FIRST ADDENDUM TO THE

ENVIRONMENTAL IMPACT ASSESSMENT

OF

OCEANSIDE CHANNEL DREDGING PROJECT IN MEEDHOO ISLAND, ADDU CITY

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Prepared for

Ministry of Housing and Infrastructure

Maldives

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ޖުލައި 2016

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List of Abbreviations

COADS	Comprehensive Ocean-Atmosphere Data Set
DO	Dissolved Oxygen
EIA	Envrionmental Impact Assessment
GPS	Global Positioning System
IPCC	Intergovernmental Panel on Climate Change
IPPC	International Plant Protection Convention
IUCN	International Union for Conservation of Nature
MEE	Ministry of Environment and Energy
MHI	Ministry of Housing and Infrastructure
MoTAC	Ministry of Tourism, Arts and Culture
MoTCA	Ministry of Tourism and Civil Aviation
MSL	Mean Sea Level
MWSC	Maldives Water and Sewerage Company
NAPA	National Adaptation Programme of Action
NE	North East
NEAP II	National Environmental Action Plan II
NW	North West
SAP	Strategic Action Plan
SE	South East
SW	South West
TDS	Total Suspended Solids
ToR	Term of Reference
UNFCCC	United Nations Framework Convention on Climate Change and the Kyoto Protocol

Acknowledgements

The lead author of this report is Dr. Ahmed Shaig

Additional assessments were undertaken by the following team members.

Ms. Shahdha (Social Assessments)

Field assistance was provided by

Mr. Mohamed Ali (Marine assessments)

Ali Moosa Didi (Surveying assistance)

The curriculum vitae's of the EIA consultants are attached in Appendix F of this report.

Lead Consultant's Declaration

I certify that statements made in this Environment Impact Assessment are true, complete and correct to the best of my knowledge and available information.

Dr. Ahmed Shaig

Proponent's Declaration

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See Appendix G

Executive Summary

The purpose of this document is to fulfil the requirements to get necessary environmental clearance from the Environmental Protection Agency to carry out the remaining works of the proposed Oceanside channel dredging project in Meedhoo, Addu City. A part of the channel has already been dredged and completed but the outer rim of the channel could not be dredged or dislodged using conventional methods. It is proposed to undertake controlled reef blasting to dislodge the hard substrate. The proponent of this project is Ministry of Housing and Infrastructure.

The rationale for the proposal to blast the reef entrance is based on the fact that all other options available in the Maldives have failed to dislodge the hard substrate. The project already has had two contractors, both of whom had failed to cut through the outer reef rim. The present contractor was handed the task of finishing the project by Ministry of Housing based on a special request by the Meedhoo locals. The contractor has tried a number methods, including drop hammer, but has not been successful in dislodging the substrate. The only remaining financially feasible option is to use controlled blasting. The project has been dragging on for six years and the longer marine works continue, the higher the impacts on marine and coastal environment. Failure to complete the channel will also be a waste of public money as 90% of the project has already been completed.

The site already has about a 905 m x 35 m channel dredged to a depth of -3.5 m. The originally planned channel was 920 m x 35 m. The area in question is the last 15 m of hard substrate before it reaches the ocean.

The project proposes to dislodge the 15 m x 27 m section of the reef using about 50 bags of 25 kg Ammonia Nitrate placed 1 m apart along two rows.

All proposed project activities are in conformance to the laws and regulations of the Maldives, and relevant international conventions that Maldives is party to. The key laws and regulations applicable to this project are: Environmental Protection and Preservation Act, Environmental Impact Assessment Regulation 2012 and Dredging and Reclamation Regulation.

Significant impacts of this project during construction phase of the project are the potential impact of underwater noise and vibration on marine life, potential damage to property due to vibration, potential formation of reef slope cracks and sedimentation and turbidity associated with dredging. The project is being carried out in proximity to a listed sensitive area. All these impacts apart from potential geological impacts are reversible. Any damage to the reef substrate could be irreversible. Thus, the potential geological impacts will be a risk for this project.

The main mitigation measures include carrying out construction activities during low tide hours and calm weather, carrying out the work during daylight hours, informing the public about blasting activities and, schedule and proper supervision of all activities by qualified personnel. A precautionary approach is required for this project due to the unknowns associated with the geological impacts. It is recommended to minimised the charges to the lowest required levels and reduce the critical ground vibration distance (i.e. 10 mm/s) from the blast site. The site should be monitored for reef cracks. If any cracks are observed and depending on the severity of the cracks, all reef blasting activity must be ceased until geological assessments determine it is safe to proceed. Windy days should be avoided especially if the wind is blowing from the west. There are safety risks associated with this project. It has been recommended not to allow any snorkelling or diving within a 1.5 km radius of the blast site. This should include sand miners, fishermen and tourists, among others.

The "No Project" option was explored. The project involves significant risks to physical environment. Given the community's desire to complete this channel, the benefits it bring to the fishing community, and potential loss of public money if this project is not completed, the No Project option has a higher opportunity cost. However, in the absence of a viable alternative, it was recommended that EPA consider approving this project based on conditions. Alternative methods to dislodge the hard substrate were considered, but these options have already been tried and failed.

The monitoring plan is designed to assess damages to reef structure, infrastructure and housing, and loss of marine life. Physical environment damage will be checked using marine surveys and damage to nearby buildings will be undertaken in specific sites and based on complaint. Damage to biological environment will focus on larger fish and protected species.

The management plan for this project has been updated to include the key management requirements before and during blasting activity.

The support for this project is mixed. In the consultations undertaken for the original EIAs and this Addendum, there is overwhelming support by the locals from Meedhoo and Hulhudhoo for this project. The City Council supports this project but is apprehensive about reef blasting as they believe it is detrimental to the future of Addu City. EPA and MRC do not encourage reef blasting.

This report has highlighted the risks and impacts associated with reef blasting on the site. It has also provided actions that can avoid or minimize the known risks. This report should now be used as a decision making tool by the implementing agency and regulatory authority to determine how to proceed with the project. There is no legal hindrance for this project to go

ahead. If the proponent and EPA decides to move forward with the project, the following course of action is essential to align the project with sustainable development principles.

1. Use the minimum charge possible to effectively dislodge the substrate and minimise the radius of critical ground vibration (i.e. 10 mm/s)
2. Continuous monitoring of the site for reef cracks. If any cracks are observed and depending on the severity of the cracks, all reef blasting activity must be ceased until geological assessments determine it is safe to proceed.
3. Given the potential impact of this project on the public and the future generations, it is recommended that EPA take all possible measures to solicit views from the public for this EIA
4. Safety precautions are essential. Divers, sand miner, fishermen and swimmers need to be properly informed in a timely manner and monitored during work days.

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މި ދިރާސާ ރިޕޯޓަކީ ސ. މީދޫ ފުޅުގައި ފުންޖަހަން ނެރުއް ކަނޑުފުޅުގެ މަޝްރޫޢުއާއި ގުޅިގެން ތިމާވެއްޓަށް ކޮށްފާނެ އަސަރު ވަޒަންކުރުމުގެ ގޮތުން ކުރެވިފައިވާ ދިރާސާގެ ފުރަތަމަ އެޑެންޑަމް ރިޕޯޓެވެ. މިރިޕޯޓުގެ މައިގަނޑު ބޭނުމަކީ މަޝްރޫޢަށް ގެނެސް ފައިވާ ބައެއް ބަދަލުތަކަށް ބޭނުންވާ ތިމާވެށީގެ ހުއްދައަށް މަޢުލޫމާތުތައް އެންވަޔަރަމަންޓް ޕްރޮޓެކްޝަން އެޖެންސީއަށް ހުށަހެޅުމެވެ. މިމަޝްރޫޢަކީ 2009 ވަނައަހަރުން ފެށިގެން ހިނގަމުން އަންނަ މަޝްރޫޢެކެވެ. މަޝްރޫޢުގެ އެކި މަރުހަލާތަކަށް ނިސްބަތުން 90% މަސައްކަތް ވަނީ ނިމިފައެވެ. ނަމަވެސް ފަޅުގެ ބޭރުކައިރީގެ އަންގަނޑު ހަރުކަމުން އާންމުކޮށް ރާއްޖޭގައި ބޭނުންކުރާ ސަލާން (ޑްރެޖަރ ހެމަރ އަދި އެއަރ ގަން) ބޭނުންކޮށްގެން ވަނީ ފުރުއްވާ ނުލެވިފައެވެ. މިމަޝްރޫޢު މިހާ ދިގުލައިގެން ދިއުމުގެ އެއްސަބަބަކަށްވެސް ވެފައިވާ މިއެވެ. މިހާ ކޮންޓްރެކްޓަރ މިހާރު ހުށަހަޅަނީ ނުކުރު ބޯމާރުކުރުމެވެ. މި ދިރާސާ ރިޕޯޓުގެ މައިގަނޑު މަޤްސަދަކީ ނުކުރު ގޮތުގައި ބޯމާރުކުރުމުގެ ސަބަބުން ދިމާވެދާނެ ގޮތްތަކާއި ދިރާސާކޮށް މަޝްރޫޢުގެ އެދިފައިވާ އަދި އިޖްތިމާއީ މިމަޝްރޫޢަށް ގޮތެއް ނިންމުމަކަށް އެހީވުމެވެ. މިމަޝްރޫޢުގެ އެދިފައިވާ މިނިސްޓްރީ އޮފް ހައުސިންގ އެންޑް އެންވަޔަރަމަންޓް އެވެ.

މިމަޝްރޫޢުގެ ދަށުން ފަޅުގެ ބޭރު އާން ގަނޑުން 15 މީޓަރ ފުޅާ 27 މީޓަރ ދިގު ސަރަހައްދެއްގައި އެވްރެޖް ނަމްބަރުގެ 50 ކޮޅަށް އެކަމަކު އަސްކަންތަ 1 މީޓަރ ދުރުމިނުގައި އަޑުގަދައި ގޮއްސާފައިވާނެއެވެ. ގޮއްސާ ބައިވަރު އެކްސްޕްލޯސިވްގެ ކޮންގެން ނޯޓުކޮށްފައެވެ. މިމަސައްކަތް ކުރާނީ ކޮންޓްރެކްޓަރގެ ބޯޓުގެ ދަށުން އެމްއެންޑީއެފްގެ އެހީގައެވެ.

ތިމާވެއްޓަށް ކުރާއަސަރު ދެނެގަތުމަށް ކުރިޔަށްދާ ރިޕޯޓް ކަމާއި ބޭނުން އިދާރާތަކުން ފާހަގަކުރާ ރާއްޖެތެރޭގެ މައްސަލަތައް ކުރިއަށް ގެންދެވޭނެއެވެ. މިމަޝްރޫޢުގެ ހިނގާނެކަމަށް ތަފާތުކުރެވިފައިވާ މުއްދަތަކީ 2 ނުވަތަ 3 ދުވަހެވެ.

ނުހަނު ހަދުމުންދާ ސަރަހައްދަކީ އަތޮޅުގެ ކަނޑު ރަޖެގެ އެންމެ ރީތި އެއް ސަރަހައްދެވެ. މިތަނުގައި ކައިރިގައިވާ ސަރަހައްދުތަކަކީ އިޤްތިސާދީ ސެންސިޓިވް ހެރިޓޭޖްގެ ގޮތުގައި ލިސްޓް ކޮށްފައިވާ ތަންތަނެވެ.

މިދިރާސާއިން ފާހަގަކުރެވުނުގޮތުގައި މިމަޝްރޫޢުގެ ސަބަބުން އަދި މަސައްކަތުގެ މަރުހަލާގައި ތިމާވެއްޓަށް ކޮށްފާނެ ނޭދެވޭ އަސަރުތަކުގެ ތެރޭގައި ގޮއްސާފަ އެޅު އަދި ގޭގެދުވާ ސަބަބުން މިސަރަހައްދާއި ކައިރިގައި ކަނޑުގައި ދިރިއުޅޭ ތަކެތީގެ ބޮޑުބައެއް މަރުވެ ނުވަތަ އަސަރުކުރުމާއި، ފަރަށް އަންނަ ގެއްލުމުގެ ސަބަބުން ފަޅުގައި ހުރިވަރާއި، އެއްގޮތުގައި ހުރި ބައެއް ތަފާތުވާނެ ގޭގައިން އަސަރު ކުރުމާއި، ފެންގަނޑު ވަޑިގެގެން ތަޣައްޔަރުވުމާއި، މިސަރަހައްދުގައި ދުވާން އެކި އުފެދިހުންނަން އަސަރުކުރުން ހިމެނެއެވެ.

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1 INTRODUCTION

1.1 Purpose of the EIA Addendum

This Environment Impact Assessment (EIA) addendum report is an evaluation of the potential environmental, socio-economic and natural impacts of the proposed alterations to the channel dredging project in Meedhoo Island, Addu City. The project is proposed by Ministry of Housing and Environment. Alterations are mainly proposed to control blast the Oceanside rim which has proven difficult to dredge using conventional methods.

This document is submitted to EPA by the proponent to fulfil the requirements of Environmental Protection and Preservation Act (EPPA) of the Maldives (4/93), more specifically the clause 5 of the Act which states that a report should be submitted before implementation of any project that may have a potential impact on the environment.

This report provides the background to the proposed changes to the project as well as an assessment of their likely environmental and social impacts, both beneficial and adverse. The proposed enhancement and mitigation measures are outlined where necessary together with an environment management plan and a monitoring programme.

A separate EIA was prepared and approval for the project was received in 2011. Following the expiry of the original EIA, the EIA was updated and the Decision Note was renewed in 2013. Hence, this report contains references and some material from the initial EIAs.

The original EIA for the project was approved on 19 October 2011 (Decision Note Number: 203-FINHUM/426/2011/18).

1.2 Project Scope

The overall project involves dredging a 30 m x 960 m channel to access to the ocean side through the Hulhumeedhoo Reef, Addu Atoll. About 90% of the project is completed but a section of hard substrate is proving difficult to dredge using conventional methods. The proposed change to the project is to control blast the section in question. A section about 15 m wide and 28 m long is to be control blasted using 50 bags of Ammonia Nitrate placed at 1 m interval in two rows. Once dislodged, the material will be removed using excavators and transported to dredge waste disposal sites.

See next chapter for more details.

1.3 Background and rationale for the proposed changes

The project has a long history for simple channel dredging project. The project has already had three separate contractors. The initial dredging work are reported to have started prior to 2010 by the locals. The initial dredging works were undertaken using excavators that were mobilised to the island for various projects. Works were initially limited on a small section on the ocean side.

In 2011, the EPA informed the City Council that no work should be undertaken without EIA approval. Thus, a formal EIA was prepared and approved. Following the approval the first contractor managed to dredge the channel up to 50 m from the reef edge and some section on the southern half. They abandoned the project partially due to the inability to dredge through the rim. The second attempt to dredge the area was after 2013 after a renewal of the EIA approval. They completed the north half of the channel but was unable to dredge through the rim.

The present contractor was contracted by Ministry of Housing and Infrastructure to complete all the remaining works on the channel, while they were mobilized for the Hulhumeedhoo harbour dredging project. The contractor reported that they tried general excavation using high capacity excavators, hydraulic hammer attached to an excavator and drop hammer. However, the rim substrate could not be dislodged. The reef entrance work has been completed apart from a 15 m section on the reef rim. The contractor is unable to demobilise due to this and is incurring costs.

The contractor and MHI has identified that the only viable option to complete the channel is to control blast the remaining 15 m on the rim. They have informed us that all other options available in the Maldives have been tried and were unsuccessful.

It has been over 7 years since work on this channel had started and delays in completion is having environmental impacts due to the sand beds and the continued dredging. The project needs to be completed as soon as possible.

1.4 Aim and objectives

The aim of the overall project is to operationalise a channel, which would allow direct access to Hulhumeedhoo Island from the ocean side.

The objective of the proposed changes is to dislodge the hard substrate, which has been a problem area for all contractors, and complete the works.

1.5 Consultants, Contractors and Government Institutions

All the EIA related work is undertaken by consultants from CDE Consulting. Design criteria and technical specifications have been developed by the proponent. The contractors are Senok Trade Combine Pvt Ltd.

No donor agencies are involved in this project. The project is being financed and executed by Ministry of Housing and Infrastructure.

1.6 Scope and Terms of Reference of EIA addendum

The scope of this EIA is broadly based on the Environmental Impact Assessment Regulations 2012. The assessment more specifically adheres to the Terms of Reference (ToR) issued by the Environmental Protection Agency on 20 August 2013. The ToR is based on scoping meetings held between the stakeholders on 7 August 2013. A copy of the ToR is attached in Appendix A.

The EIA report contains the following main aspects.

- A description of the project changes including the need for the project, how the project will be undertaken, full description of the relevant parts of the project, methodology used in the assessment, implementation schedules, site plans and summary of project inputs and outputs *(Chapter 1 and 2).*
- Any additional legislation relevant to the project *(Chapter 3).*
- Additional information about the existing baseline environmental conditions of the site, primarily on marine water quality, noise and marine environment *(Chapter 4).*
- An assessment of the potential impacts during both construction and operational stages of the project as well as identification and cost of the potential mitigation measures to prevent or reduce significant negative impacts during both construction and operation stages of the project *(Chapter 5 & 6).*
- Assessment of alternatives for the proposed changes *(Chapter 7)*
- Updated Environment Management Plan (Chapter 8)
- Updated environmental monitoring plan *(Chapter 9).*
- Potential gaps in information *(Chapter 10)*
- Main conclusions (Chapter 11)

1.7 Summary of Assessment Methodology

1.7.1 General Approach

This EIA is broadly guided by the EIA Regulations published in 2012.

This report has been prepared to ensure that the significant environmental and social impacts of the proposed changes to the project have been considered and assessed at the project planning phase.

The process followed in the preparation of this EIA report consists of six parts. These are: scoping consultations; literature review; field surveys; stakeholder consultations; analysis of results; and compilation of the assessment in the form of a report.

In order to conduct a broad based and inclusive study, the proponent and the consultant have from the onset ensured the exercise is participatory. As such, discussions were held with community members in the projects area and relevant stakeholders with the assistance and coordination of the proponent.

1.7.2 The Study Area

The study area for the project is the reef entrance site, immediate reef and the settlement area within a 500 m radius.

1.7.3 Field Observations

Additional field assessments were undertaken on 21 April 2016. Field visits include marine assessments and water quality assessments in the area around the channel site.

Marine Assessments

Line Transect Survey

The composition of the substrate was assessed by taking twenty high-resolution images every 5 m (pictures covering 0.5 m^2 of the seabed) along the same transect line used for the fish surveys. These were later analysed using CPCe. CPCe, or Coral Point Count with excel extension, developed by the National Coral Reef Institute, is software designed to determine coral community coverage and diversity using transect photographs. Underwater photographic frames are overlaid by a matrix of randomly generated points, and the fauna/flora of species or substrate type lying beneath each point is identified. 20 random points per picture were analysed to characterize the substrate composition (sample size: 200 points per transect).

Fish Census

A category-based methodology was adopted to estimate fish abundance and the mean number of fish per category and observation was extracted to estimate species and family abundance. The categories used to estimate abundance is displayed in Table 1.3.

Table 1.3: Fish abundance categories

Category	Number of fish
1	1
2	2 - 4
3	5 - 16
4	17 - 64
5	65 - 256

Visual snorkelling surveys were carried out at select locations of the lagoon. General status of these sites were recorded, special attention was given to types of corals and fishes present at these sites and the environmental conditions that could affect growth such as suspended solids, depth, and other threats to coral life.

Water Quality

Water quality was assessed from MWSC laboratory. Water quality samples were taken at four locations around proposed sand borrow sites. Parameters tested include pH, temperature, turbidity, Total Suspended Solids (TSS), Nitrates, Phosphates and Biological Oxygen Demand. Samples were collected using 1500ml PET bottles at 1m depth.

Bathymetry and topographic survey

The bathymetric survey was conducted using a single-beam echo-sounder (Sonarmite) and GPS attached to a survey vessel. The bathymetric survey conducted using a 25 m grid with data collected up to the reef line.

Vertical control was established by doing a tide observation on site during the surveyed period. The observation was calculated and reduced to the MSL using the predicted tide table provided by Maldives Metrological Service, (UH SEA LEVEL CENTER Data). Predicted tide data of Hulhule tide station was used for the corrections.

1.7.4 Desk Study Review

A literature review was conducted to acquire background information on the site and its environment as well as to identify possible environmental impacts of similar developments in island settings. In this context, the EIA Regulations 2012, best practices from similar

development activities, scientific studies undertaken in similar settings around Maldives and previous documents/historical publications were considered.

The literature review comprised of, but is not limited to the following:

- The original EIA prepared for the proposed project in 2011
- The Revised EIA prepared for the proposed project in 2013

1.7.5 Key Stakeholder Consultation

Stakeholder consultations were undertaken with the following stakeholders:

- Public consultation
- Addu City Council
- EPA
- MRC

1.7.6 Data Analysis

The EIA experts used their experience and knowledge in their respective fields to analyse the data from the previous studies and field visits in order to determine the potential impacts of the proposed projects, the severity of effects arising from these impacts and how any adverse impacts can be best mitigated and positive impacts enhanced. This analysis provides the framework for the recommendations on corrective actions and remedial measures and provides the basis for the formulation of the environmental management plan which forms part of this report EIA.

1.7.7 Report Format

The report format and structure presented here follows the report formatting guidelines issued by EPA.

1.8 Study Team Members

The team members of this EIA are:

- Dr. Ahmed Shaig (Lead Author and Coastal Environment Consultant)
- Mr. Mohamed Ali (Marine Surveying)
- Mr. Mohamed Faizan (Marine biologist)
- Mr. Ali Moosa Didi (surveying)

The curriculum vitae of the EIA consultants are attached in Appendix F of this report.

2 PROJECT DESCRIPTION

2.1 Project Location

The island of Hulhumeedhoo is located on the eastern rim of Addu Atoll at approximately 73°13'48.50" E and 0°35'05.60" S (see Figure 2.1). It is approximately 3200 m long and 2100 m wide, and has a land area of approximately 300 Ha (see figure 2-2). In terms of administrative boundary, Hulhumeedhoo is the fifth largest island in the Maldives. Hulhumeedhoo comprises of two administrative units: Hulhudhoo Island and Meedhoo Island. Each of these islands have their administrative setups but in recent years and in the new land use masterplan all major developments are to be treated as belonging to one administrative unit. The island is about 12 km from Gan' International Airport. The nearest resort is Herathera Island Resort (50 m) and Shangri-la at Viligilli Resort (7 km).

The project site is located between Isamhela hera and Meedhoo Island.

2.2 Outline of proposed changes and site plan

The overall proposed site plan is presented in Appendix B. A Reduced version of the site plan is provided in Figure 2.3 below. The areas potentially affected by the project are presented in Figure 2.4.

This proposed activity mainly involves control blasting a 15 m x 28 m section of the reef.

The next section provides the details of the project components.

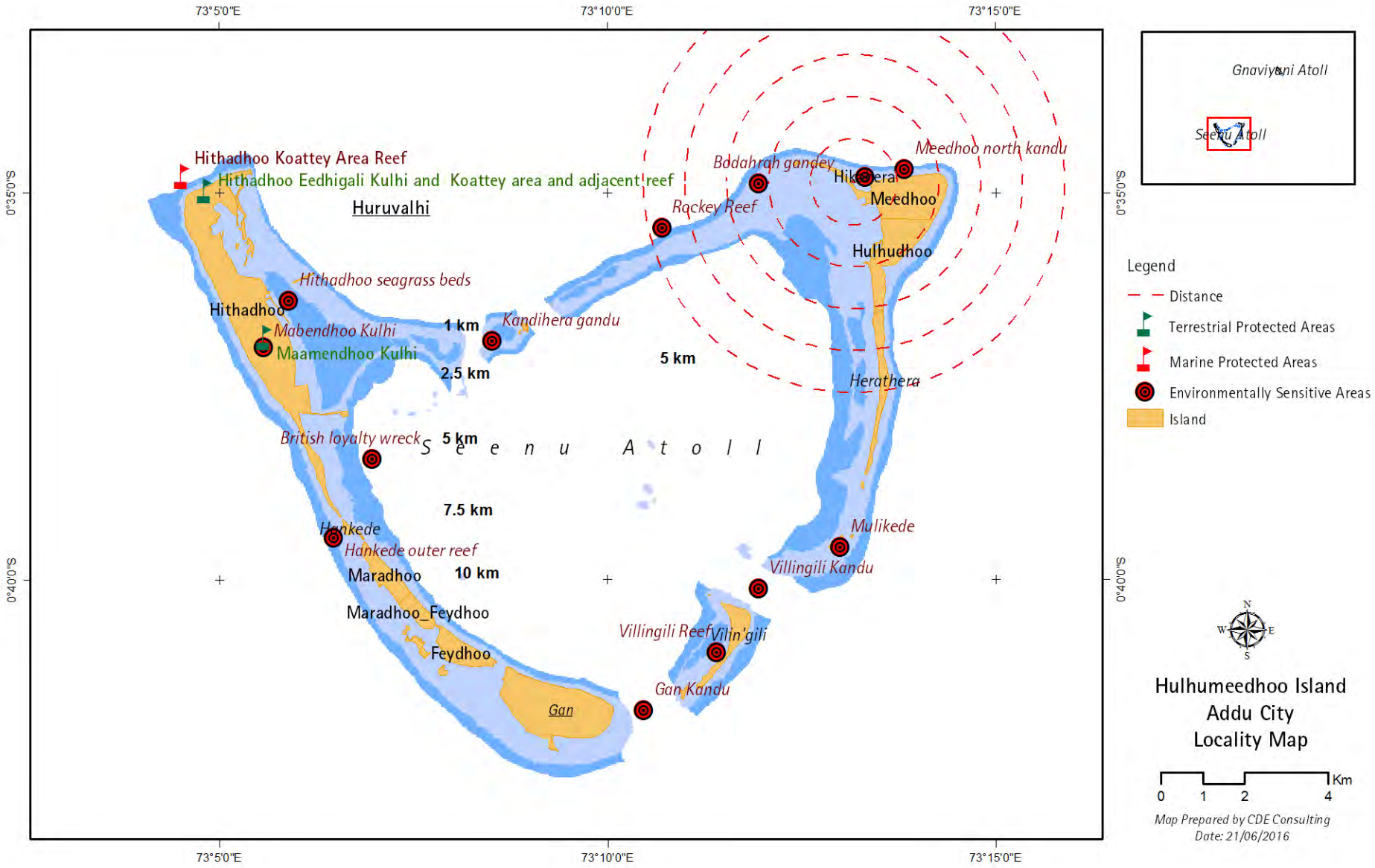

Figure 2.1: Location map of Hulhumeedhoo

Figure 2.2: Satellite image of proposed site

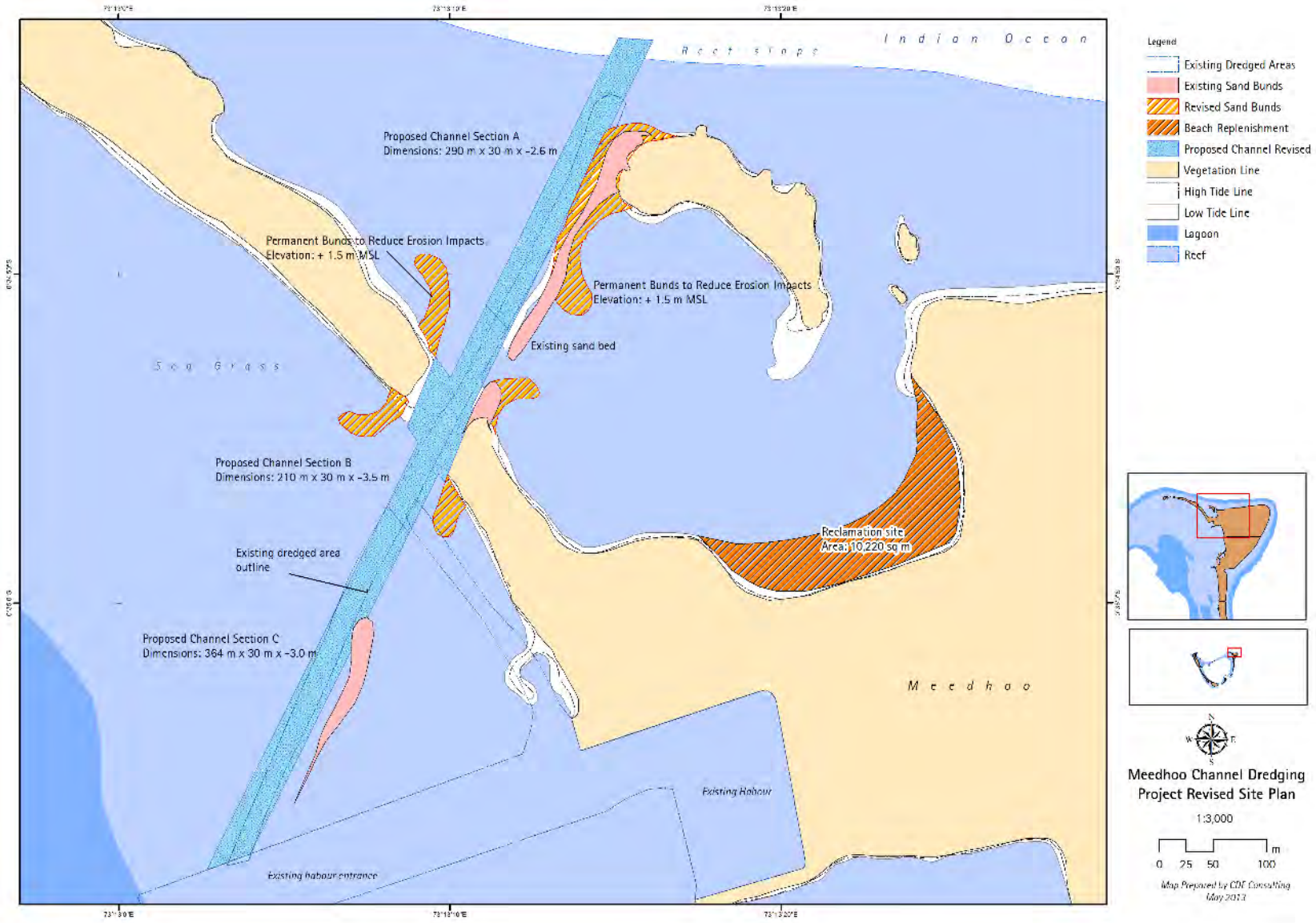

Figure 2.3: Original Project Site Plan

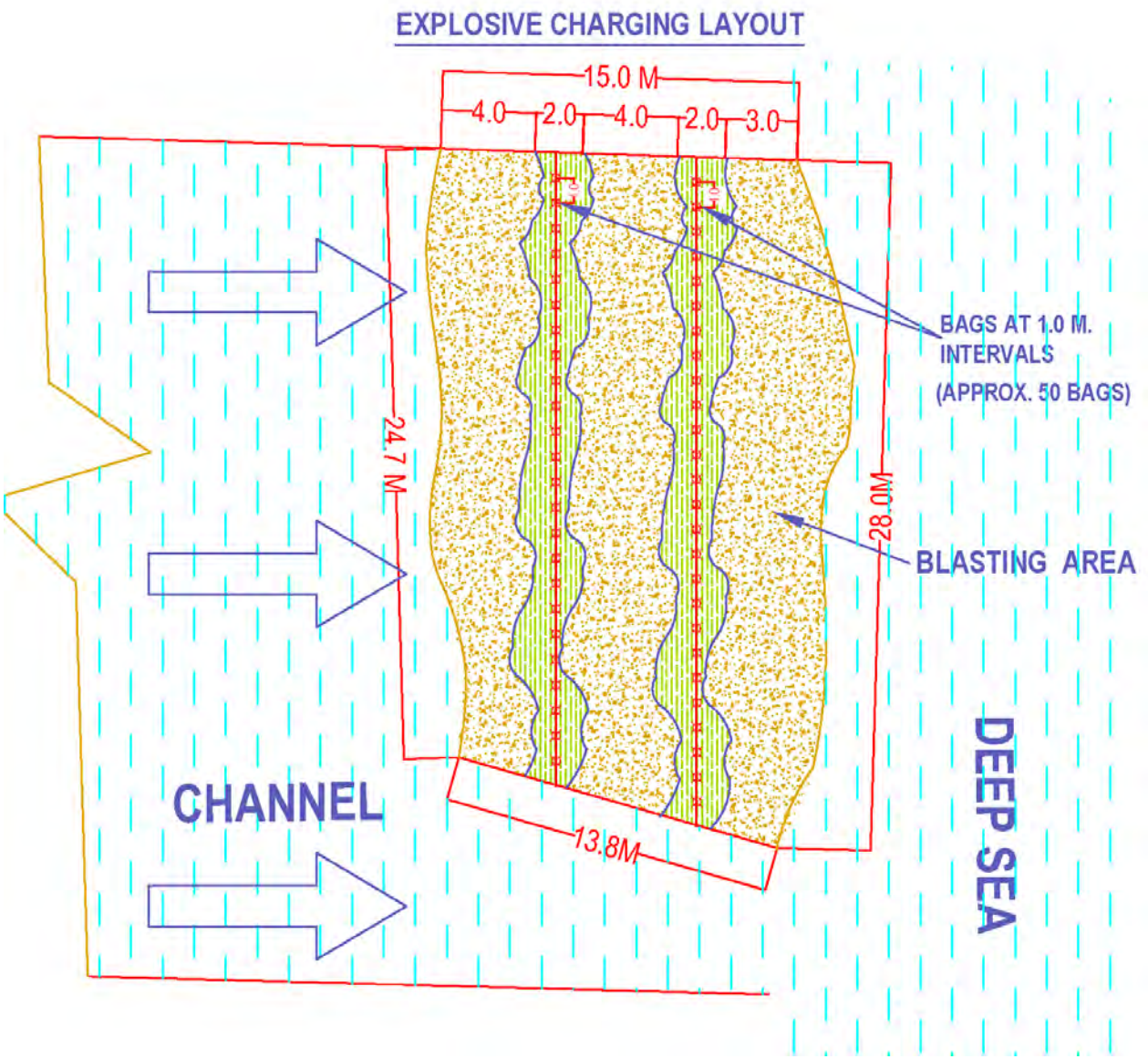

Figure 2.4: Proposed blast area layout

Figure 2.5: Project foot print and Potential Affected Areas

2.3 Detailed Project Outline and Work Methodology

2.3.1 Justification of the method

As identified in Chapter 1 control blasting has only been proposed for the site after trying out general excavation, hydraulic hammers and drop hammers. These are the main options available in the Maldives and in most cases these methods work. However, occasionally, a very hard substrate may be encountered on the reef rim, which cannot be dislodged without resort to extreme methods such as controlled blasting. The method has been proposed out of necessity.

2.3.2 Method statement

The hard coral area to be dislodged is approximately 15 M x 27 M. Average surface level of the coral layer is -2.1 MSL. Expected minimum depth of the channel is -3 M and the contractor plans to have a depth of -3.5M.

The layout of the charges is presented in Figure 2.4. The contractor is proposing to make two trenches of average 2 m width on the hard coral layer to facilitate the excavators to demolish the total area as fast as possible, since the temporarily access roads made for machinery movements are subjected to washed away within a short period.

Explosive materials for blast

Main explosive material used for this blast is Ammonia Nitrate which comes in 25 Kg bags. Each 25 kg bag of Ammonia Nitrate will be spread over a steel plate. 2.5 Litres of diesel fuel will be added to Ammonia Nitrate and mixed properly to achieve a homogeneous mix.

This mix is sufficient to make three bags of explosive each having approximately 8 kg. Mixed material need to be packed in a thick polythene bag and a 4 inch dynamite stick is fitted with an electric detonator (See Figure 2.5).

To electrical wires connected to the electric detonator is taken out from the bag and bag should be sealed thoroughly using waterproof tape to prevent any water leak. Each small bag fitted with dynamite stick will be placed in the middle of a sand bag filled with approximately 30 kgs of sand. This bag too will be thoroughly sealed using water proofing tape leaving wire terminals out of the bag (See Figure 2.6).

To get the required blasting depth explosive bags will be placed at 1 m intervals.

Maximum number of bags recommended for each blast is six. Wire terminals of all six bags shall be connected in parallel to each other and taken away to a safer distance where wires will

be connected to a positive and negative terminals of 12 volts fully charged battery through a switch.

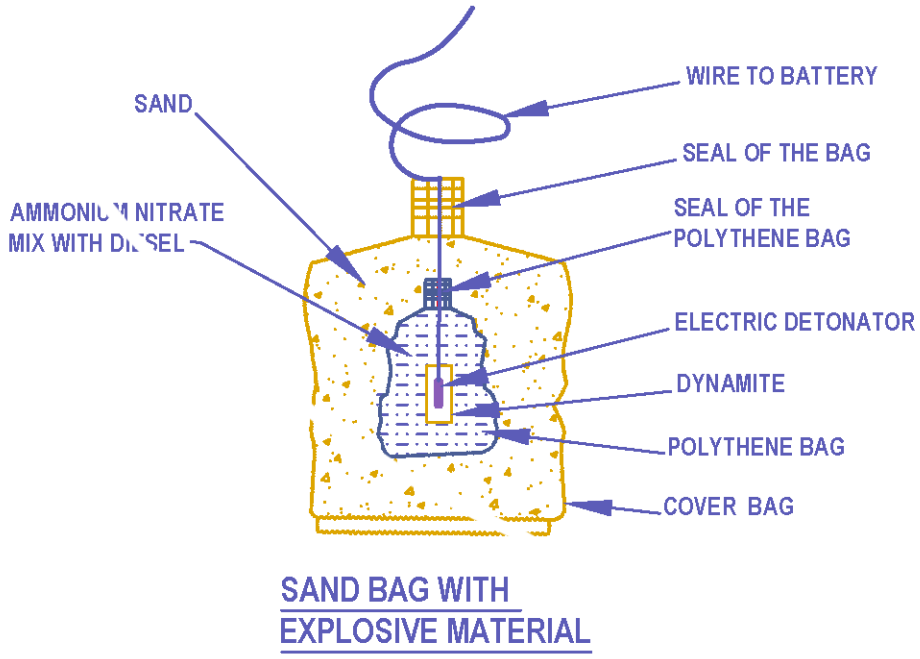

Figure 2.5: Details of bag setup

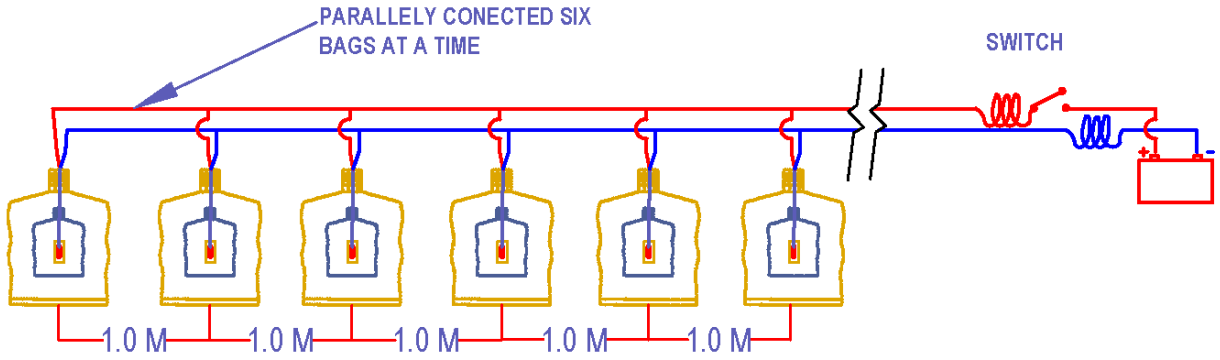

Figure 2.6: Details of bag connection

Preparation of the surface for the blasting

Prior to placing the explosive bags, the coral rock surface will be cleaned to be free of any loose material and bags shall be position at 1 m intervals on the center line of the trench.

Blasting will be conducted during high tides to minimize the effect of the explosion on the water surface including the atmosphere and to have a greater impact on the rock which need to be blasted.

After each blast loose materials of the blast need to be cleaned thoroughly to minimize the flying away of small rock particles during next blast.

Approximately 50 explosive bags will be placed and total requirement of ammonia nitrate is 400 kgs.

Purchase and transport of explosive materials

Once the EIA approval is obtained a request will be made to Public Works Department of MHI to supply necessary ammonia nitrate approximately 400 kg, dynamite sticks and required number of detonators.

Explosive materials will be transported with the MNDF escort in a speed launch to the site and shall be kept in a safe container with necessary security arrangements.

If there are, any excess explosive materials after completing the job this material will be hand over back to Public Works Department following the same procedure.

Once the total operation blasting is completed, a 300 class excavator will be deployed to demolish the surrounding area of the trenches to connect the channel to deep sea having a depth of -3 to 3.5 and width of 35 M.

Public Works Department will supply experienced diver and blasting technician to execute this controlled blast.

Safety Precautions prior to blasting

The following safety measures are expected to be taken for the activity:

- Island office will be notified on the proposed blasting to bring this to the notice of all the island community, fishermen and other boat users and visitors to the island.
- All the access roads to blasting area will be barricaded against unauthorized entry of outsiders.
- 10 minutes prior to the blasting a siren will be blown to notify the blasting.
- There will be two more additional siren blows within the ten minutes and thereafter blasting will be carried out using electrical ignition switch.
- All the blasting shall be conducted during day time when the water level is high.

- After removing the demolished loose material second blast will be carried out following the same procedure.

2.4 Schedule and Life Span

The blasting is expected to be carried out within a span of 7 days. The number of blasts will depend on the progress made. Excavation work will have to be completed in the next 7 to 10 days as the wave conditions will make it difficult to retain the sand bed.

All works will be carried out after Ramazan.

2.5 Waste Management, Logistics and Safety Measures

All construction waste management and disposal methods, pollution control measures, turbidity control measures and health and safety measures identified in the original EIA should be followed.

2.6 Summary of Additional Project Inputs and Outputs

Additional materials that will go into the development and from where and how this will be obtained are given in Table 2.1 and the type of outputs (products and waste streams) and what is expected to happen to the outputs are given in Table 2.2.

Table 2.1: Major Project Inputs

Input resource(s)	**Source/Type**	**How to obtain resources**
Construction workers	Local and foreign	Existing workforce for the project
Engineer and blast specialist	Local	Ministry of Housing and Infrastructure
Ammonia Nitrate	Overseas	Through Ministry of Housing and Infrastructure and MNDF
Explosives and wires	Overseas	Through Ministry of Housing and Infrastructure and MNDF
Sand	Dredge waste	From existing dredge waste
Bags	Overseas	Import from overseas
Fuel	Light Diesel	Local suppliers

Table 2.2: Major Project Outputs

Products and waste materials	**Anticipated quantities**	**Method of disposal**
Dredge waste	Small quantity	Used for land reclamation.

Bags	Small quantities	Sent to Meedhoo waste site.
Residual Ammonia Nitrate	Small quantities	Handed over to MHI and MNDF for storage

3 POLICY AND LEGAL FRAMEWORK

All applicable laws and regulations have been covered in the original EIA and no additional regulations apply to the changes proposed for this project.

4 EXISTING ENVIRONMENT

4.1 Physical Environment

4.1.1 Water quality assessment

The primary objective of the lagoon water quality sampling was to determine the baseline conditions of the marine water around the project site. Water samples were collected from two locations. The samples were collected in clean PET bottles. All water quality tests were done at the MWSC laboratory.

The following table shows the test results of the marine water samples collected on 24 April 2016. Laboratory results are attached in Appendix D.

Table 4.1: Marine and Water Quality Parameters

Parameter	Optimal Range (EPA)	Results	
		SW1	SW2
Physical appearance		Clear	Clear
pH	8.0 – 8.3	8.36	8.45
Nitrate (mg/L)	<5	3.8	3.0
Phosphate (mg/L)	0.005 – 0.020	**0.82**	**0.08**
Total Suspended Solids (mg/l)	-	55	38
Turbidity	<5 NTU	4.81	5.83
Nitrogen Ammonia		0.12	0.14

Marine water qualities for some of the parameters tested appear to be within acceptable ranges at all sites. Parameters, pH and nitrate are within acceptable limits. Phosphate levels for both sites tested are above the optimum range provided by EPA. Increased levels of phosphates can easily accelerate plant growth reducing the dissolved oxygen in the water compromising the aquatic life. Since the phosphates levels for the tested sites are not significantly high, this may not be unfavourable.

Turbidity level for site 2 is above the optimum limit of 5 NTU and turbidity level for site 1 is at boundary mark with 4.81 NTU. As turbidity determines the clarity of the water, the results

indicate the presence of suspended solids. Accordingly, the results also show high levels of Total Suspended Solids (TSS) in the water with 55 mg/L and 38 mg/L in sites 1 and 2 respectively. High levels TSS means presence of sediment in water and it can limit the amount of light that can enter the water body. In general, the water around the project site is contaminated with sediments which reducing the overall aesthetic quality of the water.

Salinity levels at the site are not expected to have changed since the water quality testing for the initial EIA. Hence, salinity result from the water quality testing of initial EIA is used as the baseline for this addendum. Salinity at location W1 was found to be 31.12ppt.

4.1.2 Bathymetry

A bathymetric survey of the site was undertaken for this assessment and is provided in Appendix E. As the site has already been dredged, the depths represent an existing channel.

4.1.3 Noise levels

Noise measurements were undertaken at selected sites to establish the baseline background noise conditions. The results are presented in Table 4.2.

	Noise dB(A)	**Notes**
At the projects site	70-80	Breaking waves visible
Near Harbour	75-80	Vessels and vehicles in operation at times
Near harbour restaurant	75-80	Vessels and vehicles in operation at times; conversations
Near school	60-70	Vehicle traffic
Nearest house	60-70	Vehicle traffic

4.2 Biological Environment

The aim of this assessment is to establish the baseline condition at the proposed project location. Marine assessments were carried out from 21st April 2016, the sea was rough and the sky was partially cloudy during the survey. The main objectives of this assessment were:

1. to determine the general status of the reef associated with the island
2. to assess the condition of the marine environment which will be directly impacted by the project
3. to determine the fish species abundance and composition of the reef system

The following sub-sections provide details site, the methodology adapted for this assessment and the results.

4.2.1 Marine Protected Areas and Environmentally Sensitive Sites

The nearest Marine Protected Area to the project site is Hithadhoo Protected Area, located at the northern end of Hithadhoo Island about 13 km west of the proposed project site.

Four environmentally sensitive areas are located within 5 km of Hulhumeedhoo: Meedhoo North Kandu, Bodahrah Gandey, Maakanaa Heragandu and Rocky Reef.

4.2.2 Photo Quadrat Survey and Fish Census

Transect 1

This transect was deployed at 4 m depth, along the reef edge on the northern side of the island, to the west of the channel. This site was assessed as it is the nearest reef, to the proposed project activities.

Live coral made up about 19.58% ± 2.02 SE of the survey area, and 12.13% ± 3.65 SE of the area was made up of either partially or completely bleached corals. High percentage of coral bleaching recorded is possibly due to heat stress. Approximately 24.14% ± 7.24 SE was made up of dead corals covered in algae.

A total of 25 fish species 12 fish families were recorded during the fish census. Highest number of fishes were recorded from families *Pomacentridae* (5 species) and *Serranidae* (4 species). Members of Pomacentridae family predominantly feed on planktons and zooplanktons, while *Serranidae* feeds on small fishes and crustaceans.

Figure 4.1: Select images showing benthic composition along transect 1

Figure 4.2: Benthic substrate composition along transect 1

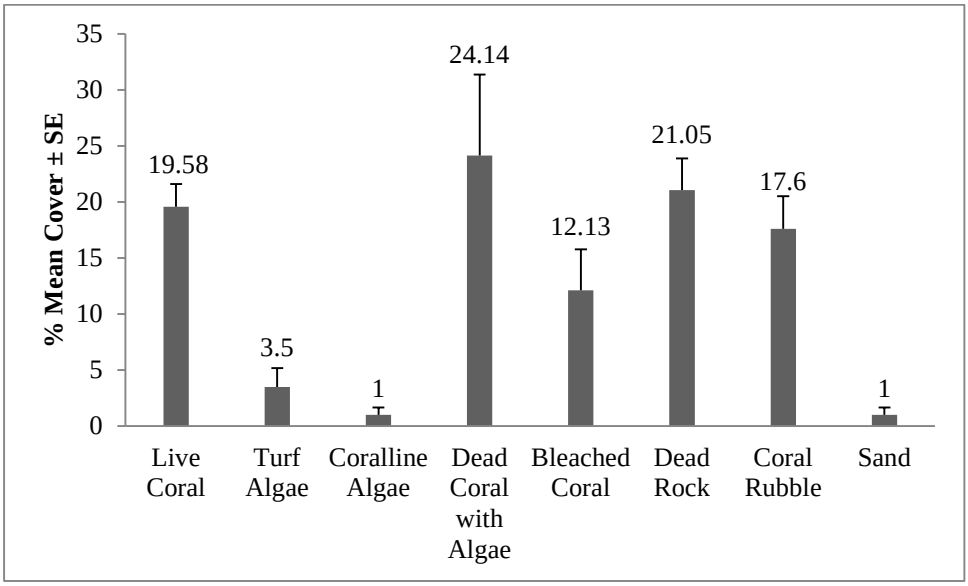

Table 4.1: Summary of fish census data along transect 1

Family	**Species**	**Diet**	**Abundance**
Holocentridae	*Sargocentron spiniferum*	Benthic invertebrates	2
Serranidae (Groupers)	*Cephalopholis argus*	Small fishes; small crustaceans	2
	Cephalopholis miniata	Small fishes; benthic invertebrates	2
	Aethaloperca rogaa	Small fishes; small crustaceans	2
	Cephalopholis nigripinnis	Small fishes; crustaceans	2
Haemulidae	*Plectorhinchus vittatus*	Benthic invertebrates	2
Lethrinidae	*Gnathodentex aurolineatus*	Small fishes; benthic invertebrates (crabs/snails)	3
Mullidae	*Parupeneus macronema*	Small fishes; benthic invertebrates	5
Mullidae	*Parupeneus barberinus*	Benthic invertebrates	2

Family	Species	Diet	Abundance
Chaetodontidae	*Chaetodon xanthocephalus*	Coral polyps; algae	2
	Chaetodon meyeri	Coral polyps	2
	Chaetodon auriga	Coral polyps; crustaceans; algae; worms	2
Pomacentridae	*Dascyllus trimaculatus*	Benthic invertebrates; zooplankton	3
	Chromis ternatensis	Algae; zooplankton	2
	Chromis dimidiata	Zooplankton	6
	Pomacentrus nagasakiensis	Algae; zooplankton	3
	Pomacentrus indicus	-	2
Labridae	*Gomphosus caeruleus*	Benthic invertebrates	2
	Hemigymnus fasciatus	Benthic invertebrates	2
Scaridae	*Scarus sordidus*	-	3
Zanclidae	*Zanclus cornutus*	-	2
Acanthuridae	*Acanthurus leucosternon*	Algae	3
	Acanthurus nigricauda	Zooplankton	2
	Acanthurus lineatus	Algae	2
Balistidae	*Sufflamen bursa*	Zooplankton; small fishes; benthic invertebrates	2

Transect 2

This transect was deployed at 4 m depth, along the reef edge to the north eastern side of the island, to the east of the channel. Live coral made about 26% of the transect line.

A total 29 fish species belonging to 11 fish families were recorded during the fish census at this site. Highest number of fish species were recorded from family *Pomacentridae* (8 species); members of this family is known to feed predominantly on zooplanktons.

Figure 4.3: Select images showing benthic substrate cover along transect 2

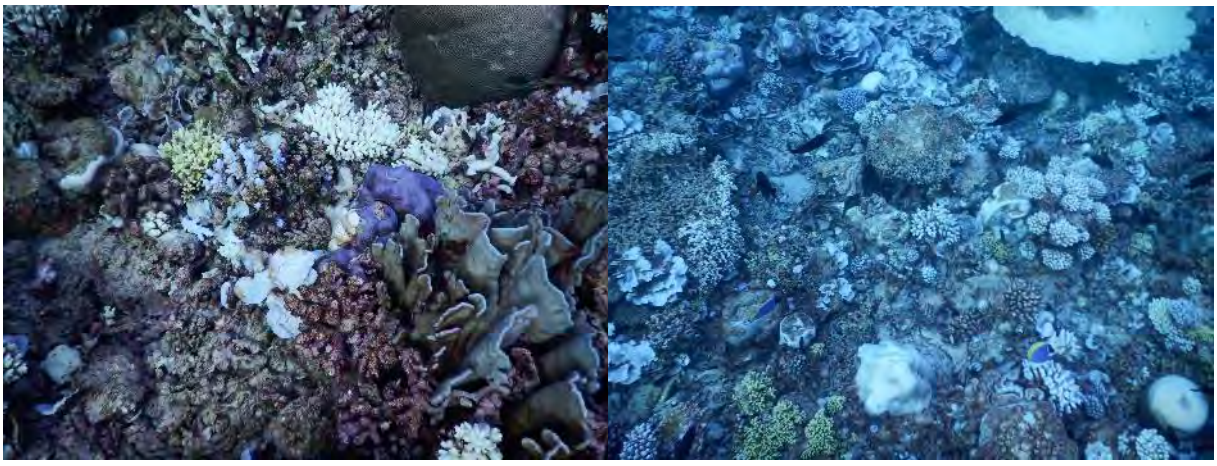

Figure 4.4: Benthic substrate composition and coral genera composition along transect 2

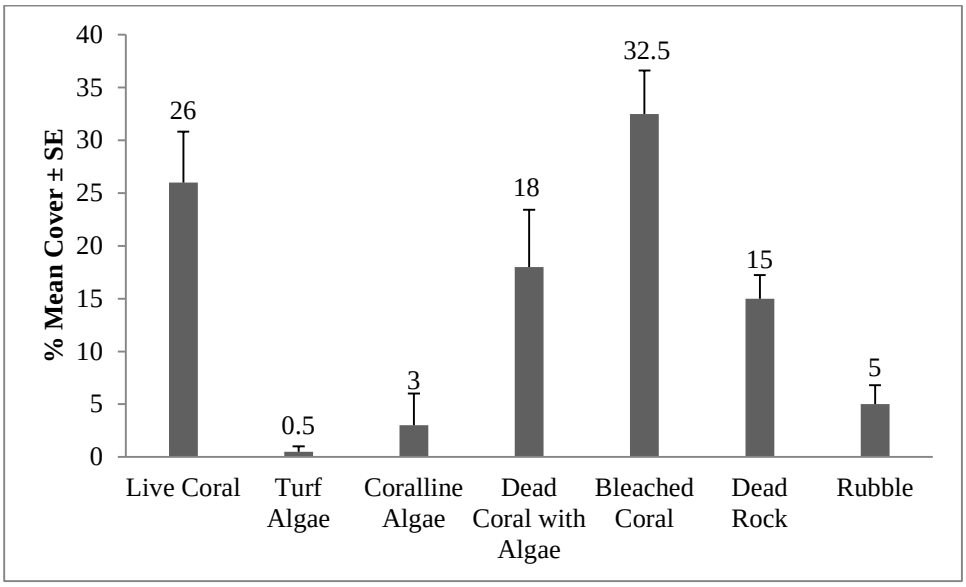

Table 4.2: Summary of fish census data along transect 2

Family	Species	Diet	Abundance
Holocentridae	*Sargocentron melanospilos*	-	2
	Myripristis violacea	Benthic invertebrates	2
Serranidae (Groupers)	*Aethaloperca rogaa*	Small fishes; small crustaceans	2
Lethrinidae	*Monotaxis grandoculis*	Molluscs; brittle stars; sea urchins; crabs; polychaetes; sea squirts; sea cucumbers	2
	Gnathodentex aurolineatus	Small fishes; benthic invertebrates (crabs/snails)	3
Nemipteridae	*Scolopsis aurata*	Small fishes; benthic invertebrates	2
Mullidae	*Parupeneus cyclostomus*	Benthic invertebrates	2
	Mulloidichthys vanicolensis	Benthic invertebrates	5
Chaetodontidae	*Chaetodon trifasciatus*	Coral polyps	2
Pomacentridae	*Chromis dimidiata*	Zooplankton	6
	Pomacentrus caeruleus	Algae; zooplankton	5
	Pomacentrus nagasakiensis	Algae; zooplankton	2
	Pomacentrus indicus	-	2
	Abudefduf vaigiensis	Algae; zooplankton	2
	Plectroglyphidodon lacrymatus	Benthic invertebrates; algae	2
	Plectroglyphidodon dickii	Benthic invertebrates; small fishes	2
	Chromis nigrura	-	2
Labridae	*Gomphosus caeruleus*	Benthic invertebrates	2
	Epibulus insidiator	Benthic invertebrates; small fishes	2
	Bodianus axillaris	Benthic hard-shelled invertebrates (snails/clams)	2

Family	Species	Diet	Abundance
	Hemigymnus melapterus	Benthic invertebrates	2
Scaridae	*Scarus sordidus*	-	2
	Scarus scaber	Algae covered rock; coral branches/mounds	2
Acanthuridae	*Acanthurus leucosternon*	Algae	3
	Acanthurus lineatus	Algae	2
	Ctenochaetus striatus	Film algae; detritus	2
	Zebrasoma desjardinii	Algae	2
	Naso lituratus	Brown kelp	2
Balistidae	*Sufflamen bursa*	Zooplankton; small fishes; benthic invertebrates	2

4.3 Work Completed

About 90% of the project is reported to have been completed and field assessments confirm this finding. Figure 2.2 shows a satellite image of the site on April 2016. Figure 4.5 below shows the project side during construction while attempts were made to dislodge the hard substrate using a 6 ton drop hammer.

Figure 4.5: Project side during construction while attempts were made to dislodge the hard substrate using a 6 ton drop hammer

5 IMPACTS IDENTIFICATION

5.1 Introduction

Potential adverse and beneficial impacts of construction and operation stage of the associated with the proposed development activities are identified and evaluated in this section. Significant impacts are identified and evaluated in two stages. The first stage identifies the environmental and socio-economic components that may be impacted from key project activities. The second stage determines the significance of impacts of each component. The following sections provide details of the evaluation of impacts.

5.2 Nature of Potential Impacts on Key Components

Nature of potential impacts is defined here as No Impact, Adverse Impact or Beneficial Impact. Table 5.1 below provides the nature of potential impacts from the proposed project on environmental and socio-economic aspects by the project components. Where impacts are not applicable to different components, this is indicated as 'X'. Some aspects may be affected both adversely (indicated as [-]) and beneficially (indicated as [+]) from the project.

5.3 Identification of Significant Impacts

Environmental and socio-economic aspects that may be impacted by the project as identified in Table 5.1 are further evaluated to identify significant impacts. Assessments of the impacts are conducted using the four criteria of Magnitude, Reversibility, Duration and Distribution as described below. Evaluation of key impacts is provided in Table 5.2.

1. **Magnitude**: Refers to the quantum of change that will be experienced as a consequence of the impact.
2. **Reversibility:** Refers to the degree of reversibility of an impact (i.e. ease of reversing the conditions).
3. **Duration:** Refers to the temporal scale (i.e. duration, frequency) of the impact. It does not take into account the duration of the impact's effects.
4. **Distribution:** Refers to the spatial scale of the area impacted (e.g. a small portion of a reef or an entire lagoon)

Estimates for negative impacts represent a 'worst case scenario' based on the assumption that the project will undergo full-scale development with no consideration for its environmental and social consequences, i.e. significance is assessed prior to implementation of mitigation measures. Values are attributed by the EIA team on the basis of direct observation of surveyed sites, professional judgment and pre-existing experience in development projects of similar nature.

Figure 5.1: Affected Area

Table 5.1: Impact Identification Matrix

NATURE	Noise Level	Air Quality	GHG emissions	Coastal processes	Soil condition	Geology	Terrestrial Flora	Terrestrial fauna	Marine water	Marine flora and fauna	Unique/ Protected species/ habitats	Landscape integrity	Natural hazard risk	Health and safety	Local economy	Social cohesion
Construction Stage																
Reef blasting	-	-	x	x	x	-	x	-	-	-	-	x	-	-	+	+/-
Dredging	-	-	-	-	x	x	x	x	-	-	x	x	-	-	+	+

X (no impact), - (negative impact) + (positive impact)

Table 5.2: Evaluation of key impacts on the natural and socioeconomic environment

Impact area	Potential impacts	Magnitude	Reversibility	Duration	Distribution	Significance
Ambient noise level	**Noise pollution:** Reef blasting will generate excessive noise both on the ground and underwater High noise levels will be lethal for some marine animals and disturb avian fauna. High noise levels will also cause discomfort for the locals	Moderate negative	Easily reversible	Short term	Vicinity of project site 5-10 km	Moderately High
Vibration	**Ground vibration:** Vibration on land may damage infrastructure and structures on the island; can damage reef structure **Underwater Vibration:** Underwater vibration can be lethal for some animals	Major Negative	Reversible in the long term	Long term	Island and reef level	Major
Geology	Potential damage and cracks in reef structure, particularly on the reef slopes.	Major Negative	Irreversible	Long term	Reef level	Major
Marine water	**Pollution of marine environment**: Possibility of temporary pollution in the area due to the use of Ammonia Nitrate **Increased turbidity and sedimentation**: Dredging and removal of dislodged material will involve turbidity and sedimentation	Moderate negative	Reversible in the long term	Long term	Island level	Major

Impact area	Potential impacts	Magnitude	Reversibility	Duration	Distribution	Significance
Terrestrial Fauna	**Disturbance to Fauna:** Terrestrial fauna is likely to be affected at the time of blasting.	Minor negative	Reversible in the long run	Short term	Site level	Minor
Marine Flora and Fauna	**Habitat loss and degradation**: The habitat of marine organisms in the direct footprint of the area to be blasted and within a radius of 30 m may be lost. **Biodiversity loss**: The excessive underwater noise and vibration will kill all fish within the vicinity or at least within 50 m of the site. Other sensitive species may be affected even about 500 m away.	Moderate negative	Reversible in the long term	Long term	Site level	Major
Health and Safety	**Risks to health and safety**: Accidents related to explosives handling and pollution can occur during construction.	Moderate	Possibly irreversible	Long term	Island level	Moderate
Social Cohesion	**Social discontent:** It is expected that there will significant discontent from the locals not only from Meedhoo and Hulhudhoo but from the entire atoll. The discontent is likely to spill over to a national level through social media and media reports.	Major negative	Reversible	Short term	National level	Moderate
	Community wellbeing: The potential damage to housing property and island infrastructure cannot be ruled out. Damage to shore protection measures, harbour	Moderate	Reversible	Long term	Island level	Moderate

Impact area	Potential impacts	Magnitude	Reversibility	Duration	Distribution	Significance
	and nearby houses are the key concerns					

6 SIGNIFICANT IMPACTS AND MITIGATION MEASURES

6.1 Impacts on the Natural Environment

6.1.1 Vibration

Reef blasting will involve significant ground vibrations. An estimation of the anticipated vibration levels have been undertaken. For the purposes of this assessment the scaled distance prediction formula was used:

$$PPV = k\,(D/Q^{0.5})^{e} \qquad (1)$$

Where: PPV: peak particle velocity (mm/s),

D: distance between the blast and the point of interest (m),

Q: the maximum charge per delay (kg), = 400 kg

k: site constant; A value of 1900 was used based on Australian Standard 2187.2, 2006

e: site exponent: a value of -2.1 was used for carbonate limestone

The figures for the constant and exponent are conservative and is intended to look at a high impact scenario. The results of the assessment are summarised in Table 6.1 and Figure 6.2.

Table 6.1: Blasting ground vibrations at varying distances

Distance (m)	Peak Ground Velocity (mm/s)
50	277.38
100	64.70
250	9.45
500	2.20
750	0.94
1000	0.51
1500	0.22
2000	0.12
2500	0.08
3000	0.05
3500	0.04
4000	0.03
5000	0.02

A person can normally feel ground vibration levels of approximately 0.5 mm/s. Australian Explosives Code 2187.2, 2006 recommends a general level of 10 mm/s for ground vibration resulting from blasting at houses and 25 mm/s for all other structures. The peak particle velocity measured for ground surface on Meedhoo shall not exceed limits recommended in table 6.2:

Table 6.2: Recommended Maximum Peak Particle Velocity

Type of Building or Structure	**Peak Particle Velocity (mm/s)**
Houses and low-rise residential buildings; commercial buildings, breakwater and seawalls not included below	10
Commercial and industrial buildings or structures or reinforced concrete or steel construction	25

Air blast overpressure is a vibration pulse in the air induced by ground vibrations, and can cause damage to buildings and structures through resonance. Australian Explosives Code 2187.2, 2006 recommends a limit of 120 dB as the threshold for human discomfort and 133 dB to avoid structural damage.

Water borne vibrations can be caused due to shock waves radiating from a blast. It has the potential to kill or injure animals or even humans within the vicinity of the blast site. Based on the ICI 'Handbook of Blasting Tables', the underwater concussive effect may be estimated using the following formula:

$$P = A\left(\frac{R}{\sqrt[3]{W}}\right)^{-1.13} \qquad (2)$$

where: P = peak pressure (kPa)

W = charge mass per delay (kg)

R = distance from charge (m)

A = 54.6 x 103

Table 6.3 provides the results for the assessment. Again, these figures are conservative.

Table 6.3: Estimated water borne vibration

Distance	Peak Pressure (kPA)
50	6272.86
100	2866.17
250	1017.72
500	465.01
750	294.09
1000	212.47
1500	134.38
2000	97.08
2500	75.44
3000	61.40
3500	51.58
4000	44.36
5000	34.47

The following figures may be used a guide to physiological effects of blasting underwater.

Table 6.4: Estimated water borne vibration

Peak Pressure	Report Injury
3500	Absolutely lethal to humans
1400	Lung injuries
280	50% chance of being lethal to small animals
40	Completely safe to humans and animals

Therefore, a radius of 4 km is estimated to be affected due to the blasting activity. A radius of 1.5 km is not safe for swimming. Marine animals, particularly fish and turtles within a 1 km radius is likely to be severely affected.

The sensitive marine environment of Meedhoo North Kandu is going to be affected.

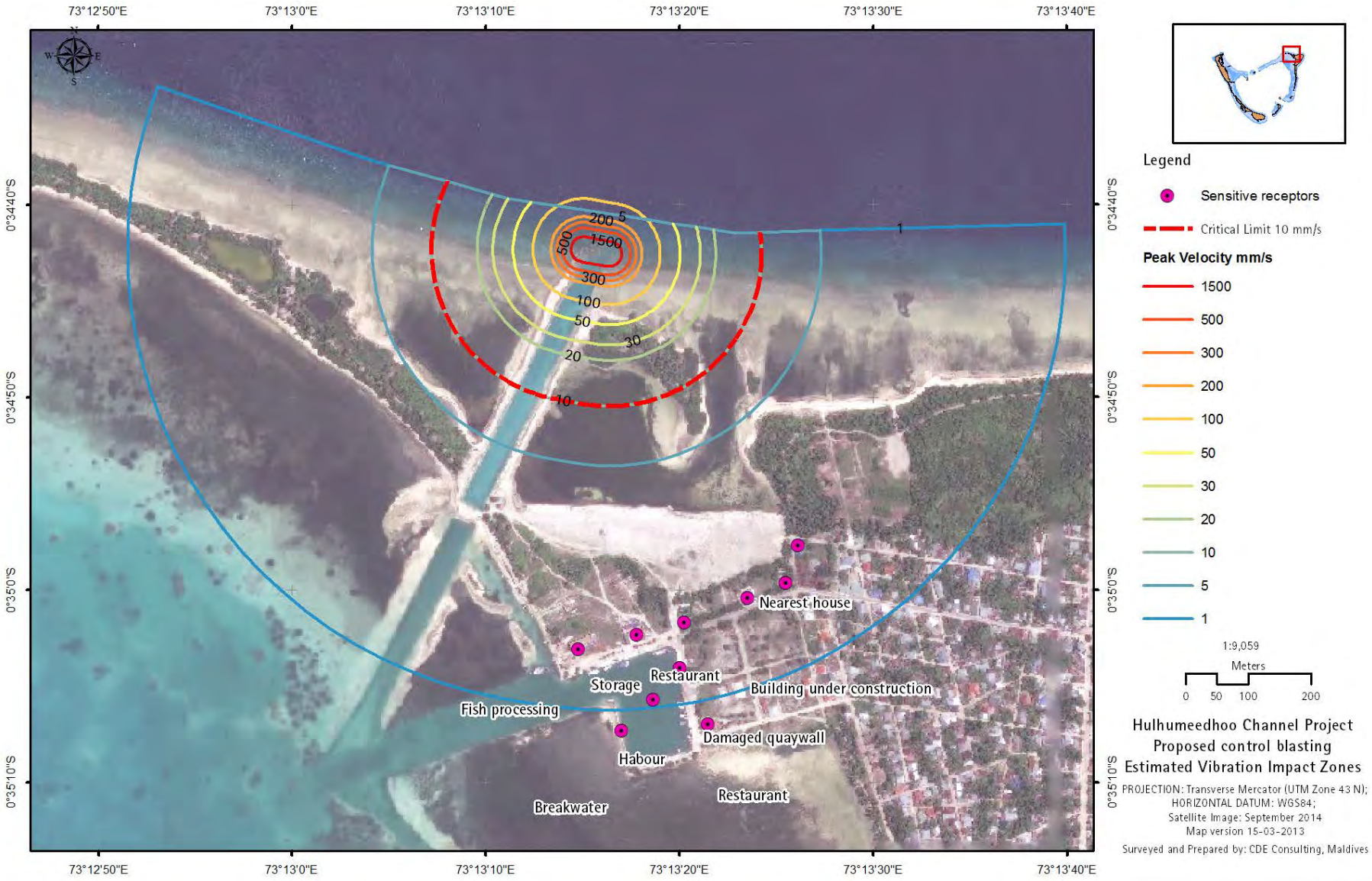

Figure 6.1: Estimated ground vibration limits

Mitigation measures

- Use surface or near surface blasting as much as possible. (i.e. use the minimum hole depth
- The limit for ground vibration should not exceed 10 mm/s beyond 250 m.
- An over pressure limit of 134 dB should not be exceeded.
- Only the required charge delay must be used.
- No blasting to take place during night time
- Ensure that the correct design relationship exists between burden, spacing and hole diameter.
- Coordinate with Police and City Council to ensure that no person is swimming in the water within 4 km of the blast site on the ocean side of Meedhoo reef and within 3 km on the lagoon side. These include sand miners on the lagoon side. Any person swimming within 100 m is at risk from death or severe lung damage.
- Costs for these mitigation measures are included in the contract value.

6.1.2 Noise

The use of explosives to dislodge the hard Oceanside reef rim will generate high levels of noise. It is anticipated that the point source of noise may generate about 100-120 dBA. Most audible noises on the surface are expected to go down considerably by about 3 km from the point source. The blasts will also be for a very short time period limiting any physiological damage on humans. Thus, noise levels are not expected to cause any major health issues to the current settlement. The blast noise is expected to be noticeable at least 5 km from the site.

As noted in section 6.1.3, the Australian Explosives Code 2187.2, 2006 recommends a limit of 120 dB as the threshold for human discomfort and 133 dB to avoid structural damage.

The effects on marine life on noise sensitive animals, such as dolphin and whales could be felt up to 50 km. As noted in 6.1.3, moderate to significant impacts on marine life are expected within 1 km of the site. However, these impacts are reversible in the long-term.

Mitigation measures

- An over pressure limit of 134 dB should not be exceeded.
- No blasting to take place during night time
- Do not undertake work during high periods of high wind speed.

- Cost of these mitigation measures is included in the contract value.

6.1.3 Geology

The impacts on geology could not be identified for the project due to lack of geological data on the site and limited studies on ocean side reef blasting impacts.

The most significant impacts anticipated based on studies undertaken in Male' Island is the potential for cracks forming in the reef and in worst cases, reef slope failure. It is not possible to determine where the cracks may occur as the geological data is not available. Some of these cracks can do long-term damage to the reef slope as it may widen over time. Effects of blasting may become many years after the work has been completed.

Based on the vibration assessment, the most likely impact zone is within 300-500 m from the blast site. It is unlikely that Meedhoo Island itself will be affected as the blasting is carried out in a limited area and for a short time.

Nonetheless, the impacts on geology are not clear and can be irreversible in the long-term. Caution is required to proceed with the proposed blasting work.

Mitigation measures

- Use surface or near surface blasting as much as possible. (i.e. use the minimum hole depth. Do not design to clear the entire area with a single blast.
- Reduce the explosives as much as possible in an effort to reduce the Peak Vibration within the 50 m radius.
- Monitor the reef for cracks for damage very day
- If there are any cracks visible, cease blasting immediately and indefinitely.
- Survey for reef crack monitoring is estimated to cost Rf3000 per survey.

6.1.4 Marine Biodiversity

Direct impacts on marine biodiversity will include permanent loss of benthic organisms, habitats and coral colonies within the blasting foot print.

A significant amount of siltation and sedimentation of the lagoon waters has already occurred. Further impacts are likely during excavation.

Degradation of the water quality due to Ammonia Nitrate is expected. However, this impact will be localised and is likely to disburse immediately. Moreover, the marine life in the area polluted will already be dead or would have moved away due to the blasting effects.

Detailed impacts on the coral reef and fish populations have been addressed in the original EIA. This assessment will focus on underwater noise and vibration impacts.

Blasting will involve noise levels reaching about 100-120 dBA. There will also be water borne vibrations (See Table 6.3). The vibration and noise will affect fish and turtle population within a 4 km radius in the short-term. Fish and mammals within 1 km are expected to be severely affected. Those within 100-150 m are likely to die. Under worst-case scenario, the number of dead fish may reach over a thousand, as fish life is good on the northern rim of Meedhoo.

Impacts on marine life will be significant and its magnitude is also high. Protected and endangered marine species were observed during the past surveys along the northern rim of Meedhoo. However, these impacts are reversible in the long-term.

Mitigation measures

- Monitoring to identify population and community level changes
- Visual inspections of site before any construction activities to ensure sea turtles are not present within 300 m of the site before blasting
- Carryout all construction works during low tide, and calm sea conditions to minimize adverse impact on marine life from sea water quality degradation.
- Visual survey is estimated to cost Rf3000 per survey.

6.1.5 Marine Water Quality

Significant temporary impacts on marine water quality are expected due the use of Nitrogen Ammonia. The residual material that may remain after the blast will contaminate the area temporarily but is expected to flush quickly. Pollution is unlikely to affect the marine life as all life within the foot print of the blast area is likely to be already severely depleted.

Ammonia nitrate stored on land may also spill during handling.

Mitigation measures

- Close supervision of construction activities and monitoring for littering and spills
- Chemical handling kits on site

- Carryout all construction works during low tide and Calm Sea conditions to minimize spread of sediment plumes, and degradation of water quality. Avoid working during strong wave activity on the ocean side.
- Cost of these mitigation measures is included in the contract value.

6.2 Impacts on the Socio-Economic Environment

6.2.1 Health Risks to Workers and Local Community

Health and safety risks arising from construction work is very high, especially due to the use of explosives. Accidents can lead to injury and fatalities.

The use of explosive chemicals involve risks to health and safety. Accidental spills/ leakage of hazardous substances can contaminate the site and pose risks to human health, including workers on the site.

Workers and locals swimming within a 1.5 km radius of the blast site are at risk due underwater vibration and noise.

Any person within a 300 m radius is at risk from flying debris.

The island is located away from the 10 mm/s ground vibration zone, which is the critical limit for structural damage. Thus, structural damage is not expected. However, caution should be raised on that this assessment is theoretical and can vary due to a number of factors such as weather, underlying reef geology and the age of the structure.

The noise generated from the blasting event can shock young and the elderly.

Mitigation Measures

- Inform all the community about the schedule of the blasting activity and warn the public using mobile megaphones or from the Island Administration Office loud speakers before blasting.
- Inform all classrooms in session before blasting.
- Avoid undertaking blasting during a prayer time.
- Ensure no one is swimming, snorkelling or diving within a 3 km radius at the time of blasting.
- Inform all resorts and dive school about the schedule and avoid any diving within 5 km of the proposed site.

- Secure the project work site at least within a radius of 350 m from the blast site.
- Work should be undertaken with people experienced in explosives handling. The supervisor must have over 10 years' experience in reef blasting activity.
- Cost of these mitigation measures is included in contract value. Additional costs may be incurred and are estimated to range between Rf7500-10, 000.

6.2.2 Impacts on Social Stability of Island and Atoll Community

The main negative social impacts likely from this project are:

a. Locals unhappy about their reef being damaged for the benefit of a few fishermen on the island. It is expected that there will be people who are not in favour of such a drastic approach to channel dredging. Their unhappiness may spill over to frustration against the project contractors and Administration.
b. It is expected that there will be opposition to this project from the rest of Addu City. The City Council has already expressed the general view that they are not in favour of reef blasting.
c. The issue could also become national as the modern communications methods such as social media is used to express dissatisfaction against reef blasting.

Thus, the project is expected to have a negative impact on the social cohesion of the island and atoll community.

Mitigation Measures

- Sufficient time needs to be given for the public to comment on this EIA and express their views to EPA.

6.2.3 Impacts on Other Resource Users

Resort diving activities within a 5 km radius is likely to be affected during reef blasting days.

Sand mining activities and bait fishing that involves underwater activities within a 5 km radius also need to cease during reef blasting. There will be income loss from these activities.

Mitigation Measures

- Inform the resorts, sand miners and fishermen with sufficient time to manage their activities.

6.2.4 Beneficial impacts on local economy and transportation

As noted in the original EIA, the project is expected to have potential beneficial impacts during the operational phase including:

- Reduced cost of passenger travel between Fuvahmulah and Meedhoo.
- Increased connectivity of Meedhoo and Hulhudhoo Island
- Reduce fuel costs and usage by fishermen, thereby increasing the productivity and profitability of fishing industry
- Reduced fuel usage, thereby reducing imports and greenhouse gas emissions

The question of whether there is any need for the channel to link up with Fuvahmulah was raised since Fuvahmulah now has an airport and the ferry between the two atolls was discontinued. However, the locals reported that the ferry has restarted again.

Nonetheless, the percentage of Addu City population and Hulhudhoo, Meedhoo population directly benefitting from this project seems to be small, compared to other reef entrance projects in the Maldives.

6.3 Suggested Mitigation Measures for Adverse Impacts

Table 6-1 Suggested mitigation measures for potential adverse impacts

Environmental Aspect	Mitigation Measures	Mitigation Cost	Responsible Party
Noise Level	• An over pressure limit of 134 dB should not be exceeded. • No blasting to take place during night time • Do not undertake work during high periods of high wind speed.	• Included in contract value	Contractor/ proponent
Vibration	• Use surface or near surface blasting as much as possible. (i.e. use the minimum hole depth • The limit for ground vibration should not exceed 10 mm/s beyond 250 m. • An over pressure limit of 134 dB should not be exceeded. • Only the required charge delay must be used. • No blasting to take place during night time • Ensure that the correct design relationship exists between burden, spacing and hole diameter. • Coordinate with Police and City Council to inform public and prevent swimming in affected areas.	• Included in contract value	Contractor/ proponent

Geology	• Use surface or near surface blasting as much as possible • Reduce the explosives as much as possible in an effort to reduce the Peak Vibration within the 50 m radius. • Monitor the reef for cracks for damage very day • If there are any cracks visible, cease blasting immediately and indefinitely.	• Rf3000 per survey	Proponent/ consultant
Marine biodiversity	• Monitoring to identify population and community level changes • Visual inspections of site before any construction activities to ensure sea turtles are not present within 300 m of the site before blasting • Carryout all construction works during low tide, and calm sea conditions to minimize adverse impact on marine life from sea water quality degradation	• Monitoring cost covered in the monitoring programme. • Rf3000 for visual survey	Contractor/ proponent
Marine water	• Close supervision of construction activities and monitoring for littering and spills • Chemical handling kits on site • Carryout all construction works during low tide and Calm Sea	• Included in contract value	Proponent/ contractor

	conditions		
Health and safety	• Inform all the community about the schedule of the blasting activity and warn the public using mobile megaphones or from the Island Administration Office loud speakers before blasting. • Inform all classrooms in session before blasting. • Avoid undertaking blasting during a prayer time. • Ensure no one is swimming, snorkelling or diving within a 3 km radius at the time of blasting. • Inform all resorts and dive school about the schedule and avoid any diving within 5 km of the proposed site. • Secure the project work site at least within a radius of 350 m from the blast site. • Work should be undertaken with people experienced in explosives handling. The supervisor must have over 10 years' experience in reef blasting activity.	Included in contract value; additional costs estimated at MVR 7500 to 10,000	Proponent/ contractor
Social cohesion	• Public to comment on this EIA and express their views to EPA.	N/A	EPA
Impacts on resource	• Inform the resorts, sand miners and fishermen with	N/A	Proponent/ contractor

sharing	sufficient time to manage their activities.

7 ALTERNATIVES

7.1 "No-project" Alternative

The option of a No-Project alternative for the proposed reef entrance has been considered for the project in the original EIA. This chapter only looks at No Project option only for the Reef Blasting part, which is addressed in this report. The advantages and disadvantages of the No Project option are presented in Table 7.1.

Table 7.1: Summary of "No Project" Alternative

Options	Advantages	Disadvantages
No Reef Blasting	– Damage to marine life due to blasting is avoided. – Potential unknown and irreversible damage to reef geology and their future consequences are avoided. – Possible safety risks to workers and public avoided – Possible social conflicts and cohesion issues related to reef blasting is avoided. – Potential damage to structures, particularly harbour infrastructure avoided. – Damage to one of the most beautiful coral reef areas in Addu City and the sensitive environment avoided. – Potential disruption to resort operations during blasting (related mainly to diving and snorkelling) avoided.	– The reef has already been dredged and damages to the reef associated with marine works have been incurred. Leaving the channel as it is will leave the channel unusable and the objective of the channel unachieved. – Public money already spent on this project will be wasted. – Fishing industry continues to burn unnecessary fuel to access the fishing ground. – Comparatively higher fuel consumption when travelling between Fuvahmulah and Gan. – Local subsistence fishermen not able to access the fishing ground or the outer reef for fishing due to prohibitive costs of the alternative transport route – Social tension may increase if this project is not completed. The contractor is presently stuck on the site due to this final hurdle. Locals may prevent contractor

Options	Advantages	Disadvantages
		from leaving. – Politicians have already made a promise to assist in finishing the channel. Their lobbying power within the Government can add to further tension relating to a decision on not finishing the channel.

The proposed reef blasting activity involves significant environmental impact and the risks are exacerbated due to the fact that Meedhoo's northern rim is a listed sensitive environment and limited knowledge on the potential damage to reef structure. EPA reported that reef blasting has also not being carried out in the Maldives for a long time and the Agency discourages this activity. Damage to marine life is reversible in the medium-term but damage to reef geology is irreversible and could affect generations to come. From an environmental perspective, when using a precautionary principle or ecologically sustainable development principle, reef blasting should be avoided in the Maldives until more detailed studies can rule out potential long-term damage to reef geology. Addu City Council also prefers the precautionary principle. Thus, from a purely physical and biological environment perspective the No Project option has to be preferred.

On-the-other-hand, the reef entrance in question is already dredged and only a 15 m stretch is in the way of this project's completion. The contractor needs to demobilize. If they demobilize without opening the channel, the channel will not be useable for medium to large vessels and the project would remain a waste of public money. There is strong support in the community to move forward with this project dating back to 2009 (three separate consultations have been undertaken for this project between 2009 and 2016).

Given the community's desire to complete this channel, the benefits it bring to the fishing community, and potential loss of public money if this project is not completed, the No Project option has a higher opportunity cost. Thus, in the absence of any other alternative, it is recommended that EPA consider approving this project based on conditions. The most important condition being that of precaution. The contractors, proponent and the public should understand that the project will need to be ceased if any cracks are observed on the reef during the blasting process. Crack monitoring should be undertaken by EPA or by an independent party

7.2 Alternative hard substrate dislodging methods

According to the statements provided by contractor and the proponent, various alternative methods have already been tried for this project. Options available for this project are summarized below.

1. Drop hammer

A drop hammer is a large, heavy weight raised mechanically and allowed to drop from a height onto the area proposed to be dislodged. It is usually attached to a crane and lifted in the air. This method works in shallow water areas.

Both these methods involve significant vibration and the use of drop hammer could be associated with unknown damage to reef geology as well.

It was reported that both these methods were used by the proponent and were unsuccessful (see Figure 7.1 below).

Figure 7.1: Drop hammer being used at the proposed site

2. Pneumatic hammer attached to an excavator

Marine Airguns which can dislodge 1000 kg can be used to break the rim. Airgun is a pneumatic hammer driven using air pressure. The gun will be attached to an excavator. It works as a jack hammer by dislodging hard substrates. The dislodged material will be removed by an excavator. There are reports that the previous contractor tried this method but could not be independently verified.

Thus, considering that at least one of the most common methods available in the Maldives has already been tried for four months, the remaining option is to undertake control blasting.

8 ENVIRONMENTAL MANAGEMENT PLAN

The original Environmental Management Plan (EMP) proposed for the project has been updated. The table showing the updated management plan is presented in Table 8.1

Table 8.1: Updated Environmental Management Plan for construction and operation phase

Activity	**Management measures**	**Responsible party**	**Timing**
Training of staff and contractors	All construction workers and project management staff will be provided information on general environmental issues, compliance with environmental permits and EMP. All staff involved with environmental monitoring will be provided training in environmental monitoring procedures.	Project proponent & Environmental Consultant	Before commencement of construction activities
Documenting non-conformances and corrective actions	All non-conformances to the environmental permit conditions, observed during monitoring will be documented. Necessary corrective actions and preventative actions will be identified Corrective actions will be implemented, with systematic follow ups to ensure effectiveness of these measures	Project proponent & Environmental consultant	Continuous during construction phase
Control of contamination	Oil, solid waste and hazardous waste handled carefully and transported in sealed containers. All paints, lubricants, and other chemicals used on site stored in a secure and bunded location.	Project proponent	Continuous during construction phase

Activity	**Management measures**	**Responsible party**	**Timing**
	Littering and accidental disposal of construction wastes avoided by preplanning. All raw materials stored away from the vicinity of the coastal areas. General refuse stockpiled in one central area. Construction activities carried out under the supervision of an experienced person. Regular visual inspection of surrounding marine environment for waste		
Waste management (Waste generated from construction activities, the domestic and sewage waste generated by construction workforce)	All waste segregated, stored temporarily and transferred to the existing waste management site and domestic sewage generated will be dealt through the existing sewerage system or septic tanks	Project proponent	Continuous, during construction phase
Supervision of project activities	Assign suitably experienced and qualified personnel to supervise the entire project and ensure that all activities are carried out with minimal adverse impact on the environment A suitably experienced and qualified person should oversee the blasting activity. It must be carried out by personnel from Ministry of Defence and National Force qualified and authorized	Project proponent MNDF	Before commencement of the project Continuous during blasting process

Activity	**Management measures**	**Responsible party**	**Timing**
	to handle explosive.		
Additional public input for the project	Arrangements need to be made by EPA to facilitate public to comment on this EIA	EPA	Before approval
Impacts on resource sharing	Inform the resorts, sand miners and fishermen with sufficient time to manage their activities.	Proponent	Before commencement of the project and as required
Monitoring for reef cracks	Monitor the reef for cracks for damage very day If there are any cracks visible, cease blasting immediately and indefinitely.	Proponent / Environment consultant or EPA	Continuous during blasting process

9 ENVIRONMENTAL MONITORING PLAN

The existing environment management plan for the project has been updated to include reef crack, vibration and noise monitoring. In addition, a post blasting reef survey is to be included as well. The additional requirements are summarized in Table 9.1.

Table 9.1: Additional parameters for the Monitoring Plan

Monitoring Attribute	**Indicator**	**Methodology**	**Location and Frequency**	**Estimated Cost**
Reef slope monitoring	Presence of cracks and their length and width	Manual measurements	300 m length on each side of the blast site on the ocean side reef slope. Once after completion for blasting	Rf 3500 per survey
Noise	Equivalent day time noise levels (Leq) in dBA Nosie complaints received	Using noise meter continuously during daytime during proposed working days	In the nearest house and nearest school. Daily during days when blasting is to take place.	Rf1500 per survey
Coral reef health	Percentage of live coral cover, and fish species abundance and composition Observation of any large fish or protected species affected	Line transect survey; Fish census Manta tow survey	On the two transect sites. On completion of project and six months and one year after blasting activity.	Rf3500 per survey
Vibration	Vibration velocity measurements in mm/s	Using vibration monitoring equipment continuously during blasting activities	In the nearest house and harbour structure	Rf2000 per survey

9.1 Monitoring Report

Monitoring requirements are the same as the original EIA, which is to submit an annual monitoring report to EPA.

9.2 Commitment for Monitoring

The proponent is fully committed to undertake the additional monitoring program outlined in this Chapter (refer Appendix G of this report).

10 STAKEHOLDER CONSULTATIONS

Stakeholder consultations for this EIA were conducted between 20 April 2016 and 21 April 2016. Addu City Council, Hulhumeedhoo public and Hulhumeedhoo District Office were consulted for this EIA. During each consultation stakeholders were briefed about the proposed project and asked about their views and concerns about the project activities, and to give recommendations.

Following sections provide more details of consultations with each of the stakeholders.

10.1 Addu City Council

Date: 20 April 2016

Time: 13:00 hrs

Participant:

Mr. Abdulla Sodiq

Addu City Council Mayor

Contact: 7924030

Summary of Discussions:

- Mayor expressed strong concerns about the risks to the reef from the proposed blasting method. He explained that protected species such *as Napolian Wrasse* are seen in this reef and the project will have significant impacts on these fishes.
- According to the Mayor, majority of the city council members oppose reef blasting. They have previously opposed a reef-blasting project in Gan as well.
- Mayor explained that there are positive and negative impacts of this project, but in his opinion the negative impacts outweigh the benefits. He said that the new reef entrance will significantly reduce the travelling distance for fishing boats and other vessels, nonetheless, considering the significant environmental costs involved in reef blasting, the channel dredging is not worth undertaking.
- Mayor advised to consider all other alternative methods for reef entrance dredging instead of using the blasting method. Reef blasting should be the last option after exploring all other methods and if no other method is proven feasible.
- He said that the costs of excavation would be higher but since environmental risks are lower, excavation method is preferred over blasting.

10.2 Hulhumeedhoo Public and District Office

Date: 21 April 2016

Time: 20:30 hrs

Place: Seenu Atoll School

Proceedings:

A brief introduction of the EIA firm was given and participants were explained about the role of the EIA firm. Participants were asked about their prior knowledge of the project followed by explaining each of the project components in more detail. Potential impacts of the project were explained and participants were asked about their final opinion about the project.

Summary of Discussions:

- Participants were well aware of the project and the proposed method of dredging.
- All the participants except one person said they are strongly in favour of the project and that they would like the project to be implemented as soon as possible. They also stated that majority of the island public want the project and that this is a project the public of Hulhumeedhoo has wanted since long.
- There was consensus among participants that dredging a channel between Hulhumeedhoo and Ismehelahera would significantly improve economic activities of Hulhumeedhoo island, particularly fisheries as the travel distance for fishing boats will be significantly reduced, thus saving money spent on fuel. One participant also pointed out that the existence of a channel in this location would be a great advantage for Ismehelahera too if the island is developed as a resort in the future.
- One individual noted that the amount of explosives should be carefully calculated to ensure that explosives are not used in excess, as excessive use of explosives will cause unnecessary damage to the reef.
- Two senior persons in the meeting reflected on their past involvement in similar reef blasting projects during British rule and claimed that the previous blasting projects did not have major impacts on the environment or people.
- Participants argued that the project should be implemented despite few adverse environmental impacts since the socioeconomic benefits of this project outweigh the negative environmental impacts. They supported this argument with reference to coastal developments in Male' and other islands such as Fuvahmulah, emphasizing that many development projects have environmental costs but are justified based on the needs of the society.

- Participants further argued that the closure of the Hulhumeedhoo-Ismehelahera channel has been causing erosion on previously stable beach areas of Hulhumeedhoo by blocking the natural current flow and movement of sediments along the shoreline. The reopening of the channel would prevent further beach erosion and this should be another good reason to consider the dredging of this channel, according to the meeting attendees.
- During the discussion, participants suggested to make the channel wider and deeper than the proposed width and depth, to allow safe use of the channel by a wider range of users such as cargo boats and passenger boats. They argued that if the channel were dredged as per the proposed dimensions, it would not be safely accessible for large vessels such as cargo boats during rough sea conditions. No specific depth or width was suggested during the meeting.
- The participant who opposed the project spoke with EIA team after the meeting and explained that while he himself owns a small boat and will benefit from a shorter route to the ocean, he is strongly against using explosives to dredge the reef entrance. He said that he believes that the blasting will have significant vibration impacts on the island and cause irreversible damages to the reef, therefore the project is not worth continuing despite the socioeconomic benefits.

Observations

- Almost all members apart from one person was very much in favour of the project and had no issues with reef blasting.
- We note that the meeting was arranged by the Island Administration and may not be an equal or adequate random representation of differing public views.

10.3 Environment Protection Agency

Date: 7 August 2016

Time: 15:00 hrs

Place: Over the phone interview

Participant: Ibrahim Naeem,

Summary of Discussions:

- The project was explained to Mr. Naeem and he was aware of the project.
- He noted that there is an internal memo in EPA where all the departments have agreed not to allow reef blasting in the Maldives due to the high impacts from this activity on marine life and coral reef.
- There are also a lot of unknowns related to this activity particularly in relation to reef geology.
- EPA does not encourage or condone reef blasting in the Maldives.
- Reef blasting has already been stopped in the Maldives and it has been a long time since the last reef blasting activity.

10.4 Marine Research Centre

Date: 8 August 2016

Time: 08:00 hrs

Place: Marine reseach centre

Participant: Dr. Mohamed Shiham Adam

Summary of Discussions

- The project was explained to Dr. Shiham and he had the following recommendations.
- As a matter of principle he does not encourage reef blasting. He noted that this activity involves significant damage to marine life and potentially to the reef geology.
- The main issue lies not with the marine life as impacts on them could be reversible in the long-term. The issue lies with the reef geology and possible unknown impacts it may have on the reef structure, which is irreversible. These impacts could be felt for generations to come.

- Since the reef entrance project is already 90% completed, he suggested that if the Government decides to proceed with the project, they should use the minimum possible charge and do it layer by layer rather than try to dislodge the reef in one attempt.

Table 9.1: List of persons consulted

#	Name	Address/ Organization	Designation/ Occupation	Contact No.
1	Ali Mohamed	Addu City Council	Hulhumeedhoo Councilor	7900512
2	Ibrahim Jamal		Captain	9932113
3	Ahmed Zuhair		Fisherman	7722185
4	Ahmed Didi		worker	9666053
5	Ibrahim Didi		Fisherman	7696126
6	Ali Ahmed		Fisherman	7772827
7	Ali Didi			7773120
8	Abdullah Didi		Fisherman	7851571
9	Ahmed Didi			7902718
10	Abdul Samad		Fisherman	7710769
11	Mohamed Waseem		Fisherman	7825307
12	Javadulla Zaahiru		Captain	7972242
13	Abdullah Ibrahim Didi	Paris , S.Meedhoo		9722725
14	Ibrahim Waheed	Randhan , S.Meedhoo		7711320
15	Ali Wafir	Dhivehi, S.Meedhoo		9787564
16	Hussen Didi	Dream Rose, S.Meedhoo		7925750
17	Hassan Thakkhaan	Champapoolmaage, S.Hulhudhoo		7855476
18	Ahmed Waseem	Dolphin, S.Meedhoo	Ferry captain	7492422
19	Ahmed Waheed	Dhonveli, S.Hulhudhoo	Dive Dhoani Captain	7934337
20	Ismail Rasheed	Farivaage, S.Hulhudhoo		7670812
21	Abdulla Manikfaanu	Theena, S.meedhoo	Fisherman	7593301
22	Ahmed Didi	Maavas, S.Meedhoo		9134367
23	Ahmed Nizam	Sarna, S.Hulhumeedhoo		7978078
24	Ahmed Didi	Rastha, S.Meedhoo	Boat Owner	7949625
25	Ahmed Mujuthaba	Vilotvaadhy, S.Meedhoo		7751312
26	Mohamed Abdulla	Sevina, S.Hulhudhoo	Speedboat Captain	7926290
27	Mohamed Ibrahim	-	Hulhanguge/S.Meedhoo	-

Note: Contact details have not been included as most of them objected to putting their phone number

11 POTENTIAL DATA GAPS AND ASSESSMENT LIMITATIONS

11.1 Gaps in Information

In addition to the gaps specified in the original EIA, this assessment has a deficiency in terms of geological assessment. No geological studies have been undertaken at the site and no geological information is available as secondary data for the project site. Geological data up to a 25-30 m depth is important to determine the potential impacts on the reef structure.

There is also no data on the structural stability on the existing houses and infrastructure on Meedhoo Island. No specific studies were undertaken for this EIA as it was not specified and in the EIA and the project does not have enough time to undertake such an assessment. Infrastructure in the vicinity such as the harbour quay walls and breakwater already have some sections damaged but the extent of the structural issues of these facilities are not known.

It is difficult to prove visually that the contractor has exhausted all available options such as pneumatic hammer or drop hammer to dislodge the reef. What we have is a written statement from the contractor that all these options have been used and were unsuccessful. Please see Appendix H for the letter.

11.2 Uncertainties in Impact Prediction

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. As note earlier, there is also no long term data and information regarding the particular site under consideration, which makes it difficult to predict impacts. It is important to consider that there will be uncertainties and voluntary monitoring of natural processes as described in the monitoring programme is absolutely essential.

The absence of geological data creates very high uncertainly over the potential impacts on the reef. If this project is to go ahead, all parties and EPA needs to be aware that there are risks involved. The option available to minimise this impact is to reduce the charge and to monitor the site for reef cracks daily.

The vibration and noise modelling provided in this report are based on commonly practiced mathematical formulas which provides a best guess but should not be treated as the absolute values. Precaution is always required.

12 CONCLUSIONS

The proposed changes to the project involves a single activity: reef blasting. All other activities of the project have already been approved in two separate EIAs.

This assessment shows that the project will involve significant damage to the environment. Most notably, fish and marine life within the vicinity is likely to die or be severely affected. The underwater effects may extend up to 5 km from the site. There is potential for vibration impacts on old houses although the modelling results show that the critical ground vibration zone does not fall on to Meedhoo Island. However, these impacts are reversible in the long term.

The main concern of this project is related to the unknown impacts on reef geology and reef slope. These impacts will be irreversible and may effect generations to come. In the absence of geological assessments and past studies on geological impacts of reef blasting in Maldives, it is difficult to predict the actual impacts on the reef.

Reef blasting is not encouraged by the EPA due to the high impact on marine life, potential unknown impacts on the reef and known cases of structural damage on inhabited islands. EPA reports that reef blasting has not been carried out in the Maldives for long time.

The support for this project is mixed. In the consultations undertaken for the original EIAs and this Addendum, there is overwhelming support by the locals from Meedhoo and Hulhudhoo for this project. Sometimes, it appeared that people who have an opposing opinion were holding back because most people on the Island want to move forward with it. The City Council supports this project but is apprehensive about reef blasting as they believe it is detrimental to the future of Addu City. EPA and MRC do not encourage reef blasting.

The locals have emphasized the need for this project for many years (as reported it the two original EIAs). It has gone through a stop-start process since 2009. Up to three contractors have been involved so far. The current contractor has been unable to demobilize without completing this section. The overall project is almost completed and only a small section of the reef stands in the way of its completion. If the section of reef rim in question is not dredged, the reef entrance will not be useable for medium to large vessels, including fishing vessels. The proponent suggests that the project will essentially be a failure. Moreover, the longer the project drags on the higher the impacts on marine and coastal environment.

This report has highlighted the risks and impacts associated with reef blasting on the site. It has also provided actions that can avoid or minimize the known risks. This report should now be used as a decision making tool by the implementing agency and regulatory authority to determine how to proceed with the project. There is no legal hindrance for this project to go

ahead. If the proponent and EPA decides to move forward with the project the following course of action is recommended to align the project with sustainable development principles.

1. Use the minimum charge possible to effectively dislodge the substrate and minimise the radius of critical ground vibration (i.e. 10 mm/s)
2. Continuous monitoring of the site for reef cracks. If any cracks are observed and depending on the severity of the cracks, all reef blasting activity must be ceased until geological assessments determine it is safe to proceed.
3. Given the potential impact of this project on the public and the future generations, it is recommended that EPA take all possible measures to solicit views from the public for this EIA.

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APPENDIX A – Terms of Reference

بسم الله الرحمن الرحيم

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"Dhivehin" – Always Maldivian, Forever Independent

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Fax: [+960] 333 5953 :ފެކްސް

އެންވަޔަރަންމަންޓަލް ޕްރޮޓެކްޝަން އޭޖެންސީ
ގްރީން ބިލްޑިންގ، 3 ވަނަ ފަންގިފިލާ، ހަނދުވަރީހިނގުން
މާލެ، ދިވެހިރާއްޖެ، 20392
އީމެއިލް : Email: secretariat@epa.gov.mv
ވެބްސައިޓް : Website: www.epa.gov.mv

EPA/ToR/2015/170

Terms of Reference for Addendum I for Environmental Impact Assessment the proposed Channel Dredging Project in S. Hulhumeedhoo, Addu Atoll.

The following is the Terms of Reference (ToR) is for undertaking the Addendum 1 for the EIA of the proposed Channel Dredging Project at *Hulhumeedhoo Island, Addu City.* 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 linked to other activities that are carried out or that is being carried out within the project boundary.

2. **Study area** – Submit a minimumA3 size scaled plan with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size.

3. **Scope of work**– Identify and number tasks of the project including preparation, construction and decommissioning phases.

   Task 1. Description of the proposed project – Provide a full description and justification of the relevant parts of the proposed method, using maps at appropriate scales where necessary. Information on the following activities should be provided where appropriate: materials used for the controlled blast safety precautions taken, procurement of materials.

   - Methodology of blasting
   - 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, 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)

   Task 2. Description of the environment – Assemble, evaluates and presents the environmental baseline study/data regarding the study area and timing of the project (e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a

way that they will be usefully applied to future monitoring. The report should outline detailed methodology of data collection utilized.

The baseline data will be collected before construction and from at least two benchmarks. All survey locations shall be referenced with Geographic Positioning System (GPS) including water sampling points, reef transects, vegetation transects and manta tows sites for posterior data comparison. Information should be given in relation to the following:

- Sea water quality measuring the following parameters: Temperature, pH, Salinity, turbidity, total suspended solids (sea water quality should be tested from atleast one control site).
- Bathymetric profile of the existing channel.
- Benthic and fish community monitoring at the project site.
- Noise measurements at the nearest residential household.

Task 3. Legislative and regulatory considerations – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. The report should clearly identify the different articles and clauses that apply to the said project and should state how the project meets these requirements.

Task 4. Potential impacts (environmental and socio-cultural) of proposed project, incl. all stages – The EIA report should identify all the impacts, direct and indirect, during and after construction, and evaluate the magnitude and significance of each. Particular attention shall be given to impacts associated with the following:

- Impacts on the natural environment and the reef of blasting
- Any vibration impacts on residential households
- Noise impacts

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 alternative options for channel dredging. In addition, alternative mechanisms for blasting should be examined. Justify the best alternative based on existing literature and the potential impacts and mitigation measures.

Task 6. 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. temporal sediment control structures and coral reconstruction. Measures for construction shall be identified. Cost of the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be

given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

Task 7. Development of monitoring plan - Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan. Ecological monitoring will be submitted to the EPA to evaluate the damages during construction, after project completion and every three months thereafter, up to one year and then on a yearly basis for five years after. The baseline study described in task 2 of section 2 of this document is required for data comparison. Detail of the monitoring program including the physical and biological parameters for monitoring, cost commitment from responsible person to conduct monitoring in the form of a commitment letter, detailed reporting scheduling, costs and methods of undertaking the monitoring program must be provided. Monitoring is required in:

- Marine ecosystems monitoring (coral reef, seagrass and fish and invertebrates communities).
- Vibration and noise monitoring during blasting activity.

Task 8. Stakeholder consultation – Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders. Consultation shall be undertaken with Addu City Council and the general public of Hulhumeedhoo. The EIA report should include evidence of consultation, including names of those consulted and their contact details. The EIA report should include the methodology of consultation with justification, details of the date, time and place of the consultation and the summary outcomes. The report should include evidence that EIA report has been submitted to atoll council prior to submission to EPA.Consultation needs to be done with MNDF

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

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

.....

04 November 2015

APPENDIX B – Site Plan

73°13'0"E
73°13'10"E
73°13'20"E
73°13'30"E
73°13'40"E

0°34'40"S
0°34'50"S
0°35'0"S
0°35'10"S

Indian Ocean

Proposed area of blasting

Reef slope

Proposed Channel

Existing sand bed

Sea Grass

Reclamation site

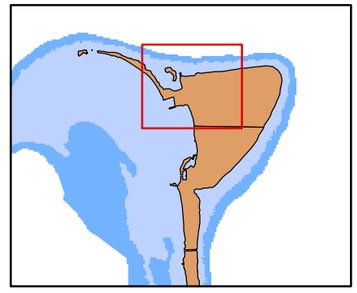
Meedhoo

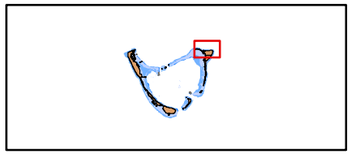
Existing Habour

Existing habour entrance

Legend

- Proposed opening
- Vegetation Line
- Low Tide Line





N
W E
S

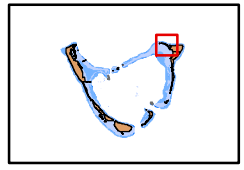
Meedhoo Channel Dredging Project Revised Site Plan

1:4,607

0 50 100 200 m

Map Prepared by CDE Consulting
May 2013

APPENDIX C – Survey Locations



Transects

Site	X_Start	X_Finis	Y_Start	Y_Finish
T1	73.2222	73.2227	73.2227	-0.57853
T2	73.2196	73.2191	73.2191	-0.57809

Water Quality

code	X	Y
W1	73.2215	-0.577507
W2	73.2191	-0.577488

Legend

- Water Samples selection
- Marine Transects selection

N W E S

1:9,856

Meters

0 50 100 200

Hulhumeedhoo Channel Dredging Project
Proposed control blasting Survey Locations

PROJECTION: Transverse Mercator (UTM Zone 43 N);
HORIZONTAL DATUM: WGS84;
All features based on GPS surveys (March 2013)
Satellite Image: September 2009
Map version 15-03-2013

Surveyed and Prepared by: CDE Consulting, Maldives

APPENDIX D – Water Quality Results

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

بسم الله الرحمن الرحيم

WATER QUALITY TEST REPORT

Test Report No: 300678/2016/26

Customer Informations : ***CDE Consulting Pvt Ltd***
H.Orchidmaage 4th Floor
Ameeru Ahmed Magu
Male'
Rep.of Maldives

Date: 28/04/2016

Sample Description / Location~	S. Meedhoo		TEST METHOD	UNIT
	SW1	SW2		
Sample Type~	Sea water			
Sampled Date~	24/04/2016			
Sample Received Date	26/04/2016			
Test Requisition Form No.	900164138			
Sample No.	823499	823500		
Date of Analysis	26/4/2016 - 27/4/2016			
PARAMETER	**ANALYSIS RESULT**			
Physical Appearance	Clear	Clear	Visual	-
Nitrate	3.8	3.0	Method 8171 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
pH	8.36	8.45	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Nitrogen Ammonia	0.12	0.14	Method 8038 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Phosphate	0.82	0.08	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Total Suspended Solids (TSS)	55	38	Method 8006 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Turbidity	4.81	5.83	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU

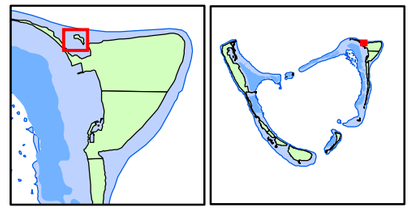
Keys:
mg/L: Milligram Per Liter, **NTU:** Nephelometric Turbidity Unit

Checked by:	Approved by:
Abdulla Rasheed Senior Quality Officer	Mohamed Eyman Senior Technical Officer

Notes:
Sampling Authority: Sampling was not done by MWSC Laboratory
This report shall not be reproduced
This test report is ONLY FOR THE SAMPLES TESTED.
~ Information Supplied by the customer

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

APPENDIX E – Bathymetry



Legend

Depth in meters

N
W E
S

Meters

0 25 50 100

Hulhumeedhoo,Seenu Atoll
Hulhumeedhoo Neru EIA
Bathymetry

PROJECTION: Transverse Mercator
(UTM Zone 43 N); HORIZONTAL DATUM: WGS84;
Map version: 22/06/2016

Surveyed and Prepared by: CDE Consulting, Maldives

APPENDIX F – CV's of Consultants

Ahmed Shaig

Phone: (+960) 77 88 758 shaig@cde.com.mv

Personal Details

Date of Birth: 19/02/1976 **Nationality:** Maldivian **Gender:** Male **Marital Status:** Married

Permanent Address: Maldives **Present Address:** M. Muleege, Orchid Magu, Male', Maldives.

Education

PhD, Environmental Science, 2009
James Cook University, Townsville, Australia

Research degree on 'Settlement Planning for Natural Hazard Resilience in Small Island States: The Population and Development Consolidation Approach'

BSc Land and Spatial Information Studies/Information Science. (double major), 1999-2001
University of Otago, Dunedin, New Zealand

Diploma in project planning, implementation, monitoring and evaluation, 1995
ILO training Centre, Turin, Italy

Employment History

Director, Environmental Services 2008 to present
CDE Consulting Supervisor: Dr. Simad Saeed
Republic of Maldives Phone: +(960) 7777445
Head of environmental wing

Assistant Under-secretary, Spatial Planning 2002-2004
Ministry of Planning and National Development Supervisor: Hon. Hamdun Hameed
Republic of Maldives Phone: +(960) 332-3919
Head of Spatial Planning Unit. Relevant Tasks include:

- Oversee environment related projects and application of environmental guidelines for planned projects.
- Plan, implement and oversee the development of a National GIS;
- Aid/facilitate/oversee urban planning, housing, land use planning, natural resource planning and environment related projects; Provide assistance in project planning (includes urban and regional planning, natural resources planning)

Project Manager, National Digital Mapping Project 2005 (8 months)
Ministry of Planning and National Development Supervisor: Hon. Hamdun Hameed
Republic of Maldives Phone: +(960) 332-3919

- Project involved aerial photography and satellite imagery of entire Maldives, ground surveying of key settlements, digital conversion of data and setting up a Mapping Unit.

Assistant Planning Officer/Planning Officer 1994-1999
Ministry of Planning and National Development Supervisor: Mr. Mohamed Hunaif
Republic of Maldives Phone +(960) 331-3040
Relevant tasks involved:

- Assisting in the National GIS Development Programme (Junior GIS developer)
- Facilitate urban planning, housing, land use planning, natural resource planning and environment related projects.

Experience in Consultancy

- *September 2002:* Member of the team appointed for environmental surveying and carrying capacity assessment of islands for tourism development in the southern atolls of Maldives for Ministry of Tourism Maldives.
- *October 2002:* Developed the Census GIS for United National Population Fund
- *December 2002:* Developed the Maldives Protected Areas Systems GIS for Maldives Home Affairs Housing and Environment.
- *February 2003*: Participated in the preparation of Royal Island and Spa Resort Annual Environmental Monitoring Report for Royal Island and Spa.
- *April 2003:* Member of the team selected for developing town plans for urban centres in Northern and Southern Regional Development Zones, looking specifically into environmental control measures, for Ministry of Planning and National Development.
- *April 2003:* Participated in the preparation of Environmental Impact Statement for Coastal Modifications on Rihiveli, South Malé Atoll, Maldives.
- *April 2003:* Participated in the surveying and preparation of Environmental Impact Statement for the proposed coastal improvements to address coastal erosion concerns on Royal Island Spa Resort, Baa Atoll, Maldives.
- *May 2003:* Participated in the bathymetry survey and preparation of Initial Environmental Examination for Deepening of Existing Entrance Channel to Service Jetty, Soneva Gili Resort and Spa, North Malé Atoll, Maldives
- *May 2003:* Participated in the preparation of Initial Environmental Examination for development of an access channel into the natural inner lagoon (*Vilu*) of Mayafushi resort, North Ari Atoll.
- *May 2003:* Participated in the preparation of Environmental Impact Assessment for Landaa Giraavaru Pvt. Ltd. for the development of a Four Season's Tourist Resort on the island of Landaa Giraavaru in Baa Atoll, Maldives.
- *June 2003:* Participated in survey and preparation of Initial Environmental Examination for the Development of a Mooring Area and Associated Beach Replenishment in, Boduhithi Club, North Malé Atoll, Maldives.
- *July 2003:* Participated in the surveying and preparation of Initial Environmental Examination for Short-term and Long-term Shore Protection Measures at Alimatha Tourist Resort, Vaavu Atoll, Maldives.
- *July 2003:* Conducted shoreline and vegetation line of Alimatha Tourist Resort, Vaavu Atoll, Maldives.
- *July 2003:* Participated in the surveying for Initial Environmental Examination for Short-term and Long-term Shore Protection Measures at Dhiggiri Tourist Resort, Vaavu Atoll, Maldives.
- *July 2003:* Participated in conducting and preparation of Fun Island Resort Annual Environmental Monitoring Report.
- *July 2003:* Participated in conducting and preparation of Sun Island Resort Annual Environmental Monitoring Report.
- *July 2003:* Participated in conducting and preparation of Holiday Island Resort Annual Environmental Monitoring Report.
- *August 2003:* Developed the Initial Environmental Examination for the construction of Sun Decks along the southern beach of Kudarah Island Resort.
- *September 2003:* Participated in surveying and preparation of Fonaddoo Environmental Impact Assessment Report for the development of fisheries complex, Fonaddoo, Maldives.
- *October 2003*: Participated in surveying and preparation of Kuda Rah Erosion Study and recommendations for shore protection and erosion prevention
- *November 2003:* Conducted vegetation and shoreline survey of Dhonveli Beach and Spa and Four Seasons Report for the Boundary Delineation between the two islands.
- *December 2003:* Contributed to the Landuse Planning Guidelines of Maldives (environmental aspects) for Ministry of Housing and Urban Development.
- *December 2003*: Contributed to the Development of a Building Code of Maldives for Ministry of Housing and Urban Development.
- *January 2004:* Co-author to the Environmental Guidelines for the Development of Resort Islands in Maldives, Ministry of Tourism.
- *February 2004:* Developed the Baa Atoll Spatial Development Plan for Ministry of Planning and National Development.

- *April-July 2004:* Participated in the preparation of the Environmental aspects of the 8 bid proposals for resort Development for various proponents.
- *November 2005:* Participated in the preparation of EIA for L.Gan Resettlement Project for Ministry of Housing.
- *December 2005:* Participated in the surveying and preparation of EIA for Gn Fuvahmulaku Tourist Hotel Development
- *November 2005:* Developed a GIS for strategic planning to select islands for tourism development for Ministry of Tourism.
- *January 2006:* Local consultant for the Strategic Environmental Assessment (SEA) of Maldives Regional Development Plan, for AGRIFOR Consult Consortium, Belgium.
- *June 2006:* Developed the Baa Atoll Resource Management GIS for Ministry of Environment and Energy.
- *August 2006:* Consultant to the Integrated Climate Change System (ICCS) project – Assessment of vulnerability of Maldives Islands and Beaches to climate change
- *September 2006:* Consultant to the ICCS project – Assessment of vulnerability of Maldives Infrastructure to climate change
- *November 2006:* Consultant to the preparation of National Adaptation Programme of Action in Maldives for Ministry of Environment.
- *December 2006*: Environmental Consultant to the United Nations Development Programme (UNDP) Project: Disaster Risk Assessment of Selected nine Safe Islands in Maldives.
- *April 2007:* Prepared the Coastal Erosion Assessment and Management Report for Ga.Meradhoo Island.
- *May 2007:* Participated in the preparation of EIA for N. Randheli Resort Development Project, I&T Management group.
- *June 2007:* Participated in the preparation of Millennium Development Goals, Maldives Country Report.
- *October 2007*: Natural Hazard Assessment consultant to the UNDP Project: Disaster Risk Assessment of Selected Safe Islands in Maldives.
- *November 2007*: Prepared the EIA for proposed coastal protection, beach replenishment and access improvement of Elaa, Thaa Atoll, for Mr Abbas Mohamed, H. Merry Rose.
- *May 2009*: Participated in the preparation of EIA for sand sourcing and beach replenishment project of Viligilli Island, Addu Atoll, for Shangri-La at Viligilli..
- *April 2009:* Participated in the preparation of EIA for N. Maafaru Airport Development Project for Noonu Hotels Pvt Ltd.
- *May 2009:* Participated in the preparation of EIA for resort development in Huvandhumaavattaru, Noonu Atoll
- *June 2009:* Prepared a status of the environment report Randheli Island, Noonu Atoll.
- *July 2009:* Prepared the Environmental EIA for harbour development in Fiyoari, Gaafu Dhaalu Atoll.
- *July 2009:* Participated in the preparation of EIA for Jetty and arrival lounge development project in Gan, Addu Atoll, for Island Aviation Services Private Limited.
- *July 2009:* Team Leader for the socio-economic risk assessment of Selected Safe Islands in Maldives.
- *August 2009:* Coastal erosion data synthesis for selected islands of Maldives, for World Bank Maldives Environmental Management Project.
- *September 2009:* Prepared the beach management plan and development control measures for Reethibeach Island Resort, Baa Atoll.
- *September 2009:* Participated in the preparation of EIA for agricultural island development in Felivaru, Noonu Atoll, for Fantasy Private Limited.
- *September 2009:* Consultant to review the safer islands programme and cost benefit study of mitigation measures in three islands in the Maldives for UNDP.
- *October 2009:* Consultant to the Maldives Environmental Management Project for waste management technical assistance for World Bank.
- *December 2009:* Environmental consultant for advising on resort development and development control measures in Randheli Island, Noonu Atoll.
- *January 2010:* Prepared the beach management plan and development control measures for Shangri-La Island Resort, Addu Atoll.
- *January 2010:* Consultant to the Atoll Ecosystem Conservation project conservation component defining conservation areas and development controls.
- *February 2010:* Prepared the environmental audit of Thunbafushi Island, Kaafu Atoll, for Champa Brothers Private Limited.

- *March 2010:* Prepared the beach management plan and development control for Herathera Island Resort, Addu Atoll.
- *March 2010:* Lead author in the preparation of EIA for power plant upgrading project in Palm Beach Island in Lhaviyani Atoll.
- *April 2010:* Lead author in the preparation of EIA for Seagrass removal and beach replenishment project in Olhuveli Island Resort and Spa, Kaafu Atoll.
- *April 2010:* Prepared an EIA addendum for resort development in Gaakoshibee Island, Shaviyani Atoll.
- *May 2010:* Consultant to undertake island environmental scoping studies in 30 islands in North Maldives to determine islands with resort development potential for GMR Group of India.
- *May 2010:* Lead author in the preparation of EIA for harbour development project in Madidhoo Island, Shaviyani Atoll.
- *June 2010:* Lead author in the preparation of EIA for deep piling project in Olhuveli Island Resort and Spa, Kaafu Atoll.
- *July 2010:* Lead author in the preparation of EIA for the development of an aquaculture site in Kanduoigiri, Kaafu Atoll.
- *July 2010:* Environmental planning consultant for Shangri-La at Viligilli Maldives, Addu Atoll.
- *July 2010:* Environmental planning consultant to the Addu Land Use Planning project (including defining development controls) in Addu Atoll Maldives for South Province Office.
- *August 2010:* Environmental Consultant for the Atoll Ecosystem Conservation Project to declare Baa Atoll as a UNESCO Biosphere reserve.
- *September 2010:* Lead author in the EIA for Seagrass removal and beach replenishment project in Herathera Island, Addu Atoll.
- *September 2010:* Lead author in the EIA for resort redevelopment in Vilamendhoo Island Resort, Ari Atoll.
- *September 2010:* Lead author in the preparation of EIA for Gulhifalhu land reclamation project in Gulhifalhu, Male' Atoll, for Capital Investment and Finance Limited, UK.
- *September 2010:* Participated in the preparation of EIA for sewerage system development project in Miladhoo, Noonu Atoll.
- *October 2010:* Consultant to undertake the coastal adaptation survey of 40 islands in Maldives for Ministry of Housing and Environment.
- *November 2010:* Environmental consultant for advising on resort development and development control measures in Maamigili Island, Raa Atoll
- *January 2011:* Lead author in the preparation of EIA for sewerage and water system development project in Hithadhoo Island, Addu City for Bi-water International Private Limited.
- *February 2011:* Lead author in the preparation of EIA for sewerage and water system development project in Maradhoo Island, Addu City for Bi-water International Private Limited.
- *March 2011:* Lead author in the preparation of EIA for sewerage and water system development project in Feydhoo Island, Addu City for Bi-water International Private Limited.
- *April 2011:* Lead author in the preparation of EIA for sewerage and water system development project in Maradhoo-Feydhoo Island, Addu City for Bi-water International Private Limited.
- *May 2012:* Coastal erosion mitigation assessment and planning for Six Senses Laamu, Laamu Atoll
- *January 2012:* Lead author in the preparation of EIA for sewerage and water system development project in Fuvahmulah Island, Addu City for Bi-water International Private Limited.
- *February 2012:* Coastal erosion mitigation assessment and planning for Fushivelavaru Island
- *March 2012:* EIA for the proposed resort redevelopment project in Conrad Rangali Island for Champa and Crown Resorts
- *March 2012:* EIA for the proposed resort redevelopment project in Gasfinolhu Island Resort, Champa and Crown Resorts
- *May 2012:* Environmental consultant for advising on resort development and development control measures in Gasfinolhu Island, Male' Atoll
- *June 2012:* Environmental consultant for advising on resort development and development control measures in Nakachchaa Huraa Island, Male' Atoll
- *April 2012:* Member of the consultant team that prepared the Tourism Opinion and Profile Survey 2011, Ministry of Tourism.
- *October 2012:* Environmental consultant to the preparation of 4th Tourism Master plan for Ministry of Tourism, Maldives.
- *November 2013:* Environmental consultant for advising on land reclamation, resort development and development control measures in Dhiffushi Island Reef, Male' Atoll.

- *January 2013:* Environmental consultant for advising on resort development and development control measures in Hankede Island, Addu Atoll
- *January 2013:* Environmental consultant for advising on resort development and development control measures in Hankede Island, Addu Atoll
  June 2013: Local Environment consultant to the WCCM project, HIDRIA and Aquatica, Spain.

Membership of Professional Bodies

- Member of Building Code Committee, Maldives
- Member of Commission on Sustainable development
- Member of the Technical Committee for Developing Spatial Plans for conducting tourism related activities in Ari Atoll.
- Member of Climate Advisory Council to the President of Maldives 2009- to present.
- Registered EIA Consultant in Maldives Environment Protection Agency roster.

Major Publications

SHAIG, A. (2001) "An Overview of Web Based Geographic Information Systems". In Proceedings: Thirteenth Annual Colloquium of the Spatial Information Research Centre. P.A. Whigham (ed). 2 - 5 Dec, Dunedin, New Zealand. University of Otago, pp.255-264.

SHAIG, A. (2006). Climate Change Vulnerability and Adaptation Assessment of the Coastal Infrastructure of Maldives. Technical Paper submitted to Maldives National Adaptation Plan of Action for Climate Change. Ministry of Environment, Energy and Water, Male', Maldives.

SHAIG, A. (2006). Climate Change Vulnerability and Adaptation Assessment of the Land and Beaches of Maldives. Technical Paper submitted to Maldives National Adaptation Plan of Action for Climate Change. Ministry of Environment, Energy and Water, Male', Maldives.

SHAIG, A. (2007) Land Study of Maldives, 2006. Ministry of Planning and National Development, Male' Maldives.

SHAIG, A. and Aslam, M (2007) Detailed Island Risk Assessment Maldives Volume I to Volume IV – Natural Hazard Assessment (Final Draft). UNDP, Male' Maldives

SHAIG, A. (2007) Detailed Island Risk Assessment Maldives Volume I to Volume IV – Environmental Vulnerability Assessment (Final Draft). UNDP, Male' Maldives.

Academic Achievements

2001 Critchlow Associates Prize in Surveying, New Zealand.
Prize awarded annually by University council for the highest standard of Achievement in Spatial Information Studies in University of Otago.
1994 Certificate for best results in General Certificate of Examinations, Advanced Level.
Science Education Centre, Male', Maldives

References

Hamdun Hameed
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David King, Dr.
Associate Proffessor
James Cook University
Townsville, QLD,Australia, 4811
Tel: (+61) 747 81 4441 ,Fax: (+61) 747 81 5581
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Peter Valentine
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James Cook University
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Tel: (+61) 747 81 4441 ,Fax: (+61) 747 81 5581
Email: peter.valentine@jcu.edu.au

Clarification

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications and my experience. I understand that any willful misstatement described herein may lead to my disqualification or dismissal, if engaged.

Signature Date: 15 July 2013

Mohamed Faizan

Contact Details

Address: H. Pent Land,
Lansimoo Goalhi,
20041 Male',
Maldives

Tel: +960-7501205

E-mail: Mohamed.faizan@gmail.com

Education

August 2012 – September 2014 **University of Malaya, (Malaysia)**
- Master of Technology (Environmental management),
- Dissertation title "Study on the impact of anthropogenic pressure on coral reefs around Cape Rachado, Malacca and recommendations to improve its management"

July 2006- June 2010 **International Islamic University Malaysia, (Malaysia)**
- Bachelor of Biotechnology (Honours).
- Final year thesis title "Spatio-temporal study on coastline changes along Tanjung Lumpur – Cherok Paloh Coast".

June 2002 – June 2004 **Centre for Higher Secondary School, (Maldives)**
- GCE Advanced level.

January 1997 – February 2002 **Majeediyaa School, (Maldives)**
- GCE Ordinary level.

Employment History

July 2014 – Present **CDE Consulting**
- **Environmental Consultant** at CDE Consulting. Roles and responsibilities include preparation of Environmental Impact Assessment reports, undertaking environmental baseline surveys, and conduct environmental monitoring.

June 2010 – July 2012 **CDE Consulting**
- **Environmental Consultant** at CDE Consulting. Responsibilities included undertaking environmental baseline studies for Environmental Impact Assessments, and environmental monitoring. In addition, co-ordination of field surveys.

February 2005 – April 2006 **Integrated Climate Change Strategy**
- **Project Assistant** for the Integrated Climate Change Strategy implemented by Ministry of Environment, Energy and Water (Maldives).
- Responsibilities included assisting the project manager, in preparation of financial reports, organizing workshops.
- Helped launch monthly newsletter on climate change "Nakaiy".

EIA experience

Environmental Impact Assessment (EIA)	Proponent	Date
EIA for the proposed sewerage system project at Kanditheem, Shaviyani - Marine environment assessment and report for the EIA	Male' Water and Sewerage Company Pvt Ltd	April 2014
EIA for the proposed beach replenishment project in Holiday Inn Resort Kandooma, Maldives, South Male' Atoll - Marine environment assessment and report for the EIA	Holiday Inn Resort Kandooma Maldives	April 2014
EIA report for the proposed sewerage system at Maduvvari, Raa Atoll - Undertook the baseline assessment surveys, including stakeholder consultations. Complied the EIA report.	Mr. Ibrahim Shazyl, Venture Maldives Pvt Ltd	February 2012
EIA report for the proposed installation and operation of desalination plant at Hithaadhoo, Baa Atoll - EIA report compilation.	Mr. Ismail Shafeeu, Static Company Pvt Ltd	January 2012
EIA report for the proposed Solid Waste Management facility at Thilafushi - Baseline marine assessments and EIA report compilation.	Tatva Global Renewable Energy (Maldives) Private Limited	December 2011
EIA for the development of a domestic airport on Koodoo, GA. Atoll - Undertook baseline assessments for the EIA, and prepared the existing environment chapter for the EIA.	Bonavvista (Maldives) Private Limited Singapore	October 2011
EIA prepared for the proposed harbor entrance channel dredging project in Bodufolhudhoo Island, North Ari Atoll - Undertook the baseline assessments for the EIA, and prepared the existing environment chapter of the EIA and compiled the overall EIA report.	Ministry of Housing and Environment	August 2011
EIA prepared for the proposed re-development – phase I of Gasfinolhu Island Resort, Kaafu Atoll, Maldives - Baseline marine assessments and report preparation for the EIA.	Mr. Hussain Afeef	July 2011
EIA prepared for the proposed re-construction of Shaviyani Foakaidhoo Harbour - Undertook the marine baseline assessments and, prepared the marine assessment report for the EIA.	Ministry of Housing and Environment	March 2011
EIA for the sewerage system development in N. Miladhoo - Marine environment assessments	Works Corporation Limited	September 2010

PERSONAL DETAILS

Name in Full : Ali Moosa Didi
Date of Birth : 18.06.1985
Gender : Male
Nationality : Maldivian Address:
Permanent : Saraasaruge Aage, S.Hithadhoo
Neelonfaru Magu

Present : Ma. Rose Villa SE, 4th Floor Dhevina Magu
Male'

Telephone : +960 9912001

EDUCATIONAL QUALIFICATIONS

Madharasthul Islamiya School

Certification, University of Cambridge General Certification of Education O/L

Subject English Mathematics
Business Account Commerce
Economics

Secondary School Certificate Islamic Studies
Dhivehi Language

WORK PLACE DETAILS

Commerce Development and Environment Pvt.
H. Orchidmaage, 4th Floor
Ameeru Ahmed Magu,
Male', Republic of Maldives
Telephone: + 960 3312514
Fax: + 960 3315926
E-mail: ali@cde.com.mv

EMPLOYMENT RECORD

January 2004 – December 2008 Commerce Development & Environment Pvt

Assistant Surveyor January 2009 – December 2009 Ryco Investment Pvt
HR. Officer

January 2010 – To Current Date Commerce Development & Environment Pvt Surveyor

WORK EXPERIENCE

Assistant Surveying Officer (Sep 2008 – To Current Date)
-Survey proposed areas for the new projects under the instruction of survey officer.

-Determine precise location and measurements of points, elevations, lines, areas, contours for the construction studying the morphology of the seabed mapmaking and for construction staking, defining and managing parcels data, as-built and profiling.

-Utilize recourses to the optimum level.

-Use company civil/ survey software for contouring, setting alignments, setting points construction, land division.

-Edits and troubleshoot incoming data collector files in accordance with company procedures.

Processing Survey Data's Using Topcon Tools, Surfer, Sonar XP, etc

-Reviews and utilize survey crew field notes. -Imports verified data into the appropriate CAD drawing file, using company standards point layer management and description keys.

-Prepares survey drawings and documents using company standards, prototypes, templates and blocks.

-Operate digital cameras and download photo files into database and/ or CAD drawings.

-Utilize company scanners to transfer reference maps into CAD files to facilitate utility mapping and property line.

-To perform bathymetric and topographical survey before start of the Projects

-Plotting survey data using AutoCAD 2006-2009

-Processing Survey Data's Using Topcon Tools, Surfer, Sonar XP, etc.

-Modeling accurate contours

-Advanced at ESRI ArcGIS (ArcMap, Arc Catalogue)

-GPS, wetland vegetation species identification, extensive geological identification skills

-Preparation of survey maps

-Make sure all the survey instruments are working in good condition.

AHMED HAIMAN RASHEED

PERSONAL DETAILS

Full Name:	**Haiman Rasheed, Ahmed**	NIRC:	**A297924**
Gender:	**Male**	Date of birth:	**September 24, 1993**
Place of birth:	**S.Feydhoo, Republic of Maldives**	Nationality:	**Maldivian**

Permanent Address: **Goal Corner**
S.Feydhoo 19040
Republic of Maldives

Contact Details**:** **(Mobile): +960 7684393**

Email for correspondence: **haiman@cde.com.mv**

EDUCATION

Year	Name of Education Institute	Title of Qualification	Status
2007 – 2009	**DHARUMAVANTHA SCHOOL**	**GCE / IGCSE O' Level under the curriculum of University of Cambridge**	**Graduated**

EMPLOYMENT HISTORY

Time Period	**Position Held, Employee**	**Task assigned**
February 2014 – present	Associate Consultant, CDE Consulting	- Marine surveying (Conducting inspections, surveys & examinations of reefs) - Beach surveying - Compiling Marine reports (Prepare reports on types of surveys conducted
August 2013 – February 2014	Assistant technician, Ministry of Fisheries and Agriculture	- Designing the structure of FAD (Fish Aggregating Device) - Research on the status and pelagic fishes found near FADs
January 2011 – January 2012	Research officer, CDE Consulting	- Marine surveying (Conducting inspections, surveys & examinations of reefs) - Beach surveying - Compiling Marine reports (Prepare reports on types of surveys conducted
December 2009 – June 2010	Research officer, CDE Consulting	- Marine surveying (Conducting inspections, surveys & examinations of reefs) - Beach surveying - Compiling Marine reports (Prepare reports on types of surveys conducted)

REFERENCES

Name	Address, Telephone & Fax	Email, Occupation & Business Title
Ahmed Shaig, PhD	**CDE Pvt Ltd** **4th Floor, Orchidmaage** **Ameer Ahmed Magu, Henveiru** **Male', Maldives** **(Telephone): +960 3312514** **(Fax): +960 3315926**	**Director** **CDE Pvt Ltd** **info@cde.com.mv**
Ahmed Yameen	**Ministry of fisheries and agriculture** **7th Floor, velaanaage** **Ameer Ahmed Magu, Henveiru** **Male', Maldives** **(Telephone): +960 3322625** **(Fax): +960 3326558**	**Assistant director**

Mohamed Ali

ID #:	A 094918
Nationality:	Maldivian
Languages:	English, Sinhalese, Dhivehi
Date of Birth:	13/09/1983
Telephone:	960-790-6007
Email:	mohamed.ali@cde.com.mv

Experience

Marine Environmental Specialist — June 2011- Present
CDE Consulting

Marine Environment Officer — July 2008 – May 2011
Banyan Tree Vabbinfaru

Freelance Lobster Hunter, Shark Fisherman — Jan 2007 - July 2008
Laamu Atoll

Dock Assistant — Sep 2006 - Jan 2007
Tourist Submarine Maldives

Education and Certifications

PADI Rescue Diver	June 2011
PADI Enriched Air Diver	June 2011
Emergency First Responder	May 2011

Basic Computer Science — 2001 - 2006
Singapore Informatics, Colombo Sri Lanka

Profile

I am very passionate about protecting the marine environment. After having worked as both a fisherman and a marine environment officer I am aware of the impact that human activity has on our fragile marine environment. My favorite activities are reef monitoring and planting coral gardens. With my undying passion for the underwater world and also with my vast experience diving all over the Maldives, educating people on the marine environment is my greatest mission, to ensure the preservation and protection of our most valuable treasure. Furthermore, I have got the opportunity to work besides the greatest marine experts in the world namely Prof. J.E.N. Veron,Dr. Norman Queen and Dr. Daphne G. Fautin.

References

N.D. Abdul Azeez Abdul Hakeem
Former Director of Conservation
Mobile: + 960 7784263
Banyan Tree Maldives

Dr. Steve Newman
Former Marine Lab Manager at Banyan Tree
steve.newman@ncl.ac.uk

Robert James
Former Marine Lab Manager at Banyan Tree

Shahdha

Sustainable Development Consultant

CDE Consulting Pvt Ltd

Phone: +960 9700169 E-Mail: shahdha@cde.com.mv

Professional Experience

Sustainable Development Consultant

CDE Consulting Private Limited, Male', Republic of Maldives. **1 March 2015- Present**

- Experience

Environmental Impact Assessments

- EIA for the proposed test drilling For Hulhule'-Male' Bridge construction project
- EIA for the proposed redevelopment of Nasandhura Palace Hotel, Male'
- EIA for the proposed Hulhule'-Male' Bridge Project
- EIA for the proposed construction of a 9-storey building at the compound of ADK Hospital, Sosun Magu, Male', Maldives
- EIA for the proposed tourist development project at Madivaru Island, Kaafu Atoll
- EIA for the proposed land reclamation and resort development project in Ithaafushi Reef, South Male' Atoll
- EIA for the proposed resort development in Bodukaashihuraa, Alifu Dhaalu Atoll, Maldives

Surveys

- Maldives Visitor Survey 2015 for the Ministry of Tourism
- Maldives Democracy Survey 2015 for International Foundation for Electoral Systems (IFES)

Environmental Monitoring Projects

- Environmental and Social Performance Annual Monitoring 2014 for Shangri-La's Vilingili Resort & Spa, Addu Atoll, Maldives

- Key Skills and Competencies

- Ability to interpret environmental laws and regulations and act accordingly
- Sound knowledge of environmental management procedures and assessment of risk
- Solid understanding of waste management, climate change, disaster prevention and mitigation, and coastal environment and processes
- Profound knowledge of sustainable development issues
- Ability to assess and analyze complex social problems
- Competent in identifying and communicating with stakeholders
- Skilled in data collection, analysis and report writing

Clinical Assistant

Indhira Gandhi Memorial Hospital, Male, Republic of Maldives **February 2010- December 2011**

Relief Teacher

HDh. Atoll School, HDh. Vaikaradhoo, Republic of Maldives **July 2009- November 2009**

Academic Qualifications

Bachelor of Environments 2012-2014

Major: Environmental Geographies, Politics and Cultures,

The University of Melbourne, Melbourne, Victoria, Australia.

Advanced Level Edexcel Examination

Higher Secondary Certificate (HSC) Examinations 2007-2009

Center for Higher Secondary Education, Male', Republic of Maldives

Cambridge GCE O-level

IGCSE Examinations

Secondary School Certificate (SSC) Examination 2004-2006

Cener for Higher Secondary Education, Male', Republic of Maldives

Achievements

- Dean's Honours Award for outstanding academic achievement in 2014 (University of Melbourne) 2014
- Australian Development Scholarship 2011
- Fourth place among the National Top 10 Achievers in the Higher Secondary School Completion Examinations 2009 2009
- Second place among the National Top 10 Achievers in the Secondary School Completion Examinations 2006
- Best All Round Student of H Dh. Atoll School 2006
- Haveeru Atolls Scholarship Award 2007-2009
- School Captain at H Dh. Atoll School.
- Student Association's Vice President in 2006 at H Dh. Atoll School 2006
- Deputy and Acting School Captain in 2005 at H Dh. Atoll School
- Student Association's President in 2005 at H Dh. Atoll School 2005

Professional Development and Memberships

- Member of the University of Melbourne Australian Awards Club 2013- 2014
- Participated in the Women's Mentoring Network at the University of Melbourne 2013
- Completed a 21 hours course on Standard First Aid at the Faculty of Health Sciences, Maldives College of Higher Education 2010
- Member of the Science Club at the Center for Higher Secondary Education 2007-2009
- School Prefect Board member at the H Dh. Atoll School 2004-2006

Computer Skills

- Experienced in using Microsoft office Word, Excel, Powerpoint and Project.

Language Skills

	Understanding	Speaking	Writing
English	Excellent	Excellent	Excellent
Dhivehi	Excellent	Excellent	Excellent

APPENDIX G – Commitment Letter

بسم الله الرحمن الرحيم

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

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ދަތުރު، ތިލަފުށި.

Date: 11 August 2016

No: 138-PIS1/203/2016/195

Mr. Ibrahim Naeem
Director General
Environmental Protection Agency,
Ministry of Environment and Energy,
Green Building, Male',
Maldives.

Dear Sir,

This is in reference to the EIA report for the proposed Channel Dredging at S.Hulhumeedhoo As the Proponent of the project; we assure you our commitment to undertake the proposed mitigation measures and monitoring programme given in the report.

Thanking you

Sincerely,

Fathimath Shaana Farooq,
Director General

Ameenee Magu, Maafannu, Male', 20392, Republic of Maldives.
ދަމީނީ ދަރުމަގު، ފާހަނަ، ދަތުރު، 20392، ދިވެހިރާއްޖެ.
+(960) 300 4 300
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www.housing.gov.mv
www.facebook.com/housing.gov.mv
www.twitter.com/HousingGovMv

Proponents Declaration

Re: EIA for S.Hulhumeedhoo Channel Dredging

As the proponent of the proposed project we guarantee that we have read the report and to the best of our knowledge, all information relevant to this project in terms of project description, project construction works and operational aspects provided here are accurate and complete.

Signature: 

Name: Fathimath Shaana Farooq

Designation: Director General

On behalf of: Ministry of Housing and Infrastructure

Date: 11 August 2016

APPENDIX H – Evidence of Other Methods Used

From: "Project" <project@senoksl.com>
Date: 14 May 2016 12:42
Subject: Hulhumeedhoo Channel photograph
To: "Hassan Saamee" <hassan.saamee@housing.gov.mv>
Cc: "Amir Musthafa" <amir.musthafa@housing.gov.mv>, "Nethmi Kanakarathne" <nethmi@senoksl.com>, "Project" <project@senoksl.com>

Dear Mr. Hasan Saamee,

As per our records maintained at Hulhumeedhoo site we have used a drop hammer 6 Ton weight attached to a 35 ton crawler crane to break the hard corral layer of Isemela Hera channel during the period from 2/21[12]/2014 to 30/04/2015.

The weight was dropped to the hard corral layer from a height of 65 ft. the remaining hard core layer is at a depth of -2.5m to -2.75m and impact from the drop hammer is now less due to water resistant through the water height of nearly 2 ½ m. That's why we have to give up this method and go for a controlled blasting for the remaining area.

Please refer attached photographs taken at the site.

Best regards,
Sumanasekara.

From: shalinda tharaka [mailto:tharakasenok@gmail.com]
Sent: Saturday, May 14, 2016 10:58 AM
To: Sumanasekara <project@senoksl.com>
Cc: Ranjith <ranjith@senoksl.com>; nethmi@senoksl.com
Subject: Hulhumeedhoo Channel photograph

Dear Sir

Please find the attached channel photographs.
We used drop hammer **2/21[12]/2014** up to **30/04/2015**

Thanks
Sahlinda