

ENVIRONMENTAL IMPACT ASSESSMENT REPORT



Land Reclamation at K. Thilafushi Guarantee Fibre Glass Fabrication

January, 2016

Prepared by:





Cover Photo: Shows harbour to be reclaimed, vesseles birthed at harbour belonging to GFF and other companies. Photo: Muslih MEECO

Cover Photo 2: Shows harbour to be reclaimed, Ongoing marine ramp site development on the southern side and existing broken breakwater. Photo: Muslih MEECO

PROJECT SYNOPSIS

Name of the Project: Environmental Impact Assessment for the Proposed Reclamation of Guarantee Fibreglass plot (No. S4-033) at Thilafushi

Project Proponent: Guarantee Fibreglass Fabrication

Project Contractor: Lion Star

Project Value: MVR 400,000

Expected Duration: 34 days

EIA Consultant: Ahmed Saleem

EIA Date: February 2016

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⁻¹ = 0.44 ms⁻¹

LIST OF ABBREVIATIONS

ORP	Oxidation Reduction Potential
TCL	Thilafushi Corporation Limited
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
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
MWSC	Male' Water and Sewerage Company
MHI	Ministry of Housing and Infrastructure
PPG	Personal Protective Gear
RS	Range Values
MSL	Mean sea level
EMP	Environmental Management Plan
GHG	Green House Gas
PPC	Personal Protective Equipment
DNP	Department of National Planning
DIRAM	Detailed Island Risk Assessment in Maldives
DDRPM	Development of Disaster Risk Management Profile Maldives

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ACKNOWLEDGEMENT

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

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)

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NON TECHNICAL SUMMARY

1. This report provides the finding of an environmental impact assessment conducted for a reclamation project in K. Thilafushi, initiated by Guarantee Fibreglass Fabrications 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 ease accessibility to the company's facility and alleviate congestion at the facility due to lack of space.
2. The marine industry, and marine transportation is a crucial sector to the national development. This sector has been rapidly expanding in recent times as local tourism had kick started in the country. With the need for better and streamlined sea transportation mechanisms to connect inhabited islands where local tourism are flourishing, Guarantee Fibreglass Fabrications has experienced an insurgence of demand. With high demand comes the need to expand the current production facility and provide better services to clients. This has become a limitation to the company as the total area (65,000 ft²) allocated and leased to the company by Thilafushi Corporation Limited was found to be inadequate to meet these needs. The eastern plot leased to the company included a very shallow water body of approximately 537 m². Guarantee Fibreglass Fabrications, dredged this area and constructed a breakwater to develop an enclosed harbour to use it as an access point to their facility and to dock company vessels. However, with the expansion of industrial activities at Thilafushi, more plots were leased to companies which created congestion in the harbour. Issues of accessibility and inadequate space at their production facility prompted the company to construct a better accessibility facility and to reclaim the dredged harbour area to capitalise on the extra space it would create.
3. In order to solve, the issues of accessibility, congestion and unauthorised access to the harbour area, the proposed project includes reclaiming the harbour area that measures 17X30 m. The amount of fill material required for the proposed reclamation was calculated to be 1,700 m³
4. Environmental impacts were identified and assessed for both the construction phase (reclamation) and operational phase of the project. The project would result in permanent loss of a relatively small lagoon space. Reclamation would also result in sedimentation and degradation of water quality and relocation of vessels anchored at the location. Due to the small scale of the project, and that fact that the project environment has been heavily modified, with no live corals and very limited fish life, it is evident that the project would not result in loss of an ecologically important environment. Sedimentation as result of reclamation was found to be the most important environmental impact of the project. However, this will be contained as reclamation will be carried out after sheet piling the reclamation area. Significant positive impacts were identified for the implementation phase of the project. The project would not only address difficulty in accessibility but it will also aid the economic growth of the company and contribute to the wider economy of the nation. Alternative reclamation methods have also been proposed in the report with their advantages and disadvantages.
5. Baseline and acceptable thresholds have been established for monitoring any unforeseen negative effects of the project in the surrounding environment by establishing control points. Should the recommended thresholds exceed, the project shall temporarily cease, the casue of the problem shall be recognised and additional corrective measures shall be undertaken after consultation with the Project's environmental consultant.

6. The Proponent, Guarantee Fibreglass fabrication is committed to undertake the necessary mitigation measures and monitoring during all stages of the project that has been proposed in the report. The project is in line with the national development policies of the government and planned to be executed in compliance with the relevant laws and regulations of the Maldives pertaining to conservation of the environment if implemented in accordance with the report.
7. In conclusion, the project is expected to generate economic and social benefits while as per the assessment, carrying out the project would not result in loss of environmentally sensitive or unique habitat. Since all identified negative effects of the project can be mitigated by practical measures, it is concluded that the project can proceed as planned.

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2 INTRODUCTION

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

2.1 AIMS AND OBJECTIVES OF THE PROJECT

Guarantee Fibreglass Fabrications (GFF) requested the services of Maldives Energy and Environmental Company (MEECO) to undertake an Environmental Impact Assessment (EIA) for the proposed reclamation of their current harbour (537 m² in area) situated in their eastern plot (no. S4-033). The harbour area which was initially a shallow lagoon was developed after dredging and installing a breakwater. GFF had used the harbour as an access point to the facility and to birth company vessels since 2000. In addition to this, due to the expansion of GFF the current allocated land has been insufficient to accommodate extra vessels to be serviced.

The project aims at addressing congestion and space constraint issues faced by the company there by making its services more efficient and reliable to its customers. Improved services and production at the facility would mean economic growth and production capability of the company which would positively contribute to the national economy as well. Hence, key aims of the project are to:

- Create necessary space to improve GFF's services; and
- Prevent congestion at the production facility thereby promote safety and performance of its operations.

The project would result in creation of 537 m² of land by reclaiming lagoon. The project does not involve sand mining to obtain fill materials rather demolition waste and sand dredged and stockpiled from previous projects have been planned to be utilised.

2.2 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 to fulfil the legal requirements under the Environmental Protection and Preservation Act (4/93) and EIA Regulations 2012 and to ensure that the project has been carried out responsibly and in accordance with the principles of sustainable development.

The 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 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.

2.3 EIA REPORT AND EIA IMPLEMENTATION PROCESS

The process followed in preparing this report is as per the method outlined in the EIA Regulations. The process started with the proponent developing the project concept following which a draft TOR and EIA application form was submitted to EPA. Following this a scoping meeting was held and the project was discussed at the meeting. Based on rigorous assessments and discussions, TOR was further refined and approved. This was followed by further discussions with stakeholders and environmental experts. A site visit was organised to the project site to study all aspects of the project environment. The draft report was then submitted to the Proponent for comments. Finally, the report was submitted to the EPA together with the reclamation permit form for assessment. The project will start once the environmental clearance is received from EPA and the team of consultants will carry out the project monitoring and reporting as stated in this EIA report.

2.4 PROJECT SETTING

The project has been planned to be carried out at Thilafushi. It is situated at a travel distance of 10 minutes from Male' by sea.

Originally Thilafushi was a shallow reef platform called 'Thilafalhu' with a length of 4.5 km and a width of 0.85 km on the widest region. It came into existence as a result of growing solid waste management problem in the capital island, Male'. On December 5, 1991, the government declared Thilafalhu to be utilized to manage solid waste generated from the greater Male'. from Male' and waste disposal commenced on January 7, 1992. Today Thilafushi has a land area of approximately 80 ha

During its early years of waste disposal operations, "cells" were created, with sand bund enclosures around the internal perimeter of the cells. Waste received from Malé was dumped into the pit, which was covered by a layer of construction debris and then uniformly levelled with coral sand excavated from the same reef platform. Little or no waste segregation occurred as the importance was attached to speedy transfer of waste from Male' as opposed to proper management of waste. During the 1990s due to the high demand on land for industrial activities, the reef was further reclaimed to create an industrial island in the Greater Male' Region. In November 1997, it was decided that land was to be leased to entrepreneurs interested in acquiring land for industrial purposes. Soon after, an area of 0.2 km² was reclaimed using white sand as the filling material to provide terra firma for the more heavy industries. Initially there were 22 lease holders. GFF was one of the first companies to establish industrial activities at Thilafushi in the year 2000. Within the past 10 years, this number had doubled to 54 resulting in more than 1.2 million square feet (0.11 km² or 27.5 acres) of land being used currently for industrial activities, which generates an excess of MVR 14 million per annum. The current (major) industrial activities in the island are boat manufacturing, cement packing, methane gas bottling and various large scale warehousing.

GFF production facility is made up of three separate plots in Thilafushi zone 1. The total area of these plots are 6,038 m². These plots have been leased to the company by Thilafushi Corporation Limited (TCL). The harbour being reclaimed (537 m²) is in plot no.S4-033 located at 4.180991 N 73.45138 E and has a total area of 4,256 m². (See Figure 1). Figure 1 shows that GFF facility is already congested and there is not sufficient space to accommodate extra vessels for servicing.

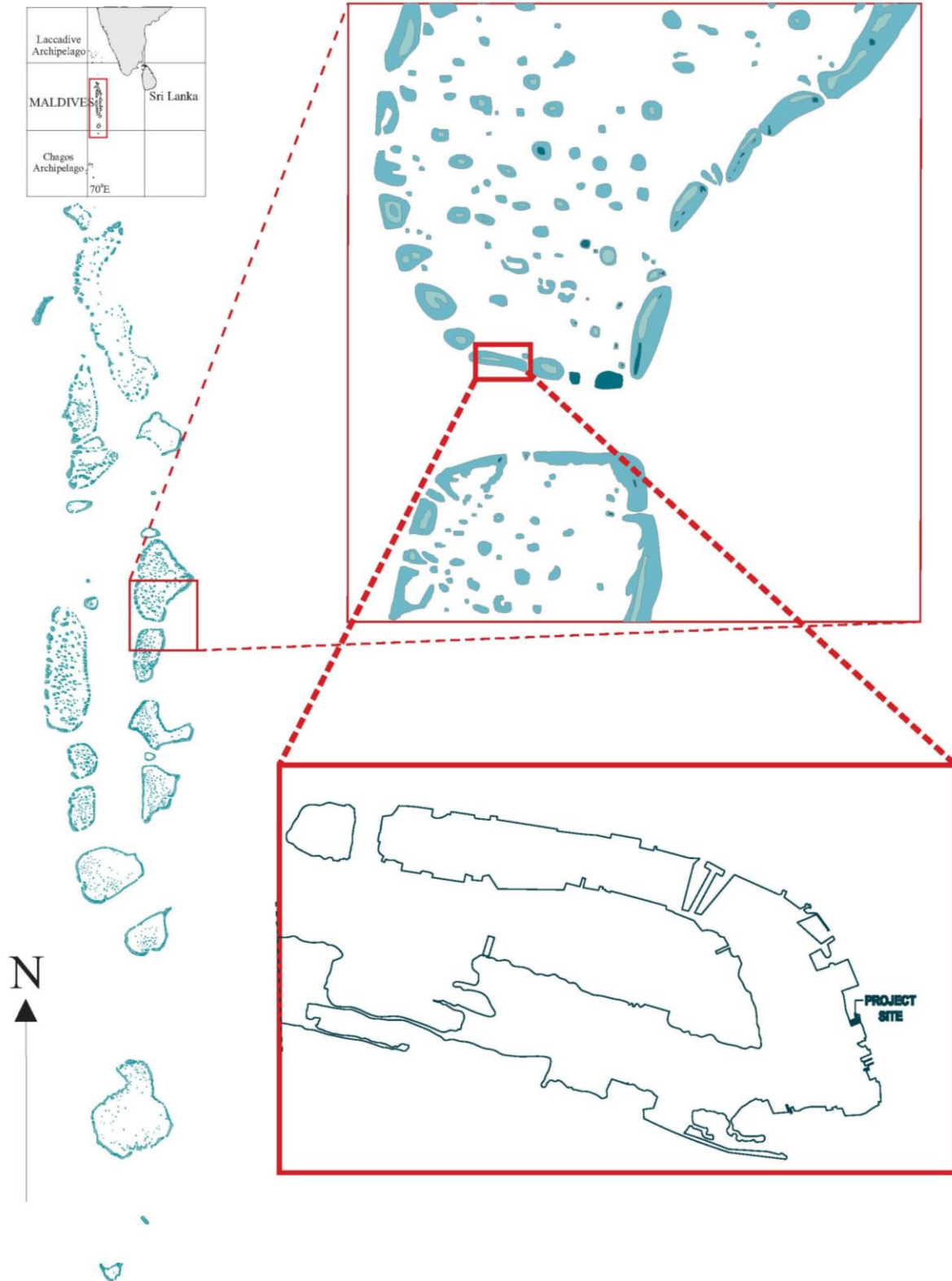


Figure 1: Project Setting (GFF facility on eastern industrial zone of Thilafushi)

2.5 PROJECT JUSTIFICATION AND RATIONALE

Guarantee Fiberglass Fabrication, is one of the first companies in the Maldives to venture into the marine boat construction sector. The company has an illustrious portfolio which has diversified from boat building to trade and manufacturing. Guarantee Fiberglass Fabrication specializes in fibre works and their vessels ranges from 2.50-23.45 m.

The company has been providing the Maldivian fishing industry with one of its most valuable inventions. The Chill Boxes used for storing Skip jack and Yellow fin tunas. The company aims at providing the Maldivian market with the highest quality products to satisfy their needs.

The marine transport sector is a crucial for the national development of the Maldives. In recent times the marine industry of Maldives has been expanding, and the potential for growth is high for this area due to the insurgence of local of tourism sector. For this reason, the company has experienced an increase in demand. This has created the need to expand its production facility and provide better services for the quickly evolving market. Expansion of companies current servicing and production facilities have become a limiting factor for the company.

When plot no.S4-033 was leased to the company a very shallow water body of approximately 537 m² was included. Guarantee Fibreglass Fabrications, dredged and constructed a breakwater in this area to use it as an access point to their facility and to dock company vessels. However, with the expansion of Thilafushi, more plots were leased to companies. This created congestion in the area. Since it was not possible to place barriers to separate and distinguish allocated boundaries within the lagoon space, people started docking their vessels on the property of Guarantee Fiberglass Fabrications for convenience. This resulted in the area unsuitable and unsafe to be used as an access point. This prompted Guarantee Fibreglass Fabrications to switch the access point towards the southern side of the plot. Construction is underway to build a slipway and a more spacious docking area at the southern side of the plot.

Switching access point to the southern side of the plot would make the existing harbour area dormant and “wasted”. It will be occupied with foreign vessels. Moreover, the harbour has been known to accumulate large amounts of waste which is aesthetically unpleasing and uses company resources to clean the rubbish that gathers at the harbour.

In order to find a solution to both the accessibility issues and lack of space at their current production facility GFF proposed that the best option is to reclaim the 537 m² of harbour area. The issue was discussed with the TCL and approval granted to proceed with the plan on condition that necessary permits such as EIA clearance and permit to reclaim land is obtained from authorities by the proponent.

The reclaimed harbour will be used to conduct finishing works of vessels. It will also be used as an access point for small vessels. The area will not be used to birth large ships or tugboats for loading and unloading activities. See 14.2 for approved site plan of the reclaimed land that is approved by the TCL.

No major negative impacts have been envisaged through this small reclamation project. The project is expected to have a significant positive impact on the regional economy and is in line with the government’s policy to encourage development of private businesses and nation’s economy building.

2.6 TERMS OF REFERENCE

This document has been developed based on the Terms of Reference (TOR) issued by the Environmental Protection Agency (EPA) on 11 February 2016. The TOR is given in Annex 1 of the report.

2.7 IMPACT ASSESSMENT AND REVIEW OF SIMILAR PROJECTS

RIAM impact assessment was used for the impact assessment. This method encompasses a holistic approach whereby 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 9 of the report.

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

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⁻¹. 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 determined average current speeds and to address particle movement on a broader scale.

3 DESCRIPTION OF THE PROJECT

This section of the report addresses task 1 of the TOR, hence describes the project setting and the project 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 9 of the report.

3.1 THE PROPONENT

The project proponent is Guarantee Fibreglass Fabrication (GFF). GFF is a wholly Maldivian owned private enterprise operating since 2000. The company specialises in fibre works, boat building and trade.

The contact details of the proponent are:

Guarantee Fibreglass Fabrication.
Filaa Building 1, 8th Floor.
Koli Umar Manik Goalhi,
Maafannu, Male', Republic of Maldives.
Tel: + (960)3334763, Fax: + (960)3326524
Email: mkt.miyavaali@dhivehinet.net.mv

3.2 PROJECT LOCATION AND SITE AREA

Thilafushi is located at 4°10'52.61"N and 73°26'58.14"E "E in central Male' atoll. The proposed reclamation area is located on the eastern coast of Thilafushi zone 1 at 4°10'52.31"N and 73°27'4.91"E. The size proposed for reclamation is 537 m².

3.3 PROJECT BOUNDARY AND IMPACT ZONE

The footprint of project area is relatively small. Figure 2 demonstrates dimensions of lagoon which will be reclaimed.

- The impacts of the proposed reclamation project are primarily concentrated to the marine environment.
- The primary impact area is determined to encompass 2,500 m² (See Figure 2).
- Sedimentation resulting from reclamation is determined to have most significant impact on environment. (Note: It is strongly recommended in the report to pile reclamation boundary before filling the harbour which will completely avoid sedimentation See section 9 and 12)
- No environmentally protected sites were found within the impact zone.

The impact area has been justified on the following basis:

1. Currents at the site were observed to propagate landward;
2. Structures that already exist in the area would prevent sediment dispersion during reclamation;
3. The scale of reclamation is very small as the area to be reclaimed is only 537 m², and the amount of material required to reclaim the area was found to be 1700 m³.

3.4 PROJECT DURATION AND SCHEDULE

The reclamation project has been contracted to Lion Star. The project involves only reclamation of the small harbour. The required number of unspecific laborers can be borrowed from Guarantee Fiberglass Fabrications if needed. The preparatory work including clearance and mobilisation is expected to take approximately one month and the reclamation is to be completed in 3 days.

Table 1: Time schedule

	Month 1																														Month 2																																
	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	1	2	3	4	5	6	7																										
Approvals & permits																																																															
Mobilization																																																															
Site set up works																																																															
Reclamation																																																															
Out survey																																																															
Demobilization																																																															

3.5 THE PROJECT

The project involves reclaiming a small 537 m² harbour that exists in plot no.S4-033 leased to GFF by TCL. The area will be reclaimed to a height of + 1.4 m from MSL. The project does not involve dredging. Main activities of the project are:

- Sheet piling and enclosing the reclamation area. (Figure x)
- Reclamation of the harbour.

Fill material for the reclamation will be:

1. Purchased from TCL or any other supplier; or
2. Dredge material obtained from the ongoing southern harbour and slipway construction project will be used.

The approved site plan for the reclaimed areas is given in section 14.2. The reclaimed area is proposed to be used as service stations and as an access point for small vessels. The area will not be used to birth large ships or to transfer vessels to the yard as the marine ramp site developed on the southern side of the plot will be used for these purposes.

3.6 EQUIPMENT AND WORK METHODOLOGY

3.6.1 Equipment

Dump truck, wheel loader and an excavator will be used for the proposed reclamation project. The reclaimed land will be levelled naturally.

3.6.2 Work Method

Conventional reclamation methods will be employed for the reclamation using standard equipment's readily available from Thilafushi. Flow chart of reclamation process is described in Figure 3.

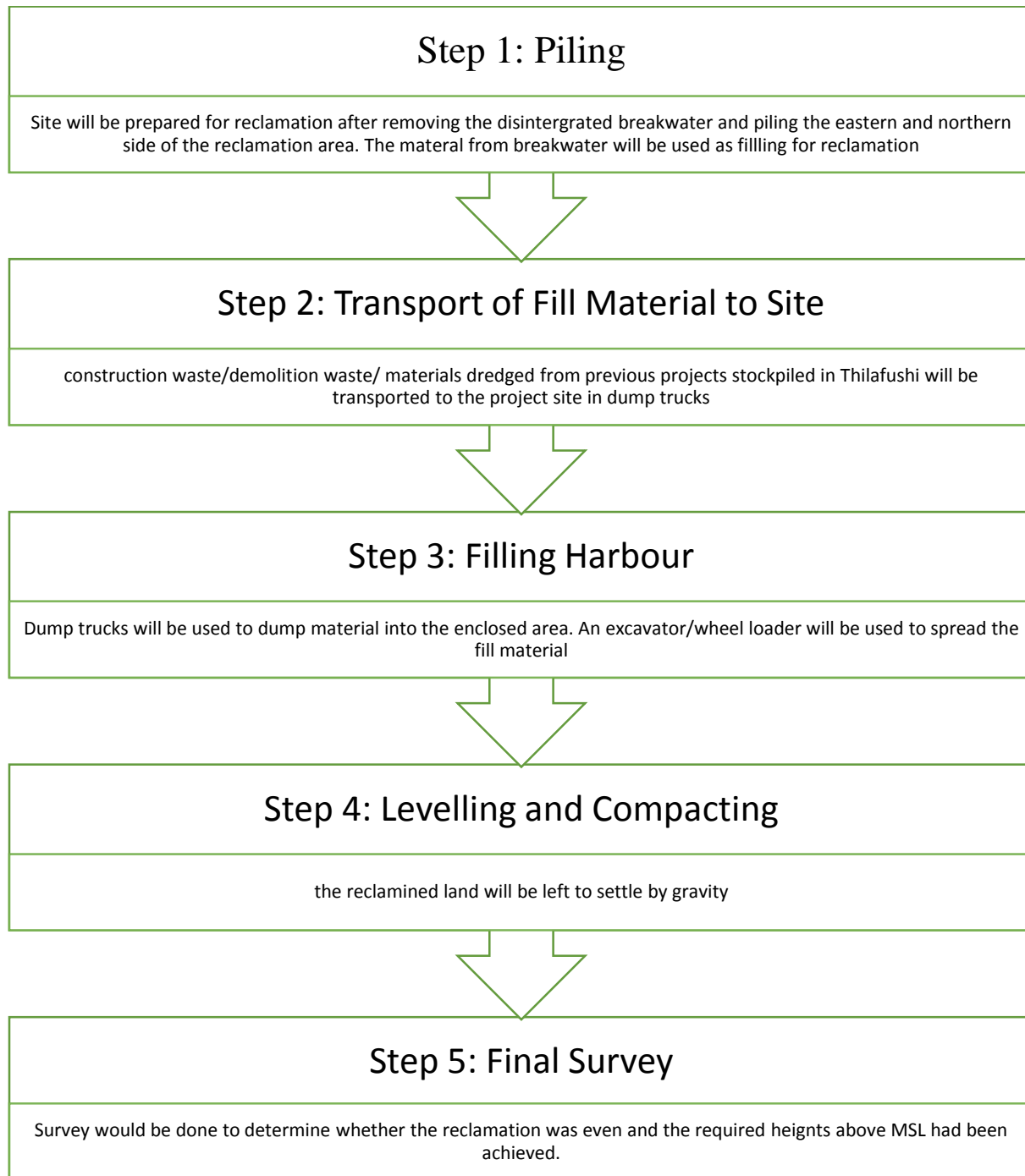


Figure 3: Work Method

Prior to infilling the lagoon space marked for reclamation, sheet piling would be required. Sheet piling had already been carried out at the seaward edge of land allocated for GFG in most part Figure 4. Approximately 35 m of linear of sheet piling will be installed enclosing the allocated entire coastal margin of the land allocated for GFG.



Figure 4: Sheet pile Plan

Piling will continue from where it had been left along the seaward edge up to the end of the planned reclamation area using sheets of interlocking edges.

The sheet piles which are vertically arranged flat sheets will act as a sediment barrier preventing sediment escape outside the project boundary during reclamation and it will also act as permanent wall retain soil preventing land loss to erosion. Horizontal anchors will be included to provide additional lateral support.

As a continuation of the existing piling works, U-piles will be used and drop-hammer method will be employed in installing the sheet piles.

Work Steps

- Sheet piling location to be scanned for existing or out - of- service utilities prior to piling works.
- Sheet piling location will be determined by proposer surveys by the contractor
- Any vehicles or machines used in the works shall have spillage containment units to capture any leakage
- Contractor will use a platform to install piling equipment's
- Contractor will use drop hammer to drive piles into the strata and pile protection to designed depth and to the top of the sheet pile wall levels required in the contract
- The contractor will liaise with the project engineer throughout the piling activity and highlight any difficulties encountered
- Work will be completed within the shortest time frame possible

3.7 PROJECT INPUTS AND OUTPUTS

The main inputs into the project are human resources, machinery, fuel, water and facilities for the workers Table 2. The major outputs would be dredged material, dredged harbour basin and entrance channel, by products, solid waste and GHG emissions which are also considered as outputs Table 3.

Table 2: Project inputs

Inputs	Source	Method of Obtaining
Project staff	Skilled and semi-skilled labour: Manager(01) Supervisor(01) Excavator operator (01) Truck operator (01) Labourer (04) Crane operator (01)	Work will be carried out by the contractor Lion Star, staff.
Machinery and Equipment	Excavator (01), Dump truck (01) Wheel Loader (01) Survey equipment. Drop Hammer (01) Crane (01) Sheet Piles	To be obtained and operated by contractor (Lion Star). Contractor will be required to bring the machines in good working conditions to avoid delays which may be caused by breakdown of machines, vehicles and equipment.
Fuel	Diesel, lubricants and Petrol (will be taken in bulk volume. (Approximately 10,000 L of fuel will be required to operate the machineries)	Purchased from Thilafushi.
Electricity (during construction period)	Thilafushi grid.	Proponent, provides the required amount of electricity from their facility.
Water	For drinking purposes during construction period. Water sourced from Thilafushi. 20l/person/day? Calculate total required	Using existing facilities at GFF facility
Communication	Existing communication networks, Dhiraagu or Ooredoo.	Contractor shall provide and facilitate the necessary communications at the project site.
Accommodation	No new accommodation will be required. Workers will be using existing staff quarters provided by the contractor	Contractor, Current accommodation arrangements of staff.
Toilets and cleaning facilities	Existing toilets at the GFG will be provided during reclamation period	GFG
Food (during construction)	Purchased from local shops and cafes in the island	Contractor

Table 3: Project outputs

Outputs	Quantities	Method of Disposal/Outcome
Reclaimed Land	537 m ²	The reclaimed area will be used as a boat servicing station.
Waste oil	Very small	Unused, fuel should be safely transported and stored in designated area and disposed of at Thlafushi dump site
Solid waste	An average of 0.45 kg/person/day according to World Bank, (2012). Approximately 35 Kg of waste will be produced during the construction phase of the project.	To be separated based on waste type, stored and transported to appropriate discard locations in Thilafushi.
Noise	Noise will be generated during operation of vehicles and piling activities. Since it is an industrial site and no sensitive population resides, noise is not expected to be a significant impact (See section 9)	Work will be conducted during daytime hours to minimise effect of noise on workers
Hazardous waste - Waste oil and grease by machinery/generator/vehicles, used batteries.	Used oils, batteries and wipe clothes are determined to be main hazardous waste. These wastes are going to be generated in very small quantities due to the small scale of the project. (See section 9 for details)	Collected, maintained in sealed containers and will be transferred to hazardous waste disposal area at Thilafushi by the contractor. GFG will monitor and keep records of this.
Wastewater	Assuming 80% of the water consumed by the workers will be eliminated as wastewater 86.4 L will be generated as wastewater	Existing wastewater management arrangements at GFG
Sedimentation	Sedimentation outside the project boundary is not expected by implementing mitigation measures. (See 6.5.1 and 9)	Managed as per the mitigation measures described in this report
Air pollution including GHG	Limited quantities of dust from machineries. Considering that approximately 10,000 L is used for the project, approximately 18,000 kg of CO ₂ -e GHG's will be produced. (DECC and Defra, 2012)	Emitted to the atmosphere (See section 9.3 for mitigation). Emission of GHG is unavoidable since the equipments and machineries use fossil fuel. However, through mitigation measures ways of minimising GHG emission will be implemented as detailed in the impact mitigation section.

3.8 PROJECT RISKS

Every project faces certain degree of risks due to, environmental, physical or financial constraints. These risks must be identified in order to prevent them and managing them. There are a few identified risks associated with the proposed project. These include:

- Harsh weather events which could pose a risk to the project progress. Bad weather could delay completion of dredging works which would interfere with harbour activities and incur unexpected costs;
- Equipment failure could prolong the completion of project;
- Unforeseen accidents such as fire incidents in vehicles, toppling of excavator and work related injuries could harm workers and also delay the project progress; and
- Financial security and delays could also interfere with the progress of the project.

Hence these project risks should be accounted for and the following mitigation measures should be considered before the project is initiated.

- Condition of equipment and machineries should be checked prior to deployment and serviced before deployment;
- Necessary spare parts, basic tools shall be 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.
- Capable and trained personnel should be hired;
- All workers must be briefed on the safety arrangements before commencing work;
- Personal protection equipments 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;
- Proper legally binding contract with clear timeframes is essential to ensure avoiding unnecessary delays which may eventually result in having to expend more resources;
- Worksite should be sealed off and necessary warning signs shall be on the site.
- The crane must be securely connected to the top of the pile until the pile is fully threaded and supported by the ground. Piles should not be allowed to free fall.
- Personnel threading the piles or handling the free end of the pile being lifted must operate from ground level. Operatives must not stand on ladders or balance on the tops of piles when piles are being pitched
- Sufficient numbers of personnel need to be available for handling the size of pile being pitched especially in windy conditions.
- One or two operatives should restrain the pile from swaying - using ropes if necessary. The crane operatives should avoid slewing or moving the jib when operatives are attempting to pitch the piles by hand. The piles should only be lowered when the correct signal is given by a qualified person.

3.8.1 Emergency plan in case of spills (diesel, grease and oil)

The contact numbers of project manager's supervisors will be available readily so that the workers are well connected. The risk of accidental oil spillage through the project is minimal. Due to the small scale of project there are not many identifiable risks apart from safety of workers. Nonetheless all-risks shall be accounted for, as accidents do happen. To avoid any serious spillage, all fueling activities will be undertaken on land. In case of an oil spill from a machinery due to damage, all work will be immediately stopped and everyone will be directed to focus their attention and effort to get the leaking stop as described in section 9. Safety of workers shall be monitored and maintained as per the mitigation measures proposed in section 9 of the report. Land and sea transport arrangements will be available in case of a serious accident

4 ADMINISTRATIVE AND REGULATORY FRAMEWORK

4.1 INTRODUCTION

The proposed project in relative terms is considered to be a minor development project. Although the project does not involve a multitude of activities a number of laws, bi-laws and regulations that fall under the mandates of various government agencies comes into play. This section highlights:

- The major stakeholders of the project
- Relevant national legislative framework applicable to the proposed project. The relevant national legislative framework provides guidance on several aspects related to planning and development in the Maldives. The legal framework pertaining to the proposed Project are also aimed at sustainable development, impact mitigation and conservation of the country's natural resources.
- The compliance of the proposed dredging project to relevant regulation, policies and laws pertaining to the Maldives.

4.2 ADMINISTRATIVE FRAMEWORK

Agencies that have a formal role with regards to the proposed dredging project include:

- Ministry of Environment and Energy; (MEE)
- Environmental Protection Agency (EPA);
- Thilafushi Corporation Limited (TCL)

4.2.1 Ministry of Environment and Energy

The Ministry of Environment and Energy (MEE) is mandated with protection of the environment.

Environmental responsibilities assigned to MEE includes

- Formulating environmental policies, coordinating, preservation and management of the environment throughout the country, and enforcing Environmental Protection and Preservation Act (EPPA) (04/93). Under Article 5(a) of EPPA.

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

4.2.2 Environmental Protection Agency (EPA)

EPA is given the broad responsibility to assess development projects that may have a significant impact to the natural environment. EPA is the key regulatory body on environment, which is a semi-autonomous body formed under the umbrella of MEE. It is mandated with implementing the EIA process in the Maldives, implementing the Environment Act and subsequent regulations on behalf of MEE, regulating water and sanitation, biodiversity conservation, waste management and coastal zone management. Also, it is responsible for developing environmental standards and guidelines in the country. EPA is also responsible for approving dredging permits which will be required for the proposed project. With regards to the current project EPA's role will be evaluating the EIA, issuing decision statement, ensuring environmental compliance and issuing dredging permit.

4.2.3 Thilafushi Corporation Limited (TCL)

Thilafushi Corporation Ltd (TCL), a state owned enterprise, incorporated in the Maldives under Company Registration Number C-52/2009. TCL is given the mandate to develop Thilafushi and its surrounding areas as an industrial zone. It is responsible for allocating plots for industrial use and managing the contracts with the landowners. It approves, development of the leased plots and acts as the main body that manages and regulates land in Thilafushi. In this regard TCL is one of the major stakeholders of the proposed project and is the acting regulatory body that approves the proposed reclamation project and land use plan for the new land. TCL in this regards has approved the proposed plan to reclaim the area and has endorsed the land use plan (see Annex 2).

4.2.4 The project proponent (GFF)

The Proponent is responsible for the implementation of the project. Follow the EIA and implement the mitigation measures during construction and operation of the project and undertake the monitoring program given in this EIA report. It is also answerable to the relevant authorities with regards to the project and managing contract with the project contractor.

4.3 POLICY FRAMEWORK

All development plans in the Maldives are pre-set to achieve certain predetermined goals which would enhance sustainable growth. This section of the report identifies and describes the major policies and plans to which the proposed project falls under.

4.3.1 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.

The proposed project is fully in line with the government's strategic economic policies and plans. It would create additional job opportunities and contribute to the growth of the local industries.

4.3.2 National Waste Management Policy (2015)

The first National Solid Waste Management Policy which was formulated in 2008 focused on the following aspects of solid waste management:

- Establishing and activating waste management governance;
- Creating waste producers' duties;
- Establishing waste management infrastructure;
- Activating waste management systems; and
- Influencing consumer choices and waste management practices.

The first National Solid Waste Management Policy framework underwent extensive review in 2015 leading to the formulation of the new National Solid Waste Management Policy framework which was launched on the 4th of November 2015.

The National Solid Waste Management Policy (2015) (NSWMP) was formulated taking cognizance of the changes in waste generation patterns resulting from the changing socio-economic conditions of the country. The main objectives of the NSWMP is to instil a uniform vision in policies, regulations, standards and plans formulated for waste management and to create and identify the responsibility 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 key 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 sustained awareness building activities at all levels to create public awareness on safe waste management practices;
- Designate the MoEE as the lead agency for the implementation of the national solid waste management policy and establish a mechanism to monitor island level waste management systems;
- Formulate solid waste management plans for each inhabited island and undertake waste management activities in accordance with such plans;
- Formulate the Waste Management Legislative framework and carry out waste management activities in accordance with the framework;

- Review medical waste management regulations and carry out waste management activities of the health sector in accordance with such regulations;
- Collect statistics on waste at island and national levels and disseminate such information;
- Establish a system to impose 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 accordance with the relevant regulations, and manage waste so transferred in the regional waste management facility;
- Conduct research on latest waste management technologies;
- Exhort preparation of waste management plans for islands designated and leased for industrial activities and conduct monitoring to ensure compliance with contents of such plans in the waste management activities; and
- Establish a “National Waste Management Trust Fund”

The proposed project is fully in line with the government’s solid waste management framework as it intends to re-sue construction and demolition waste generated from past projects which are otherwise stockpiled and kept as waste materials at Thilafushi.

4.3.3 Saafu Raajje Initiative

The “Saafu Raajje Initiative”, which is a long term plan of action for management of waste, was launched by MoEE 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 campaign, geared towards proper 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 seeks to promote safe management of waste, increase awareness of safe waste management practices and to solicit atoll and island level support for such activities.

4.4 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.

4.4.1 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. The clause 5 is directly related to the proposed project in Fiyoari and this study. As the

Government authority with a mandate for the protection and preservation of the environment, 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.

4.4.2 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.

4.4.3 Environment Impact Regulations, 2012 & other relevant regulations

4.4.4 Dredging and Reclamation Regulations

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.

4.4.5 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.

4.4.6 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 INTERNATIONAL REGULATIONS

4.5.1 MARPOL Convention

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention which covers pollution of the marine environment by ships due to operational and accidental causes. As a member party of the MARPOL convention, the convention applies to the Maldives and is expected to adhere by 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.

4.6 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 4 below summarises the compliance of the project with regard to the identified legal and policy frameworks.

Table 4: Project compliance with the relevant legal and policy frameworks

Legal Framework	Measures to Comply
Environment Act (Law No. 4/93) Environment Impact Assessment Regulation 2012	All processes followed according to EPPA, EIA has been conducted and produced as per the guidance given in the EIA Regulation 2012. The requirements under this regulation will be fulfilled when the EIA for the project is approved.
Dredging and Reclamation Regulation (2013/R-15)	The EIA has been submitted with the relevant scaled drawings of the reclamation area together with TCL approved site plans for the reclaimed 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, the project area is not located within 200 m to a marine protected site. The project site is located at a site specifically allocated for industrial activities by the government and is required for the economic development which will be significant on a national scale in line with 2013/R-15 article 8 (-). The requirement under this regulation will be fulfilled when the EIA for the project is approved.
Waste Management Regulation, (No. 2013/R-58)	In line with the waste management regulation the report proposes mitigation measures which suggests proper disposal of hazardous, organic and non-organic wastes. The monitoring report encompasses waste auditing measures, which is further designed to control chemical organic wastes which will be produced from the facility. The proponent has committed to undertake mitigation, preventive and monitoring measures recommended in the EIA report. (See 14.5 for Commitment Letter)
The Regulation on Environmental Liabilities (Regulation No. 2011/R-9)	The project is not expected to have an impact on environmentally protected areas or vulnerable species habitat. All environmental related impacts have been identified in the report with reference to their scales (See sections 8 and 9). The requirements under this regulation is in line with the regulation based on the current scope of proposed project.
Policy Framework	
Strategic Economic Plan	The proposed project aims at expansion of a skilled service sector, which will facilitate economic growth. This has been elaborated in section 2 of the report.
National Waste Management Policy (2015)	Submission of the EIA report in which the proposed mitigation measures complies with the policy described in section 4.3.2. Section 11 of the report proposes waste auditing to be included in the monitoring plan of the project.
Saafu Raajje Initiative	In line with the initiative the EIA report proposes waste management and awareness among workers to which the proponent has agreed to comply. Mitigation measures in line with the initiative have been proposed in section 9.3 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 14.5.
MARPOL Convention	In line with the convention, the EIA report proposes waste mitigation measures which applies to the numerous vessels that are expected to birth at GFF facility.
Permits and Application	
Development Approval from TCL	TCL has approved the site plan proposed by the proponent. This is attached in 14.2 Annex 2. As the main regulatory body of all developments in Thilafushi TCL requires an approved EIA for the approval of reclamation. The approval of EIA report will fulfil this requirement.
Reclamation Permit from EPA	The reclamation permit from EPA will mandatory hence, under the amendment to the EIA regulation 2014, the application requesting from reclamation will be submitted to EPA together with the EIA report.

In summary, the proposed project if followed as guided in the EIA report, would be in line 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 formulated (See section 11). 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 acceptable levels of the laws and regulation.

5 METHODOLOGIES

5.1 INTRODUCTION

This section provides a brief description of methods adopted in studying the existing environment of the project site. In line with task 2 of TOR this section describes the methods used in assessing and analysing baseline environmental conditions at the project.

Data on the existing environment was collected during the field visit on 5th December 2015 to K. Thilafushi. The survey lasted one day and was conducted in fine weather.

5.2 COAST AND SHORELINE

Terrestrial surveys of the site were carried out using a Sokkia total station (CX105) and automatic target recognizers. The total station is a device that cooperates the functions of an EDM (electronic distance measuring device) and an electronic theodolite. The EDM function of the instrument has a range of 2.8km – 4.2km, and the accuracy of measurements is 5mm to 10mm/km. Angular measurements were made using the electronic theodolite functions of the total station.

5.3 MARINE SURVEY

Marine survey in the reclamation area was conducted by taking photographs and visual observation by swimming in the area. Line transects or quadrat transects were not taken because:

- The area had been significantly modified as it had been completely industrialised.
- There was no visible benthic cover, bottom substrate was covered with rubble.

Fish surveying was done by utilising the timed swim method. Photographs and videos at the project site and reef fore outside taken for 15 minutes. The photographs and videos were later analysed to identify the type of fish species using two sources:

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

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

Table 5: Fish count range

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

5.4 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.

5.5 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. Rainfall was analysed after compiling rainfall data obtained for the past six years, referenced from Maldivian Yearly Statistic Books. The compiled data was used to calculate the average six-year monthly rainfall. Variance of these averages were 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 Thilafushi. The same method was used to determine the mean high temperature at Thilafushi.

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 oceanographic conditions expected at the project site.

5.6 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 Total Suspended Solids (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.

5.7 BATHYMETRIC SURVEY

The bathymetric survey was conducted using a hand held depth meter and GPS. Depth measurement and GPS location was taken at the intersections of an equidistance grid that had a grid width of 4 m. 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. All horizontal measurement had an uncertainty of 0.005 m.

5.8 GEOGRAPHIC LOCATION OF SAMPLING SITES

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

5.9 SOCIAL CONDITION

Social conditions at the facility was assessed based on interviews conducted with GFF.

5.10 ISLAND RISKS AND VULNERABILITY

The risks and vulnerability of Thilafushi 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.

6 EXISTING ENVIRONMENT

6.1 INTRODUCTION

All parameters in task 2 of TOR was surveyed to determine the existing environmental condition at project site. 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.

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 5)
- 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 6)
- Yearly temperature variance for the past six years was extremely consistent with a standard deviation of 0.1 °C.

Table 6: 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

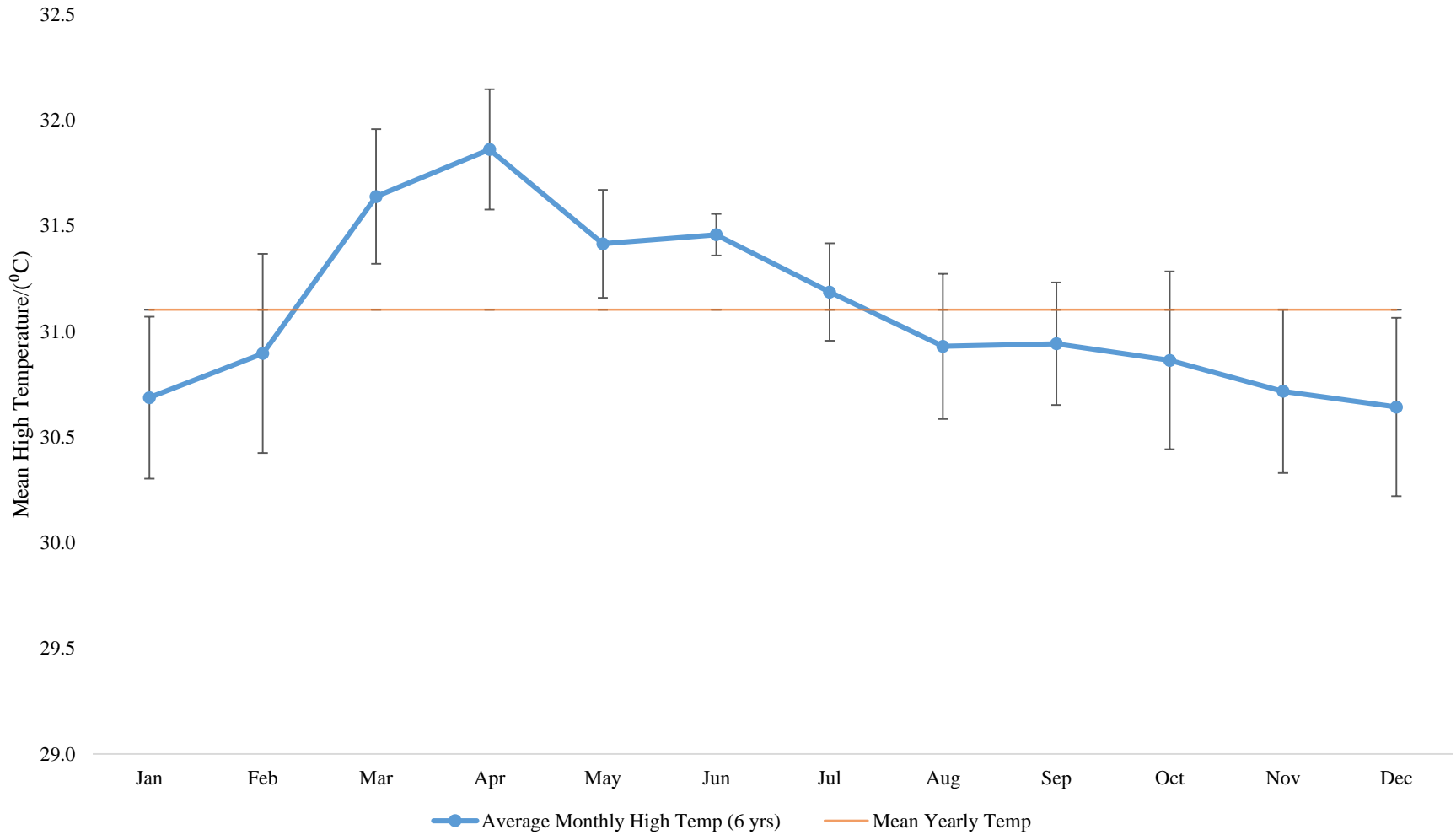


Figure 5: Mean monthly temperature (2009-2014) compared with average yearly temperature (2009-2014)

6.2.2 Rainfall

Rainfall was analysed after compiling rainfall data obtained for K. Hullhule' 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 K. Thilafushi.

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 7).
- 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 6).
- 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 7 below shows summary of rainfall data analysis for the past six years.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Average	Year
	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	2014
	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	2013
	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	2012
	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	2011
	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	2010
	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	2009
Monthly Average Over 6 yr Period	63.0	38.4	56.2	95.7	276.3	135.6	177.7	226.0	193.2	249.0	196.7	224.2	1856.9	161.0	
Standard Deviation	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	

Table 7: Mean Rainfall analysis of K.Hulhule for the past six years. Source: (Planning.gov.mv, 2016)

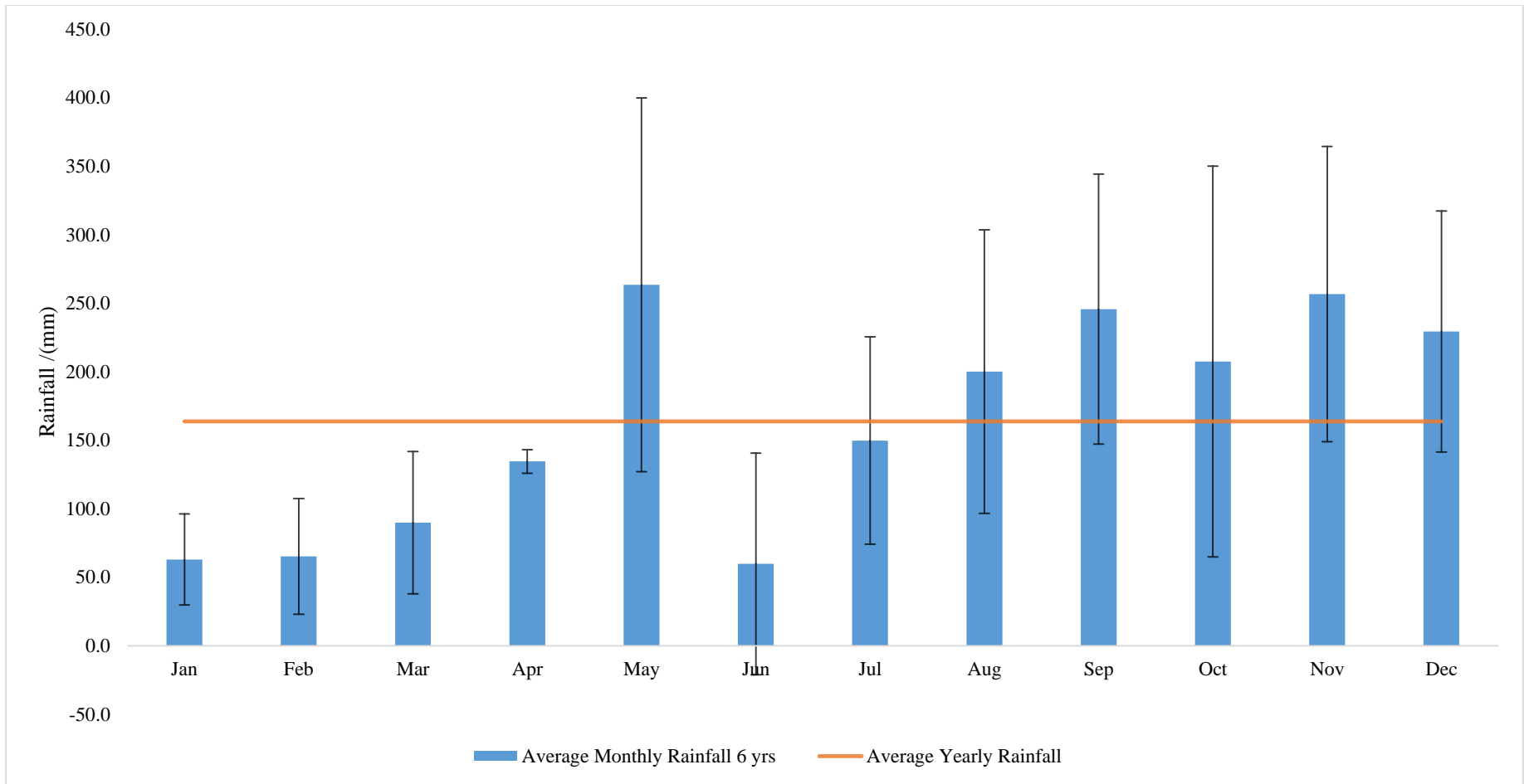


Figure 6: Annual monthly rainfall (2009-2014) compared with average yearly rainfall (2009-2014)

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 Thilafushi.

It was found through historical wind velocity analysis that:

- Westerly winds were dominant throughout the year (W – 50% and WSW – 16%). See Table 8 and Figure 8.
- 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^{-1} (9 miles hr^{-1}).
- Lowest wind speeds were recorded during March (7 miles hr^{-1}), April (6.7 miles hr^{-1}) and November (6.7 miles/hr)
- The highest and most variable wind speeds were logged in February, where average wind speeds were 5 ms^{-1} (12 miles hr^{-1}) with a variance of 3 ms^{-1} (6 miles hr^{-1}).

Table 8: Mean wind analysis of K.Hulhule for the past three years. Source: (Planning.gov.mv, 2016)

Units miles ^{hr} ⁻¹	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		

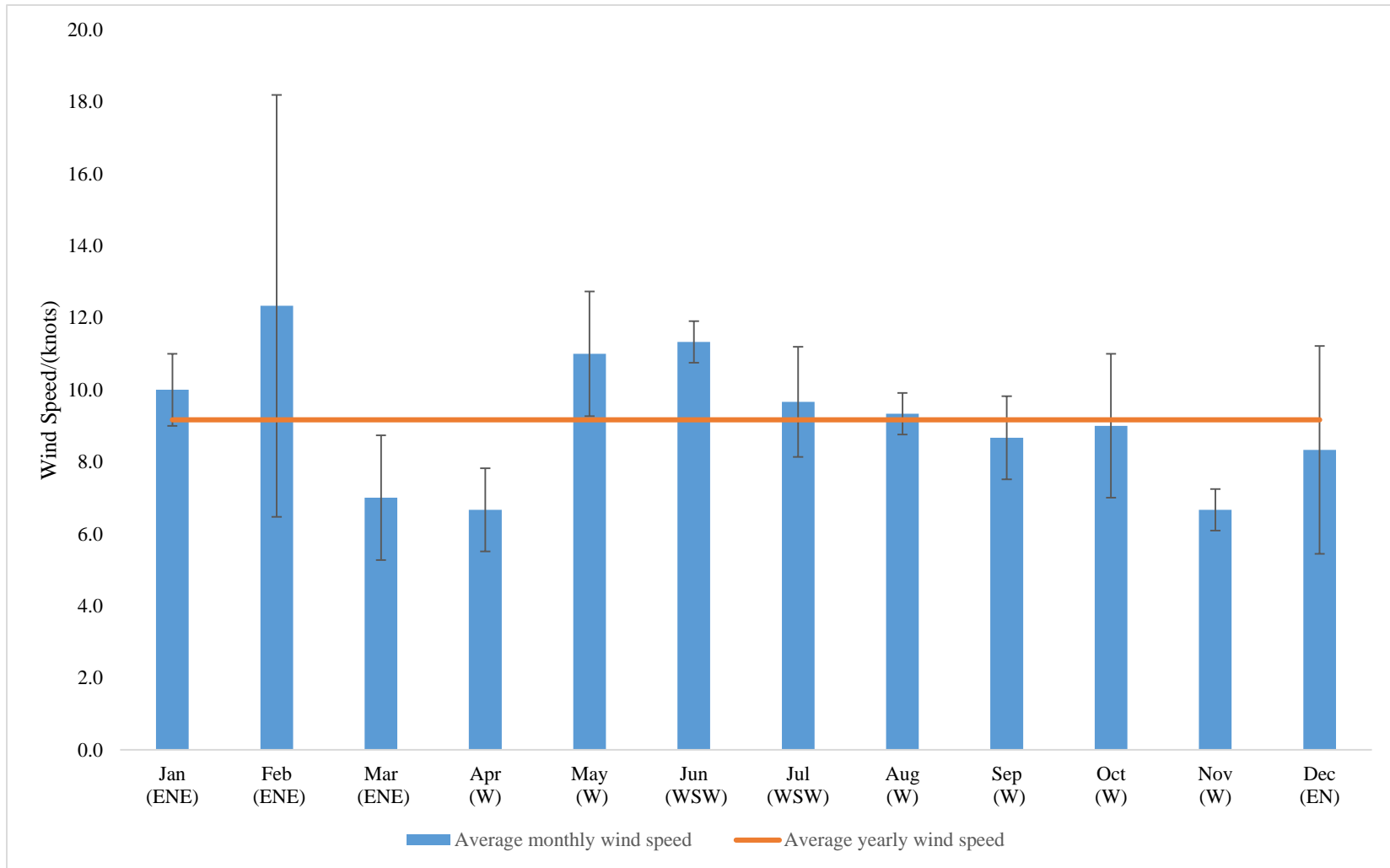


Figure 7: Annual monthly wind speed (2012-2014) compared with average yearly wind speed (2012-2014)

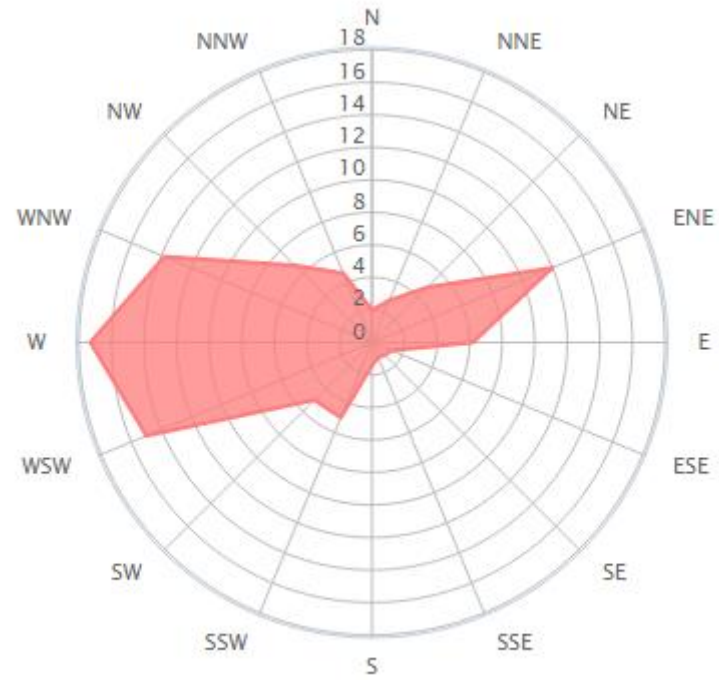


Figure 8: Mean annual wind direction at K.Hulhule' (windfinder, 2015)

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

6.3 GEOLOGICAL

6.3.1 Land form and Soil

Observations of the bottom sediments of the proposed reclamation area showed it was composed of very fine sand, mud and silt – that is very characteristic of a disturbed environment. The site has been previously dredged to deepen the area for creating harbour space. No living corals were found.

Soil properties within the project area adjoining the proposed reclamation site suggested that;

- The capacity of forming new soil through bioturbation was absent due to lack of a thriving vegetation and an organic layer. Soil was highly porous with no natural means to hold its structure together, hence extremely vulnerable to erosion due to rainfall runoff.

The inland was protected by quay walls hence chances of sediment runoff from surface was low. Soiled properties were consistent with those of reclaimed land in the Maldives using dredged fill material from shallow lagoons and reefs.

6.4 PHYSICAL

6.4.1 Coast and Shoreline

Since the area had been heavily modified for industrial use there were no natural beaches, shorelines or vegetation line. The eastern coast of Thilafushi zone 1 was modified with quay walls and marine ramps. A break water had been installed in the project site which was 27 m long. The structure was partially disintegrated, however it was effective at blocking waves and trapping waste at the harbour area. Presence of breakwater would serve as a bund during the reclamation, trapping sediments within the harbour area. Figure 9 below shows a photo profile of the project area which shows significant coastal features.

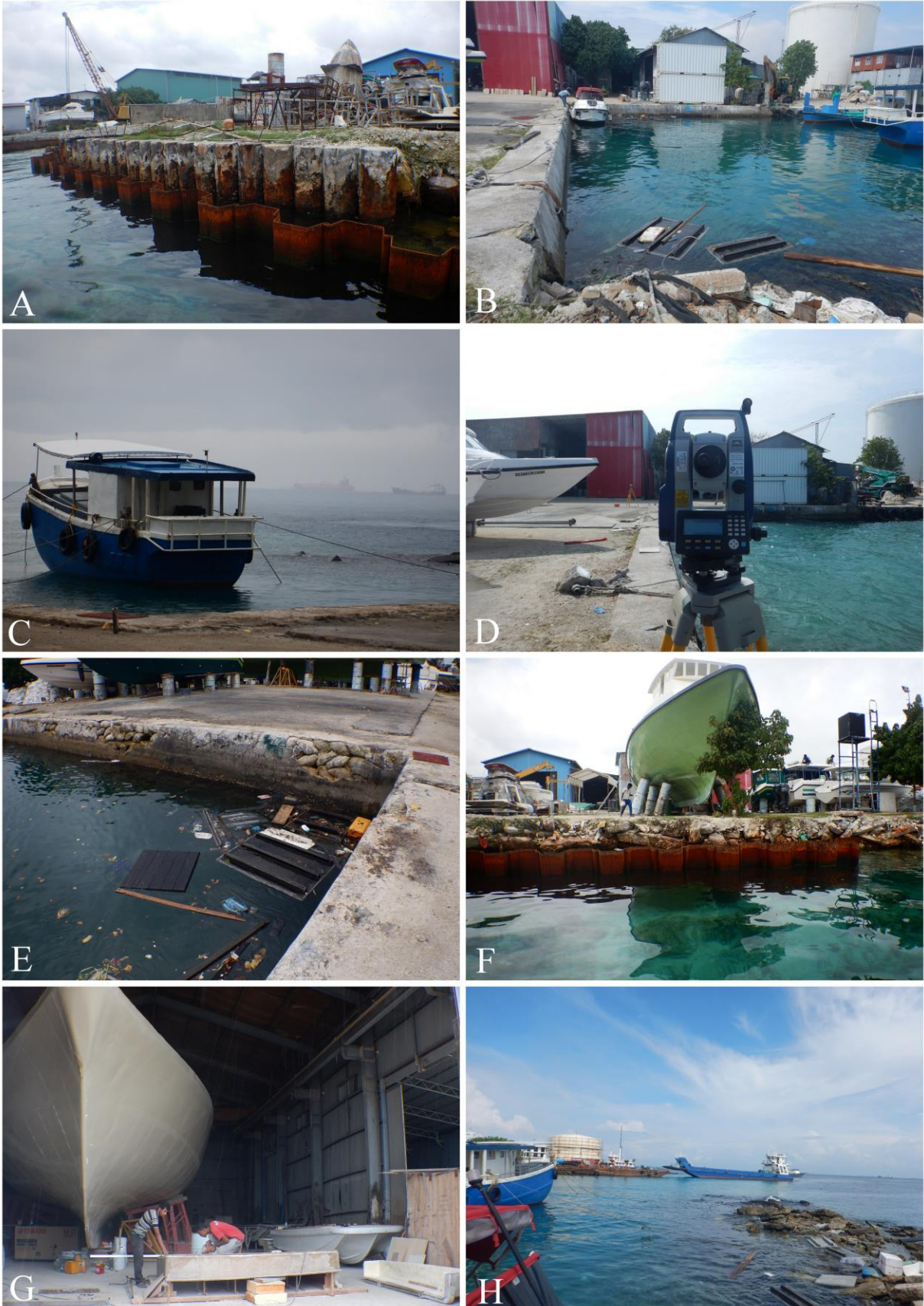


Figure 9: A-New access point construction eastern side. B- Harbour to be reclaimed. C-Foreign vessel berthed at harbour. D- Harbour area. E- Waste accumulated at harbour. F/G-Boat servicing at facility. H- Break water debris at harbour.

Historical satellite images (See Figure 10) taken in 2005 and 2015 showed that:

- Significant coastal changes have been brought to the coast of Thilafushi. Mainly through the reclamation of land east and west of Thilafushi.
- No noticeable changes have been brought to the project area within the past ten years.
- No natural beaches were observed at the project site. Eastern coast of Thilafushi had been heavily modified since 2005, with installation of quay walls and marine ramps. The eastern coast has been completely reinforced with artificial structures.

6.5 HYDROGRAPHICAL

6.5.1 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.

Four current measurements revealed that longshore currents propagated easterly with an average velocity of 0.06 ms^{-1} with a standard deviation of 0.06 ms^{-1} . Figure 12 shows where the current trials were taken and how they propagated.

Table 9 shows the current velocity and uncertainty in current measurements. Velocity distance graphs obtained for the current measurements are illustrated in Figure 11

Table 9: Current data table

Measurement	GPS Coordinates	Current Speed / (ms^{-1})	Standard Deviation/(ms^{-1})
1	N4° 10.876' E73° 27.092'	0.06	0.09
2	N4° 10.877' E73° 27.096'	0.26	0.22
Average		0.16 ms^{-1}	

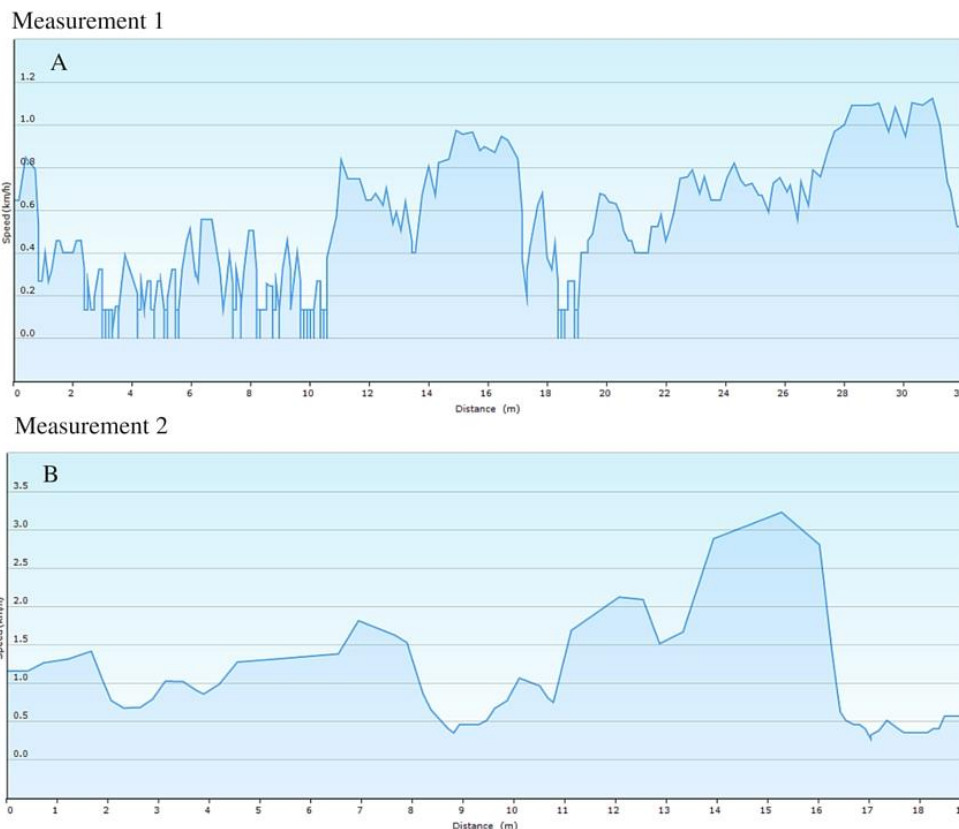


Figure 11: Graphs of speed and distance

From current measurement data:

- It was observed that the currents propagated towards the northwest.
- The average current velocity was low, where it was determined to be 0.16 ms^{-1} .
- Velocity against distance graphs revealed that during the duration of data log time the tracker covered a fairly moderate distance of 32 m for measurement 1 and 19 m for measurement 2.

In order to determine whether the current velocity would influence sediment transportation, current measurement were compared with the Hjulström curve to predict fate of sediment particles based on particle diameter and critical shear stress (See Figure 13).

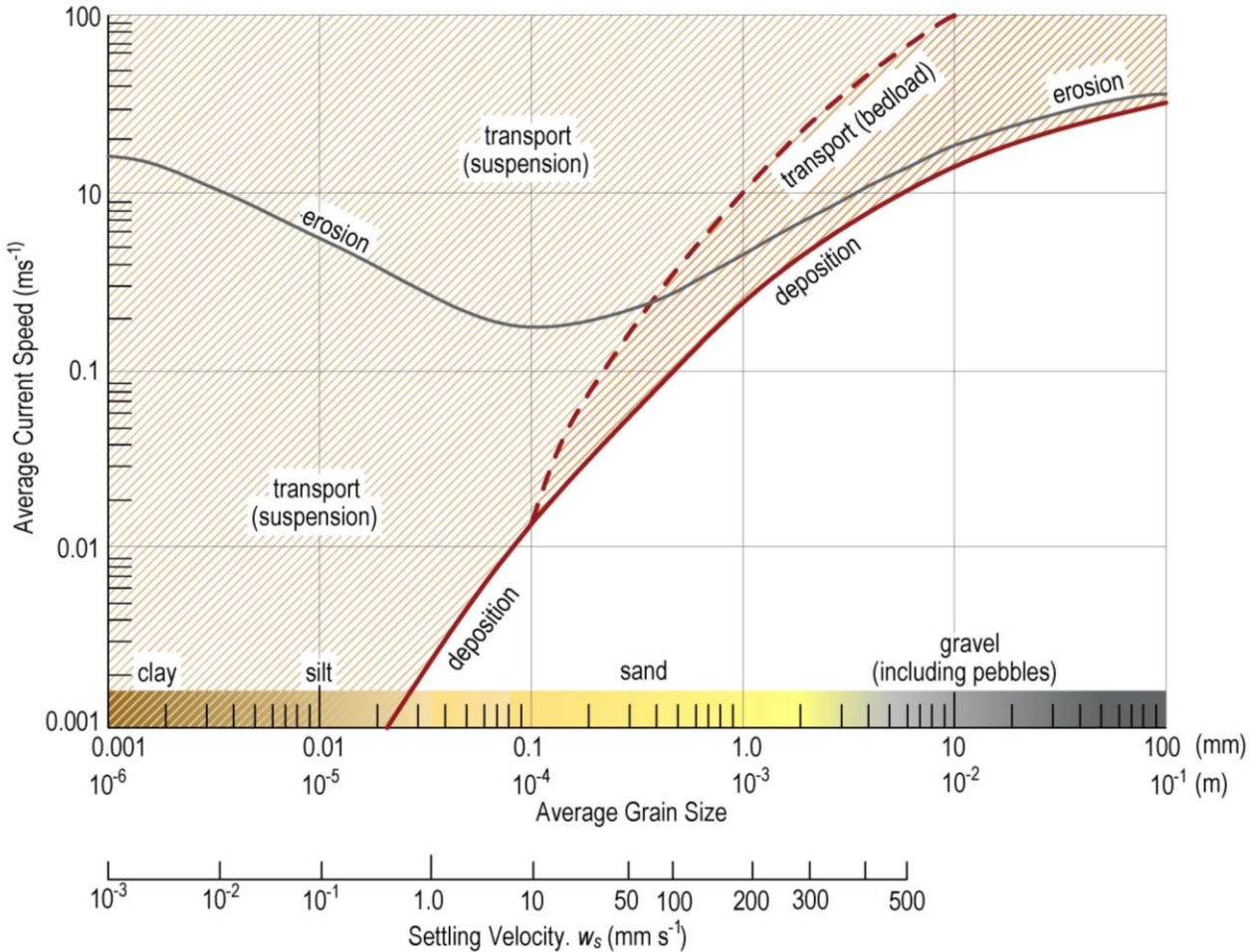


Figure 13: Hjulstrom curve (source: Goud and Aubry, 1985)

A range of sand types were observed at the area. The project area consisted of sand ranging from fine to fine gravel (average particle diameter between 0.5-4 mm).

Extrapolation of both current speed and average grain size suggested that sediments 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 ms^{-1} this is higher than the average current velocity of 0.16 ms^{-1} observed at project site. The current speeds measured at project site would however, carry and actively transport very fine silt and clay particles. Shear stress forces for silt and clay particles are overcome at 0.01 ms^{-1} hence the observed current speeds would transport these fine particles as TSS.

Hence, the method applied to predict the fate of sediment particles suggested that sediments with grain sizes less than 0.06 mm were likely:

- To be transported in a net southwestern direction due to addition of fill material and particles whose diameters are greater than 0.06 mm will 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. Hence particles will deposit after it has moved during its initial fall stage.
- 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 harbour basin.

6.5.2 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).

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

- Westerly monsoon would generate the strongest waves. Most incident waves would be wind generated.
- These wind waves would propagate from W, SW, and SSW direction mostly. Hence the reclaimed area would be shielded from wind generated waves for much of the year.
- It is highly unlikely to encounter waves exceeding 1 m frequently.

6.5.3 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 measured at the tide station in Hulhule was used to analyse the tide. The hourly tide data from the University of Hawaii sea level archive for year 2010 is used in this analysis to cover the spring and neap tides. An approximate tidal range of 1.42 m was obtained for Thilafushi.

6.6 PHYSIOCHEMICAL

6.6.1 Seawater Quality

In general, the seawater quality of the project site was satisfactory. The water was slightly alkaline with an average pH of 8.20. The average salinity and conductivity were 34.4 ppt 50.6 mScm⁻¹, characteristic of normal sea water. No sudden changes in conductivity was observed between sample sites that suggest pollution. The average Dissolved Oxygen level was 14.40 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 10).

Total dissolved solids (TDS) combine the sum of all ion particles that are smaller than 2 microns (0.0002 cm). This includes all of the disassociated electrolytes that make up salinity concentrations, as well as other dissolved organic matter. The TDS readings were normal with an average of 30.5 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.

Turbidity at project site was less than the LOQ of the instrument. Similarly TSS was also found to be below the LOQ of instrument used (See 14.3 for lab results). Since TSS was below limit of quantification turbidity at the project location was used as the baseline.

Water samples measured at the reclamation site was comparable to the readings observed at the selected control site.

For the purpose of the monitoring water quality the average values obtained shall be used as baseline of the project site (see Table 10) and monitoring shall be carried out at sites shown in Figure 14. The baseline turbidity which is the most important parameter to be monitored to determine and control the extent of sedimentation was found to be 0 NTU. The upper Threshold level of turbidity is 29 NTU, outside the project boundary at which work should be ceased temporarily (Florida Environmental Protection Agency, 2016).

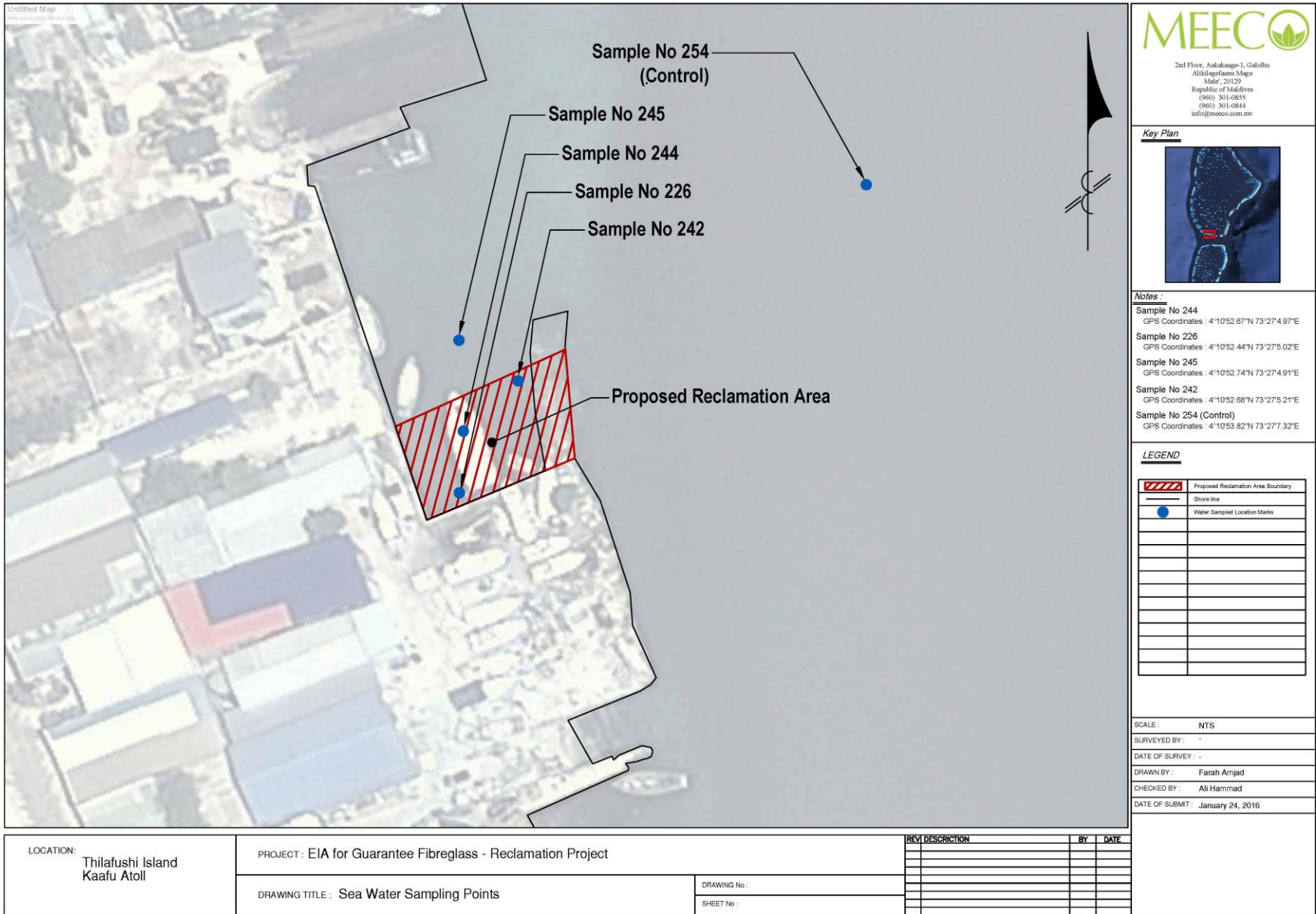


Figure 14: Water sample locations

Table 10: Water sample data

Name	Location	Salinity/(ppt)	pH	Turbidity / (NTU)	DO/(mgL-1)	Conductivity (mScm-1)	Temp/(°C)	Specific gravity	TDS/(g ^L ⁻¹)	TSS/(mg ^L ⁻¹)
244	4°10'52.67"N 73°27'4.97"E	34.2	8.31	0	15.80	50.9	29.22	21.3	30.5	
226	4°10'52.44"N 73°27'5.02"E	34.4	8.13	0	14.51	51.0	29.33	21.5	30.6	
245	4°10'52.74"N 73°27'4.91"E	34.6	8.25	0	13.71	50.9	29.36	21.7	30.6	
242	4°10'52.68"N 73°27'5.21"E	34.5	8.17	0	13.63	49.9	29.41	21.6	30.4	< LOQ
254 (control)	4°10'53.82"N 73°27'7.32"E	34.3	8.31	0	13.46	50.6	29.17	21.4	30.5	< LOQ
Average		34.4	8.20	0	14.40	50.6	29.33	21.5	30.5	

6.7 MARINE ENVIRONMENT

6.7.1 Bathymetry

Proposed Reclamation Area

Total proposed reclamation area by the proponent was 537 m², and the amount of fill material required to reclaim the area to a height of +1.4 m from MSL was 1,700 m³.

Bathymetry Analysis

Bathymetry of the proposed area showed that:

- The average depth of harbour basin area was between 1 – 3 m.
- The shallowest areas were observed at the eastern and southern edges of the project area where depths were between – 1 to 2.5 m MSL.
- The deepest area was in the middle of the harbour, where the depth was -3 m MSL.

The depth profiles of the proposed harbour area is attached in Annex 4 - Bathymetry Project Area (See 14.4). The approved site plan after reclamation of the harbour is attached in Annex 2 (See 14.2). The reclaimed area will be used to do the finishing works of vessels and as an access point for small vessels.

6.7.2 Benthic Cover

The benthic cover at the project area and its surrounding areas were dominated by rubble and sand bottom. This observation was constant throughout the eastern coast of Thilafushi. No live corals were observed at the project area and its surrounding areas. This was mainly because:

- The area had been heavily modified for industrial purposes.
- The natural marine environment of Thilafushi has been lost due to reclamation and installation man-made structures.

Figure 15 below shows locations of photo profiles. Figure 16 and Figure 17 shows benthic cover dominated by rubble and sand in the reclamation area and at the reef slope adjacent to the reclamation area.

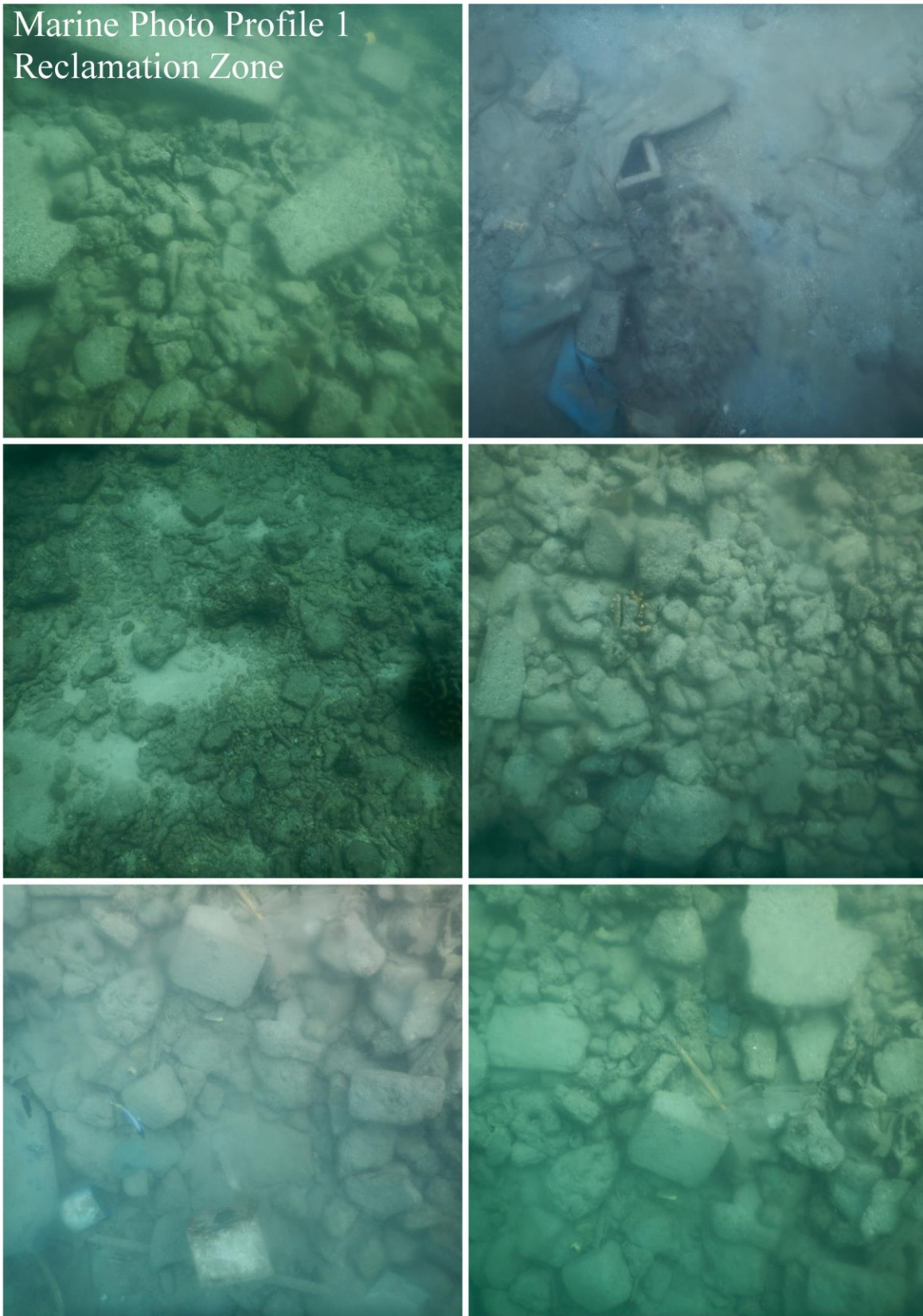


Figure 16: Benthic cover at harbour which is to be reclaimed

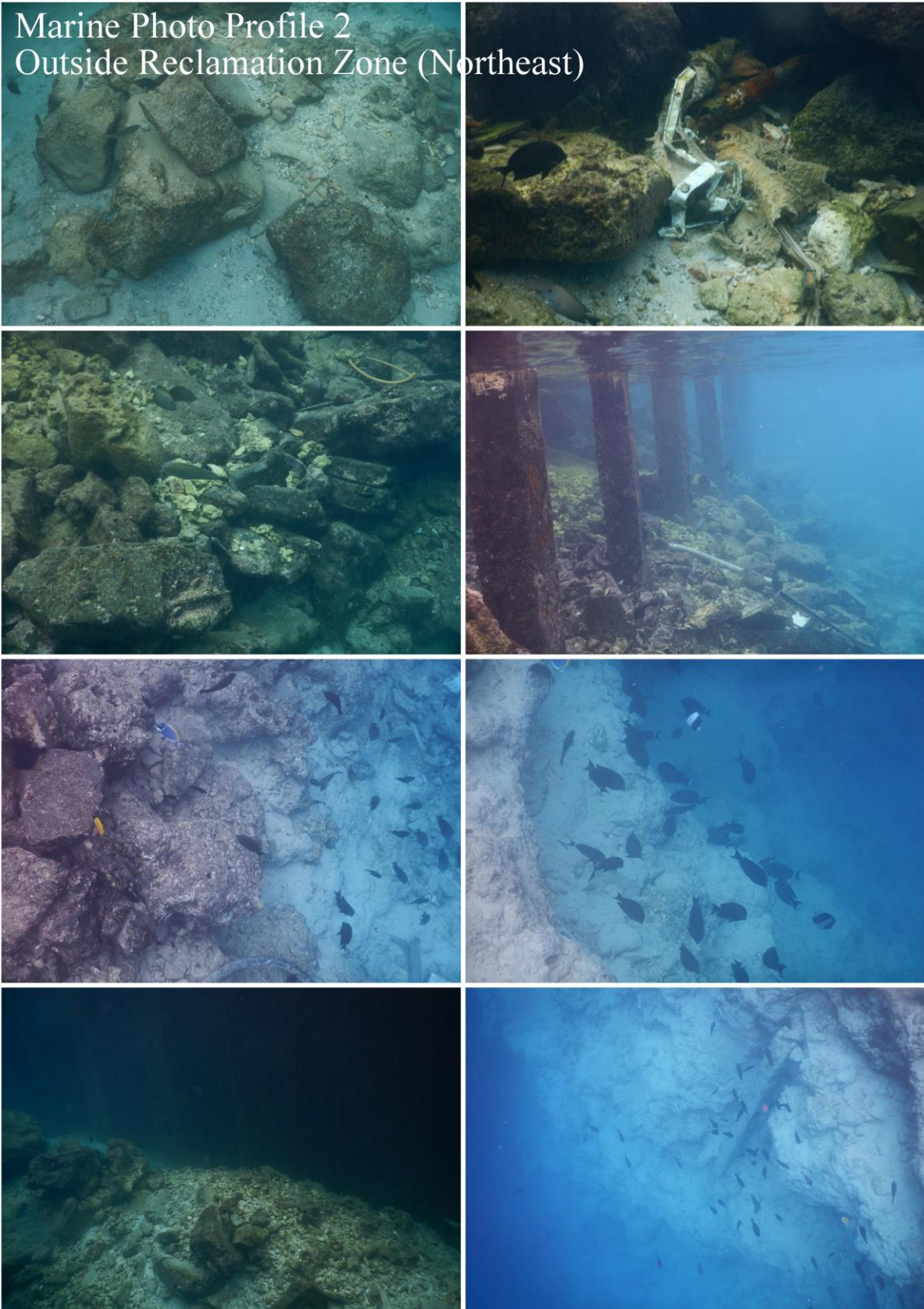


Figure 17: Benthic cover of reef slope adjacent to harbour.

6.7.3 Fish Count

During the survey, 10 families of fish were identified at the project site. These were classified into their respective families.

Table 11 summaries the scientific and common names of all fish species that were identified at the project area.

Table 11: Common and scientific names of fish species identified

Common name	Scientific Name	Relative Abundance	General description of the family
Acanthuridae			
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>	Common	
Chaetodontidae			
Black pyramid butterfly fish	<i>Hemitaurichthys zoster</i>	Rare	Butterfly fishes – Fairly common across Maldives. Diet include filamentous algae, small invertebrates, plankton, and coral.
Scaridae			
Two-colour Parrotfish	<i>Cetoscarus bicolour</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.
Pomacentridae			
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.

From the fish count analysis it was concluded that:

- The most abundant fish at the site was the Eye-stripe surgeonfish;
- Acanthuridae species were common compared to other families;
- All fish species observed at the site were common in the Maldivian reefs; and
- Endangered or protected marine life was not observed at the site.

However 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; and
- 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.

6.8 HAZARDS AND VULNERABILITY

The DIRAM Project by UNDP (2009), modelled the islands and atolls risk to potential hazards. This was done to quantify the risk probability Maldives faced based on geographic location. The disaster risk scenario for Maldives can be described as moderate in general. Despite this, Maldives is among the most severely affected countries hit by the Asian tsunami on December 2004. The report identified the existing vulnerabilities and identified mitigation measures with costing. The report had identified the social groups of children, women and low income households as the most vulnerable.

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

- Wind storms;
- Swell waves and wind waves;
- Flooding due to heavy rainfall/storms;
- Gravity waves (*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 18.

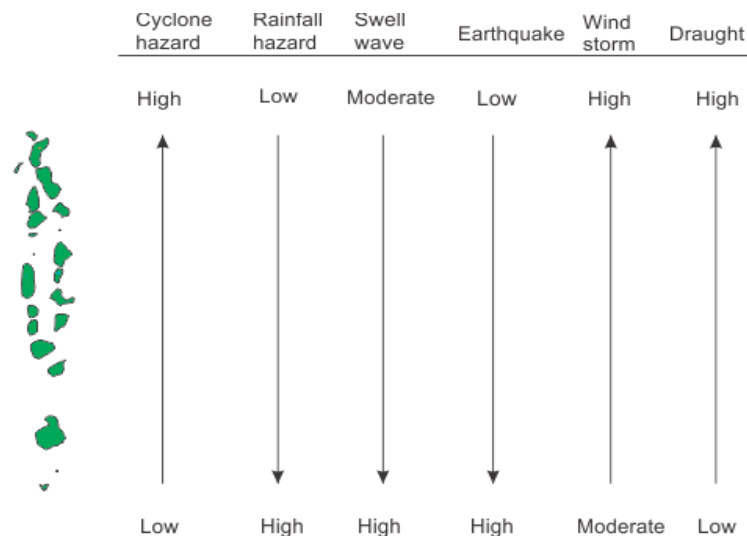


Figure 18: Exposure to hazards based on geographic location of atolls (source: adapted from DIRAM,(2009))

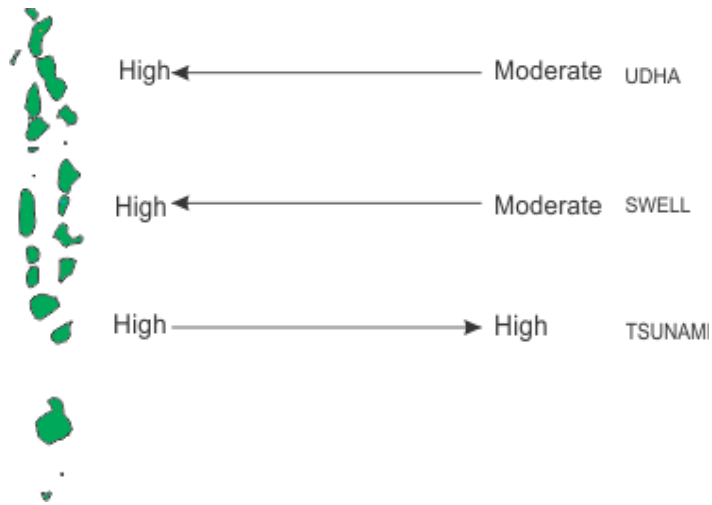


Figure 19: Major natural hazards distribution pattern in the Maldives. (A) Latitudinal variations of major natural hazards. (B) Longitudinal variations of major natural hazards across the Maldives (Adapted from UNDP, 2009)

The damage potential based on frequency of natural hazard to the Maldives is summarized in Table 12.

Table 12: 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

6.8.1 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. This level of MMI can cause moderate-high damage.

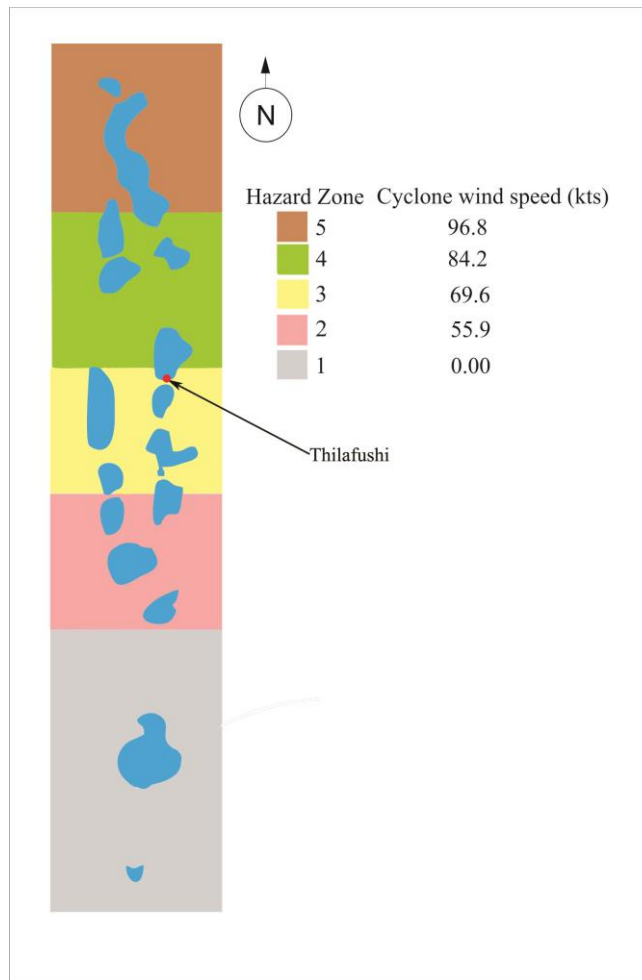


Figure 20: Cyclone risk assessment. Reference: RMSI, 2005

6.8.2 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. The risk of flooding is not considered high for the project site mainly because, the reclamation site is located on the eastern side of Thilafushi protected from southwest monsoonal swells.

7 SOCIOECONOMIC ENVIRONMENT

7.1 BACKGROUND

Thilafushi Island is mostly used as a final waste disposal site and it is the biggest waste disposal site in the Maldives. Apart of waste disposal significant land has been created to promote industrial production and economic development. As a result, gas, cement production, boat building, carpentry, brick building is among many other industries currently operational at Thilafushi. In addition, a lot of workshops, warehouses, godowns are also situated at Thilafushi.

The mission of TCL is to transform the existing business environment of the Maldives industrial sector by delivering a reliable platform for medium and large businesses to operate and to grow, helping to create the means to move towards a more robust economy.

Thilafushi Corporation's vision is to become the key facilitator for medium to large enterprises, both local and foreign, active in various industries of the Maldives. In this regard, development of GFF facility through the proposed reclamation will contribute to achieving the vision and mission of the TCL as a facilitator.

Given the limited space in Male', the capital of Maldives, the government recently announced the plan to relocate the country's main port to Thilafushi. The project has components which include, reclamation of about 70 ha of land to adequately provide the space needed for the development of international port facilities, a central distribution hub with superior warehousing and large production facilities. In addition to this strategic investment project, the government also has the plans to establish a cemetery for the greater Male' region, relocate medium wave radio antennae system and develop waste to energy incinerator facility at Thilafushi.

7.1.1 Accessibility and transport

Thilafushi is located at a distance of approximately 7 km west of Male'. Ferry transport is the cheapest and most prevalent form of transportation to the island from the capital. The island hosts a number of small to medium passenger carrying speed boats. The island hosts a number of access channel and harbours in some cases specific to the enterprise hence, accessibility and transport to Thilafushi is convenient.

8 STAKEHOLDER CONSULTATIONS

8.1 INTRODUCTION

The key stakeholders of the project are the proponent – Guarantee Fibreglass Fabrications, regulator Environmental Protection Agency and Thilafushi Corporation Limited. The stakeholders that participated in the Scoping Meeting held at EPA, discussed the various aspects and issues relating to the project. In addition to the scoping meeting, separate meetings were held with the proponent to discuss various aspects of the project and the Hawks Pvt Ltd which is the owner of the adjacent commercial venture to GFG. This section addresses Task 8 of the TOR.

8.2 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 accessibility and navigation issues. All stakeholder consultations were pre-arranged and conducted in person. Attendance sheets of meetings are attached in section 14.6 and 14.7.

8.3 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)
- Thilafushi Corporation Limited (TCL)
- Guarantee Fibreglass Fabrications (GFF)

Highlights of the Meeting:

- A brief overview and summary of the project was given by the consultant.
- TCL acknowledges the need for reclamation.
- EPA informed that a dredging/reclamation application must be submitted.
- TCL informed that approval for the proposed reclamation project will be issued through an internal review process after reviewing the business plan, technical scope of project, site plans and based on the approval of EPA once a DS for the EIA report has been released.
- Consultant/EPA highlighted that as a procedure EIA DS will be issued only after approved reclamation area site plans by the relevant regulatory bodies have been submitted to EPA. In this regard to get the reclamation/dredging permit and DS from EPA, approved site plans from TCL will be required, and included in the EIA report and reclamation/dredging application.
- TCL informed that they have received the proposed reclamation site plan drawings and that they will share the approved drawings as soon as possible so that it can be included in the EIA report and dredging/reclamation application.
- TCL informed that they would like to know how the reclaimed area will be used as an access point and include it in the EIA report. Mainly because, very recently, part of reclaimed land close to the project area toppled and slid into the ocean as unbearable loads were placed on sheet piles and the jetty.

- Proponent guaranteed that the reclaimed area will only be used by small boats and informed that no large ships or tugboats will berth at the reclaimed area. Proponent also stated that they will not be using the reclaimed area for loading or unloading.
- EPA informed that The Hawkes shall be consulted during the EIA process.
- TCL advised to include the result of consultation with occupants of plot right next to Guarantee fiberglass fabrications.

8.4 MEETING WITH THE PROPONENT

The meeting was held on 6th December 2015 at Fila Building 1, 8th Floor. The meeting was attended by the following participants:

- Ahmed Saleem (MEECO)
- Hussain Nashiz (MEECO)
- Ali Hammadh (MEECO)
- Ahmed Luthfy (CEO GFF)

Highlights of the meeting

- The proponent highlighted that the company was among the first to venture in to the marine construction market in the Maldives.
- The proponent informed that the company had diversified as a result growth in the tourism and fisheries sector of the Maldives.
- Proponent notified that 65,000 ft² of had been leased to the company by TCL. However, the minimum requirement for boat yards are 200,000 ft². Hence the facility in Thilafushi is extremely congested and expansion of services have been limited by space.
- Proponent informed that the main reasons for reclamation were to
 1. Facilitate easier access.
 2. Expand land area which is congested.
- The proponent informed that fill material would not be dredged to reclaim the proposed area. Sand stacked from dock construction or sand purchased from a third party will be used to reclaim the harbour area.
- Proponent also pointed out that TCL has given permission to reclaim the proposed area.

8.5 MEETING WITH THE HAWKES

The meeting was held on 15th December 2016 at H. Soanary, 3rd Floor. The meeting was attended by the following participants:

- Ali Hammadh (MEECO)
- Hassan Rifau (CEO The Hawkes)

Highlights of the meeting

- The Hawkes mentioned that they have no objection with regard to the proposed reclamation project.
- They informed that it is imperative to install sheet piles on the northern side of the plot so that when it is backfilled/reclaimed it would not cause any obstruction to the activities of the Hawkes.
- They also acknowledged that reclaiming the area would ease the traffic at the harbour area if the northern side of the reclaimed area is not used as an access point.

9 ENVIRONMENTAL IMPACTS AND MITIGATION

9.1 INTRODUCTION

Developmental projects involving reclamation are considered to generate various levels of environmental impacts, some of which can be felt on the immediate environment and some impacts can be cumulative. Marine environment is directly affected from changes in hydrodynamics due to coastal modification from dredging and reclamation projects as coral reefs are very vulnerable to immediate changes that will be sustained from most of the development activities. Therefore, during the scoping, designing of the project activities and field surveys, consideration must be given to minimize the impacts felt on the environment. This Chapter describes in detail the potential environmental impacts and measures proposed to mitigate the impacts arising from reclamation project, both during construction and operation phases of the proposed project. This section covers all the parameters which have been identified in task 4 and 6 of the TOR.

9.2 IMPACT ASSESSMENT METHODOLOGY

Impact characteristics of the activities related to the project have been determined through information and data gathered from field work, surveys, stakeholder meetings and experience gained from projects of similar nature. Information obtained from these sources were analyzed to predict the extent and significance of the impacts that may arise from the proposed project. Impact analysis was based on Rapid Impact Assessment Matrix (RIAM) (Pastakia and Jensen, 1998).

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 ecosystem services, ecosystem significance, potential for environmental degradation, and economic development.
2. Impact assessments were done for the construction phase and operational phase of the reclamation project to get a better understanding of the overall impact of the project.
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 described while providing a brief overview, discussion on possible positive or negative effects that may arise and the context to which they fall into.
5. Impact areas were then scoped based on RIAM classifications. These were physical/chemical (P/C), biological/ecological (B/E), Social/Cultural (S/C) and Economic/Operational (E/O). Impact areas were classified based on these categories.
6. Since impact extent were dependent on future outcomes, the condition at a specific time and due to the holistic nature of impact areas, situational impact criteria's were assigned to impact areas after examination 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 changed and is a measure of the control over the effect of the condition. Cumulative property is a measure of whether the effect will have a single direct impact or whether there will be an accumulated effect over time, or a synergistic effect with other conditions.
7. Significance of the impact on impact area was assigned after calculating an environmental score (ES) for each impact area identified.
8. The significance of ES numbers was assessed based on alphanumeric range bands (RS).

Following is an example impact assessment calculation for one of the impact areas based on the methodology utilized in this report.

Application of methodology:

Impact area: Navigation/Accessibility

Phase of project: Construction

Cause: Accessibility temporarily difficult due to reclamation.

Situational impact criteria: Permanence (temporary)

Duration: Specific only to the constructional phase

Significance of outcome:

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

Equation: 1

Where:

$I = 1$ (Important to local condition).

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

$M = -2$ (disruption in navigataion and use of harbour)

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

$P = 2$ (harbour closed temporarily)

$C = 2$ (Cumulative because the progress of construction depends on factors)

$R = 1$ (No change in reversibility)

The Situational criteria scale:

Table 13: 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:

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

$$ES = 1 \times (-2) \times (2 + 2 + 1)$$

$$ES = -10$$

ES value was then compared to the range band:

Table 14: 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

Hence navigation had a negative impact during the construction phase of the project. However, the same impact area was observed to have an ES value of 36 (significant positive impact) during the operational phase of the project (See Table 16). This was because, once the harbour has been reclaimed it will be much easier and faster for vessels to berth and use the new slipway to access the facility.

9.3 IMPACT ASSESSMENT AND MITIGATION

Impact assessments were done for both the construction and operational phase of the project. Table 15 and Table 16 are 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 illustrated in Figure 21. The illustration 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. Table 17 summaries, causal link of impacts and provides mitigation measures for the negative impacts.

Table 15: Constructional phase impacts

MOBILISATION & CONSTRUCTIONAL PHASE IMPACTS								
		Permanence	Reversibility	Cumulative	Condition	Magnitude	Environmental Score(ES)	Range Value (RS)
Physical/Chemical (P/C)								
Coastal morphology	(P/C)-1	1	2	1	1	-1	0	-A
Sediment transportation	(P/C)-2	2	1	2	1	-3	-15	-B
Seawater quality	(P/C)-3	2	1	2	1	-2	-10	-A
Current pattern	(P/C)-4	1	1	2	1	0	0	-A
Wave pattern	(P/C)-5	3	1	1	1	0	0	N
Hazardous waste	(P/C)-6	2	1	1	1	-1	-8	-A
Solid waste	(P/C)-7	2	1	1	2	-2	-16	-B
Ambient air quality & GHG	(P/C)-8	1	1	3	2	-1	-10	-B
Ambient Noise	(P/C)-9	2	2	2	1	-2	-12	-B
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	1	3	-1	0	N
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	3	1	1	1	-1	-5	-A
Public health and well being	(S/C)- 3	3	1	2	1	-1	-6	-A
Recreational value	(S/C)- 4	1	1	1	0	0	0	N
Economic/Operational (E/O)								
Infra structure	(E/O)- 1	1	1	1	1	0	0	N
Regional economy	(E/O)- 2	2	1	1	1	-1	-4	-A
Employment	(E/O)- 3	1	1	1	1	1	3	A
Individual income	(E/O)- 4	1	1	1	1	1	3	A
Fisheries	(E/O)- 5	1	1	1	4	0	0	N
Agriculture	(E/O)- 6	1	1	1	1	0	0	N
Navigation/Accessibility	(E/O)- 7	2	2	2	1	-1	-6	-A

Table 16: Operational phase impacts

OPERATIONAL PHASE IMPACTS								
		Permanence	Reversibility	Cumulative	Condition	Magnitude	Environmental Score(ES)	Range Value (RS)
Physical/Chemical (P/C)								
Coastal morphology	(P/C)-1	1	2	1	1	0	0	N
Sediment transportation	(P/C)-2	1	1	1	0	0	0	N
Seawater quality	(P/C)-3	1	1	3	1	-1	-5	-A
Current pattern	(P/C)-8	1	1	1	1	0	0	N
Wave pattern	(P/C)-6	3	1	1	1	0	0	N
Hazardous waste	(P/C)-5	2	2	1	2	-1	-10	-B
Solid waste	(P/C)-4	2	2	1	2	-2	-20	-C
Ambient air quality & GHG	(P/C)-7	2	2	3	1	-1	-7	-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	2	1	-3	-18	-B
Aesthetic and cultural value	(S/C)- 2	3	2	1	1	1	6	A
Public health and well being	(S/C)- 3	3	1	1	1	0	0	N
Recreational value	(S/C)- 4	1	1	1	0	0	0	N
Economic/Operational (E/O)								
Infra structure	(E/O)- 1	1	2	3	2	0	0	N
Regional economy	(E/O)- 2	2	2	2	2	2	24	C
Employment	(E/O)- 3	2	1	2	2	1	10	B
Individual income	(E/O)- 4	2	1	2	1	1	5	A
Fisheries	(E/O)- 5	2	2	3	2	0	0	N
Agriculture	(E/O)- 6	1	1	1	2	0	0	N
Navigation	(E/O)- 7	2	3	1	2	3	36	D

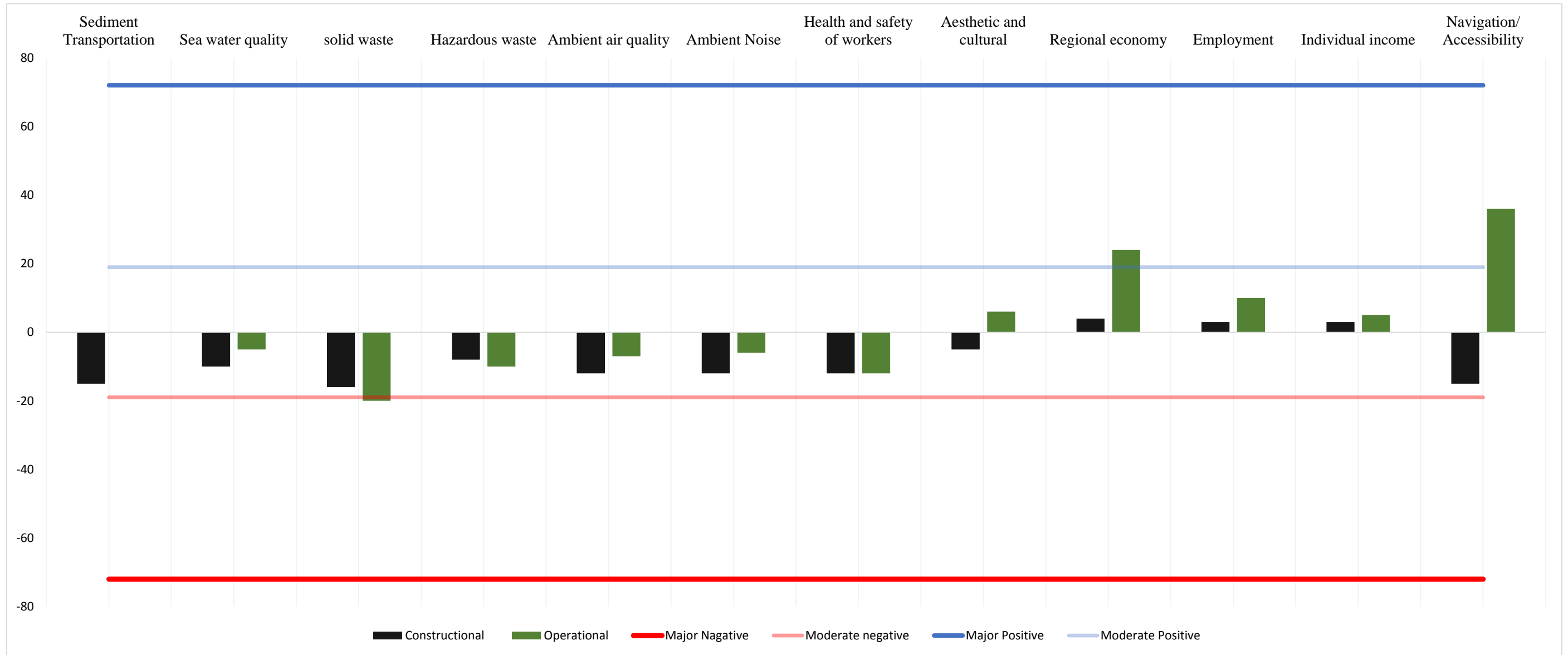


Figure 21: Impact assessment graph contrasting extent of constructional and operational phase impact

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Table 17: Relationship of impact area to the project and their relevance to the environment

Impact Area	Significance & General Description of Impact Area to the Environment	Cause	Duration	Impact Classification	Mitigation
Physical/Chemical (P/C)					
Sediment transportation (P/C-2)	<p>Sediment disturbances as a result of dredging has the potential to carry bedload as suspension in water. The increase in particles in water column directly results in the increase of water turbidity and TSS. Currents transport these suspended sediments before deposition.</p> <p>Increase in turbidity affects ecosystem as it restricts penetration of light which is compulsory for photosynthesis. Furthermore, it decreases the oxygen partition factor in water which effects respiration of organisms. Physically when sediments deposit on top of live corals, it blocks light which is required by zooxanthella in corals to photosynthesise. Since the actual living material of a coral is present in a very thin superficial layer of the coral exterior, corals die easily due to sediment deposition.</p>	<p><u>Construction phase</u> of the project is expected to have a short term negative impact because:</p> <ul style="list-style-type: none"> • Surveys (See section 6.5.1), found that the current velocities measured were relatively low and propagated in a net north easterly direction. Shear stress comparisons suggested that only very fine sediments were likely to be transported. • An artificial barrier was already present at the site which would stop sediments from being dispersed into the fore reef. • The marine life at the project site was very scarce, mainly because the coast and reef had been changed significantly through reclamation and installation of concrete structures (See 6.7.2). • Recent sediment monitoring conducted at L. Baresdhoo for entrance channel dredging suggested that sediment 	Short term	Slight Negative impact (RS –A)	<ul style="list-style-type: none"> • Before reclamation, sheet piles should be installed on the northern side of harbour. The breakwater should be removed and the eastern side shall be sheet piled. In this way sediment dispersal will be prevented and it would not disturb neighbouring areas. • No residual impact expected with the mitigation measure, hence sedimentation associated with reclamation can be completely avoided.

	The transport of sediments in the water column is governed by cohesion and angle of internal friction between particles. When the force component of the water body exceeds the critical shear stress of particles they are transported as suspension.	transportation had a cut off distance of approximately 15 m with measured currents much higher than that observed at Thilafushi (Saleem et al. (2015)). These observations further suggest that the impact is going to be very minor.			
		<u>Operational phase</u> This phase of the project is not considered to cause sediment transportation.	-	-	-
Seawater quality (P/C-3)	Water quality is an important parameter that sustains the health and wellbeing of the ecosystem. The quality of sea water is maintained between an optimum level which facilitates respiration and photosynthesis in the photic zone of the ocean.	<u>Construction phase</u> of the project is considered to have a short term negative impact on sea water quality mainly because: <ul style="list-style-type: none"> Reclamation would temporarily increase the turbidity of water body which is expected to be highly localised due to the low current measurements and due to presence of barriers at reclamation site (See 6.5.1). Construction workers will use the harbour basin to discard solid waste, waste oil, and other wastes which may pollute marine environment. 	Short term	Negative impact (RS-B)	<ul style="list-style-type: none"> Daily water quality monitoring during the reclamation period at the control site just outside the reclamation area just a precaution even though, sedimentation is not envisaged as a result of mitigation measure explained for (P/C-2) Avoid construction waste run off into the sea. Place signs which illustrates that the littering in the marine environment is not allowed. make sure the materials are not overstocked in carrying vehicle to avoid spill over during transport and dumping into reclamation site.
		<u>Operational phase</u> is considered to have a long term slight negative impact on sea water quality mainly due to:	Long term	Slightly negative	<ul style="list-style-type: none"> Place signs to prevent discarding waste.

		<ul style="list-style-type: none"> • Increase in vessels birthing which will increase amount of waste discarded. • Harbour basin being used to discard human wastes. 		(RS-A)	<ul style="list-style-type: none"> • Provide easy access to bathroom facilities at the harbour. • Burn waste only in designated areas. Do not burn any type of waste within the facility.
		<p><u>Operational phase</u> Similar to the construction phase of the project the operational phase is expected to result in a slight negative impact.</p>	N/A	Slight negative impact (RS-A)	
<p>Solid waste (P/C-6)</p> <p>Include:</p> <p>a. Solid waste</p>	<p>Solid non organic wastes takes a long time to disintegrate naturally. These pose a danger to living organisms as these wastes could suffocate, trap or kill living organisms.</p> <p>Solid waste also makes the area aesthetically displeasing.</p>	<p><u>Construction phase</u></p> <p>a. Construction Waste These include clothes used for wiping machineries, batteries and hydraulic lubricants.</p> <ul style="list-style-type: none"> • The construction waste produced is considered to be small as the project involves only reclamation and the duration of project is expected to be around 10 days <p>b. Municipal Solid Waste Plastics and organic materials will be the main, municipal solid waste generated during the construction phase. The amount</p>	Short term	Moderate negative impact (RS –C)	<p>Proposed mitigation measures for the operational phase and constructional phase include:</p> <ul style="list-style-type: none"> • Placing waste bins at project location and installing signs that prohibit littering. • Discarding waste in appropriate designated bins. • Waste shall be stockpiled and moved to disposal area after completion of the project. • Construction waste should not be burned at GFF facility.

		<p>of waste produced is perceived to be moderate because:</p> <ul style="list-style-type: none"> • Less than 10 workers will be deployed, for approximately 10 days. • Considering that each worker in their day to day activities produces 0.45 kg/per day of waste as referenced from World Bank (2012) for the expected duration of project (10 days), the total solid waste produced by workers will be $\text{Total solid waste} = 0.45 \times 10 \times 7$ $\text{Total solid waste} \approx 31.5 \text{ kg}$ <p>Hence, it is anticipated that solid waste production during the construction phase would have a minor short term negative impact.</p>			<ul style="list-style-type: none"> • Plastic, organic and non-hazardous construction waste should be separated and transported to disposal site. • Quantity of waste produced at project site and discarded at disposal site should be recorded. Waste auditing shall be logged according to EMP. (See section 11)
		<p><u>Operational phase</u></p> <p>b. Municipal Solid Waste Plastics and organic material would be the main forms of municipal waste generated from the facility by the workers.</p> <p>Considering the lack of quantifiable waste audit data in the report, operational phase of the project is expected to have a moderate negative impact.</p>	Long term	Moderate negative impact (RS-C)	<ul style="list-style-type: none"> • Placing sign boards in the area indicating not to discard waste • Separate plastics and organic waste by placing labelled waste bins within the facility. • Auditing waste production as proposed in the EMP to better assess the extent of waste production. • Ensuring that waste is not burned within the GFF facility.

<p>Hazardous Waste (P/C-7)</p>	<p>In regulatory terms, a hazardous waste is a waste that exhibits one of the following four characteristics:</p> <ol style="list-style-type: none"> 1. Ignitability, 2. Corrosively, 3. Reactivity, or 4. Toxicity. <p>Most fiberglass boats are made of glass fiber and polyester resin using basic bucket and brush moldings (Casey, 1999).</p> <p>Polyester resin is supplied in drums as liquid and glass fibers come in rolls.</p> <p>The glass fibers are saturated with polyester resin in the presence of peroxide catalyst (MEKP) Methyl ethyl ketone peroxide.</p>	<p><u>Construction phase</u> The project is not expected to yield significant amounts of hazardous waste. The main hazardous waste expected are oils, batteries, electronics from machines and lubricants. Quantities produced will be insignificant as only few machineries will be used for the reclamation (See Table 2).In addition, measures will be adopted to minimise the generation of hazardous waste. Where hazardous waste is generated it will be disposed of in an environmentally friendly manner.</p> <p>Hence, it is expected that construction phase of the project will cause a short term slight negative impact.</p>	Short term	Slight negative impact	<p>Proposed mitigation measures for both the construction and operational phase are:</p> <ul style="list-style-type: none"> • Oils, lubricants, batteries and electronic parts should be separated and disposed of in appropriate containers at Thilafushi. • In case of accidental spillage, do not let the waste wash into drains. Soak them up using dry absorbent material/sponges and discard it in appropriate labelled containers. • Accidental oil spills can be dealt with skimming and through the use of sorbent material. In-situ burning of spilled oil is not recommended. • The equipment used should be in good working condition to mitigate waste generated from maintenance. • Hazardous waste containers should be sealed and labelled carefully • Disposal containers shall not be overfilled with oils and sufficient containers must be used.
		<p><u>Operational phase:</u> Waste generated will include mainly chemicals used in the manufacture of vessels. These include:</p> <ul style="list-style-type: none"> • Vinyl ester resins • Epoxy resins • Phenolic resins • Peroxides • Fiberglass trimmings • Dust • Asbestos <p>The amount of hazardous waste produced during the operational phase of the project is not expected to be significantly high because:</p> <ul style="list-style-type: none"> • Most of the reactants will be converted into fibreglass 	Long term	Slightly negative impact (RS-A)	

		<ul style="list-style-type: none"> The catalyst peroxide will be reused. The reaction between glass fibres and polyester resin in the presence of catalyst is efficient. <p>However reactants, fibre glass trimmings, dusts and varnishes will constitute to hazardous waste that will be produced from the facility</p>			<ul style="list-style-type: none"> Signs and boards should be placed throughout the harbour explaining harbour rules. Resin must never be poured down drains. It will build up causing blockages in the drains. Spillages with resin should be mopped up immediately. Trimmings and dust should not be dumped near water course or drain. Discard them in appropriate containers and make sure PPG are worn when handling hazardous waste which include, wearing nitrile gloves and eye protection.
Noise and vibrations (P/C-9)	Exposure to elevated noise can cause hearing impairment, hypertension, ischemic heart disease, annoyance, and sleep disturbance. Changes in the immune system and birth defects have also been attributed to noise exposure.	<p><u>Construction phase:</u> noise is expected to be a short term negative impact mainly because:</p> <ul style="list-style-type: none"> Hammer impact cause higher levels of noise and vibration than other types of pile driver, but will drive piles into any type of soil and may be the only method available for driving into stiff, cohesive soils or soft rock. Hence, given the substrate type of varying hardness expected and limited options and know-how available locally for driving piles this may be the only option available for the driving piles for the proposed project. 	Short-term	Slight negative impact (RS-B)	<p>Generic management level mitigation measure should be sufficient to mitigate the minor negative impact. These include:</p> <ul style="list-style-type: none"> Ensuring that the project does not get delayed due to equipment failure or financial constraints. Carrying out work involving machineries during daytime. Regular servicing of the equipment's and vehicles. <p>Providing workers noise cancellation headphones.</p>

		<ul style="list-style-type: none"> • Reclamation is set to take place in the open away from living quarters. • Piling would result in loud noise, however since the location has been allocated for industrial activities noise is not considered to be a significant negative impact. • Based on wind analysis (See Section 6.2.3), wind was generated from the west throughout most of the year, hence noise will be shielded by the wind which would diffuse it to the east. <p>In the case of the current project, there are no local population residing, schools, public services or hospitals in the area. Thilafushi being an industrial island the noise levels are generally accepted to be higher compared to a local island and that the workers there are expected to be used higher noise levels. Also important to note is that the project activities are carried out at the coastal edge away from areas where work is concentrated at Thilafushi. The project related activities are not expected to cause disruptions to the normal activities. However, noise generated from piling is not perceived to be pleasing even in an industrial site. Hence it is important to take necessary measures to ensure that the construction time is minimized and work</p>		<p>Although impact hammer method produces highest level of noise and vibration compared to other methods further reductions in noise levels can be achieved by:</p> <ul style="list-style-type: none"> • the use of shrouding to enclose the area where noise is generated. • forewarning the businesses that operate in the close by areas of the forthcoming work and its duration and assuring them of the very low risk of damage to property <p>Generally, vibration generated using an impact hammer are greatest close to the pile and in this case considerable distance separates nearest buildings from the pile driving sites and therefore effect of vibration is not expected to be serious. This assumption is backed by experience gained from piling activities in the same location in the past. No serious issues related to vibration or noise was registered. However, as a precautionary measure it the following have been recommended</p> <ul style="list-style-type: none"> • Carrying out property surveys, before and after your work • Use of modern hydraulic drop hammers that are efficient and controllable. The combination of a controllable hammer and vibration monitoring can help to meet vibration limits, while
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		proceeds with acceptable level of noise and vibration.			<p>achieving effective pile installation.</p> <ul style="list-style-type: none"> • Particular care should be taken to ensure that the pile is maintained in a vertical position by using well-designed guide frames or a leader. An appropriate size of hammer should be selected, and the hammer should strike the centroid of the pile along its axis. Equipment should be in good condition and piling should be stopped if any head deformation occurs, until the problem is identified (ArcelorMittal, 2008). • Noise cancellation and other personal protection gear should be available to workers • Adequate distance shall be maintained from the reef edge and foot of the pile so as to avoid slope failures during piling.
		<u>Operational phase</u> : noise is expected to have a minor negative impact and is not expected to be different from the current levels.	No change	No change	-

<p>Ambient air quality & GHG Emission (P/C-8)</p>	<p>Air pollutants include benzene, CO₂, CO due to incomplete combustion and NO_x derivatives from exhaust pipes, which are both warming and toxic gases (WHO, 1999). Maldives is extremely vulnerable to climate change. The current CO₂ concentration is 398 ppm. Increase in CO₂ has been causally linked to rise in global mean temperature and it is linked to permafrost and polar ice caps melting. This has resulted in gradual sea level rise</p> <p>Moreover, dust fall, particularly PM₁₀ and PM_{2.5} particulates contain carcinogens and neurotoxins such as atmospheric cadmium, lead and asbestos (Breuer, 2015).</p>	<p><u>Construction phase</u> of the project is expected to have a minor negative impact because:</p> <ul style="list-style-type: none"> Project is expected to be completed within a short period of time) <p>The construction phase of the project is estimated to be approximately 10 days hence amount of emission within this time is considered to be low. Considering that 800 l of diesel is consumed each day by the excavator. GHG emissions for 10 days was determined to be approximately 15,000 kg of CO₂-e (DECC and Defra, 2012)</p> <p><i>The above calculation is based on estimates of fuel required to only operate the excavator for 7 days nonstop.</i></p> <ul style="list-style-type: none"> The reclamation work will be carried out in the open where wind would quickly carry particulate matter away from the island and dissipate them into the atmosphere. 	Short term	Moderate negative impact (RS-C)	<p>To reduce emission of GHG to levels as low as reasonably practical the following mitigation measures have been proposed.</p> <p>These include:</p> <ul style="list-style-type: none"> Ensuring the vehicles and marine vessels brought by the contractors complies with road worthiness and seaworthiness requirements of the Transport Authority and all vehicles in use display compliance stickers on the windscreen. Obtaining fill material from Thilafushi which will reduce transportation costs and environmental burden If possible position the exhausts so that fumes are blown, away from the island. <p>Improve fuel efficiency by:</p> <ul style="list-style-type: none"> Minimize idling time either by 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. Maintain all construction equipment in proper working
		<p><u>Operational phase</u></p> <p>The operational phase of the project is expected to result in a slight negative</p>	-	Slight negative impact (RS-A)	

		<p>impact in ambient air quality mainly because:</p> <ul style="list-style-type: none"> • The facility would be increased by 537 m², which would slightly increase the carbon footprint. This increase in considered to be minor. 		<p>condition according to manufacturer's specifications.</p> <ul style="list-style-type: none"> • The equipment must be checked by a certified mechanic and determined to be running in proper condition before it is operated. • Train equipment operators in proper use of equipment. • Use the proper size of equipment for the job. • Use equipment with sustainable green technologies installed • Encourage and provide transportation pooling when travelling to project site.
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Social Cultural Impacts

<p>Health & safety of workers (B/C-6)</p>	<p>Health hazards 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.</p>	<p><u>Construction phase</u></p> <p>Accidents have been reported to be rare for projects of similar nature in the past. But cannot be completely ruled out especially in projects which involve handling heavy machineries and flammable liquids such as fuel and chemicals.</p> <ul style="list-style-type: none"> • Incidences of fire have been reported in the past. • Toppling of machines during dredging have been reported. • Minor injuries to workers during operation and maintenance of vehicles • Workers will be exposed to fumes from machineries. • 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. <p>Hence this phase of the project is considered to have a slight negative impact.</p>	<p>Short term</p>	<p>Negative impact. (RS-B)</p>	<p>Mitigation measures include:</p> <ul style="list-style-type: none"> • 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 workers camp;
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		<p><u>Operational phase</u></p> <p>Although no health related accidents have been identified at Guarantee fibreglass fabrication, there is potential for work related accidents. These include:</p> <ul style="list-style-type: none"> • Inflammation of the skin from the chemicals used in preparing fibre glass. • Health issues caused by fibreglass trimmings and dust particles at the facility. • Cuts and bruises from sharp objects and heavy items that may fall. <p>Due to these potential scenarios, this phase of the project is expected to have a slight negative impact.</p>	N/A	Negative impact (RS-B)	<ul style="list-style-type: none"> • 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
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<p>Aesthetic and cultural value (S/C-2)</p>	<p>Aesthetic and cultural values are important to preserve the national identity of the Maldives.</p>	<p><u>Construction phase</u></p> <p>It has to be noted that aesthetic values are highly subjective. The proposed project is set to reclaim a small harbour which is considered to be a slight positive impact when the harbour is observed superficially. It would bring a stoppage to accumulation of waste in the harbour.</p> <p>Culturally the project, is not considered to have a significant impact because:</p> <ul style="list-style-type: none"> • Thilafushi is solely used as an industrial zone and locals do not live at Thilafushi. • There is a significant population of foreign workers at Thilafushi already, however it is important that the foreign workers are accustomed to the customs of Maldives. <p><u>Operational phase</u></p> <p>No change expected from current condition</p>	<p>Long term</p>	<p>Slight positive impact RS A</p>	<ul style="list-style-type: none"> • Provide necessary information to the neighbouring businesses on the project to alert and inform the public of the planned work to avoid unnecessary accidents and conflicts; • Records of any complaints related to project shall be kept and resolved as soon as possible.
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Economic and Operational Impacts					
Regional economy (E/O-2)	The regional economy is important in order to become financially viable, to fast track development projects and built development capacity. When economic activities are low within a region, accessibility to basic needs tend to be poor.	<u>Construction phase</u> Not expected to change.	Short term	N/A	N/A
		<u>Operational phase</u> the project is expected to increase the regional economy significantly mainly because: <ul style="list-style-type: none"> The reclaimed land (527 m²) will provide space to service extra boats (approximately 5 or 6) at the facility. 	Long term	Significant positive impact (RS C)	-
Individual income (E/O-4)	Individual income is important as it serves as a mean for people to access better health care, education and transportation.	<u>Construction phase:</u> Individual income is not expected to change.	N/A	N/A	-
		<u>Operational phase:</u> is expected to increase individual income slightly mainly because: <ul style="list-style-type: none"> An increase in GFF productivity and sales would have a positive impact on its employees 	Long term	Slight positive impact	
Navigation and Accessibility (E/O-7)	Navigation is important to ease accessibility to GFF facility. Disadvantages of poor accessibility to the facility is explained in section 2.5. -	<u>Construction phase</u> Not expected to change from existing conditions.	Short term	N/A	Mitigation measures include <ul style="list-style-type: none"> Planning work beforehand so that reclamation works is carried out when the facility is least busy.
		<u>Operational phase</u> The operation phase of the project is expected to ease safer navigation and accessibility to GFF facility.	Long term	Moderate positive impact.	-

		<ul style="list-style-type: none">• The reclaimed land will provide the much needed space to service more vessels.• Facility can be accessed from the eastern and southern side, without hindrance from foreign vessels.			
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9.4 SUMMARY OF IMPACT ASSESSMENT

- No major negative impacts were identified for the project.
- Most significant negative impacts identified with no mitigation measures in place were sedimentation from reclamation and noise/vibrations generated from sheet piling.
- Apart from these 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 a minor negative impact during construction phase include:
 1. Solid waste
 2. Hazardous waste
 3. Air quality
 4. 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. Through cumulative and holistic relationships, the impact assessment also envisaged a slight negative impact to the health and safety of workers during operational phase.
- Areas which are determined to have positive impacts include:
 1. Navigation and Accessibility
 2. Regional economy
 3. Employment

- Economic/operational (E/O) aspect of the environment was found to have the most positive impact 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. Significant mitigation measures to be taken include:
 1. Installation of sheet piles as illustrated in Figure 4 which would effectively control all negative environmental impacts envisaged from project
 2. Proper management and treatment of waste
 3. Establishment of proper occupational hazard risk prevention measures.

9.5 UNCERTAINTIES

Environmental impact prediction itself involves a certain degree of uncertainty, as the predicted impacts may vary according to weather, ecological conditions and social conditions in the atoll or island. Absence of ‘before’ data and natural variation data further add to uncertainty in predicting impacts. Uncertainties of the impact assessment include:

- Lack of confirmed amounts of resources and inputs that will be utilised. Hence calculations of GHG emission and solid waste production were based on estimates.
- The impact assessments and mitigations measures provided in the report would only be applicable to the current scale and scope of project.

Due to the small scale and nature of the project, only minor negative impacts have been envisaged. Based on existing environment and proposed mitigation measures the impact assessment conducted for the project encompasses minimal uncertainties.

All predicted limitations have been taken into account during the compilation of the report and proposed adaptability measures include

- Taking baseline data at the time of project based on limitations identified in the report.

10 ALTERNATIVES

According to the EIA regulations, alternatives of the options for the proposed project must be considered. The first alternative is the option of “no project option”. Other alternatives that have been proposed in this report are:

- Alternative reclamation method.

10.1 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 implication to the proponent. The advantages and disadvantages of the no project option are discussed below in Table 18

Table 18: Advantages and disadvantages of no project option

Advantages	Disadvantages
Environmental issues related to project can be avoided.	Congestion at GFF facility will persist. There won't be enough space to expand the facility.
No development costs to the proponent.	The development, productivity and expansion of company will be impeded.
	No unique or exceptional environment preserved.
	Risk of losing the funds if not utilised for allocated purpose before the end of the fiscal year
	Vessels at risk of facing damages

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

10.2 ALTERNATE RECLAMATION METHODS

10.2.1 Alternate Fill Material.

Generally, fill material for reclamation works in the Maldives is obtained from shallow lagoons and reefs. Cumulative impacts arising from continued dredging places a huge stress on coral reefs which is the most valuable natural resource of the Maldives. Loss of coral reefs would have adverse impacts on the environment as well as national economy as it is one of the most crucial resources that needs to be preserved. 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; and
3. Plasma treated waste.

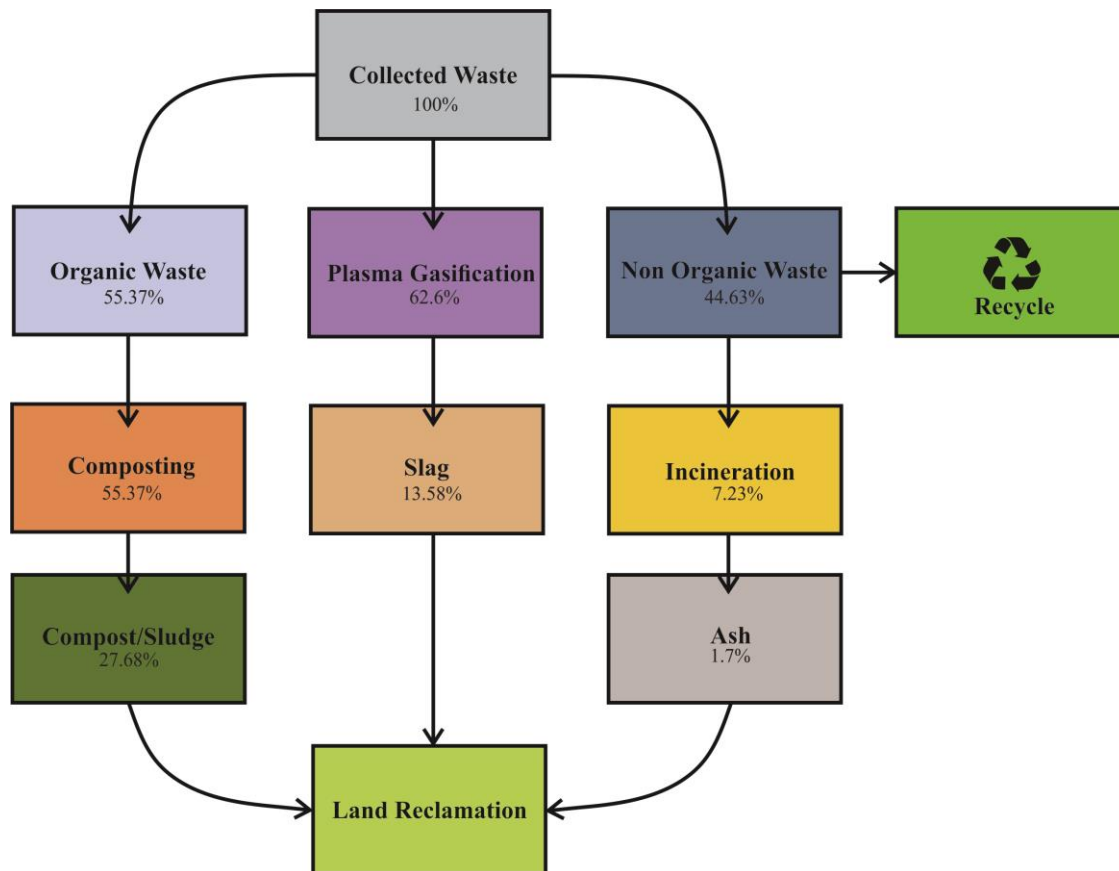


Figure 22: Alternative fill material for reclamation and how they can be obtained. Efficiency of each method is provided based on initial raw material input. (Sourced: Han, Schaefer and Barry, 2013)

Based on Figure 22 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 are not feasible in the current reclamation project. Moreover, with reference to marine environment (section 6.7.2) and environmental impacts and mitigation (Section 9), the project is not expected to have a significant impact on the marine environment. Furthermore, the project does not involve dredging within the scope of its activities, further reducing the impact footprint.

10.3 ALTERNATE SHEETPILE METHOD

There are different types of piling systems on the market all of which have advantages and disadvantages, depending upon a number of factors. Pile selection will essentially need to take into consideration the following (Federation of Piling Specialists, 2010)

- Safety – both during construction and in use, along with a consideration of potential re- use or removal
- Requirements of the proposed structure and applied loadings
- The ground conditions
- Environmental factors – including nuisance, effect on wildlife and habitat, noise and vibration, waste products (spoil), carbon reduction etc.
- Access to and location of site
- Proximity to existing assets (e.g. utilities, roads railways), in particular when
- Proximity to sensitive structures
- Cost
- Local availability of technology

Common piling methods available:

Hydraulic pile pressing technology enables piles to be driven almost silently without causing noticeable vibration. However, this method will work only when the soil conditions are appropriate.

Vibrodrivers, which offer the fastest rate of installation of any pile driving system in granular soils, cause more vibration than pile presses, but are less disruptive than impact hammers. Engineering advances have given operators the ability to vary the frequency and amplitude of vibrations generated by the machine, so that the system can be tuned to suit the ground conditions. This technology has also eliminated the severe vibrations generated close to the pile when the vibrodriver passes through the resonant frequency of the surrounding ground and buildings during run up and run down.

Impact hammers cause higher levels of noise and vibration than other types of pile driver, but will drive piles into any type of soil and may be the only method available for driving into stiff, cohesive soils or soft rock. Hence, given the substrate type of varying hardness expected and limited options and know-how available locally for driving piles this may be the only option available for the driving piles for the proposed project.

Impact hammer method was determined to be the best method considering the available equipment and geological form of the coral reef, as hard strata maybe encountered.

11 ENVIRONMENTAL MONITORING

11.1 INTRODUCTION

This chapter outlines the monitoring plan for the reclamation project as per task 7 of the TOR. Adoption of appropriate mitigation measures as described in Table 19 can further reduce the environmental damage by accounting for uncertainties detailed in section 9.5. However, occurrence of unforeseen impacts are still a possibility, even with proper implementation of mitigation measures. Moreover, some of the predicted impacts may turn out to be greater than predicted, necessitating different or more rigorous mitigation measures. Therefore, monitoring of the environment is vital, in order to avoid and reduce the chances of such events, and to minimize the impact and cost of unforeseen events by taking prompt remedial action if such events occur.

The monitoring plan is based on impact analysis outlined in Section 9 of the report and the existing environmental conditions determined in Section 6 of the report.

The main scope or objectives of the environmental management plan are to:

- a) Monitor and manage any unforeseen impact on the project environment;
- b) Produce a framework for anticipated impacts, by including practical systems for monitoring, reporting and implementing corrective actions during reclamation;
- c) Manage environmental matters in a synchronized manner and to collect information that can be used for documentation and verification of environmental impacts;
- d) Collect information that can be used for evaluating the effectiveness of implemented mitigation measures;
- e) Provide evidence of compliance to laws, regulations and requirements of relevant agencies;
- f) Embrace the variability and uncertainty in environmental system to distinguish between change and variability;
- g) Broaden the adaptability of the management plan, as some of the decision during reclamation have to be made based on physical conditions at the time;
- h) Assess the magnitude of the impacts resulting from dredging; and
- i) Validate the fate of sedimentation which has been modelled through the report.

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

- Topography
- Water quality (sedimentation);
- Waste quantity
- Healthy and Safety of Workers

11.2 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 site.
- b) Sedimentation arising from reclamation was determined to be the most significant environmental impact arising from the project.
- 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.

11.3 ENVIRONMENTAL MONITORING PLAN

Monitoring would begin from the EIA preparation phase to record any possible changes to the environment due to reclamation and would continue into the operational phase until the end of the monitoring plan.

This program would commence at the start of construction phase. The proponent is committed to continue the monitoring program for a year after the construction phase. See section 14.5.

11.4 REPORT FORMAT

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)
- Health and Safety (Form/checklist which should account for safety gear, any incidents, date and time)
- 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 20.

11.5 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 19 and a summary of environmental monitoring is presented in Table 20.

Table 19: Environmental monitoring plan

Environmental aspect	Parameters and Methods of Monitoring	location monitored and compliance	Monitoring Frequency	Cost (USD)	Baseline Study
Topography	<p>Ensure whether reclamation had achieved the required heights which would ensure sufficient storm water runoff etc.</p> <p>GNSS RTK could be used to survey the topography</p>	<p><u>Height of the newly reclaimed land with respect to mean sea level – finished height to be 1.5m from msl. Survey will be carried with respect to established PSMs at Thilafushi</u></p>	<p><u>Construction phase</u> Once after reclamation.</p>	<p>Approx. USD 1000</p>	<p>N/A</p>
			<p><u>Operational phase</u> Not required</p>		
Waste	<p>Measuring quantities of solid waste and hazardous waste produced.</p> <p>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 to ensure that all wastes are disposed of appropriately at designated areas.</p>	<p><u>Project site</u></p>	<p><u>Construction phase</u> Once at the end of construction when all the wastes have been separated and stored in appropriate containers.</p>	<p>Approx. USD 1000</p>	<p>N/A</p>
			<p><u>Operational phase</u> Waste management should be continued at the facility monthly to account for hazardous resin and peroxide wastes that will be produced .</p>		
Water quality (Sedimentation)	<p>Water quality should be measured to check the turbidity or TSS, DO, temperature and conductivity.</p> <p>A multi parameter probe could be used to check these parameters or samples can be collected on site</p>	<p>Control site as shown in Figure 14. The average figures for the set parameters given in Table 10 shall be used as the baseline any deviation from baseline shall trigger corrective actions and temporary cessation of work.</p>	<p><u>Construction phase</u> Water quality should be monitored daily for the duration of dredge period.</p>	<p>Approx. USD 1500</p>	<p>See section 6.6.1</p>

	and transported to a lab within 24 hrs.		<u>Operational phase</u> Water quality should be monitored once after two months		
Health and safety	<p>Ensuring whether the necessary safety equipment and measures are set in place during construction.</p> <p>Monitoring can be done using a simple checklist and findings shall be included in the final report.</p>	<u>Project site</u>	<u>Construction phase</u> Health and safety should be monitored daily.	Approx. USD 900	

11.6 SUMMARY OF ENVIRONMENTAL MONITORING

Four parameters have been identified to be monitored these include:

1. Topography
2. Water Quality (sedimentation)
3. Waste Quantity
4. Health and safety

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 20: Summary of environmental monitoring

Parameter	Number of Assessments	Detail
Topography	1	Right after reclamation
Water quality (sedimentation)	2	Daily during reclamation Once after two months.
Waste	1	Once after construction Logged monthly during operational phase.
Health & safety	1	Daily during construction

12 CONCLUSION AND RECOMMENDATION

12.1 CONCLUSION

The report confirmed that the reclamation of the small harbour in plot no. S4-033 would ease accessibility and congestion issues which have been decreasing the productivity and growth of GFF.

The existing environment at the project area was found to be highly modified. No significant vegetation or marine life was identified at the site. The area had been reclaimed and cleared for industrial activities.

Hydrographical conditions at the site were stable, as the eastern coast would be protected from swells generated during the southwest monsoon. Currents at the project site were significantly low and propagated landward 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 harbour was very shallow with the deepest region situated in the middle. The amount of fill material required to reclaim the 537 m² harbour to existing flat ground level was 1,700 m³.

The project was subjected to rigorous options evaluation which studied the proposal against potential environmental and social impact. The impact assessment was classified into two phases of the project. The construction phase of the project was found to comprise only minor short term negative impacts mainly to the physical environment. These impacts were minor due to the small scale and footprint of the project as it does not involve dredging for fill material. Sedimentation was determined to have a negative impact, however with the proposed work method to contain the harbour using sheet piles, all major impacts arising from the proposed project will be contained. 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, accessibility, navigation and the regional economy.

Due to the inherent and complex nature of natural environment, the impact assessment and prediction of impacts would carry uncertainties, however based on small scale and nature of project and its environment the impacts assessment was conclusive. However, in order to account for uncertainties and assess whether the environment system remains within its equilibration capacity, monitoring is crucial. The EMP devised in the report proposes to monitor three key parameters identified from the impact assessment to better understand and mitigate any negative impacts that may arise.

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 GFF plot in Thilafushi 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.

12.2 RECOMMENDATIONS

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

1. It is strongly recommended to sheet pile the northern and eastern side of harbour after removal of the breakwater. This would completely control sedimentation which is the main negative environmental impact identified for the proposed project. Doing so would have secondary benefits, as it would not disrupt harbour activities of neighbouring facilities and it would clearly mark the area to be reclaimed.
2. It is strongly recommended to obtain fill material from Thilafushi as it would minimise cost and impacts associated with transportation of fill material.
3. During reclamation it is recommended to supervise the works carefully to avoid occupational accidents and delays.
4. The calmest months were identified to be March-April in terms of weather conditions hence, if feasible it is recommended to carry out reclamation works during this time of the year to avoid weather related risks.

13 REFERENCE

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14 ANNEX

- Annex 1 – Terms of Reference
- Annex 2 – Site Plane
- Annex 3 – MWSC Water Test
- Annex 4 – Bathymetry Project Area
- Annex 5 – Commitment Letter by Proponent
- Annex 6 – Scoping Meeting Attendance Sheet
- Annex 7 – Attendance Sheet Hawkes Meeting
- Annex 8 – CV of Contributing Authors

14.1 ANNEX 1 – TERMS OF REFERENCE

14.2 ANNEX 2 – APPROVED SITE PLAN

14.3 ANNEX 3 – MWSC WATER TEST

14.4 ANNEX 4 - BATHYMETRY PROJECT AREA

14.5 ANNEX 5 – COMMITMENT LETTER BY PROPONENT

14.6 ANNEX 6 – SCOPING MEETING ATTENDANCE

14.7 ANNEX 7 – ATTENDANCE SHEET (MEETING WITH THE HAWKES)

14.8 ANNEX 8 – CV’S OF CONTRIBUTING AUTHORS



203-EIARES/PRIV/2016/81

Terms of Reference for Environmental Impact Assessment for Reclamation work at K.Thilafushi Guarantee Fiberglass Fabrication Plot

Introduction and rationale:

The following is the Terms of Reference (ToR) following the scoping meeting held on 11 February 2016 to undertake the EIA of the proposed reclamation project in K.Thilafushi while every attempt has been made to ensure that this ToR addresses major issues associated with proposed reclamation project in K.Thilafushi., 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.

Introduction: Describe the reclamation project based on the key project activities outlined in the EIA application. Objectives of the reclamation project should be specific and clearly outlined. Identify the funding source, key stakeholders and the institutional arrangements relevant to this reclamation project.

- 1. Study area** – Submit a minimum A3 scaled map showing proposed reclamation site and borrow areas if any. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the reclamation area and borrow sites.
- 2. 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 key activities of the reclamation works, using maps, diagrams and figures using appropriate scales where necessary. The following should be provided (inputs and outputs related to the proposed activities):

The main activities of the reclamation and coastal works are

- a) Location and size of reclamation area
- b) Justification for the proposed reclamation.
- c) Quantity of fill materials required
- d) Method and equipment used for reclamation with justification for selecting the methods and equipment
- e) Duration of activities
- f) Labour requirements and (local) labour availability
- g) Housing of temporary labour, and
- h) Emergency plan in case of environmental contaminant spills (diesel, grease, oil etc.)
- i) Construction of bunds if required
- j) 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 in case of spills)



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Dhivehin' - Always Maldivian, Forever Independent

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Environmental Protection Agency EPA



k) Environmental monitoring during construction activities;

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). The report should outline detailed methodology of data collection utilized.

- a) Temperature, rainfall, wind, waves (including extreme conditions)
- b) Bathymetry (bottom morphology) using maps;
- c) Tidal ranges and tidal currents;
- d) Wave climate;
- e) Wind induced (seasonal) currents;
- f) Seawater quality (physical) to include temperature, pH, salinity, turbidity, TSS and dissolved oxygen.
- g) Benthic and fish community at the reclamation area and control site near the reclamation site.
- h) Description of the coral reef formation and type of coral species
- i) Accessibility and (public) transport to other islands;
- j) Service quality and accessibility (water supply, waste/water disposal, energy supply, social services like health and education);
- k) Community needs;
- l) Vulnerability of area to flooding and storm surge.

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 social) of proposed project: The EIA report should identify the impacts, direct and indirect from the operations. Particular attention shall be given to impacts associated with the following:

Task 4a. Impacts to natural Environment

- a) Changes in flow velocities/directions, resulting in changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology.
- b) Loss of marine biota, both in the borrow area as well as in the reclamation site, resulting in (temporary) loss of bottom life, which may impact fish stocks and species diversity and its density.
- c) Sediment dispersion in water column (turbidity at the dredging sites), possibly resulting in changes in visibility, smothering of coral reefs and benthic communities and affecting fish and shellfish etc.
- d) Impacts of noise, vibration and disturbance.
- e) Impacts on unique or threatened habitats or species (coral reefs, sea turtles etc.), and



Task 4b. Impacts on the socio-economic environment

- a) Impacts of the works in fishing activities (disturbance);
- b) Impacts of the harbour development and channel deepening works to nearby islands or sites, if any (e.g resorts and dive sites);
- c) Impacts on employment and income, potential for local people to have (temporary) job opportunities (and what kind) in the execution of the works;
- d) Employment and economic opportunities and diversification;

Task 4c. Construction related hazards and risks

- a) Pollution of the natural environment (e.g. oil spills, discharge of untreated wastewater and solid waste, including construction waste);
- b) Risk of accidents and pollution on workers and local population, and

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 project option “. Determine the best practical environmental options. This should include but not limited to alternative equipment/machinery for dredging and alternative containment measures.

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 sedimentation control. Mitigation measures to avoid, minimize or compensate habitat destruction caused by reclamation need to be considered, e.g. temporal sediment control structures. Give cost of the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An environmental management plan (EMP) 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 impacts shall be given.

Task 7. Development of monitoring plan- Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan. Give details of the monitoring program including the physical and biological parameters for monitoring, cost of monitoring and commitment letter from responsible person to conduct monitoring, reporting format and schedule. The monitoring report shall cover if required and shall not be limited to:

- a) Sea water quality: that includes EC, Turbidity, pH, DO and rate of sedimentation
- b) Assessment of nearby marine sensitive ecosystems
- c) Re-colonization of the benthic organisms in the impact zones.
- d) Erosion and accretion;



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Environmental Protection Agency EPA



Task 8. Stakeholder consultation and Inter-Agency coordination.

Identify appropriate mechanisms for providing information on the land reclamation project to relevant stakeholders, government authorities such as:

- Ministry of Housing and infrastructure
- Thilafushi Corporation Limited
- Thilafushi Industrial Community

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.

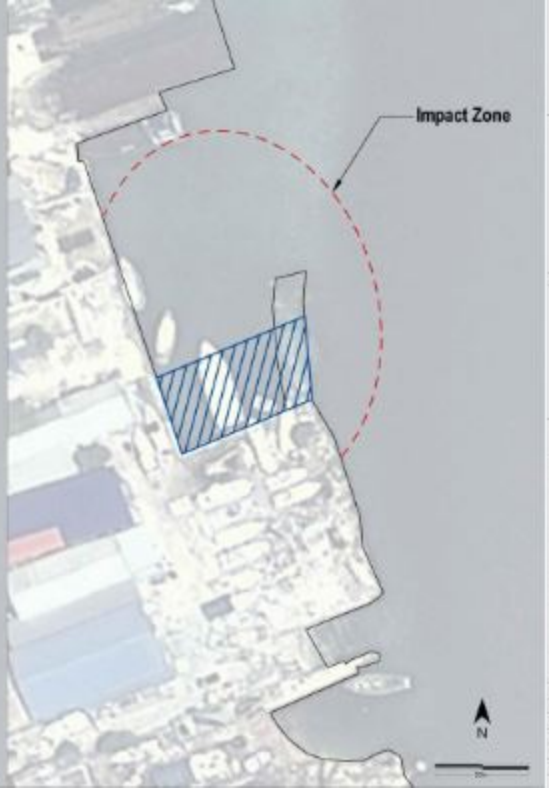
Presentation- The environmental impact assessment report need to be presented in digital format, shall be concise and focus on significant environmental issues. The environmental assessment report shall be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2012 and the relevant amendments.

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

11 February 2016



ECA002



Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory

FEN Building 5th Floor, Machangoalhi, Ameenemagu, Male', Maldives
 Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

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WATER QUALITY TEST REPORT

Test Report No: 301032/2015/23

Customer Informations :

Meeco,
 G. Aakakaage-1, 2nd Floor,
 Alikilegefaanu Magu,
 Male'
 Rep. of Maldives

Date: 17/12/2015

Sample Description / Location~	4°10'52.80" N 73°27'5.28" E	TEST METHOD	UNIT		
	Thilafushi Z1				
Sample Type~	Sea water				
Sampled Date~	07/12/2015				
Sample Received Date	07/12/2015				
Test Requisition Form No.	900162676				
Sample No.	821017				
Date of Analysis	14/12/2015				
PARAMETER	ANALYSIS RESULT				
Physical Appearance	Clear			Visual	-
Total Suspended Solids (TSS)	<5 (LoQ 5mg/L)	Method 8006 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L		
Turbidity*	0.194	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU		

UNITS: µS/cm: Micro Seimen per Centimeter, ‰: Parts Per Thousand, mg/L: Miligram Per Liter, NTU: Nephelometric Turbidity Unit

LoQ: Limit of Quantification

<p>Checked by:</p>  <p>Nihaz Ali Zahir Laboratory Services</p>	<p>Approved by:</p>  <p>Abdulla Rasheed Quality Officer</p>
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Notes:

Sampling Authority: Sampling was not done by MWSC Laboratory

This report shall not be reproduced except in full, without written approval of MWSC

This test report is ONLY FOR THE SAMPLES TESTED.

~ Information Supplied by the customer

* Parametres accredited by DAC under ISO/IEC 17025:2005

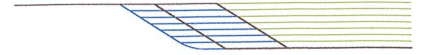
*****END OF THE REPORT*****



Guarantee Fiberglass Fabrication - GFF

Designer and manufacturer of fiberglass products.

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Date: 09/03/16

Ref No: FS/GOV-1020/GFF/16

Ibrahim Naeem,
Director General,
Environmental Protection Agency,
Ministry of Environment and Energy,
Ameenee Magu, Maafannu,
Male' 20392, Maldives

Dear Sir,

Sub: EIA for the Proposed Reclamation Project in K. Thilafushi – Guarantee Fiberglass Fabrication

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. Ahmed Luthfy
(Chairman)



Manufacturer · Contractor · Distributer · Importer · Since 1981

GFF

Tel:(960)3334763,3314709,3330918. **Mobile:**(960)7772682 **Fax:**(960)3326524.
Head Office: Filaa Building 1, 8th Floor. Koli Umar Manik Goalhi. Male', Maldives.
Factory: Kaafu Thilafushi. Plot Nos. 10, 11, 12, 13, 94 and 105.
E-mail:mb5m@dhivehinet.net.mv **Website:**www.guaranteefiberglass.com






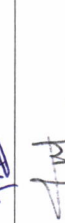
Environmental Protection Agency
Male', Rep of Maldives

Meeting: Reclamation of K. Thilafushi Plot No: S4-033

Date: 11/02/2016 (Thurs)

Time: 11:00

MEETING ATTENDANCE

	Name	Designation	Office	Email	Phone No.	Signature
01	Adnan	Coordinator	Guaranteee	wydadhen@gmail.com	7914709	
02	Ahmed Nihureh	Projects Coordinator	TCL	ahmed.nihureh@tcl.com.mv	7771745	
03	Mohamed Waseem	Manager projects	TCL	mohamed.waseem@tcl.com.mv	7791677	
04	Safa Ahmed	Asst. Director	EPA/ECA	safa.ahmed@epa.gov.mv	9645680	
05	FARATI AMJAD	ASST. RESEARCHER	MEECO	farah.amjad@meeeco.com.mv	7688861	
06	ALI HAMMADH	ASST. DIRECTOR	MEEC	ali.hammadh@meeeco.com.mv	1433241	
07						
08						
09						
10						

MP DinalShalika priyaruwan,

Parana Alupothagama,

Badalkumbura,

Monaragala,

Srilanka.

dinalshalika@gmail.com

+94773764203 /

+94555682479/+967685313

PERSONAL INFORMATIONS

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

Objective:

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

ACADEMIC QUALIFICATIONS

*Now following Civil HND.

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

- Which included following theory subjects:

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

Nishshanka Central College.Badalkumbura.

(1993 – 2007)

*General certificate of education Advanced Level – 2007

Biology – S Physics – S Chemistry – S

*General certificate of education Ordinary Level – 2003

A - 2 (Including Science) B -2 C – 6

TECHNICAL SKILLS

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

WORKING EXPERIENC E

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

* Preliminary hydrographic survey for EIA study of **Th-Guraidhoo**

* Tree & TOPO graphical survey for a construction requirement of

Hibalhidhoo island.

2)..May 2015- Up to now :Worked As a Land Surveyor At SAMMANEE ASSOCIATE.

& March 2014 –2015 Sep :As a Land Surveyor. Worked
At SGCC (Southern Group Civil Construction) pvt ltd.

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

*Thoppuwa-Dankotuwa- Naththandiya-Madampe.

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

(Widening, Improving and Asphalt Overlaying)

*Dayatakirula Project(Helagama to Okkampitiya).

* Galle fort access Road (Southern expressway).

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

* A-32 Road Project,(Mannar)

* Uva 5 Project Badulla.

PERSONAL REFEREES

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

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

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

Shalika M.P.D.

18/11/2015

Ali Hammadh

Address:

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

Personal statement

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

Key Skills

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

Employment History

Townsville Atmospherically deposited Dust Metal Study

(August 2014 – December 2014)

Responsibilities

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

Media report:

<http://mobile.abc.net.au/news/2014-12-05/high-toxin-levels-in-townsville-playgrounds-alarms-researchers/5946730?pfm=sm§ion=qld>

Laboratory Demonstrator At MQ University Study Labs

(June 2014 – July 2014)

Responsibilities:

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

Note Taker for Unit: PHYS 159

(August 2012 – December 2012)

Responsibilities:

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

Ministry Of Tourism

(February 2011 – March 2011)

Responsibilities:

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

Education

Macquarie University

(January 2012 – December 2014)

Award: Bachelor of Environment

Major: Chemistry

Environmental Management

- GPA 3.3

CHSE

(June 2008 – June 2010)

Four Edexcel Subjects

- Chemistry Grade A
- Physics Grade A
- Biology Grade B
- Maths Grade B

Majeediyya School

(2004 – 2007)

Six Cambridge GCE Subjects

- Chemistry Grade A
- Physics Grade A
- Biology Grade A
- Computer Studies Grade A
- English as a Second Language Grade A
- English Language Grade A

Jammaluddin School

(2000 - 2007)

Achievements

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

Hobbies & Interests

- Sea
- Diving
- Fishing
- Sports

References

Attachments include:

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

