harbor as the project works will not have 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

3. Wave and tide

82. Wave and tide data were used for the purpose of understanding general wave and tide condition at 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.

4. Surface Currents

83. 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. Shoreline changes

84. 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.

6. Sediment characteristics

85. 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 gain size. The location of sediment samples are given in Figure 5.

B. Marine Survey

86. 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

87. The ecological setting of sites R1, R2 and 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.

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

88. 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 an 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 of various level 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.

89. 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 result of proposed coastal modification through dredging and reclamation. Locations of various surveys including reef survey sites are shown in Figure 5.

C. Water quality analysis

90. In order to assess the sea water quality, seawater samples taken from 4 locations (Figure 5 and Table 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

D. Socioeconomic condition

91. 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 information available from Poverty and Social Assessment study that included in the project design component consultancy work has also be used.

V. EXISTING ENVIRONMENT

A. General setting

92. The Maldives archipelago is a long double chain of coral atolls formed over the Lacadives-Chagos ridge that runs 1deg north to 9deg 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.

93. Similar to the atolls, the characteristics of the Maldivian islands also greatly vary from the North to the South of the archipelago. While the 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.

94. 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

B. Geographic location and general setting of Kulhudhuffushi

95. Kulhudhuffushi is located on the eastern side peripheral reef of Thiladhummathi Atoll, at geographic coordinates of N6° 37' 24" and E73° 04' 10" (Official Alas of Maldives, MPND), (Figure 7). For administrative purpose the atoll is also referred as Haa Dhaal atoll, the second northern most atoll of Maldives. At is the administrative focal island of Haa Dhall atoll. This 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.

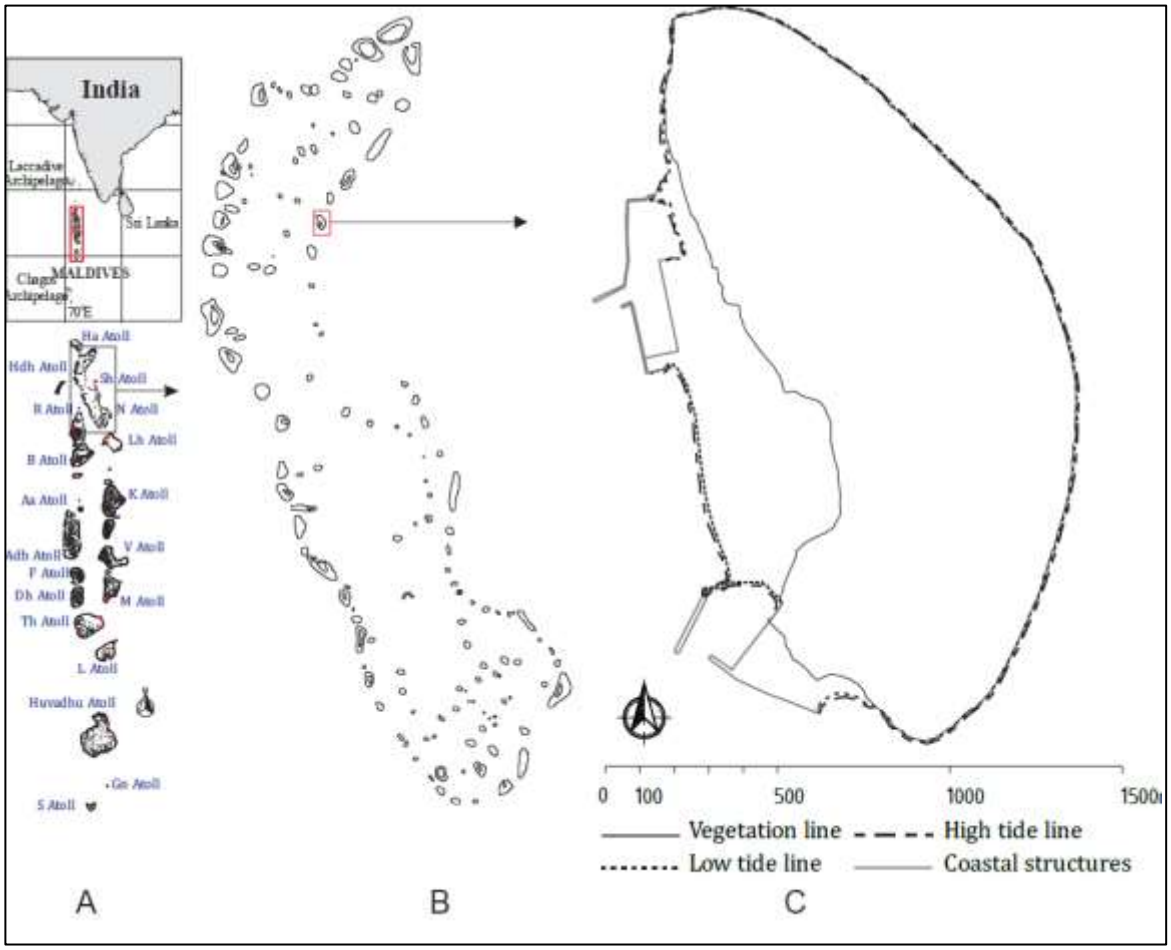

Figure 7: Location of Haa Alif Atoll in Maldives (A), location of Kulhudhuffushi within Ha Alif Atoll (B) and an enlarged image of Kulhudhuffushi showing significant shoreline features (C) (Sources: A and B – Thakuru Publishers, C – LaMer and Riyan survey group)

96. As typical of many islands in the north of Maldives, the reef 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 island are 2.53km and 0.9km. It also has significantly large wetlands (mangrove fringed) on north and south end with a combined areas 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)

C. Ambient air quality

97. 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 diesel based production of electricity. Harmful component 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, to include their sizes, elevation and proximity to the ocean it is unlikely that air quality will be a significant issue.

D. Ambient noise

98. 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 activity 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 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.

E. Shoreline survey

99. 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 doe 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.

100. 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 study which include shoreline profiles. Comparison of these profiles to 2013 survey including profiles are shown in Figures 15-21.

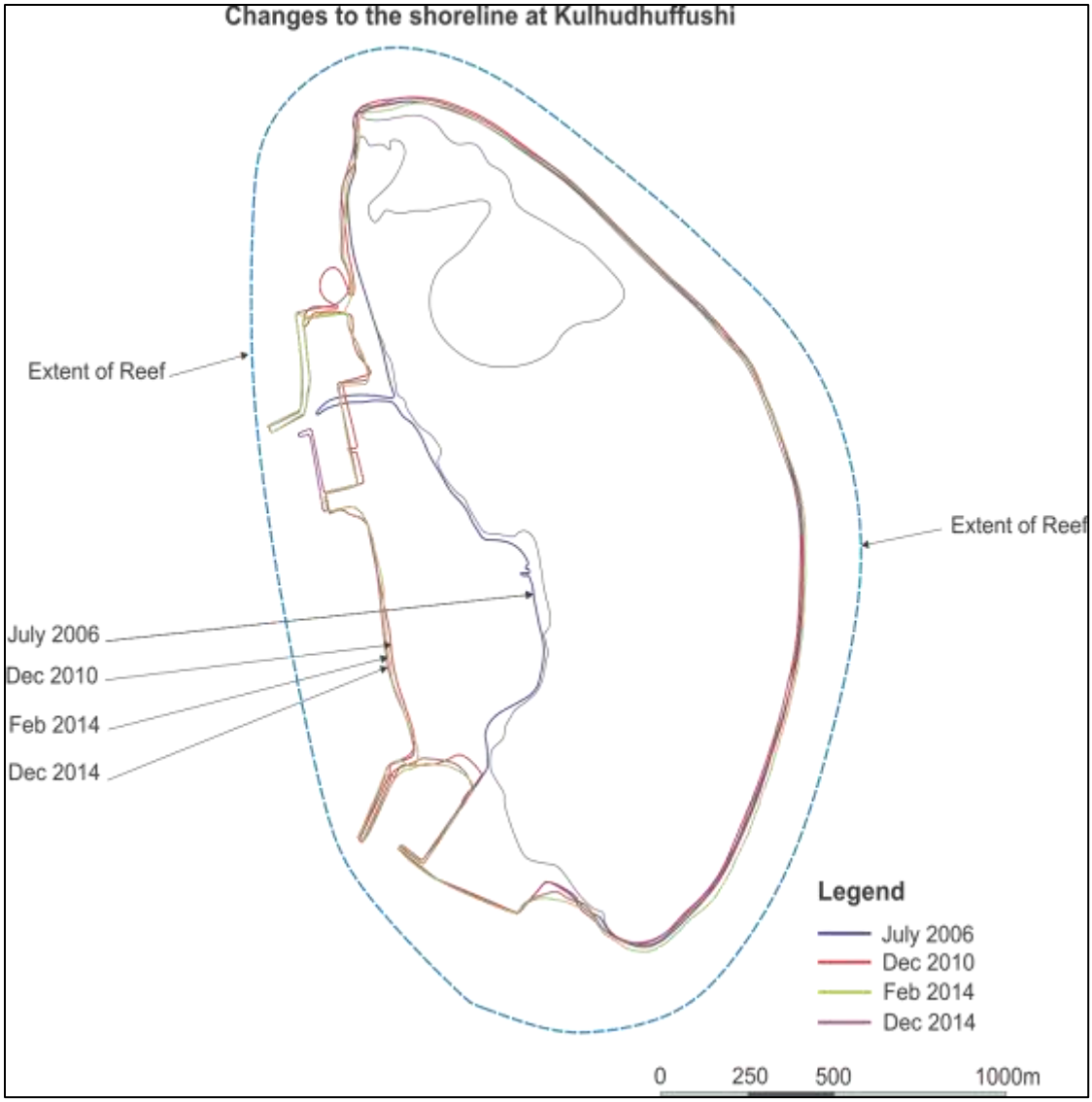

Figure 8: Results of shoreline survey compared

F. Climatology and oceanography

1. Temperature

101. 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^{o}C and 29^{o}C. The lowest recorded temperature was at 24.2^{o}C while the highest recorded temperature was at 32.5^{o}C.

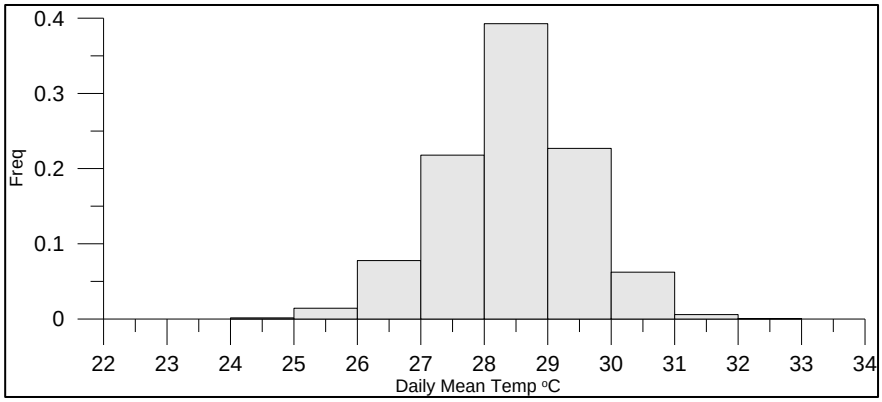

Figure 9: Frequency distribution of daily mean temperature recorded at Haa Dhaal Hanimaadhoo station (May 2008 – December 2012)

2. Rainfall Characteristics

102. No site specific rainfall data are available, hence rainfall data for the analysis of the existing environment at Kulhudhuffushi was used as 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.

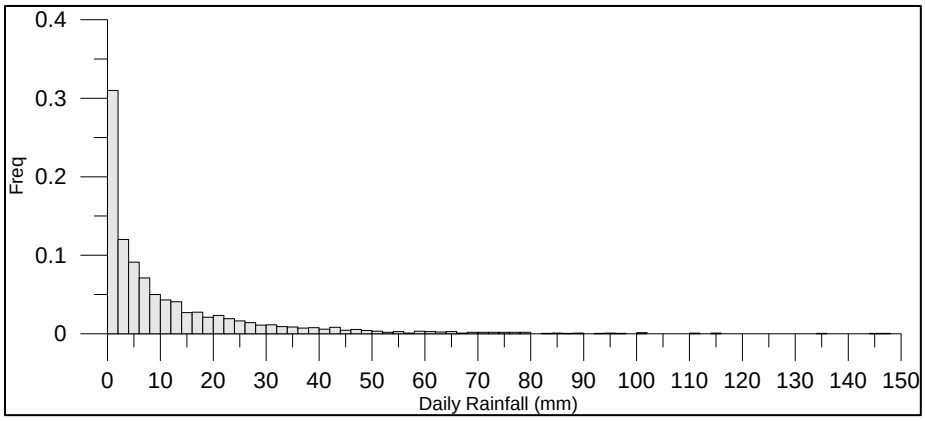

Figure 10: Frequency distribution of daily mean rainfall recorded at HDh. Hanimaadhoo station (May 2008 – December 2012)

103. 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.

104. 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.

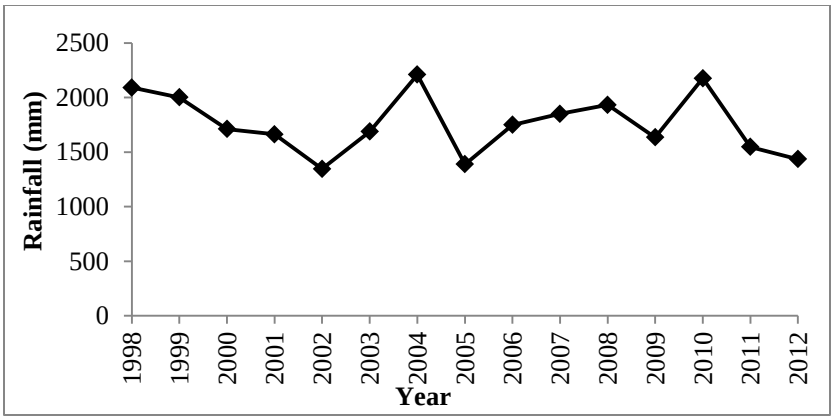

Figure 11: Average yearly rainfall for the 15-year period between 1998 and 2012

3. Wind climate

105. 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.

106. 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

Season	Month
	June
	July
	August
	September
Transition Period 2	October
	November

107. 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.

108. 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%

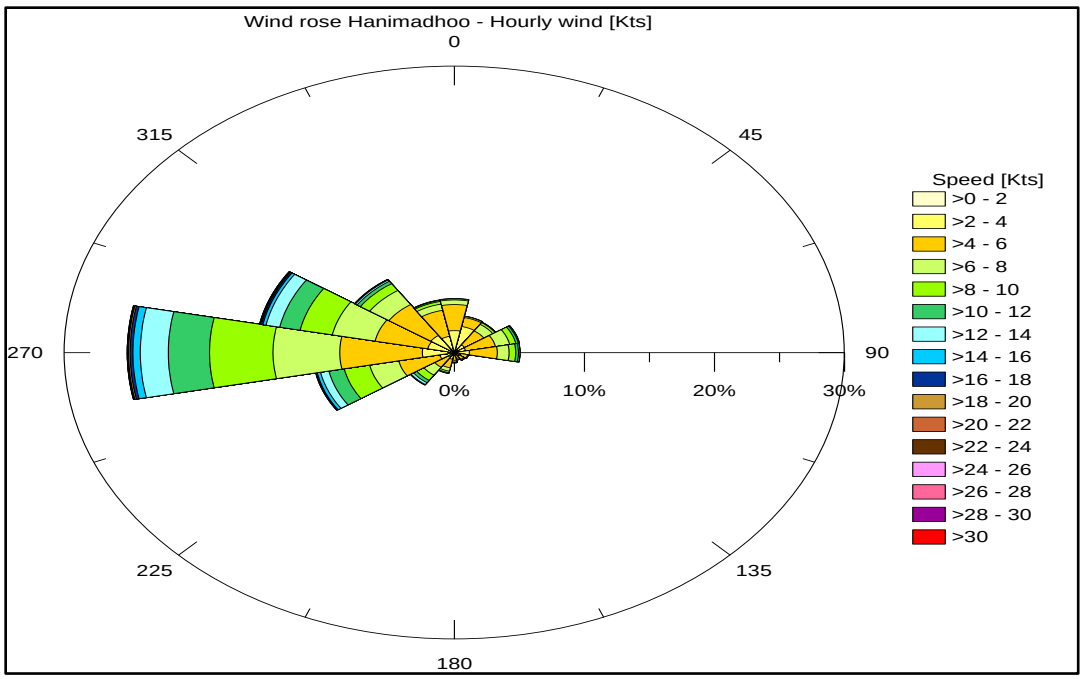

Figure 12: Wind rose plot for Hanimaadhoo Meteorological station, based on hourly wind data for the period of May 2008 to December 2012

4. Tide

109. 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.

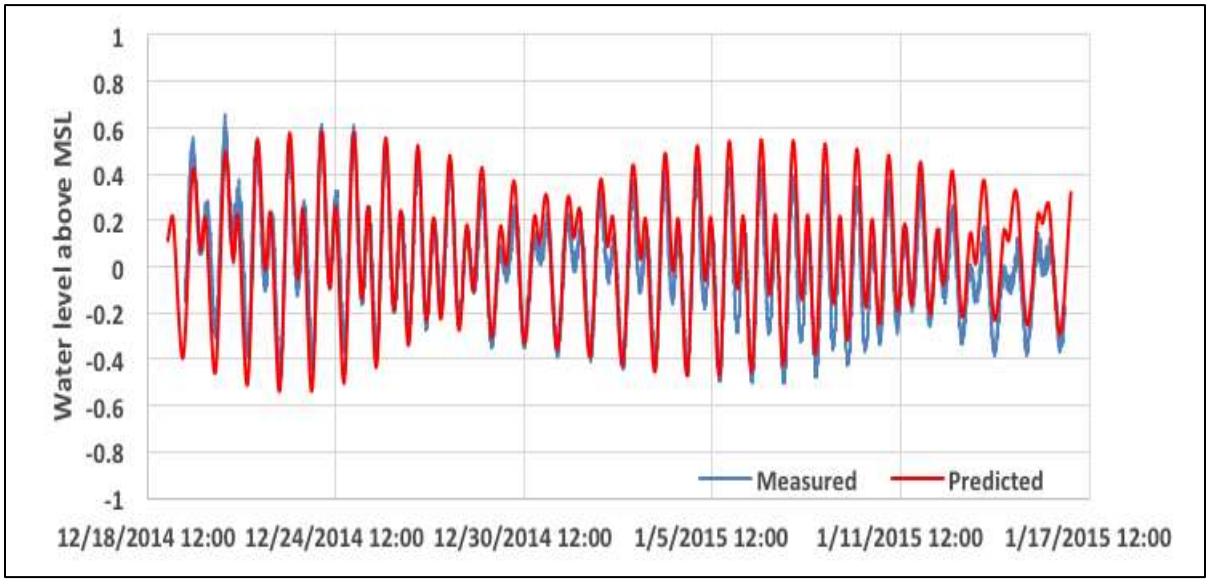

Figure 13: Observed tide at nearby location to Kulhudhuffushi and predicted tide for Hanimaadhoo Station

5. Wave

110. 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.

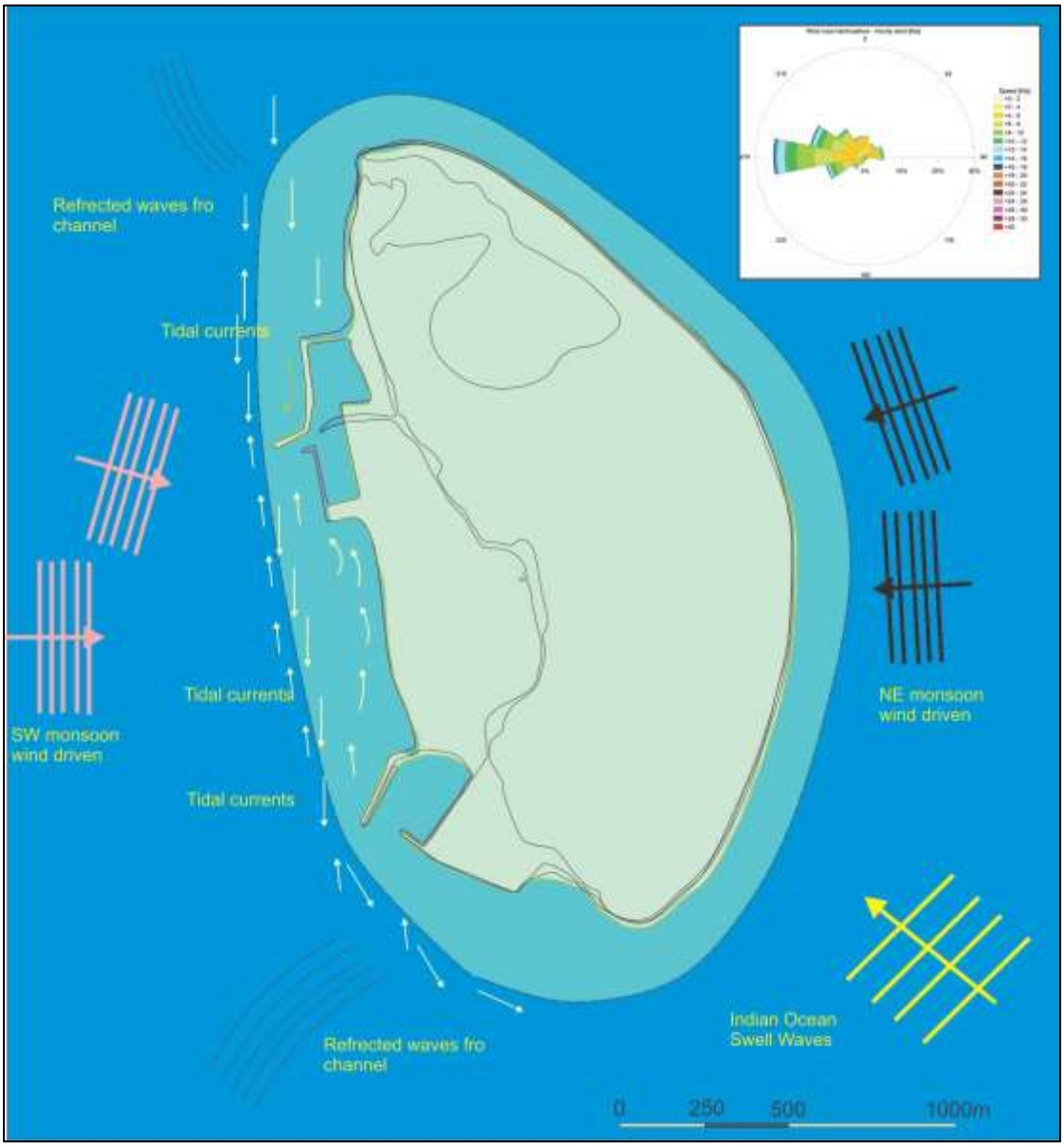

Figure 14: Refraction and shoaling of waves from the atoll channel openings dominating the waves on the eastern side

6. Current

111. 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 slow. Currents are mainly along the reef and along the shoreline with 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.

G. Beach environment

112. 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.

113. The existing beach is shaped after a large reclamation works 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 (IEE 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 beach based on the profiles shown a significant decrease in level of beach with respect to MSL (Figure 15). Same profile also indicate that this part of beach has eroded significantly. This may be a seasonal pattern as beach movement is influenced by monsoonal wind and associated near-shore hydrodynamic influence.

114. 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 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.

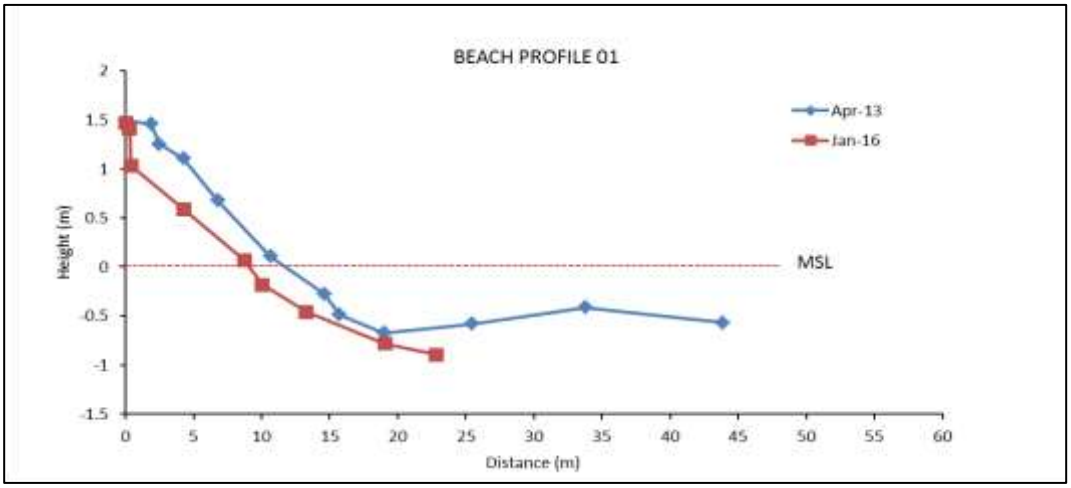

Figure 15: Beach profiles compared 2013 and 2016 (IEE field survey) on the north end of the beach (see Appendix 5:Beach profile)

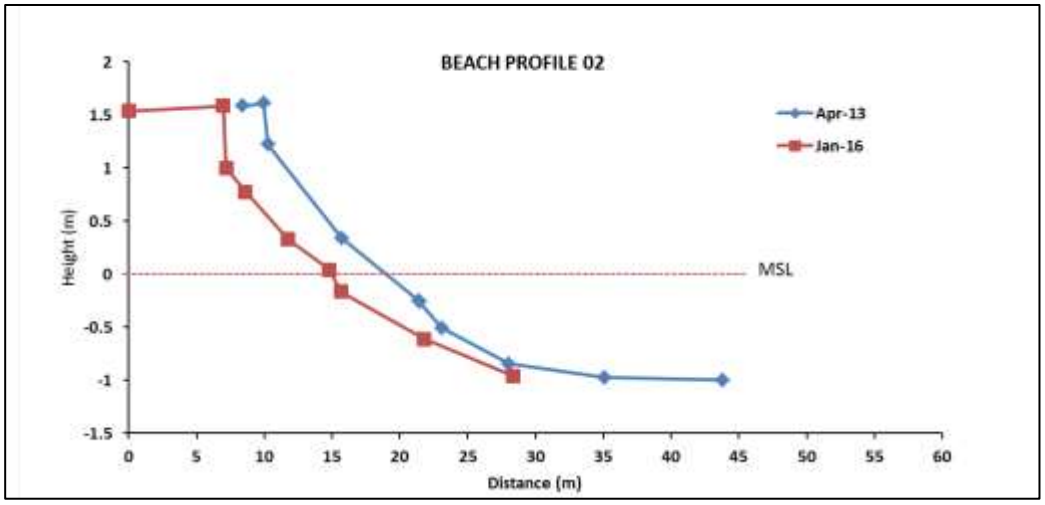

Figure 16: Beach profiles compared 2013 and 2016 (IEE field survey) on the north end of the beach (see Appendix 5:Beach profile)

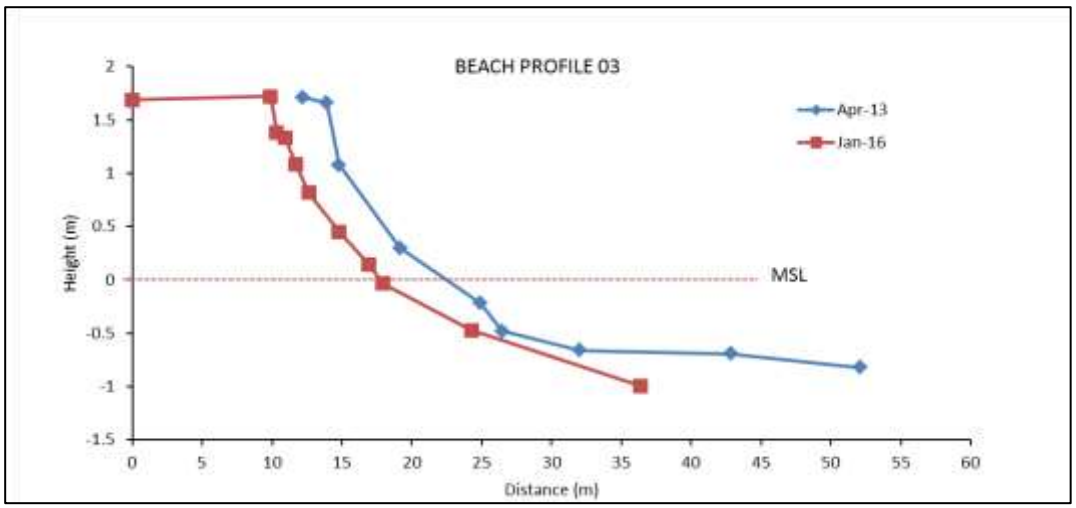

Figure 17: Beach profiles compared 2013 and 2016 (IEE field survey) on the north extent of beach (see Appendix 5:Beach profile)

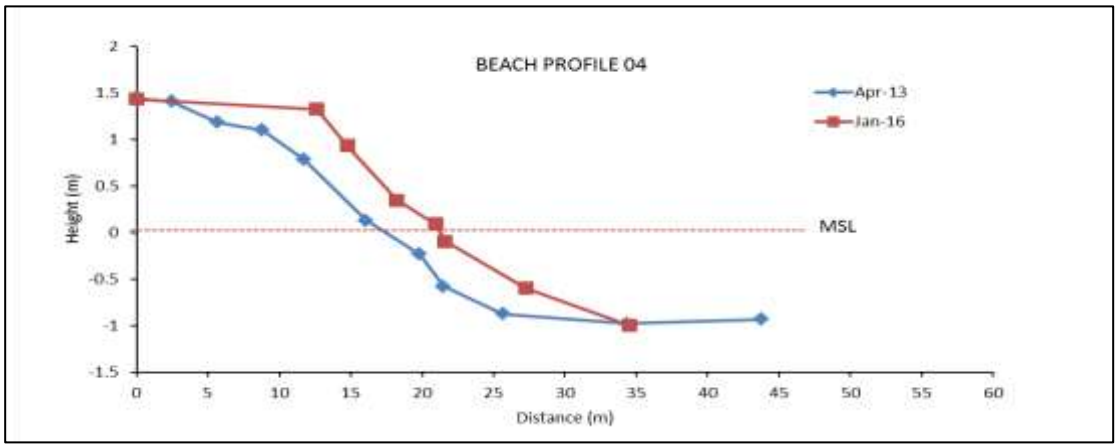

Figure 18: Beach profiles compared 2013 and 2016 (IEE field survey) on central part of beach (see Appendix 5: Beach profile)

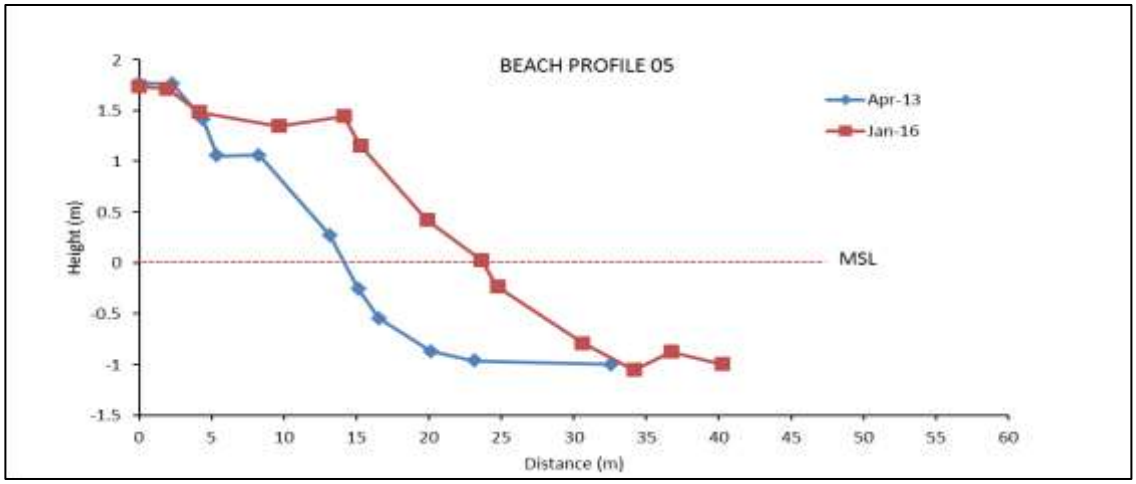

Figure 19: Beach profiles compared 2013 and 2016 (IEE field survey) on south-central part of beach (see Appendix 5: Beach profile)

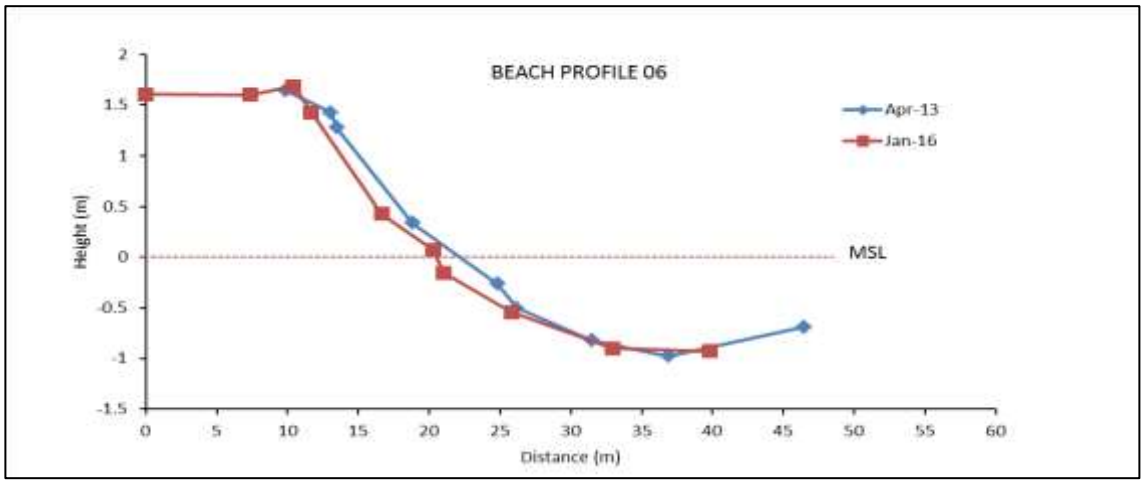

Figure 20: Beach profiles compared 2013 and 2016 (IEE field survey) on south of beach (see Appendix 5:Beach profile)

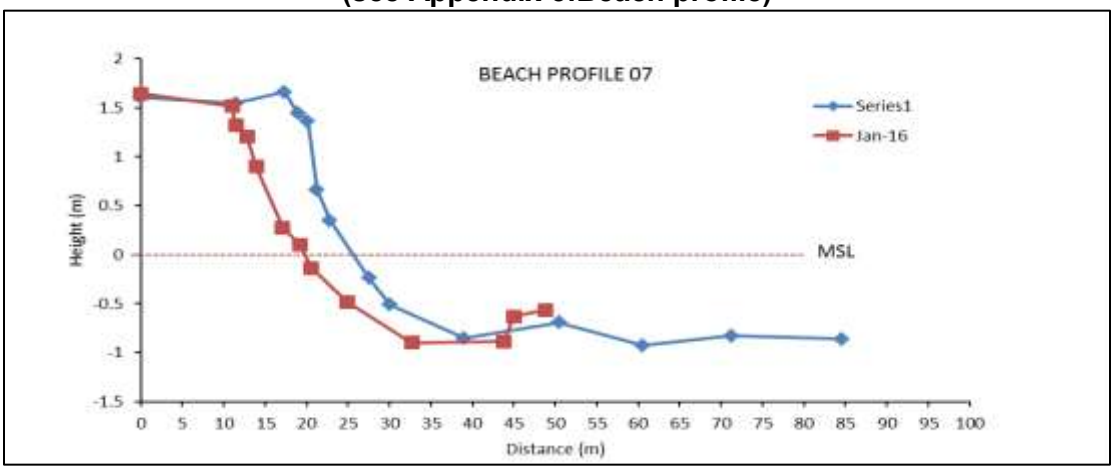

Figure 21: Beach profiles compared 2013 and 2016 (IEE field survey) on south extent of beach (see Appendix 5: Beach profile)

H. Sediment characteristics

115. Natural sediments of Maldives are entirely marine based and calcareous origin since the atolls of Maldives are developed on a oceanic ridge topped 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 or 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.

116. 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.

117. Sediment samples 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 characteristic of sediments samples are given in Table 9. Graphical description of the samples from sieve analysis is given in Appendix (sieve analysis data).

118. Sediments were not sampled or 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 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 a near symetrical 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

I. Coastal features at project site

119. Coastal features at the project site was assessed along the three transect 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 cementing of this area through wave breaking continuously in this portion of reef. Wave energy during filed 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.

120. 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 the reef slope the sea bottom is sandy.

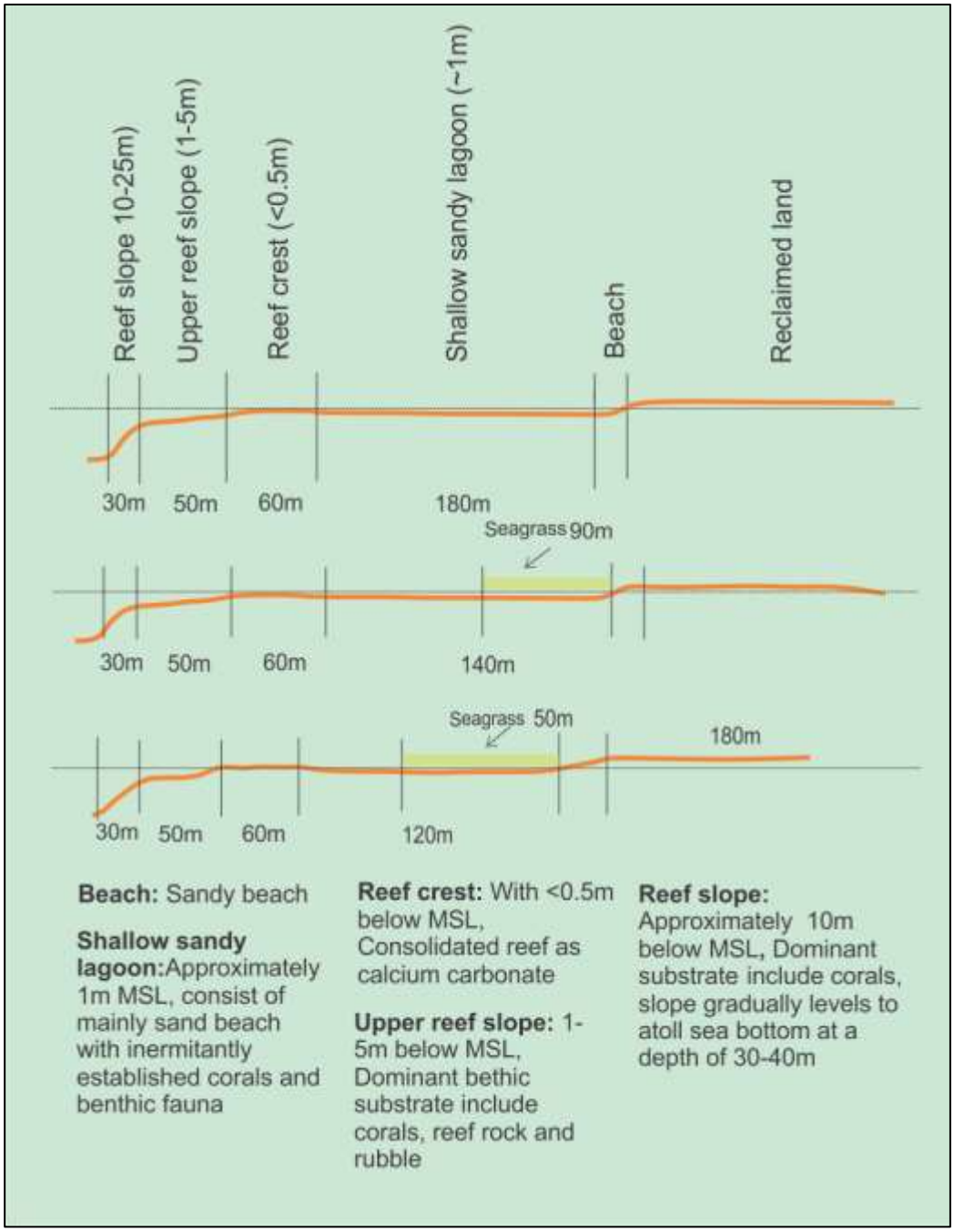

Figure 22: Three transects showing general characteristic of the sea bottom showing all major and significant features

J. Flora and Fauna

121. Assessment of flora and fauna focuses only on the marine environment and not terrestrial 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 has experienced recent and significant disturbance due to excavation and reclamation works which were completed in 2010 while R2 represents an

undisturbed reef site located some 500m north of the recently disturbed area also referred as the control site. Qualitative assessment of adjacent lagoon which is dominated by sea grass was also carried out.

1. Corals in Survey Site R1 (Disturbed site)

122. 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 depth 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%.

123. 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) corals groups such as acropora and pocillopora (less than 20%)

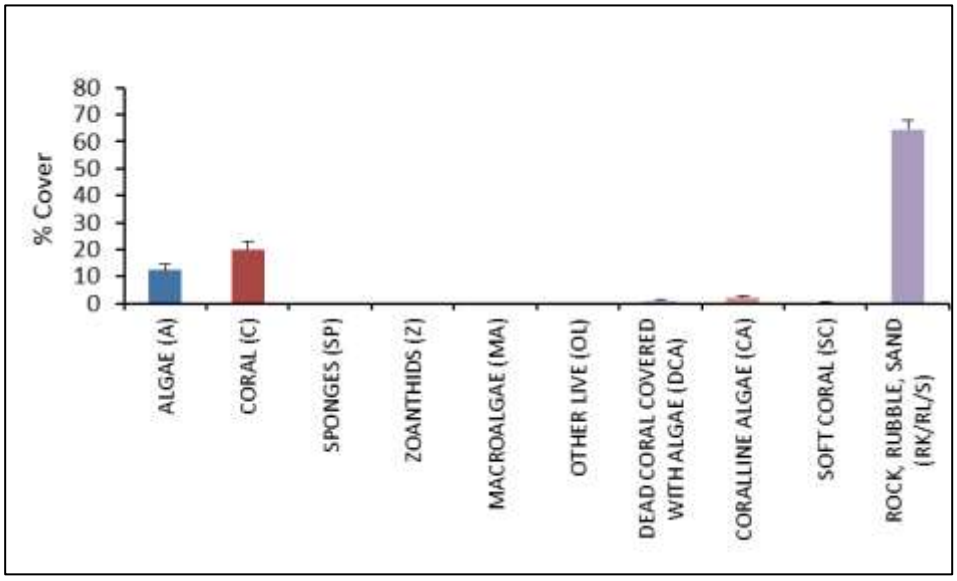

Figure 23: Reef benthic community structure at the upper reef slope (5m) at baseline survey location R1. Values are mean (n = 40), error bars are standard error (SE) of mean

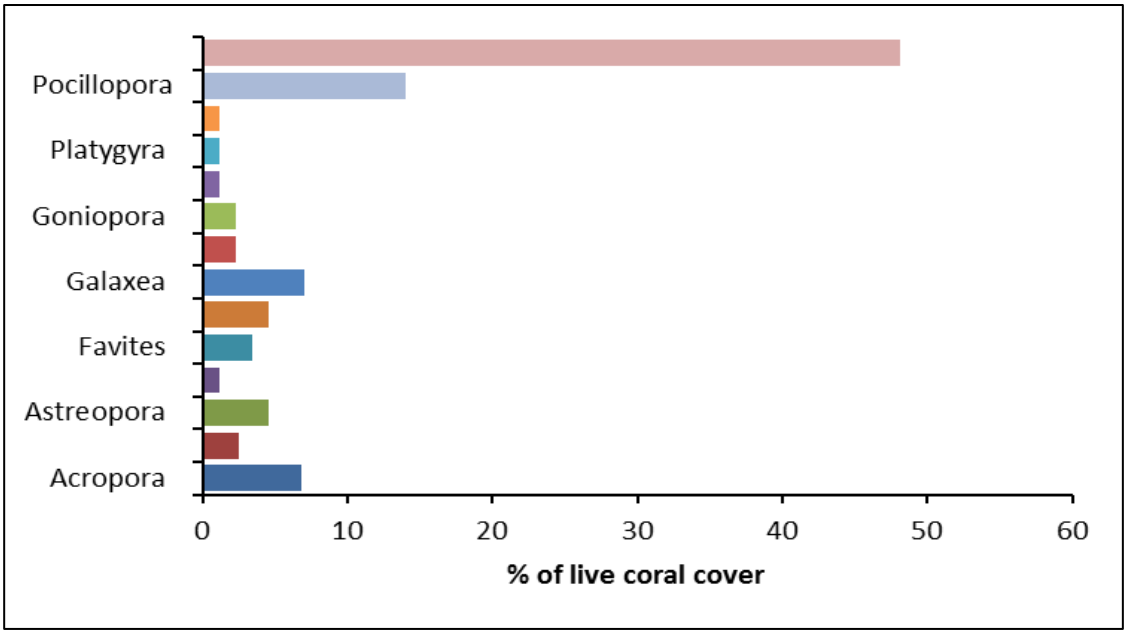

Figure 24: Coral genera (diversity) at R1 5m

124. 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,

125. 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.

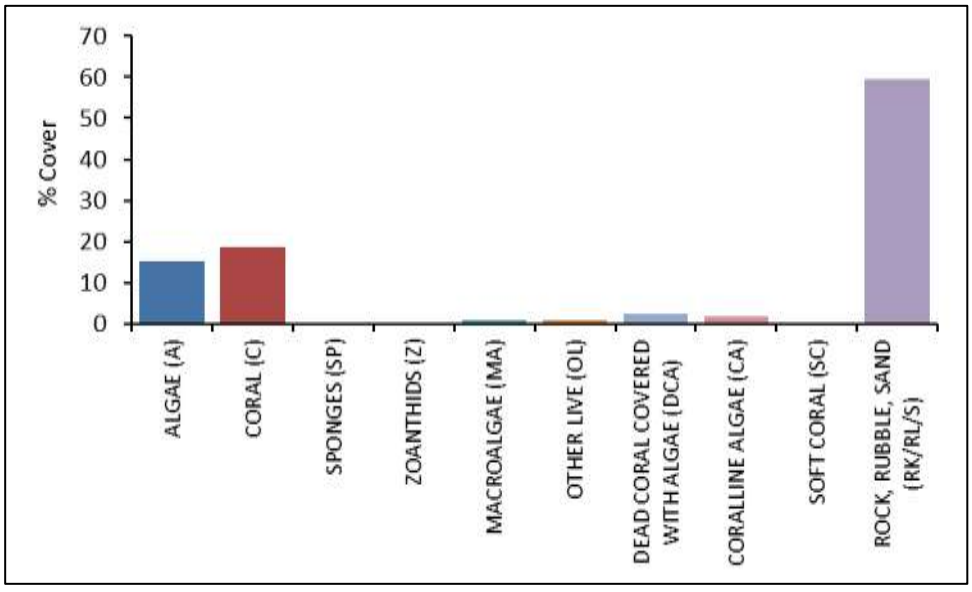

Figure 25: Reef benthic community structure at the reef slope (10m) at baseline survey location R1. Values are mean (n = 40), error bars are standard error (SE) of mean

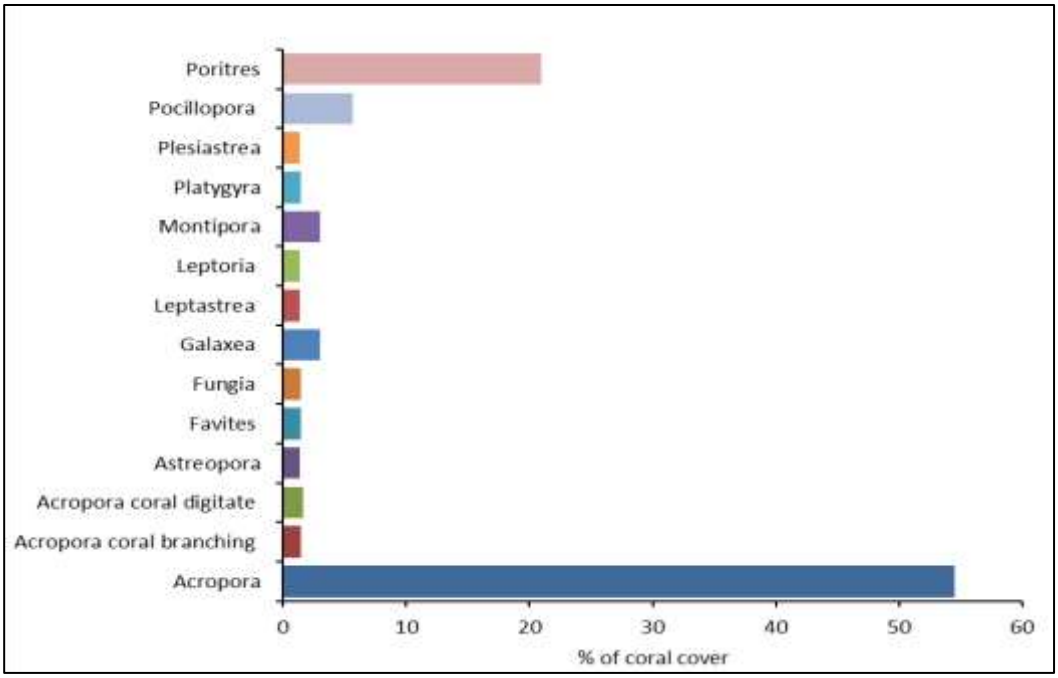

Figure 26: Coral genera (diversity) at R1 10m

2. Corals in Survey Site R2 (Control site)

126. This site was chosen a control site to compare with potential residual impact from dredging activities that may effect benthic coral community. At 5m coral cover 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

127. 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) corals groups such as acropora and pocillopora (over 35%). Among acroporids, table shape acroporid (*Acopora hyacinthus*) accounted for 15% of live coral cover.

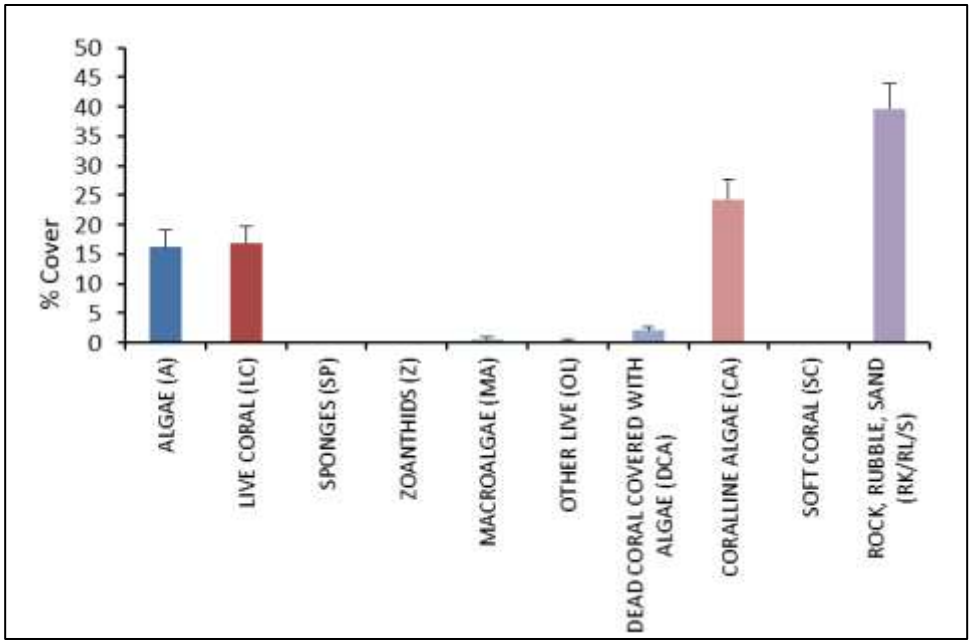

Figure 27: Reef benthic community structure at the upper reef slope (5m) at baseline survey location R2. Values are mean (n = 40), error bars are standard error (SE) of mean

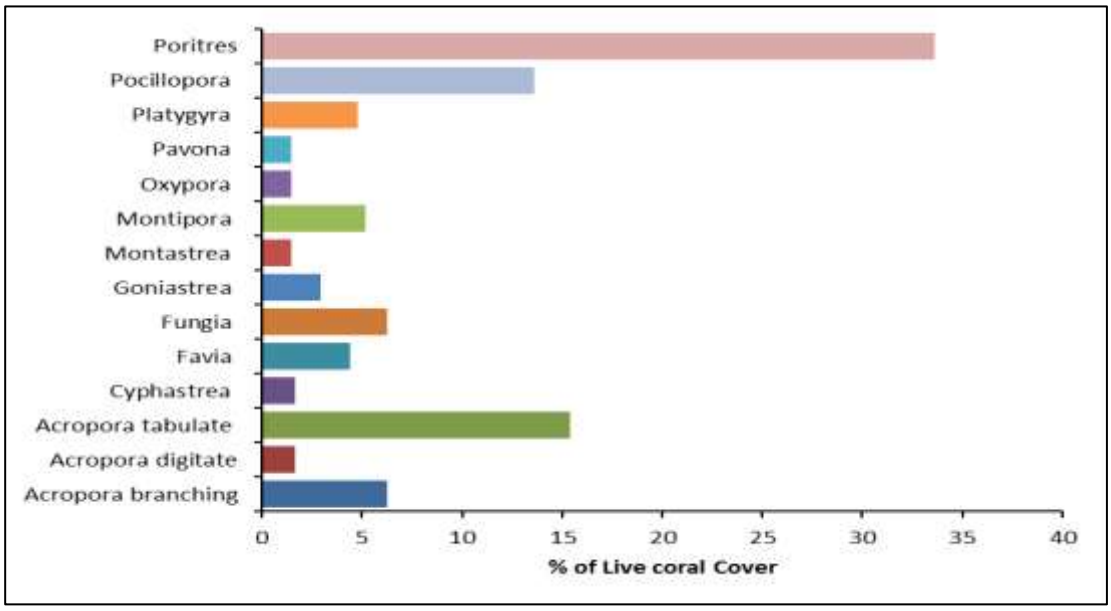

Figure 28: Coral genera encountered at 5m depth at baseline survey location R2, as percentage of total coral cover

128. 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 depth surveyed including coral cover,

129. At 10m depth at survey location R2 only 9 coral general was encountered which is 14% of the total generic diversity of corals. (Figure 30). 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.

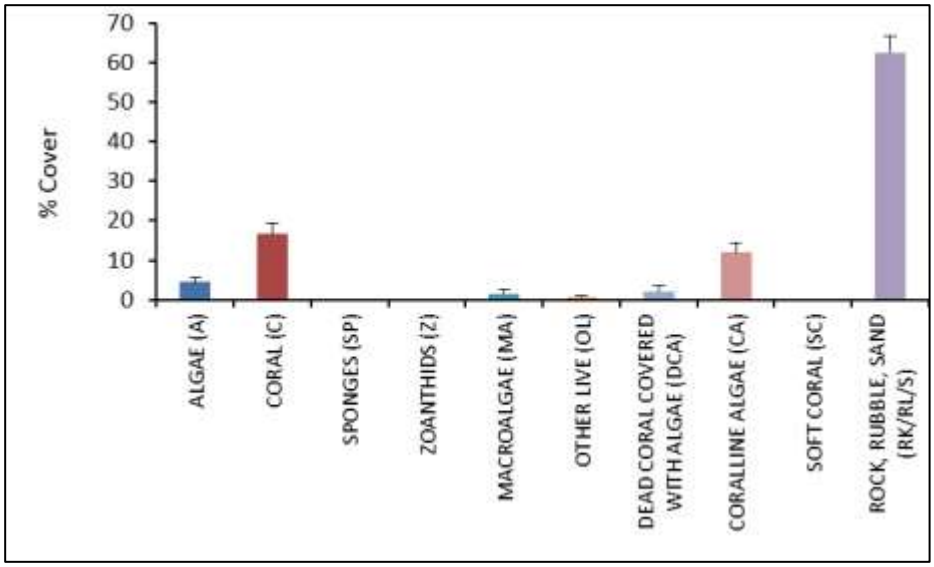

Figure 29: Reef benthic community structure at the reef slope (10m) at baseline survey location R2. Values are mean (n = 40), error bars are standard error (SE) of mean

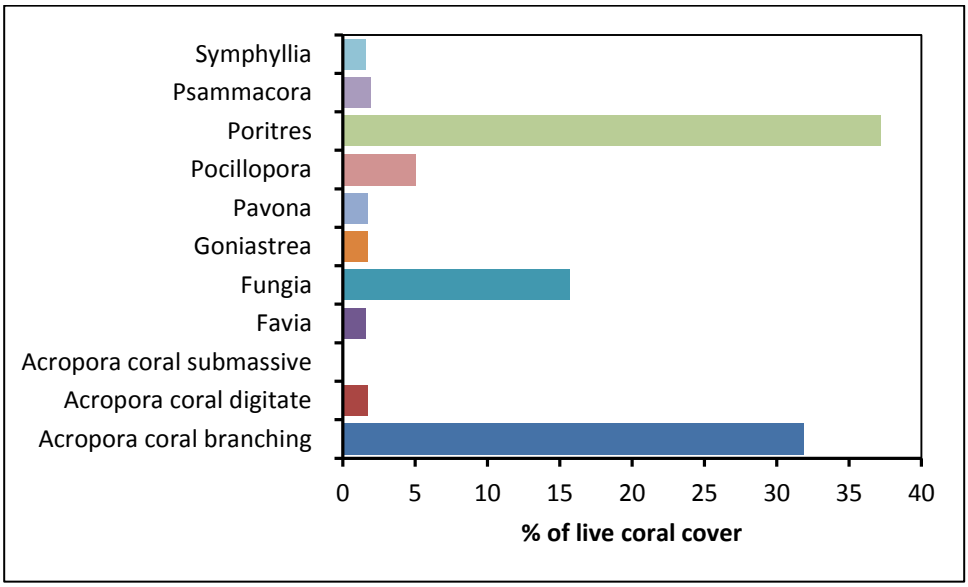

Figure 30: Coral genera encountered at 10m depth at baseline survey location R2, as percentage of total coral cover

130. A maximum of only 20% of the coral genera diversity for Maldives was recorded in the project site (R2). The number of coral species recorded in the Maldives is 230 (Picheon and Benzoni, 2007). It is estimated that number of coral species at the reef sites would be less than 30 or only 13% of what is found in the Maldives. No IUCN listed critically endangered (CE) or endangered (EN) coral species were encountered within the survey area.

3. Sea grass community

131. 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, not yet assessed by IUCN), *Holdule uninervis* (common, not yet assessed by IUCN) *Cymodocea rotundata* (common, IUCN category: LC) and *Syringodium isoetifolium* (occasional, IUCN category: LC) in their establishment. Photographic representation of sea grass meadow is given in Appendix 6.

4. Fish community

132. 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 to establish baseline data on fish community for the required environmental monitoring of these sites during construction and operation phase. Table 10 show abundance of major trophic groups of fish and other fauna at all survey sites combined.

133. Commercially important food fishes present at both sites include, *Aphareous viridiscence Lutjanus gibbus Lutjanus bohar Lutjanus kashmera 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)	IUCN status
Herbivores					
Acanthuridae	*Naso brevirostris*	Browsers	C	L1, L2	LC
	Acanthurus leucosternon	Grazers/detrivores	C	L1, L2	LC
	Acanthurus lineatus	Grazers/ detrivores	A	L1, L2	LC
	Acanthurus dussumieri	Grazers/ detrivores	C	L1, L2	LC
	Naso lituratus	Browsers	C	L1, L2	LC
	Naso hexacanthus	Browsers	C	L1, L2	LC
	Zebrasoma scopas	Grazers/ detrivores	R	L1, L2	LC
Pomacentridae	*Chromis viridis*	Grazers	A	L1, L2	Not assessed
	C. atripectoralis	Grazers	C	L1, L2	Not assessed
	C. ternatensis	Grazers	C	L1, L2	Not assessed
	Dascyllus aruanus		C	L1, L2	Not assessed
Pomacanthidae	*Centropyge multispinis*	Grazers/ detrivores	R	L1, L2	LC
	P. xanthometopon	Grazers/ detrivores	R	L1, L2	Not assessed
	Pygoplites diacanthus	Grazers/ detrivores	C	L1, L2	LC
	Aolemichthys xanthurus	Grazers/ detrivores	R	L1, L2	Not assessed
Chaetodontidae	*Chaetodon collare*	Browsers	C	S1	LC
	Chaetodon trifascialis	Browsers	R	L1, L2	NT
	Chaetodon melannotus	Browsers	C	L1, L2	LC
	Chaetodon guttatissimus	Browsers	C	L1, L2	LC
	Chaetodon kleinii	Browsers	C	L1, L2	LC
	Forcipiger longirostris	Browsers	C	L1, L2	LC
Labridae	*Cetoscarus bicolor*	Browsers	C	L1, L2	LC
	Hipposcarus hairid	Browsers	C	L1	Not assessed
	Scarus festivus	Scrapers/excavator	C	L1	LC
Balistidae					
	Odonus niger	Grazers/ detrivores	C	L1, L2	Not assessed
	Melichthys indicus	Grazers/ detrivores	C	L1, L2	Not assessed
Carnivores					
Lutjanidae	*Aphareous viridiscence*	Predator	(O)		Not assessed
	Lutjanus gibbus	Predator	(C)	L1, L2	Not assessed
	Lutjanus bohar	Predator	(O)	L1, L2	Not assessed

Family	Species	Functional group	Abundance	Presence (location)	IUCN status
	Lutjanus kashmera	Predator	(A)	L1, L2	Not assessed
	Lutjanus monostigma	Predator	C	L1, L2	Not assessed
Lethrinidae	*Gnathodentex aurolineatus*	Predator	(A)	L1, L2	Not assessed
	Monotaxis grandoculis	Predator	C	L1, L2	Not assessed
Bait species					
Bpadhi					
Caesionidae	*Caesio sp*		A	L1, L2	Not assessed
	Sprateloides delicatlus		A	L1, L2	Not assessed

Note: C = Common; O = Occasional; A=abundant; CR: Critically endangered; EN: Endangered; VU; Vulnerable LC: Least Concern; CD: Conservation dependent; NT: Near threatened;

5. Other Fauna

134. Of the 5 species of sea turtles that are reported to occur in the Maldives only a hawksbill turtle was seen once 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. Other fauna species found were the Black sea cucumber (*Actinopyga miliaris*) and Impatient sea cucumber (*Holothuria impatiens*).

135. The following table (Table 11) lists the faunal species other than fishes that were seen in the project area during field surveys.

Table 11: Faunal species in the Project area

No.	Common name (Species)	Locally protected	IUCN Red List category
1	Hawksbill turtle (*Eretmochelys imbricate)*	Yes	CR
2	Spiny lobster *(Penulirus versicolor)*	No	LC
3	Maxima clam *(Tridacna maxima)*	No	CD
4	Fluted giant clam (*Tridacna scuamosa)*	No	CD
5	Black sea cucumber (*Actinopyga miliaris*)	No	VU
6	Impatient sea cucumber (*Holothuria impatiens*)	No	Data Deficient

CR: Critically endangered; EN: Endangered; VU; Vulnerable LC: Least Concern; CD: Conservation Dependent; NT: Near threatened;

6. Conclusion on habitat type

136. The project site has corals and sea grass which are remnants of a larger area which had undergone significant disturbance and change under the land reclamation project which was completed in 2010, about 5 years ago. The surveys found a large number of fishes, one turtle, some clams and sea cucumber. Of all the species it is only the hawksbill turtle which is critically endangered under IUCN. The lone hawksbill turtle was spotted on the reef slope in the control site R2 (north of the project site). With this sighting together with the fact that the project direct impact area is highly disturbed it is highly likely that the hawksbill turtle if at all comes near the project area will go only to the reef slope which is beyond the project construction zone.

137. The SPS designates habitat types into “modified”, “natural” or “critical”. It is clear that the project area does not comprise “critical habitat” as the field surveys found only one critically

endangered species once on the reef slope in the control site (R2). The project site does not fall inside a protected area nor are there any protected areas near the project site. The highly disturbed conditions of the remaining corals, sea grass evidenced by minimal or negligible visits from fishes and turtles shows that the primary ecological functions of the corals and sea grass in the project site have been lost. Hence the project area cannot be classified as “natural habitat” either. Therefore it is concluded that the habitat type in the project area is “modified habitat”.

7. Seawater quality

138. 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.

139. 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 of the impact area for a prolonged period.

140. 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 outside (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

K. Social Economic environment

1. Demography

141. According to National Census 2014 by National Bureau of Statistics the population of Kulhudhuffushi is 8,224 of which 3712 males and 4299 females (excluding expatriate immigrants). Based on 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).

142. 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.

2. Access to social services and Amenities

143. **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 Affeudheen 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.

144. 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.

145. **Electricity:** Electricity is provided to the island by government owned company, Fenaka Corporation Pvt. Ltd. Electricity is provided for 24 hours. The quality of the 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.

146. **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 was waste including food and plant litter are usually burnt in open. Other waste 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 is 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..

147. **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.

148. 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 all people of the working population have a mobile phone. Meanwhile, internet services are provided by Dhiraagu and Infocom Private Limited.

149. **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.

150. 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.

151. **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 rapid 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.

152. 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.

153. 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. The table below shows the total number of reported cases by selected disease in Kulhudhuffushi in 2012.

VI. STAKEHOLDER CONSULTATION

A. Scoping under EPA requirements

154. 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 Terms of Reference for preparation of EIA was submitted to EPA along with scoping application form.

155. EIA scoping meeting was held on 27th of December with representatives of various stakeholder of the project. This included representatives of 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.

B. Meeting with MHI and concept design team

156. IEE consultant was member of the concept design team. Hence throughout the concept design at various stages of design related consultations and discussion the 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

C. Meetings with local stakeholder

157. 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 were consulted. 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.

D. Meetings with Public (Kulhuduffushi)

158. IEE 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.

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

160. The people who attended the meeting were briefed how the IEE 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. IEE 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 IEE report. As part of IEE, 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 IEE report.

161. 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 14)

Table 14: 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 incorporated into the design? They were concerned that enough means of circulation to clear the harbor may not be given.	Already considered in the concept design and details of the circulation and flushing related 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 boats 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.	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 1.4 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 been considered.

Concern	Response/Action taken/Recommendation
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 is 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 to this.
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	

E. Finding of stakeholder consultations

162. 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 Ports Limited is not being operated to its full capacity.

163. 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.

164. 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.

165. 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.

VII. ENVIRONMENTAL IMPACTS

A. Impact Identification

166. 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.

167. 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 15.

Table 15: 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

168. 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.

169. 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.

170. 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.

171. 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.

B. Limitation or uncertainty of impact prediction

172. Uncertainty of impact prediction are mainly due to the lack of long term data (shoreline, local currents and wave climate), inherent complexity of ecosystem (reef 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.

173. 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. The 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).

C. Impact Analysis

174. An analysis of the impacts due to the project was done using the Leopold matrix (Table 16). Magnitude and importance of an impact is given a numerical value from 1-10, 1 being the lowest and 10 highest. + signs represent positive impacts and no + sign represents negative impact. No number represents no impact. Importance of impact is judged based on existing environment data, methods used and past experience with similar project. For example on the upper left side of the table the magnitude of impact from dredging on seawater quality during construction is quite high. Therefore a value of 7 has been assigned. Values at the lower right hand side of the table However during operation the health and safety of the people during operation of the harbour and recreational area is expected to be good. Hence a value of +10 has been assigned.

175. The matrix shows 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 habitats and water quality impacts aspects are direct and indirect.

176. 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 the shallow lagoon will be modified by dredging for harbor basin and reclamations combined. Though this shallow area has less than 1% coral cover and approximately 2 hectares of sea grass. It is anticipated that most if not all of the 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.

177. 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 organism when regular threshold is disturbed.

178. 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. Furthermore, construction of the harbor facility on the western side of the island also provides protection 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 16: 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	

D. Construction Phase Impacts

179. 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

1. Changes in hydrodynamic pattern

180. 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.

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

181. 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 was present at the meadow dominated by *Thallasia hemprichii.* None of them are IUCN endangered or critically endangered. 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 which exist on the northern and southern ends of the island. Live coral cover within the impact area was estimated to be approximately 1%. Therefore impact on live coral will be insignificant.

182. Impact of habitat loss is irreversible at the basin and entrance location and unavoidable. However, this overall this will not have significant impacts since the habitat type is “modified habitat” according to the ADB SPS as the shallow lagoon area with the corals and sea grass in the project site is already highly disturbed from the land reclamation works that were carried out in 2010. No IUCN endangered or critically endangered species of corals, sea grass, fishes and other marine species are expected to be directly impacted by the project. The Hawksbill turtle a critically endangered species, one of which was sighted once in the control site on the reef slope is not expected to frequent the highly disturbed sea grass and corals in the Project direct impact area.

3. Indirect impact on reef environment due to sedimentation

183. The sediment plume due to the dredging works in 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 impact on seawater quality is anticipated to be moderate as it 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 impact on live coral cover in the area due to sedimentation is also envisaged to be minor. More over this impact will be temporary and limited to the 18 month construction period. Hence, overall indirect impacts are deemed insignificant under the project.

4. Impacts of noise, vibration and other disturbances

184. 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.

5. Impacts on sensitive habitats and protected species

185. 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 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.

186. 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.

6. Socioeconomic impacts

187. 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 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.

7. Occupational health and safety hazards for construction workers and local public

188. Occupational health hazards has 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 ours in loud areas. For workers working in the water environment, they will be provided with safety life jackets. 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.

E. Operational phase Impacts

1. Water quality

189. 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 of vessel loading and unloading, handling, and storage activities. Mitigation measures include the boat operators and Island council (responsible for managing operation of the existing north harbor and project harbour) 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.

190. Currently a key issue with all harbors in the country is the release of waste water and sewage from boats and vessels directly into the water. This results in pollution of water and creation of an unhygienic environment in the harbour and land area adjacent to the harbour especially in the urban and residential areas. This is recurrent issue which needs to be addressed at a national level and is beyond the scope of the project. However, for the project area a separate Capacity Development Technical Assistance support is being provided by ADB along with the project to build the capacity of Kulhudhufusshi Council on harbour operation and maintenance. This will include activities on waste management. With this CDTA it is expected that initiatives will be taken for finding solutions to address the problem of the direct release of waste/sewage water from boats into the sea water.

2. Air quality

191. Dust from operation of vehicle and emissions from boat engines are the likely sources that would impact air quality from the operation of the 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 to increase but the extent of this is difficult to estimate.

192. The maneuvering of boats and handling of cargo from land-based vehicle will result in air emissions from (mainly diesel) engines. Emissions from the 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 dioxide and nitrogen dioxide 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 national air quality standards available as of now harbor management shall give consideration to implementing the MARPOL regulations.

193. 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.

3. Noise

194. 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.

F. Cumulative and Induced Impacts

195. With the existing harbour on the northern part of the project site and the KPL harbour on the southern part the sea water and land adjacent to the respective harbours are already exposed to solid and liquid waste problems associated with the movement of the boats and vessels. Operation of the project harbour will add to the existing issues and induce generation of more waste.

196. All boat operators in the 3 harbours (2 existing plus the one proposed under the project) and the Kulhudhuffushi council responsible for managing operations of the existing north and the project harbour are liable to comply with the National Waste Management Regulation, which prohibits disposal of any oil and solid waste in the sea water. There is a waste collection facility in the island which will be used for disposal of solid waste.

197. As discussed in the earlier section a key issue with all harbors in the country is the release of waste water and sewage from boats and vessels directly into the water. Hence, it is expected that the addition of the new harbour to the existing north harbour and KPL will worsen the quality of the sea water further particularly near the island. However, considering that the natural habitat has already been removed (for the 2 existing harbors) and will be removed for the project harbor it is expected that there will be highly limited species of fauna that will frequent the harbour waters. And considering that the traffic will not very high (currently 150 boats per day plus another 100 boats per day under the project harbour), it is expected that the indirect impacts of pollution on the waters and marine ecology near the harbour water towards the sea will be limited given the huge dilution effect from the large volume of the sea water.

198. A separate Capacity Development Technical Assistance support is being provided by ADB along with the project to build the capacity of Kulhudhufusshi Council on harbour operation

and maintenance. This will include activities on waste management. With this CDTA it is expected that initiatives will be taken for finding solutions to address the problem of the direct release of waste/sewage water from boats into the sea water.

199. In terms of beneficial induced impacts, the harbor expansion project will reduce the burden of existing harbor traffic in the north harbor and also accommodate future requirements. The expansion will enable segregation of harbor activities into. a separate passenger /cargo harbor basin, a recreational activity area and fishing harbor. The project harbor activities will be limited to distribution of imported goods and local produce.

G. Climate Change Risk Assessment

1. Review of Literature on Climate Change Risks specific to Maldives

200. Acording to the International Panel on Climate Change (IPCC), 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 to respond and adapt to climate change impacts. Additionally, these islands are in a special risk of being inundated as sea level rise, land loss and beach erosion continues to increase under a changing climate.

201. The only comprehensive report titled: "***Developing a Disaster Risk Profile for Maldives****",* was developed in May 2006 with assistance from the United Nations Development Programme (UNDP) under a broader disaster risk management programme for Maldives. This detailed risk assessment maps out where risks from multiple hazards are concentrated and who is affected and how. The probability of hazards across different regions of Maldives is based on geological evidence, historical data and projections derived from theoretical analysis.

202. A background paper called: "**National Adaptation to Climate Change",** prepared by the Ministry of Housing, Transport and Environment of the Government of Maldives in March 2009, unequivocally states that Maldives today is faced with unprecedented challenges unwitnessed by previous generations of Maldivians with climate change impacts threatening the very existence of the nation. The nation is recognized as the most vulnerable and least defensible countries to the projected impacts of climate change and associated sea level rise with the extraordinary challenge to make Maldives resilient and adaptable to the impacts of climate change. To understand the vulnerability of Maldives to this challenge, a vulnerability assessment was undertaken in 2001 and was presented in the **First National Communication of the Maldives** to the UNFCCC. Based on the findings of the First National Communication, and at the request of the UNFCCC, the Maldives prepared its **National Adaptation Programme of Action** (NAPA) in 2007.

203. The Maldives 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 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

204. The **Maldives Climate Change Policy Framework** (MCCPF) prescribes the Government and the people of Maldives strategic polices for responding to climate change impacts over the next 10 years (2014–2024).The 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.*

2. Climate Change Considerations for Kulhudhufushi Harbor Expansion Project (KHEP)

205. The coasts 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 processes by which the shores and the 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.

206. Kulhudhufushi is located on the eastern rim of Thiladhunmathi Atoll, at approximately 73° 04' 10"E and 6° 37' 24" N, about 276 km from the nation’s capital Male’ and 19 km from the nearest airport, Hanimaadhoo. (Figure 31). 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, swell waves and *udha* (gravity wave flooding), storm surges, tsunami, earthquakes and climate change.

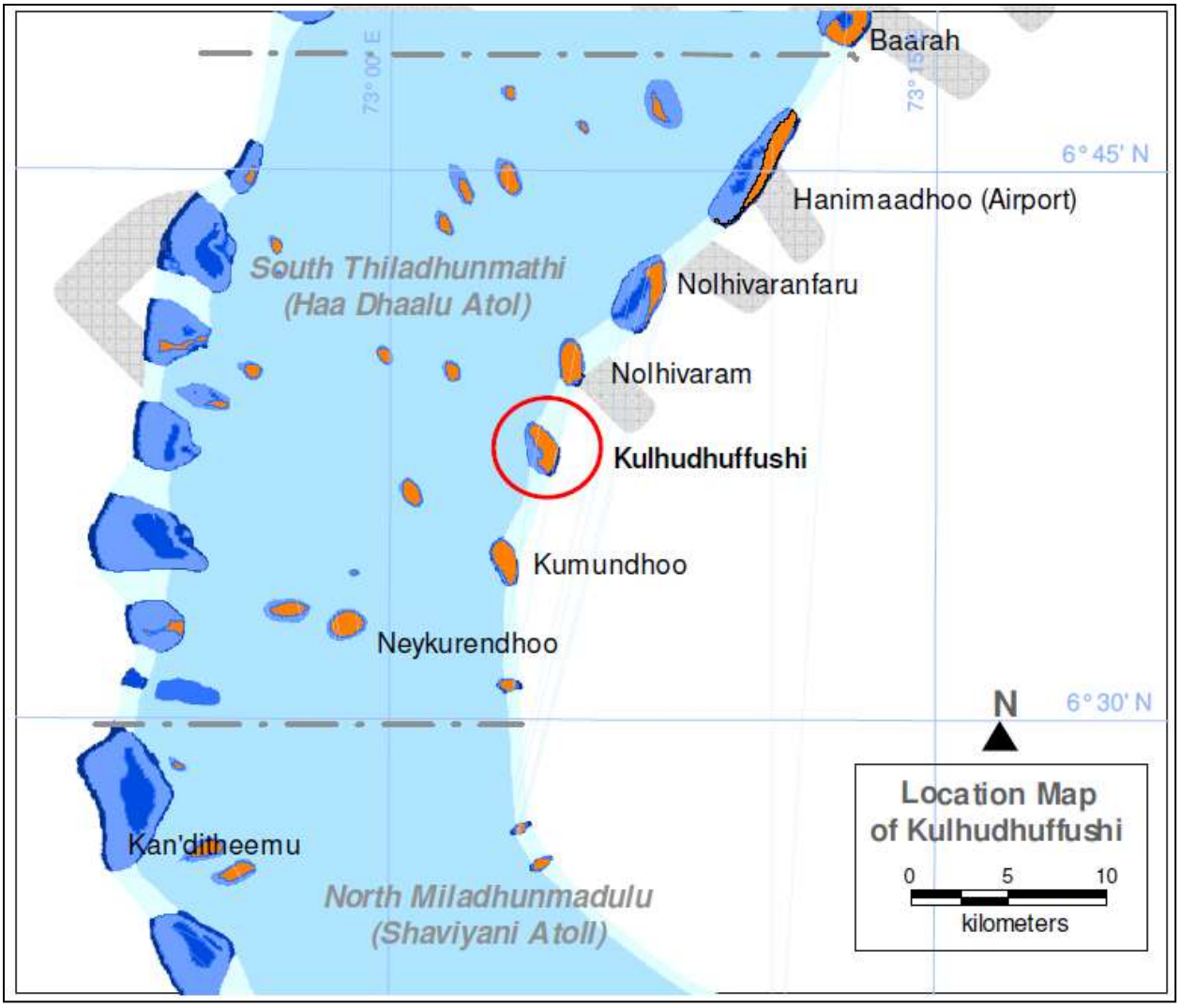

Figure 31: Location of the Project island

207. 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. 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 2006 UNDP disaster risk assessment report.

3. Sea Level Rise

208. 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 gauges and satellites 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.

209. 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).

210. 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 17: HadCM2 SLR Projections

<table>
<tr><th>Model / Methodology</th><th>Projections by Year</th><th>Remarks</th></tr>
<tr><td>Sea level rise projections for Maldives by HadCM2 (HadCM2 is a coupled atmosphere-ocean general circulation model (GCM) developed at the Hadley Centre)</td><td>
<table>
<tr><th>Scenario</th><th>2025</th><th>2050</th><th>2100</th></tr>
<tr><td>HadCM2 (IS92a – medium emission scenario)</td><td>9.3 cm</td><td>19.9 cm</td><td>48.9 cm</td></tr>
<tr><td>HadCM2 (IS92e – high emission scenario)</td><td>19.7 cm</td><td>39.7 cm</td><td>94.1 cm</td></tr>
</table>
</td><td>
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
</td></tr>
</table>

211. 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.

4. Tropical Cyclonic Winds

212. 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).

213. 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.

214. Maldives is also affected by severe local storms- thunder storms/ thunder squalls. Hazards associated with thunder storms 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, thunder storms close to the equator are less violent when compared with those in the tropical regions and beyond. Maldives being close to the equator, thunder storms 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.

215. 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 32.

216. 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). Figure 33 shows the return periods for various categories cyclones.

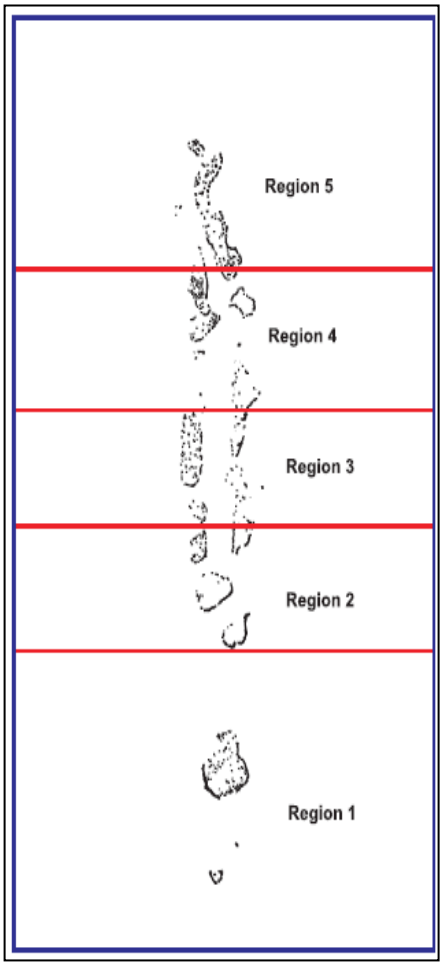

Figure 32: Cyclone Hazard Regions

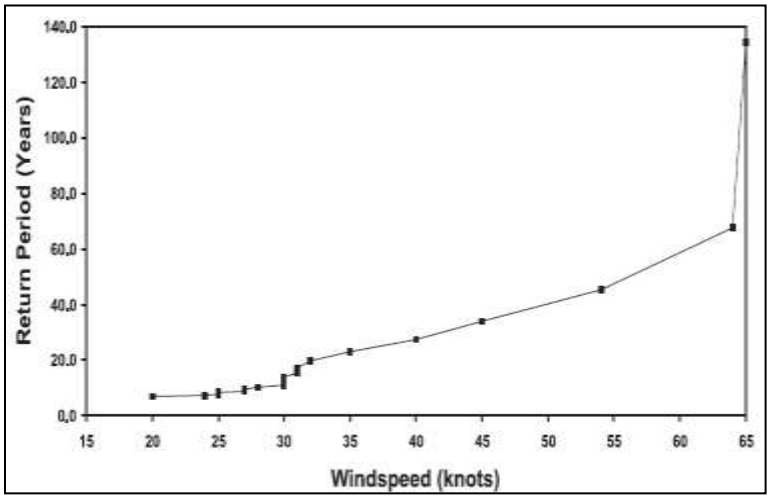

Figure 33: Cyclone Return Periods

217. 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

storm with surface winds having a speed of 65 knots are expected to recur once in 135 years in Maldives. (Note: 1 knot = 1.852 km/hr)

218. The probable maximum wind speed (PMWS) estimated for Maldives by cyclone hazard zoning as shown in Figure 32 is reproduced below in Table 18. The harbor expansion project of Kulhudhufushi island falls in Zone 5.

Table 18: 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

219. 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 however, due to incomplete data, hazard zones have not been drawn for the local storms.

5. Storm Surges

220. 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 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 Maldives islands is shown in Table 19. (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 19: Estimates of Storm Tide

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
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

6. Probable Maximum Precipitation (PMP)

221. 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 20 below.

Table 20: 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

7. Adaptation Considerations in the Design of Coastal Defense Structures

222. 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 aim to reduce future risks, reactive if they alleviate impacts once they have occurred.

223. Planning and designing for adaptation in a coastal environment is a complicated matter that requires 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 a sufficient amount 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 very perplexing.

224. 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 medium emissions scenario for SLR by the 2006 UNDP report which bears semblance with IPCC projections has been appropriately used in the preliminary design report understanding that 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.

225. Taking the recommendations of the "Safe Shelters Design Guide[1]", a design life appropriate for small craft facility which is 30 years has been adopted. A design return period of 50-years follows a modelling of a 50-year probability wave and a storm wave in 1987, coupled

[1] Oriental Consultants, 2012, Developing guideline and database for the life-cycle management system of "vessel safe shelters" in the Maldives, final technical standard and design manual, Ministry of Housing and Infrastructure (Safe Shelters Design Guide)

with a high tidal level, an output of a shore protection study[2] conducted by JICA in 1992. The design incorporates a sea level rise of 0.2 m which is consistent with HadCM2 (IS92a – medium emission scenario) by 2050 and that of IPCC's projected 400 mm SLR over the next 100-years.

226. 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". Most climate change literature assume that it is likely under a changed future climate, where frequencies and intensities of extremes are likely to increase, that a 1 in a 50 year event could become a 1 in 20 or so year event in the future and in such a case the sizing of any structure is achieved by doubling the return periods to account for climate change rather than using a lower recurrence period.

227. 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. A one-off adaptation measure undertaken just once for coastal structure design to deal with long-term (which is uncertain) is probably not sensible.

8. Adaptation Measures in the Design of the Project Harbor

228. In light of the above analysis and given the small project scope and short design life of only 25 years, of the risks identified, only the risk of sea level rise by 20cm was found to be relevant and applicable to the project. Accordingly the height of the breakwater was raised by 20cm. The estimated additional cost for this is $53,000 amounting to 0.65% of the total civil works cost of $8.11 million. Further adaptive maintenance management or incremental adaptation has been recommended to be implemented over successive short timescales (say every 5-10 years or so). This approach has the advantage to manage climate change uncertainty iteratively, based on gradually increasingly reliable climate change data whilst reducing the risk to commit to highly expensive investment which could tune out to be inadequate and jeopardize the economic viability of the project.

H. Green House Gas (GHG) Emissions GHG

229. 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 CO2 is the largest contributer to GHGs 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, CO2 per capita emmissions 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 increasing. Although per capita CO_2 emmissions are relatively high the country's contribution to GHG emissions as proportion of global emmissions is minimal.

230. 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 CO2e by 2020 (UNDP Risø Centre and Ministry of

[2] JICA Main Report Japan International Cooperation Agency, 1992, The Development Study on the Seawall Construction Project for Male Island in the Republic of Maldives, Main Report 1 (JICA 1992 Main Report)

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.

231. 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 34 shows the share of each sector in national GHG emissions.

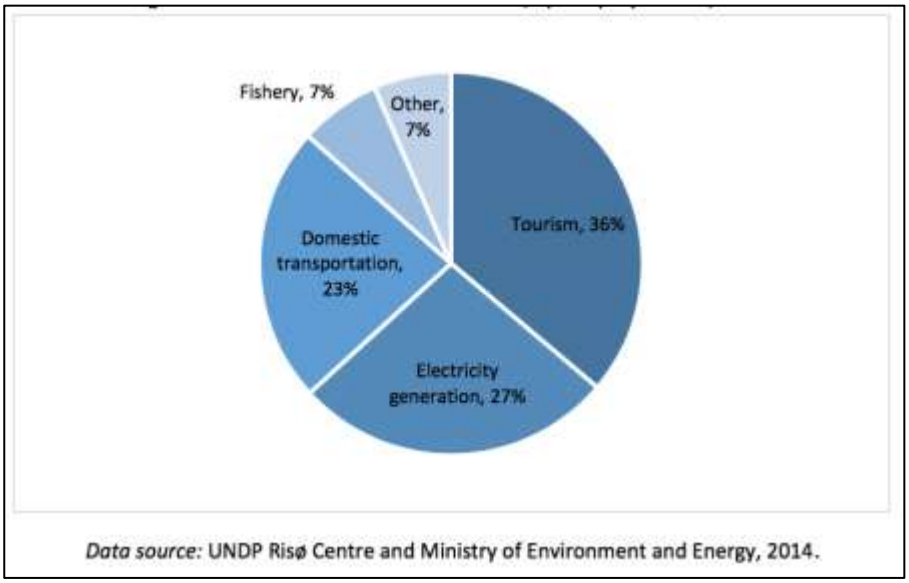

Figure 34: GHG emission by sector

232. For the Kulhuduffushi Maritime Transport Project, CO_2 as primary component of GHG emmission as a conservative estimate was calculated based on available data. The following varailable was 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)

233. The following table (Table 21) provides figures used for the calculation.

Table 21: Attributes used for emissions calculation for maritime transport vessels at Kulhuduffuashi

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

234. Based on the data it is conservatively estimated that 12074 vessels will emmit 141, 131 tonnes of CO_2e. Emmission 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. Based on this figure it can be safely assumed that the emissions with the additional traffic during the design life of the expanded harbour, will be far lower than 100,000 tons of CO_2e per annum. Thus further requirements for detailed quantification and monitoring as required by the ADB SPS is not triggered.

235. 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 reduce GHG emmisions through Intended Nationaly Determined Contribution (INDC) officlaly communicated with UNFCCC in 2015. In this regard a 10% reduction for GHG emmision by 2030 as Bussiness as Usual (BAU) has been pledged. This pledge and 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 energy requirement met by import of fossile fuel this is highly challenging. Energy from renewable sources are mainly from solar energy amounting to less than 0.2 %. Primary area of emisson reduction focuses 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 GHG emissions can assist reduction in GHG emissions in this sector.

VIII. ALTERNATIVES

236. When Alternatives proposed for harbor expansion works are considered there are 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 looks at the said aspects of the project as alternatives that have been considered with respect to the proposed design. Based on these alternative and their impact consideration from environmental and economic perspective the preferred options are discussed.

A. Considered alternatives

1. Design

Proposed design: See appendix 2

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

2. Location of harbor and other civil structure

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.

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 to this move entrance channel to north corner or center of the outer extent of harbor.

4. Construction materials and methods

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

5. Method of dredging and reclamation

Proposed methods: The proposed method dredging is by using excavators

Alternative : Cutter suction dredger

B. Considered options

1. Design

237. Proposed design is preferred in the absence of an alternative. It 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 the rational

associated with expansion. It can also be justified in terms of finance available for this expansion works.

2. Location of harbor and entrance channel

238. 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 existing harbor alternative option is 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.

3. Materials and methods

239. 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.

240. 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 fro the proposed harbor expansion. Due to the proximity of the two proposed area 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 a dredger instead of a dredger.

C. The no-project scenario

241. 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.

IX. ENVIRONMENTAL MANAGEMENT PLAN

242. An environmental management plan is an implementation plan that consists of mitigation measures, monitoring program and institutional setup to be adapted 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.

A. Mitigation measures: Construction Phase

243. 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 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.

244. **Dredging, reclamation and construction of breakwater:** Dredging of the harbor basin will would generate sandy material of varying size, causing disturbance to the bottom sediments, impacts on the 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 dredge 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 will 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 occur 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.

B. Mitigation measures: Operation Phase

245. Harbor expansion works aims 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 handles 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. This 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 the wastewater during the berthing period since there is no local regulation prohibiting such actions.

246. The following table (Table 22) provide environmental mitigation measures for all relevant components identified that may have an impact on either natural or socio economic environment. It was provided 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

Potential Impacts	Mitigation measures	Location	Impact intensity	Implementing agency	Supervising agency	Estimated cost (USD)
1. Detailed design and Pre-construction stage						
1.1 Non compliances due to lack of clearances and permits	Secure the environmental clearance before the start of any civil works Secure all other permits and no objections that may be necessary for construction works	N/A	High	PMU	MOHI	Covered by MOHI
1.2 Inadequate EMP	Review the EMP and revise it based on the detailed design as necessary for approval by the PMU.	N/A	Moderate	PMC	PMU	Covered under PMC costs
1.3 Poor environment safeguards planning and implementation documents	Prepare the following plans for review and approval by the PMC and before the start of the respective works: - Construction camp layout and management plan - Dredge management plan - Spoil disposal plan - Emergency management plan	N/A	Moderate	Contractor	PMC	Covered under Contractors costs
2. Construction stage						
2.1 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	Minor to moderate, short term impact	Contractor	PMU, PMC	N/A (no additional cost)

Potential Impacts	Mitigation measures	Location	Impact intensity	Implementing agency	Supervising agency	Estimated cost (USD)
	During works 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	Minor	Contractor	PMU, PMC	Included in the initial cost of project
2.2 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	Minor, short term impact	Contractor	PMC, PMU	N/A
	Remaining material and machinery demobilized after completion of dredging works Reclamation and dredging operational area be limited to bare minimum so that the impacted zone is minimal,	On land	Minor	Contractor	PMC, PMU	N/A (may cost more for the material unloading process)
2.3 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 Install silt screens and of bund wall around the dredging area to confine sediments within the construction site Limit dredging and reclamation works mostly to day time and where possible to low tide. Working at low tide will ensure fine	Lagoon	Major to moderate, short term impact	Contractor	PMC, PMU	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

Potential Impacts	Mitigation measures	Location	Impact intensity	Implementing agency	Supervising agency	Estimated cost (USD)
	sediments are not readily washed off to residual impact areas,					
2.4 Physical damage to marine flora and fauna	Avoid operation of heavy machinery out of construction area or boundary Prohibit workers from harvesting/fishing or intentially harming any marine flora or fauna and penalize them if anyone carries out any of these prohibited activities	Lagoon / reef	Minor to moderate	Contractor	PMC. PMU	N/A
2.5 Seawater contamination,	Oil /chemical handling and management procedures will be made known to all relevant staff, appropriate supervision, Take precaution to avoid spillage or leakage of diesel, oils and lubes from construction vehicles. Conduct maintenance of these vehicles only at designated areas and surfaces in the construction yard and not inside the water Spills / leaks, if any, will be recovered and disposed according to local standards. Locate worker camps within the reclaimed land and away from the beach area	Reef flat area/ lagoon	Moderate impact	Contractor	PMC, PMU	N/A (included in the initial project cost)

Potential Impacts	Mitigation measures	Location	Impact intensity	Implementing agency	Supervising agency	Estimated cost (USD)
	Equip camps with necessary facilities / amenities such as water supply, power supply, wastewater collection, solid waste collection and sanitation. Domestic wastes generated from the camps will be disposed at local waste disposal site					
2.6 Air pollution	Heavy machinery used dredging and reclamation works operated Minimized Regularly maintain diesel driven engines of workboats, barges and dredgers and ensure they meet required emission levels for diesel vehicles.	Air	Minor/short termed	Contractor	PMC, PMU	N/A (may increase labor cost)
2.7 Noise pollution	Avoid use of heavy machinery during night hours	At construction site	Minor/short term	Contractor	PMC, PMU	N/A (same as above)
2.8 Poor occupational Health and Safety	Provision of adequate safety gear to workers such as gloves, face masks, ear plugs, boots, life jackets etc. Maintain a fully equipped first aid kit on the construction site and establish proper links with the local medical facility to treat more injuries and sickness Maintain hygienic environment in construction	Construction site	Moderate	Contractor	PMC, PMU	Covered under contractors costs

Potential Impacts	Mitigation measures	Location	Impact intensity	Implementing agency	Supervising agency	Estimated cost (USD)
	camp site by providing proper waste management facilities, clean drinking water and proper toilet facilities Provide proper fencing and signage to ensure public do not enter unsafe areas in and around the construction site					
3.Operation stage						
3.1 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	Minor if proper waste management plans are in place	Harbor management unit	EPA, Kulhudhuffushi Council	N/A (included in the initial project cost)
3.2 Release of liquid waste from boats into the harbor	Encourage boat passengers to use the toilet facilities in the Harbor terminal Explore technical solutions with the boat to have liquid waste storage systems to be disposed on land	Harbor	Moderate	Harbor management unit, Kulhudhuffushi Council CDTA consultant	EPA	

Potential Impacts	Mitigation measures	Location	Impact intensity	Implementing agency	Supervising agency	Estimated cost (USD)
3.2 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	Minor/long term	Harbor management Kulhudhuffushi Council	Kulhudhuffushi Council	USD 100-150 (cost of making markers and buoys) N/A (included in the staff training program)
3.3 Air pollution from boat operation	Engine running of the vessels when in harbor is minimized	Air	Minor if properly managed, long term	Harbor management	Kulhudhuffushi Council	N/A

C. Institutional arrangements

247. 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.

248. **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 environmental laws and rules under the Government of Maldives. 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 safeguards related documents such as the IEE 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 agency required for processing of environmental clearance and other environment safeguards 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 safeguards related challenges and significant grievances (during construction stage).

249. **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 the local environment and follows recommendations made in the IEE 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 on the job training for contract workers as needed during project construction.
- Conduct monthly site visits to the construction site.
- Review the test results for testing the 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 the site visit and submit it to the PD for review and approval.
- Based on the monthly reports prepare a consolidated Semi-Annual Safeguards Monitoring reports 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.

- 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 IEE 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.

250. **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.

251. Implementation arrangements for environmental impact mitigation and monitoring to ensure both local and ADB specific environmental safeguards are met are given in Figure 35.

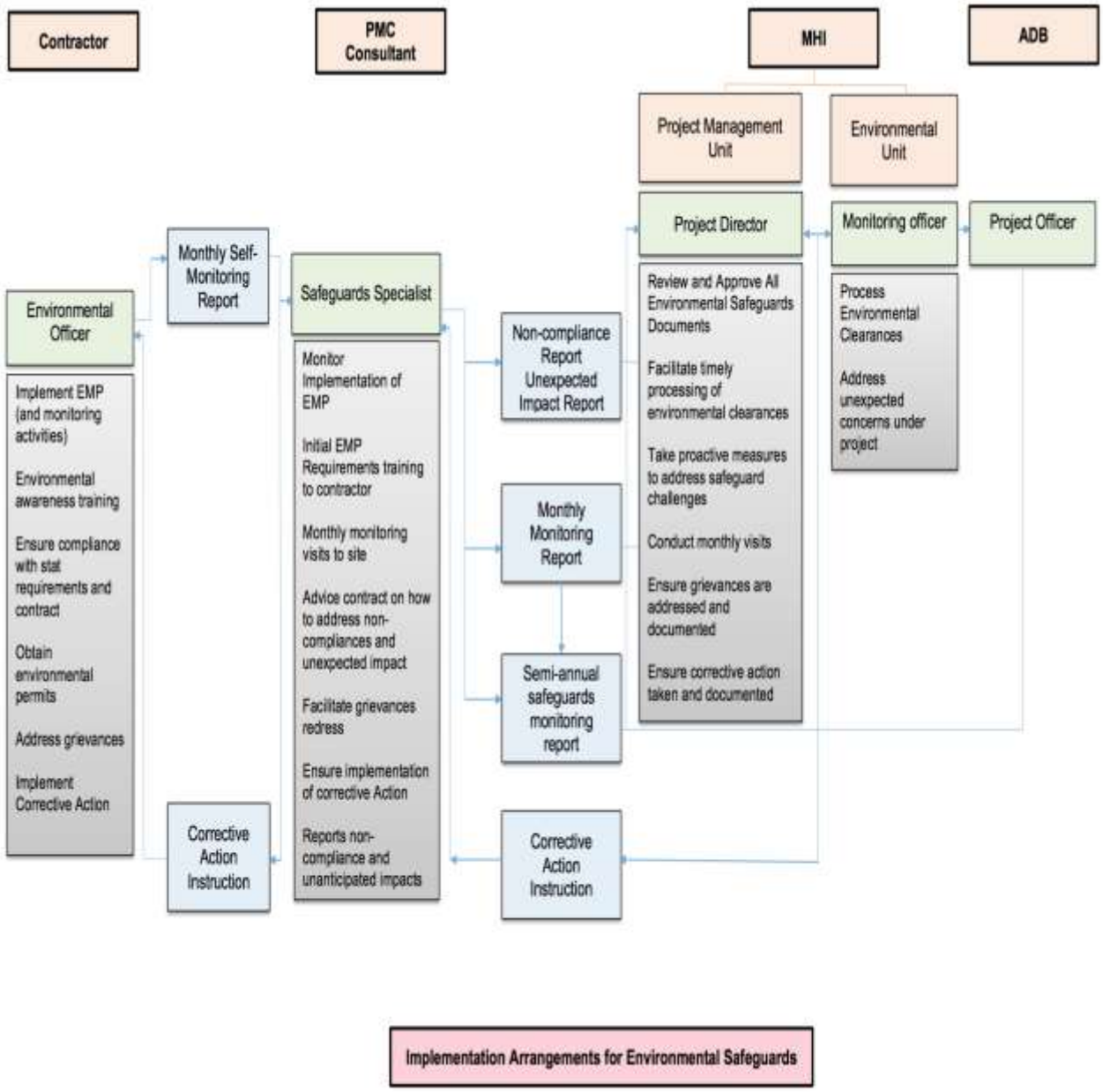

Figure 35: Institutional setup for environmental management of the project

D. Grievance Redress Mechanism

252. 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 concerns, complaints and grievances of all affected persons. 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 persons 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.

253. 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

254. Second Level GRC: Project Steering Committee

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

255. 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, community representative 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 is 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.

256. It any compliant cannot be resolved at site and no suitable remedial measure 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 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 36.

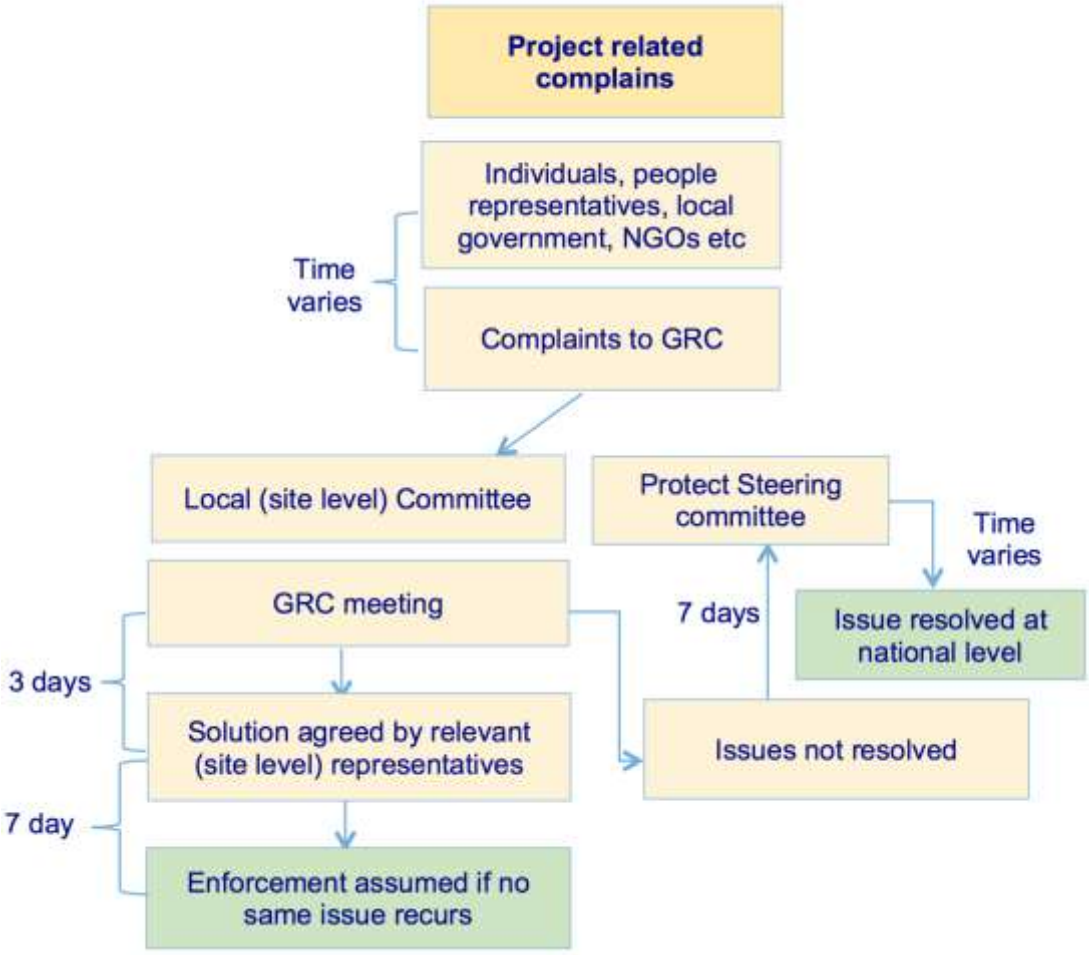

Figure 36: Grievance Redress Mechanism

E. Monitoring Program

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

- Compare predicted and actual impacts
- 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 IEE and monitoring process

258. 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 impact natural resources and dependent communities that are likely to affect 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.

259. Monitoring works during the construction and operational phase will be carried out according to the Tables 23. Cost for the monitoring (data collection) activities will be covered by Project Management Consultant (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).

260. The monitoring report structure provided in the EIA Regulations 2012 (2012/R-27) shall be used for the monitoring report preparation. Environmental monitoring reports including social safeguard inputs shall be submitted every six months to EPA and ADB for the duration of construction phase with data collected as scheduled on environmental attributes as proposed in monitoring program (See Table 23). Environmental monitoring report during operation stage of the project shall be submitted to EPA and ADB on an annual basis with data collected as scheduled on environmental attributes as proposed in the monitoring program during operation (see Table 23).

Table 23: Monitoring program for the project

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring	Responsibility
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	PMC
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	PMC

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring	Responsibility
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 month	Rate per test set USD 1000.00	PMC
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	PMC
Operation phase				
Reef benthos (coral and other benthic	Photo quadrate method at 250 by 5	Every 6 months after	USD 800.00	PMU

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring	Responsibility
cover)	meter belt transect areas at baseline project impact area and control site	construction phase is completed (total 2 years)		
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	PMU
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	PMU
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	Quarterly for 2 years	USD 1000.00	PMU

Reef community	Methodology	Sampling frequency	Estimated cost for monitoring	Responsibility
	Oxygen Demand, Nitrite, Nitrate, Phosphate, Sulfates **Biological properties:** Total coliforms, fecal coliforms **Metals including heavy metals:** Iron, Copper, Tin, Zinc, Magnesium, Mercury,			

F. Monitoring reporting and format

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

X. CONCLUSION

262. The findings of this Initial Environmental Examination shows 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 for safer mooring and docking for fishing, cargo, and passenger vessels and small crafts, and generating environmental and socio economic benefits.

263. 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.

264. This environmental assessment and the proposed EMP and Monitoring Program is found to be adequate to ensure that the project will not bring about any significant irreversible environmental impacts. The EMP will be reviewed and updated if necessary during preparation of the detailed design for the proposed Project Harbor.

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Appendix 1: Terms of Reference

"Dhivehin" – Always Maldivian, Forever Independent

Environmental Protection Agency EPA

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

- 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

- 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

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

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

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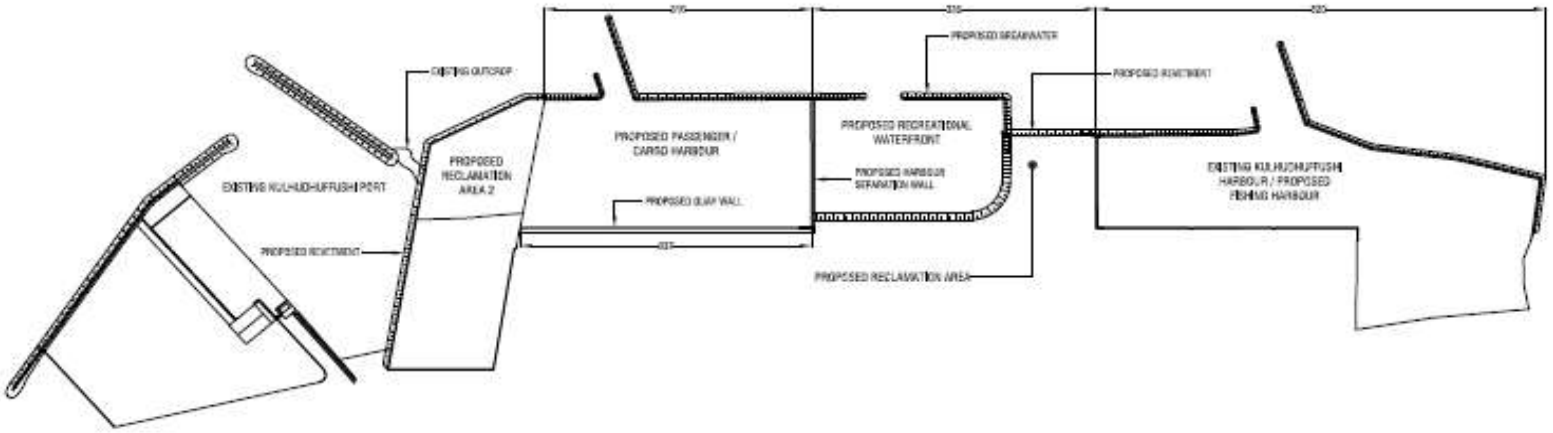
- Relevant stakeholders of Kulhudhufushi
- Ministry of Housing and Infrastructure

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

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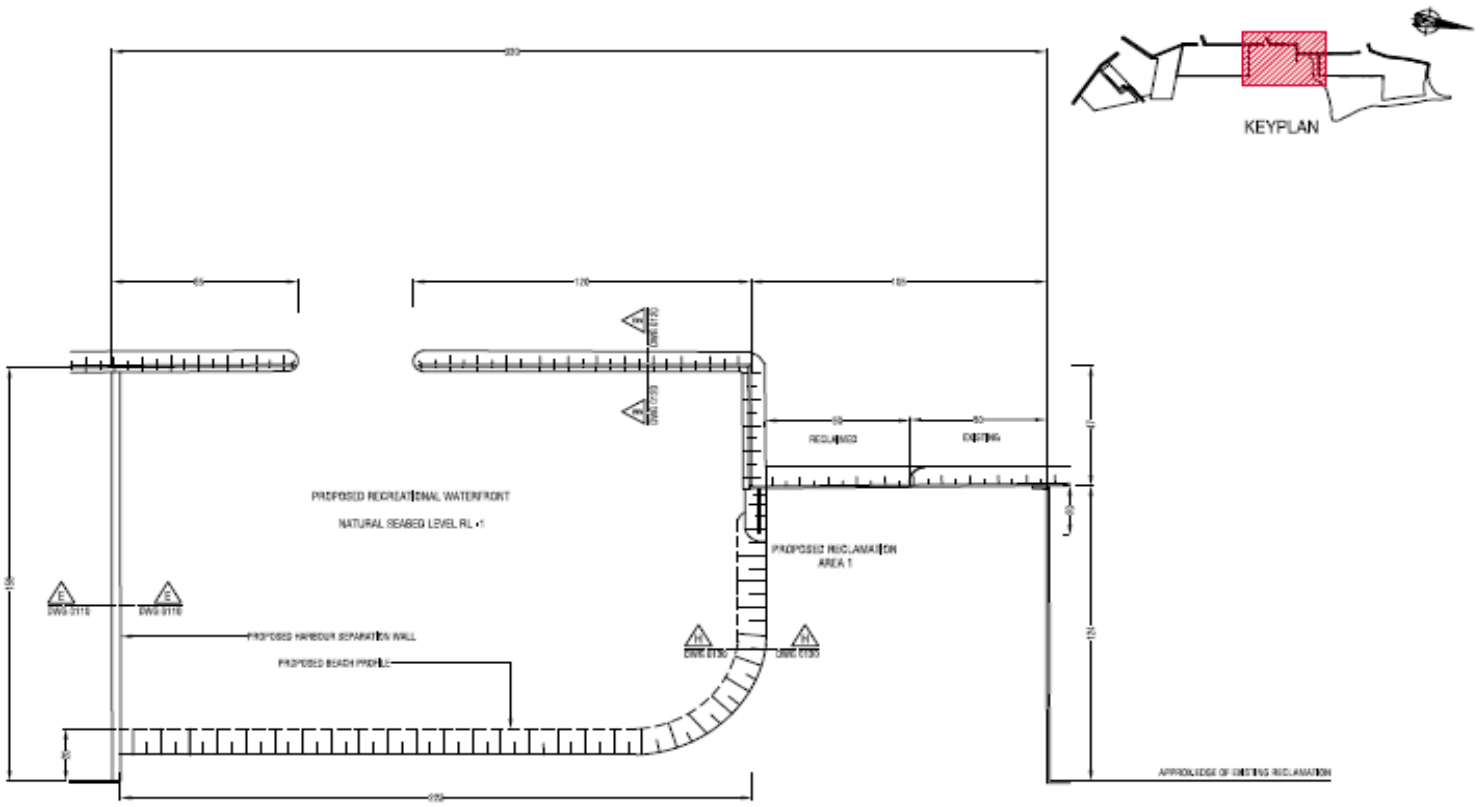
PADECO

ROHAN PRIVATE LIMITED



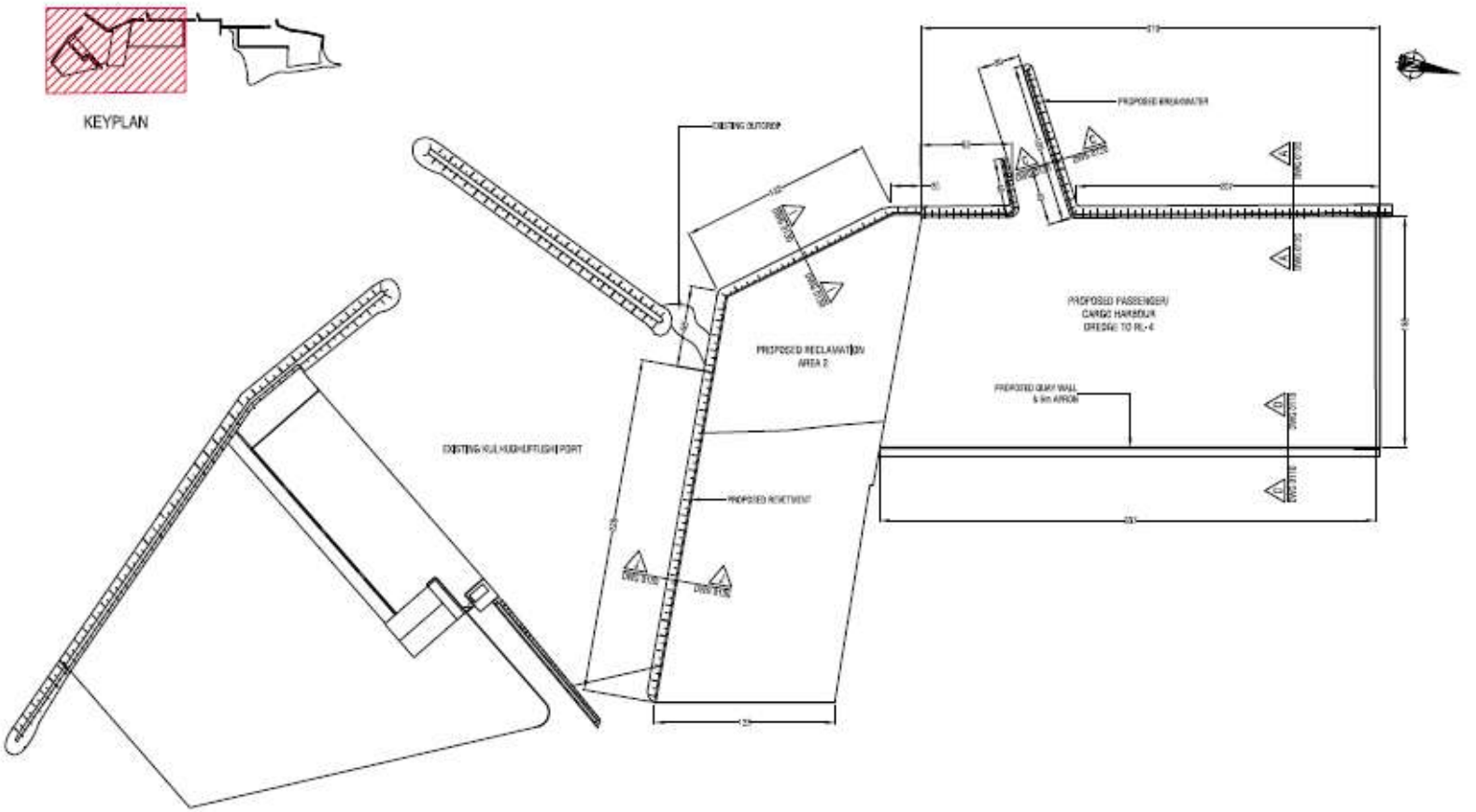
NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. ALL LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT: KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD#29 "	DWG. NO: 0000	SCALE: 1#500	SIZE: A3	REV. NO: A	DATE: 16/DEC/19
TITLE: PROPOSED RECREATIONAL WATERFRONT (OPTION - 1)		DRAWN BY: AM	CHECKED BY: JD	APPROVED: I	PROJECT. NO: #6/0/00

DO NOT SCALE. ONLY USE FIGURED DIMENSIONS GIVEN

PADECO

ROHAS PRIVATE LIMITED

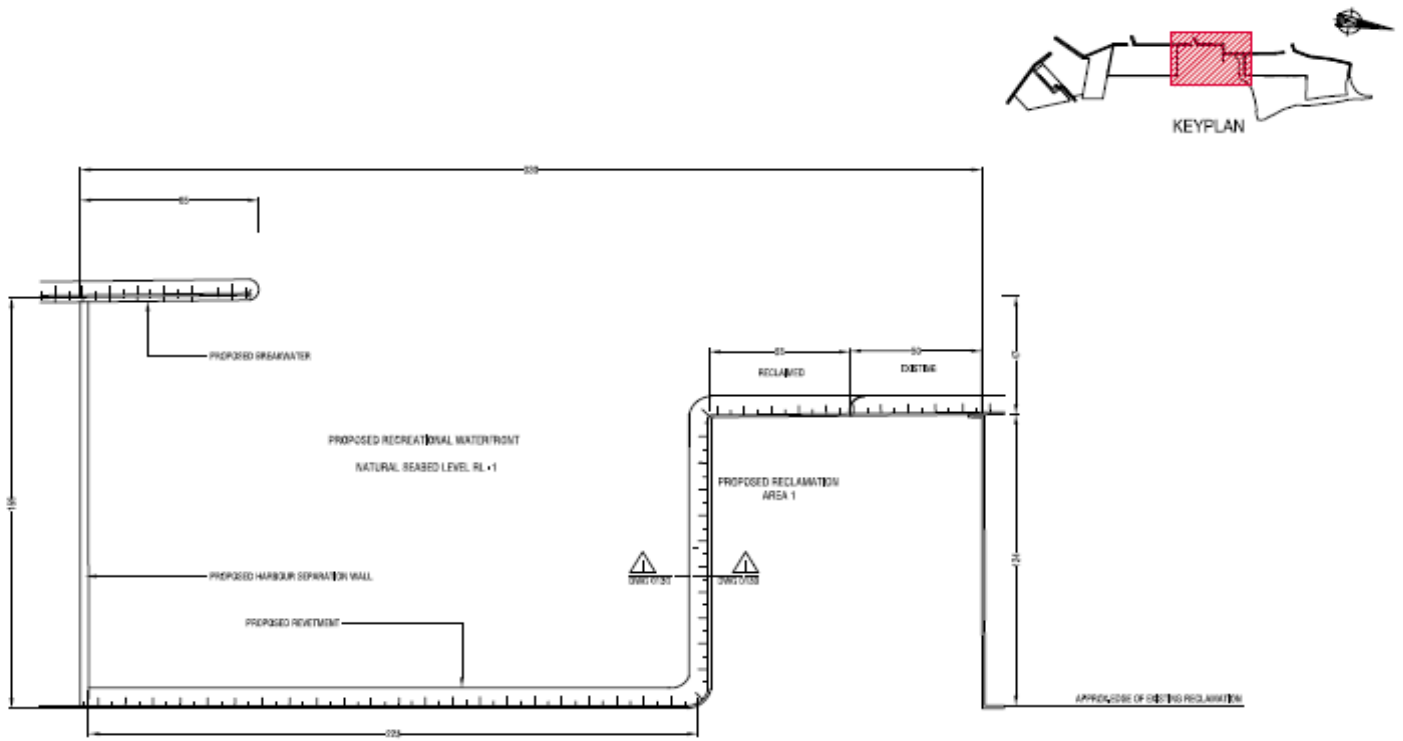


NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. ALL LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT: KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD8829 "	DWG NO	SCALE	SIZE	REV. NO	DATE
			A3		
TITLE: PROPOSED PASSENGER / CARGO HARBOUR & RECLAMATION		DRAWN BY	CHECKED BY	APPROVED	PROJECT NO

DO NOT SCALE. USE 'C' OR FIGURED DIMENSIONS ONLY

THE CONTENTS OF THESE DRAWINGS REMAIN THE PROPERTY OF ADECO PTE. LTD. AND ARE NOT TO BE COPIED OR REPRODUCED IN ANY FORM WHATSOEVER



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: KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD#429 "	DWG. NO: 0370	SCALE: 1:500	SIZE: A3	REV. NO: A	DATE: 16/DEC/15
TITLE: PROPOSED RECREATIONAL WATERFRONT (OPTION - 2)		DRAWN BY: AM	CHECKED BY: JD	APPROVED: 1	PROJECT. NO: #MD16/02

DO NOT SCALE, ONLY USE PROVIDED DIMENSIONS GIVEN

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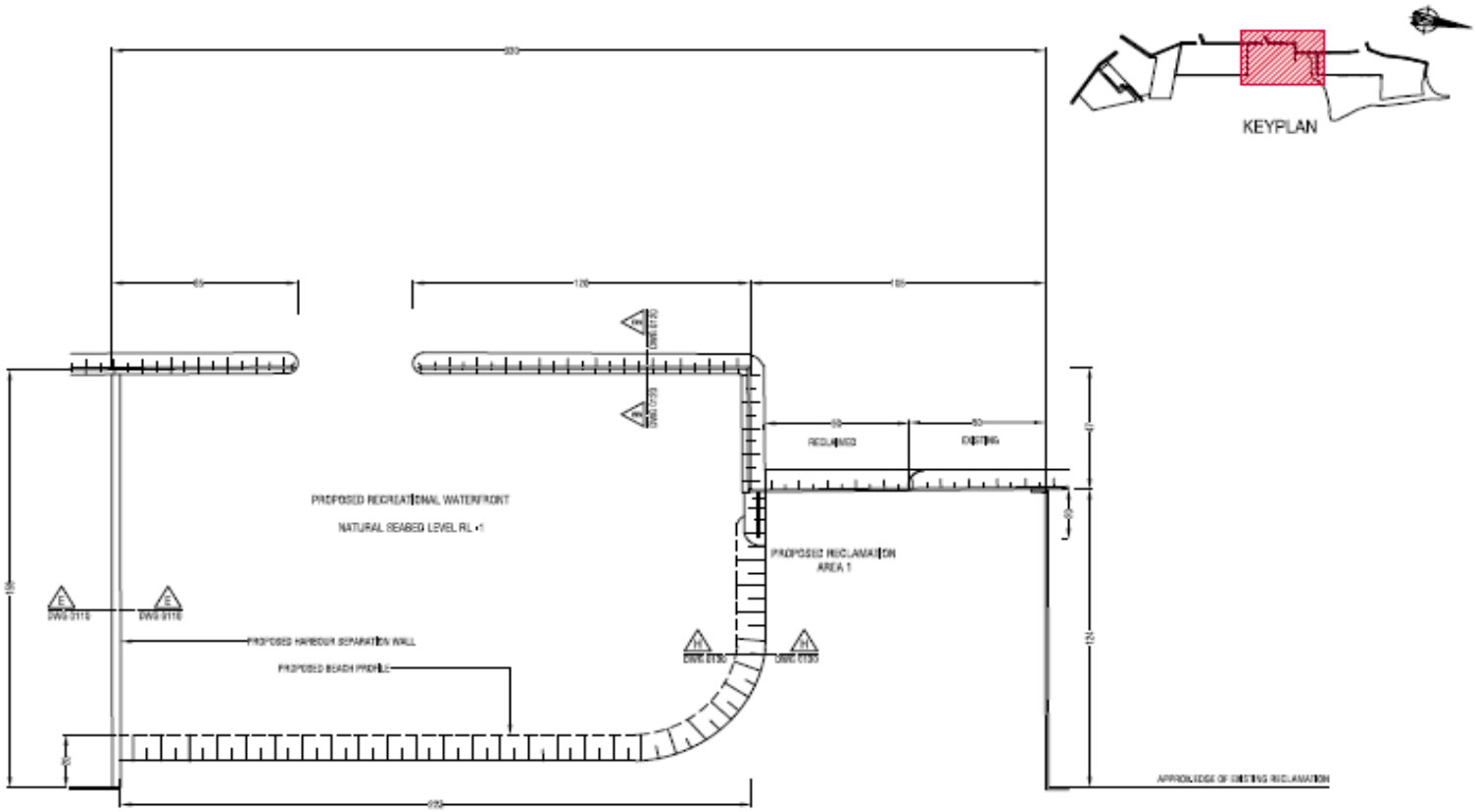


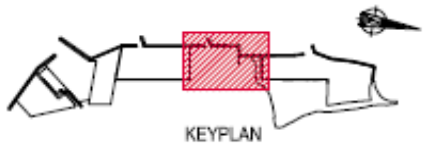
NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. ALL LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

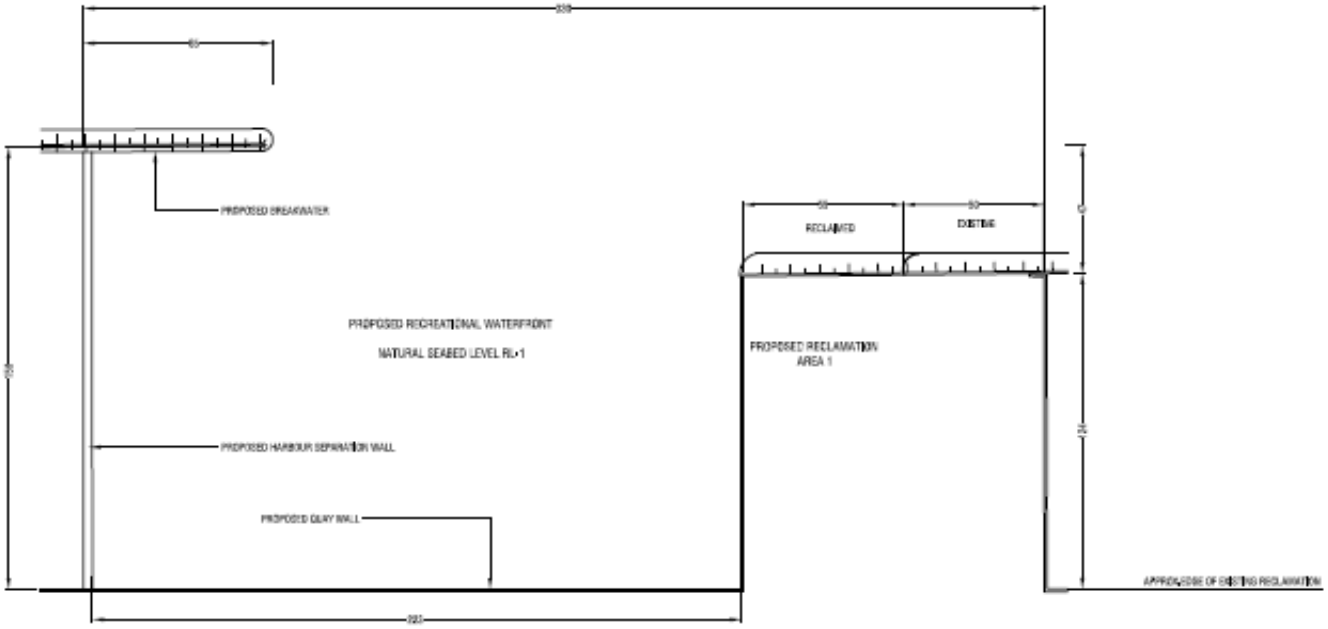
PROJECT: KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD####29 "	DWG. NO: 0000	SCALE: 1#500	SIZE: A3	REV. NO: A	DATE: 16/DEC/15
TITLE: PROPOSED RECREATIONAL WATERFRONT (OPTION - 1)		DRAWN BY: AM	CHECKED BY: JD	APPROVED: I	PROJECT. NO: HB016/02

DO NOT SCALE. ONLY USE FIGURED DIMENSIONS GIVEN

PADECO

ROHAN PRIVATE LIMITED





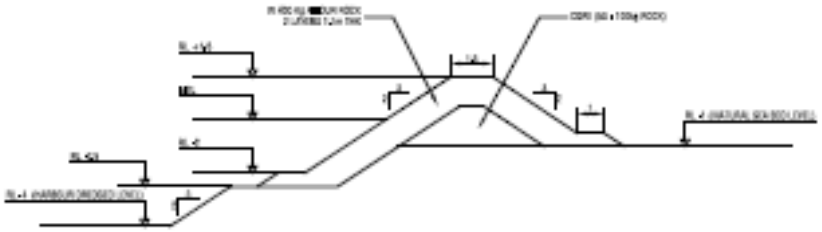
NOTES:
1. ALL DIMENSIONS ARE NOMINAL AND SHOWN IN METERS (m) U.N.O.
2. ALL LEVELS IN METERS (m) TO MEAN SEA LEVEL (MSL) DATUM U.N.O

PROJECT: KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD####29 "	DWG. NO: 0080	SCALE: 1:1000	SIZE: A3	REV. NO: A	DATE: 16.DEC.19
TITLE: PROPOSED RECREATIONAL WATERFRONT (OPTION - 3)		DRAWN BY: AM	CHECKED BY: JD	APPROVED: I	PROJECT. NO: ########

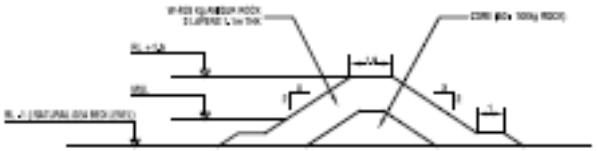
DO NOT SCALE. ONLY USE FIGURED DIMENSIONS GIVEN

PADECO

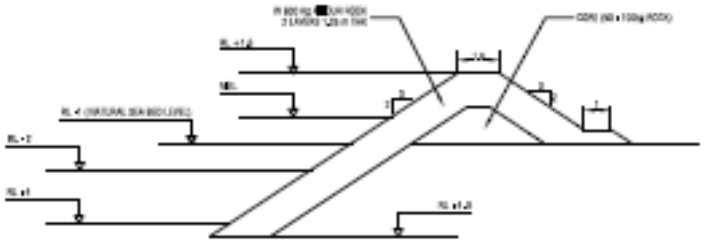
######## PRIVATE LIMITED



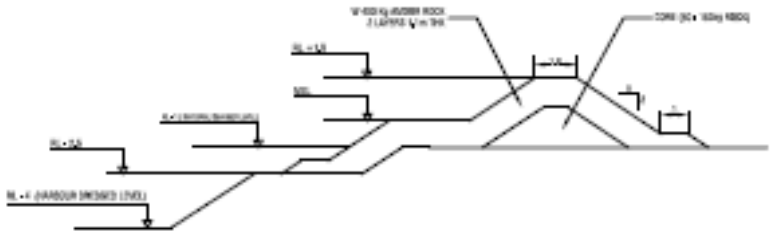
SECTION A-A
REF. DWG D050



SECTION B-B
REF. DWG D060



SECTION C-C
REF. DWG D060



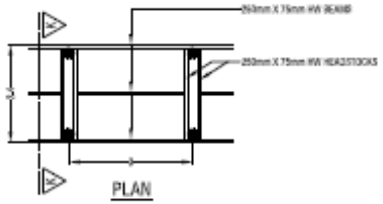
SECTION B-B (MODIFIED)
REF. DWG D060

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:
KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD&C20 "

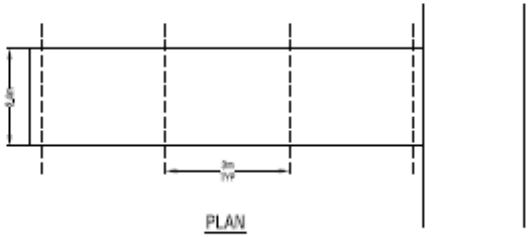
TITLE:
BREAKWATER SECTIONS

TIMBER JETTY

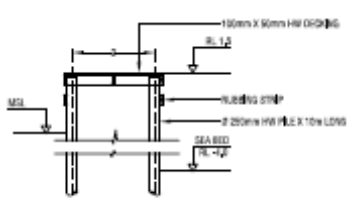


PLAN

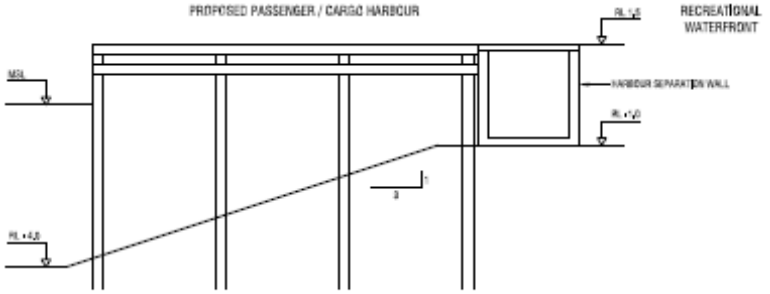
TIMBER FINGER JETTY



PLAN



SECTION K-K



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: KULHUDHUFFUSHI HARBOUR EXPANSION PROJECT " MLD#429 "	DWG. NO: 0100	SCALE: 1:100	SIZE: A3	REV. NO: A	DATE: 19/08/15
TITLE: TIMBER JETTY		DRAWN BY: AM	CHECKED BY: JD	APPROVED: I	PROJECT. NO: MB19/02

DO NOT SCALE. ONLY USE FIGURED DIMENSIONS GIVEN

PADECO

NIRAN PRIVATE LIMITED

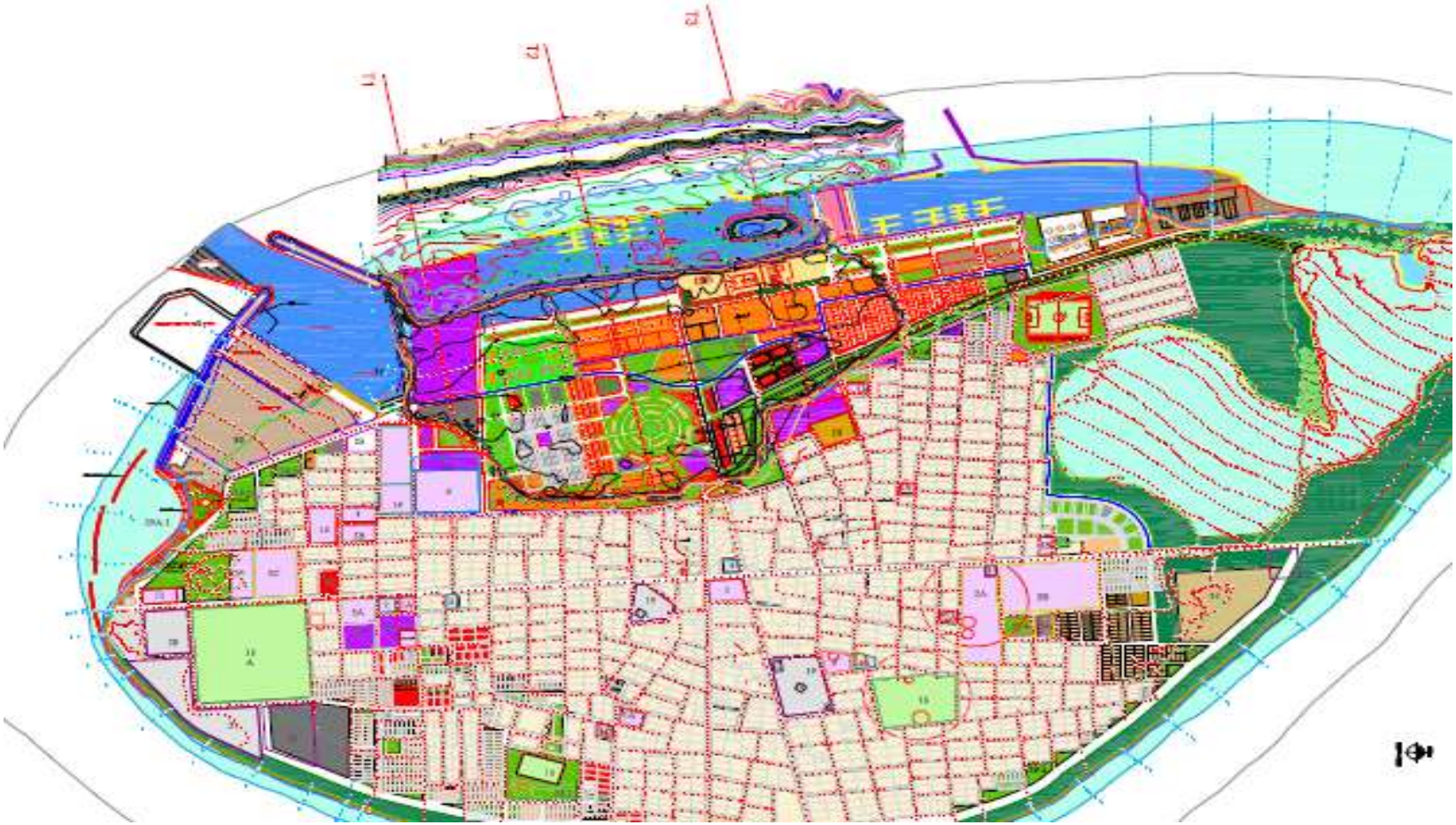
PROJECT:
KULHUDHUFFUSHI HARBOR EXPANSION PROJECT " MLD6829 "

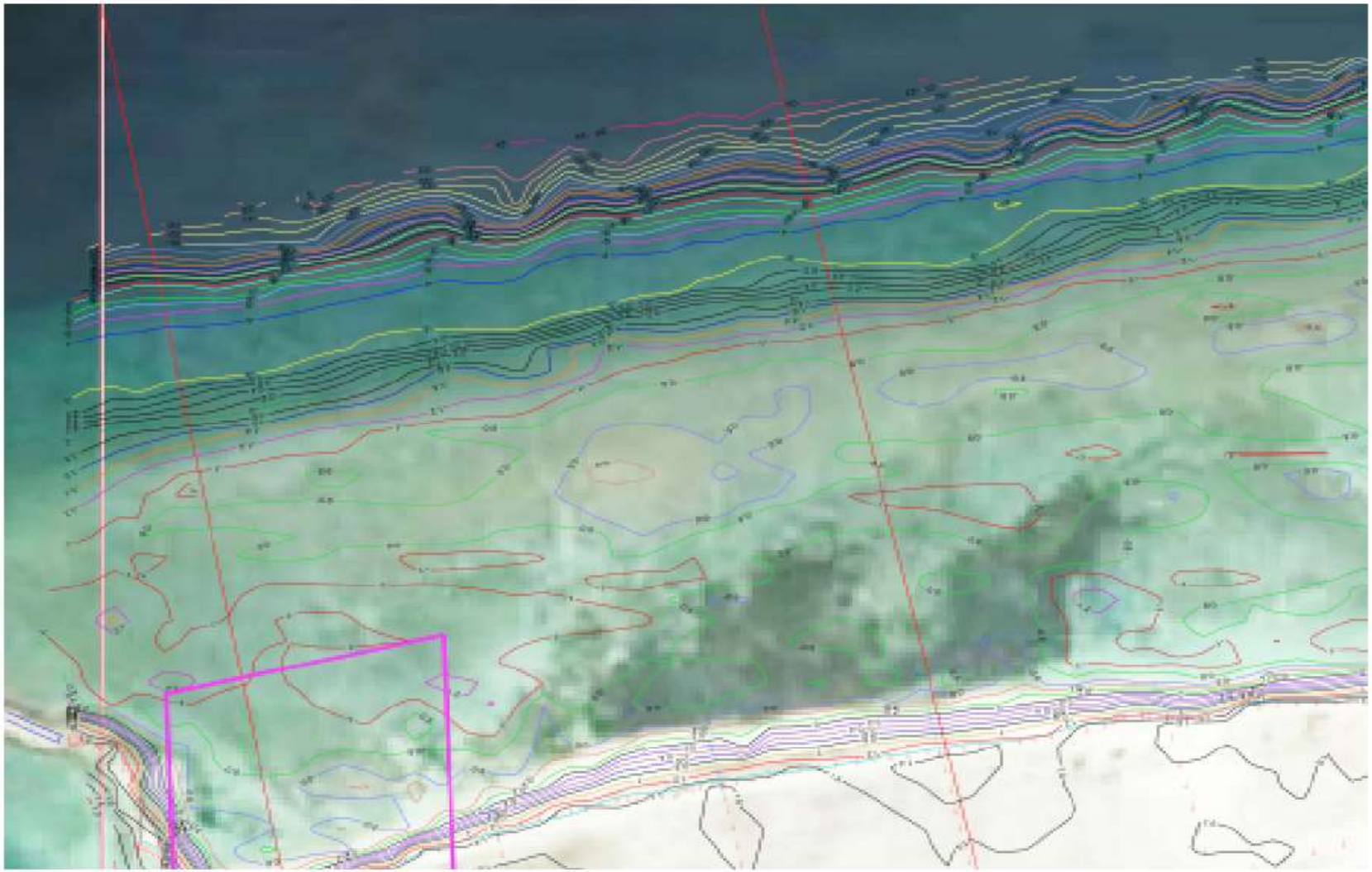
DWG. NO:

TITLE:
ANCILLARY FACILITIES

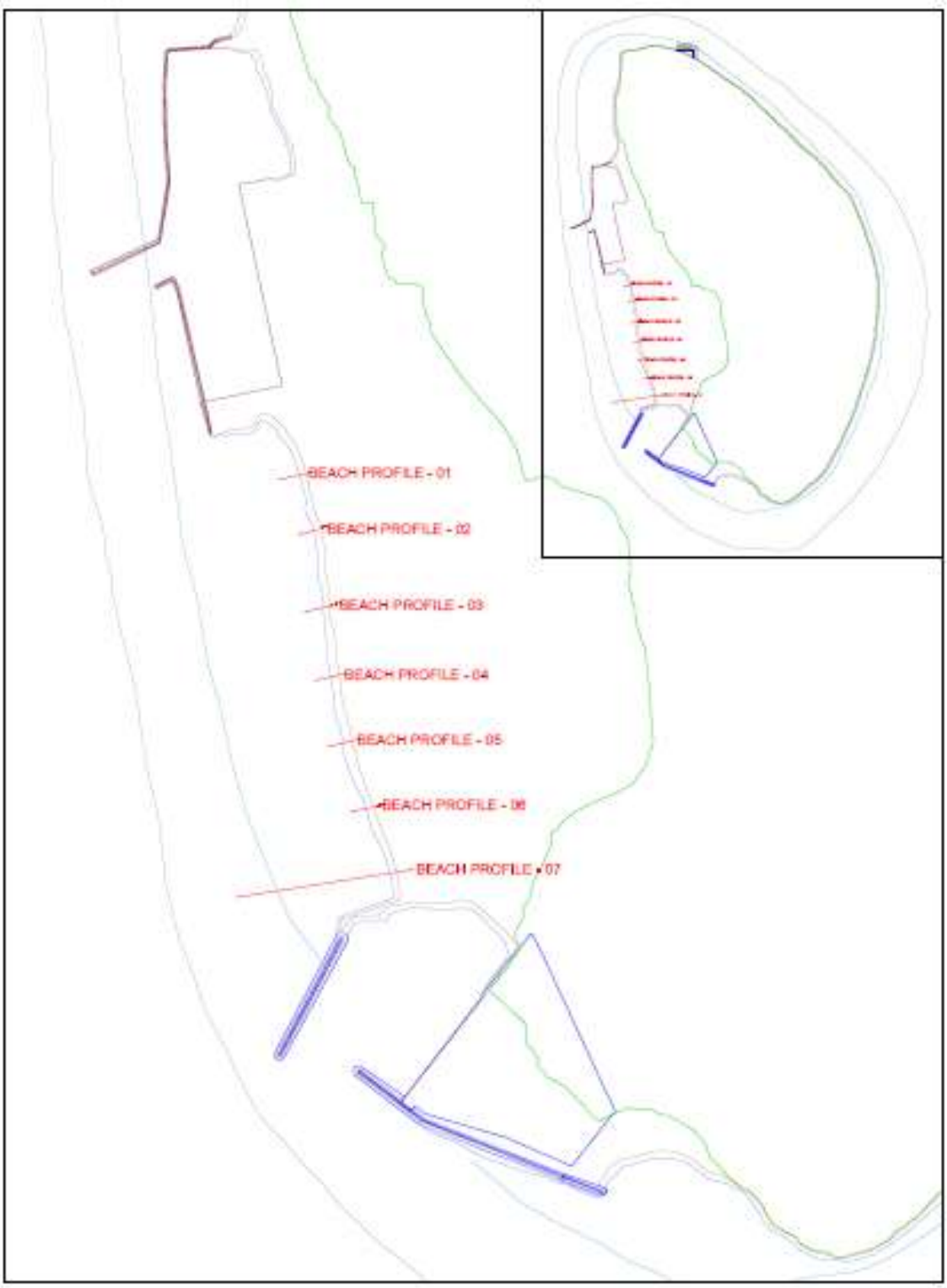
Appendix 3: Land Use Plan of Kulhudhuffushi

Appendix 4 Bathymetry of the proposed harbor expansion and breakwaters





Appendix 5: Beach profile locations



Appendix 6: Sea Grass Pictures

Appendix 7: 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

Appendix 8: Reef Pictures

Appendix 9: Water test results

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

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 examination 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	86	0	18	Colilert® 18/Quanti-Tray®	CFU/100mL

Key:
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

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 10: Existing Harbor Front