

## PROJECT SYNOPSIS

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**Name of the Project:** Reclamation of Eastern Side of A Dh. Fenfushi

**Project Proponent:** A Dh. Fenfushi Council

**Project Contractor:** MTCC

**Project Value:-**

**Expected Duration:** 43 days

**EIA Consultant:** Ahmed Saleem

**EIA Date:** April 2016

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## WEIGHTS AND MEASURES USED IN THE REPORT

1 metric tonne = 2,204 pounds (lbs.)

1 kilogramme (kg) = 2.2 lbs.

1 metre (m) = 3.28 feet (ft.)

1 millimetre (mm) = 0.03937 inches (")

1 kilometre (km) = 0.62 mile

1 hectare (ha) = 2.471 acres

1 milehr<sup>-1</sup> = 0.44 ms<sup>-1</sup>

1 knot = 0.51 ms<sup>-1</sup>

1 hectare (ha) = 10,000 m<sup>2</sup>

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## LIST OF ABBREVIATIONS

ORP	Oxidation Reduction Potential
MWSRP	Maldives Whale Shark Research Programme
MPA	Marine Protected Area
GFF	Guarantee Fibreglass Fabrications
EPPA	Environmental Protection and Preservation Act
DO	Dissolved Oxygen
Hs	Peak Height
NEAP	National Environmental Action Plan
MEE	Ministry of Environment and Energy
ES	Environmental Score
NBSAP	National Biodiversity Strategy and Action Plan
NSWMP	National Solid Waste Management Policy
EIA	Environment Impact Assessment
GoM	Government of Maldives
MEE	Ministry of Environment and Energy
EPA	Environmental Protection Agency
MTCC	Maldives Transport and Contracting Company
MHI	Ministry of Housing and Infrastructure
MOFA	Ministry of Fisheries and Agriculture
PPG	Personal Protective Gear
RS	Range Values
MSL	Mean sea level
EMP	Environmental Monitoring Plan
GHG	Green House Gas
PPC	Personal Protective Equipment

CBD	Convention on Biological Diversity
DNP	Department of National Planning
CO <sub>2</sub> -e	Carbon dioxide equivalent
DIRAM	Detailed Island Risk Assessment in Maldives
DDRPM	Development of Disaster Risk Management Profile Maldives

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## **ACKNOWLEDGEMENT**

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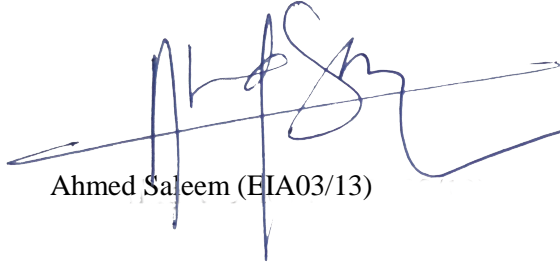
The authors of this report would like to acknowledge the support given by the proponent during field work and their assistance in compilation of the report.

## DECLARATION

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### Consultant

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



Ahmed Saleem (EIA03/13)



### Proponent


The proponent has elected to submit an Environmental Impact Assessment for the proposed reclamation project in accordance with Environmental Protection and Preservation Act (Act No. 4/93) and the EIA Regulations (2012). The proponent has gone through the report and agrees to implement mitigation measures.



President  
Fenfushi Island Council



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1. דרך תרומת הקרקע והעבודות אשר יבוצעו במסגרת התוכנית נבנו ונסווגו על פי חוק התכנון והבנייה (93/4) וקרן התרומה הועברה למסגרת התוכנית. שטח הקרקע הוא כ- 39314 מ"ר. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד.

2. שטח הקרקע, בעל שטח של 219,059 מ"ר, נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד.

3. שטח הקרקע, בעל שטח של 39,314 מ"ר, נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד.

4. שטח הקרקע, בעל שטח של 28,477 מ"ר, נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד. שטח הקרקע נמצא בבעלות ממשלת ישראל ומועצה מקומית אשדוד.







## NON TECHNICAL SUMMARY (ENGLISH)

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1. This report provides the finding of an environmental impact assessment conducted for a proposed reclamation project in A Dh. Fenfushi, initiated by Fenfushi island council in accordance with the Environmental Act and EIA Regulations 2012. The report was compiled by Maldives Environment and Energy Company (MEECO) to fulfil the requirements of law. The main objective of the project is to create space to establish developmental infrastructures that have been planned, which include providing the necessary recreational facilities to the island population.
2. Fenfushi is situated at the southern tip of A Dh. Atoll and has a land area of 218,422 m<sup>2</sup>. The island is situated close to a resort and an uninhabited island which has been leased to the resort. Surveys show that eastern side of the island is populated while the western side largely remains natural. The island has a population of 1,000. Most of the people from the island are employed in the tourism sector. Since the majority of the island consists of young adults, the need for public recreational facilities are great. However, the island does not have enough recreational facilities such as football fields. The only football field on the island is next to a cemetery. Sightings of human remains lead to the field being abandoned.

The project was devised to address the needs of islands main population group which comprises of young adults who require recreational facilities. The current football field is situated next to the island cemetery and part of the field is on top of the cemetery few inches above burial sites. This has created a sense of fear amongst its users as playing on top of burial sites is emotionally stressing and on religious terms unacceptable. In order to address the issue, the council had initially designed to construct a football field and net ball court within the current footprint of the island, however lack of space available in the island specially populated side (eastern) of the island prompted the council to devise and propose reclamation of eastern side of the island to solve the developmental and space issues faced by the island.

3. The proposed project will involve reclamation of of 39,314 m<sup>2</sup> from the eastern lagoon of the island. Field surveys indicated 28,477m<sup>3</sup> sand will be required as fill to reclaim up to +1.4 m MSL. The study also revealed that the required fill material can be obtained by dredging the current harbour basin. Three zones have been distinguished within the harbour basin which can be used to obtain the dredge material. When combined, the three zones have enough fill material to reclaim the proposed area in the lagoon.
4. Sedimentation resulting from dredging and reclamation was identified to be the main environmental impact arising from the project. However, due to the existing quay wall on the southern side of the reclamation area which would act as a sediment barrier, distance of house reef from reclamation area, its depth, and hydrographical conditions observed at the site and based on expert opinion from MWSRP, sedimentation resulting from the proposed project is not envisaged to have any negative impacts on marine protected area located in A Dh. Atoll. It is recommended to install bunds as specified in the report to enclose area before reclamation further mitigate sediment transportation.
5. The report also assessed alternative materials, methods and locations. The comparison of alternative reclamation areas through comparative option analysis of three locations (East, South and West) suggested that the proposed location was most feasible. It was close to the populated areas of the island where infrastructure for electricity exists and the groyne installed at the site would act as a sediment barrier that would mitigate sediment transportation.

6. No irreversible major negative impacts to the environment have been identified due to the proposed project. Impact assessments done for the construction phase (reclamation) and operational phase of the project resulted in minor/moderate temporary negative impacts. Appropriate and practical mitigation measures have been identified and included in this report to address these negative impacts. These include monitoring water quality at set locations to assess extent of sedimentation. Constructing sand bunds surrounding the reclamation area to contain sedimentation due to reclamation.

Significant positive impacts were identified for the implementation phase of the project. The project is expected to significantly contribute to social and developmental aspect of the island. Most importantly create land space for recreational activities of the island.

7. The Proponent of the project, Fenfushi Island Council guarantees their commitment to undertake the necessary mitigation measures and monitoring during all stages of the project that has been proposed in the report. The project complies to national development policies of the government and is planned to be executed in compliance with the relevant laws and regulations of the Maldives relevant to conservation of the environment if implemented in accordance with the report.
8. In conclusion, the EIA has looked into the key factors that shall be taken into account during construction and operational stage of the project. Even though this project does have significant environmental impacts to the immediate marine environment, with appropriate measures, minor negative impacts envisaged can be further mitigated. Given that the Proponent has committed to the mitigation actions it is anticipated that the project can be implemented with minimum negative residual environmental and socio-economic impacts.

## 2 INTRODUCTION

---

This section of the report describes the proposed project, the need for the proposed project and objectives of this EIA, the scope and major stakeholders of the proposed reclamation project as per the **Task 1 of the TOR**.

### 2.1 BACKGROUND

A Dh. Fenfushi Island Council requested Maldives Energy and Environmental Company (MEECO) to undertake an Environmental Impact Assessment (EIA) for the proposed reclamation of eastern side of the island's lagoon to fulfil the legal requirement prior to implementing the project. In preparing the report the consultants followed the procedure set out in the EIA Regulations the Terms of Reference (TOR) agreed between the EPA and the client.

### 2.2 AIMS AND OBJECTIVES OF THE PROJECT

The broad objective of the project is to address the land shortage issue to build and develop the necessary infrastructure. The key aims of the project are to:

- Create land to develop recreational facilities for the youth, which will include a football field and a netball court; and
- enable expansion of existing cemetery which is now part of the football field.

### 2.3 PURPOSE OF THE EIA

Given the potential adverse environmental impacts associated with reclamation works, the proponent has requested consultancy services for preparation and submission of an Environmental Impact Assessment (EIA) report to EPA that fulfil the requirements stipulated by the Environmental Protection and Preservation Act (4/93) and EIA Regulations 2012.

The specific objectives of the EIA study are:

- a) Study the key aspects of the project;
- b) Assess the environmental condition of the project site;
- c) Conduct consultations with the relevant project stakeholders;
- d) Ensure project's compliance to necessary laws, regulations pertaining to protection and conservation of environment and policies;
- e) Assess the major activities that may cause adverse effects on the environment;
- f) Identify likely impacts of the project;
- g) Recommend necessary mitigation measures;
- h) Propose a monitoring program to ensure the sustainability of the project; and
- i) Make conclusions and recommendations based on the findings of the assessment.

## **2.4 EIA REPORT AND EIA IMPLEMENTATION PROCESS**

The process followed in preparing this report complies with EIA Regulations. The process was initiated by the proponent (Fenfushi council) which involved developing the project concept following which a draft TOR and EIA application form was submitted to EPA. Following this a scoping meeting was held on 10<sup>th</sup> February 2016 the project was discussed at the meeting with relevant stakeholders which included MHI, EPA, Fenfushi Council, MEECO and Atoll Council. The draft TOR was approved after the scoping meeting with the agreed changes. To collect environmental data and assess the baseline environmental conditions related to the proposed reclamation project a site visit was organised to Fenfushi on 22<sup>nd</sup> February 2016. Following field data collection, draft report was compiled and then submitted to the proponent and Atoll council for comments. The report was then submitted to the EPA together with the reclamation permit form.

## **2.5 PROJECT SETTING**

The proposed project takes place in Fenfushi Island, Alifu Dhaalu Atoll. The island is situated on the southern edge of Alifu Dhaalu atoll at the geographic coordinates of 3°29'22.02"N and 72°47'03.64" E. Fenfushi Island is located within a very large reef system. There are a total of 6 islands on this reef system. These include; two inhabited islands (Fenfushi and Maamigili), two resorts (Holiday Island Resort & Spa and Sun Island), an uninhabited island (Tholhifushi) and numerous sand banks frequented by sea birds. The closest inhabited island is Maamigili which is located 5.34 km east of Fenfushi. Maamigilli hosts an international airport situated on a large parcel of reclaimed land. As far as Fenfushi is concerned, changes have been brought to its natural setting by development of a harbour and access channel. The basic geographical characteristics of the project island is given in Figure 1 and Table 1 describes the key features of the proposed project.

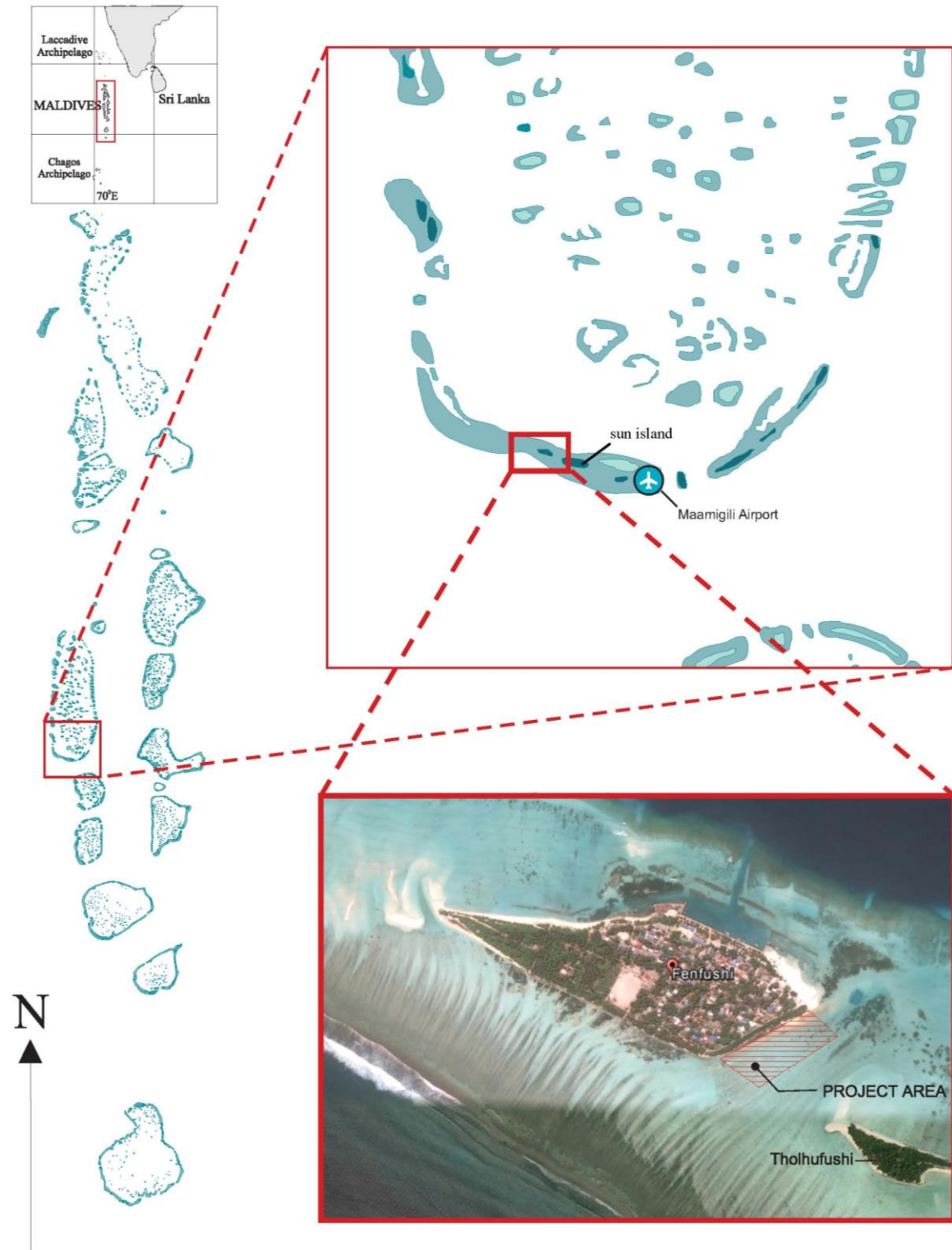


Figure 1: Geographical setting of the project

Table 1: Geographical characteristics of the project site

Island name	Fenfushi
GPS Coordinates	3°29'22.02"N and 72°47'03.64"E
Area of island	219,059 m <sup>2</sup>
Distance to atoll capital	36 km
Distance to Male'	111 km
Nearest inhabited island	Maamigili
Nearest uninhabited island	Tholhifushi
Nearest Airport	Villa Airport at Maamigili
Nearest Resort	Sun Island
Distance to the nearest resort	0.90 km

## 2.6 PROJECT JUSTIFICATION, OBJECTIVE AND RATIONALE

A Dh. Fenfushi has a population of approximately 1020 people where majority of the population consists of working class young adults, where the majority work in tourism industry. Fenfushi is situated in a tourism hot spot, where two resorts Sun Island and Holiday Island occupy the same lagoon as Fenfushi. Furthermore, the local airport at Maamigili is also situated in the same lagoon as Fenfushi. Hence, most of the islanders are employed in tourism related sectors.

A total of 43 vessels are used and operated in the island mainly for tourism related activities, to supply goods and transport people to and from resorts and safaris. Reef fishing and sea cucumber culture also contribute to the local economy of the island. Two mechanized huge reef fishing vessels operate in the island that supplies catch to nearby resorts and safaris.

The island heavily relies on its working population for the expansion of local economy which is crucial to implement projects that are beneficial for improving social services and development of youth and basic services such as housing/medical/educational/recreational facilities. Fenfushi council gives high priority to improve its economy and develop its community and social infrastructure.

The council has been working to build the islands developmental capacity and to identify the needs of public to provide better services.

In this regard, the council had identified major development issues in the island that needs to be addressed promptly. These include:

### 1. Lack of recreational facilities in the island:

A petition was signed by 100 youths of the island requesting the council to build a football field on the island. The current football field is situated next to the island cemetery and part of the field is on top of the cemetery few inches above burial sites. This has created a sense of fear amongst its users as playing on top of burial sites is emotionally stressing and on religious terms unacceptable. In order to address the issue, the council had initially designed to construct a football field and net ball court within the current footprint of the island and use the existing football field as an extension of the existing cemetery. However, implementation of these projects were obstructed due to lack of available land space on the island. Western side of the island where space is available, had been allocated for local tourism development under the islands master plan. Central section of the island consists of municipal buildings and private properties which extends to the eastern section of the island as well.

2. Lack of proper harbour facilities in the island:

Currently there are insufficient mooring points at the harbour. This is mainly because two vertical quays constructed in the year 2000 enclosing the harbour basin had collapsed partially. Currently small vessels owned by locals are moored to trees and to any existing solid structure on the island. Apart from being aesthetically unpleasing a lot of rope and manual labour is required to anchor vessels at sea to a structure on land. Moreover, this presents safety risks to the vessels and there is not enough space to accommodate approximately 43 vessels operated in the island.

The harbour was found to be congested due to high inflow of foreign vessels and usable space being occupied up by the existing entrance channel located in the middle of the harbour. FAD's installed south of Fenfushi causes a lot of foreign fishing vessels to use the islands harbour for convenience which creates congestion and traffic at the harbour.

To overcome these major issues, the council had proposed to:

- To reclaim approximately 39,314m<sup>2</sup> of land from the eastern side of the island. The council's proposition has been supported by Ministry of Housing and Infrastructure (MHI) as an important development project which would address space issues.

The proposed project is expected to achieve the following:

- Provide the necessary land area to establish recreational/educational/medical/social facilities essential for the public wellbeing and prosperity.
- Expand and renovate the cemetery which has been identified to be space constrained

The objectives will be achieved ensuring

- Ecological integrity, amenity and social values of the project location
- Responsibly managing environmental, health and safety requirements
- Implementing sound environmental management in all phase of the development

## 2.7 IMPACT ASSESSMENT AND REVIEW OF SIMILAR PROJECTS

RIAM impact assessment was used to assess and analyse environmental impacts, where cumulative, permanence and reversible nature of all impacts have been taken into account. This method encompasses a holistic approach where situational criteria's such as cumulative and indirect properties related to the impact area are taken into account. The method is further explained in section 8 of the report.

In any impact assessment, limitations arise from gaps in predicting future and lack of quantification of certain criteria's related to the impact area. In order to account for the limitations and make the impact assessment more reliable, data and observations made on similar dredging/reclamation projects were reviewed. These include:

**Aleem, A. (2014). *Environmental Impact Assessment: for the breakwater construction of the harbour, A Dh. Fenfushi, Maldives***

The breakwater construction project is the reference EIA report for the proposed reclamation project at Fenfushi. The break water construction project involves

1. Widening the harbour basin (Fill material obtained used to reclaim areas illustrated in Figure 2)
2. Installation of breakwater as illustrated in Figure 3
3. Maintenance dredging of shallow areas in harbour.

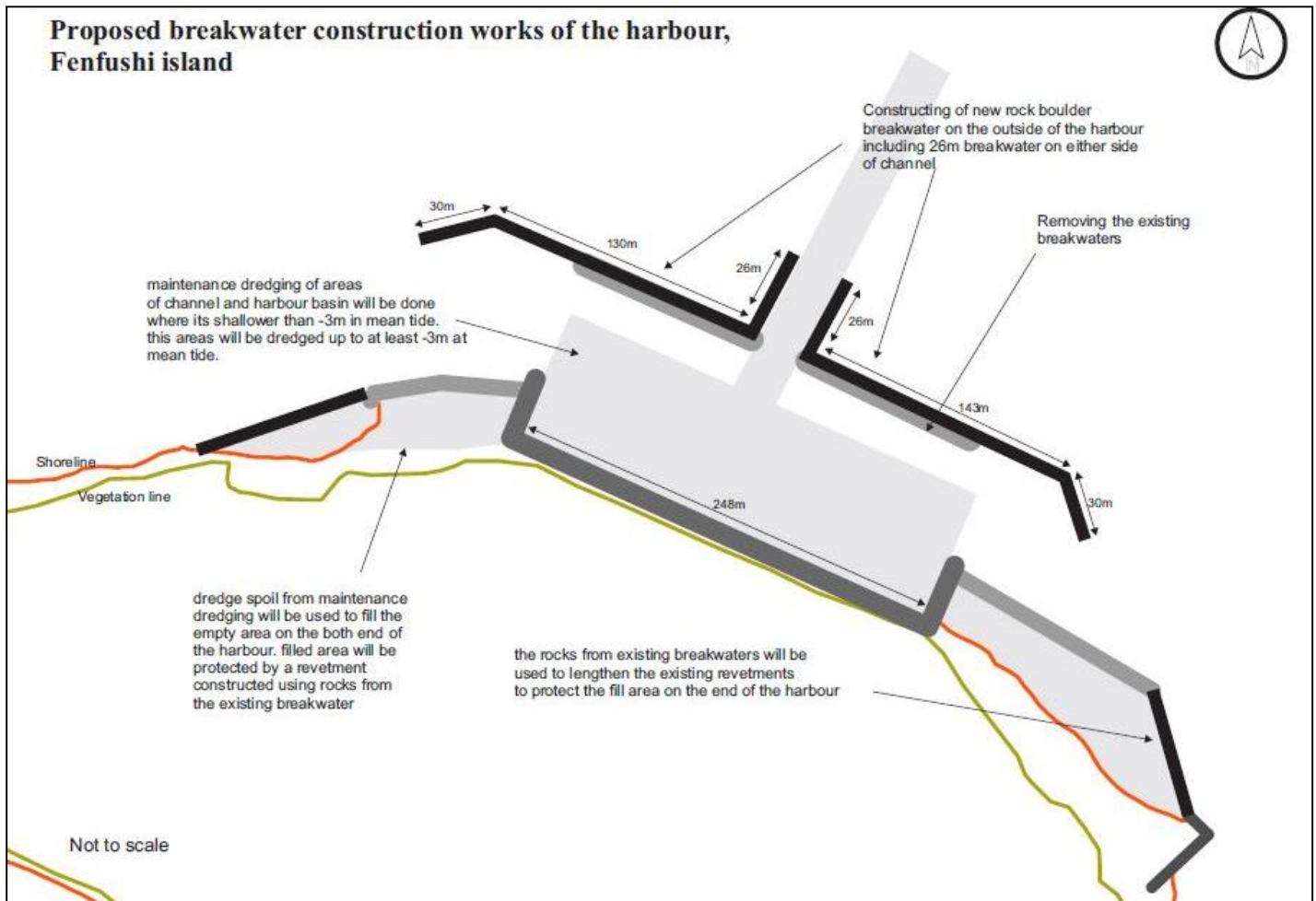


Figure 2: Summary and design of ongoing breakwater construction project at Fenfushi (Source: Directly from Aleem, 2014)



Figure 3: Breakwater design details and summary of ongoing project at Fenfushi

At the time of survey, break water construction was ongoing. Fill material obtained from widening the existing harbour basin had already been used to reclaim western land fill area. The dredging had not been completed, hence water quality was measured within the harbour basin and outside harbour basin during dredging. These readings have been used in the current EIA report to establish threshold turbidity levels at Fenfushi (See section 6.5.1) and to determine how effective harbour basin is at retaining sediments. These findings are also used in the impact analysis.

The areas proposed to obtain fill material for reclamation of eastern side are within the footprint of harbour that will be created as a result of the ongoing breakwater construction project as illustrated in Figure 3. In this sense, the report identifies three zones within the harbour basin that can be dredged to obtain the required fill material. These areas are highlighted in Figure 18. Details of bathymetry findings are included in sections 6.6.1 and 13.4.

**Saleem, A., Amjad, F., Hammadh, A. and Naeem, S. (2015). *Environmental Monitoring Report: L. Mahakanfushi & Baresdhoo Integrated Resort Project Project Phase: Mahakanfushi Harbour, Entrance Channel and Causeway Works. Monitoring Report No.1.***

The report determined and addressed, extent of sedimentation after dredging an entrance channel using an excavator. Monitoring conducted after dredging identified the movement of sand particles of different sizes in the current range of 0.1-0.4 ms<sup>-1</sup>. Primary impact zones and secondary impacts zones were identified with the extent of damage to live corals in each zone. Since, sedimentation was determined to be the most significant environmental impact arising from the project, the monitoring report was heavily referenced in determining environmental impacts, mitigation measures and significance of sedimentation in reclamation of GFF harbour.

**Saleem, A. (2015). *Environmental Impact Assessment of Dhonmaagaa Lagoon.***

The project involved reclamation of a shallow lagoon to create an island. The EIA was prepared after gathering extensive current data. Hence this study was used to determine average current speeds and to address particle movement on a broader scale.

**Saleem, A., Hammadh, A. and Naeem, S. (2015). *Environmental Impact Assessment: K.Hinmafushi Reclamation.***

The project involved extensive consultations and discussions on how effective certain methods are at controlling sedimentation. The project was able to devise work methods to effectively reduce sedimentation while aerating stagnant bodies of water.

## 2.8 POTENTIAL FILL MATERIAL BORROW OPTIONS

Fill material required for the proposed reclamation was calculated to be 28,477m<sup>3</sup>. Surveys suggested that the amount of fill material required for the reclamation can be obtained from existing harbour basin. (see section 6.6.1 for details)

The following options have been suggested/recommended to obtain fill material.

1. Using material from ongoing harbour expansion and maintenance dredging works to reclaim the eastern side.
2. Dredging areas within the footprint of harbour basin to obtain the fill material. These include zone 1,2,and 3 which have been identified ( See Section 6.6.1 and 13.5 for details and scaled drawing).

Alternative areas/concepts have also been identified and proposed to obtain fill material. These include:

3. Dredging an alternative entrance channel east of the harbour to shift the main entrance channel towards the east. (See Section 9 for details and evaluation of dredging alternate entrance channel)
4. Dredging lagoon area west of the harbour to obtain fill material.

It is concluded that options 1,2 and 3 are the most favourable based on their relatively small impacts to the environment and due to the socio-economic and logistic benefits they would provide.

- Utilisation of material from an ongoing project will reduce costs, such as those associated with mobilisation and time.
- Dredging areas that have already been modified which will reduce environmental footprint due to both projects.
- Obtaining fill material within the enclosed boundary of the harbour would mitigate sediment transportation which is one of the major environmental impacts resulting from dredging and reclamation projects.

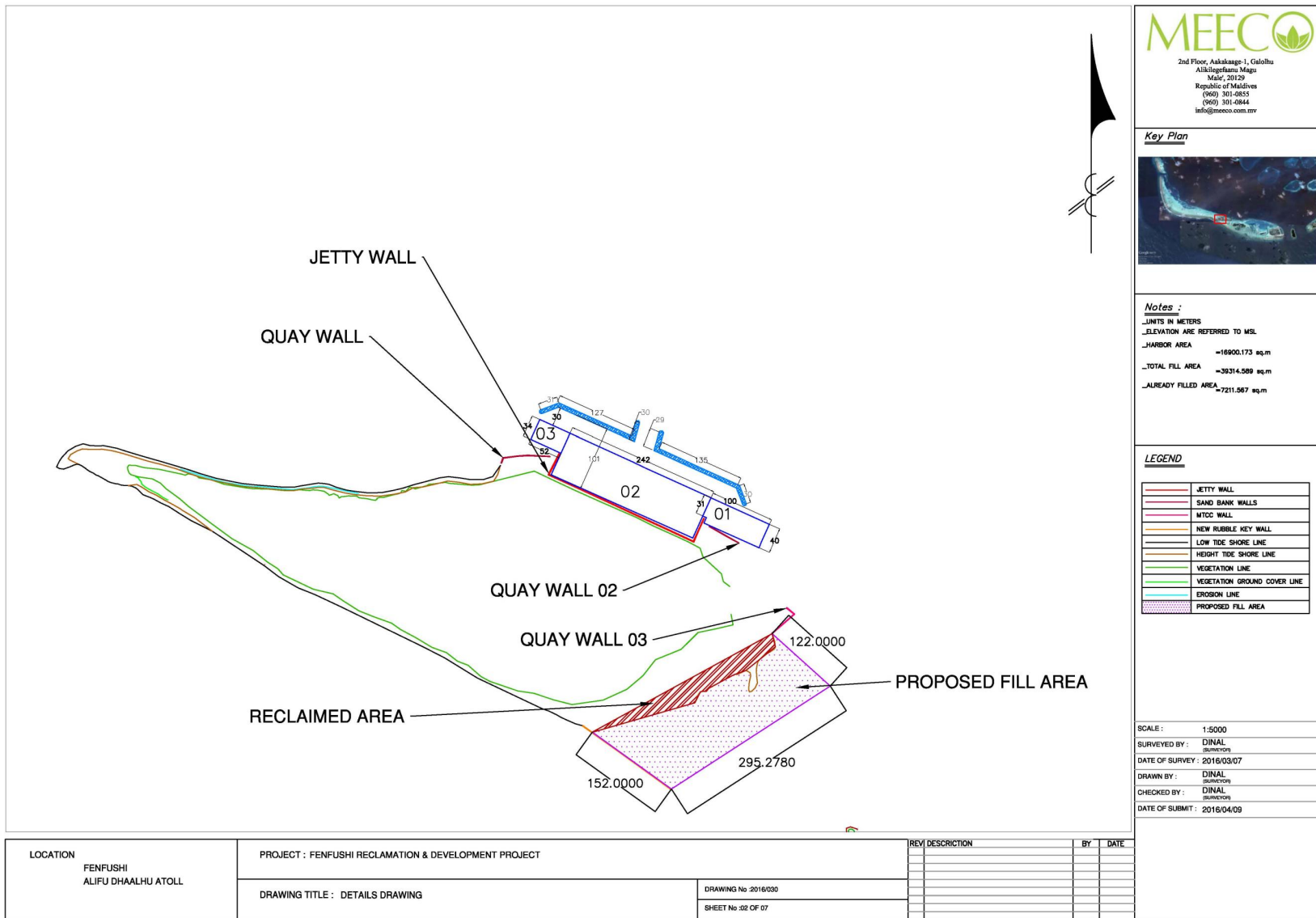


Figure 4:Size/condition of proposed reclamation area. Zones 1,2 and 3 that are proposed to obtain fill material.

### **3 DESCRIPTION OF THE PROJECT**

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This section of the report addresses task 1 of the TOR, hence describes scope of work in detail with the proposed work method. The perceived impact boundaries based on the proposed project and work method is also highlighted in the section. As per task 2 the section identifies all the inputs and outputs of the proposed project including equipment's and how they will be obtained. Findings of the section have then been used to for the impact assessment, section 8 of the report.

#### **3.1 THE PROPONENT**

The proponent for the proposed reclamation project is A Dh. Fenfushi Island Council:

Secretariat of ADh Fenfushi Island Council  
Tel: + (960)6680539, Fax: + (960)6680539  
Email: fenfushi@adh.gov.mv

#### **3.2 THE TERMS OF REFERENCE**

The Terms of Reference (attached in 13.1 Annex 1) outlines the requirements that should be considered in preparing the EIA. This EIA report has been prepared in line with the Terms of Reference (TOR) issued by the Environmental Protection Agency (EPA) 10<sup>th</sup> February 2016. This document is submitted to EPA by the proponent to fulfil the requirements stipulated by the Environmental Protection and Preservation Act (EPPA) of the Maldives (4/93).

#### **3.3 PROJECT LOCATION AND SITE AREA**

Fenfushi is situated at 3°29'22.02"N and 72°47'03.64"E in South of Ari Atoll. The proposed reclamation region is located on the eastern coast of Fenfushi at 3°29'15.12"N and 72°47'9.95"E. The size of the proposed reclamation area is 37,161 m<sup>2</sup>.

#### **3.4 PROJECT BOUNDARY AND IMPACT ZONE**

The footprint of project area is estimated to be 0.03 km<sup>2</sup>. Figure 2 demonstrates dimensions of land area which will be reclaimed. The impacts of the proposed reclamation project are primarily concentrated to the marine environment. The impact zones of the project have been developed as primary and secondary zone. Primary zone is the reclamation zone where direct impact on marine environment is expected. Secondary impact zone is the area that has the potential to be impacted by sediment movement. Approximately 0.6 km from the primary impact zone, South Ari Atoll Marine Protected Area is situated. (See sections 6.6.6 and 7.7 for detailed description). No protected areas were found within 200 m of primary impact boundary. Hence the reclamation area is in line with article 13 (♾), dredging

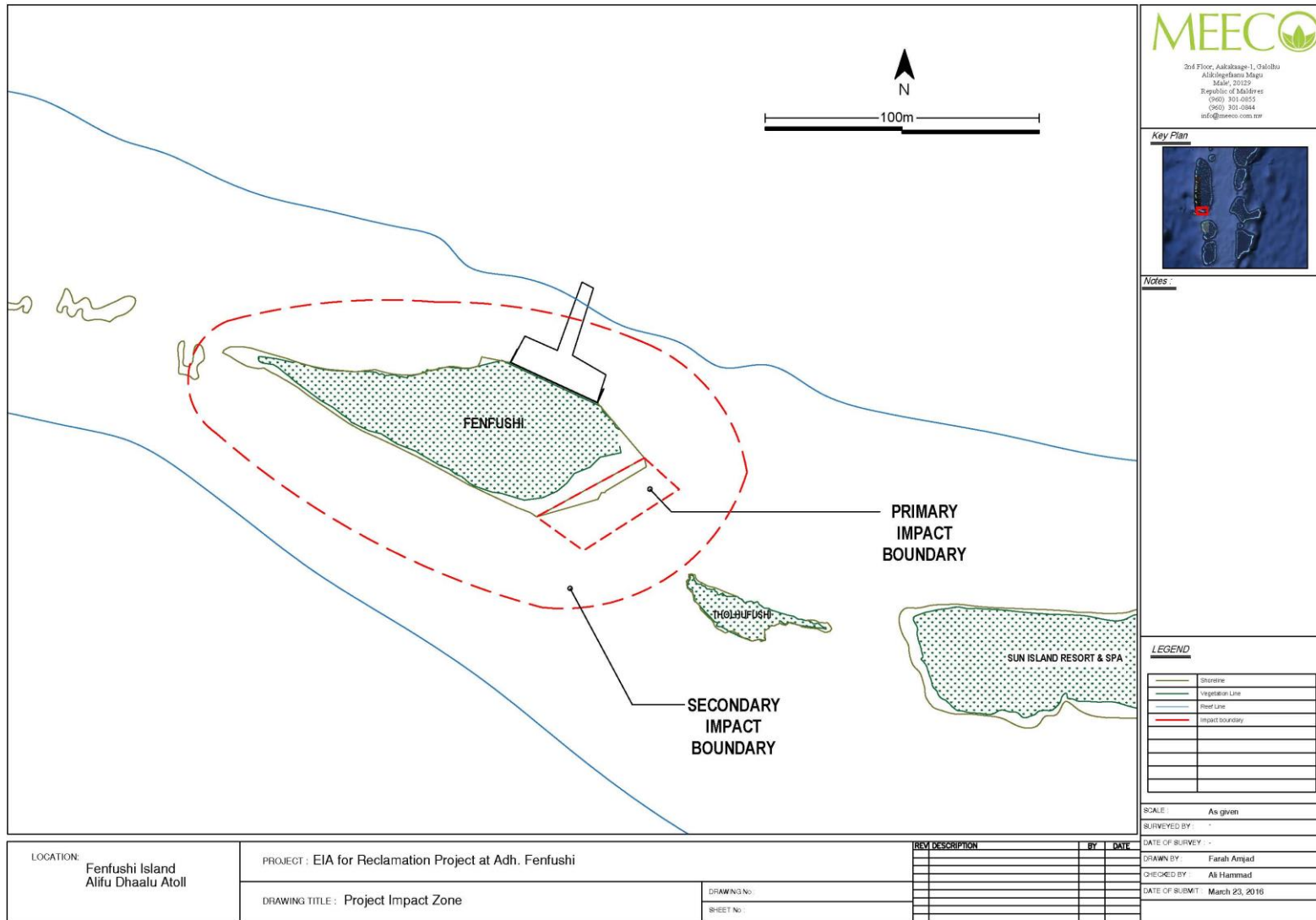


Figure 5: Project impact boundary

### 3.5 PROJECT DURATION AND SCHEDULE

Once EIA approval has been granted dredging and reclamation will begin instantly. Equipment's and workers camp have already been established at Fenfushi. The dredging and reclamation work is expected to be completed within approximately 40 days. The tentative schedule of the project is given in Table 2.

Table 2: Project schedule

	Days																																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43						
EIA Approval	█																																																
Mobilisation	-																																																
Dredging/Reclamation		█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█		
Topography Survey																																												█					
De-Mobilisation																																																█	█

### **3.6 THE CONTRACTOR**

The contractor for the proposed project will be MTCC who are already working on the breakwater project in the island. Once the EIA and dredging permit have been acquired work shall begin instantaneously.

Details of the contractor are given below:

Maldives Transport and Contracting Company Plc.,  
7th Floor, MTCC Tower,  
Boduthakurufaanu Magu,  
Fax: +(960) 332 3221  
Phone: +(960) 332 6822  
Email: [info@mtcc.com.mv](mailto:info@mtcc.com.mv)

### **3.7 THE PROJECT COMPONENTS**

The most significant component of the project involves reclamation of 39,314 m<sup>2</sup> from eastern lagoon of Fenfushi (See 13.2 and 13.5 for approved site plan and detailed drawing). The fill material required for the reclamation will be obtained from the harbour basin.

- The volume of fill material required for the proposed reclamation was 28,477m<sup>3</sup>. (See Annex 4 for Bathymetry)
- Volume of material available at the harbour basin was determined to be 37,362 m<sup>3</sup>. Optimal areas for dredging are marked in 13.5. See section 6.6.1 for bathymetry analysis.

Reclamation and dredging are the only activities that will have significant impact on the environment. These included suspension of sediments and loss of 0.0002% of lagoon space permanently.

### **3.8 EQUIPMENT AND WORK METHODOLOGY**

The equipment and work methodology described here are based on methods and equipment's generally adopted for small scale projects of similar nature in the Maldives. The equipment's required for the project are already in the island hence mobilisation impacts do not apply to the project.

#### **3.8.1 Equipment and Machinery**

- a. Wheel loader (1 Caterpillar 950 or similar)
- b. 2 Excavator capacity (1 Caterpillar 320 or similar)
- c. Dump truck

### 3.8.2 Work Method

Conventional reclamation and dredging method will be employed for the reclamation using standard equipment's readily available at site already. Table 3 below shows the general work methodology.

Table 3: Work method

Steps	Description
Step 1	Excavator will be used to dredge harbour basin up to - 3.5 m from MSL. Bunds will be created when dredging the harbour basin. Material dredged will be directly loaded onto a dump truck which will transport the fill material to the project site (reclamation area).
Step 2	Bund walls will be set up during reclamation enclosing reclamation area. It is recommended to enclose fill area before reclamation as shown in Figure 6 or in any similar way. Dredged fill will be loaded to dump truck which will transport them to the reclamation area.
Step 3	Wheel loader will distribute the fill material stacked evenly reclaiming eastern side. It is preferred to reclaim the outer boundaries of the area as to create an enclosed bund using the excavator, into which the dump truck can release the fill material excavated. This would also minimise sediment loss and discharge resulting from reclamation.
Step 4	Concrete fill bag, quay walls will be installed to enclose reclaimed area as shore protection.
Step 5	Reclaimed area will be left to settle naturally.
Step 6	Topographical survey to determine whether the required levels have been achieved.
Step 7	De-mobilisation. Transportation of equipment's from project site, management of hazardous waste appropriately.

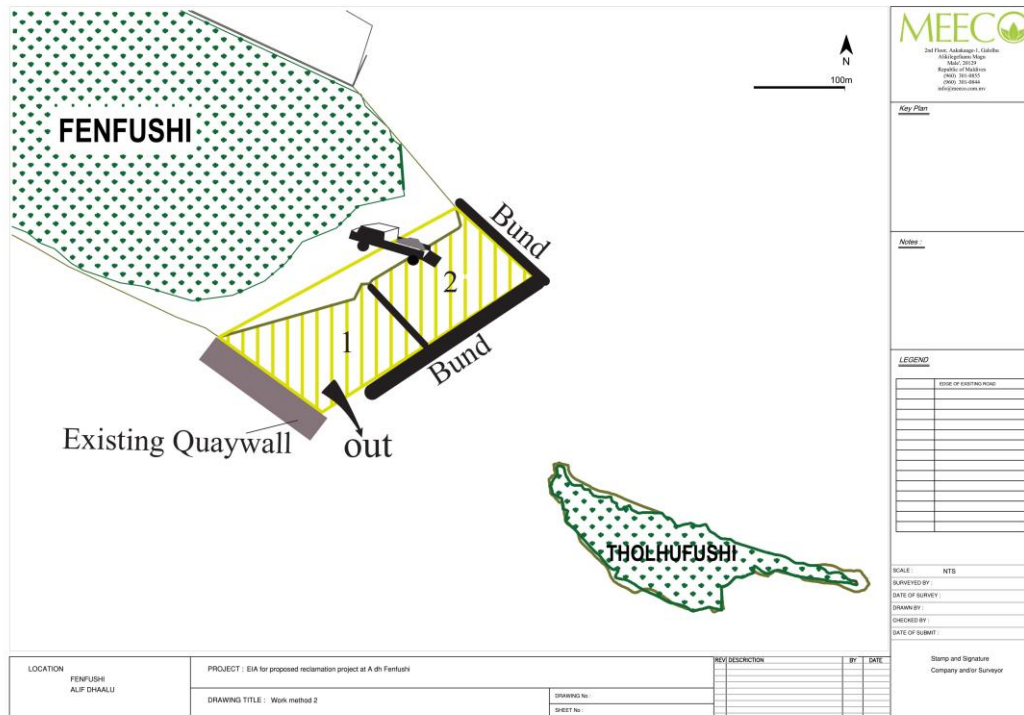
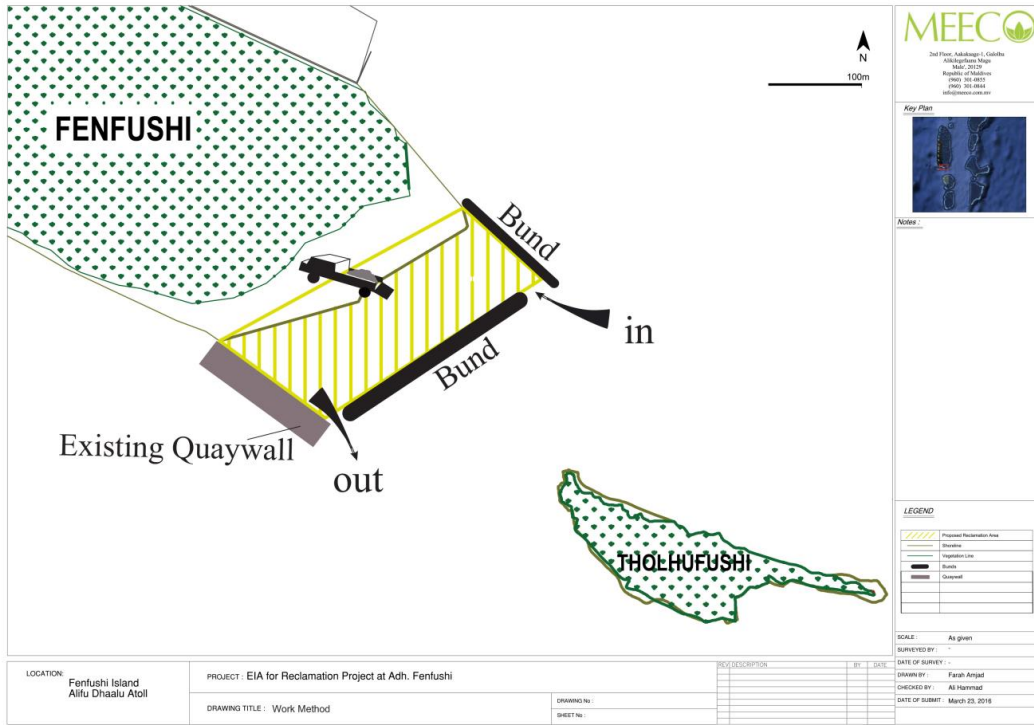


Figure 6: Recommended reclamation method to reduce environmental impacts

### 3.9 PROJECT INPUTS AND OUTPUTS

The resources that are necessary to implement the project (project inputs) include human resources, financial resources, machinery and equipment. Availability of these resources are necessary to ensure efficient delivery of the project activities. The activities that have a direct link to the project (project outputs) are dredged material, dredged entrance channel, reclaimed area, solid wastes and emissions. Project inputs and outputs are listed in Table 4 and 5.

Table 4: Project inputs

Inputs	Source/Quantity	Method of Obtaining
Labour	Skilled and semi-skilled labour: Manager (01) Supervisor (01) Excavator Operator (01) Loader operator (01) Dump Truck driver (01) Labourer (02)	MTCC staff.  The workers will be competent and would possess necessary skills to undertake the tasks assigned.  Foreign workers shall have the necessary legal documents and permits.
Machinery and equipment	Excavator (01), Dump truck (01) Wheel loader (1) Survey equipment	To be operated and obtained by the contractors  Contractor will be required to bring/maintain the machines in appropriate conditions to avoid delays which may be caused by damage to machines, vehicles and equipment.
Fill Material (Dredged Sand/rubble)	Existing Harbour basin. 28,477m <sup>3</sup> .	Dredging the shallow areas, within the harbour basin.
Materials for shore protection	Filled cement bags	These will be purchased and obtained by the council.
Fuel	Diesel, lubricants and Petrol (will be taken in bulk volume. The amount of fuel required by excavators are 15 l/hr, loaders are 26.6 l/hr and dump truck are 2.2 l/km. (Cabello Eras et al.,2013)  The following formula was used to estimate the amount of fuel required for the project. $C_e = V_j \times I_{ce} / C_a$ where Ce stands for the fuel consumption of the equipment e used during the excavation, Vj is the soil volume to be excavated (27,523 m <sup>3</sup> ), Ice is the fuel consumption by equipment (excavator 15 l/h) and Ca is the work capacity of the equipment in (80 m <sup>3</sup> /h).	Purchased from Male, and transported to project site.

	Based on this estimation the amount of fuel required for all three machineries were approximated to be 20,000 l	
Water (Drinking)	Approx. 3200 L for the duration of project, considering 8 l/day/person.	Rain water stored at tanks in worker's camp.
Finance	It is estimated that the reclamation project will cost approximately MVR 2,400,000 Considering MVR 85 per m <sup>3</sup> . The cost does not involve shore protection.	Financed by project proponent
Electricity (during construction period)	Power obtained from Fenfushi power grid.	Proponent, provides the required amount of electricity from their existing facilities.
Communication	Existing communication networks, Dhiraagu or Ooredoo.	Contractor
Accommodation	Workers camp	Workers camp which has been set at the north eastern corner of the island for the currently ongoing breakwater project will be used.
Food (during construction)	Purchased from local shops and cafes in the island	Contractor
<i>Note: Most of the inputs required for the project are already at the island for the ongoing breakwater construction.</i>		

Table 5: Project outputs

Outputs	Expected Quantities	Method of Disposal/Outcome
Reclaimed Land	39,314 m <sup>2</sup>	The reclaimed area will be used as a football playground, and for recreational activities.
Waste oil	60 l	Waste oil should be disposed of in designated containers and transported to Thilafushi waste management centre. Unused, fuel should be safely transported and stored in designated area.
Solid waste	An average of 0.45 kg/person/day according to World Bank, (2012). Number of workers = 8 Duration = approx. 40 days Amount of waste generated = 144 kg approximately.	To be separated based on waste type, stored and transported to the nearest waste management facility. Organic waste can be treated and used as compost.  A Composting facility already exists at Fenfushi where suitable organic waste can be transported to.
Waste water	120 l/person/day Total wastewater produced during project = 41,000 l	Septic tank at workers camp.
Noise	Noise impact is determined to be insignificant, mainly because dredging and reclamation will take place in the open (See section 8)	Noise will diffuse away in the open, no specific method for disposal.
Hazardous waste - Waste oil and grease by machinery/generator/vehicles, used batteries.	Used oils, batteries and wipe clothes are determined to be the main hazardous waste generated from the project activities. These wastes are going to be generated in insignificant quantities as the project is small and involves few activities that would generate hazardous waste.	Collected, separated, and disposed at Thilafushi by contractor.
Sedimentation	Sedimentation transportation is limited to only fine particles and the likelihood for impacts due to sedimentation was found to be low. (See Section 8)	Managed as per the mitigation methods described in this report
Air pollution including GHG	Limited quantities of dust from machineries. Given that approximately 20,000 l of fuel is used for the project, approximately 53,440 kg of CO <sub>2</sub> -e GHG's will be produced directly. (DECC and Defra, 2012)	Emitted to the atmosphere (See section 8.3 for mitigation)

### 3.10 PROJECT RISKS

This Section identifies risks associated with implementation of the proposed project. Identification of these risks is essential to prevent potential barriers for successful implementation of the project. The following risks were assessed based on a desktop review and past experience gained from similar projects.

- Bad weather could delay completion of reclamation works which would prevent reclamation works and may incur additional costs;
- Equipment failure may impede project activities;
- Fire accidents;  
There are many different reasons to initiate fire. Typical circumstances that may cause a fire include, use of flammable liquids, use of combustible materials, welding activities for repair or maintenance, cigarette butts not properly extinguished.
- Injury to workers due to work related accidents may also impede the progress of the project.

The above risks will be minimised and avoided through proper planning and by ensuring that following safety measures taken during the operations

- Condition of equipment and machineries should be checked prior to deployment and serviced before deployment;
- Equipment and machineries should be handled by professionals and should be tested prior to the operation;
- Spare parts, should be readily available on site;
- Project date should be set based on meteorological data, based on weather analysis months between March-April was found to be calmest and most stable suitable;
- Capable and trained personnel should be hired;
- All workers must be briefed on the safety arrangements before commencing work;
- Personal protection equipment's shall be available and made use of appropriately;
- First aid kit shall be available on the site;
- Firefighting equipment should be easily accessible and installed in vehicles;
- Workers should be given instructions on emergency procedures;
- First aid kit should be made available on the site;
- Safety equipment should be worn by the workers;
- Firefighting equipment should be easily accessible and fixed in vehicles; and
- Worksite should be properly covered and necessary safety and warning signs should be made visible on site.

### 3.10.1 Emergency plan

Four main emergencies have been identified for the proposed project based on exposure to risks, and previous reclamation projects. The identified emergencies include:

- Injury to workers
- Fire related accidents
- Spillage of fuel/hazardous chemical to the ocean

Table 6 below summarizes the procedure that should be followed in case of these emergencies

*Table 6: Expected emergency scenarios and relevant contact authorities*

Emergency	Description	Relevant Contacts
Injuries	<p>Injuries that require emergency response are those that is a threat to the wellbeing of the person involved. These may result from unforeseen accidents, poor workmanship or irresponsibility. In order to prevent such emergencies:</p> <ul style="list-style-type: none"> <li>• All workers must wear safety gear (PPG)</li> <li>• Access to work site shall be controlled and relevant signs shall be placed.</li> <li>• Only qualified/competent personnel should be assigned for the job.</li> <li>• Site supervisors should be on site and always available.</li> </ul>	<p>In case of an injury related emergency:</p> <p>These agencies/companies/people should be contacted:</p> <p>Site supervisor MTCC head office Island council Atoll health center</p> <p>In case of work related death, island police station should be notified.</p>
Fire	<p>Fire related incidents although rare in reclamation project should be considered. Fire incidents can result from equipment malfunction or carelessness of workers. In order to mitigate fire related accidents:</p> <ul style="list-style-type: none"> <li>• All equipment shall be serviced, engines checked after work.</li> <li>• Naked flames should never be allowed machines/equipment's</li> <li>• Fire extinguishers should be present in excavator/dump truck and wheel loader.</li> </ul>	<p>In case of fire emergency, endure to notify these agencies/companies/people</p> <p>Police services Island Council MTCC Head office Maldives Coast Guard</p>
Spillage	<p>The total volume of fuel which will be used by the project is estimated to be approximately 20,000 L. The chances of spillage are very rare for the project.</p>	<p>In case of spillage</p> <ul style="list-style-type: none"> <li>• All work shall be stopped and attention shall be focused on stopping the leakage and trapping the fuel.</li> </ul>

	<p>To prevent spillage of fuel into the ocean all fueling should be done on dry land.          Fuel absorbent material should be on hand</p>	<ul style="list-style-type: none"> <li>• The supervisor shall be notified immediately and absorbent material or ladles should be used to scoop up the top layer.</li> <li>• Island council shall be notified.</li> </ul> <p>Based on the total amount of fuel input for the project, spillage of significant concern is not expected.</p>
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## **4 ADMINISTRATIVE AND REGULATORY FRAMEWORK**

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This section of the report addresses task 3 of the TOR, hence identifies the pertinent legislation regulations standards, and environmental policies that are relevant and applicable to the proposed project. The appropriate authority and jurisdictions that specifically apply to the project have also been determined. The section also identifies clauses and articles of the legislative and regulatory requirements and how they are complied.

### **4.1 INTRODUCTION**

The project is initiated by Fenfushi island council and it would be executed by MTCC.

The following areas are highlighted and discussed in this section.

- The key stakeholder relevant to the project
- Applicable national legislation to the proposed project. The legislative frameworks outlined in this section provides guidance on environmental sustainability, planning and development aspects in the Maldives
- The compliance of the proposed reclamation project to relevant laws, regulations, policies and procedures pertaining to the Maldives. Compliance to policy and legal framework are summarised in section 4.6 and Table 7.

### **4.2 ADMINISTRATIVE FRAMEWORK AND STAKEHOLDERS**

A number of stakeholders were determined for the proposed project. These include:

- Ministry of Housing and Infrastructure (MHI);
- Ministry of Environment and Energy (MEE);
- Environmental Protection Agency (EPA);
- South Ari Atoll Council;
- Fenfushi Island council;
- Sun Island Resort;
- Maldives Whaleshark Research Programme. (MWRP) and
- Ministry of Fisheries and Agriculture (MFA).

#### **4.2.1 Island and Atoll Councils**

The South Ari Atoll Council and Fenfushi Island Council have been established under the Act on Decentralization of the Administrative Divisions of the Maldives. (Law No7/2010). The Decentralization Act devolves specific responsibilities with regard to governing projects and activities that fall within their jurisdiction.

Fenfushi island council is the project Proponent Apart from being the project proponent, the decentralization Act mandates the council to administer and develop the island in accordance with the constitution and statutes and provide municipal functions as prescribed in the Act. The council is also mandated to assist government ministries and atoll councils in monitoring the progress of various development initiatives, and be accountable to the atoll council during project implementation. The council can also lease out and give lagoons and land for different purposes as mandated by national authority for land management in line with the Land Law as per the islands land use plan.

As the project proponent Fenfushi council is responsible for:

- Financing the project.
- Implementing mitigation and monitoring measures proposed in the EIA report
- Obtaining the relevant permits and approvals from government authorities such as land use plan.

Role of atoll council (Lecred report)

A copy of the EIA report was submitted to south Ari atoll council and Fenfushi island council and their acknowledgement of receipt is given in **Error! Reference source not found.** and 13.9.

#### **4.2.2 Ministry of Housing and Infrastructure**

Ministry of Housing and Infrastructure (MHI) is the key government institution responsible for developing and implementing policies related to housing, land use planning, construction industry development and infrastructure improvement in the Maldives. The Ministry is also responsible for regulating dredging and land reclamation projects. Coastal protection and harbour development also falls under the Ministry.

The most important function of MHI are:

- Approval of proposed reclamation project and land use plan. The project has been approved where reclamation concept was prepared by MHI. Approvals of site plan is attached in 13.2.

#### **4.2.3 Sun Island Management**

Sun island resort employs numerous locals from neighboring islands including Fenfushi. Sun Island is one of the largest tourist resorts in the Maldives.

Since Sun island resort falls within the same lagoon as Fenfushi Island, and the small uninhabited island Tholhufushi lying 471 m, has been leased to Sun Island and is considered part of the resort. Due to the spatial proximity of resort grounds to the reclamation area the resort has been considered as an important stakeholder. In this regard Sun Island Resort management has been consulted, where details of consultations and outcomes are presented in section 7 of the report detailing outcomes of the meeting.

#### **4.2.4 Ministry of Fisheries and Agriculture (MFA)**

Fisheries Regulations provide guidelines in determining the boundary line for islands that are housed in a single reef platform. As Fenfushi and Tholhufushi which shares the same lagoon are involved, MFE is considered as a stakeholder.

Fisheries regulation (05/87) provides details in defining boundaries of two islands within the same lagoon (reef platform). The clause on Fishing in the Lagoons (clause 11c) stipulates if a reef area boundary needs to be marked between two islands within a reef system that have more than one island, the boundary line shall be the median line between the two islands in a manner the two islands have equal reef extents. The clause states that the boundary line will be demarcated by the Atoll office with guidance from the Ministry.

The Decentralised Administration Act (Law no 7/2010) devolves planning and implementation functions including rule making functions to the council.

#### **4.2.5 Ministry of Environment and Energy (MEE)**

The Ministry of Environment and Energy (MEE) is the key governmental body assigned with responsibilities of protecting the environment. Environmental responsibilities assigned to MEE includes formulating environmental policies, coordinating, preservation and management of the environment throughout the country, and enforcing Environmental Protection and Preservation Act (EPPA) (04/93).

Under Article 5(a) of EPPA, Environmental Impact Assessment (EIA) is mandatory for projects that may pose potential damage to the environment. The EIA report has to be submitted to the EPA for approval before commencement of a project. As per this legislation, any project that has any undesirable impact on the environment can be discontinued without compensation by MEE.

MEE is not considered as a direct stakeholder since the implementation of the EIA Regulations and management of protected areas have been assigned to EPA.

#### **4.2.6 Environmental Protection Agency (EPA)**

EPA is given the responsibility to assess development projects that may have a significant impact on the natural environment. EPA is the enforcing and regulating authority on environmental matters. EPA is a semi-autonomous body formed under the umbrella of MEE. It is mandated with implementing the EIA processes in the Maldives, implementing the Environment Act and subsequent regulations on behalf of MEE, regulating water and sanitation, biodiversity conservation, waste and air quality management, coastal zone management and protected area management. It is also responsible for formulating environmental standards and guidelines in the country.

Responsibilities of EPA that directly relate to the proposed project include:

- Approval TOR
- Approval of EIA by issuing DS
- Approval of dredging and reclamation application
- Overseeing and assessing monitoring as per the EIA.

#### **4.2.7 Maldives Whale Shark Research Programme (MWSRP)**

South Ari Atoll Marine Protected Area located approximately 0.6 km south of Fenfushi is a famous whale shark point, which is one of the most important natural resources available to Maldives and is significant on a national level. Hence protection of this area is imperative. MWSRP was identified as an important stakeholder for the project mainly because the NGO possess in depth knowledge about the species and behaviour. Protection of South Ari atoll is of not only national interest but is significant at an international level. Hence it is imperative that impacts are mitigated to acceptable levels.

## 4.3 POLICY FRAMEWORK

All development initiatives in the Maldives are required to reach certain predetermined goals which would improve sustainable growth of the nation. This section of the report identifies and describes the major policies and plans to which the proposed project falls under.

### 4.3.1 National

#### 4.3.1.1 Strategic Economic Plan

The Strategic Economic Plan highlights the need for further public sector investments into the development of support infrastructure such as harbours and jetties, and in doing so, strengthening linkages between the different sectors, as well as inter-island linkages required for economic growth.

#### 4.3.1.2 National Waste Management Policy (2015)

The following of aspects of solid waste management are outlined in the policy

- Establishing and activating waste management governance;
- defining waste generators duties;
- Establishing regional waste management infrastructure;
- Activating waste management systems; and
- Influencing consumer choices and encouraging good waste management practices.

The national solid waste management policy envisages the regionalisation of waste management in order to achieve economies of scale, and encourages for the development of regional facilities for management and disposal of waste. The primary objective of the NSWMP is to establish a vision in policies, regulations, standards and plans formulated for sound waste management and to create and identify the responsibilities for waste management at individual, household, community, regional and national levels, establish a policy basis for introducing charges for waste management, identify the role of private partners in the waste management hierarchy and identify relevant stakeholders.

The NSWMP 2015 outlines the main policy goals targeted at addressing the solid waste management problem facing the nation. They are as follows:

- To reduce waste generation, promote and inculcate 3R concept;
- Conduct continual awareness building initiatives with regard to safe waste management approaches
- Designate the MEE as the lead agency for the implementation of the national solid waste management policy and in place a mechanism to monitor island level waste management systems;
- Formulate solid waste management plans for each inhabited island and undertake waste management activities in line with the plans
- Develop the Waste Management Act and carry out waste management activities in accordance with the framework;
- Review medical waste management regulations and ensure that waste management activities of the health sector align with such regulations;
- Collect and compile data on waste generation at island and national levels and publish such information;
- Establish a system to levy and collect fees/charges from waste producers/generators;
- In each inhabited island, establish a waste management system which is suitable for the needs of the island (to be determined based on the size of the island and the island population) and provide

necessary tools and machinery and carry out waste management activities through the established system;

- In a sustained manner conduct training programmes on safe management of waste targeting stakeholders;
- Establish, maintain and update an inventory of waste management systems established in inhabited islands;
- Establish regional waste management facilities in all the designated regions of the Maldives;
- Transfer residual waste (after waste management at island level) to regional waste management facilities in line with the relevant regulations, and manage waste transferred in the regional waste management facility;
- Undertake research on latest waste management technologies;
- Encourage preparation of waste management plans for islands designated and leased for industrial activities and conduct monitoring to ensure compliance with such plans in the waste management activities; and
- Establish a “National Waste Management Trust Fund”

#### **4.3.1.3 Saafu Raajje Initiative**

The “Saafu Raajje Initiative”, which is a long term plan of action for management of waste, was launched by MEE as a pre-event to the Sixth Regional 3R Forum in Asia and the Pacific held in the Maldives (16-19 August 2015). The initiative, which is a nation-wide campaign, targeted to encouraging environmentally sound waste management and encouraging a significant reduction in waste generation was organised by the government of Maldives with the participation of more than 100 resorts operating in the Maldives. The initiative attempts to promote safe management of waste, increase awareness of safe waste management practices and to obtain atoll and island level support for such activities.

#### **4.3.1.4 National Biodiversity Strategy and Action Plan (NBSAP) (2016-2025)**

Marine biodiversity in the Maldives is characterised by the large megafauna found in the waters of Maldives. Over 20 species of whales and dolphins, and 40 species of sharks have been identified. Over 167 species of birds, of which 5 are endemic to the country, have been identified in the Maldives. Majority of these are migratory species and protected under Environment Protection and Preservation Act of Maldives (4/93).

Maldives is also characterised by mangroves, one of the unique coastal ecosystems that act as a buffer as well as a drainage during floods and other natural hazards. Fourteen species of mangrove plants and many more associated species have been identified in Maldives.

Maldives prepared its first NBSAP in 2002. Since its preparation, NBSAP was widely used as guidance for other national policies, work plans and regulations on biodiversity

The most recent NBSAP are based on the following three principles.

1. The people of this generation and the generations to come reserves the right to access and share benefits of rich biodiversity and ecosystem services;
2. Responsibility of conserving and sustainably using biodiversity lies on everyone’s shoulders and shall be taken as a shared responsibility;
3. Biodiversity shall be mainstreamed into all sectors and in a manner whereby monitoring progress and accountability is ensured.

The strategies under the NBSAP 2016-2025 are:

- Strategy 1 – Strengthen governance, policies and strategies for biodiversity
- Strategy 2 – Enhancing communication and outreach through awareness programs and capacity building
- Strategy 3 – Work together globally for biodiversity conservation
- Strategy 4 – Ensure sustainable use of biological resources
- Strategy 5 – Address threats to conserve biodiversity
- Strategy 6 – Strengthen Information Management and Resource Mobilisation

## 4.4 INTERNATIONAL

### 4.4.1.1 *MARPOL Convention*

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention which addresses pollution of the marine environment by ships due to operational and accidental causes. As a party to the MARPOL convention, Maldives is required to oblige and maintain the standards specified by the convention with regard to maritime pollution and their control. These include pollution due to

- Oil spillage
- Noxious liquid substances in bulk
- Spillage of harmful substances carried by sea in packaged form
- Sewage and garbage from ships
- Air pollution from ships

Prevention measures should be taken into account with regard to these sources of pollution during the developmental and functioning stage of the project.

### 4.4.1.2 *Convention on Biological Diversity*

The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a multilateral treaty. The Convention has three main goals:

1. conservation of biological diversity (or biodiversity);
2. sustainable use of its components; and
3. fair and equitable sharing of benefits arising from genetic resources

In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity. It is often seen as the key document regarding sustainable development.

The convention recognized for the first time in international law that the conservation of biological diversity is "a common concern of humankind" and is an integral part of the development process. The agreement covers all ecosystems, species, and genetic resources. It links traditional conservation efforts to the economic goal of using biological resources sustainably. It sets principles for the fair and equitable sharing of the benefits arising from the use of genetic resources, notably those destined for commercial use. It also covers the rapidly expanding field of biotechnology through its Cartagena Protocol on Biosafety (Maldives is not yet part of), addressing technology development and transfer, benefit-sharing and biosafety issues. Importantly, the Convention is legally binding; countries that join it ('Parties') are obliged to implement its provisions.

Article VI (a) of the CBD calls for development of “national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, inter alia, the measures set out in this Convention relevant to the Contracting Party concerned”. NBSAP was prepared as a provision to CBD.

## **4.5 LEGAL FRAMEWORK**

All development projects identified by law must meet certain pre-set conditions for their approval. These legal frameworks are in place to protect the delicate natural environment of the Maldives, promote sustainable development, build resilience, and facilitate better decision making and management of the environment. This section of the report identifies the legal context to which the proposed dredging project falls under. Hence identifies and describes the relevant laws and regulations which applies to the proposed dredging project.

### **4.5.1 Environment Act**

Environment Protection and Preservation Act of Maldives (Law No: 4/93) was enacted in April 1993 as an umbrella law to protect and preserve the environment of the country. The articles and clauses of the law are given below. Ministry of Environment and Energy has the responsibility of formulating policies, laws and regulations on environmental protection and conservation.

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

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

#### **Introduction**

1. The natural environment and its resources are a national heritage that needs to be protected and preserved for the benefit of future generations. The protection and preservation of the country’s land and water resources, flora and fauna as well as the beaches, reefs and lagoons and all natural habitats are important for the sustainable development of the country.

#### **Environmental guidance**

2. The concerned government authority shall provide the necessary guidelines and advise on environmental protection in accordance with the prevailing conditions and needs of the country. All concerned parties shall take due consideration of the guidelines provided by the government authorities.

#### **Environmental protection and conservation**

3. The Ministry of Environment shall be responsible for formulating policies, as well as rules and regulations regarding the environment in areas that do not already have a designated government authority already carrying out such functions.

### **Protected areas and natural reserves**

4. (a) The Ministry of Environment shall be responsible for identifying protected areas and natural reserves and for drawing up the necessary rules and regulations for their protection and preservation.
- (b) Anyone wishing to establish any such area as mentioned in (a) of this clause, as a protected area or a reserve shall register as such that at the ministry of Environment and abide by the rules and regulations laid by the Ministry.

### **Environmental Impact Assessment (EIA)**

5. (a) An impact assessment study shall be submitted to the Ministry of Environment before implementing any development project that may have a potential impact on the environment.
- (b) The Ministry of Environment shall formulate the guidelines for EIA and shall determine the projects that need such assessment as mentioned in paragraph (a) of this clause.

### **The Termination of Projects**

6. The Ministry of Environment has the authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation

### **Waste disposal, oil and poisonous substances**

7. (a) Any type of waste, oil, poisonous gases or any substance that may have harmful effect on the environment shall not be disposed within the territory of the Maldives.
- (b) In case where the disposal of the substance stated in paragraph (a) of this clause becomes absolutely necessary, they shall be disposed only within the areas designated for the purpose by the government. If such waste is to be incinerated, appropriate precautions shall be taken to avoid any harm to the health of the population.

### **Hazardous/ Toxic or nuclear wastes**

8. Hazardous/Toxic or Nuclear Wastes that is harmful to human health and the environment shall not be disposed anywhere within the territory of the country. Permission shall be obtained from the relevant government authority at least 3 months in advance for any transboundary movement of such wastes through the territory of the Maldives.

### **4.5.2 Environment Impact Assessment Regulations (2012)**

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

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

The law also gives power to the relevant Government authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation. According to the EPPA waste disposal, oil and poisonous substances any type of waste, oil, poisonous gases or any substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives.

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

Environment Impact Regulations, 2012 & other relevant regulations

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

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

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

#### **4.5.3 Dredging and Reclamation Regulations (2013/R-15)**

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

#### **4.5.4 The Regulation on Environmental Liabilities (Regulation No. 2011/R-9)**

The objective of this regulation is to prevent actions violating the Environmental Protection and Preservation Act 4/93 and to ensure compensations for all the damages that are caused by activities that are detrimental to the environment. The regulation sets mechanisms and standards for different types of environmental liabilities and equal standards that shall be followed by the implementing agency while implementing the regulation. According to this regulation the Government of Maldives reserves the right to claim compensation for all the activities which have breached the Environmental Protection and Preservation Act 4/93.

#### **4.5.5 Regulation and Waste Management**

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

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

#### **4.5.6 Maldivian Land Act**

The Act governs the allocation of Maldivian land for different purposes and uses and other issues regarding the issuing of land, issuing of state dwellings for residential purposes, conduct regarding state dwellings or private dwellings constructed for residential purposes and the sale, transfer and lease of Maldivian Land.

All transactions concerning the issuing, receiving, owning, selling, lease, utilizing and using Maldivian land shall be conducted in compliance with this Act.

The Ministry of Home Affairs, Housing and Environment shall entrust the land allocated for different purposes and uses in accordance with sections 3 and 4 of this Act to the concerned Ministries

#### **4.6 POLICY AND REGULATORY COMPLIANCE**

The applicable administrative, policy and legal frameworks for the project has been identified and described in detail. It is important to ensure that the proposed project falls within the scope of these frameworks.

Table 7 below summarises the compliance of the project with regard to the identified legal and policy frameworks

Table 7: Compliance to relevant legal and policy frameworks

Legal Framework	Measures to Comply
Fisheries Regulations (05/87)	<p>Reclamation boundary will be marked and ensuring that the requirements stated in the General Fisheries Regulations (clause 11 c) is fulfilled and half-way line in to the lagoon space of the Sun Island Resort is not exceeded. This has been confirmed through shoreline/vegetation surveys. Drawings are attached in 13.5, which illustrate that reclamation area does not exceed midline of two islands.</p> <p>Distance of vegetation line between two islands Fenfushi and Tholhufushi was 471 m. The midpoint was located 235 m from Fenfushi. As illustrated from Figure 7 the proposed reclamation boundary exists within the midpoint line, hence the proposed project complies with the law.</p>
Environment Act (Law No. 4/93) Environment Impact Assessment Regulations 2012	<p>All processes followed according to EPPA, EIA has been conducted and produced as per the requirements stated in the EIA Regulation 2012. The report was based upon the TOR approved by the major stakeholders of the project. Significant impacts to environmental protected area (South Ari Atoll Marine Protected Area) have been assessed through the report and conclusions derived based on input from Maldives whale shark research organisation.</p>
Dredging and Reclamation Regulations (2013/R-15)	<p>The EIA has been submitted with the relevant scaled drawings of the reclamation area together with site plans for the reclamation area in accordance with 2013/R-15 article 6. The report defines the scope and context of the project with the perceived environmental impacts to the existing environment. Moreover, in line with the regulation article 13 (↘), dredging or reclamation area is not located within 200 m of a marine protected site.</p> <p>The proposed project is important for the socio-economic development of the island which will be significant on a national scale in line with 2013/R-15 article 8 (↘).</p> <p>The requirement under this regulation will be fulfilled when the EIA for the project is approved. Furthermore, with the EIA, dredging and reclamation application will also be submitted.</p>
Waste Management Regulation, (No. 2013/R-58)	<p>The report outlines mitigation measures for sound management of hazardous and municipal solid waste. The monitoring report details out waste auditing measures which is expected to reduce and manage municipal and hazardous waste generated during the project works. The proponent has committed to undertake mitigation, and monitoring measures recommended in the EIA report. (See 13.8 for Commitment Letter)</p>
The Regulation on Environmental Liabilities (Regulation No. 2011/R-9)	<p>The project is not expected to cause adverse impact on environmentally protected areas or vulnerable species habitat. Potential environmental impacts have been identified and discussed in the report with reference to their scales (See sections 8). The requirements under this regulation complies with the regulation based on the current scope of the proposed project.</p>
Land Act	<p>Land in the Maldives can only be allocated a. for the construction of households and buildings for residential purposes. b. For commercial use. c. For social use. d. For environmental protection. e. For government use.</p>

	As per section three 4a of the Act, the reclaimed land at Fenfushi will be used for social purposes to develop recreational facilities. See 13.2 for site plan attachment. Site plan was prepared by MHI. Land used plan proposed is at final stage of approval. See approved land use plan from council attached in 13.2.
<b>Policy Framework</b>	
Strategic Economic Plan	The proposed project aims at addressing issues of land constraints, which will contribute to economic growth.
National Waste Management Policy (2015)	Submission of the EIA report in which the proposed mitigation measures is in line with the policy described in section 4.3.2
Saafu Raajje Initiative	In line with the initiative the EIA report proposes waste management and awareness measures to which the proponent has agreed to comply. Mitigation measures in line with the initiative have been proposed in section 8.3 of the report and commitment letter by the proponent adhering to the measures proposed in the report during the implementation stages are attached in section (See 13.8 for Commitment Letter)
MARPOL Convention	In line with the convention, the EIA report proposes waste mitigation measures which applies to the vessels operationalised during the project work.
National Biodiversity Strategy and Action Plan (NBSAP) (2016-2025)	<ul style="list-style-type: none"> <li>• Strategy 1 – Involves inclusion and mainstreaming biodiversity. At a project level the EIA process was able to highlight and include all relevant stakeholders of which input from biodiversity research groups have been included.</li> <li>• Strategy 2 – The EIA process, which is a decentralizing process that requires participation from all levels, facilitates collaboration and involvement which raises awareness regarding issues related to the proposed project. The EIA brought together numerous parties whose concerns and input have been input in formulating the EIA and EMP. This facilitated inclusion of local knowledge in assessing baseline environmental conditions, management schemes and historical events.</li> <li>• Strategy 3 – Consultation process carried out during the impact assessment process allowed participation of numerous stakeholders from local council to international NGO's involved in understanding South Ari Atoll MPA and whale sharks.</li> <li>• Strategy 4 – At a project level, the report has recommended measures to reduce environmental footprint through bathymetry surveys conducted. The study identified the smallest, safest area to be dredged to obtain the required fill for reclamation. In this regard the assessment reduced dredge impacts on undisturbed areas and proposes to obtain fill material from an area that had already been modified.</li> <li>• Strategy 5 – The EMP proposed in the report focusses on addressing threats (mainly sedimentation) to the environment and bio diversity.</li> <li>• Strategy 6 – Submission of the completed assessment to the relevant regulatory authority (EPA) would allow the body to gather data and findings on similar project level studies. This will strengthen the information data base and help in facilitation of national data systems and help in designing financing mechanisms for bio diversity.</li> </ul>

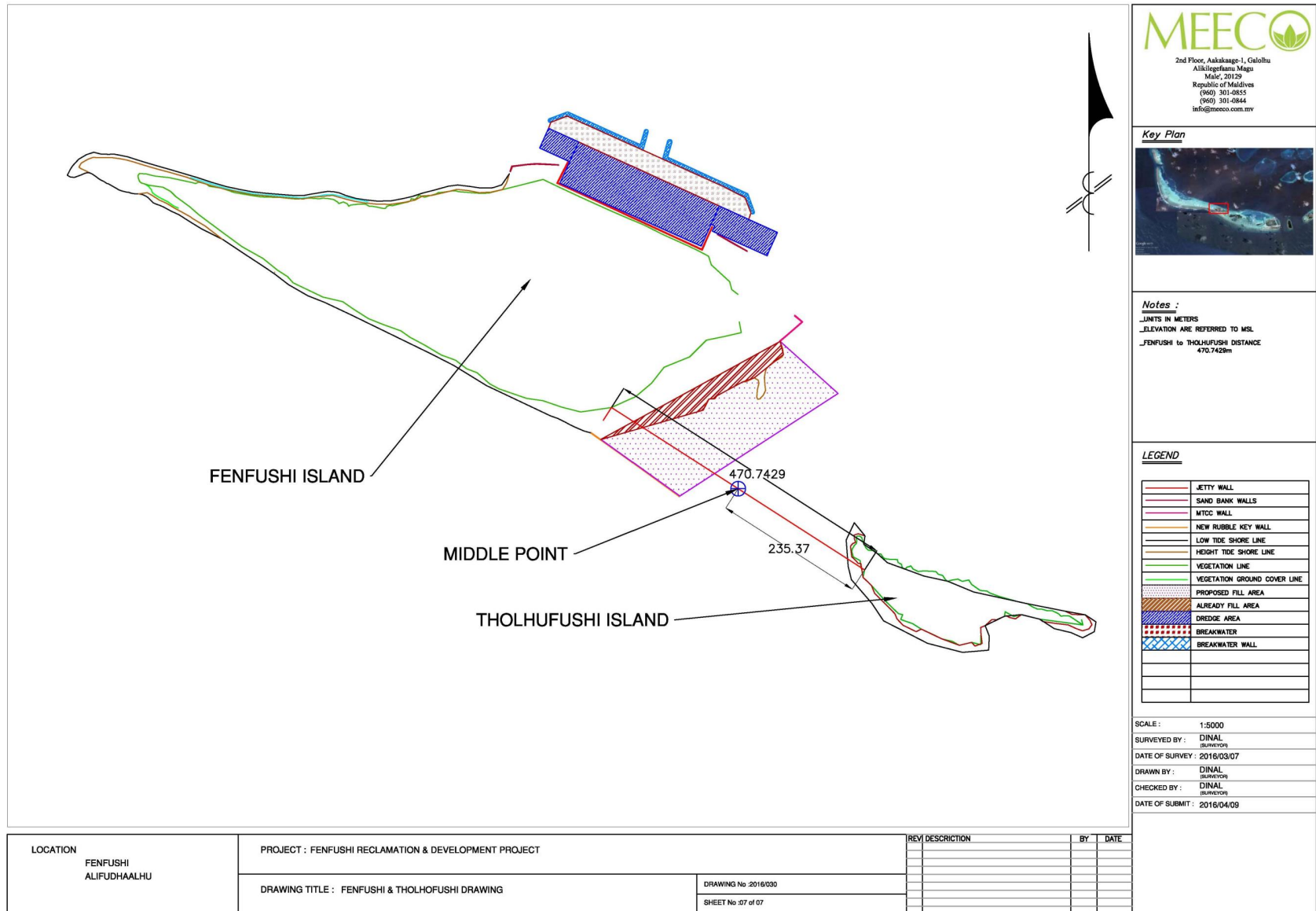


Figure 7: Distance of vegetation line from Fenfushi to Tholhufushi

As described in the Table 7 above, the proposed project if followed as outlined in the EIA report, would comply with the relevant government policies, initiatives, and all applicable environmental legislation, and regulatory statutes. In order, to ensure that these policies and regulations are followed, a monitoring plan has been developed (See Section 10). The proponent has agreed to ensure that the mitigation measures stipulated in the report will be effectively implemented and that the monitoring program is conducted to ensure perceived impacts of the project is kept within the standards set by the laws and regulation.

## 5 METHODOLOGIES

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### 5.1 INTRODUCTION

This section of the report addresses **Task 2** of the TOR and provides descriptions of the methods deployed to collect data regarding the existing environment as per the guidelines published on EPA website. The section addresses sensitivity and limitations of methods used in the study. Survey was designed so that the data obtained can be used to:

- Determine the feasibility of the project with regard to economic equity, social and environmental justice.
- Develop an adaptable monitoring plan based on participatory management in order to maintain the baseline environment within the variability of dynamic equilibrium.

In addition, relevant literature was reviewed and previous studies utilised as described in section xx. Data on the existing environment was collected during two field visits from 22<sup>nd</sup>-24<sup>th</sup> February 2015 and 29<sup>th</sup> February to 3<sup>rd</sup> March 2015 to Fenfushi. The survey lasted for six days and was conducted in fine weather during the northeast monsoon.

### 5.2 COAST AND SHORELINE

GNSS RTK System relative to PSM, was used to determine the coast, shore line, current beach profile, vegetation, and building structures within the project boundary to a confidence interval of 3 mm.

The bathymetric survey was conducted using the RTK method as spot heights of the shoreline. The accuracy of the horizontal measurements was always less than 0.002 m and the vertical measurements were less than 0.005 m. This is one of the most accurate methods of determining the shoreline and vegetation line of the island.

### 5.3 MARINE SURVEY

Line Intercept Transect (LIT) method and photo profile method was utilised to assess the benthic cover of burrow areas, protected area and reclamation area. Four 20 m geo-referenced transects were placed at the project area as illustrated in Figure 8. Overhead photographs were taken along the length of the line transect. Photographs were later analysed to develop a count graph which was used to determine the cover, morphology and diversity of the benthic. The assessment consisted of 9 coral forms, laminar, encrusting, free living, columnar, foliaceous, branching, massive, digitate and tabular.

Fish surveying was done by taking timed photographs and videos at the location specified in Figure 8. The photographs and videos were later analysed to identify the type of fish species using two sources:

1. Anderson and Hafiz, 1987 and
2. Kuiter, 2014.

Fish abundance was assigned by counting, and comparing the count to a selected range which was specific for the area. The count and range band are as follows:

Table 8: Fish count range

Fish Abundance	Count Range
Rare	0 - 10
Common	10 - 35
Abundant	35+

Line transect method has few limitation and is considered as a method deployed at a management level. Compared to research monitoring limitations of management level monitoring include reduced detail of benthic cover at species level.

#### 5.4 COASTAL VEGETATION

Vegetation at the reclamation area was determined through line transect method. Pictures of 50 m lines were taken for the total length of the vegetation line to determine the type and frequency of vegetation.

#### 5.5 NEARSHORE CURRENTS

A Garmin foretrex301 GPS tracker was submerged on the surface of water and position data was logged every second to determine the current direction and its speed. Four trials were logged, from which direction and speed of currents were calculated. The tracker was launched into the water, and the drift progress was timed between the tracker entering the water and coming out. Using tracker software these times were filtered out to calculate the velocity and current direction. Normal distribution based standard deviation was also calculated for the average current velocity.

The method is limited by its accuracy as, wind and external forces on the drift would influence output result.

#### 5.6 CLIMATE, WAVES AND TIDES

Climate and oceanographic regime requires long-term data on climate and oceanographic conditions. Climate data collected at Hulhule' international airport was considered for this study. Although, Maamigili International is closer to Fenfushi, lack of long term data which are readily available prompted to use climate data from Hulhule', which is 100 km away.

Rainfall was analyzed after compiling rainfall data obtained for the past six years, from Maldivian Yearly Statistics Book. The average monthly rainfall was calculated based on six years of monthly data. Monthly variance in rainfall was determined through standard deviation calculations. The individual monthly averages were then compared with mean annual rainfall calculated based on six years of data and these patterns were used to assess the rainfall conditions at Fenfushi. Same approach was used to determine the mean high temperature at Fenfushi.

Literature was reviewed to determine the wave and tide conditions at the project area. Hence historical data on climate and oceanography was used to predict and extrapolate climate and oceanographic conditions.

#### 5.7 SEAWATER

Water samples were analysed using HORIBA U-52 Multi-water Quality Checker that had been span calibrated using standard grade reagents. All the parameters were measured and logged in real time on field which preserves the chemical constituents in equilibrium with their natural physiochemical environment, thus giving a more accurate picture of the quality and status of water samples. The instrument uses voltammetry methods to analyse conductivity, Dissolved Oxygen (DO) and Turbidity of water samples. This technique is more reliable than wet laboratory chemical analyses which would require numerous pre-processing steps to alleviate the effect of reduced and oxidized material.

## **5.8 BATHYMETRIC SURVEY**

The bathymetric survey was conducted using a SonarMite MILSpec™ which has an accuracy of 0.01 m. The boundaries of dredge area were determined after referring to scaled drawings. The dredge areas were selected based on community and council consultations. The echo sounder was connected to a 50 hp 25ft dingy. The vessel was driven in consecutive adjacent 20 m wide transects in consecutive north south direction and east west direction within the reclamation boundary and burrow area.

The survey determined the volumes of sand that will be obtained from the burrow areas and the amount of fill material required to reclaim the proposed area. Dynamic heights of area below sea level was incorporated in the volume calculation of area below MSL.

Volumes were calculated using the surface comparison method in Civil3D. Both the average end method and conic approximation method were utilized to calculate the volumes. Existing surface is generated using the field survey data with functions in the software. The method utilised for bathymetry in the study is one of the most accurate methods available in the market.

## **5.9 GEOGRAPHIC LOCATION OF SAMPLING SITES**

Geographic location was determined based on Garmin GPSmap 64 and the GNSS RTK system. Geographic locations for water samples and transects were marked as way points using the hand held GPS.

## **5.10 SOCIO-ECONOMIC ENVIRONMENT**

Social conditions were determined based on information provided by the island council and through interviews conducted with locals. Two questionnaires were prepared and shared with the council which covered information regarding local historic events to current socio-economic conditions of the island.

Stakeholder consultations were pre-arranged and conducted in person and through electronic means. The stakeholders were explained briefly about the project. A set of questions were asked so as to get their opinion on social, economic and environmental aspects in relation to the proposed development. In addition, they were asked about the concept of the project and how the proposed project would solve the current social and developmental issues.

## **5.11 ISLAND RISKS AND VULNERABILITY**

The risks and vulnerability of Fenfushi was determined through literature review, mainly Development of Disaster Risk Management Profile Maldives (DDRMP) Project done by RMSI (2005) and DIRAM (2009), which thoroughly identified the exposure to natural hazards Maldives islands faced based on location and probability of natural disasters. Island specific historical disaster events and frequencies were determined through questioners, which have been attached in the report.

Figure 8 below illustrates all survey locations of the study and, their GPS locations.

## 5.12 SURVEY MAP

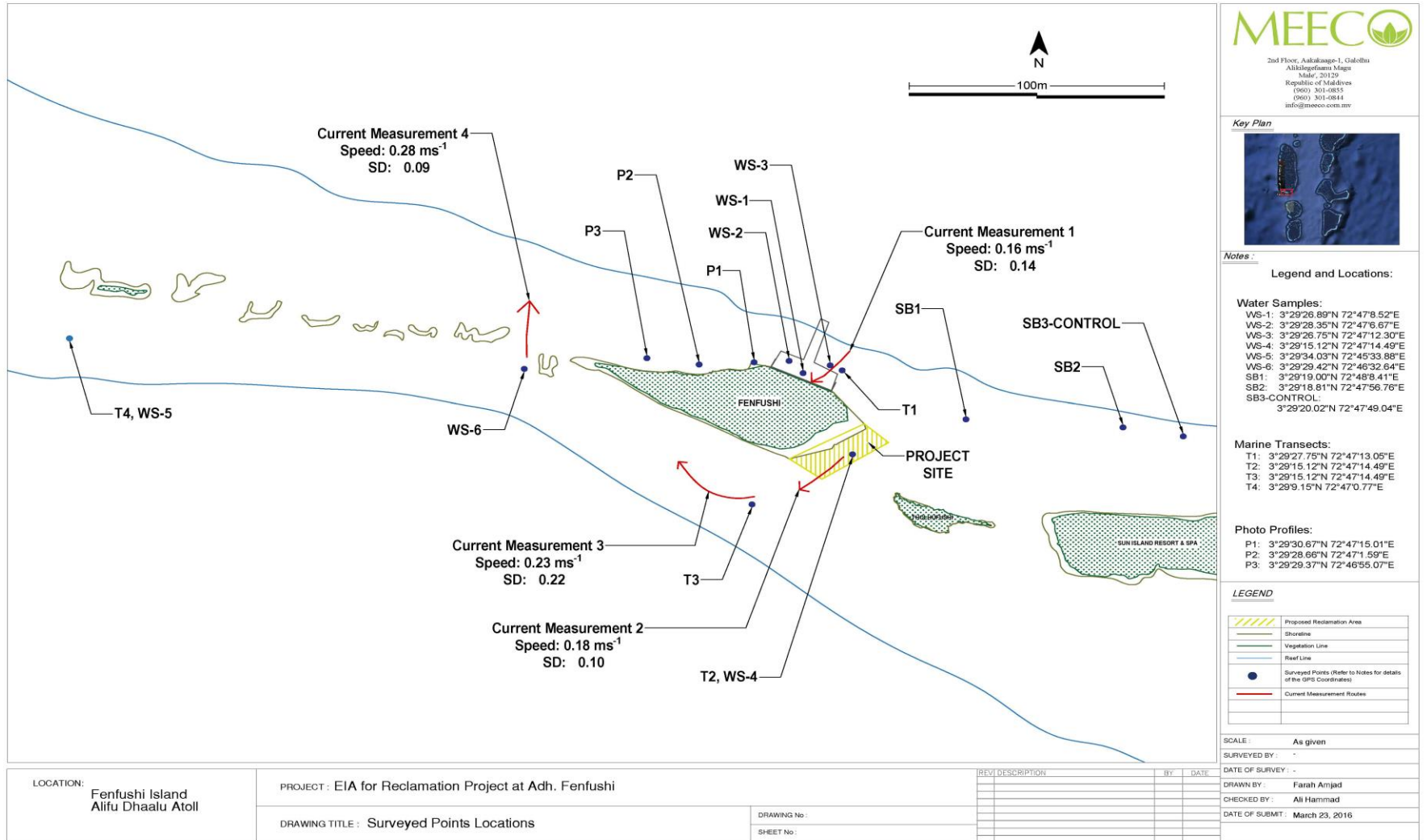


Figure 8: All surveyed points, current direction and GPS locations

## 6 EXISTING ENVIRONMENT

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### 6.1 INTRODUCTION

This section of the report addresses task 2 of the TOR and presents the existing environmental baseline conditions of Fenfushi. The analysis of existing environment is fundamental to determine the feasibility and impacts of the project and to develop an EMP. In this report seven core parameters were analysed. They were geological, geographical, physiochemical, hydrological, ecological, social and climatic aspects of the environment. These assessments were used to:

- Determine existing conditions which can then be contrasted with, in the future to understand and determine the shift in equilibrium from base conditions.
- Do an impact analysis and assess alternatives.
- Prepare an EMP

Hence, this section of the report provides:

- The main findings of the key parameters used to define the existing environment with discussions on the results obtained.

### 6.2 CLIMATE

#### 6.2.1 Temperature

The daily mean high temperature throughout the six year period for K.Hulhule' was found to be very consistent. Temperature analysis of the past six years showed that:

- Temperature gradually increases at the start of northeast monsoon and reaches a peak at April. (See Figure 9)
- The onset of southwest monsoon gradually decreased the mean high temperature where, temperature reaches its lowest in December.
- Temperature fluctuated from the mean in accordance with the monsoons, where highest and lowest registered temperatures were observed during the end of each monsoon.
- The mean yearly high temperature for the past six years was calculated to be 31.1 °C. (See Table 9)
- Yearly temperature variance for the past six years was extremely consistent with a standard deviation of 0.1 °C.

Table 9: Mean high temperature analysis of K.Hulhule for the past six years. Source: (Planning.gov.mv, 2016)

Mean High Temperature/(°C)													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Average
2014	30.9	31.3	31.9	32.1	31.8	31.4	31.1	30.7	30.5	30.6	30.2	30.3	31.1
2013	31.3	31.6	32.0	32.3	31.4	31.2	31.3	30.6	30.8	30.9	30.8	30.7	31.2
2012	30.4	31.1	31.2	32.0	31.6	31.4	30.8	31.3	31.2	31.1	31.1	30.9	31.2
2011	30.2	30.2	31.3	31.5	31.1	31.3	31.0	31.0	30.9	30.9	30.8	30.5	30.9
2010	30.8	31.2	31.7	32.1	31.6	31.2	30.7	30.6	30.4	30.4	30.1	29.7	30.9
2009	30.5	31	31.9	31.7	31.7	31.2	31.2	30.3	30.7	31.6	30.6	30.6	31.1
Monthly Average	30.7	31.1	31.7	31.9	31.5	31.3	31.0	30.7	30.8	30.9	30.6	30.5	31.1
Standard Deviation	0.4	0.5	0.3	0.3	0.3	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.1

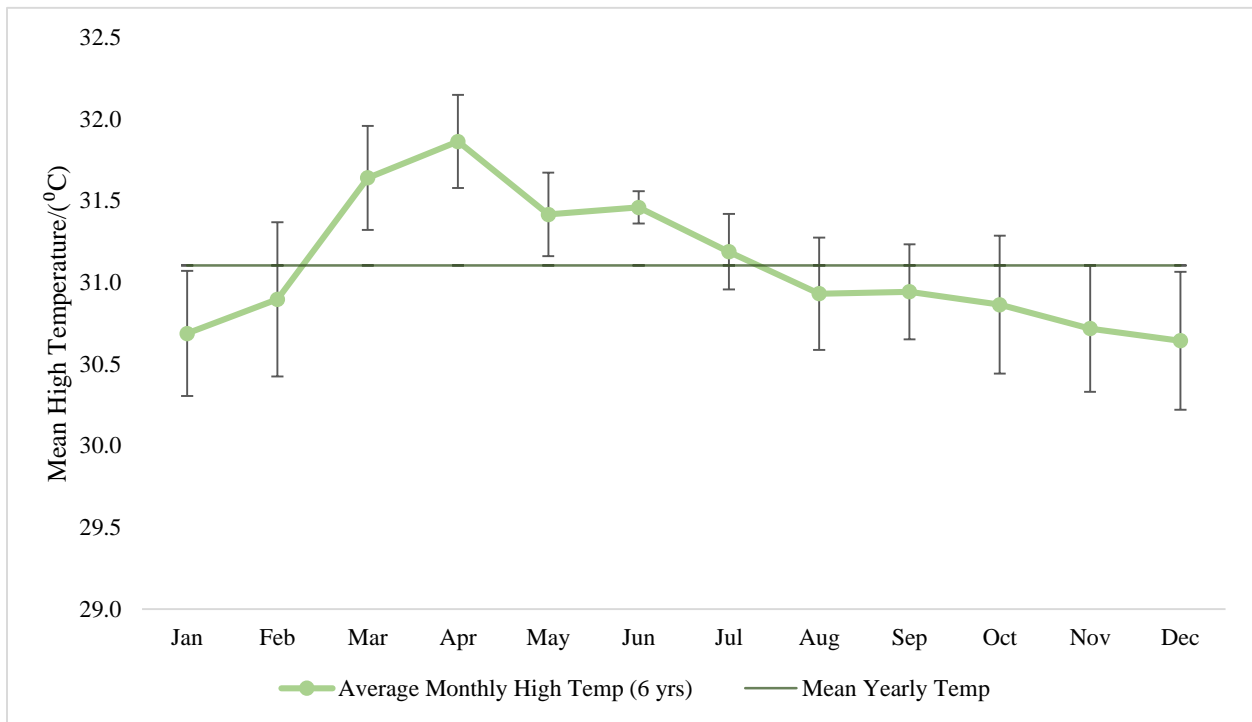


Figure 9: Mean high temperature (six year weather data)

## 6.2.2 Rainfall

Rainfall was analysed after compiling rainfall data obtained for K. Hulhule' for the past six years from Yearly Statistic provided by DNP. The average of six-year monthly rainfall was calculated from the compiled data. Variance of six-year monthly rainfall was determined through standard deviation calculations. The six year individual monthly averages were then compared with the six year mean annual rainfall and these patterns were used to assess the rainfall conditions at Fenfushi.

It was found through historical rainfall data analysis that:

- The average yearly rainfall from data was 1801 mm. A variance of 249 mm was observed for the total annual rainfall (See Table 10).
- Rain fall was lowest during the northeast monsoon. The average annual rainfall during the northeast monsoon for the past six years was 98 mm, this was significantly lower than the annual average of 161 mm. (See Figure 10).
- Rainfall was always less than annual average during the northeast monsoon.
- The highest rainfall was observed for the months of May and October where the average rainfall was 276 mm 249 mm respectively.
- The highest variance in rainfall was also observed for the months of May and October, where variance calculated based on six years were 136 and 142 mm respectively.
- On average rainfall during the southwest monsoon was always higher than annual average.
- January and December were found to have the highest rainfall variance during the northeast monsoon.
- June was found to be the month that received the least amount of rain based on six years of rainfall data (59 mm) with a variance of 26.9 mm.
- April was found to have the least variance in rainfall (8.6 mm).
- January, February and March was found to have the least incidence of rainfall for the past six years

Table 10:: Mean Rainfall analysis of K.Hulhule for the past six years. Source: (Planning.gov.mv, 2016)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total /(mm)	Yearly Average /(mm)
2014	42.4	1.9	108.3	97.6	380.4	73.9	107	259.5	176.4	431.3	174.4	280.4	2133.5	177.8
2013	72.2	25.9	135.2	92.7	493.2	170.9	220.1	165.4	62	364.4	185.4	94.4	2081.8	173.5
2012	68.8	90.8	17.9	110.3	147.6	62.7	77.3	210.8	261.1	297	114.5	206.1	1664.9	138.7
2011	101.1	6	16.7	98.4	184.5	56.8	163.6	126.2	125.3	224.4	168.3	219.4	1563.2	124.2
2010	8	92.8	22.4	88.3	276.9	236.1	222.1	177.6	340.9	69.3	128.2	355.3	1674.6	168.2
2009	85.2	12.8	36.8	86.6	175.1	213.3	275.9	416.4	193.3	107.5	409.2	189.4	2023.2	183.5
Monthly Average Over 6 yr Period /(mm)	63.0	38.4	56.2	95.7	276.3	135.6	177.7	226.0	193.2	249.0	196.7	224.2	1801.5	161.0
Standard Deviation /(mm)	33.2	42.2	52.0	8.6	136.5	80.9	75.7	103.5	98.5	142.7	107.7	88.0	249.4	23.8

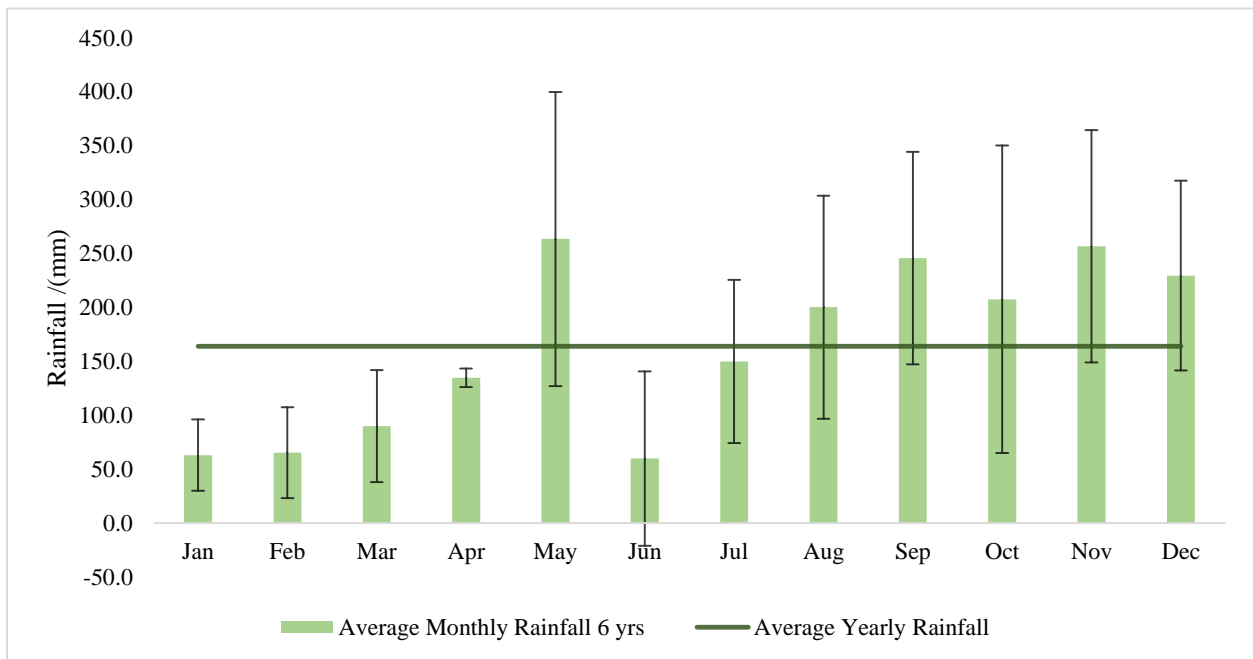


Figure 10: Annual monthly rainfall (2009-2014) compared with average yearly rainfall (2009-2014)

### 6.2.3 Wind

The wind conditions for the Maldivian islands are dominated by two monsoons. These winds approach with great constancy, primarily from the northeast and southwest directions. Some seasonal changes occur within this pattern, as a result of the relative position of the sun and the earth's surface. Strong winds and gales are infrequent although storms and line squalls can occur, usually in the period from May to October.

Wind was analysed after compiling wind data obtained for K. Hulhule' for the past three years from Yearly Climate Statistic provided by DNP. The average of three-year monthly wind speed and direction was calculated and determined from the compiled data. Variance of three-year monthly rainfall was determined through standard deviation calculations. The three year individual monthly averages were then compared with the mean annual rainfall determined based on three years and these patterns were used to assess the wind conditions at Fenfushi.

It was found through historical wind velocity analysis that:

- Westerly winds were dominant throughout the year (W – 50% and WSW – 16%). See Table 11 and Figure 12.
- Easterly winds were observed only during the northeast monsoon for the months December, January and February (ENE 33%).
- The yearly average wind speed was 4 ms<sup>-1</sup> (9 miles/hr).
- Lowest wind speeds were recorded during March (7 miles/hr), April (6.7 miles/hr) and November (6.7 miles/hr)
- The highest and most variable wind speeds were logged in February, where average wind speeds were 5 ms<sup>-1</sup> (12 miles/hr) with a variance of 3 ms<sup>-1</sup> (6 miles/hr)

Table 11: Mean wind analysis of K.Hulhule for the past three years. Source: (Planning.gov.mv, 2016)

Units miles/hr <sup>-1</sup>	Wind Speed													Yearly Average	Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
	11	19	9	6	10	12	11	9	8	7	7	5	9.5	2014	
	10	8	6	6	13	11	8	10	10	11	6	10	9.1	2013	
	9	10	6	8	10	11	10	9	8	9	7	10	8.9	2012	
Three Yrs Monthly Average	10	12	7	7	11	11	10	9	9	9	7	8	9		
Standard Deviation	1	6	2	1	2	1	2	1	1	2	1	3	0		

	Wind direction													Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	ENE	ENE	ENE	W	WSW	WSW	WSW	W	WNW	WSW	W	EN	2014	
	ENE	ENE	ENE	W	W	WSW	WSW	W	W	W	E	EN	2013	
	ENE	ENE	NW	W	W	WSW	WSW	WNW	W	W	W	E	2012	
Three Yrs Monthly Average	ENE	ENE	ENE	W	W	WSW	WSW	W	W	W	W	EN		

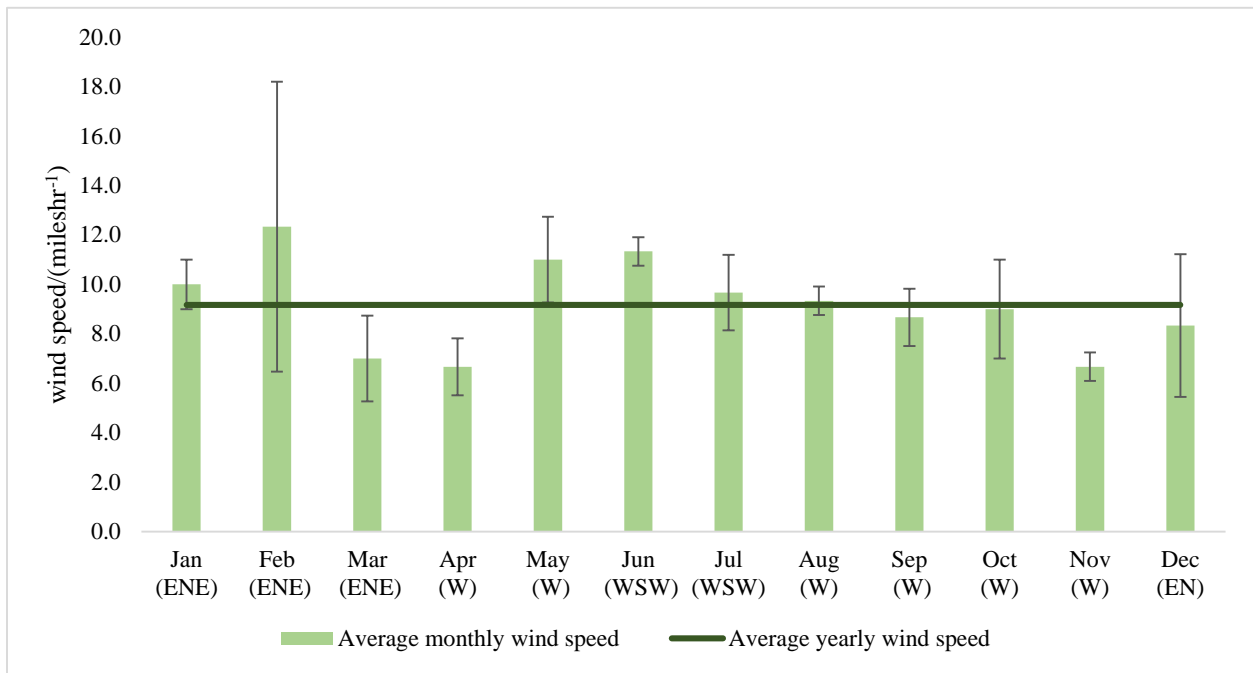


Figure 11: Annual monthly wind speed (2012-2014) compared with average yearly wind speed (2012-2014)

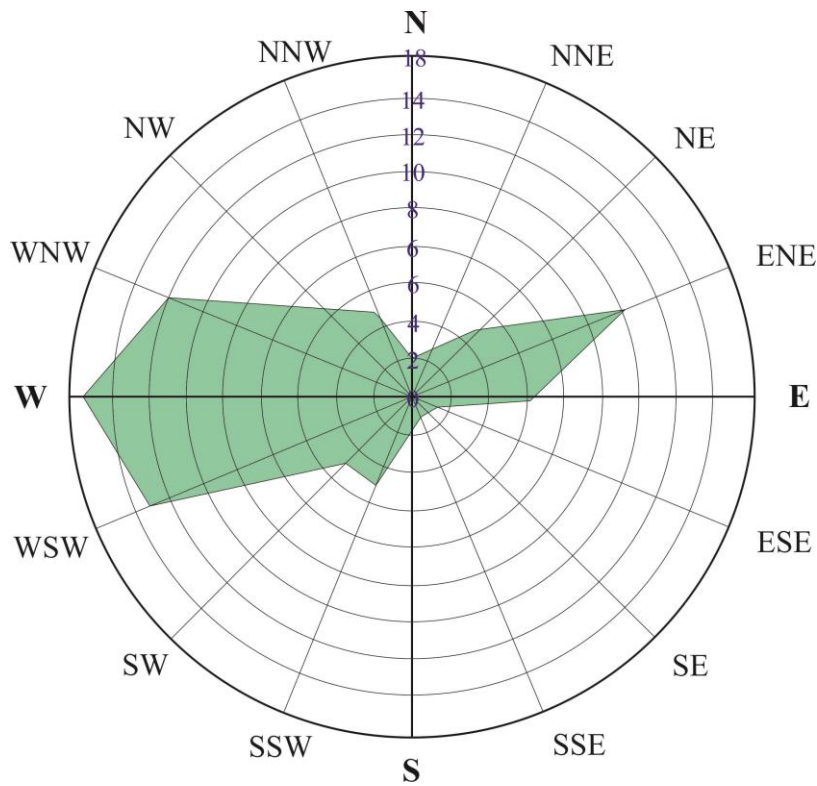


Figure 12: Mean annual wind direction at K. Hulhule' (windfinder, 2015)

#### 6.2.4 Summary Weather Analysis

- Northeast monsoon brought winds from the northeast direction for the months of December-March. The wind was dominant from the West for most of the year (April – November). The project area is expected to be calmer during the southwest monsoon as wind induced waves are expected on the west coast of the island.
- Rainfall analysis suggested that, rainfall was extremely variable but was largely concentrated to the south west monsoon.
- Rainfall was lowest during the northeast monsoon, between January – April.
- Mean high temperature was found to consistent throughout the years however, peaks are observed during the latter stages of each monsoon, where end of southwest monsoon yield the lowest temperatures and vice versa.
- The period between March-April was determined to be the calmest and most stable with the least amount of rain and wind. If the project is conducted during this period, project delays due to weather could be prevented.

## GEOLOGICAL

### 6.2.5 Land form and Soil

Fenfushi is a naturally formed island where the north eastern coast of the island is being reclaimed and modified. The island has an area of 217,059 m<sup>2</sup>. The length of its widest section is approximately 336 m. Two types of beaches were observed sandy beaches on north east and west of the island. A rocky beach was observed only on the southern side of the island. The islands geology can be considered as mature, based on the level of gradation in the soil profile in the middle of the island. The basis of soil was calcareous material similar to all Maldivian islands. Soil comprised of very coarse sand to medium silt (0.03- 1 mm in diameter). Soil featured within the project boundary did not contain B horizon, as the area is being reclaimed using fill material dredged from the harbour. Soil close to the shore was observed to be porous although a thin layer of humus, clay and organic material were present. Soil was structured in a gradational layer with no sharp changes observed between layers. However thin layer of organic material observed at the top suggested minimal occurrence of bioturbation in the soil.

Soil properties found within the project area suggested that:

- Soil was porous with larger sized particles dominating soil profile
- Soil at project site comprised of dredged material obtained from harbour basin.
- Soil comprised of calcareous material

Based on the soil structure and compaction at the coast, it was observed that the northern coast of Fenfushi had minimal natural resilience towards inland erosion.

## 6.3 PHYSICAL

### 6.3.1 Coast and Shoreline

Table below summarises the major findings of shoreline survey of the island.

*Table 12: Shoreline properties of Fenfushi*

Land Area	219,059 m <sup>2</sup> (22 Hectares)
Length of widest section	336 m
Average width of tide zone	8 m
Erosion Profile of the island	Erosion was significant as a large section of the north eastern coast of the island was being continuously eroded. 13.6 Annex 7 shows the cross section beach profiles and island profiles of Fenfushi. From these profiles it is evident that significant erosion had occurred on the north western side of the island. The height between erosion scarp and beach toe was on average 1.97 m. Erosion continued along the north western shore of Fenfushi where it gradually decreases towards the west. From the western tip of the island, patches of sand banks were observed.
Cross section profile of the island	Survey cross sections drawings are attached in 13.6 Annex 7. Elevation in the western and eastern tips of the island were 1.1 m and 0.88 m respectively. The average elevation of the island was 1 m. Western side of the island was slightly more elevated compared to the eastern side. Mid-section of the island had the lowest elevation. The lowest elevated area was observed in the middle towards the west and had an elevation of 0.66 m MSL (0+500). See 13.6 Annex 7.
quay walls, groynes and breakwaters.	Four quay walls have been installed in the island. 82 m quay wall made up of filled bags situated east of the jetty. 62 m quay wall installed east of the island close to MTCC workers camp. 154 m groyne which will become a quay wall once the area is reclaimed on the southern side of the island. 327 m long jetty wall installed in the northern coast of the island. See Figure 13. Area behind Quay wall 2 has been proposed to be reclaimed during the ongoing breakwater projects (Aleem, 2014)
Vegetation profile	Natural vegetation was observed only on the western and southern side of the island. At the northern side vegetation was at the same level as high tide zone demonstrating inland erosion. The average distance of vegetation line from the high tide zone on the southern side was 3 m
Shoreline	The average difference between high tide and low tide was observed to be approx. 4 m. Shoreline at the

	eastern side had been modified by stockpiling fill material obtained from widening the harbour for the breakwater construction project. Moreover, 7,211 m <sup>2</sup> of lagoon from the eastern side had been reclaimed.
Distance to the nearest island (Tholhufushi)	471 m. Mid-point of two islands was at a distance of 235 m. See figure Figure 7.

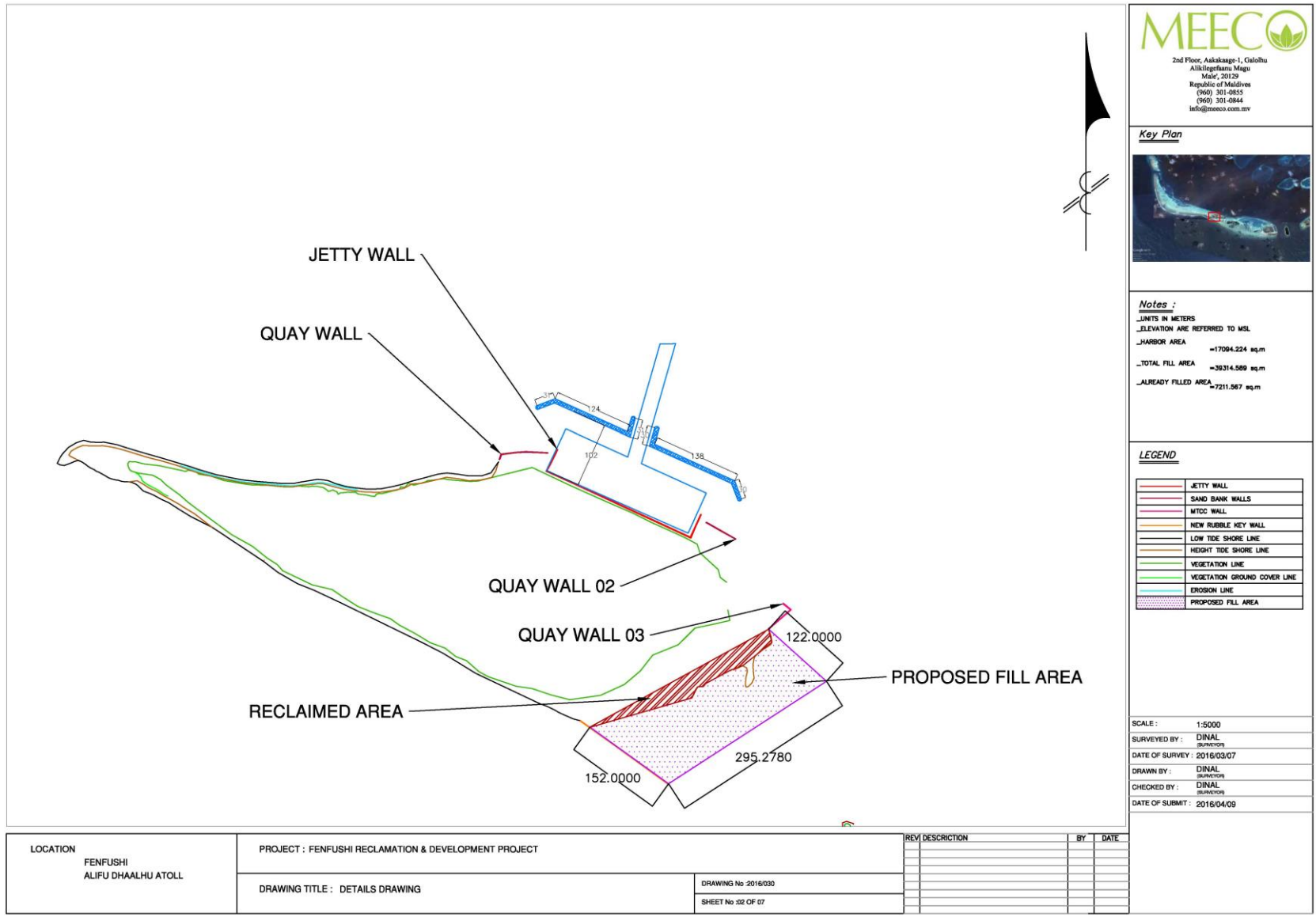


Figure 13: Detailed coastal features of Fenfushi and proposed dredge areas as alternative channels.

Comparison of historical satellite images (See Figure 14) taken in 2007 and current surveyed data showed that:

- No major changes had been brought to the land form of Fenfushi.
- Evidence of monsoonal sediment transport reversal was observed. Sediments accumulated at the western tip of the island, was observed to move in accordance with the monsoonal wind. The image taken in 2007 was captured during the southwest monsoon while the survey (2016) was done during the north east monsoon. A reversal in sediment direction can be seen from the figure.



## 6.4 HYDROGRAPHICAL

### 6.4.1 Currents

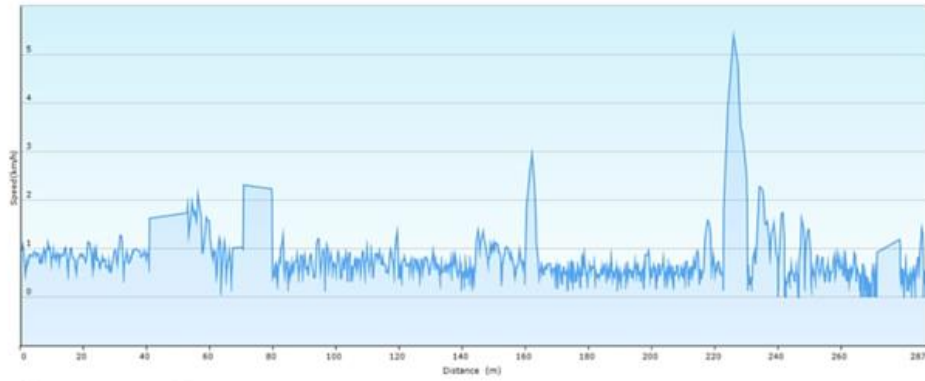
Wave breaking at an angle to the shoreline dissipates some of its energy along the shoreline, resulting in longshore currents. These currents move parallel to the shore carrying sedimentation, forming and eroding the beach through a natural process. Wave energy also gives rise to rip current that move away from the coast carrying sediments with it.

Figure 8 illustrates current propagation direction. Table 13 shows the current velocity, its direction and the uncertainty in current measurements. Velocity distance graphs obtained for the current measurements are illustrated in Figure 15.

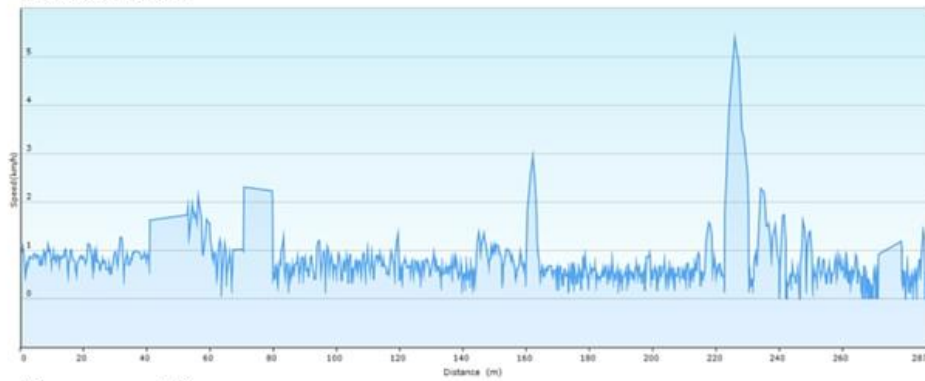
Table 13: Current data table

Current Measurement	Average Velocity /(m/s)	Standard Deviation /(m/s)	Average Direction
1	0.16	0.14	SSW
2	0.18	0.10	SW
3	0.23	0.22	SW,W
4	0.28	0.09	N

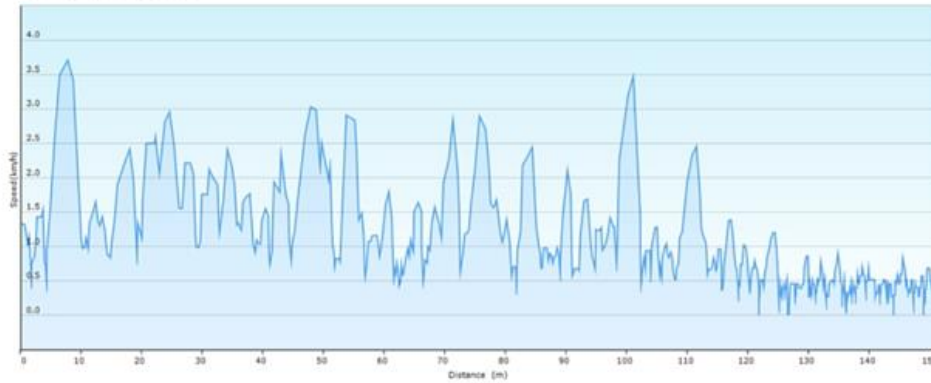
Measurement 1



Measurement 2



Measurement 3



Measurement 4

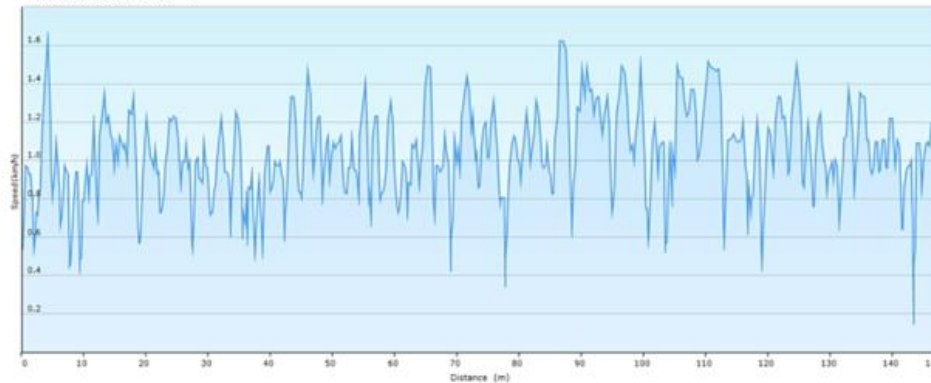


Figure 15: velocity distance graphs of the tracker

From current measurement data:

- It was observed that the currents mainly propagated towards the south.
- The average current velocity was extremely low. The four current measurements had an average velocity of  $0.21 \text{ ms}^{-1}$ .
- Velocity against distance graphs revealed that during the duration of data log time the tracker covered a fair distance suggesting that wind generated surface current was fairly moderate.

In order to determine whether the current velocity would influence sediment transportation which will result from reclamation and dredging, current measurement were compared with the Hjulström curve to predict fate of sediment particles based on particle diameter and critical shear stress.(See Figure 16).

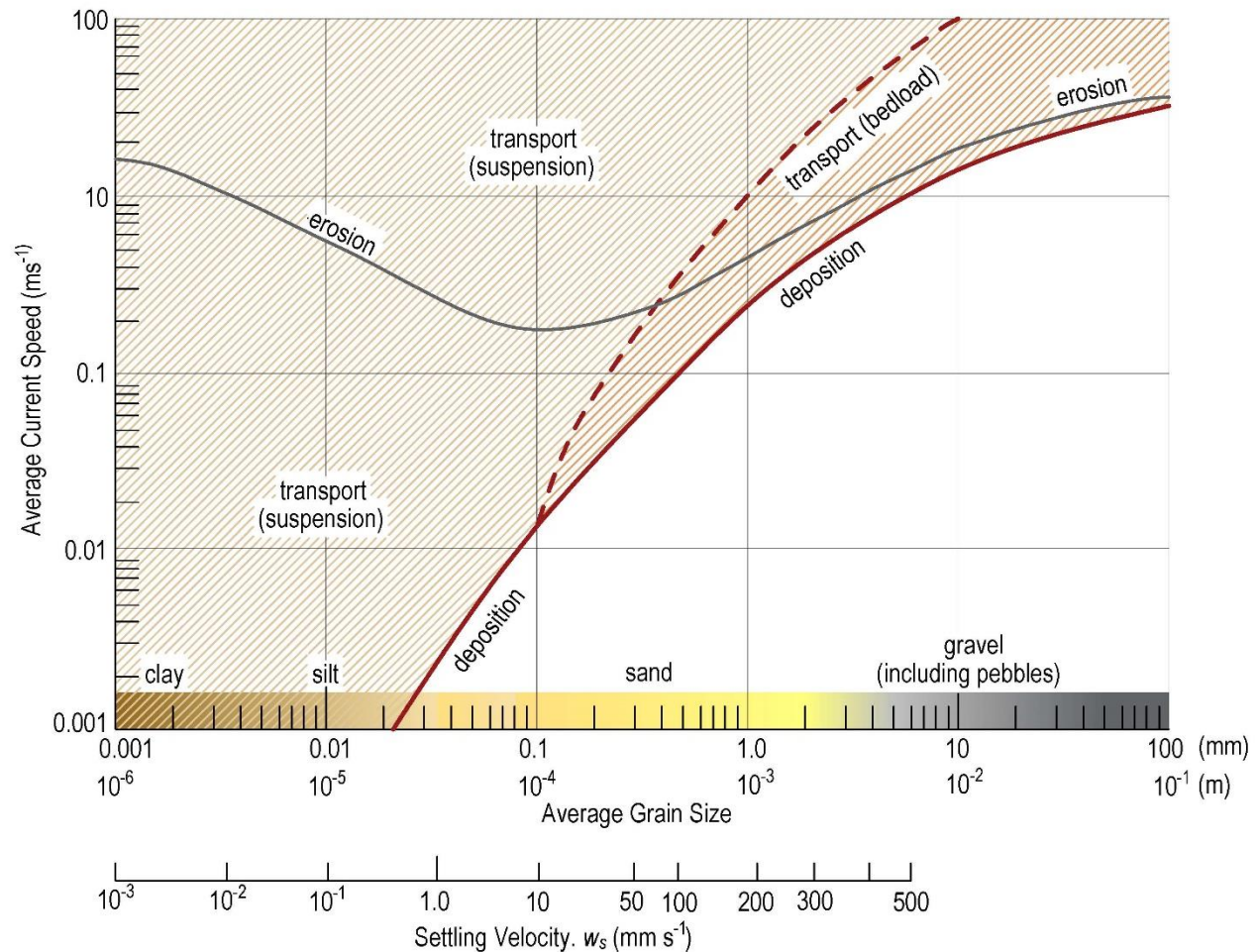


Figure 16: Hjulstrom curve (source: Goud and Aubry, 1985)

The average current speed observed for the project boundary was  $0.21\text{ ms}^{-1}$ . A range of sand types were observed for the area. The project areas consisted of sand ranging from fine to fine gravel (average particle diameter between  $0.5\text{--}4\text{ mm}$ ).

Extrapolation of both current speed and average grain size suggested that sediments greater than  $1\text{ mm}$  were likely to deposit onto the sea bed. The critical current speed required for particles of coarse sand to overcome the critical shear stress was approximately  $0.25\text{ ms}^{-1}$ .

- Based on wind generated surface currents measured around the island, it is conclusive that particles up to  $1\text{ mm}$  will be readily transported.

Hence, the method applied to predict the fate of sediment particles suggested that sediments with grain sizes up to  $1\text{ mm}$  were likely:

- To be transported in a net southerly direction due to bed load disturbance arising from dredging and particles with diameters greater than  $0.06\text{ mm}$  were likely to deposit.

However, the prediction method should be regarded as a simplified model because the methods applied encompass uncertainty as:

- Calculations were based on laminar flow only.
- Particles were assumed to be complete spheres.
- The effect of a single component of velocity acting upon the particle was utilised.
- Settling velocities and vertical velocities of sediments in still water was used in drawing the graph

The validity of these models should be concluded based on field monitoring, to better manage and understand the relationship, the project is going to have on the environment. Moreover, currents observed during field surveys were limited to a specific time and monsoon. It is important to measure current data over a longer period of time to better understand the current pattern in the harbor basin.

#### 6.4.2 Waves

Waves and swells were predicted based on data accumulated by Kench and Brander, (2006), and through comparisons of wind data logged at Hulhule' airport for 2015.

Two major types of incident waves; monsoonal forced wind waves and swell waves are believed to affect the coastal environment of the project site. Local wave conditions were studied by Lamer 2011 near Thilafushi using wave gauges which showed wind waves to be dominant. The maximum significant wave heights obtained were 0.32 m with a period of 3.87s. The average significant wave height was 0.15 m.

Satellite altimetry wave climate data (for ten-year period) indicates the dominant swell approaches from a southerly direction. On a seasonal basis, swell is from the south to southwest from April to November, with a peak significant wave height (Hs) of 1.8m in June, and from the south to southeast directions from November to March with a minimum Hs of 0.75m in March. The estimates and seasonality in wave height conditions are consistent with independent analysis of a shorter three-year record of satellite altimetry data by Woodworth (1992).

According to Kench and Brander, (2006) the dominant swell approached from a southerly and westerly directions, with some seasonal variations.

Swells were predominantly from the south-southwest, between April to November, with a significant peak in wave height (Hs) of 1.8 m observed in June. Wind data logged at Hulhule' international airport suggested a fairly strong winds in southwest monsoon from W, SW direction which confirms that waves observed were mainly wind generated.

Furthermore, wave analysis done by Zahir (2014) for Thinadhoo west coast suggested that a correlation coefficient of 0.43 was observed between wind direction and wave height. It was also discovered through the analysis that peak, wave heights were observed as a result of wind generated from the west. In general, the westerly waves were between 0.8 – 0.9 m in height and exceeded 1 m only 19% of the time. The percentage of wind generated waves were calculated to be 66%.

Based on these two studies a fairly conclusive wave pattern was identified for Fenfushi. It can be concluded that:

- Westerly monsoon would generate the strongest waves in Fenfushi. Most of the waves would be wind generated and propagate in the direction of the wind.
- Waves would propagate from W, SW, and SSW direction mostly.
- Northern side of the island will experience higher wave energy during the north east monsoon.

- The western southern coast of island is largely shielded from westerly waves as it is situated about a kilometre away from surf zone. Hence northern coast of the island is most vulnerable to wind generated waves.

### 6.4.3 Tides

Tide in the Maldives are characterized by sinusoidal oscillation containing two main cycles per day (semidiurnal tide) combined with a one cycle per day (diurnal tide). The combination of these two tides are referred to as mixed tide. Analyses of tides involve the study of harmonics which represents the period of oscillation of the celestial forcing that give rise to that harmonic.

Tide harmonic analysis by LaMer Pvt Ltd, (2013) in South Huvadhoo indicated that tide observed had a principle lunar semi-diurnal (M2) tide with a period of 12.42 hours, lunar solar diurnal (K1) with a period of 23.9210 hours. Tide observed had an F ratio of 0.3001 which indicated that the tide observed was, mixed dominantly semi-diurnal tides, where the range of water level calculated was 0.93 m (LaMer, 2013).

Hence, extrapolation of these results to Fenfushi suggested that, it would experience a mixed semi-diurnal tide where two high tides and two low tides cycles repeats daily where the peaks of two cycles are non-identical. Based on the inferred study and survey observations the change in water table at Fenfushi is approximated to be between 2-6 m.

## 6.5 PHYSIOCHEMICAL

### 6.5.1 Seawater Quality

In general, the seawater quality of the project site was satisfactory (See Figure 8 for sampling locations). The water was slightly alkaline with an average of 8.1 pH. The average salinity and conductivity were 33.5 ppt and  $51.0 \text{ mScm}^{-1}$ , respectively, characteristic of normal sea water. No sudden changes in conductivity was observed between sites that could suggest pollution. The average Dissolved Oxygen level was  $13.2 \text{ mgL}^{-1}$  which is ideal for marine sea life to flourish. The DO readings also suggested sufficient air water oxygen saturation through circulation of water within the project boundary (See Table 14).

Total dissolved solids (TDS) combine the sum of all ion particles that are smaller than 2 microns ( $0.0002 \text{ cm}$ ). This includes all of the disassociated electrolytes that make up salinity concentrations, as well as other compounds such as dissolved organic matter. The TDS readings were normal with an average of  $31.3 \text{ gL}^{-1}$ . The TDS reading were close to the salinity of water body, which suggested that sea water hadn't been polluted by non-ionic hydrocarbons such as oils, lubricants and waste water.

The ORP, a measurement that indicates the degree to which a substance is capable of oxidizing or reducing another substance was observed to be normal. The average ORP reading for the project boundary was 236 mV which suggested an oxidation potential. Most seawater bodies are oxidizing, with a positive potential. A significant negative potential would indicate an influx of reducing agent in the water.

High turbidity readings were observed for sites WS-1 and WS-2. This was mainly because readings were taken while the harbour was being dredged. This is conclusive evidence that turbidity increases quite significantly at the primary impact area. WS-3 sample was measured just outside the harbour, where turbidity had decreased significantly. This was mainly because the harbour area had been enclosed from both sides with sand bunds that obstructed dispersion of sediments. Sediments could move out only from the entrance channel which was not blocked. Apart from these observations turbidity was normal at tested sites.

For the purpose of the baseline turbidity was determined to be 0.2 NTU, where the increase in turbidity has not been incorporated. Baseline water quality parameters are shown in Table 14.

Sedimentation is determined to have the most significant impact to the natural environment as result of the proposed reclamation project. Sedimentation and its impact on the marine biota is further discussed in the marine environment section 6.6.4. Linear regression analysis of turbidity from the point of dredging onwards are used to determine Threshold turbidity levels for the proposed project based on data collected during harbour expansion dredging done under the ongoing breakwater construction project.

Table 14: Water sample data

Description	Sample Tag	Location	Date	Time	Temperature	pH	ORP/(mV)	Conductivity/ (mS/cm)	Turbidity/ (NTU)	Dissolved Oxygen (mg/L)	TDS/(g/L)	Salinity/ (ppt)	Specific gravity	Distance from dredge point
Water Sample Fenfushi	WS-1	3°29'26.89"N 72°47'8.52"E	22-Feb-16	10:54:08	30.11	8.1	174	51.3	11.1	19.07	30.8	33.7	20.9	85 m
Water Sample Fenfushi	WS-2	3°29'28.35"N 72°47'6.67"E	22-Feb-16	11:04:06	30.42	8.02	174	50.3	30.5	18.1	30.2	33	20.2	4 m
Water Sample Fenfushi	WS-3	3°29'26.75"N 72°47'12.30"E	22-Feb-16	11:10:52	30.08	8	185	49.8	7.1	17.46	30.4	32.6	20.1	200 m
Water Sample Fenfushi	WS-4	3°29'15.12"N 72°47'14.49"E	22-Feb-16	11:22:44	29.65	8.03	195	51.2	0	17.06	30.7	33.6	21	-
Water Sample Fenfushi	WS-5	3°29'34.03"N 72°45'33.88"E	22-Feb-16	11:53:05	29.81	8.18	255	51.5	0	15.37	30.9	33.8	21.1	
Water Sample Fenfushi	WS-6	3°29'29.42"N 72°46'32.64"E	22-Feb-16	12:04:53	30.8	8.3	202	50.6	0	19.56	30.4	33.2	20.3	
Average					30.2	8.1	199.2	51.0	5.5	18.5	30.7	33.5	20.7	
Water Sample Sun Island	SB1	3°29'19.00"N 72°48'8.41"E	2-Mar-16	14:53:59	30.63	8.3	165	51.7	0	22.26	31	34	20.9	
Water Sample Sun Island	SB2	3°29'18.81"N 72°47'56.76"E	2-Mar-16	14:59:33	30.17	8.11	200	51	0.5	20.21	30.6	33.5	20.7	
Water Sample Sun Island	SB3 (Control)	3°29'20.02"N 72°47'49.04"E	2-Mar-16	15:13:41	29.83	8.1	243	51.5	0	17.73	30.9	33.9	21.1	
<b>Average (Baseline readings)</b>					30.2	8.2	202.7	51.4	0.2	20.1	30.8	33.8	20.9	

### 6.5.1.1 Threshold Turbidity Level

Threshold turbidity levels were calculated based on turbidity readings taken during harbour dredging. The readings were taken while progressively increasing the distance of measurement from point of dredging. (Samples WS-1,2 and 3). Turbidity and distance measurements were then used to create a linear equation between these two parameters.

Based on the linear relationship threshold turbidity level was determined by extrapolating the distance of northern and southern reef. See Figure 17 for linear regression.

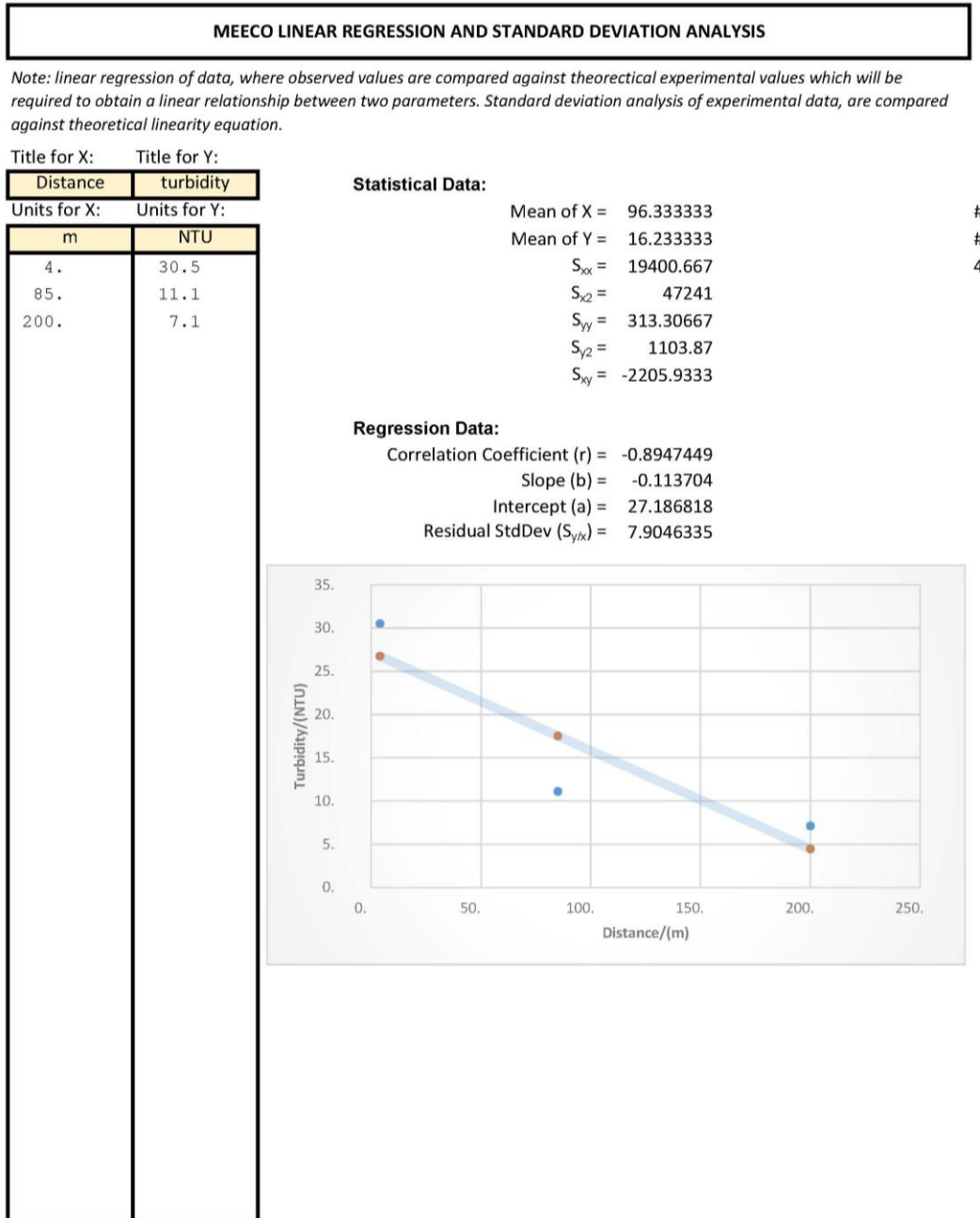


Figure 17: Linear regression analysis

The linear equation for turbidity against distance was:

$$y = -0.114x + 27.2$$

The shortest distance between dredge zones and northern reef crest (highest marine diversity) was 225 m  
Shortest distance between reclamation area and southern reef crest (MPA) was 545 m.

Hence threshold turbidity levels through extrapolation were determined to be 2 NTU for Northern reef and 0 NTU at the Southern reef and MPA.

Based on linear regression of turbidity against distance measured on site, the threshold turbidity level for the proposed project was given a range to better encompass uncertainties in the extrapolation. The threshold determined was between 0-3 NTU.

If turbidity levels outside southern reef crest and northern reef crest exceed these levels additional mitigation measures shall be taken such as installation of silt screen barriers. Monitoring shall be focused to determine turbidity levels outside these sensitive areas during project construction phase.

Furthermore, analysis showed that bund walls were very effective at preventing sedimentation from dispersing away as the ongoing dredging was being conducted after installing two inverted L bunds on the western and eastern side of the harbour.

## 6.6 MARINE ENVIRONMENT

### 6.6.1 Bathymetry

#### Proposed Reclamation Area

Total area proposed for reclamation by the proponent was 39,314 m<sup>2</sup>. The bathymetry survey determined

1. The amount of fill material which would be required to reclaim the proposed area
2. Amount of fill material available from the harbour basin excluding areas that are being dredged through the ongoing breakwater construction.
3. Size and volume of fill material available from proposed dredge areas of the harbour basin.

Figure 18 below shows the proposed dredge zone within the harbour basin. The breakwater design has been imposed on the diagram to illustrate the extended harbour basin. Detailed bathymetry drawing is attached in section 13.4 of the report.

#### Bathymetry Analysis

##### Reclamation Area:

- The average depth of reclamation area was -0.5 m from MSL. The area was observed to be extremely shallow.
- The shallowest area was -0 m from MSL
- The amount of fill material required to reclaim the proposed area up to a height of + 1.4 m from MSL was 28,477m<sup>3</sup>

##### Dredge Area (Harbour Basin)

##### Zone 1:

- Situated east of the existing harbour, zone 1 is the shallow area which will be protected when the breakwater installation is complete.
- When dredged the area will be useful for small dinghies as it would act as an inter-lagoon channel at the eastern side of the harbour.
- The average depth of zone 1 was – 1.0 m from MSL.
- The size of zone was approx. 4,000 m<sup>2</sup>
- In general, the area was shallow, and a small breakwater has been installed by the locals to protect small dinghies that are docked in the area.
- Volume of material obtained if dredged to – 3.5 m MSL was calculated to be 13,575 m<sup>3</sup>

##### Zone 2:

- This was the existing harbour basin, where shallow areas were observed.
- Size of zone 2 was 17,000 m<sup>2</sup>
- The depth in zone 3 ranged from -1.3 to – 3.5 m
- Shallow areas were observed in the middle and at the sides of the area.
- Volume of fill material obtained if dredged to a uniform depth of – 3.5 m was calculated to be approx. 12,500 m<sup>3</sup>.

#### Zone 3:

- Situated west of the existing harbour, zone 3 is the shallow area which will be protected when the breakwater installation is complete.
- Size of zone 3 was determined to be 1,760 m<sup>2</sup>
- The average depth of the area ranged from – 0.4 to -1.1 MSL.
- Volume of material obtained if dredged to – 3.5 m was calculated to be 3,510 m<sup>3</sup>

#### Alternate Burrow Area:

- Alternate burrow areas were determined to be at the north eastern side of the island
- The average depth of the burrow area was -0.4 to 1.1 m.
- The area is not recommended to be dredged as the required volumes of material can be obtained from existing harbour footprint.

Based on bathymetry results, dredging zones 1,2 and 3 would yield exactly the amount of fill material required. Dredging harbour area is considered to be the most preferable. Mainly because:

- Harbour area will be enclosed by the break water, which will limit sediment transportation.
- Dredging harbour area would not have any impacts on corals because no live corals were observed in the dredged harbour.
- Approval for dredging harbour and entrance channel has already been granted for the ongoing break water construction project. (See figure Figure 18 and Figure 2).



Figure 18: Size of dredge areas and amount of fill material available at proposed dredge zones 1,2 and 3.

## 6.6.2 Benthic Cover

Observations of the marine environment to determine coral cover, diversity and abundance was carried out in areas within the project boundary that were expected to be impacted by the proposed harbour and channel development project and potential burrow areas. Survey locations are illustrated in Figure 8. Table 15 below shows GPS coordinates of all marine survey locations.

*Table 15: Marine survey descriptions and locations*

Sample Tag	Type	Sample Location
T1	Line Transect	3°29'27.75"N 72°47'13.05"E
T2	Line Transect	3°29'15.12"N 72°47'14.49"E
P1	Photo Profile	3°29'30.67"N 72°47'15.01"E
SW1	Timed Swim	3°29'30.67"N 72°47'15.01"E
T3	Line Transect	3°29'15.12"N 72°47'14.49"E
T4	Line Transect	3°29'9.15"N 72°47'0.77"E
P2	Photo Profile	3°29'28.66"N 72°47'1.59"E
P3	Photo Profile	3°29'29.37"N 72°46'55.07"E

The survey was conducted to record 9 major coral morphological forms; laminar, encrusting, free living, columnar, foliaceous, branching, massive, digitate and tabular coral forms. LIT analysis suggested that 3 of these coral forms; massive, columnar and branching coral forms were present at the study area.

In transect 1, no live coral coverage was recorded, with the entire transect consisting of dead coral colonies, dead coral fragments, sand and rubble. Dead corals comprised of approximately 58% of the transect while sand and rubble accounted for the remaining 42% of the transect length. Transect 1 was placed close to where alternate entrance channel is proposed to be dredge.

Transect 2, however, hosted a relatively higher live coral coverage with massive, columnar and branching coral forms present. Percentile index of the substrate covers are approximately 35% dead corals and dead coral fragments, 27.5% sand and rubble, 6% massive and sub-massive coral forms, 22.5% columnar corals and around 9% of branching corals.

Transect 3 was placed at the proposed reclamation area. Transect 3 was somewhat similar to transect 1 with the majority of the transect length comprising of dead corals and dead coral fragments, and just 2.65% coverage of columnar coral colonies, these colonies were observed to act as a nursing ground for juvenile fishes. Visual observations exhibited other forms of corals present at this site, such as columnar coral forms and digitate coral forms though few in numbers. A higher significance of algae growth was also observed at this location.

Transect 4 showed a high percentile of dead corals, comprising of 54.15% of the total transect length and massive coral forms amounting for approximately 7% of the total transect length. The rest of the transect consisted of sand and rubble. Visual observations of the site showed a high amount of sedimentation and presence of algae growth.

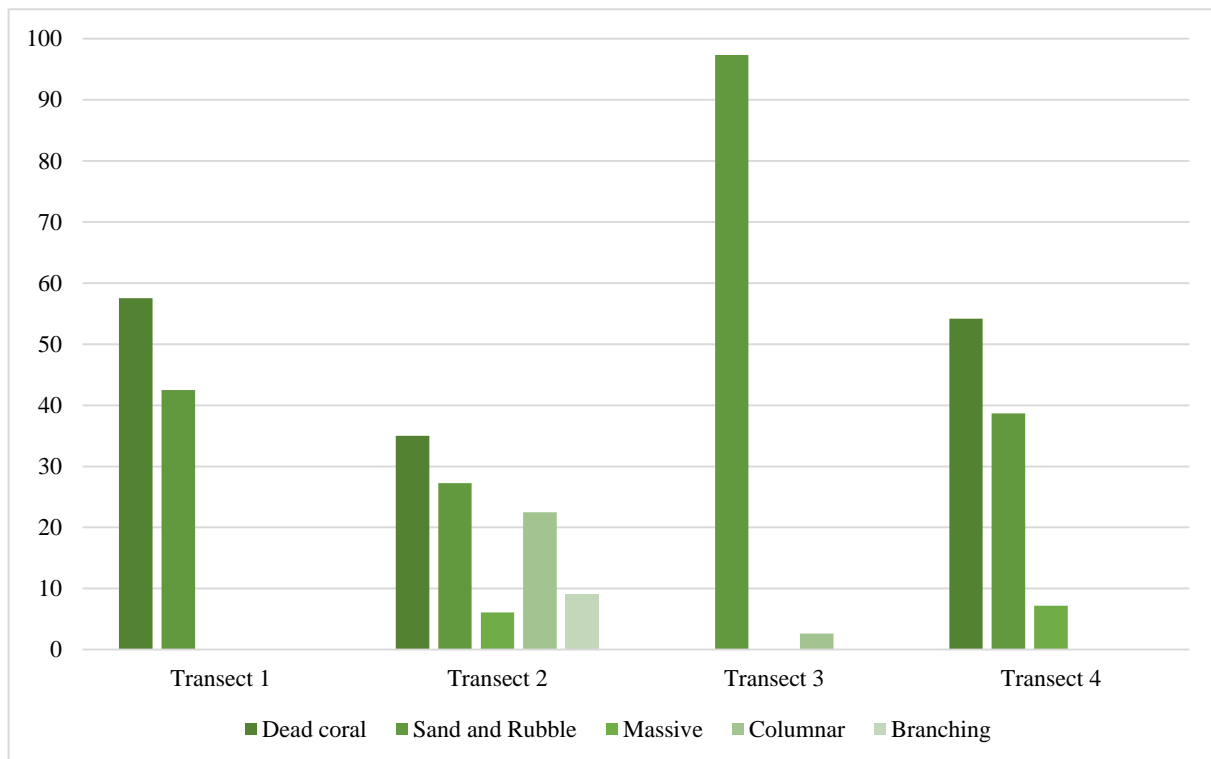
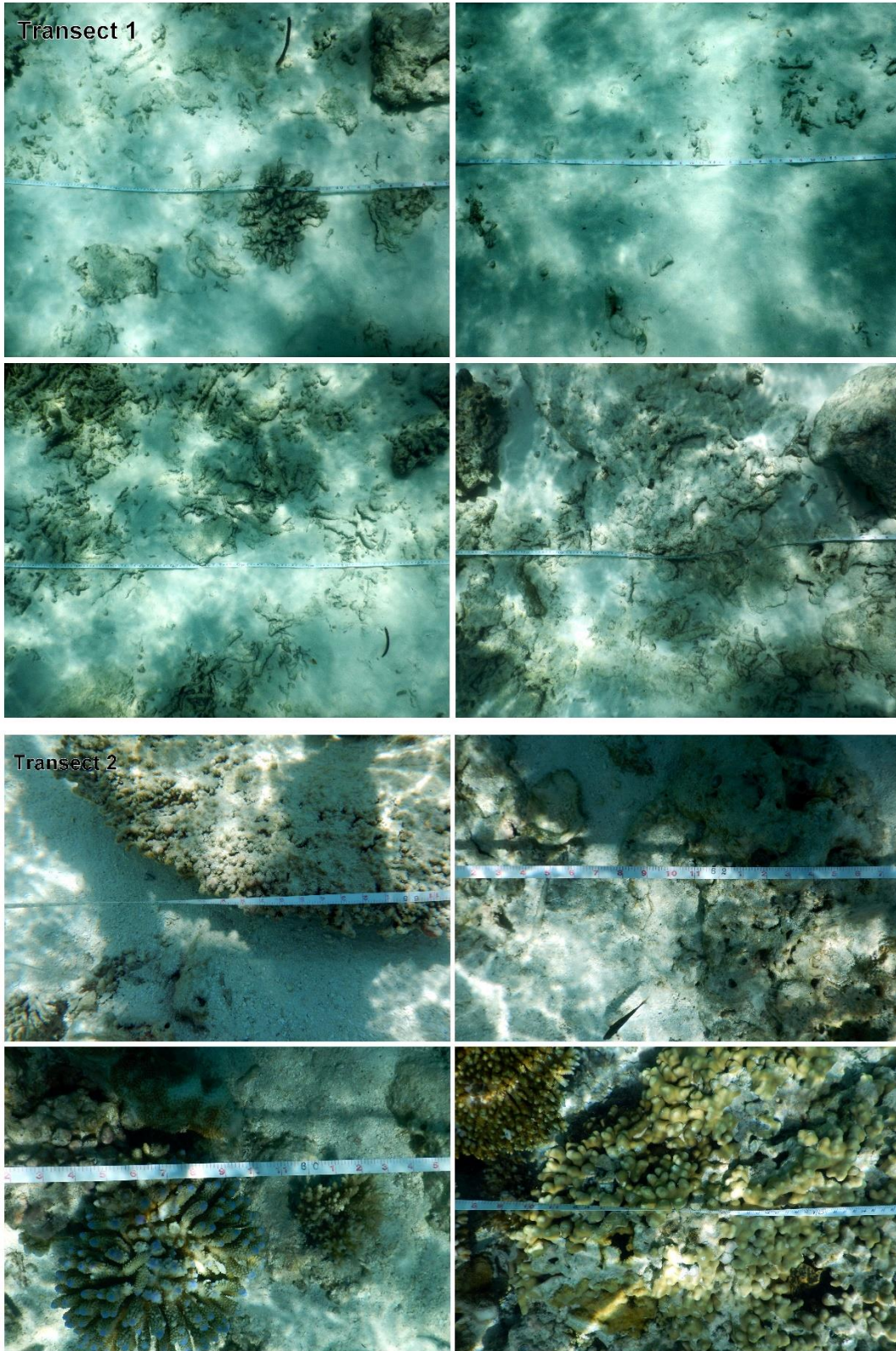


Figure 19: LT graphs illustrating benthic cover

## Transect Photo Profiles



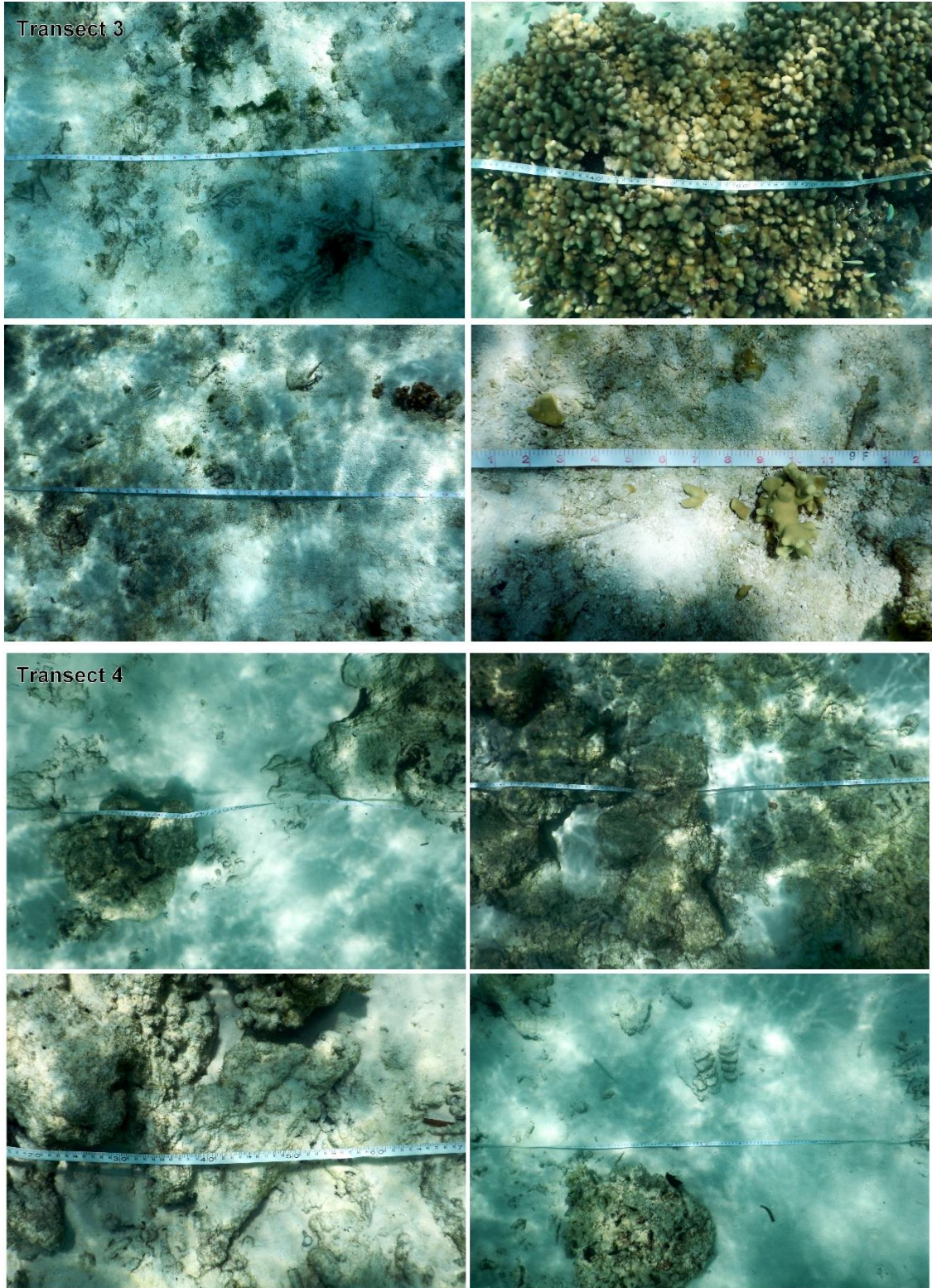


Figure 20: Photo profile of transect 1, 2, 3 and 4

Apart from the harbour and entrance channel most viable area to obtain fill material was identified to be the north western lagoon of the island. Photo profiles were taken to assess the benthic cover of this area. It was observed that the area contained sea grass and sand bottoms. Figure 21 and Figure 22 shows photo profiles at locations P2 and P3 as illustrated in survey map Figure 8.

Photo profile (P2)



*Figure 21: Alternate burrow area P2, photo profile*

Photo profile (P3)



*Figure 22: Alternate burrow area P3, photo profile*

The cover was dominated by sand, rubble and sea grass patches. Live corals were not observed at the proposed alternate burrow areas.

### 6.6.3 Calculation of Lagoon Space Lost

The following method was used to estimate the loss of lagoon area permanently as a result of the proposed project.

Table 16 shows GPS properties and size of the lagoon. Table 17 summarises lagoon size and size of proposed reclamation

Table 16: Lagoon area determination and properties

Name	Shape Type	Number of Points	Area (Sq Feet)	Perimeter/Length (Miles)	Centroid/Mid-Point (Degrees)	Bounding Box Maximum (Degrees)	Bounding Box Minimum (Degrees)
Total Lagoon Area	Polygon	69	239,389,829	22	03.4888538°, 072.7861442°	03.5340055°, 072.8458872°	03.4668022°, 072.7183642°

Table 17: Reef area and live coral incidence

Lagoon Area	239,390,000 m <sup>2</sup>
Total Project Area	39,314 m <sup>2</sup>

$$\text{Loss of lagoon space} = \frac{\text{Reclamation Area}}{\text{Total Lagoon Area}} \times 100$$

$$\text{Loss of lagoon space} = \frac{39,314}{239,390,000} \times 100$$

$$\text{Loss of coral cover} = 0.0002\%$$

Hence the percentage of lagoon space lost as a result of the proposed project is insignificant.

### 6.6.4 Impacts of Sedimentation on Benthic Cover

Sources of sediments include carbonate and igneous and siliciclastic intertidal and subtidal sediments released into the water column as a result of dredging and reclamation. Overall high Suspended solid concentration (SSCs) is one of the key pressure parameters which reduces corals from feeding.

Corals have been shown to gain some energy heterotrophically by tentacular suspension feeding. General suspension feeding mechanisms include direct interception and electrostatic attraction (LaBarbera, 1984; Rubenstein and Koehl, 1977) and once captured there is a second stage involving particle retention and a third phase involving movement of captured particles to the mouth (Shimeta and Koehl, 1997). Tentacular suspension feeding for particulate matter occurs through entrapment in mucus on the coral surface. Another capture process is via mucus threads or filaments attached to the oral disk that are swept by water turbulence entangling fine particulate material as well as larger zooplankton. Ingestion is completed by movement by cilia of particles trapped in the mucus to the mouth (Lewis and Price, 1975; Vaughan, 1916).

Sedimentation effects the energy cycling process of corals as:

- High SSCs affect feeding (heterotrophy reduction),
- It reduces light availability and its associated effects on the photosynthesis of the symbiotic microalgae of corals (photo trophy reduction), and
- Sediment smothering causes a reduction in gas (solute) transfer across diffusive boundary layers.

Figure 23 below shows vulnerability of different types of corals to sedimentation and changes to the habitat brought about by an increase in sedimentation.

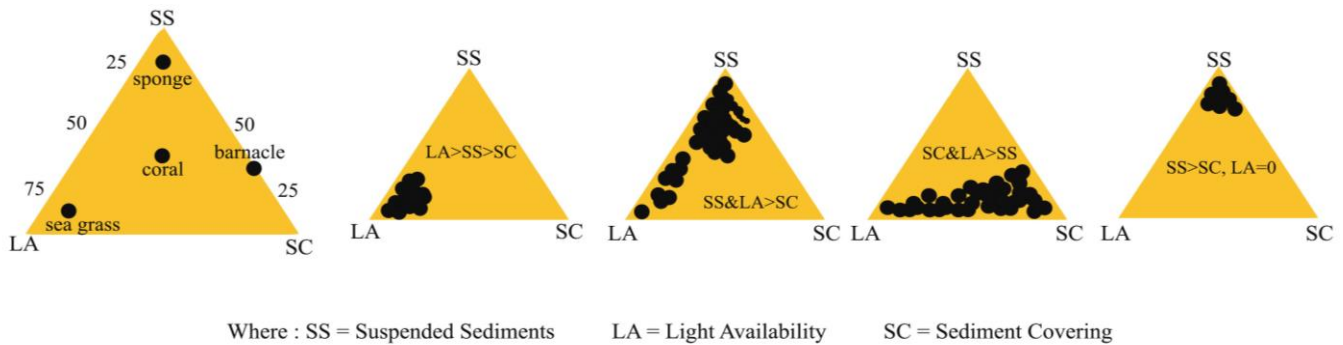


Figure 23: Ternary Diagrams (Source: LaBarbera, 1984; Rubenstein and Koehl, 1977)

Figure 23: Ternary diagrams representing the relative influence of 3 key proximal stressors associated with turbidity generation activities i.e. suspended sediment (SS), light availability (LA) and sediment covering (SC) on shallow tropical benthic organisms such as corals, sponges, seagrass and filter feeders such as barnacles. During dredging the relative influence of the proximal stressors could move on an hourly, daily, and seasonal basis, depending on the dredging activities, diel and tidal cycles, and sea-state.

Four different exposure scenarios for symbiotic corals exposed to dredging plumes are symbolized: (B) A scenario whereby a buoyant plume drifts over the reef with little contact with the corals and where light availability only is likely to be the key proximal stressor, (C) A turbidity event during relatively turbulent water conditions where (wave+current) shear stresses are sufficient to inhibit the deposition of most sediment and so suspended-sediments and reduced light availability are the predominant influences. (D) A scenario where elevated SSCs has occurred during very calm conditions and where sediment has subsequently fallen out of suspension and smothered corals, (E) represents a night time scenario of high SSCs in turbulent conditions where suspended-sediment is the sole proximal stressor.

## 6.6.5 Fish Count

The identification of fish populations was carried out by snorkelling inside the lagoon and reef crest. During the survey, 12 families of fish were recorded. These were classified into their respective families. Table 18 summaries the scientific and common names of all fish species that were identified at the project area and their abundance.

Table 18: Common and scientific names of fish species identified

Common name	Scientific Name	Relative Abundance	General description of the family
<b>Acanthuridae</b>			
Convict surgeon fish	<i>Acanthurus triostegus</i>	Rare	Very common across Maldivian reefs, with 30 species from this family known to be occur in Maldives. Most species mainly feed on algae while some supplement this with various planktons
Lined Surgeon fish	<i>Acanthurus lineatus</i>	Rare	
Powder blue surgeon fish	<i>Acanthurus leucosternon</i>	Rare	
Fine-lined Bristol tooth	<i>Ctenochaetus striatus</i>	Rare	
Eye-stripe Surgeonfish	<i>Acanthurus nigricauda</i>	Rare	
<b>Chaetodontidae</b>			
Black pyramid butterfly fish	<i>Hemitaurichthys zoster</i>	Rare	Butterfly fishes – Fairly common across Maldives. Diet include filamentous algae, small invertebrates, plankton, and coral.
<b>Scaridae</b>			
Two-colour Parrotfish	<i>Cetoscarus bicolor</i>	Rare	Family of parrotfishes. 23 species of Scaridae are known to occur in Maldives. Feeds on algae by scraping from corals. Also eat sea grass, coral polyps and invertebrates.
Roundhead Parrotfish	<i>Chlorurus strongylocephalus</i>		
<b>Pomacentridae</b>			
Sergeant Major	<i>Abudefduf vaigiensis</i>	Rare	Damselfishes are very common in the Maldives, from inshore to inner reefs and often forms large schools in various depths to about 20m. Mainly feeds on Zooplankton, benthic algae, and small invertebrates.
<b>Holocentridae</b>			
Sabre Squirrelfish	<i>Sargocentron spiniferum</i>	Rare	Squirrelfishes belong in the same family as Soldier fishes. They range over the reef bottom in search of crabs, shrimps and worms. Squirrelfishes loiter by day in caves and cervices, beneath overhangs and large corals, often in small schools.
<b>Lutjanidae</b>			
Kashmir Snapper	<i>Lutjanus kasmira</i>	Rare	Snappers form large stationary schools by day. Schools often assemble near large outcrops on the reef, and can be seen at the same spot every day.
<b>Muraenidae</b>			

Giant Moray	<i>Gymnothorax javanicus</i>	Rare	About 40 species have been recorded in the Maldives. Morays are carnivores and eat a mixture of invertebrates' whole such as shrimps, octopus and fishes, including small eels.
<b>Gobiidae</b>			
Decorated Sand-goby	<i>Istigobius decoratus</i>	Rare	Over 100 species have been recorded in the Maldives so far. All are small, and many appear to be rather dull-coloured, so they are often ignored.
<b>Balistidae</b>			
Titan triggerfish	<i>Balistoides viridescens</i>	Rare	Triggerfishes are particularly concerned to keep Wrasses and other egg-eating fish at bay, but larger ones will see off anything or anyone who comes too close.
Clown Triggerfish	<i>Balistoides conspicillum</i>	Rare	
Red-toothed Triggerfish	<i>Odonus niger</i>	Rare	
<b>Blennidae</b>			
False Cleaner fish	<i>Aspidontus taetiatus</i>	Rare	Occurs on sheltered reef slopes and crests, usually in mixed invertebrate and algae habitats. Diet comprises of various zooplankton and some species specialise in feeding on parts of other fishes.
<b>Haemulidae</b>			
Oriental Sweetlips	<i>Plectorhinchus vittatus</i>	Rare	Sweetlips are nocturnal hunters, preying on a variety of small creatures on the reef and adjacent sand flats.
<b>Alopiidae</b>			
Whitetip Reef Shark	<i>Triaenodon obesus</i>	Rare	Whitetip Reef Sharks are associated almost exclusively with coral reef habitats and are mostly encountered near the bottom around coral heads and ledges and over sandy flats in lagoons and near drop-offs adjacent to deeper water. A harmless species, adapted to feeding in small crevices and caves on small fish and cephalopods.

The method encompasses certain degree of uncertainty. These include:

- Some species may be cryptic in the presence of surveyors; hence these species would not be accounted for in the survey.
- Fast moving fishes may not be captured during the timed swim hence these species would also be under estimated.
- Time of swim may impact observation of certain species as some species are more active at night.

Hence the results obtained for the marine diversity through in the report should be considered as an underestimate of the actual marine biodiversity when all these uncertainties are factored in.

### **6.6.6 Protected Areas and Endangered Species**

#### **South Ari Atoll Marine Protected Area**

A very significant protected area in the Maldives that attracts numerous tourists from all over the world to get a glimpse of the secretive and endangered whale shark.

Protected area covers approximately 55,000 m<sup>2</sup> of Alifu Dhaalu atoll at its southern tip beyond reef crest. Figure 24 illustrates South Ari Atoll Marine protected area.

The proposed project is expected to take place within the same region as the protected site, hence Maldives Whaleshark Research Organisation was consulted with regard to the existing condition of the area and perceived impacts to the protected area as a result of the proposed reclamation project. Attached below is the response from MWSP.

Existing conditions of the MPA based on input from MWSP was taken into account in the impact assessment and EMP development. See sections 8 and 10 for more details.

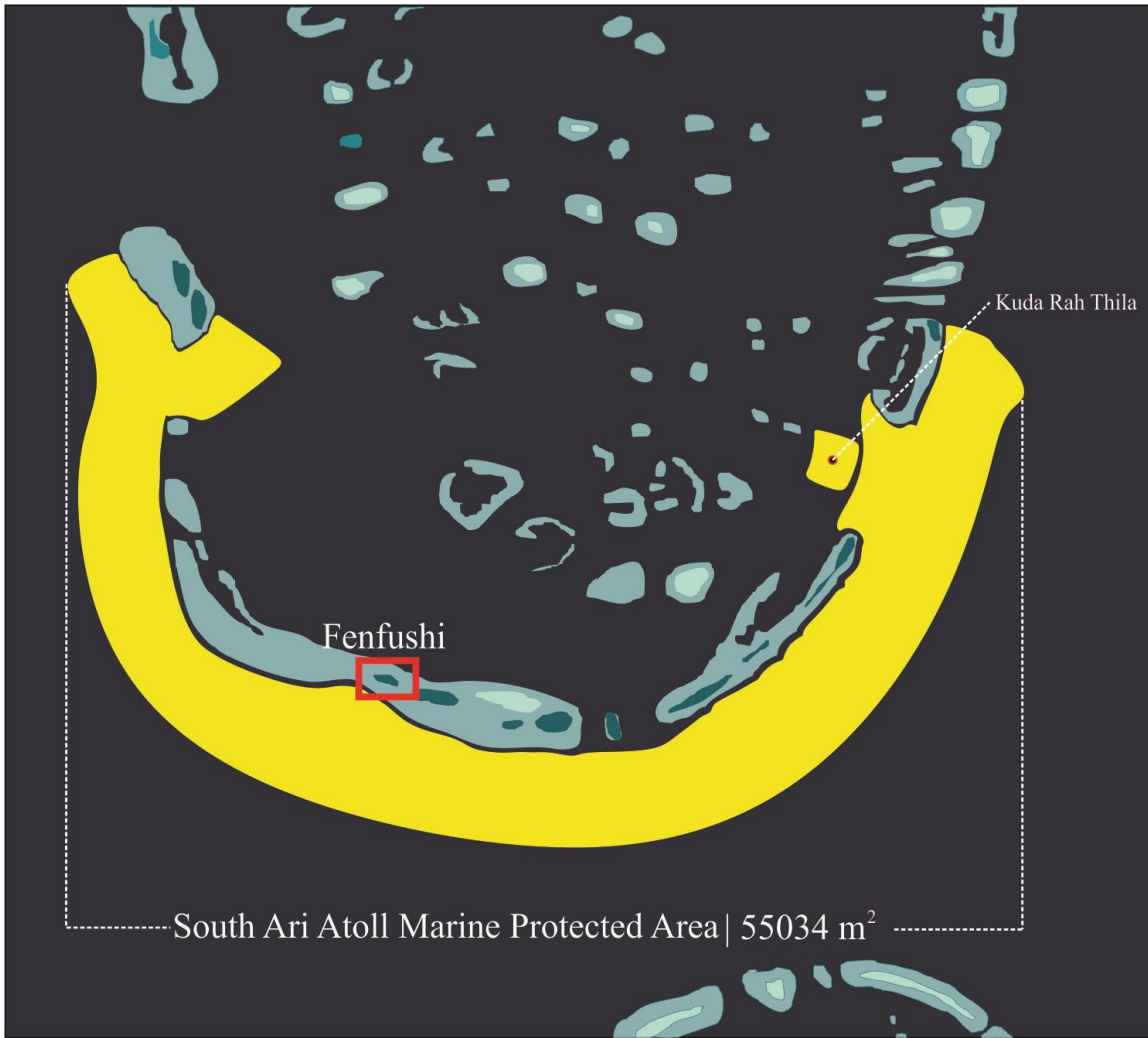


Figure 24: South Ari Atoll MPA

## 6.7 TERRESTRIAL FLORA AND FAUNA

The outpost zone vegetation close to the proposed project location generally had a dominance of coastal species common to the Maldives islands, namely *Cocos nucifera* (Coconut palm), *Hibiscus tiliaceus* (Sea hibiscus) and *Cordia subcordata* (sea trumpet) (See Table 13).

Table 19: Tree species

Local Name	Scientific name	Common Name	Genus
Dhivehi ruh	<i>Cocos nucifera</i>	Coconut palm	Arecacea / Palmae
Dhiggaa	<i>Hibiscus tiliaceus</i>	Sea hibiscus	Malvaceae
Kaani	<i>Cordia subcordata</i>	Sea trumpet	Ehretiaceae



Figure 25: Vegetation around the project area

## 6.8 HAZARDS AND VULNERABILITY

Natural hazards and vulnerability information is drawn from Detailed Island Risk Assessment in Maldives (DIRAM) report (UNDP 2009). The report details out hazard risks and vulnerability assessment of 10 islands. According to the report disaster risk for Maldives is moderate. However, the Indian Ocean tsunami caused in 2004 severely affected Maldives. The report also identified current vulnerabilities and proposed mitigation measures along with their financial feasibility. The report also highlighted into social groups including children, women and low income households as the most vulnerable to disasters.

Natural hazards that occurs in Maldives can be broadly distinguished into geological and meteorological hazards. According to the DIRAM Maldives report (2009) the following hazards are relevant to the project location.

- Wind storms;
- Swell waves and wind waves;
- Flooding due to heavy rainfall/storms;
- Gravity waves (sea swells and *udha*); and
- Tsunami.

DIRAM report has stated that major natural hazards in the Maldives are strictly controlled by the geophysical and climatic settings and shows quite different patterns in their distribution, as shown in Figure 26.

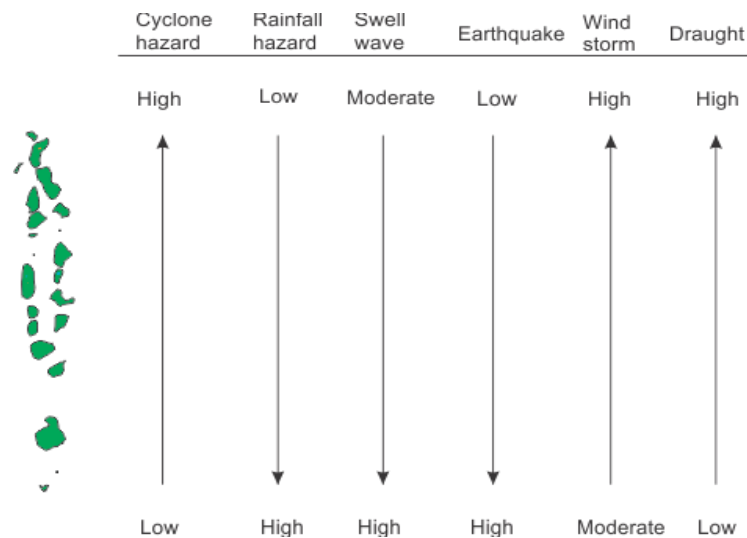


Figure 26: Exposure to hazards based on geographic location of atolls (source: adapted from DIRAM, (2009))

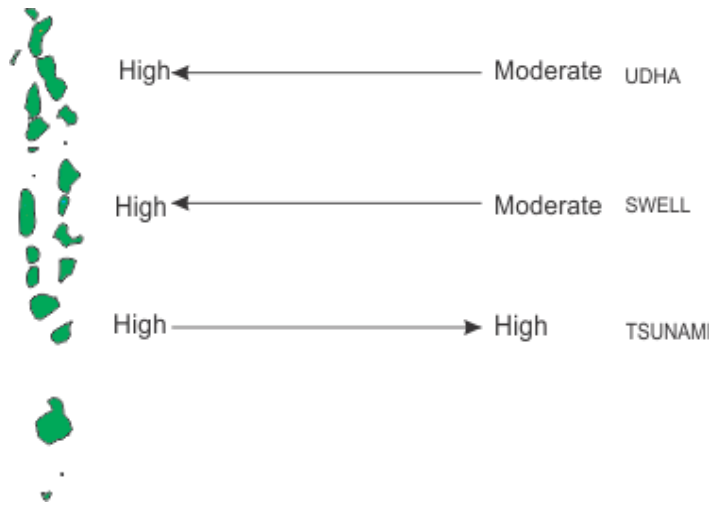


Figure 27: Major natural hazards distribution pattern in the Maldives. (A) Latitudinal variations of major natural hazards. (B) Longitudinal variations of major natural hazards across the Maldives (Adapted from UNDP, 2009)

The damage potential based on frequency of natural hazard to the Maldives is summarized in Table 20.

Table 20: Damage potential based on frequency of hazard

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

Apart from the DIRAM studies, questionnaires were filled during the field visit to identify any local significant disaster event that have occurred in recent history. Results of these surveys are attached below as Figure 28.

The survey conducted was not able to identify higher frequencies of cyclones, swells or flooding in Fenfushi. The island is located in the southern tip of atoll fairly shielded from the east and west.



### 6.8.1 Potential for Flooding

Strong winds can cause higher incident waves to break on the reef and the sea-level can rise locally due to sheer force of wind on the water surface. The rise in water level due the sheer force of winds and the wave setup created as a result of breaking waves on the reef edge can produce high water level set up on the reef flat. Similarly surges or swell waves beyond significant wave heights of 9 m can cause water levels to rise 3.0 m on the reef flat. When such water level rises are combined with high tides there could be strong surges of water flow across the coast.

- The elevation of Fenfushi was found to be approximately 0.99 m at the northern coast. The quay wall had an elevation of 1.32 m. Since these are low elevation there is a significant chance for inland flooding due to waves and swells generated by very strong winds.
- Cross sectional profiles of the island (See 13.6) show that the average height of island from MSL at mid-section was 0.95-1 m. Due to the dip which created in the middle of the island there is a higher possibility of inland water retention due to swells or heavy rainfall.

## 6.8.2 Wind Storms and Cyclones

Maldives being located within the equatorial region of the Indian Ocean is generally shielded from cyclonic activity (RMSI, 2005). There have only been a few cyclonic strength depressions that have tracked through the Maldives, all which occurred in the northern and north central regions.

The northern atolls are at greater hazard from cyclonic winds and storm surge. This reduces gradually to very low hazard in southern atolls. The maximum probable wind speed in zone 5 is 96.8 knots (180 kmph) and the cyclonic storm category is a lower CAT 3 on Suffir-Simpson scale. At this speed high damage is expected from wind, rain and storm surge hazards.

Except for Seenu, Gnaviyani and Gaafu atolls the earthquake hazard is low across the country. The probable maximum MMI is estimated as 7-8 in zone 5 where Fenfushi is located. This level of MMI can cause moderate-high damage, however frequency of occurrence is rare.

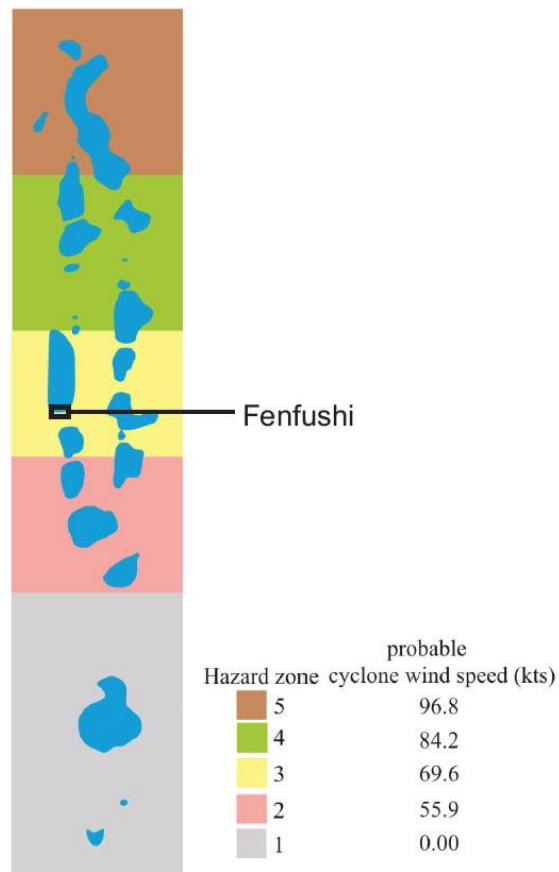


Figure 29: Cyclone risk assessment. Reference: RMSI, 2005

## 6.9 SOCIOECONOMIC ENVIRONMENT

### Population

The island of Fenfushi is one of the inhabited islands in South Ari Atoll (ADh), located approximately 110 km south of the country capital, Male' City. The total population of the island as of the population census of 2014 was 836, which contributes to about 9% of the total population of the atoll. (See Table 21). A slight increase in population (growth rate 3.02%) was evident between the 2006 and 2014 censuses. As per the data from the Island Council the current population of the island is 1020.

Table 21: Population breakdown in Fenfushi, Alifu Dhaalu Atoll. (Source: population census, NBS, 2014)

	Male	Female	Total
Local	353	371	724
Foreign	108	4	112
Total	461	375	836

### Socioeconomic Environment

The main economic activities of the Fenfushi population includes tourism related occupations, construction work, reef fisheries, ornamental and sea cucumber fisheries. According to the information provided by the island council, Fenfushi currently has a total of 43 operating vessels, with an average length of 40ft. 2 are these vessels are used for fisheries and the rest are used for various other purposes.

The island has 24-hour electricity, provided by STELCO. The island power house has a total capacity of 265 kW, though 165 kW is the average peak load for the island. Fenfushi has a Health Centre and a pharmacy operated by STO, which provides the basic health care needs. The health centre has 1 doctor and 4 nurses. The island school teaches up to the 12<sup>th</sup> grade. The island has no banking facilities, and the inhabitants has to travel to Mahibadhoo for cash withdrawals and banking needs, however, a boat from the bank stops at the island once a month. At present, there are no water and sewerage provisions in place, and the inhabitants rely on bottled water for drinking purposes and collections of rain water for other needs. The island council has taken an initiative and has established a waste management program, in which waste is segregated and composted where applicable. The Island Council plans to sell composted material to nearby resorts in the future. The main means of accessibility are dependent on the nearby airport at the island of Maamigili, which has daily flights coming in from Hulhule Airport. In addition to this, the islanders rely on the Maamigili ferry boat and MTCC atoll ferry for transportation needs.

During our visit to the island, the team came across some heritage spots which are of cultural and historical significance for the country. Among these include a sun dial which dates back to the 1800s, an old mosque 'hukuru miskih' and an old bathing well 'veyoa'. Photo profile of the island showing socially and economically significant site are illustrated in Figure 30 where the proximity of cemetery to the football field is evident. Results of social survey is attached below in Figure 31.

The proposed reclamation project is not expected to have any impacts on historic sites or bring about a change to the daily lives of the islanders. It is not expected to have any impacts on demography of Fenfushi either. The project, is not expected to place any considerable pressure on utility services as well. It is expected that through reclamation, more effort can be put into the expansion and renovation of historic sites.

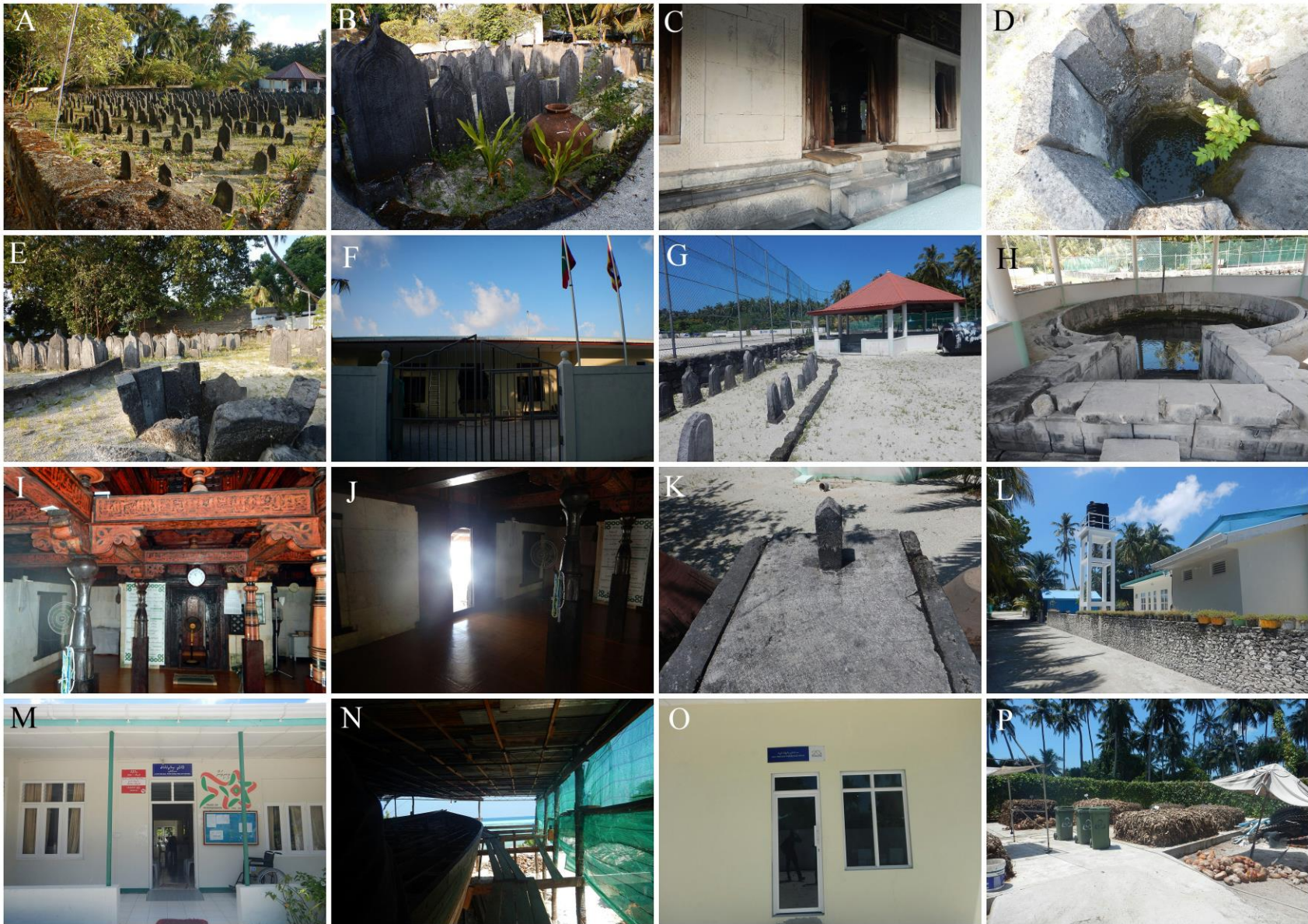


Figure 30: A-K cemetery, historic mosque, G- football field next to burial sites, L- Power house, M- Health centre, N-Boat Yard, P- Composting facility



## 7 STAKEHOLDER CONSULTATIONS

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### 7.1 INTRODUCTION

This section addresses **Task 8** of the TOR. The key stakeholders of the project are the proponent – Fenfushi council, regulator Environmental Protection Agency, Ministry of Housing and Infrastructure and Sun Island.

### 7.2 METHODOLOGY

The stakeholders were explained briefly about the project. A set of questions were asked so as to get their opinion on social, economic and environmental aspects in relation to the proposed development. In addition, they were asked about the concept of the project and how the proposed project would solve the current social and developmental issues. All stakeholder consultations were pre-arranged and conducted in person.

### 7.3 SCOPING MEETING

The Scoping meeting was held on 11 February 2016 at EPA. The meeting was attended by the following institutions:

- Maldives Environment and Energy Company (MEECO)
- Environment Protection Agency (EPA)
- Fenfushi Council
- Atoll Council

#### Highlights of the Meeting:


- A brief overview and summary of the project was given by the consultant.
- EPA questions the proponent of the project and identifies that the proponent should be very clear.
- MHI acknowledges that a government initiated breakwater and harbour dredging project is underway at Fenfushi.
- Fenfushi council informs that they only require the fill material to be emptied on the eastern side of the island in the proposed reclamation site.
- MHI informs that the project can be included as an addendum to the ongoing breakwater and harbour maintenance dredging project.
- EPA seconds the conclusion.
- Consultant agrees to provide detail bathymetry of areas from which fill material could be obtained.

However, after discussions between MHI senior staff it was concluded that the proposed reclamation cannot be included as an addendum to the ongoing project EIA and MHI will not be the proponent of the proposed reclamation project. Hence an EIA was needed to be submit to EPA, Fenfushi council as the proponent.

## 7.4 MEETING WITH THE PROPONENT

The meeting was held on 9<sup>th</sup> February 2016 at G.Aakakaage, 2<sup>nd</sup> Floor. Figure 32 below shows meeting attendance sheet.

*BBH*



MEECO  
Reg. No: C-0333/2014

2<sup>nd</sup> Floor, Aakakaage-1, Galolhu  
Aikilegefamun Magu, Male', 20129  
Republic of Maldives

Meeting With: *Fenfushi council members*  
*-MEECO*

Date *9TH FEB 2016*      ~~6-01-2016~~  
 Time *5:00pm*      ~~1:00pm~~  
 Venue *MEECO*  
 Subject *Fenfushi EIA*      Re:

Name	Post/Organisation	Contact Number	Signature
<i>Shahid Abdul Raheem</i>	<i>Counciler Raees</i>	<i>7915336</i>	<i>[Signature]</i>
<i>Mohamed Ibrahim</i>	<i>"</i>	<i>7706759</i>	<i>[Signature]</i>
<i>Mohamed Abobakuru</i>	<i>"</i>	<i>7775323</i>	<i>[Signature]</i>
<i>Moosa Ali</i>	<i>"</i>	<i>7939317</i>	<i>[Signature]</i>
<i>Mohamed Ibrahim</i>	<i>Health Admin</i>	<del><i>7706759</i></del> <i>9810044</i>	<i>[Signature]</i>
<i>Ahmed Saleem</i>			
<i>Hammad</i>			
<i>Farah</i>			
<i>Ashar</i>			

Figure 32: Attendance sheet, meeting with proponent


### Highlights of the meeting

- Proponent highlighted that the current football pitch was next to the island cemetery. Council plans to restore the cemetery and expand the cemetery once football field has been relocated.
- The need for reclamation is crucial to provide basic public services to the working class adults of the island.
- The proponent also highlighted lack of proper berthing facilities for the large number of small vessels that operate within the lagoon.
- The proponent also informed that the reclaimed land will be mainly used to build a football stadium and other recreational facilities.
- Proponent informed that when the breakwater is installed there will be an area of approximately 100 ft which will be protected from waves which they would like to dredge to make a small channel 100 × 40 ft for the small vessels. Hence proposes this area as a potential dredge site.
- The proponent informed that their main objective is to identify possible burrow areas from where the required amount of fill material for reclamation can be obtained.
- They also informed that they have requested MHI to shift the main entrance channel east of the harbour, and if approved would also provide fill material for reclamation.
- The proponent informed that the main reason for shifting the entrance channel was because a lot of space is wasted when the entrance channel is in the middle.

- The proponent informed that the only viable area to be reclaimed is the eastern side, mainly because the west has been secured for local tourism development and it is far away from the populated area of the island.

## 7.5 MEETING WITH SUNISLAND

The meeting was held on 23<sup>rd</sup> February 2016 at Sun Island resort and spa. The meeting was attended by the following participants:



Reg. No: C-0333/2014

2<sup>nd</sup> Floor, Aakakaage-1, Galolhu  
Alikilegefaanu Magu, Male', 20129  
Republic of Maldives

Meeting With : MANAGEMENT OF SUN ISLAND RESORT

Date 23<sup>RD</sup> FEBRUARY 2016  
 Time 3:15 PM  
 Venue SUN ISLAND RESORT AND SPA  
 Subject FENFUSHI Re: RECLAMATION WORKS - CONSULTATION



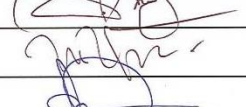
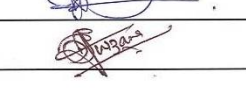
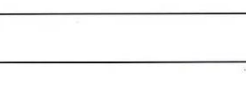
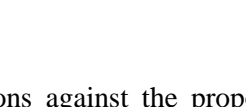
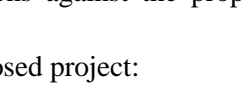
Name	Post/Organisation	Contact Number	Signature
Abdulla Mausoom	General Manager.	7791001	
Ibrahim zaheen	Deputy General Manager.		
Mohamed Hassan	Resident Manager.		
Ali Naseer	Sales & Marketing Manager		
Abdul Rasheed	Deputy Chief Engineer	7944439	
Dakshina Moorthy	Environment Manager.		
Farzana Dawrie	Admin. Secretary.		

Figure 33: attendance sheet, meeting with sun island management

### Highlights of the meeting

- Sun island management informed that they do not have any objections against the proposed development project.
- However, management identified two main concerns related to the proposed project:
  1. Noise, visual impacts during construction
  2. Security concerns during construction and operational phase
- The management informed that Tholhufushi is part of the resort and there have been numerous incidents where locals have trespassed and caused grief to the guests.
- Hence management proposes alternative reclamation areas.
- Consultant agrees to explore all the alternative reclamation locations suggested.
- Management agrees that the proposed reclamation should be in line with all relevant laws and proper mitigation measures shall be recommended and enforced during construction phase of the project.

## 7.6 MEETING WITH THE PUBLIC

The meeting was held on 22<sup>nd</sup> February 2016 at Holiday Inn guest house. The meeting was attended by the following participants:



2<sup>nd</sup> Floor, Aakakaage-1, Galolhu  
Alikilegamau Magu, Male', 20129  
Republic of Maldives

Meeting With : FENFUSHI PUBLIC.

Date 22<sup>nd</sup> FEBRUARY 2016  
Time 9:30 PM  
Venue FENFUSHI  
Subject PUBLIC CONSULTATION Re:

Name	Post/Organisation	Contact Number	Signature
Ahmed Atkol Mohamed		7939313	
Hussain Ibrahim		9838538	
Abdulkarim Sheehan		7629060	
Casim Mohamed		9503230	
Abdulkarim Sheehan		7660868	
Ali Adan		7945814	

Figure 34: attendance sheet, meeting with public.

### Highlights of the meeting

- The participants highlighted that it was impossible to play close to the cemetery and nobody uses the existing football field as it is situated on top of burial sites.
- They recommended that eastern side was the most ideal because it was already close to their houses and nobody really goes past the vegetated area which is not populated.
- The participants highlighted that they had signed a petition and they are in need of a place to practice in order to participate in regional tournaments.
- Small dingy owners highlighted that if the small channel is dredged through the project it will be easier for them access the channel, and if land is reclaimed they will have more space to dock the vessels.

## **7.7 CONSULTATION WITH MALDIVES WHALE SHARK RESEARCH PROGRAMME (MWSRP)**

MWSRP was consulted as an MPA was situated close to the project primary impact zone. Initial observations of the area suggested sedimentation from reclamation or dredging effecting area outside southern reef crest of Fenfushi was minimal mainly because:

- Dredging will take place on the northern side of the island and mostly confined to the enclosed harbour basin.
- Current speeds were low and shear stress analysis suggested that particles whose sizes are greater than 0.5 mm were likely to deposit.
- Primary project area is situated at a fair distance of 0.6 km away from MPA.
- The surf zone on the southern side of Fenfushi is extremely shallow where part of the reef flat protrudes out of sea and at low tide is completely exposed, hence the reef flat acts as a barrier.
- A concrete groyne of length 152 m is already exists at the project area which would also act as a sediment barrier.
- The proposed dredging and reclamation is of moderate scale.

Keeping these observations in mind, MWSRP was consulted as the area in question a highly significant and crucial environmental environment for the wellbeing of the nation and the endangered whale sharks. Response from MWSRP with regards to the project is attached in 13.10.

MWSRP informed that, caution should be taken to effectively mitigate sedimentation. No impacts from the project are envisaged from the project if the project is carried out with mitigation measures to reduce sedimentation.

Hence, these consultations were heavily inferred during impact assessment. Following section of the report presents the in depth environmental impact assessment conducted for the proposed reclamation/dredging project at Fenfushi.

## 8 ENVIRONMENTAL IMPACTS AND MITIGATION

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### 8.1 INTRODUCTION

Developmental activities involving reclamation are known to cause environmental impacts some of which are direct, or indirect or cumulative impacts. During the scoping, and designing phase of the project activities and field surveys measures should be undertaken to ensure that the impacts cause on the environment is minimal. This chapter provides an assessment of impacts that the proposed reclamation project will potentially have on the environment in particular marine environment. Included in the assessment is also consideration of the management objectives for each environmental factor at risk; mitigation and management measures proposed to reduce impacts, evaluation of environmental outcomes due from each of the evaluated project aspect.

### 8.2 IMPACT ASSESSMENT METHODOLOGY

Impacts characterises of the activities relevant to the project have been identified through information and data collected from field visit, surveys, stakeholder meetings and experience gained from similar nature projects. Information collected from these sources were rigorously assessed to predict the extent and significance if the impacts that may arise from the proposed projects. Impact analysis was underpinned by Rapid Impact Assessment Matrix (RIAM) after (Pastakia & Jensen ,1998). RIAM method allows to integrate multi-disciplinary aspects of an EIA in a transparent and semi quantitative manner. This approach has been to be effective for EIA involving coastal development projects.

Past activities have considerably altered the bathymetry and coastal processes of the island, including historical northern side dredging, and harbour construction activities undertaken in 2000. In order to identify, predict, evaluate and analyse impacts:

1. Possible impact areas which could either have a positive or a negative impact were first identified based on their ecological values, ecosystem significance, social use values, potential for environmental degradation, and economic development.
2. Impact assessments were carried out for the construction phase and operational phase of the reclamation project to quantify impacts
3. Where possible causal links of the project were identified, to explain the relationship to the impact areas identified
4. Significance of impact areas were discussed along with overview of the impacts, discussion on potential positive or negative impacts that may originate and the dimension to which they fall under
5. Impact areas were then identified based on RIAM classifications. This include physical/chemical (P/C), biological/ecological (B/E), Social/Cultural (S/C) and Economic/Operational (E/O).
6. Since impact magnitude were dependent on future outcomes, the condition at a specific time and due to the interconnected nature of impact areas, situational impact criteria were assigned to impact areas after assessment and consultation. Criteria that are of value to any situation are defined as permanence, reversibility and cumulative properties. Any situation would inherently encompass these three criteria. Permanence defines whether a condition is temporary or permanent. Reversibility defines whether the condition can be altered and is a measure of the control over the effect of the condition. Cumulative property is a measure of whether the effect will have a single direct impact or whether there will be an accumulated impact over time, or a synergistic effect with other conditions.
7. Significance of the impact on impact area was given after calculating an environmental score (ES) for each impact area identified.
8. The significance of ES numbers was determined based on alphanumeric range bands (RS).

Outlined below is an example impact assessment calculation for one of the impact areas based on the methodology adopted in this report.

**Application of methodology:**

**Impact area:** Coral reef

**Phase of project:** Construction

**Cause:** Reclamation

**Situational impact criteria:** Permanent

**Duration:** Impact caused during construction phase and is irreversible

**Significance of outcome:**

$$ES = I \times M \times (P + R + C)$$

**Equation: 1**

Where:

*I* = 3 (important to regional/national interests)

**Importance of condition scale:**

4 = important to national/international interests

3 = important to regional/national interests

2 = important to areas immediately outside the local condition

1 = important only to the local condition

0 = no importance

*M* = -1 (minor negative change to reefs envisaged (See section 7.7))

**Magnitude scale:**

+3 = major positive benefit

+2 = significant improvement in status quo

+1 = improvement in status quo

0 = no change/status quo

-1 = negative change to status quo

-2 = significant negative dis-benefit or change

-3 = major dis-benefit or change

*P* = 2 (During construction coral reef will be impacted temporarily)

*C* = 2 (Cumulative because if dredging is extended any impact on reefs will cumulate)

*R* = 2 (Reversible once construction is over coral reefs gain recover nutrition loss or the stress they encountered)

**The Situational criteria scale:**

Table 22: Situational scale

SCORE	PERMANENT (P)	REVERSIBLE (R)	CUMULATIVE (C)
1	No change/not applicable		
2	Temporary	reversible	Non-cumulative/single
3	Permanent	irreversible	Cumulative/synergistic

Hence:

$$ES = I \times M \times (P + R + C)$$

ES= - 18

ES value was then compared to the range band:

Table 23: Range bands for ES

ENVIRONMENTAL SCORE (ES)	RANGE VALUES ALPHABETIC (RS)	Description of Range band
72 to 109	E	Major positive impact
36 to 71	D	Significant positive impact
19 to 35	C	Moderate positive impact
10 to 18	B	Positive impact
1 to 9	A	Slight positive impact
0	N	Negligible/No change
-1 to -9	-A	Slight negative change/impact
-10 to -18	-B	Negative impact
-19 to -35	-C	Moderate negative impact
-36 to -71	-D	Significant negative impact
-72 to -108	-E	Major negative impact

Based on the above assessment reclamation will cause a significant negative impact during the construction phase of the project.

### **8.3 IMPACT ASSESSMENT AND MITIGATION**

Impact assessments were done for both the construction and operational phase of the project. Table 24 and Table 25 shows impact assessment calculation tables where environmental scores (ES) for impact areas are calculated and described using alphabetic RS values for construction and operational phases of the project.

The impact analysis and differences between extent of negative and positive impacts are shown in Figure 35. The figure shows a graphic representation of differences in impacts between two phases of the project and the extent of how positive or negative the impact will be as a result of the proposed reclamation project.

Section 8.4 summaries, causal link of impacts and discusses mitigation measures for the negative impacts that may cause due to the proposed project.

Table 24: Construction phase impacts

MOBILISATION & CONSTRUCTIONPHASE IMPACTS								
		Permanence	Reversibility	Cumulative	Importance of Condition scale	Magnitude	Environmental Score(ES)/Impact score	Range Value (RS)
Physical/Chemical (P/C)								
Coastal morphology	(P/C)-1	3	3	1	1	-1	-7	-A
Sediment transportation	(P/C)-2	2	1	2	3	-2	-30	-C
Seawater quality	(P/C)-3	2	1	2	1	-3	-15	-B
Current pattern	(P/C)-4	1	1	2	1	0	0	N/A
Wave pattern	(P/C)-5	3	1	1	1	0	0	N/A
Hazardous waste	(P/C)-6	2	1	2	1	-2	-10	-A
Solid Waste	(P/C)-7	2	1	1	2	-2	-16	-C
Ambient air quality & GHG	(P/C)-9	1	1	3	1	-1	-5	-B
Ambient Noise	(P/C)-10	2	2	2	1	-2	-12	-C
Biological/Ecological (B/E)								
Terrestrial environment	(B/E)-1	1	1	1	1	0	0	N
Protected species	(B/E)-2	1	1	1	1	0	0	N
Mangroves	(B/E)-3	1	1	1	1	0	0	N
Sea grass beds	(B/E)-4	1	1	1	0	0	0	N
Eutrophication	(B/E)-5	1	1	1	1	0	0	N
Coral reef	(B/E)-6	3	1	3	4	-1	-24	-C
Social/Cultural (S/C)								
Health and safety of workers	(S/C)- 1	2	1	3	1	-2	-12	-B
Aesthetic and cultural value	(S/C)- 2	1	1	1	1	-1	-3	-A
Public health and well being	(S/C)- 3	3	3	1	1	0	N/A	N
Recreational value	(S/C)- 4	3	1	1	0	0	N/A	N
Economic/Operational (E/O)								
Regional economy	(E/O)- 2	2	1	1	3	1	12	A
Employment	(E/O)- 3	1	1	1	1	1	3	A
Individual income	(E/O)- 4	1	1	1	1	1	3	A

Table 25: Operational phase impacts

OPERATIONAL PHASE IMPACTS								
		Permanence	Reversibility	Cumulative	Importance of Condition scale	Magnitude	Environmental Score(ES)/Impact score	Range Value (RS)
Physical/Chemical (P/C)								
Coastal morphology	(P/C)-1	3	3	1	1	-1	-7	-A
Sediment transportation	(P/C)-2	1	1	1	2	0	N/A	N
Seawater quality	(P/C)-3	1	1	2	1	-1	-4	-A
Current pattern	(P/C)-8	1	1	1	1	0	N/A	N
Wave pattern	(P/C)-6	2	2	1	1	0	N/A	N
Hazardous waste	(P/C)-5	2	2	1	2	0	N/A	N
Solid waste	(P/C)-4	2	2	1	2	0	0	N
Ambient air quality & GHG	(P/C)-7	3	3	3	1	1	9	A
Ambient Noise	(P/C)-8	2	2	2	1	-1	-6	-B
Biological/Ecological (B/E)								
Terrestrial environment	(B/E)-1	1	1	1	3	0	0	N
Protected species	(B/E)-2	1	1	1	1	0	0	N
Mangroves	(B/E)-3	1	1	1	0	0	0	N
Sea grass beds	(B/E)-4	1	1	1	0	0	0	N
Eutrophication	(B/E)-5	1	1	1	0	0	0	N
Coral reef	(B/E)-6	1	1	1	1	1	0	N
Social/Cultural								
Health and safety of workers	(S/C)- 1	2	2	1	1	0	0	N
Aesthetic and cultural value	(S/C)- 2	3	2	1	1	1	6	A
Public health and well being	(S/C)- 3	3	3	3	1	+3	27	C
Recreational value	(S/C)- 4	3	3	3	1	+3	27	C
Economic/Operational (E/O)								
Regional economy	(E/O)- 2	2	2	2	2	1	12	B
Employment	(E/O)- 3	1	1	1	2	1	6	B

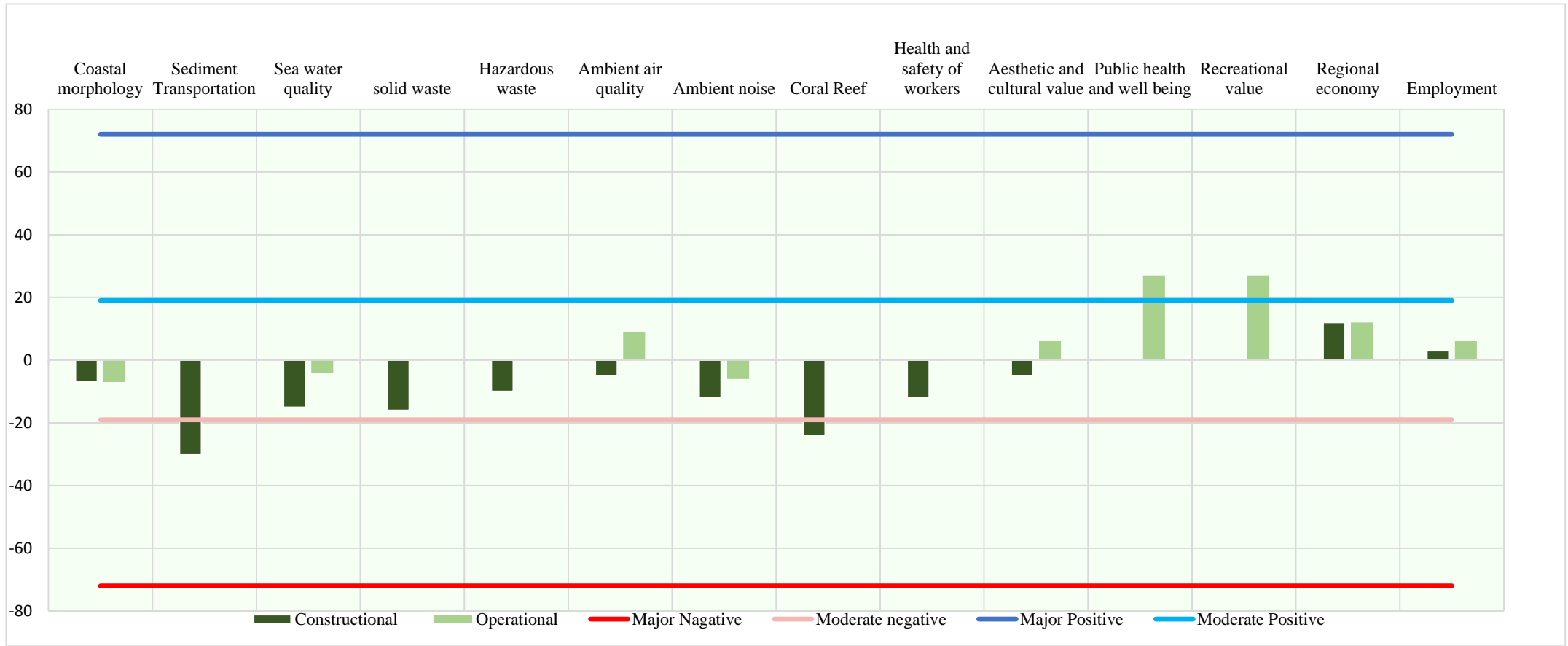


Figure 35: Impact assessment graph for two key phases (construction and operational) of the proposed project. Y-axis RIAM score

## 8.4 ENVIRONMENTAL IMPACTS

### 8.4.1 Physical Chemical

#### 8.4.1.1 Coastal Morphology

The existing coastal analysis of Fenfushi suggested that northern side of the island was more prone to erosion. This was also the side subjected to coastal modifications. Historical image analysis suggested monsoonal reversal of eastern tip of the island (See section 6.3.1). There is a possibility that coastal modifications could disrupt the natural sediment accretion and erosion pattern of the island. Where accretion is disrupted, it may lead to inland erosion. Northern coast of the island was observed to be significantly eroded and exposed to swell waves while the southern side of the island was shielded from wave energy by the shallow extended reef flat. Based on the existing environment the proposed project during:

Construction phase: is expected to have a slight negative impact where the ES score was -9.

During construction phase large amounts of sediment will be trapped within the reclaimed boundary by coastal protection measures that will be installed. This will disrupt the natural accretion and erosion pattern.

#### Construction Mitigation

- Dredging only specific areas which have been suggested in the report. This includes harbour basin and small entrance channel which would provide the sufficient amount of fill required to reclaim the proposed area without having a huge impact on bottom morphology that could interfere with bed load transportation.

Operational phase: Expected to have a slight negative impact similar to construction phase.

#### Operational Mitigation

- Routine maintenance of coastal protections installed. This may include servicing cracks to retain coastal integrity. Cost associated with inspection and maintenance depends on the extent of damage. However, each inspection may cost MVR 10,000.

#### 8.4.1.2 Sediment Transportation

It is expected that sediments will be produced during dredging activities. The spatial extent of the plume will be determined based on several factors including the dredging method, sediment characteristics of the area, ambient current movement, water depth and wind direction. Sediment particles produced will also cause an increase of total suspended solid (TSS) in the water column.

The net effect of sediment particles being mobilised from dredging will result in an increase in total suspended solid (TSS) concentrations in the water column. TSS movement is governed by hydrodynamics and particle size. In areas where higher currents are observed, particles will remain suspended for a longer period of time while in calmer waters particles are more likely to fall out of suspension. Larger sediment particles will fall out of suspension before smaller particles as they are heavier, and require more energy to keep them in suspension.

The existing baseline current measurements suggested that the currents were very mild and would not allow particles greater than 1.5 mm to be actively transported (See section 6.4.1). The currents propagated in a net southerly direction where dredged material from the harbour basin will travel towards the harbour away from the northern reef crest (based on currents at the time). In case particles do move towards south at the reclamation area, a gryone has been installed which has a length of 152

m. This would act as a barrier. Similarly, the extended shallow reef flat observed at the southern side of the island will also act as a sediment barrier. This would effectively mitigate sediments from being transported towards the MPA. Moreover, the project area is located approximately at a distance of 0.6 km from the MPA.

Chances of sediments being transported towards sun island are also very low based on the current pattern and distance of resort from project area. Based on baseline existing environment, the proposed project during:

Construction phase is expected to have a short term moderate negative impact where the ES score was -30.

During construction phase, action of the excavator would suspend sediments and as evident from previous studies and field measurements sedimentation would remain at 30 NTU (See section 6.5.1) during dredging, in the primary dredge zone. These are high turbidity levels which would stress benthic organisms if exposed to continuously.

Even though the chances of suspended sediments being actively transported are very low mitigation measures shall be taken. (See section 6.4.1 for sediment movement analysis at project site)

#### Construction phase Mitigation

- Completing the dredging works in the shortest time possible. To achieve this, all machineries and equipment's shall be serviced. Work shall be conducted during the calmest months of the year (April-June based on weather analysis)
- Placing sand bunds/quays or barrier as illustrated below, to contain sediments at the reclamation area. sufficient aeration should be provided to the enclosed water body by installing mechanisms similar to that illustrated in Figure 36 and Figure 6.
- Measuring water quality frequently during construction and reclamation. If sediment levels increase beyond the threshold level of 0-3 NTU that has been determined through the impact assessment, at either side of the reef crest or within the boundary of sun island house reef, the project shall be stopped temporarily. The project shall be resumed after consultation with engineers and environmental specialist or when sedimentation returns to acceptable level.
- If during construction phase turbidity levels exceed the threshold level of 0-3 NTU, silt curtains shall be placed based on current direction at the time. These mitigations would be most effective when water quality is measured in situ using hand held meters. Cost for measuring water quality and installing sediment barriers are approximated to be MVR 50,000.
- If alternate entrance channel is dredged, bunds should be installed and based on currents at the time sediment barrier should be installed if water quality exceeds 0-3 NTU 200 m away.

Sedimentation is not expected to have any impacts during operational phase of the project.

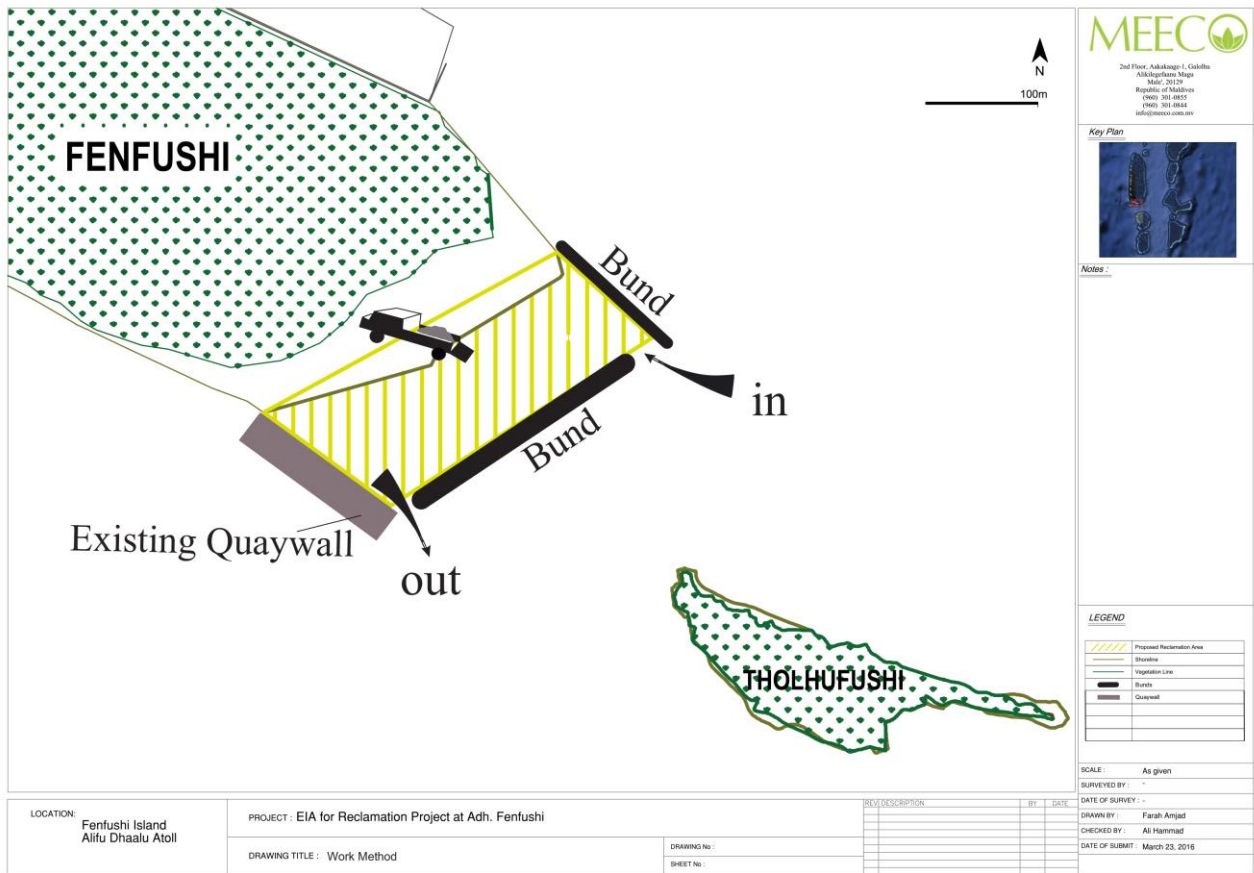


Figure 36: Reclamation work method

### 8.4.1.3 Sea Water Quality

Reclamation activities will impact sea water quality by elevating suspended particles in the water column which may reduce the quantity and quality of light available, which will result in poor photosynthetic production (Turner et al. 2006). Suspended particles can also settle and potentially smother marine benthic biotas including corals. Smothering can lead to the alteration of the organisms' photosynthetic rates, feeding and respiratory mechanisms. These effects would immediately cause stress and reduce productivity and increase mortality risk if continued (Turner et al 2006). Moreover, filter feeders such as whale sharks are also sensitive to sedimentation, hence TSS and turbidity levels are the most crucial parameters that shall be controlled to manage and mitigate impacts to the environment.

Baseline seawater quality was satisfactory where baseline turbidity levels were 0.2 NTU. Marine environment LT analysis suggested that frequency of live coral at the primary dredge and reclamation zones were minimal. permanent loss of lagoon area due to reclamation was calculated to be 0.0002 %. Hence based on the existing environment, the proposed project during:

Construction phase is expected to have a short term negative impact where the ES score – 15.

- During dredging the turbidity will be as high as 35 NTU at primary dredge site due to movement of the bucket and seepage of material from the bucket. Similarly, reclamation would also result in high turbidity at the primary zone however it is not envisaged to be as high as that of dredging, because reclamation is a deposition process as opposed to dredging.

#### Construction phase Mitigation

- Placing bunds as described in Figure 36, this would trap fill material during reclamation, avoiding loss of fill material. Enclosing the area would further reduce transportation of the sediments and will ease deposition.
- Dredging the enclosed harbour area and proposed small alternative channel only. This would confine dredging within the enclosed harbour basin. Hence water quality outside the harbour will be maintained at an acceptable level.

Water quality is not expected to change from baseline levels during operational phase of the project. However it has been recommended to monitor water quality once two months after construction for residual impacts (See Table 32 for EMP and approximated cost).

#### 8.4.1.4 Solid Waste

Package wrapping, PET bottles and organic waste will be the main types of municipal solid waste generated during the construction phase. Clothes/sponges used for wiping machineries, batteries and hydraulic lubricants will be the main form of construction waste produced.

Construction phase will have a short term negative impact where the calculated ES was – 16.

Based on the inputs (Table 4), approximately 8 workers will be stationed for the duration of the project (40 days)

Considering that each worker in their day to day activities produces 0.45 kg/per day of municipal/general waste as referenced from World Bank (2012) for the expected duration of project (40 days), the total solid waste produced is estimated to be 144 kg. Construction specific wastes are not considered to be as significant and based on previous similar projects it is expected that construction waste from the project will not exceed 60 kg.

#### Construction phase mitigations

- Waste should be separated based on type.
- Compostable waste should be transported to the local composting facility.
- Solid waste should be stored in appropriate containers.
- Clear signage and coverage of waste should be provided
- Records of waste disposal should be kept.
- Solid waste will be placed in appropriate containers and transported to be disposed of at designated locations in Thilafushi Island according to the requirements stipulated by Waste Regulation.

#### 8.4.1.5 Hazardous Waste

Hazardous waste is defined by Basel Convention as any substance that have one of the following properties:

- Ignitability,
- Corrosively,
- Reactivity, or
- Toxicity.

The main hazardous waste expected from project are oils, batteries, electronics from machines and lubricants. Quantities produced will be minor as three heavy duty machines will be used for the proposed project (See Table 4). Risk of oil spills are minor however these shall be accounted for during project implementation

Construction phase: Based on the inputs of the project, it is expected that construction phase of the project will have a short term slight negative impact where ES was – 10.

#### Construction phase mitigation

- Adequate and appropriate equipment, materials and resources should be available to prevent spills to marine environment from working machinery (eg; Spill trays, one way valves or other spill prevention measures
- The contractor should comply with spill response preparedness and should have an oil spill contingency plan developed
- Emergency drills should be conducted prior to the commencement of project works

- Suitable and adequate spill response equipment including oil absorbent pads should be readily available and accessible in case of a hydrocarbon spill
- Firefighting equipment shall be present in excavator, dump truck and wheel loader.
- Work shall be designed and conducted similar to that proposed in Figure xx, in case of a spill the design would contain spill within the bund wall.
- All hazardous waste shall be separated in appropriate containers and sealed.
- Hazardous waste shall be transported to Thilafushi or appropriate waste management centre. It should never be discarded at Fenfushi landfill area.

#### **8.4.1.6 Ambient Air Quality**

Industrial activities and heavy vehicles such as trucks emit complex mixtures of air pollutants, many of which are detrimental to human health. Of these pollutants, fine particulate matter is produced from fuel combustion. These fine particulate matter, particularly PM<sub>10</sub> and PM<sub>2.5</sub> particulates contain carcinogens and neurotoxins such as atmospheric cadmium, lead and asbestos (Breuer, 2015). The excavator, wheel loader and dump truck will be operated in the open where emissions would be easily diffused away by wind. Based on location and project inputs:

Construction phase of the project is expected to have a temporary slight negative impact on the air quality where ES was calculated to be -5.

The construction phase of the project is estimated to be 40 days. Pollutants will be emitted due to combustion. Pollutants includes CO, CO<sub>2</sub> and PAH's together with PM and nitrous oxides.

It is estimated that the machineries will consume 1000 L of diesel per day. Hence GHG emissions for 40 days was calculated to be approximately 105,000 Kg CO<sub>2</sub>-(DEFRA 2007)

#### Construction phase mitigation

To reduce emission of GHG emission and improve air quality following mitigation measures are suggested:

- shutting equipment off when not in use or reducing the time of idling.
- Provide clear signage that posts this requirement for workers at the entrances to the site.
- Service all construction equipment in proper working condition according to manufacturer's specifications.
- The equipment must be checked by a certified mechanic and determined to be running in proper condition before it is operated.
- Ensuring the vehicles and marine vessels brought by the contractors complies with road worthiness and maritime worthiness requirements of the Transport Authority
- If possible position the exhausts in a manner fumes are blown, away from the island.

Improve fuel efficiency by:

- Minimizing idling time, by switching of machineries when not in use. Only using full power when required
- Training equipment operators.
- Using the proper size of equipment for the job.
- Planning dredging works based on bathymetry surveys (See 13.4), so that only specific areas are dredged. This will not only make dredging efficient, but it will also reduce environmental footprint.

Operational phase: of project is expected to have a long-term slight positive change where ES was calculated to be 9.

During the operational phase of the project, the reclaimed land will be vegetated. Planting trees in the reclaimed land would have a positive impact on air quality.

#### 8.4.1.7 Ambient Noise

Increase in noise level during construction will be a significant impact to the public as well as nearby Sun-Island resort and spa. Prolonged high noise will disturb the tourists and exposure to high noise levels for a long period of time could have health implications.

Construction phase: of the project is expected to have a short term negative impact where calculated ES score was -12.

Noise will be generated by the engines of excavators, dump trucks and wheel loaders. The peak noise generated by these machines will be cyclical hence they all have an acoustic usage factor. The average peak noise of these three equipment within a radius of 15 m is tabulated below.

Table 26: Peak noise measurements of machineries. Source: (Roberts, 2009)

Equipment/Machine	LA <sub>max</sub> noise limit at 15m/ dB(A)	Acoustic Usage Factor/ (%)
Front End Loaders	80	40
Excavators	83	40
Dump Truck	84	40

The noise will be significantly lower as the distance increases. Impacts of noise at Sun island located at a distance of approximately 1 km, during construction would be negligible. However, noise impacts felt on Tholhufushi may be moderate, as it is located at a distance of approx. 400 m. Apart from noise impacts, light pollution may have a negative impact in case work is carried out during night time.

In terms of vibrations from the proposed project, R-wave which is the most significant disturbance along the surface of the ground, and the only clearly distinguishable wave at large distances from the source have been considered. Values of vibration velocity for loaded trucks, wheel loaders and excavators are in the range of 1.9 mm/sec at 7.6 m reference ppv. Propagation of R- wave is highest for hard strata, which is not observed at the project site. The seabed is made up of loose soils hence vibrations from machineries having any effect beyond 7.6 m is negligible to minor (Roberts, 2009). The premises of Sun island are further shielded as the two islands a discontinuous and is situated approximately 1 km away from dredge/reclamation area.

Wind data analysis show that significant velocities of wind are not generated at the project area which would amplify and attenuate sound waves. Hence chances of noise being amplified towards the resort or within the island is negligible. Noise is not expected to be modified due to wind.

#### Construction phase mitigations

- Ensuring that the project is completed according to the schedule within a short time frame
- Carrying out work that involve machineries during day time only
- Regular servicing of the equipment and vehicles.
- Providing operators with ear protection aids such as noise cancellation headphones
- Informing resort management of work schedule so that they can make arrangements on the usage of Picnic Island.
- Installing proper signs at Fenfushi and resort, informing public and guest regarding construction work.
- Using trained personnel so that work is completed efficiently.

## 8.4.2 Biological/Ecological Impacts

### 8.4.2.1 Coral Reef and MPA

Healthy corals are crucial for island ecosystems to maintain its structure integrity and functioning of its ecosystem services. Reefs act as natural barriers for the protection of the island from waves and nourishes the beach through sand production. Sediment plumes produced by dredging activities has the potential to smother benthic biota including corals. Reclamation activities will result in loss of coral at the site if they are not relocated.

Benthic analysis of dredge area and reclamation area suggested that live coral cover was low, below 15% for most transects. However slightly higher coral cover, was observed at the eastern side at 22% for columnar corals. The harbour area and proposed small entrance channel dredge area had negligible coral cover. See section 6.6.2. Based on existing marine environment:

Construction phase of the project will have a direct moderate negative impact where calculated ES score was -24.

This is mainly because reclaiming the proposed area through construction of bunds would smother and kill of all live corals within the reclamation boundary. 0.0002% of the lagoon area will be permanently lost as a result of the project. Effects of dredging activities being felt on the northern reef is perceived minimal because dredging will take place inside the harbour and current at the time of survey propagated landward. Dredging within the harbour basin would restrict sediment transportation.

Reclamation effecting the marine protected area is also considered minimal. A groyne exists on the southern side which would act as a sediment barrier. Moreover, southern reef flat is extremely shallow, distance from island to reef flat is approximately 1 km. The currents at the site were mild (See section 6 and 7). Nevertheless, chances of corals being smothered exists hence mitigation measures shall be taken.

#### Construction phase mitigation

- Dredging areas recommended in the EIA report. This includes harbour basin and small entrance channel, to obtain the required fill material and also reduce the environmental foot print.
- Designing work method as illustrated in Figure 36, to avoid loss of sediments.
- Relocating corals before reclamation to the southern lagoon which is close by in similar physio-chemical conditions.
- Water chemical monitoring shall be conducted as described in section 10 of the report.
- Before reclamation relocating any movable corals to the southern side of the island if feasible. Relocation may cost approximately MVR 25,000 to hire the personal and equipment.

### 8.4.3 Social/Cultural Impacts

#### 8.4.3.1 Health and safety of workers

Health impacts are associated with skin contact, eye contact, and/or inhalation of fumes and vapours. Health effects from exposure to fumes include headache, skin rash, sensitization, fatigue, reduced appetite, throat and eye irritation and cough. Workers are exposed to these risks significantly while the public and tourists will not be exposed to these risks.

Construction phase of the project is expected to have a short term negative impact on workers where ES was calculated to be -12.

Occurrence of accidents are reported to be low for projects of similar nature. Nevertheless, workers are required to adopt safety measures when handling heavy machineries and flammable liquids. The proposed project may have the potential for work related accidents. These include:

- Minor injuries to workers while operating heavy machineries
- Workers will be exposed to vehicular emissions
- Heat and extreme weather conditions
- Toppling of machineries during dredging
- Workers will also be exposed to heat, salt and unexpected weather conditions.
- Risk of unforeseen health hazards and accidents are more common during this phase of the project.

#### Construction phase mitigation

- Personal protection equipment's (PPE) are necessary to protect workers from burns and irritation when handling lubricants/ fuels.
- Flammable liquids shall be kept in an enclosed area with clear warning signs such as “No Smoking”, “No Naked Flames” etc.
- Work site shall have signs for the public indicating construction work ahead.
- PPE shall be worn by all workers. These include helmets, gloves, safety shoes and ear muffers during heavy machinery use and during fibre works.
- Workers safety instructions shall be clearly made visible at the project site;
- Site accessibility shall be carefully controlled to avoid unauthorised access to the site.
- First aid kit shall be available at the worker's camp;
- Only certified workers shall be allowed to operate machineries and vehicles
- All marine based machineries such as excavators shall have fire extinguishers.
- Workers able to swim should be deployed to the sea.
- All machineries used during construction and operations of the facility should be stored at the designated storage area.
- It is important to where safety shoes, nitrile gloves, long sleeves when undertaking fibre works at the facility.
- Make sure foreign workers are briefed on the local customs and they do not behave in socially unacceptable ways.

*Note: These mitigation costs will be bared by the contractor.*

#### **8.4.3.2 Aesthetic and cultural value**

Aesthetic values are highly subjective. The proposed project is set to reclaim approximately 0.3 ha from the east.

Construction phase: of the project is expected to have a slight short term negative impact where calculated ES was -5.

The sight and sound of construction work may be viewed differently. Public may welcome the sight and sound of construction machineries. Resort management and guest may view the noise and sight of industrial machineries as unpleasing and unfitting to the natural beauty of the landscape. The dual nature of the impact was incorporated in calculating the ES. Culturally the project is not expected to have any impacts.

##### Construction phase mitigation:

Mitigation measures are largely targeted to reduce impacts to neighbouring resorts.

- Limit construction work to day time.
- Inform resort management about the project progress so that necessary arrangement can be made for the guests in case Tholhufushi is to be used by guests during reclamation period.

Operational phase: of the project is expected to have a long-term slight positive impact. ES = 6.

The land area of Fenfushi would have increased creating more space to develop recreational facilities all of which are positives to the public. However, reclamation of eastern side would further reduce the distance between Tholhufushi and Fenfushi. Proximity of the two islands has been raised as a concern by the resort management who see operational phase of the project as a negative to their culture of serenity which they try to maintain and depict amongst resort guests. Security concerns during operational phase of the project is considered as a negative impact by the resort based on previous experience.

##### Operational phase mitigations

- Council taking necessary steps to prevent unauthorised access to the island, by creating awareness among the public.
- A vegetation belt should cover the eastern boundary of reclaimed area to mitigate operational phase visual impacts. The vegetation belt would create sense of naturalness and it will mitigate any visual impacts on guests.

#### **8.4.3.3 Recreational value, Public health and well being**

Construction phase of the project will not have any impacts on recreational value, public health and wellbeing. However, during the operational phase of the project, recreational value and public wellbeing would have risen significantly. These parameters are considered to be one of significant long term positive impacts of the project where the ES score calculated for both parameters were 27.

Operational phase: Reclaimed land will be used to establish a fully functioning football field, which the public has requested for and are in desperate need of. The land will also be used to establish other social developments as required by the public, which include netball courts and docks for small vessels. Establishment of these facilities at the reclaimed land will increase its recreational value by numerous folds. These facilities will also have non direct positive impacts on public health, as they would be more engaged in exercise.

## **8.4.4 Economic/Operational Impacts**

### ***8.4.4.1 Regional Economy and employment***

Both parameters are expected to have positive impacts as a result of the project.

Construction phase: Short term slight positive impacts

During construction phase, regional economy would have a positive impact mainly due to the workers utilising facilities in the island, such as food outlets and shops. Employment is expected to have a slight positive impact because if the need arises, local labourers would be hired.

Operational phase: Long term slight positive impact

Mostly because, staff shall be employed to look after the proposed developments at the reclaimed land, such as the football field and netball courts.

## 8.5 SUMMARY OF IMPACT ASSESSMENT

- No major negative impacts were identified for the project.
- Only minor short term negative impacts were identified for the constructional phase of the project.
- Majority of negative impacts were short term, localised to physical/chemical environment and specific to construction phase only.
- Areas which have been determined to have negative impacts during construction phase include:
  1. Sediment transportation
  2. Seawater quality
  3. Coral reef
  4. Solid waste
  5. Construction waste
  6. Air quality
  7. Ambient noise
  8. Health and safety of workers
  
- The operational phase of the project was mainly found to comprise of moderate to major positive impacts. To some extent minor negative impacts were also identified for the operational phase.
- Areas found to have a negative impact during operational phase were solid waste and hazardous waste production and management at the facility. Hazardous waste is mainly generated as a result of fibreglass works at the facility. Areas which are determined to have positive impacts include:
  1. Land availability for recreational activities which is expected to improve health and well-being of the community
  2. Local economy
  3. Employment
  
- All Economic/operational (E/O) aspects assessed were found to have positive impacts during the operational phase of the project.
  
- Mitigation measures, specific to the negative impacts during the construction and operational phase of the project have been proposed. The single most important parameter which needs to be mitigated in order to reduce environmental impacts from the proposed project was sedimentation. Significant mitigation measures to be taken include:
  1. Installing bunds as described to enclose reclamation area.
  2. Dredging harbour basin and small entrance channel to obtain fill material

## 8.6 LIMITATIONS

Environmental systems are complex and dynamic, this cause impacts prediction challenging. Major limitation of the study includes:

1. Lack of long term data for physical/chemical properties of the environment (mainly current pattern which is most related to sediment movement)
2. Lack of site specific historical data. For instance, on data on patterns of accretion and erosion were unavailable specific for Fenfushi.
3. Subjectivity in impact assessment. Parameters such as aesthetic value and employment are to a large extent subjected to opinion and conditions/decisions of managers at the time of implementation unless determined prior to implementation.
4. Unpredictability of environmental systems.

The assessment addressed these limitations by

1. Referring to previous similar works as described in section 2.7.
2. Assessing historical weather data
3. Calculating ES scores based on input from a panel of consultants to reduce bias and subjectivity.
4. Internal consultation that involved specialist from marine, atmospheric and engineering sectors.
5. External consultations with whale shark specialist
6. Collecting excessive samples to get a reliable baseline for water quality.

Although measures will be adopted by the contractor to mitigate identified impacts, there is always the potential that unpredictable impact may arise. It is also noted that some of the impacts predicted in this report may turn out greater or less than predicted. Although impact assessment method looked into to the inter-connected nature of environmental system, gaps may still exist in identifying the inter-connected nature of the ecosystem. The unpredictability and limitations can be better addressed through the monitoring program outlined in this report (See section 1). Over all, the level of uncertainty associated with is project is considered to be low

## 9 ALTERNATIVES

This section of the report addresses task 5 of the TOR, hence explores and weighs the advantages and disadvantages of:

- The no project scenario
- Alternate fill material usage for reclamation
- Alternate dredge material and equipment.
- Alternate reclamation sites

### 9.1 NO PROJECT SCENARIO

If the “no project scenario” was considered, environmental impacts associated with the project could be avoided completely. No project would also mean no financial implications to the government. The advantages and disadvantages of the no project option are discussed below in Table 27

*Table 27: Advantages and disadvantages of no project option*

Advantages	Disadvantages
<p>Environmental issues related to project can be avoided.</p> <p>No development costs to the government and council.</p>	<p>Space for recreational activities will not be available.</p> <p>Social and religious issues related to playing close to the cemetery will persist.</p> <p>The future development plans of the island would be impeded.</p> <p>No unique or exceptional environment preserved.</p> <p>Public pressure on the government would persist.</p> <p>Risk of losing the funds if not utilised for allocated purpose before the end of the fiscal year and term.</p> <p>Vessels at risk of facing damages</p> <p>Main source of local economic growth would be left undeveloped.</p>

The disadvantages of not undertaking the project outweighs the advantages, hence the no project option cannot be considered as viable as a preferred option that will satisfy all the stakeholders involved.

## 9.2 ALTERNATE RECLAMATION METHODS

### 9.2.1 Alternate Fill Material.

Most of the fill material for reclamation in the Maldives is obtained from shallow lagoons and reefs. Cumulative impacts arising from continued dredging places a huge stress on coral reefs. Loss of coral reefs would have adverse impacts on the country as it is one of the most crucial resources that needs to be secured. Dredging at shallow depths have been a convenient method to obtain fill material for many years, as it is less costly and not limited by available dredging equipment's. However, this is one of the most destructive methods of obtaining fill material. Mainly because, it takes thousands of years for corals to regrow and recover.

The need to explore and implement innovative and adaptable sustainable alternatives in reclamation projects have become necessary to save one of the most valuable natural resources of the country. Hence the scheme below illustrates alternative fill materials which could be used. These include:

1. Compostable organic waste, sludge
2. Treated non organic waste, ash
3. Plasma treated waste

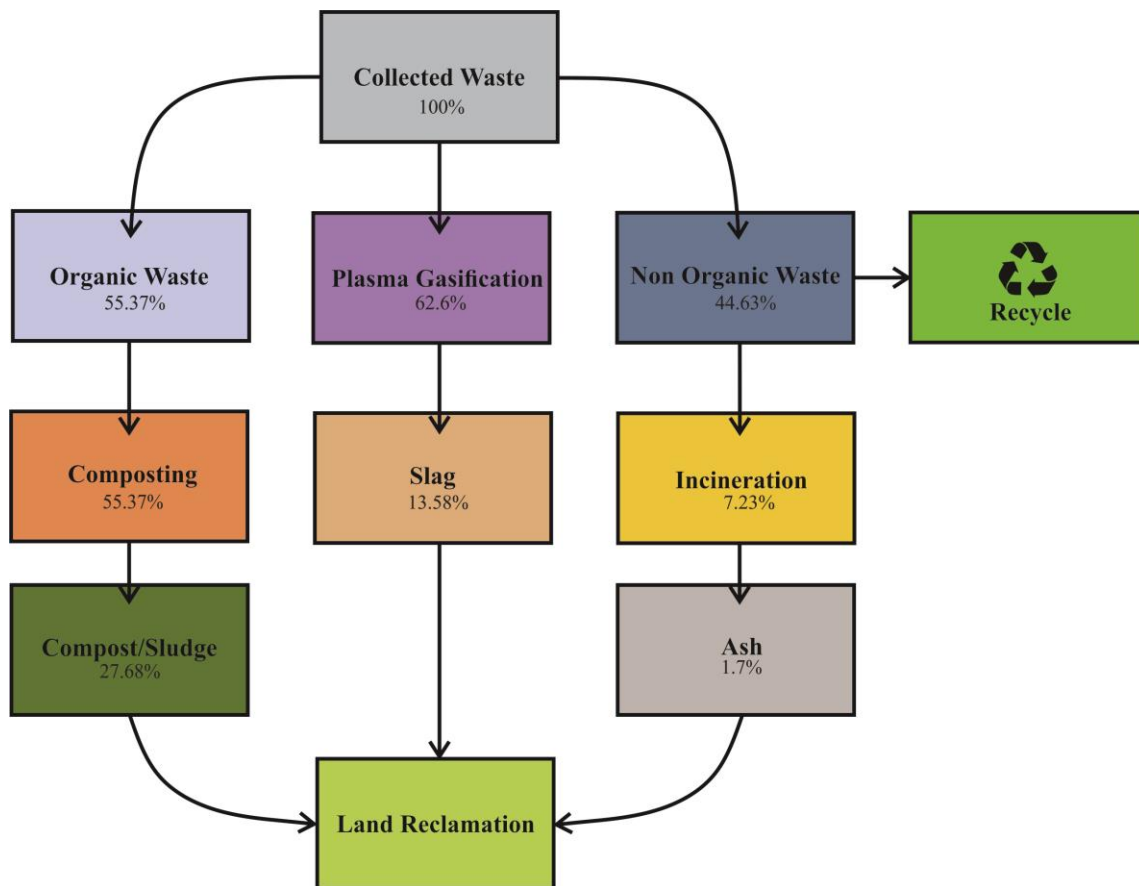


Figure 37: Alternative fill material for reclamation and how they can be obtained. Efficiency of each method is provided based on initial raw material input. (Sourced: Han, Schaefer and Barry, 2013)

Based on Figure 37 use of organic material was found to be the most efficient raw material in obtaining end products that are suitable as fill material. Waste organics is not, only limited to compost but includes treated sewage which results in sludge. Use of treated sludge has become a very popular alternative, especially after mixing it with chemicals and cement to strengthen their load carrying capacity. Onsite mixers are becoming increasingly popular as they can produce tonnes of treated sludge daily. Han, Schaefer and Barry, (2013) suggested that geo bags can be filled with treated sludge and laid as the base. Implementation of these methods would not only assist in the waste management but are non-destructive and sustainable.

Numerous challenges exist in implementing such methods in Maldives. These include:

- Lack of proper waste management schemes;
- Lack of exploration into alternative approaches, which include feasibility studies; and
- Lack of support for sustainable innovation at a policy level.

Considering these limitations and challenges, adoption of these methods will be very challenging, however, Fenfushi already bio compost leaves and seaweed at the island. The council has established efficient waste collection mechanisms in the island. Organic waste collected could be used as fill material when reclaiming eastern side of the island. This is already the case as organic material and sand dredged from the ongoing breakwater installation project are combined to reclaim part of eastern side. (See Figure 13 to see the area which has already been reclaimed).

Use of alternative fill material would utilise waste and it will reduce amount of fill material that needs to be dredged. It will also facilitate bioturbation of the reclaimed land.

## 9.3 ALTERNATE DREDGE METHODS AND EQUIPMENT

### 9.3.1 Clam Shell Dredger

The grab dredger is the most common used dredger in the world, especially in North America and the Far East. It is a rather simple and easy to understand stationary dredger with and without propulsion. In the latter the ship has a hold (hopper) in which it can store the dredge material, otherwise the material is transported by barges. The dredgers can be moored by anchors or by poles (spuds). The capacity of a grab dredger is expressed in the volume of the grab. Grab sizes varies between less than 1 m<sup>3</sup> up to 200 m<sup>3</sup>.

The opening of the grab is controlled by the closing and hoisting wire or by hydraulic cylinders.

The dredging process is discontinuously and cyclic and includes:

1. Lowering of the grab to the bottom
2. Closing of the grab by pulling the hoisting wire
3. Hoisting starts when the bucket is complete closed
4. Swinging to the barge or hopper
5. Lowering the filled bucket into the barge or hopper
6. Opening the bucket by releasing the closing wire.

The area's most suitable for use of clam dredgers are bulk dredging. While the smaller ones are mostly used for special jobs, such as:

- Difficult accessible places in harbours
- Small quantities with strongly varying depth.
- Along quay walls where the soil is spoiled by wires and debris
- Borrowing sand and gravel in deep pits

The production of a grab depends strongly on the soil. Suitable materials are soft clay, sand and gravel. Though, boulder clay is dredged as well by this type of dredger. In soft soils light big grabs are used while in more cohesive soils heavy small grabs are favourable.

The dredging depth depends only on the length of the wire on the winches. However, the accuracy decreases with depth.

One of the main advantages of clam dredgers over backhoe excavator dredging as proposed to be used in the project is the accuracy it provides. However logistically clam dredges are unfavourable as it would be very difficult to manoeuvre the dredger within the enclosed harbour. It would also disrupt harbour activities quite significantly. Clam shell dredgers are not common in the Maldivian market.

### 9.3.2 Cutter Suction Dredger

The cutter suction dredger is a stationary dredger equipped with a cutter device (cutter head) which excavate the soil before it is sucked up by the flow of the dredge pump(s).

During operation the dredger moves around a spud pole by pulling and slacking on the two fore side-line wires. This type of dredger is capable to dredge all kind of material and is accurate due to their movement around the spud. The spoil is mostly hydraulically transported via pipeline, but some dredgers do have barge-loading facilities as well.

Cutter suction dredgers are applied for dredging harbours, channels, reclamation areas and so on. The transport distance of the mixture is limited to a maximum 10 km. Cutter suction dredgers are very useful when the accuracy of the works is important.

One of the main environmental mitigations which could be achieved through the use of cutter suction dredgers are prevention and reduction of sedimentation loss. The workings of the cutter suction dredgers suggest that it aims to suck in all the sediments which are suspended as a result of the cutting process which is how it accumulates fill material. This vacuuming effect of sediments mean that dispersal of sediments is minimized through the process. Hence, this is a positive aspect of cutter suction dredgers when compared to the bucket method. If volumes greater than the bucket are hauled, sediments seep through the bucket into the harbour basin making the area highly turbid. This was evident from the water samples tested during ongoing dredging of harbour at Fenfushi during field visit (see section 6.5).

Main disadvantage of these dredgers are difficulty in mobility of the dredger within the harbour relatively small harbour basin of Fenfushi.

## 9.4 ALTERNATIVE RECLAMATION LOCATION

An option analysis was done to determine the most feasible location to be reclaimed. Comparative scoring method was utilised in assessing and contrasting two options, of which the post positive score was determined to be the most favourable option.

### Method:

1. Three options were identified.
  - (A) Reclamation of the proposed eastern side.
  - (B) Reclamation of the southern side.
  - (C) Reclamation of the western side of the island.

The following range band was set, which identified whether a certain parameter would be impacted positively or negatively.

Table 28: Option analysis range

Range	Major Negative	Moderate negative	Minor Negative	No Change	Minor positive	Moderate Positive	Major Positive
	-3	-2	-1	0	1	2	3

2. Eleven critical parameters were selected as follows.

Table 29: Option analysis parameters

Number	Parameter	Code	Description
1	Noise impacts	S1	Significance of noise impacts to resort
2	Visual impacts	S2	Significance negative visual impacts
3	Wave Action	S3	Effect of waves on reclaimed land
4	Security concerns	S4	Trespassing resort property / Stealing
5	Accessibility	S5	Accessibility to the reclaimed area
6	Access to infrastructure	S6	Access to existing infrastructure from reclaimed land
7	Public view	S7	Opinion of public and their views regarding reclamation area
8	Future Land Use Plan	S8	Impact on future plans/Potential for future plans due to reclamation
9	Aesthetics	S9	Significance of proposed area to the aesthetics of existing environment
10	Marine Diversity	S10	Significance of coral cover and benthic diversity at the proposed outfall location
11	Current movement	S11	Current movement and sediment transportation at the project site

3. Each parameter was given a score based on existing environment, consultation with relevant stakeholders, consultant judgement and available historical data. All scores were then summed where option that resulted in the most positive value was determined to be the most favourable.

Table 30 below shows the option analysis table.

Table 30: Option analysis matrix in determining the reclamation area.

	(A) Reclamation of East (Proposed)	(B) Reclamation of South		(C) Reclamation of West	
(A) Reclamation of East (Proposed)		(A)	(B)	(A)	(C)
		S1 -2	S1 2	S1 -2	S1 3
		S2 -2	S2 3	S2 -2	S2 3
		S3 0	S3 -1	S3 0	S3 -1
		S4 -3	S4 0	S4 -3	S4 3
		S5 3	S5 -2	S5 3	S5 -3
		S6 3	S6 -2	S6 3	S6 -3
		S7 2	S7 -3	S7 2	S7 -3
		S8 1	S8 3	S8 1	S8 -3
		S9 0	S9 0	S9 0	S9 -3
		S10 0	S10 -2	S10 0	S10 -1
		S11 -1	S11 -1	S11 -1	S11 -1
	<b>Total 1</b>	<b>Total -3</b>	<b>Total 1</b>	<b>Total -9</b>	
(B) Reclamation of South				(B)	(C)
				S1 2	S1 3
				S2 3	S2 3
				S3 -1	S3 -1
				S4 0	S4 3
				S5 -2	S5 -3
				S6 -2	S6 -3
				S7 -3	S7 -3
				S8 3	S8 -3
				S9 0	S9 -3
				S10 -2	S10 -1
				S11 -1	S11 -1
			<b>Total -3</b>	<b>Total -9</b>	
(C) Reclamation of West					

Option A was determined to be the most favourable location to be reclaimed. Table 31 below describes significance of each parameter between the three options.

Table 31: Description/justification contrasting options

Parameter	Justification/Description
(S1) Noise impacts	Noise impacts although significant will be mostly localised only to the picnic island (Tholhufushi) and will be temporary.
(S2) Visual impacts	Option A: Significant negative visual impacts to the resort are envisaged only during construction phase. This will not be an issue for other two options
(S3) Wave Action	Option A: Unchanged because the proposed reclamation area is shielded from waves by the reef which extends hundreds of meters from the island.
(S4) Security concerns	Option A: Security concerns for the resort are significant during operational phase of the reclamation project. This could be completely avoided for Option C and B. However, security concerns could be mitigated through collaboration between resort management and island council.
(S5) Accessibility	Option A: Convenient accessibility as it is already close to the populous eastern side of the island. Option C is the most unfavourable as it is furthest away from population and infrastructure followed by option B.
(S6) Access to infrastructure	Option A most favourable as it is closest to the populated area of the island.
(S7) Public view	Public in favour of option A compared to the other two as it is closest to public infrastructure and populated area.
(S8) Future Land Use Plan	Option B most favourable for future development plan as this area can be reclaimed up to the reef crest.
(S9) Aesthetics	Option C most unfavourable because the area is proposed to be developed for local tourism. Western side attracts migrant sea birds and contains natural sand banks which would be lost if reclaimed.
(S10) Marine Diversity	Option B most unfavourable as it is much closer to the whale shark point and do not contain a barrier to control sedimentation as observed for option A (See Figure 13).
(S11) Current movement	Fairly consistent across all the proposed options. Hydrographic changes are expected during reclamation. The extent of change shall be monitored.

Based on analysis Option A: reclamation of the eastern side was determined to be the most favourable.

## 9.5 ALTERNATE BURROW AREA (ENTRANCE CHANNEL)

The council proposed that it would be much easier if the main entrance channel is shifted towards the east. The council requested approval from MHI to shift the main entrance channel east of the harbour due to its advantages which include:

- Reduction of noise impacts to the school from directly approaching vessels.
- Availability of space in the harbour.

Details of the Alternate Entrance Channel:

- Area of the alternative entrance channel approx. 12,933 m<sup>2</sup>
- The average depth of the areas was -1.3 m MSL
- Southern side was slightly shallower than the northern side. Depth range was -0.4 to -1.1 m
- Volume of material obtained if dredged to – 3.5 m was calculated to be 7,479 m<sup>3</sup>

The advantages of shifting the entrance channel are:

- It would create more space in the harbour basin.
- It would reduce noise impacts experienced by Fenfushi school as the current entrance channel faces towards the school.
- It would provide substantial amount of fill material to reclaim the eastern side.
- It will be much calmer to navigate during north east monsoon.
- Incidence of live corals at the area were negligible. Transect 1 represents the area (See 6.6.2 and Figure 8)

The disadvantages of shifting the entrance channel to the east are:

- The cost and time associated with dredging the new entrance.

From an environmental perspective, shifting the entrance channel to the east is not considered as having a significant negative impact. The frequency of live corals in the area was negligible, the amount of lagoon space lost will be small.

## 9.6 SUMMARY OF ALTERNATIVES

### **Alternate Fill Material**

Combination of organic waste and fill material obtained from dredging is recommended to be used during reclamation as it would:

- Save amount of fill material that is to be dredged
- Facilitate bioturbation of the reclaimed land

### **Alternate Dredge Methods**

Use of excavator for dredging has been considered the most favourable mainly because:

- The equipment's are already on site and readily available.
- The scale of dredging and reclamation is small.
- It will be easier to manoeuvre in the narrow channels and small harbour area.

### **Alternate Reclamation Location**

Option A: reclamation of the eastern side was considered the most favourable based on the option analysis. Option a received the most positive score while options B and C received more negative scores based on the analysis. Main advantages of option A:

- It's close to the populated area of the island where infrastructure to access the area has already been established.
- It does not impede future development plans of the island
- There is a groyne already installed which would act as a natural sediment barrier.

### **Alternate Entrance Channel**

Since shifting the main entrance channel to the east will solve the congestion issues at the harbour and is not envisaged to have a significant loss of marine bio-diversity and it will provide 7500 m<sup>3</sup> of fill material, this alternative is recommended.

## 10 ENVIRONMENTAL MONITORING

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### 10.1 INTRODUCTION

This chapter provides the monitoring plan for the proposed project. Adoption of appropriate mitigation measures as described in Table 32 & 21 is expected to minimise environmental damage by accounting for uncertainties detailed in section 8.5. It should be noted that adopting of mitigation measures do not guarantee unforeseen impacts. Environmental monitoring is an essential requirement to ensure that post-construction and operational impacts are identified and avoided in a timely manner. Identifying and addressing to impacts earlier would result in cost saving and also help planning and operationalization processes.

The monitoring plan is based on impact analysis outlined in Section 6 of the report and the existing environmental conditions determined in Section 8 of the report.

The main key objectives of the environmental management plan are to:

- a) Protect the MPA during construction phase of the project, by reducing and monitoring sedimentation
- b) Develop a framework for potential impacts, by including practical systems for monitoring, reporting and implementing corrective actions during the proposed project
- c) Monitor and manage any unforeseen impacts
- d) Manage environmental matters in a systematic manner and to collect information that can be used for documentation and verification of environmental impacts;
- e) Collect data that can be used for assessing the effectiveness of implemented mitigation measures.
- f) To meet statutory requirements and acceptable standard of relevant agencies
- g) Assess the magnitude of the impacts resulting from dredging
- h) Verify the transport regime of sedimentation which has been assessed through this study

The measures and parameters that are most relevant for monitoring and managing the impacts that may arise from the proposed project are:

- Topography
- Water quality (sedimentation);
- Waste quantity

## **10.2 ENVIRONMENTAL MONITORING SYSTEM**

The environmental monitoring framework for the proposed project is based on the standards and policies set out by the Environmental Protection Agency under EIA Regulation 2012.

Environmental monitoring plan formulation:

- a) Field data was collected and baseline environmental conditions were determined for the project.
- b) Sedimentation arising from dredging and reclamation was determined to be the most significant environmental impacts.
- c) Seawater quality (turbidity) was identified to be the parameter that shall be monitored.
- d) Threshold levels of sedimentations was determined based on international standards.
- e) Management plan was devised to incorporate and address all negative impacts identified from the impact assessment.

## **10.3 ENVIRONMENTAL MONITORING PLAN**

Monitoring would begin from the EIA preparation phase to establish baseline data before modifying the marine environment. This program would commence at the start of construction phase. Figure 38 shows potential sites to monitor sedimentation resulting from the project. If turbidity levels exceed 29 NTU at location B the project shall be resumed until viable solutions are set in place. The proponent is committed to continue the monitoring program for a year after the construction phase. See section 13.8 for commitment letter by the proponent.

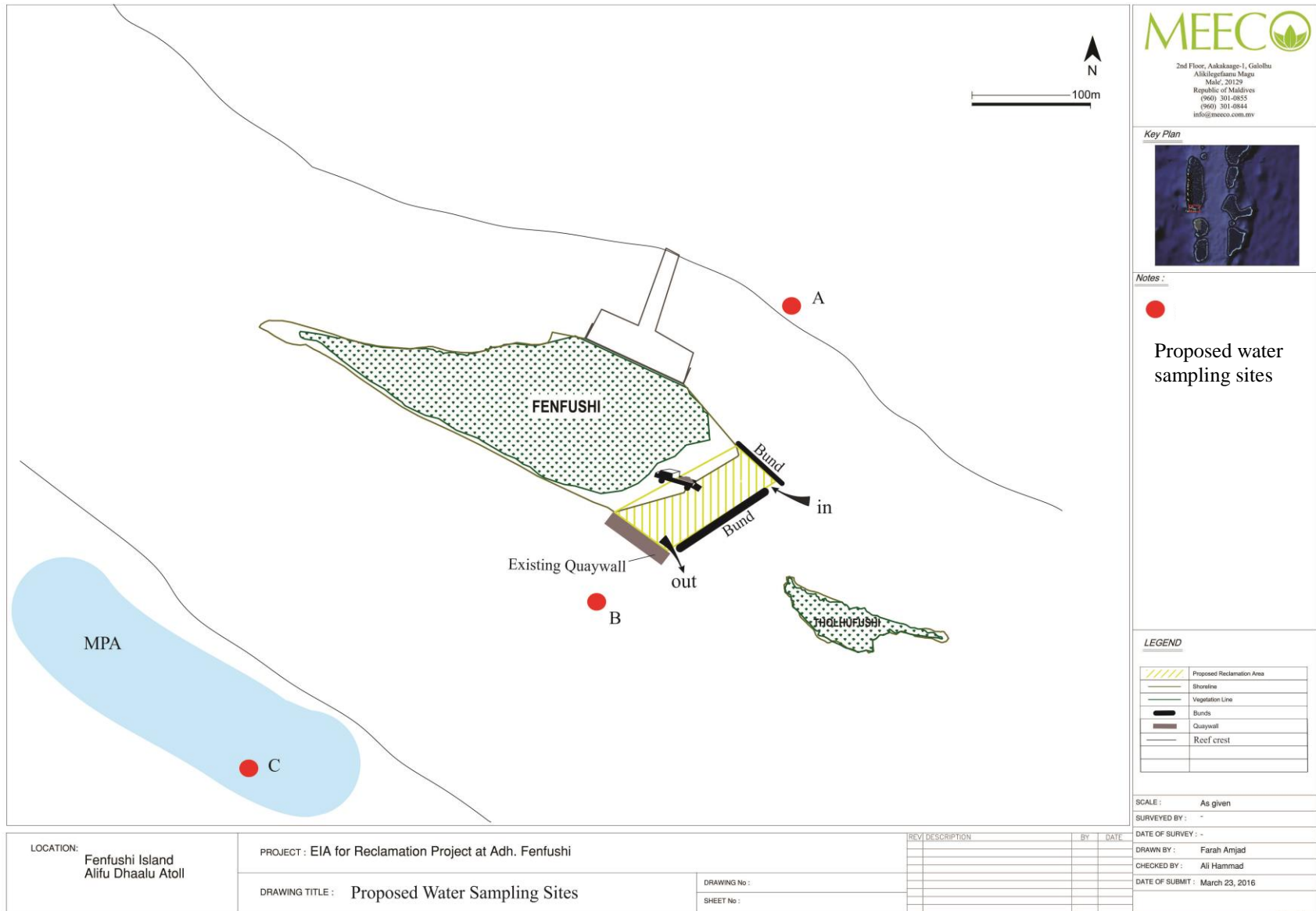


Figure 38: Proposed monitoring plan

## 10.4 REPORTING

Reporting will be carried out by the environmental consultant assigned for the purpose by the proponent. The report will include;

- Details of the site (This shall include baseline hydrographical and climate conditions at the time of monitoring);
- Methodology of data collection and data analysis;
- Major findings; and
- Section contrasting findings with the baseline
- Mitigation measures that would be implemented based on the monitoring.

### Sample Format

- Introduction
- Aims and Objective
- Method
- Results
- Topography
- Water quality
- Waste (Forms/checklist which should classify type volume and weight)
- Water quality comparison with baseline
- Conclusion and recommendations

A detailed environmental monitoring report is required to be compiled and submitted to the EPA at the end of the one-year monitoring period as summarised in Table 33.

## 10.5 PROJECT MONITORING COST & TIMEFRAME

This monitoring should be commenced during the preparation stage and continued for at least one year after the completion of the project. The monitoring frequency, costs and details of various monitoring aspects are explained in Table 32 and a summary of environmental monitoring is presented in Table 33.

Table 32: Environmental monitoring plan

Environmental aspect	Parameters and Methods of Monitoring	Monitoring Frequency	Cost (USD)	Baseline Study
Topography	Ensure that reclamation has met appropriate height to so that flooding does not occur in the reclaimed area GNSS RTK could be used to survey the topography	<u>Construction phase</u> Once after reclamation.  See 6.6.1 bathymetry of area before reclamation.	Approx. USD 1000	N/A
		<u>Operational phase</u> Not required		
Waste	Waste audits should be conducted to determine the solid waste and hazard waste generated during the construction phase of the proposed project  Quantities of each type of waste can be determined through weight or volume measurements. Waste quantity shall be measured at production site and then compared with the quantity measured at disposal site at Thilafushi to ensure that all wastes are disposed of appropriately at designated areas	<u>Construction phase</u> Once at the end of construction when all the wastes have been separated and stored in appropriate containers.	Approx. USD 1000	N/A
		<u>Operational phase</u> Not required		
Water quality (Sedimentation)	Water quality should be measured to check the turbidity or TSS, DO, temperature and conductivity. The aim of water quality measurements is to monitor sedimentation.  A multi parameter probe could be used to check these parameters or samples can be collected on site and transported to a lab within 24 hrs.  It is important to measure the current direction during dredge time using simple drogue techniques to determine the geographical locations of sample	<u>Construction phase</u> Water quality should be monitored daily for the duration of dredge period.	Approx. USD 2000	See section 6.5.1 for baseline readings for comparison
		<u>Operational phase</u> Water quality should be monitored once two months after project.		

## 10.6 SUMMARY OF ENVIRONMENTAL MONITORING

Four parameters have been identified to be monitored these include:

1. Topography
2. Water Quality (sedimentation)
3. Solid Waste and hazardous waste Quantity

A single monitoring report is to be submitted at the end of one year to EPA and shall have the following data included in the report:

*Table 33: Summary of environmental monitoring*

Parameter	Number of Assessments	Detail
Topography	1	Right after reclamation
Water quality (sedimentation)	2	Daily during construction phase (approximately 40 days)  Once, two months after project to determine effects of residual impacts.
Waste	1	Once after the construction phase of the project

A SINGLE report shall be submitted to EPA at the end of project with these four assessments based on format described in 10.4.

# 11 CONCLUSION AND RECOMMENDATION

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## 11.1 CONCLUSION

The EIA confirmed that the proposed reclamation would find a solution to the needs of the public by creating land to develop recreational facilities and docking facilities. It will also allow the council to expand and renovate the cemetery.

No significant vegetation or marine life was identified at the direct impact zone. Hydrographical conditions at the site were stable. Currents at the project site were significantly low and propagated southerly at the time of survey. Sediment transportation based on measured current readings were found to be limited to very fine particles. Water quality assessment indicated that the site had not been polluted as parameters tested were within the normal range. The bathymetry of project area suggested that on average the site was extremely shallow and uniform. The amount of fill material required to reclaim the proposed area to + 1.4 m MSL was 28,477m<sup>3</sup>. The study determined that harbour basin and proposed small entrance channel within the basin can be dredged to obtain the required fill material.

The south Ari Atoll MPA was located close to Fenfushi. Consultations and assessments conducted during the impact study confirmed that no significant negative impacts to the MPA were anticipated as a result of the project.

The project was subjected to rigorous options evaluation which studied the proposal against potential alternatives, environmental and social impact. Alternatives assessed include method and location alternatives. The proposed reclamation site (Eastern side) scored the highest from a comparative option analysis matrix that compared alternate reclamation locations.

The impact assessment was classified into two phases of the project. The construction phase of the project was found to comprise only minor/moderate short term negative impacts mainly to the physical environment. Sedimentation was identified to be the single most crucial impact resulting from the project that needs to be mitigated to reduce negative impacts to the environment. Main mitigation measures include focussing on efficiency and devising work method to enclose reclamation area. The operational phase of the project was found to mainly comprise of positive impacts. Areas that were identified to have significant positive impacts during this phase of the project were, recreational value and public wellbeing.

The impact assessment was mainly limited due to lack of historic data and subjectivity in determining impacts. However, these have been sufficiently addressed with reference to similar studies and input from a panel of consultants. Nevertheless, in order to account for uncertainties and assess whether the environment system remains within its equilibration capacity, an EMP has been provided. The EMP devised in the report proposes to monitor three key parameters including sedimentation through sea water quality. A single monitoring report has been proposed to be submit with the main focus on monitoring sea water quality, outside reclamation/dredge areas and within MPA and reef flats.

The environmental impact assessment did not predict potentially significant or major negative impacts to the environment as a result of the proposed project. The project is not expected to have a negative impact on a protected site, species or habitat. The report identified that any perceived minor negative impacts were found to be within the natural dynamic equilibrium zone of the environment or small enough in scale that they do not require specific intervention measures. No negative impacts were identified that could be of regional or national significance. The impact assessment demonstrated that implementation of the project is expected to improve the socio-economic condition of the region and enhance environmental quality of the project site to some extent.

If all the proposed mitigation measures and recommendations are taken into account, the project will align with all the environmental objectives stipulated by relevant regulators and laws. Therefore, based on the environmental impact assessment the proposed reclamation project at Fenfushi is not expected to have any significant or major negative impacts to the environment. Positive impacts of the projects far outweigh any minor negative impacts that have been envisaged. Based on the above factors it is concluded that the proposed project to be environmentally acceptable.

## 11.2 RECOMMENDATIONS

The following recommendations are suggested based on the impact assessment and existing environmental conditions.

- During reclamation, site should be enclosed before filling using sand bunds or any other similar method which would achieve the purpose of trapping sediments. If project area is enclosed for a long period of time, water should be aerated and circulated routinely to avoid smell related issues.
- The calmest months were identified to be March-April in terms of weather considerations hence, if feasible it is recommended to carry out reclamation works during this time of the year to avoid weather related risks.
- It is recommended to only dredge the harbour basin to obtain the required fill material. These include zones 1,2 and 3 that have been identified. Work method shall be devised based on the bathymetry drawings provided to increase the efficiency.
- The recommended alternate fill material source: shifting entrance channel to the east. Mitigations measures shall be in place, which include construction of bunds and barriers. .
- It is recommended to monitor turbidity levels at proposed areas during construction and ensure that turbidity levels do not exceed the threshold (0-3 NTU) outside southern and northern reef crest.
- Resort management shall be informed about the project progress so that they have enough time to make the necessary arrangements with guests.

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## 13 ANNEX

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### 13.1 ANNEX 1 – TERMS OF REFERENCE



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## Terms of Reference for Environmental Impact Assessment for the proposed Land Reclamation Project in ADh. Fenfushi

The following is the Terms of Reference (ToR) following the scoping meeting held on **10<sup>th</sup> February 2016** for undertaking the EIA of the proposed *Land Reclamation and Project in A.Dh Fenfushi*, proposed by **A.Dh. Fenfushi Council**. 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. Identify the donors and the institutional arrangements relevant to this project.
2. **Study area** – Submit a minimum A3 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. The study area should include adjacent or remote areas, such as relevant developments and nearby environmentally sensitive sites (e.g. coral reef, sea grass, mangroves, marine protected areas, special birds site, sensitive species nursery and feeding grounds). Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites
3. **Scope of work**– Identify 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 reclamation works, using maps at appropriate scales where necessary. The following should be provided (all inputs and outputs related to the proposed activities shall be justified):

The main activities of the project are:

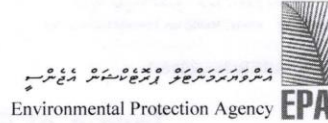
- Reclamation of the eastern side
- Dredging for fill material
- Stockpiling of fill material;
- Mark Location and size of dredge areas (s) on a map or burrow areas if relevant;
- Justification for the selection of this location;
- Quantity, and characteristics of fill material;

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- Method and equipment used for excavation;
- Waste management; and
- Pollution control.
- Identify safety measures that should be adopted during construction phase.
- Dredging material from burrow area and pumping it into the reclamation/backfilling area;
- Finishing reclamation area to required levels;
- Construction of quaywall
- Construction of buildings
- Measures to protect environmental values during construction and once the new island has been established.
- Project management (include scheduling and duration of the project and life span of facilities; communication of construction details, progress, target dates, construction/operation/closure of labour camps, access to site, safety, equipment and material storage, fuel management and emergency plan)

### TI.1 Reclamation/ backfilling and Coastal Works

The following details of Dredging and reclamation activity shall be furnished:

- Location and size of sand burrow areas;
- Justification for the selection of these location;
- Dredge disposal methods and locations;
- Quantity, quality and characteristics of fill material;
- Indication of guarantees for sufficient availability of fill material;
- Method and equipment used for dredging, including description of positioning system, depth control system and operational control procedures;
- Justification for selecting the methods and equipment;
- Duration of dredging activity;
- Labour requirements and (local) labour availability;
- Housing of temporary labour, and
- Emergency plan in case of spills (diesel, grease, oil)
- Location of sand beds (if any) during construction

**Task 2. Description of the environment** – Assemble, evaluate and present 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. All data must be collected as per the requirements of the EPA Data Collection Guidelines (published on [www.epa.gov.mv](http://www.epa.gov.mv)). The report should outline detailed methodology of data collection utilized.

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**Task 3. Legislative and regulatory considerations** – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. The EIA report should clearly identify the different applicable clauses and articles of the legislative and regulatory 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

- impact on the natural environment;
- impacts of noise, and disturbance;
- impact on marine environment due to the excavation of fill material;
- impacts on environment as a result of sediment transportation during reclamation and dredging
- construction related impacts and risks of the natural environment pollution;
- (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste);
- Safety of workers and risk of accidents.
- impacts on physiochemical environment
- impacts on socio-economic condition of the island

Construction related hazards and risks

- Pollution of the natural environment (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste);
- Risk of accidents and pollution on workers, and
- Impacts on social values, norms and belief due dredging from within atoll lagoon.

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

**Task 5. Alternatives to proposed project** – Describe alternatives including the “no action option” should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the “no action alternative”. This should include but not limited to alternative borrow sites, alternative equipment/machinery for dredging, alternative disposal sites and alternative containment measures. The report should highlight how the dredging and reclamation location was determined. All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

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ދިވެހިރާއްޖޭގެ ބާވަތްތަކާ ގުޅިގެން  
Environmental Protection Agency **EPA**

**Task 6. Mitigation and management of negative impacts** – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These should include both environmental and socio-economic mitigation measures with particular attention paid to the management of the waste, sedimentation control during dredging and reclamation. Mitigation measures to avoid or compensate habitat destruction caused by excavation shall be considered. Measures for both construction and operation phase shall be identified. The confirmation of commitment in the form of a commitment letter, of the proponent 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 (see appendix)**– Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan. Detail of the monitoring program including the physical and biological parameters for monitoring, 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 where appropriate.

**Task 8. Stakeholder Consultation** – Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders. In this respect consultation shall be undertaken with the following stakeholders and any other relevant stakeholders identified during the preparation of the EIA report:

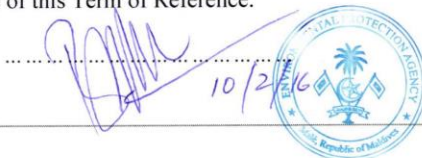
- Ministry of Housing and Infrastructure
- Island Council
- General public

Details of the consultative meetings including summary outcomes, participants, date, time and location should be described. The EIA report should include a list of people/groups consulted, their contact details and summary of the major outcomes. The EIA report should be submitted to the atoll council and evidence of which included in the EIA report.

**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 of 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 Regulation 2012 and the relevant amendments.

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

.....  
10/2/16



Environmental Protection Agency  
Green Building, 3<sup>rd</sup> Floor, Handhuvaareehlingun  
Male, Rep. of Maldives, 20392  
Tel: [+960] 333 5949 [+960] 333 5951  
Fax: [+960] 333 5953

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5 of 6

ދިވެހިރާއްޖޭގެ ބާވަތްތަކާ ގުޅިގެން  
ދިވެހިރާއްޖޭގެ ބާވަތްތަކާ ގުޅިގެން  
ދިވެހިރާއްޖޭގެ ބާވަތްތަކާ ގުޅިގެން  
20392  
ފޯމުވަނަ : secretariat@epa.gov.mv  
ފެކްސް :  
Website: www.epa.gov.mv



ދިވެހިސަރުކާރުގެ ގެޒެޓް - ޖުމްހޫރިއްޔާއެކުވާދާ ދިވެހިންނަށް  
 "Dhivehin" – Always Maldivian, Forever Independent



10<sup>th</sup> February 2016

Environmental Protection Agency

Green Building, 3<sup>rd</sup> Floor, Handhuvaareehingun

Male', Rep. of Maldives, 20392

Tel: [+960] 333 5949 [+960] 333 5951 ޖެނެރަލް ފޯން ނަންބަރު

Fax: [+960] 333 5953 ފެކްސް ނަންބަރު

6 of 6

ދިވެހިސަރުކާރުގެ ގެޒެޓް - ޖުމްހޫރިއްޔާއެކުވާދާ ދިވެހިންނަށް  
 ޖެނެރަލް ފޯން ނަންބަރު : 333 5949 ފެކްސް ނަންބަރު : 333 5953  
 20392

ޓެލިފޯން : 333 5949 ފެކްސް : 333 5953  
 Email: secretariat@epa.gov.mv

ފެކްސް : 333 5953  
 Website: www.epa.gov.mv

13.2 ANNEX 2 – SITE PLAN



A.dh. Fenfushi proposed reclamation project  
scale 1:10000mm

A.dh Fenfushi



SCALE:  
  
1:10000MM

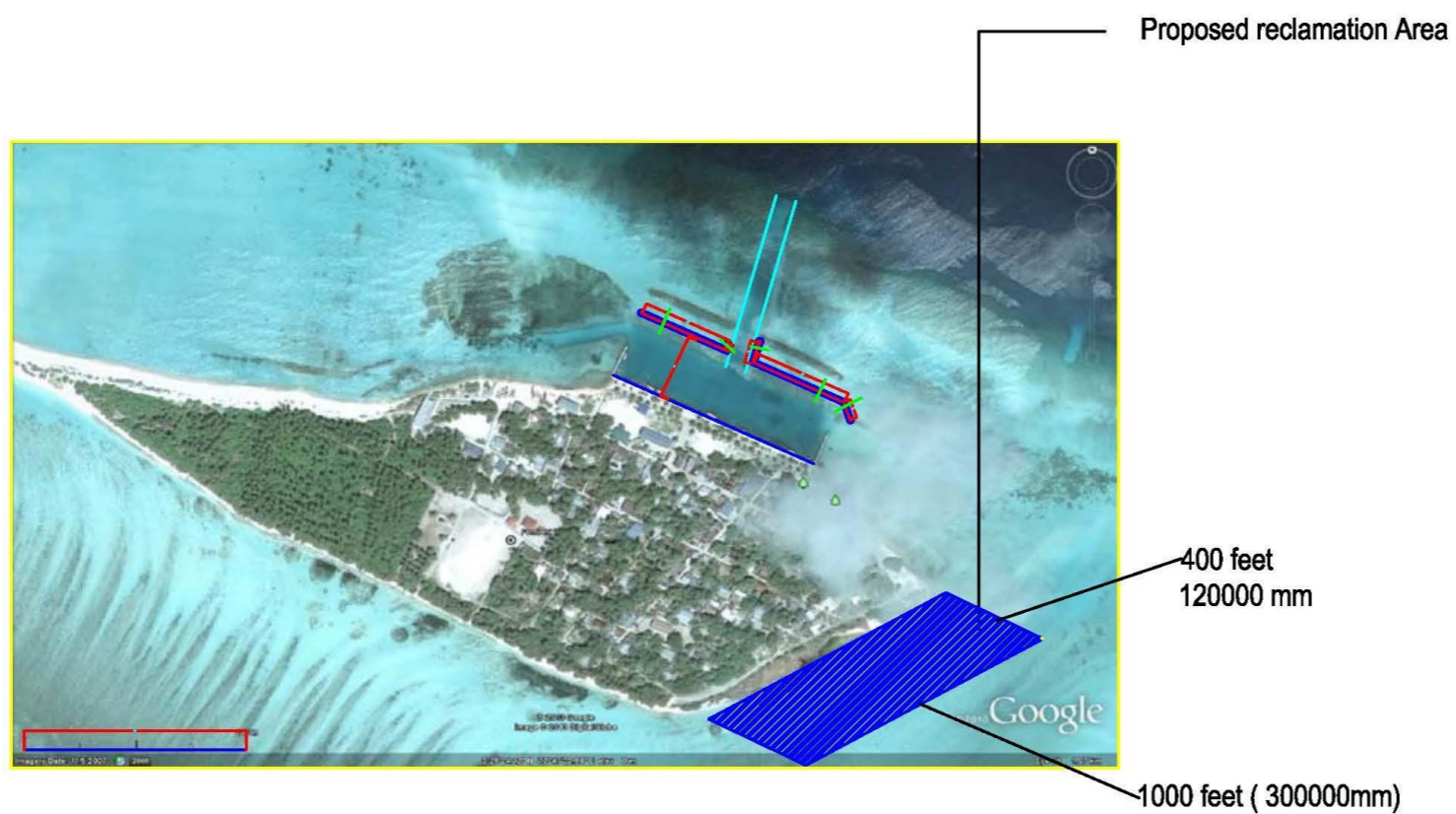
LEGEND:

PROJECT: RECLAMATION PROJECT

CONTENTS:

DATE: 28TH AUGUST 2013

 COASTAL & CIVIL ENGINEERING SECTION  
MINISTRY OF CONSTRUCTION AND PUBLIC INFRASTRUCTURE  
REPUBLIC OF MALDIVES  
TEL:3326254, 3326474, FAX:3326300



A.dh. Fenfushi proposed reclamation Area  
scale 1:10000mm

A.dh Fenfushi




SCALE:  
  
1:10000MM

LEGEND:  
  
 RECLAMATION AREA

PROJECT:  
RECLAMATION PROJECT

CONTENTS:

DATE: 28TH AUGUST 2013


**COASTAL & CIVIL ENGINEERING SECTION**  
 MINISTRY OF CONSTRUCTION AND PUBLIC INFRASTRUCTURE  
 KAZHIBHESHU MALU' MALU' 28-01  
 REPUBLIC OF MALDIVES  
 TEL:3332554, 3333474, FAX:3330000





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

ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި  
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138-E/2/355/2013/01

ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި  
ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި

ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި

ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި 21 ޖުލައި 2013 ސަލާމަތުގައި  
ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި.

ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި 400 ޖަނަވަރު 1000 ޖަނަވަރު  
ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި 18 ސެޕްޓެމްބަރު 2013 ގައި  
ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި 25 ޖުލައި 2013 ގައި

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18 ސެޕްޓެމްބަރު 2013 ގައި

25 ޖުލައި 2013 ގައި

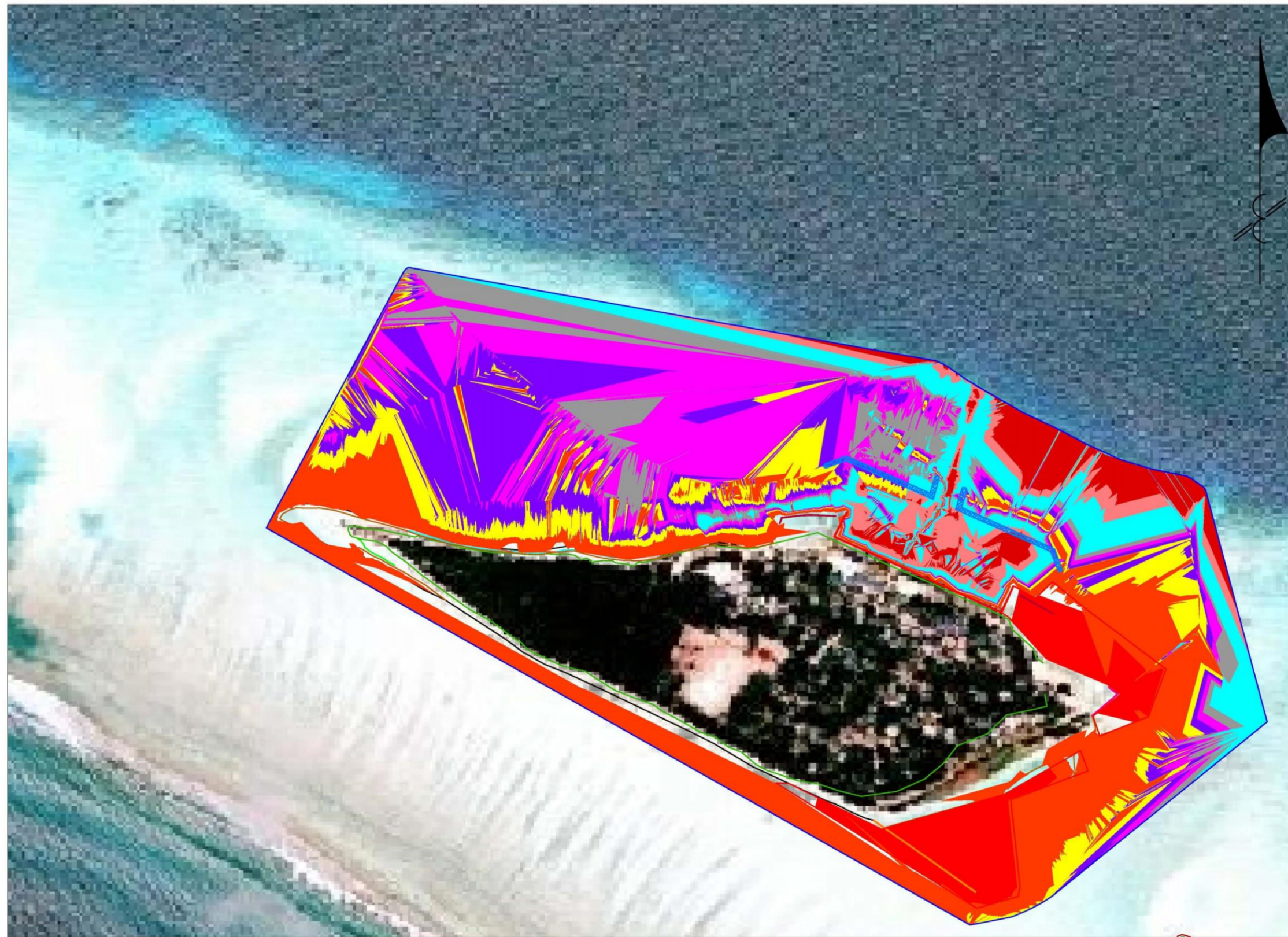
ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި  
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514		ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި ބަޔާންކޮށްފައިވާ ގޮތުގައި
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13.4 ANNEX 4 - BATHYMETRY PROJECT AREA



2nd Floor, Aakakaage-1, Galolhu  
 Aikilegefaanu Magu  
 Male', 20129  
 Republic of Maldives  
 (960) 301-0855  
 (960) 301-0844  
 info@meecco.com.mv

**Key Plan**



**Notes :**

\_UNITS IN METERS  
 \_ELEVATION ARE REFERRED TO MSL

**LEGEND**

	HARBOR
	SAND BANK WALLS
	MTCC WALL
	NEW RUBBLE KEY WALL
	LOW TIDE SHORE LINE
	HITIDE SHORE LINE
	VEGETATION LINE
	VEGETATION GROUND COVER LINE
	BREAKWATER
	-14.546m TO -3.561m
	-3.561m TO -2.799m
	-2.799m TO -1.396m
	-1.396m TO -1.170m
	-1.170m TO -0.962m
	-0.962m TO -0.746m
	-0.746m TO -0.476m
	-0.476m TO -0.500m

SCALE : 1:5000

SURVEYED BY : DINAL (SURVEYOR)

DATE OF SURVEY : 2016/03/07

DRAWN BY : DINAL (SURVEYOR)

CHECKED BY : DINAL (SURVEYOR)

DATE OF SUBMIT : 2016/04/09

LOCATION FENFUSHI ALIFU DHAALHU ATOLL	PROJECT : FENFUSHI RECLAMATION & DEVELOPMENT PROJECT	REV DESCRIPTION BY DATE
	DRAWING TITLE : BATHYMETRY DRAWING	DRAWING No :2016/030 SHEET No :01 OF 07



**MEECO**  
 2nd Floor, Aakakaage-1, Galolhu  
 Alikilegefaanu Magu  
 Male', 20129  
 Republic of Maldives  
 (960) 301-0855  
 (960) 301-0844  
 info@meecco.com.mv



**Notes :**  
 \_UNITS IN METERS  
 \_ELEVATION ARE REFERRED TO MSL  
 \_ DREDGING AREA (01)  
 SIZE=3958.854sq.m  
 VOLUME=13575.35 CU.M  
 \_DREDGING AREA (02) (HARBOR)  
 SIZE=16900.173sq.m  
 VOLUME=12453.31 CU.M  
 \_DREDGE AREA (03)  
 SIZE=1756.367sq.m  
 VOLUME=3506.94CU.M  
 \_TOTAL DREDGE AREA  
 SIZE=22815.90sq.m  
 VOLUME=29535.60CU.M  
 \_DREDGE AREA FOR BREAK WATER  
 SIZE=9890.562sq.m  
 \_FILL REQUIRED TO RECLAIM WHOLE AREA  
 SIZE=39314.589 sq.m  
 VOLUME=35514.25 CU.M  
 \_ ALREADY FILL MATERIALS  
 SIZE=7211.567 sq.m  
 VOLUME=7036.83 CU.M  
 \_ REQUIRED NET VOLUME  
 VOLUME=28477.42cu.m

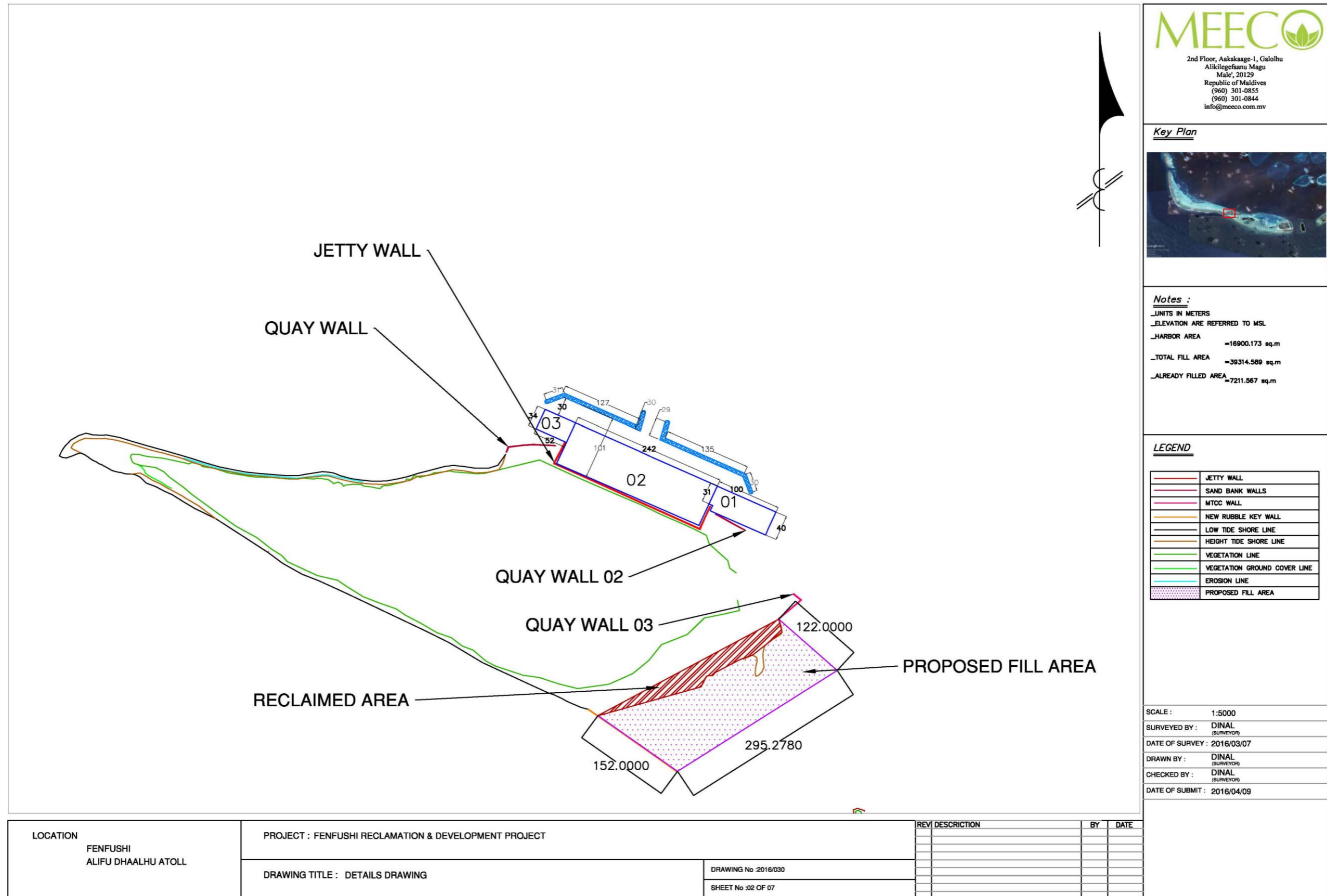
**LEGEND**

	HARBOR AREA & BREAKWATER
	SAND BANK WALLS
	MTCC WALL
	NEW RUBBLE KEY WALL
	LOW TIDE SHORE LINE
	HITIDE SHORE LINE
	VEGETATION LINE
	VEGETATION GROUND COVER LINE
	SURFACE BOUNDARY
	PROPOSED FILL AREA
	ALREADY FILL AREA
	PROPOSED DREDGE ZONE
	ALREADY DREDGE AREA

SCALE : 1:5000  
 SURVEYED BY : DINAL (SURVEYOR)  
 DATE OF SURVEY : 2016/03/07  
 DRAWN BY : DINAL (SURVEYOR)  
 CHECKED BY : DINAL (SURVEYOR)  
 DATE OF SUBMIT : 2016/04/09

LOCATION FENFUSHI ALIFU DHAALHU ATOLL	PROJECT : FENFUSHI RECLAMATION & DEVELOPMENT PROJECT	REVI	DESCRIPTION	BY	DATE
	DRAWING TITLE : FENFUSHI VOLUME CALCULATED AREA				
	DRAWING No :2016/030				
	SHEET No :03 OF 07				

13.5 ANNEX 5 – DETAIL DRAWING OF FENFUSH



2nd Floor, Aakakaage-1, Galolhu  
 Alikilegefaanu Magu  
 Male', 20129  
 Republic of Maldives  
 (960) 301-0855  
 (960) 301-0844  
 info@meeeco.com.mv

Key Plan



Notes :

\_UNITS IN METERS  
 \_ELEVATION ARE REFERRED TO MSL  
 \_HARBOR AREA =16900.173 sq.m  
 \_TOTAL FILL AREA =39314.589 sq.m  
 \_ALREADY FILLED AREA =7211.567 sq.m

LEGEND

	JETTY WALL
	SAND BANK WALLS
	MTCC WALL
	NEW RUBBLE KEY WALL
	LOW TIDE SHORE LINE
	HIGHT TIDE SHORE LINE
	VEGETATION LINE
	VEGETATION GROUND COVER LINE
	EROSION LINE
	PROPOSED FILL AREA

SCALE : 1:5000

SURVEYED BY : DINAL (SURVEYOR)

DATE OF SURVEY : 2016/03/07

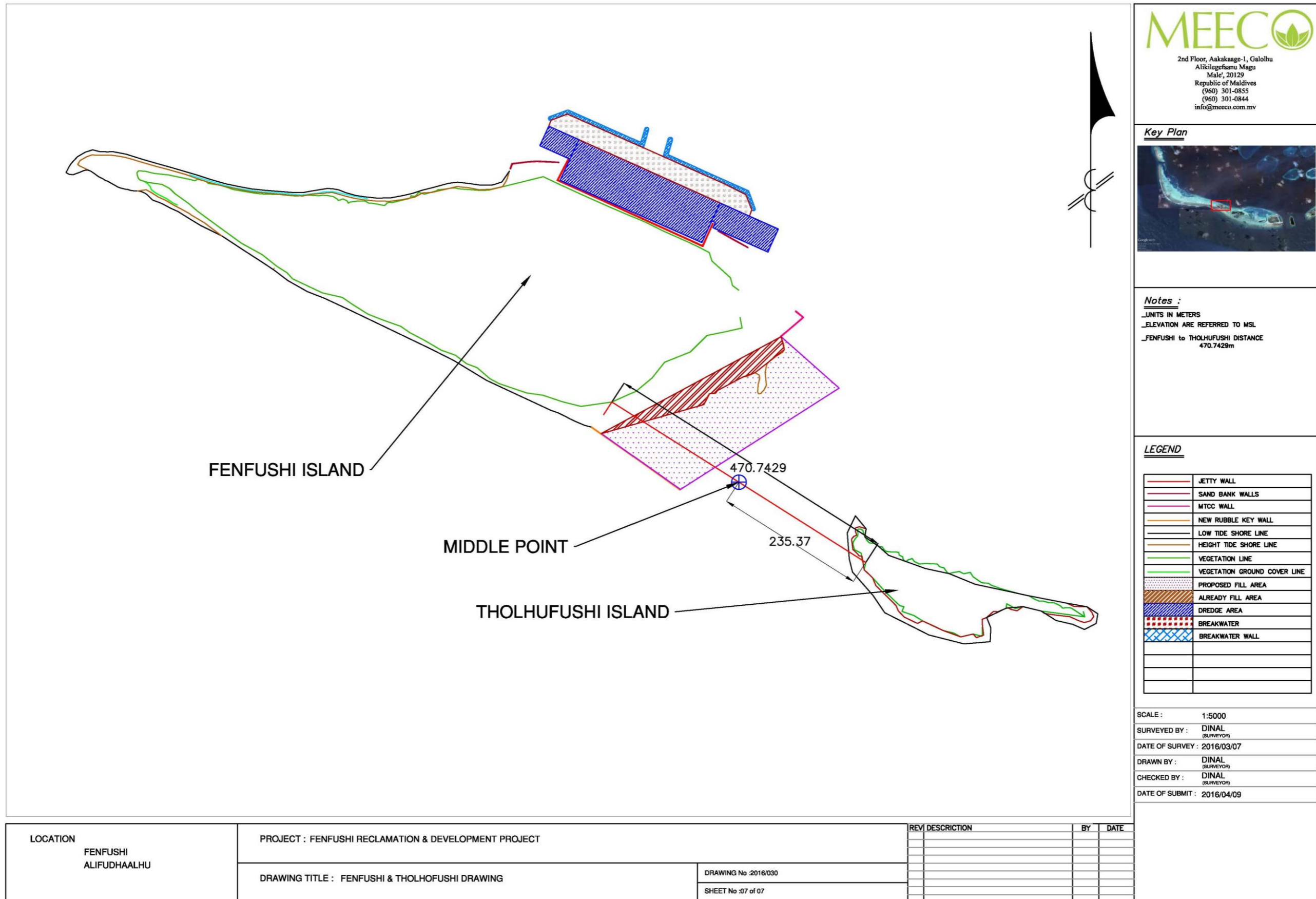
DRAWN BY : DINAL (SURVEYOR)

CHECKED BY : DINAL (SURVEYOR)

DATE OF SUBMIT : 2016/04/09

LOCATION FENFUSHI ALIFU DHAALHU ATOLL	PROJECT : FENFUSHI RECLAMATION & DEVELOPMENT PROJECT	REV	DESCRIPTION	BY	DATE
	DRAWING TITLE : DETAILS DRAWING				
	DRAWING No :2016/030				
	SHEET No :02 OF 07				

13.6 ANNEX 6 – FENFUSHI/SUN ISLAND BOUNDARY



13.7 ANNEX 7 – BEACH PROFILES/ ISLAND CROSS SECTIONS



2nd Floor, Aakakaage-1, Galolhu  
 Aikilegefaanu Magu  
 Male', 20129  
 Republic of Maldives  
 (960) 301-0855  
 (960) 301-0844  
 info@meeeco.com.mv

Key Plan



Notes :

UNITS IN METERS  
 ELEVATION ARE REFERRED TO MSL

LEGEND

	-14.546m TO -3.561m
	-3.561m TO -2.799m
	-2.799m TO -1.396m
	-1.396m TO -1.170m
	-1.170m TO -0.962m
	-0.962m TO -0.746m
	-0.746m TO -0.476m
	-0.476m TO -0.500m
	PROPOSED FILL AREA
	ALREADY FILL AREA
	SAMPLE LINE
	PROFILE LINE

SCALE : 1:5000  
 SURVEYED BY : DINAL (SURVEYOR)  
 DATE OF SURVEY : 2016/03/07  
 DRAWN BY : DINAL (SURVEYOR)  
 CHECKED BY : DINAL (SURVEYOR)  
 DATE OF SUBMIT : 2016/04/09

LOCATION FENFUSHI ALIFU DHAALHU ATOLL	PROJECT : FENFUSHI RECLAMATION & DEVELOPMENT PROJECT	REV DESCRIPTION BY DATE
	DRAWING TITLE : PROFILE DETAILS DRAWING	DRAWING No :2016/030 SHEET No :05 OF 07



### 13.8 ANNEX 8 – COMMITMENT LETTER BY PROPONENT

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ



Secretariat of Fenfushi Council South Ari Atoll  
A.Dh. Fenfushi

Date: 11<sup>th</sup> April 2016

Ref No. 355-ESMS/203/2016/1

Ibrahim Naeem  
Director General  
Environmental Protection Agency  
Ministry of Environment and Energy  
Ameenee Magu, Maafanu,  
Male' Maldives

Dear Sir,

Sub: EIA for the proposed Reclamation Project in A Dh. Fenfushi.

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

Sincerely

Mr. Shahid Abdurraheem

President



## 13.9 ANNEX 9 - RESPONSE FROM ATOLL COUNCIL

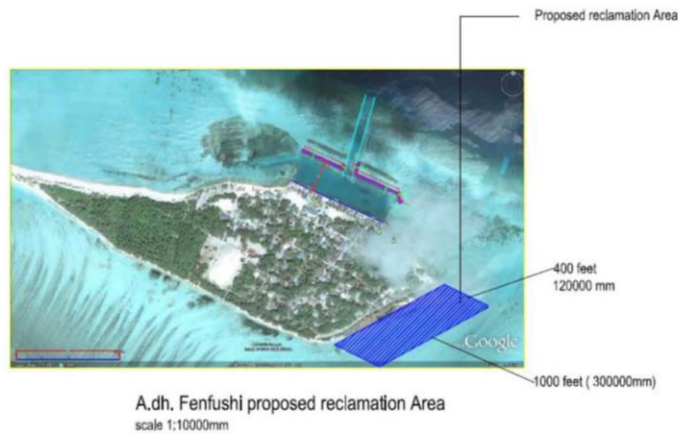
Attached.

### 13.10 ANNEX 10 – RESPONSE FROM MWRP



**Re: Environmental Impact Assessment for a Land Reclamation Project in A Dh. Fenfushi South Ari Atoll**

Site: A Dh Fenfushi Island



**Proposed Development as per EPA:**

*To reclaim approximately 37,161 m<sup>2</sup> of land from the eastern side of the island. The council's proposition has been seconded by Ministry of Housing and Infrastructure (MHI) to alleviate the major social, logistic and developmental issues faced by the island.*

**Clarifications**

To clarify our understanding, although situated within very close proximity, the site is strictly speaking outside of the defined boundary of the South Ari atoll MPA (S.A.MPA). The closest boundary is that of the 'Reef Crest' which separates the fore reef from the lagoon on the inside of the reef.

**Previous Experience**

As this project will be taking place inside the atoll and not directly in the fore reef zone the whale sharks are typically found in, direct physical disturbance by the operation is not expected. The primary area of concern is increased sedimentation in a section of the S.A.MPA adjacent to the dredging and sand pumping operation.

At this time, no literature exists on the impact of increased suspended sedimentation specifically on whale shark in terms of habitat usage or feeding behaviour. Studies do exist showing that increased sedimentation has a detrimental effect on benthic filter feeders and increases avoidance behaviour in some fish species (unless the increased sedimentation increases prey density) due to gill irritation and foraging

efficiency impact. As filter feeding fish therefore, it may well be conjectured that an increase in sediment carrying no nutritional benefit to shark nor their prey would have a negative impact on usage of that area in an unconfined environment.

In addition, a filter feeding animal and the fragile coral reef habitat will be highly susceptible to any harmful chemicals leaked or leached into the surrounding water during construction, so this should be contained at all costs.

The MWSRP team can only draw on previous limited experience of the land reclamation for the airport at Maamigili (circa 2007 – 2009) to try to establish the effects of sedimentation in this region. During this period there was a clear increase in suspended substrates and sedimentation along the outer reef over the length of Maamigili island.

The MWSRP would require more time to produce spatial and temporal encounter maps for the Maamigili area compared to the surrounding area during this period.

At an MPA scale during this time MWSRP sightings frequency data is as follows;

- 1.53 sightings per day on average in 2006 (26 encounters over 17 days at sea)
- 1.5 in 2007 (63 encounters over 42 days at sea)
- 3.0 in 2008 (169 encounters over 56 days at sea)
- 3.1 in 2009 (206 encounters over 67 days at sea)

As MWSRP was not operational prior to 2006, no systematic records were kept to identify whether 2006 and 2007 were unusually low. Environmental and oceanic variables must be considered as contributing factors in sighting frequency, although it should also be noted that MWSRP team experience and spotting efficiency has also increased over time.

#### **Suggested Potential Stakeholder Concerns**

Whale sharks are currently spotted almost exclusively from excursion vessels. This is a time inefficient and fuel costly searching technique. Most vessels are only successful in spotting a whale shark when conditions such as water visibility are favourable. In the event that the whale sharks do not show any avoidance behaviour to a sediment affected region (as suggested above), it should be noted that excessive sediment will make the water cloudy and will make spotting whale sharks from the deck of an excursion vessel more difficult. In this scenario, there are the following potential impacts;

- There is a potential for increased boat strikes on whale sharks in any area affected by sedimentation as it will be harder for crew members on excursion vessels to spot a whale shark in their path. Currently 69% of whale sharks bear injuries from such collisions in this region already
- Guest satisfaction and safety may be affected. Poor in water visibility in an area affected by sedimentation will mean it will be more difficult for guests to see the shark in the water, potentially leading to vessels dropping their guests closer to the shark. There is a cumulative risk of snorkelers surfacing from duck dives in poor visibility with vessels closer to them than would normally be the case to be considered too
- Guests not getting a good view of the shark in poor visibility may approach the animal more closely, so causing a potential harassment risk to the shark

The above points are of course accepting that this is only a small spatial region within a large MPA, however in repose the potential spatial and temporal range of any excess sediment is unknown at this point.

The MWSRP is also aware of and has provided a similar response for the proposed land reclamation for a tourist development on Bodufinolu (0.4ha island located west of Fenfushi). Attention should be given to the timing of these projects as any sedimentation and pollution will be amplified by having two such developments occurring in close proximity.

Finally, the popular dive site Bodufinolu Thila is located on the outside reef close by to the proposed site. This site is frequented by a number of resort, local guesthouse and safari based dive operators and it is likely that any damage to this site due to sedimentation will be a cause for concern among the industry.

Whale shark distribution in the MPA appears to be affected by the prevailing monsoon conditions. During the North East Monsoon whale sharks are more likely to be spotted on the West facing side of the atoll

(Rangali – Maamigili), whereas during the South West monsoon whale shark encounters occur towards the Eastern (Dhidhoo - Dhigurah) side of the atoll. Given the location of the proposed site (Western zone), it would be our suggestion that works be carried out during the South West Monsoon so as to avoid a period during which there are known to be a high number of whale sharks and whale shark excursion vessels (and divers at Bodufinolou Thila) in the vicinity of the development site.

### **Summary**

In the instance that this development is granted then the major concerns for MWSRP are based around known and unknown effects of a localised increase in sedimentation within a section of the MPA adjacent to the dredging and sand pumping operations.

We do not discount the potential of what will likely be a significant increase in suspended substrates having a negative effect on whale shark overall abundance in the region near the work, but do not have comparable data either from our work or from literature reviews from which to reference for a definitive answer.

Therefore, from the point of view of mitigating any potential impact on whale sharks in the S.A.MPA the recommendation of MWSRP would be to conduct this work in a manner which limits the amount of suspended sediment that crosses the reef crest into the MPA. The mechanism for doing so is ultimately not something we are able to comment on, but in terms of timing it would be our suggestion that in order to coincide with a period of relatively low whale shark abundance and tour operator presence in the vicinity the development should be carried out during the South West monsoon. Due to the close proximity of an additional proposed tourist development at Bodufinolu the potential for amplifying the effect of sedimentation by running two developments side by side should be taken into account.

## **13.11 ANNEX 11 – RESPONSE FROM ISLAND COUNCIL**

See Commitment Letter. See IX

## 13.12 ANNEX 12 – CV’S OF CONTRIBUTING AUTHORS

Attached.