

ENVIRONMENTAL IMPACT ASSESSMENT

FOR JETTY WORKS PROJECT
IN V. FULIDHOO



Prepared for: Ministry of Housing and Infrastructure (MHI)
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Acknowledgment

The author would like to acknowledge the kind support and assistance given by the proponent, the V. Fulidhoo Council and the residents of V. Fulidhoo in conducting the surveys and obtaining the relevant information to complete this report.

Consultants Declaration

As the lead consultant of this EIA,

This EIA has been prepared according to the EIA Regulations. I hereby, declare that the content in this EIA is complete, true, and correct to the best information that I had while compiling this EIA.

A handwritten signature in blue ink, consisting of several loops and a long horizontal stroke at the bottom.

Name: Hamdhoon Mohamed (EIA P03/2017)

Executive Summary

This report discusses the findings of the Environmental Impact Assessment (EIA) study undertaken by Independent Environmental Consultant (Mr. Hamdhoo Mohamed) recruited by Ministry of Housing and Infrastructure to construct a Jetty and associated dredging works at the Fulidhoo Island in Vaavu Atoll. This report is prepared in accordance with Environmental Impact Assessment Regulation (2007) under the Environmental Protection and Preservation Act (1993) and the Amendments to the EIA regulation. The purpose of this EIA report is to fulfill the requirements of the aforementioned law and regulation and conduct an assessment of possible impacts on the ecological, biophysical and socioeconomic environment arising from the proposed Jetty works project in V. Fulidhoo Island.

The main rationale of this project to construct a jetty at V. Fulidhoo is to provide a reliable accessibility infrastructure for the island residents in V. Fulidhoo. There is an existing old jetty. However, this jetty is inadequate to meet the demand of the jetty users. Moreover, the old jetty is surrounded by accreted sediments which make the jetty unusable during the low tide period.

The proposed project will involve construction of 31.5 m long T- jetty with 4 m width walkway, ground leveling the jetty area, dredging near Jetty area 40m width and 30 m length area, dredging a new entrance channel 24 m width & 181 m length. However, during the field assessments it was found that the proposed dredging area and the access channel have a depth in the range of 4 – 7 meters hence there will be no requirement of dredging during the construction phase of the project. Furthermore, it was found that if the jetty is constructed with a length of 31.5m, there may be a requirement for maintenance dredging during the operational phase of the project. Hence, it is recommended to extend the jetty length upto 60m which will reduce the requirement for the maintenance dredging during the operational phase as the depth of the jetty area will be around 5-6 meters.

Key Impacts

The project will involve impacts both during the construction and the operational phase of the project. The main project activities which may result in impacts during the construction phase include; excavation for piling the foundation and the footing of the jetty. However, the impact arising from this activity is expected to be short-term. Another project activity during the construction phase of the project which will have a significant impact is ground leveling of the jetty area. The ground leveling will be done from the excavated materials obtained from excavations to place the footing and piling foundation of the jetty.

The main project activities during the operational phase which may have a significant impact on the environment include: maintenance dredging during the operational phase of the project. However, there are very few scattered corals found on the jetty area, hence the direct loss of habitat will be minimal. Sedimentation will be a key impact during the maintenance dredging and with the proposed mitigation measures the impacts of the sedimentation will be reduced.

The other project activities which may have impact on the biophysical environment of V. Fulidhoo is stockpiling of the dredged material. The stockpiling will be done on locations identified in this report which are areas of shoreline which are prone to erosion. Coastal protection measures will be constructed prior to stockpiling of the dredged material in order to reduce the adverse impacts of sedimentation.

The major socioeconomic impact is found to be positive. The provision of a reliable accessibility infrastructure to V. Fulidhoo will improve the safety and livelihood of the island community in V. Fulidhoo. Furthermore, it is anticipated that the access to improved and reliable accessibility infrastructure will increase the economic opportunities for the island community of V. Fulidhoo in the form of local tourism.

Mitigation Measure

The mitigation measures were proposed based on conducting appropriate field surveys and environmental assessment of the V. Fulidhoo Island, proposed and alternative locations for jetty construction. The main mitigation measures which needs to be taken during the construction phase include carrying the excavation work only during low tide, exposing the excavated material to rain before utilizing it for ground leveling work and taking precautionary measures and making oil confinement equipment available in order to prevent oil spill accidents.

The main mitigation measures to be taken during the operation phase of the project include conducting the maintenance dredging during low tide. Continuous monitoring of the turbidity of seawater in order to reduce the sedimentation impacts during maintenance dredging works. Stockpiling of the dredged material should be done after treating the dredged material with rainwater and coastal protection measures need to be taken in order to avoid sedimentation as a result stockpiling the dredged material.

Alternate location, length of jetty and fate of the existing old jetty

Alternative location for the jetty construction was proposed on the south-western side of the island. However, the field assessments suggested that construction of jetty at the alternative location will have greater environmental and social impacts on V. Fulidhoo. Hence, the proposed location was chosen. **The length of the jetty is proposed for 31.5 m in length, however consideration should be given to extend the length to 60 m which will significantly reduce the chances for requirement of a maintenance dredging during operation of the jetty.** The existing old jetty can be removed which will enhance the longshore sediment transport. However, the island residents and island council intend to use this jetty for commercial purposes such as loading and unloading of goods and construction materials.

Environmental Management and Monitoring

An environmental management plan with environmental monitoring was developed taking into consideration the impacts and mitigation measures to be implemented. The important elements that require checks such as seawater quality, beach profile, coastal morphology and currents will be monitored according to the developed monitoring program during construction and operation period.

Although the project involves inevitable negative environmental impacts, such impacts are not serve as to not undertake the project. Mitigation measures have been proposed to adequately minimize the significant impacts. Hence, the project is justifiable in light of the socioeconomic conditions and anticipated benefits from the project which clearly outweigh the negative environmental impacts.

1. Introduction

1.1 Purpose of this report

This EIA report is aimed to fulfill the statutory requirements under the Environmental Protection & Preservation Act of the Maldives (Law No. 4/93) and precisely the Environmental Impact Assessment (EIA) Regulation (2007) and First Amendment (2012) to the EIA regulation. These legal frameworks were utilized as a basis for preparation of this document.

This Environmental Impact Assessment report is an evaluation of the potential environmental impacts which will accompany with the construction of a jetty in V. Fulidhoo and dredging of the jetty area and a new entrance channel. This report will provide background information on the project components of aforementioned project and their potential impacts on the natural and social environment of V. Fulidhoo island. Mitigation measures to minimize the environmental impact will be proposed in this report. An Environmental Management Plan and monitoring program will be formulated to evaluate the effectiveness of the proposed mitigation measure. Alternatives for the project components included but not limited to locations, designs, environmental considerations will be suggested in this report. Overall, this report will contribute to minimization of the environmental impact due to project interventions of proposed jetty works in V. Fulidhoo.

1.2 Project Title

The project is called Access Jetty works in V. Fulidhoo project.

1.3 Project Proponent

The proponent of this project is Ministry of Housing and Infrastructure (MHI). The Ministry of Housing and Infrastructure is mandated with provision of accessibility infrastructure to the citizen of the Maldives. This project contributes to the aforementioned mandate. The following are the details of the proponent;

Ministry of Housing and Infrastructure

Ameenee Magu, Maafannu

Male', Maldives

1.4 Scope of the EIA and Terms of Reference

As per the approved terms of reference, the scope of this Environmental Impact Assessment is to generally assess, identify and predict the environmental and social impacts of the proposed Jetty works project in V. Fulidhoo. The main project components include construction of 31.5 m long T- jetty with 4 m width walkway, ground leveling the jetty area, dredging near Jetty area 40m width and 30 m length area, dredging a new entrance channel 24 m width & 181 m length. However, during the field assessments it was found that there will be no requirement for dredging the jetty area or entrance channel during the construction phase of the project. However, the dredging may be required during the operational phase of the project. Importance was given to include all the project components and predict the environmental and social impacts which may arise due these project interventions. Furthermore, significance was given to ensure compliance with legal requirements of project of this nature.

This Environmental Impact Assessment study also include the existing natural and social environment of V. Fulidhoo and predicts the environmental impacts which may arise due to project and how these impacts can be managed, mitigated and reduced.

The assessment more specifically adheres to the Terms of Reference (TOR) issued by Environmental Protection Agency on 23rd July 2017. The TOR is based on scoping meetings held between the stakeholders on 18th July 2016. A copy of the TOR is attached in Annex 1 of this report.

The EIA report contains the following main aspects:

- A description of the project including the need for the project, how the project will be undertaken, full description of the relevant parts of the project, methodology used in the assessment, implementation schedules, site plans and summary of project inputs and outputs;
- A description of the pertinent national and international legislation;
- Information about the exiting baseline environmental conditions of the site. These include coastal and marine environment of the site and natural hazard vulnerability of the site;
- An assessment of the potential impacts during both construction and operational stages of the project as well as identification and cost of the potential mitigation measures to prevent or reduce significant negative impacts during both construction and operation stages of the project
- Assessment of alternatives for the proposed project
- Details of the environmental monitoring plan
- Conclusions

1.5 EIA Methodology

The methodology adopted to predict identify, predict & assess impacts of the project intervention include the following;

- Assessment of the baseline of the environmental indicators within the project area prior to project work initiation. This assessment was conducted via field survey which was aimed to determine the environmental components as well as the social aspects required under the approved TOR.
- Prediction of impacts on various environmental indicators by the project interventions such as excavation for placement of jetty footing and maintenance dredging if required during the operational phase of the project using environmental impact matrix.
- Ranking the predicted environmental impacts using significance analysis.
- Professional judgment, expert opinion and review of similar environmental impact assessment studies were used to for prediction and identification of environmental impacts and evaluation of these impacts.
- A specific section of this report has been dedicated to discuss various methods used for collection of baseline environmental and social data (See Section 4, page 35).
- The impact assessment methodology (environmental impact matrix) and significance analysis will be discussed in the Environmental Impact & Mitigation Measures (See Section 6, page 60 & 7, page 78).

1.6 Reviewed Reports

The following Environmental Impact Assessment reports have been reviewed as background information and for familiarization of project of similar nature. These reports were reviewed as a part of literature review for preparation of this EIA report;

- Environmental Impact Assessment to upgrade/renovation of vessel loading jetty at STO go-down (plot no 2) and Shore protection of the (plot no 111), at K. Thilafushi, Maldives;
- Environmental Impact Assessment for undertaking sand dredging at Gulhifalhu Jetty Area, Gulhifalhu, Kaafu atoll
- Environmental Impact Assessment for Rehabilitation and Repair of Harbour at Kanduhulhudhoo Island, Gaafu Alifu Atoll;
- Environmental Impact Assessment for rehabilitation and repair of harbor at Kumundhoo Island, Haa Dhaalu Atoll;
- Environmental Impact Assessment for the proposed harbour maintenance project in Feydhoo, Shaviyani atoll;
- Environmental Impact Assessment for the proposed harbour maintenance project in Narudhoo, Shaviyani atoll.

All these aforementioned EIAs were conducted for coastal modification projects which involves construction of accessibility infrastructure or coastal protection. Hence, these EIAs were used as a reference to understand the environmental impacts involved with coastal modification or construction of coastal infrastructure such as jetty or harbor.

1.7 Project Aims and Objectives

The aims and objectives of the Jetty works project in V. Fulidhoo is to develop a jetty facility which enhance the accessibility to V. Fulidhoo and also meet the requirement of the jetty users. The main components of the project include;

- construction of 31.5 m long T- jetty with 4 m width walkway;
- ground leveling the jetty area;
- dredging near Jetty area 40m width and 30 m length area;
- dredging a new entrance channel 24 m width & 181 m length.

However, during the field assessments it was found that there will be no requirement for dredging the jetty area or entrance channel during the construction phase of the project. However, the dredging may be required during the operational phase of the project.

2. Project Description

2.1 Project Location and Study Area

Fulidhoo is one of the inhabited island of (V) Vaavu Atoll of Maldives. The island of V. Fulidhoo is located 3° 40' 49.41" N and 73° 24' 57.41" E. The distance between the island and the capital Male' is approximately 55 km. The island measures approximately 0.68 km in length and 0.21 km in width. The Table 1 provides key information regarding V. Fulidhoo. The Figure 1 is a map showing the location and V. Fulidhoo and Figure 2 show the boundary of the study area which is expected to be impact by the project. The scaled plan of the proposed jetty construction works is attached on the Annex 02 of this report.

Table 1: Key information about V. Fulidhoo

Island Name	V. Fulidhoo
Location	3° 40' 49.41" N and 73° 24' 57.41" E
Population	360
Length	Approx. 684 m
Width (at the widest)	Approx. 217 m
Distance to Velana International Airport	Approx. 56 km



Figure 1: Aerial photograph and location of V. Fulidhoo

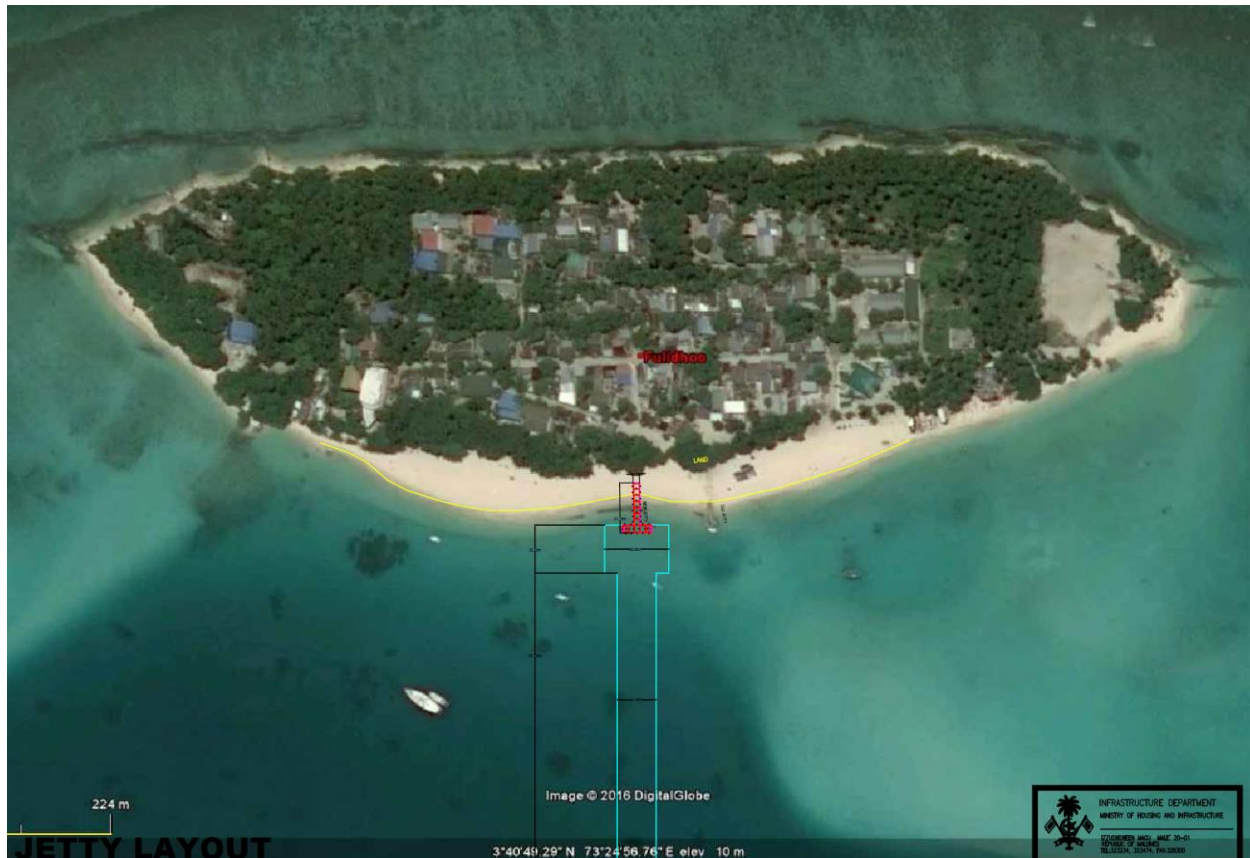


Figure 2: The study area for the EIA and project boundary

2.2 Justification for the project

Accessibility to the island is one of the key challenges faced by the islands in the Maldives. V. Fulidhoo faces the same problem. Due to ferry network operated by the Maldives Transport and Contracting Company (MTCC) there are large number of island residents travelling between the other islands of the V. atoll and to the capital Male' city. These travelers require easy accessibility to the island. Furthermore, there are 9 tourist facilities in the form of guesthouses operational in V. Fulidhoo and 9 more planned to be opened in a near future. These tourist facilities require a proper accessibility infrastructure in V. Fulidhoo. Many of the recreational activities such as diving, snorkeling and recreational fishing which is offered by these tourist facilities require a proper accessibility infrastructure such as a jetty.

2.2.1 Current Situation

There is an existing jetty in the island. This is the 7th Jetty which has been constructed in the island. The current jetty is inadequate to meet the demands of the jetty users. The jetty area has been accreted with sediments from the longshore sediment transport. Most of the accreted sediments include fine sand particles. Accretion of the sediments have made the existing jetty futile during low tide and boats has to be anchored in deeper areas of the lagoon and people use small boat such as “dingee” or “bohkuraa” to access the island. The Figure 3 are photographs of existing jetty which vividly shows the level of sediment accretion near the jetty area. In addition, the jetty area is dangerous to be used during the rough weather as the depth around the jetty area is very shallow.



Figure 3: A photograph of MTCC ferry users using the existing old jetty in V. Fulidhoo & level of accretion around the jetty area of V. Fulidhoo

2.2.2 Expected Benefits of the project

The proposed jetty works project is expected to construct a jetty which will be suitable for jetty users in V. Fulidhoo. The jetty will be 31.5 m in length T-jetty with a walkway with a width of 4 m. The jetty will be constructed just west of the existing old jetty (see Figure 2). The newly constructed jetty will be used solely for the purpose of island access. The tourist facilities and commuters of ferry network as well as fisherman of the island are expected to benefit from this proposed jetty as they have a reliable access infrastructure for the island. Maintenance dredging will be carried out by the proponent in order to maintain the desirable depth during the operational phase of the project if required.

The construction of the proposed jetty is expected to have economic benefits for the island community in V. Fulidhoo as tourist facilities could engage their guest in various recreational activities such as diving, snorkeling and fishing which require a reliable accessibility infrastructure. Furthermore, accidents involving small boats which carry passenger between boats and island will be significantly reduced thus eliminating risk of accidents during accessing the island.

2.3 The project

2.3.1 The project outline and project site plan

The project mainly involves construction of a jetty on V. Fulidhoo island and associated works. The project main components include the following;

- construction of 31.5 m long T- jetty with 4 m width walkway;
- ground leveling the jetty area;
- dredging near Jetty area 40m width and 30 m length area;
- dredging a new entrance channel 24 m width & 181 m length.

The Figure 4 is a schematic diagram of the proposed project activities;



Figure 4: Schematic diagram of the project components

2.4 Detailed Project Outline

2.4.1 Construction of the T-jetty

2.4.1.1 Dimensions and Construction Materials

The proposed dimension of the jetty is 31.5 m in length with a walkway of 4m width. The structural diagrams of the jetty are attached in the Annex 03 of this report. The construction materials which will be used for construction of the T-jetty include cement, steel bars and aggregates.

A total of 38 concrete columns will be placed into the sea bed as a footing structure for the concrete deck of the jetty. The diameter of the concrete column will be 0.25 m and they will have place in a foundation of 1.2 m x 1.2m x 0.3 m concrete foundation. The excavations will be done into a depth of 1.2m below the sea bed.

2.4.1.2 Method, equipment & Justification

Footing of the jetty will be made from concrete columns placed on pre-cast concrete footings. The footing will be made on land and placed using the barge. The columns will be transported to the jetty area on trucks or excavators. Since the pre-casting and temporary construction area is in close proximity to project area and it's an area within the beach zone no vegetation clearance will be involved. Once the concrete columns are in place, in-situ beams will be cast to receive concrete deck.

The main equipment used for the project include Dozer, Dump truck, Excavators, Barge, Concrete mixer.

The aforementioned method for construction of the T-jetty is considered to have limited impacts on the environment. There will be no land clearance or removal of any tree involved in the project.

2.4.1.3 Duration of the construction works

The expected duration of the project is 12 months. The construction of the jetty is expected to take 9 months for completion. The Figure 5 is the project schedule.

	MONTHS											
	1	2	3	4	5	6	7	8	9	10	11	12
Awarding contract	■											
Finalise detail design	■											
Preliminary works		■	■									
Mobilization			■	■								
Construction of footings and columns				■	■	■						
Installation of columns					■	■	■	■	■			
Construction of beams and deck							■	■	■	■		
Demobilization											■	■
Handover the project												■

Figure 5: The project schedule

2.4.1.4 Labor requirement and availability of the local labor

It is expected that approximately 10 semi-skilled workers and 1 supervisor will be the workforce requirement for the proposed jetty works project in V. Fulidhoo. The contractor will recruit local workforce where possible, however due to the small population of the island and many are employed in service industry and fisheries, expatriate workers may be recruited by the contractor to supplement the locally recruited workers.

2.4.1.5 Housing for temporary labor

The housing for the temporary expatriate workers will be in the existing facilities of the island including local rental facilities. No labor quarter will be established for this project as very few workers are involved in this project.

2.4.1.6 Site location for the concrete works

The site for the concrete work is just north of the proposed project location. This area is within the beach area and no vegetation clearance will be required as this site is already cleared. The Figure 6 shows the location of the temporary construction site where the concrete works will be carried out.

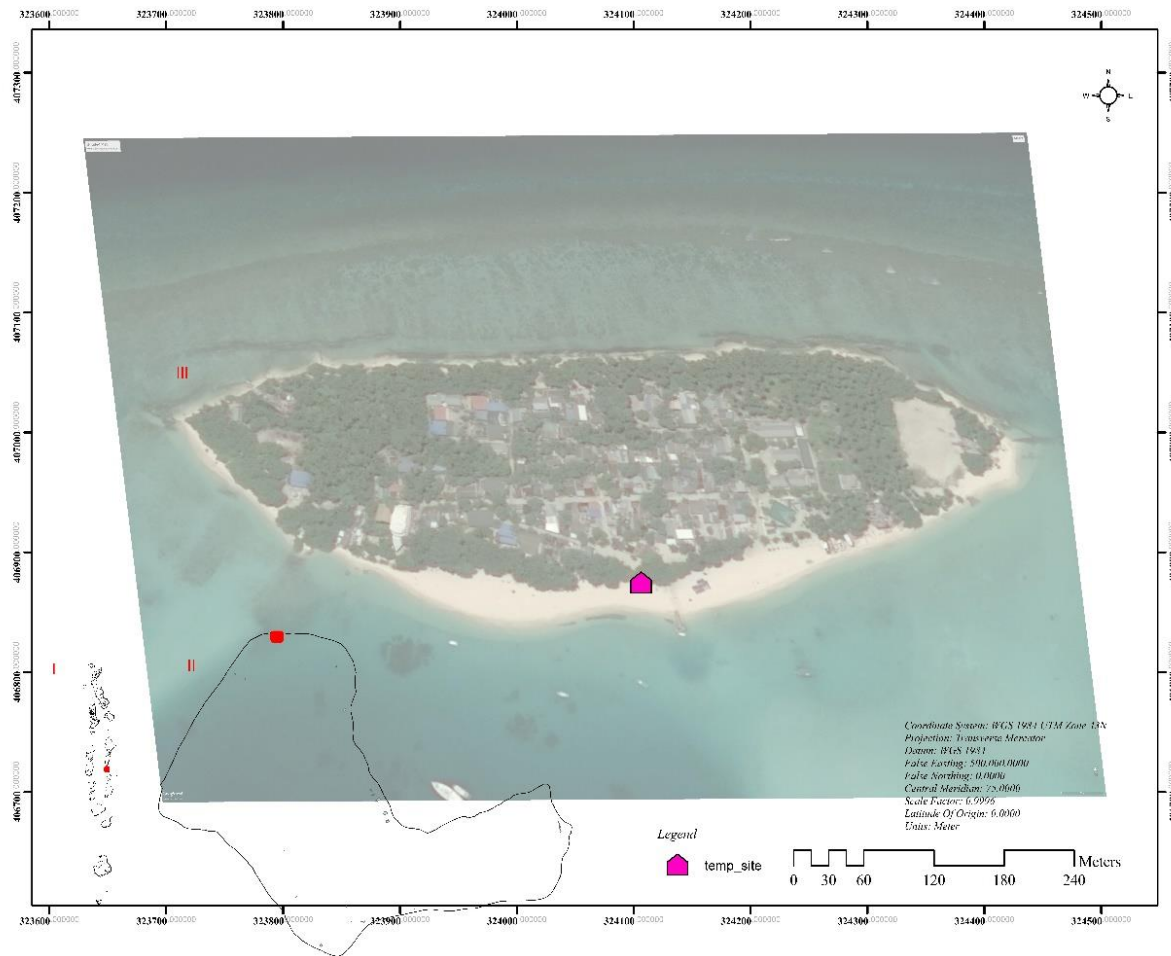


Figure 6: The location of the temporary construction site

2.4.1.7 Emergency plan in case of spills

An emergency response plan for spills involving diesel, grease & oil would be in place prior to commencement of the construction. This plan would be consisting of the following precautionary and preparatory measures including;

- Placement of the fuel storage area away from sensitive environment. In this case the fuel will be stored in the local fuel storage facility existing in V. Fulidhoo;
- Storage in secure and bunded facilities;
- Training of the workers on good practices in fuel handling and response protocols;
- Installation of warning signs;
- Installation of response kits at easily accessible locations. The kit would include absorbents, personal protective equipment and clean-up equipment such as oil boom.
- Risk assessment, including identification of hazards, potential triggers, contaminant pathways, and impact thresholds for different chemicals
- Response procedure, defining roles and responsibilities of key personnel
- Communication protocols- among responsible personnel, and to authorities and neighbours, if required
- Long-term environmental monitoring, if required.

2.4.2 Dredging of the jetty area and access channel

2.4.2.1 Location and size of dredged area

The dredging was proposed just south-west of the jetty construction location and an access channel just southern side of the jetty. A schematic diagram of the proposed dredging areas is attached in Annex 02 of this report. The proposed size of dredging area is 40m width and 30 m length area. The proposed area of the entrance channel is 24 m width & 181 m length.

The initial assessment of the bathymetry of this proposed area shows that the average depth of this area is between 4 – 7 meters hence there will be no requirement for dredging in the project construction phase. However, the following description in this section is regarding the dredging method and equipment is applicable if there is a need for maintenance dredging during the operational phase of the project. The analysis of the coastal dynamics suggest that maintenance dredging is very likely required during the operational phase of the project if the length of the proposed jetty is not extended to 60m in length.

2.4.2.2 Method and equipment for dredging

Dredging although is not expected to be a major activity under the construction phase of the project. However, dredging is expected during the operational phase project. The process involves the following three steps; excavation, transport and disposal.

2.4.2.2.1 Excavation

It involves dislodgement of and removal of sediments and/or rocks from sea bottom of the dredge areas. An excavator will be used to dredge the material by mechanical actions. The dredging will be performed utilizing a CAT 330 hydraulic excavator equipped with Young's 3-yd hydraulic bucket. Dredging will be

conducted from a work barge platform and placed into position with a tug boat and anchored in specific locations using spuds deployed from the work barge.

2.4.2.2.2 Transport of Excavated Material

Transporting material from the dredging area to the site of utilization will be achieved as follows. Sediments will be dumped into trucks placed on a barge; when the truck is full, barge will carry the truck to the shore from where the truck move out of the barge to transport the sediment to the location of replenishment meanwhile the barge will transfer a second empty truck to the location of work barge.

Excavator with appropriate bucket size has been recommended due to the relatively small size of the area requiring dredging and due to relative simplicity of the methodology for not having to do much pre-work preparation and to shorten the job schedule.

2.4.2.2.3 Disposal of the dredged material

The dredged material will be stockpiled in a location of south-eastern side of the island and the western and south-western side of the island. The Figure 7 show the location proposed for stockpiling of the dredged material. These materials are expected to nourish the beach area and act as a coastal protection in the area which is highly susceptible for erosion. Therefore, it is highly important to construct a coastal protection measure such as off-shore break waters or on-shore rock boulders in order to prevent further erosion prior to the stockpiling of dredged material.

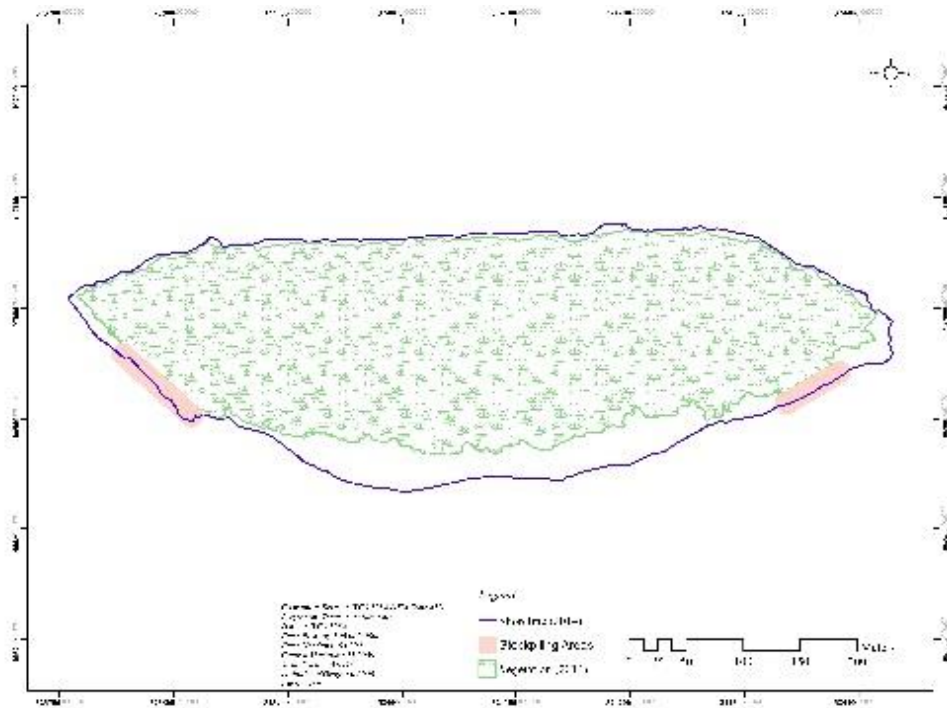


Figure 7: The proposed location for stockpiling of the dredged material during maintenance dredging in operational phase.

2.4.3 Levelling of the jetty area

Ground leveling of the jetty area will be done using the excavated material obtained from excavation for placement of the footing of the jetty. The excavated material will be kept in rain in order to reduce the saline content in the excavated material.

2.4.4 Waste Management

The main waste expected to be generated from the project include excavation materials, solid wastes in minor quantities and hazardous waste generated such as waste oil, lubricants, and chemicals, batteries in minor amounts. The following regime will be followed as waste management protocols of the project;

- The approach for development of the project is to avoid or to reduce the volume of waste generated and to re-use where possible and disposal according to the legislative requirements. No waste generated from the project will be add to the waste stream of the island. Project waste management protocol shall be developed in line with the Regulation and will be strictly followed and monitored.
- Arrangements will be made for handling temporary storage and final disposal. Waste transfer vessel shall be available for the timely removal of waste from the site.
- No large-scale recyclable waste material (e.g. metal) are expected from the project. Priority will be given for segregation of such waste from the non-inert construction waste for stockpiling at a designated site which has the potential for selling to vendors re-exporting such materials. The remaining non-recyclable waste materials will be disposed of at Thilafushi. Similarly, waste generated from the workforce shall be managed giving priority to waste separation to maximize the diversion of construction waste from being sent to Thilafushi. Non-recyclable waste will be disposed of at Thilafushi landfill sites.
- It is expected that small quantity of chemical waste will be generated during construction, which would be properly handled, stored, labelled and disposed of in accordance with the Waste Disposal Regulation at Thilafushi.
- Provided that all the identified waste materials are handled, transported and reused/disposed of in strict accordance with the relevant legislative and recommended good site practices and mitigation measures are properly implemented, no unacceptable environmental impacts are expected during the construction and operational phase.
- Floating wastes that may accumulate in the jetty area will regularly collected and managed by the Island Council during the operational phase.
- The transportation of the waste to Thilafushi is expected to be around 1500 MVR per trip.

2.4.5 Power, water and sewerage

The power required by the project for various construction activities will be obtained from the existing power grid in the V. Fulidhoo. Due to the scale of the project, there will be no provision of an independent generator for the project.

Water required for various construction activities will be obtained from water resources available in the island. The water will be extracted from already existing wells and existing community rainwater harvesting tanks. No additional well or borehole will be dug to obtain water required for the project.

2.4.6 The project inputs and outputs

The Table 2 provides a synthesis of major project inputs and outputs including how the resources will be sourced for the project. This synthesis is closely linked to identifying potential impacts of the project and recommendation of associated mitigation measures.

Table 2: The Major Project Inputs and Outputs for Jetty works project in V. Fulidhoo

Phase	Major inputs/outputs	Source/Type	How resource will be obtained/Remarks
Construction Phase	Construction materials	cement, steel bars and aggregates.	Almost all construction materials will be purchased in bulk from abroad and will be brought to island in containers. Machines and equipment will also be purchased from abroad.
	Equipment	02 excavators 02 dump trucks 01 loader 01 Concrete machine 01 Barge 01 Workshop container 01 Tug boats	To be obtained and operated by the contractor. Contractor will be required to bring to the site machines in good working conditions to avoid loss of time due to breakdown of machines, vehicles and equipment.
	Workforce approximately 10 labourers	Most semi-skilled workers will be foreign labourers. Priority will be given to local subcontractors from the island for various works. Engineers and Supervisor will be employed by contractors.	Main contractor is responsible for the workforce during construction period.
	Water	Water needed during the construction phase will be obtained from island and community rainwater harvesting tanks.	The water required for the project will be obtained from rainwater harvesting and existing wells in the island.

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	Electricity	Diesel generators	The electricity demand for the project will be obtained from the existing electricity in the V. Fulidhoo.
	Fuel	The main types of fuel to be utilized for the project work include petrol and diesel.	The fuel requirement for the project activities will be met via locally purchased fuel.
Operational Phase	Waste	Minor amounts	No wastes during the excavation will be allowed to be dumped into the sea. Human wastes will be managed through the existing wastewater management techniques available in the island. Solid waste may be transferred to Thilafushi due to proximity of the project location to Thilafushi waste disposal site.
	T- Jetty	The length of the jetty will be 31.5m but a provision for 60m jetty is recommended	
	Dredged Material	Minor quantities	The excavation material during the construction face will be used for ground levelling at jetty area. The dredged material during maintenance dredging will be stockpiled in certain locations.
	Waste oil and lubricants	Minor quantities	Gathered in a barrel and sent to Thilafushi.
	Noise	Localized disturbance	Operation of trucks and excavators will result in some level of noise. No work will be conducted at night to avoid

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			disturbance to residents living close by.
	Plastic waste	Small quantities	Will be managed through proposed solid waste management regime for the project.

The Table 3 is a matrix of the waste generated during the construction and operation of the project and their expected quantities and how waste will be managed.

Table 3: A matrix of the waste expected to be generated during the construction and implementation phase

Type of Waste	Expected Quantities	Method of Disposal
Waste oil from machinery	Minute quantities	Re-used for other applications
Construction waste such as card board, scrap metals etc	Small quantities	Recycled or managed through existing solid waste management system in the island.
Used oil and grease	Minute quantities	Reused by local garages or the contractor. Unusable waste oil will be stored in Barrel and sent to Thilafushi for disposal.
General Waste (Kitchen waste or human waste)	Small to moderate quantities	Disposed through existing solid waste management system in the island and wastewater treatment system in the island.
Excavated Material/Dredged material	Large quantities	The excavation material during the construction face will be used for ground levelling at jetty area. The dredged material during maintenance dredging will be stockpiled in certain locations identified in this report.

3. Policy and Legislative Framework

3.1 Regulatory Consideration

Due to the multitude nature of activities that take place during the construction of jetty and accompanying works in V. Fulidhoo, a number of laws, bi-laws and regulations that fall under the mandates of various government agencies come into play. This section highlights relevant national legislative framework applicable to the proposed project. The relevant national legislative framework provides guidance on several aspects related to planning, construction and operating a jetty and accompanying dredging works in the Maldives. The legal frameworks pertaining to the proposed project is also aimed at sustainable development, impact mitigation and conservation of the country's natural resources. The main national legislative framework relevant to this proposed project and proposed compliance arrangements are summarized in the below;

3.1.1 Environmental Protection and Preservation Act (Law no. 4/93)

The Environmental Protection and Preservation Act is the main legal framework for environmental protection in the Maldives. This law is the main legal instrument requires all the development project which may have a significant impact on the environment undergo environmental impact assessment process. The EIA process is administered by Environmental protection Agency (EPA) on behalf of the Ministry of Environment and Energy.

Article 2 of the Environmental Protection and Preservation Act has given mandate for Ministry of Environment and Energy to formulate relevant policies and regulations to preserve and protect the environment of the Maldives. These regulations and policies which are relevant for the project has been discussed in this section.

Article 5 (a) addresses the submission of an EIA. It states that any developing project that may have a potential impact on the environment requires an EIA submission. As per the article the Ministry of Environment and Energy is responsible for developing relevant regulations responsible for administration of the EIA process in the Maldives. These include implementation of EIA process and quality assurance of the EIA system in the Maldives.

In order for compliance of this law, an EIA is carried out prior to the construction phase of this project.

3.1.2 Environmental Impact Assessment Regulation (2007), First Amendment (2012) and Second Amendment (2015)

The most significant regulation concerning the proposed Jetty works project in V. Fulidhoo is Environmental Impact Assessment Regulation (2007) under Environmental Protection and Preservation Act. This regulation includes all the regulatory guidelines for the EIA process in the Maldives.

The first amendment to the environmental impact assessment in 2012, outlined the prime EIA procedures to be conducted and the process which development projects which require EIA should follow. It also enlisted the project which will require an EIA study to be conducted prior to the commencement of the project.

The second amendment to the environmental impact assessment regulation in 2015, excluded tourism sector related EIAs as EIA process and procedures related to tourism sector development was included to the Tourism Act (Law no. 22/99). The second amendment to the environmental impact assessment regulation also included certain administrative changes to the EIA process in the Maldives.

However, since the proposed construction of jetty and accompanying dredging project is a coastal infrastructure project, an EIA study needs to be conducted in order to comply with this regulation.

3.1.3 Dredging and Reclamation Regulation (2013)

The regulation of dredging and reclamation came into effect in April 2013. As per the requirements of the regulation, permission from EPA has to be obtained for any project which require alteration of the island either by reclamation or dredging. 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.

The proposed project has to submit an application along with the EIA report for a dredging permit under the regulation and with the recent administrative change by EPA, the dredging permit will be given at the time of approving the EIA.

3.1.4 Environmental Damage Liabilities Regulation (2011)

As a regulation under the Environmental Protection and Preservation Act (No. 4/93), the Ministry of Environment and Energy has formulated the Environmental Damage Liabilities Regulation in February 2011. This regulation includes the basis to avoid environmental deterioration, extinction of biological resources, environmental degradation and avoid wastage of natural resources.

The prime purpose of this regulation is to cease any unlawful activities on environment and implement a punitive procedure for violations and also implement a compensation mechanism on environmental damages. The Schedules of this regulation forms the basis for levying fines on various environmentally damaging components and activities.

The proposed project will be subject to this regulation for any activity outside of the EIA scope and EIA decision statement.

3.1.5 National biodiversity strategy and action plan

The goal of the National Biodiversity Strategy and Action Plan (NBSAP) are:

- Conservation of biological diversity and sustainable utilization of biological resources
- Build capacity for biodiversity conservation through strong governance framework and improved knowledge and understanding
- Foster community participation and support for biodiversity conservation

Consideration of the goals of NBSAP shall be taken into account in implementation of the project activities for minimizing potential loss of biodiversity in the area. The proponent (Ministry of Housing and Infrastructure) has committed on conservation and protection of environment while undertaking this project. Qualitative and quantitative surveys were undertaken to assess baseline coral reef and marine environment biological diversity. Practical mitigation to minimize the impact and monitoring strategies have been identified to protect the biodiversity.

3.1.6 Protected Areas and Environmentally Sensitive Areas

Under article 4 of the Environment Protection and Preservation Act of Maldives, the Ministry of Environment is vested with the responsibility of identifying and designation of protected areas and natural and drawing up rules and regulations for the management of protected areas and natural reserves in the country.

The proposed project does not propose development in a protected area and there are no protected sites in the vicinity of the site. The site surveys also showed that there no environmentally sensitive areas close to the proposed site.

3.1.7 Waste management policy

Ministry of Environment and Energy has developed a framework for a national waste management policy. The main components of this policy include safe disposal of solid waste, ensuring safe disposal of chemical industrial and hazardous waste.

Waste management of the proposed jetty works in V. Fulidhoo project will be in line with the waste management policy.

3.1.8 By-law on cutting down, uprooting, digging out and export of trees and palms

The by-law on cutting down, uprooting, digging out and export of trees and palms states that the cutting down, uprooting, digging out and export of trees and palms from one island to another should only be done if there is an absolute necessity and no other alternative. It also states that for every tree removed two more trees should be planted in the island.

Removal of the following types of tree is totally prohibited under the by-law;

- The coastal vegetation growing 15m from the shoreline and inwards toward the center of the island;
- All the trees and palms growing in mangrove and wetlands spreading to 15 meters of land area;
- All trees and palms that are growing in a designated protected area;
- Trees which are protected by the government to protect animal species which lives in the tree;
- Trees that are unusual in their structure.

The proposed Jetty Works project in V. Fulidhoo fully adheres to this bi-law as not vegetation clearance will be involved in the project.

3.2 International conventions, treaties and protocols

International conventions, treaties and protocols of most relevance to the proposed project may be identified as follows:

3.2.1 United Nations Convention on Biological Diversity (UNCBD)

The objective of UNCBD is “the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies and by appropriate funding”.

The proposed jetty works project in V. Fulidhoo will be in line with the UNCBD convention as the adverse impacts on marine biodiversity will be reduced via successful implementation of the mitigation measures.

3.2.2 The Marpol Convention

International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. Pollution and that from routine operations - and currently includes Prevention of Pollution by Oil; Control of Pollution by Noxious Liquid Substances in Bulk; Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form; Prevention of Pollution by Sewage from Ships; Prevention of Pollution by Garbage from Ships; and Prevention of Air Pollution from Ships.

Special consideration will be given to avoid spillage of fuel and other oils into the marine environment during the construction phase of the Jetty Works project in V. Fulidhoo.

3.2.3 United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is the multilateral environmental agreement which deals with mitigation and adaptation for the climate change. Under the UNFCCC the main legal instrument was Kyoto Protocol which ended on 2015. A new climate agreement known as Paris Agreement was negotiated on the Conference of the Parties number 21 in Paris, France. Maldives has ratified the Paris Agreement and has a Nationally Determined Contribution (NDC) of reducing its business as Usual (BAU) by 10 percent by the year 2030.

The proposed Jetty Works in V. Fulidhoo contributes to the emission of GHG due to fossil fuel burning. The potentially fuel-efficient machinery and equipment will be explored in order to contribute to the Government effort to fulfill the NDC outlined in the Paris Agreement.

3.3 Administrative Considerations

Due to the cross-cutting nature of the proposed Jetty Works project in V. Fulidhoo and as can be seen from the governing legal framework of the developmental aspects coastal & accessibility infrastructure as described above, a number of governmental agencies have a stake in the Project. The most of important government stakeholders of the Project are the Ministry of Environment and Energy and the V. Fulidhoo Island Council. The Ministry of Environment and Energy is responsible for EIA process in the Maldives. V. Fulidhoo Island Council will be responsible for maintenance of the jetty during the operational phase of the project.

3.3.1 Ministry of Environment and Energy

The Ministry of Environment and Energy (MEE) is key Ministry in the government mandated with the 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 either submit to EPA and 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.

3.3.2 Environmental Protection Agency (EPA)

EPA is the key regulatory body on environment, which is a semi-autonomous body formed under the umbrella of the 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 water and sewerage designs and registering RO plants.

3.3.3 Island and Atoll Councils

The Vaavu Atoll Council was established under the Act on Decentralization of the Administrative Divisions of the Maldives (Law Number 7/2010). The Council has specific responsibilities with regards to the governing the projects and activities that fall within the jurisdiction of Vaavu Atoll. Since the Council shall be accountable to the people of the Atoll, the Council has been involved in the preparation of the EIA report. A copy of the EIA report was submitted to the Atoll Council.

The government of the Maldives have decided to include the Vaavu atoll within the jurisdiction of the greater Male' Area in 2017. However, at the time of submission of this EIA report the decision of inclusion of Vaavu atoll in the greater Male' region has not been implemented by the Local Government Authority of the Maldives.

V. Fulidhoo Island council is one of the most important stakeholders of this proposed Jetty Works project in V. Fulidhoo. They are mandated with formulation of land use plans for their jurisdiction. They are also involved in the allocation of the land for different projects.

This report has been shared with both Vaavu atoll council and V. Fulidhoo Island Council for information.

3.4 Permits Obtained and Required

The following the permits which are already obtained or required from the government agencies prior to implementation of Jetty Works Project in V. Fulidhoo. These include;

3.4.1 Dredging and Reclamation Permit

In order to compliant with the Dredging and Reclamation Regulation 2013 (See Section 3.1.3) an application to obtain the dredging and reclamation permit will be applied.

3.4.2 EIA Approval

The most important environmental permit to initiate the proposed project in the lagoon would be approval of this EIA report and issuance of an Environmental Decision Statement. The EIA Decision Statement, as it is referred to, shall govern the manner in which the project activities must be undertaken. It will be the final environmental clearance granted by the EPA for the proposed project.

4. Survey Methods

This section of the report will describe the survey methods used by the EIA consultant to collect and record the baseline environmental conditions associated with the Jetty Works project in V. Fulidhoo. The following were done in order to complete this impact study. The key components that were considered are, physical, social and economic environment. Following methods were used in the analysis.

- Assessment of existing environment to identify significant environmental components that would be impacted
- Public consultations to exchange information on the project and consider their concerns
- Literature review of similar projects

4.1 General Methodology of Data collection

The methodologies used for scientific analysis of the environment are standard and internationally accepted methods of environmental assessment. Coastal and marine environment was studied using the methods and parameters that is widely practiced.

4.2 Mapping and location Identification

The reef line, shoreline and vegetation line and existing infrastructure was mapped. Mapping was undertaken using standard DGPS and mapped on AutoCAD and ArcGIS.

4.3 Bathymetry

Bathymetric survey of the area proposed for access jetty construction in V. Fulidhoo, was carried out by using echo sounder and a GPS. Differential GPS technique is used for correction of GPS locations points. Echo sounder measurements are corrected and related to the mean sea-level for the area.

4.4 Coastal Dynamics

Combination of remote sensing and GIS technology and field mapping and ground truthing were used to assess the long term coastal and morphological changes of the islands. Google earth historical image sequence was co-georeferenced with the survey data and comparatively evaluated using GIS technology to assess the long term geomorphological developments of the island. Changes in the shoreline from 2011-2014 was documented using Google earth images. Shoreline mapping of the Southern beach was conducted.

4.5 Marine Survey

4.5.1 Photo Quadrat Methodology

Photo Quadrat method was used to estimate the live coral coverage and the substrate composition at sample locations of the reef.

Equipment

- 0.5 m² PVC quadrat
- 50 m transect tape
- Digital Camera

Procedure

- Survey sites were selected, and at each site the start point was marked at a 2 m depth along the top reef.
- The transect tape was tightly stretched along the bottom of the 2 m depth contour, covering a length of 50 meters.
- The quadrat was then placed alongside the transect tape at every 5 meters.
- A digital photograph of each quadrat was taken from a fixed distance from the bottom.
- On completion of the survey, the digital photographs were processed using Coral Point Count with Excel extension. For each quadrat image 20 random points were selected, and counted using the software.
- The mean count for each substrate type (e.g. Live Coral, Dead Coral with Algae (DCA), Sand/Rubble/Rock (SPR) etc.) was then calculated for the respective sites.

4.5.2 Fish Belt Transect Methodology

Fish belt transect method is used to count the abundance and estimate the composition of different fish species that occurs at a site.

Equipment

- Slate with Pencil
- 50 m transect tape

Procedure

- Fish belt transect surveys were carried out during day time hours
- Transect tapes laid for Photo Quadrat Survey were utilized for this survey
- An observer swam slowly along the transect tape recording the fishes encountered in a 5 m belt.
- Abundance categories recorded: Single (S - 1 Fish), Few (F - 2-10 Fishes), Many (M - 11 – 100 Fishes), and Abundance (A - > 100 Fishes)

4.6 Water Quality

The quality of the marine and ground water in the proposed development site was assessed by testing water samples at location in Figure 9. The samples were tested at the MWSC laboratory. The parameter that was tested are conductivity, turbidity and pH and minerals tests.

4.7 Public consultation

The baseline socioeconomic condition of the island community was assessed using different methods of stakeholder consultations. A scoping meeting was held at Environmental Protection Agency with the involvement of the stakeholders. A focus group interview was conducted island community representatives of V. Fulidhoo. A meeting was held in the V. Fulidhoo council office regarding the proposed access jetty works project.

4.8 Uncertainties in Data Collection Method

Since most of the data on the existing environment was collected manually, human error could be the biggest uncertainty with reference to the data collection methods. However, Global Positioning System (GPS) coordinates have been recorded for future monitoring purposes. This utilization of GPS will reduce human error as exact GPS points can be monitored in future to assess changes as the result of project interventions.

Other uncertainty in the field data collected could be the timing in which assessments were conducted. The conditions in the existing environment such as waves, currents and fish populations changes from season to seasons. Nonetheless, the methods used for collection of data is very popular for environmental monitoring endeavors.

Another aspect which require special consideration which may affect the uncertainty of the data collected is limited time spend on field for environmental data collection. As a result of this, some of the assessments especially on the marine environment were done rapidly as a vast area from the surrounding environment has to be covered as part of this EIA.

5. Existing Environment

5.1 General Setting

This section covers the existing environment of V. Fulidhoo Island. Fulidhoo Island is situated in the northern Vaavu atoll as shown in Figure 8. The island is approximately 684 m long and 217 m wide. The island has an area of approximately 11.6 hectares.

V. Fulidhoo has a large reef system. The reef system is oriented in an East to West direction with the island also being oriented in a similar orientation. The island is located on the centre of the reef system and this is the only island in this large reef system. The reef system spans a length of approximately 11.90 km with a width of 1.79 km at its widest point. The closest inhabited island is V. Thinadhoo situated to the south east of the island. V. Fulidhoo is the sole inhabited island in the northern Vaavu Atoll and is situated far away from the rest of the inhabited island of Vaavu Atoll. V. Fulidhoo is located as shown in Figure 8.



Figure 8: The location of Fulidhoo in Vaavu atoll and aerial photography of V. Fulidhoo

5.2 Locations of the survey

The following Table 4 is the geographical position of the surveyed locations. These coordinates were recorded so that they can be used during the monitoring surveys. The Figure 9 is a map showing different surveyed location enlisted in the Table 4.



Figure 9: The locations of the field surveys

Table 4: The GPS coordinates for the field survey locations

Location	Significance	GPS Coordinates
M1	Marine survey location 1 Water sample location 1	3°40'43.55166" N 73°24'54.01123" E
M2	Marine survey location 2 Water sample location 2	3°40'44.34576" N 73°24'56.09163" E
M3	Marine survey location 3 Water sample location 3	3°40'44.75098" N 73°24'59.32976" E
PT1	Protected Tree (<i>Ficus benghalensis L</i>)	3°40'51.52168" N 73°24'57.65842" E
ST1	Environmentally Sensitive Tree 1 (<i>Ficus benghalensis L</i>)	3°40'47.17646" N 73°24'57.90836" E
ST2	Environmentally Sensitive Tree 2 (<i>Ficus benghalensis L</i>)	3°40'47.30408" N 73°24'56.70433" E
ST3	Environmentally Sensitive Tree 3 (<i>Ficus benghalensis L</i>)	3°40'47.43399" N 73°24'53.14238" E

5.3 Climatology

The Indian Ocean Monsoons governs the climatology of the Maldives hence monsoonal reversal plays a significant role in weather patterns. Two very distinct monsoons are observed: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. Monsoons can be best characterized by direction of wind and the amount of rainfall. The southwest (SW) monsoon is the rainy season which lasts from May to September and the northeast (NE) monsoon is the dry season that occurs from December to February. The transition period of SW monsoon occurs from March and April while that of NE monsoon occurs from October to November. The results are summarized in Table 5: Summary of the seasons in the Maldives.

Table 5: Summary of the seasons in the Maldives

Season	NE-Monsoon	Transition Period 1	SW-Monsoon	Transition Period 2
Month	Dec, Jan, Feb	Mar, Apr	May, Jun, Jul, Aug, Sep	Oct, Nov

Since there were no site-specific wind data, wind regime around the island was assumed to be that similar to the closest meteorological stations. The closest station is the meteorological station at the Male’ international airport from 2002 to 2006. Figure 10 below represents mean daily wind speeds and direction. It was determined that the winds from WSW to WNW is the dominant wind direction in the Southwest Monsoon, where wind from ENE and E was dominant during the North-East Monsoon. Wind determines the direction of the sediment movement and have an influence on the alongshore current patterns.

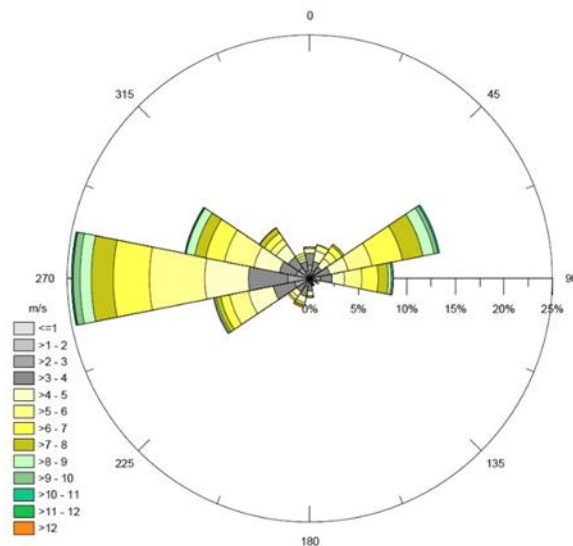


Figure 10: Wind speed and direction at Male’ international airport (adapted from EIA Lamer 2008)

5.3.1 Temperature

The daily average temperature varies between 25 °C and 32 °C. The temperature rarely drop below 25 °C and rarely go above 32 °C. The warm period of the year is between March to May with an average daily temperature above 31°C. The hottest day of the year during April, with an average high of 32°C and low of 28°C.

The cool periods last from either October or November to January with an average daily high temperature below 30 °C. The coldest day of the year is around mid-December, with an average low of 26 °C and high of 30 °C. The sea surface temperature in the Indian Ocean in July 2014 was recorded to be around 29 – 30 °C.

5.3.2 Rainfall

V. Fulidhoo is located in a medium rainfall zone of the country. Rainfall data from the three main meteorological stations, HDh Hanimaadhoo, K. Hulhule and S. Gan shows an increasing average rainfall from the northern regions to the southern regions of the country. The southern atolls receive, on average 2,277 mm of rainfall annually, while the relatively drier northern atolls receive 1,786 mm. The nearest meteorological station to V. Fulidhoo is at Velana International airport in Hulhule Island. Rainfall data for the period 1994 – 2012 from Hulhule has been used to determine rainfall pattern for V. Fulidhoo Island.

The mean annual rainfall for Hulhule is 1959.72 mm and the mean monthly rainfall is 138.67 mm. Mean rainfall varies throughout the year with mean highest rainfall during September, October and December and lowest between January and February (See Figure 11)

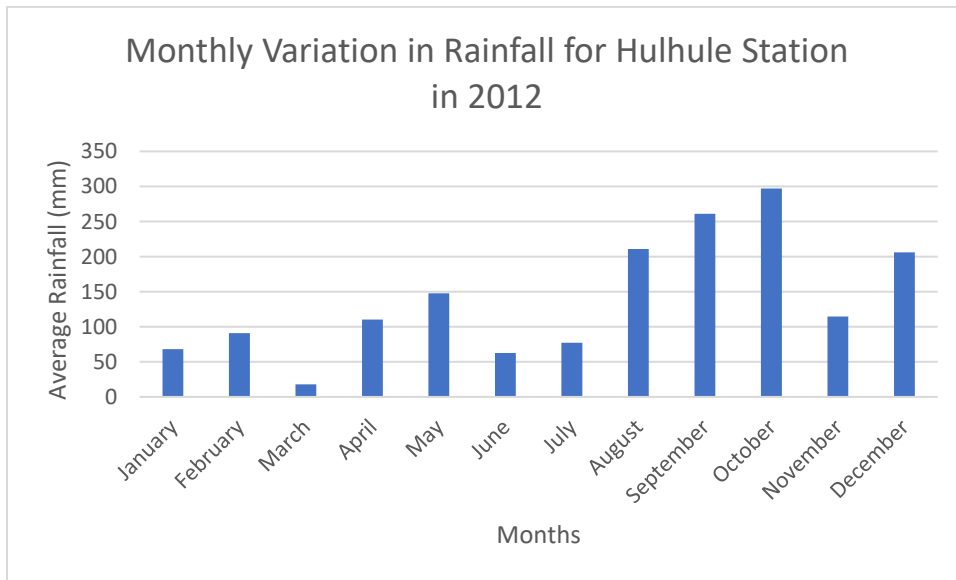


Figure 11: Monthly variation of average rainfall at Hulhule Island

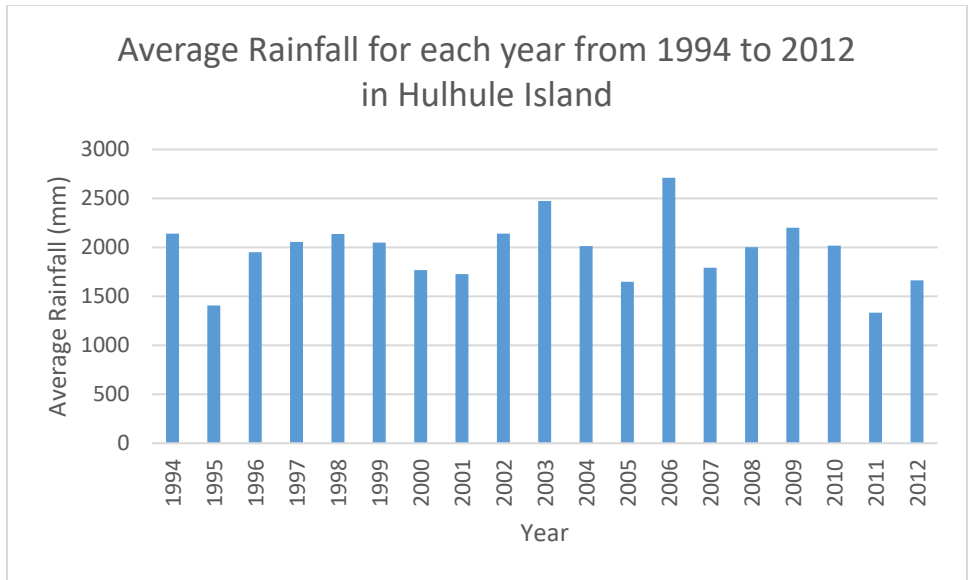


Figure 12: Annual variation of rainfall at Hulhule Island from the year 1994 to 2012

5.4 Tides and currents

Maldives experiences mixed semi-diurnal and diurnal tides with a strong diurnal inequality. There was no direct tide measured at the project site. Tide measured at the tide station in Hulhule was used to analyze the tide as in Figure 13. Tide have an influence on the wave conditions and the sediment movements in and out of the reef system. The hourly tide data from the University of Hawaii sea level archive for year 2011 is used in this analysis to cover the spring and neap tides. An approximate tidal range obtained at is 1.73 m (see Table 6). The tide observed is mixed and dominantly diurnal in nature (Figure 14) according to the analysis which is a common characteristic of the tide observed in the Maldives

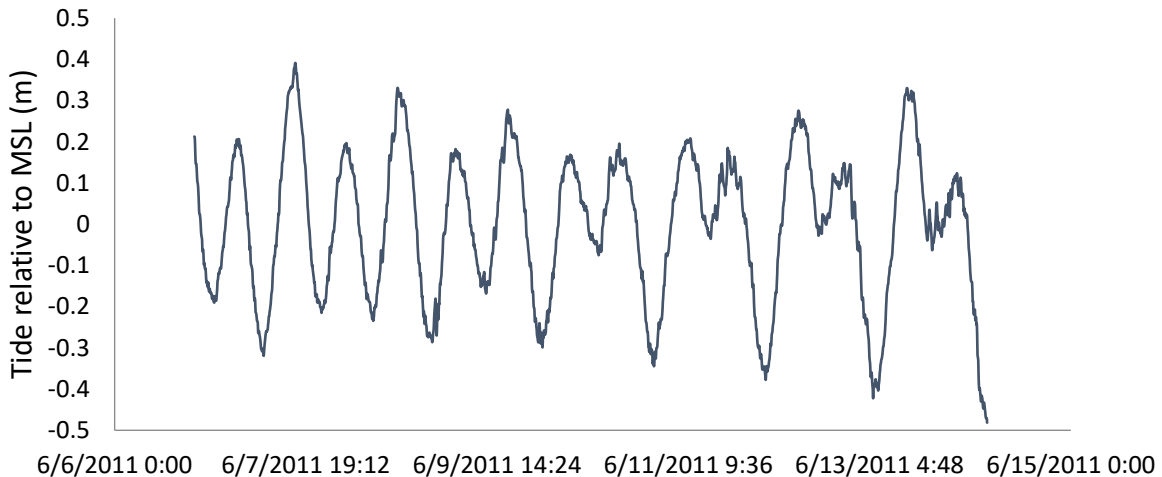


Figure 13: Typical tide at Hulhule tide station

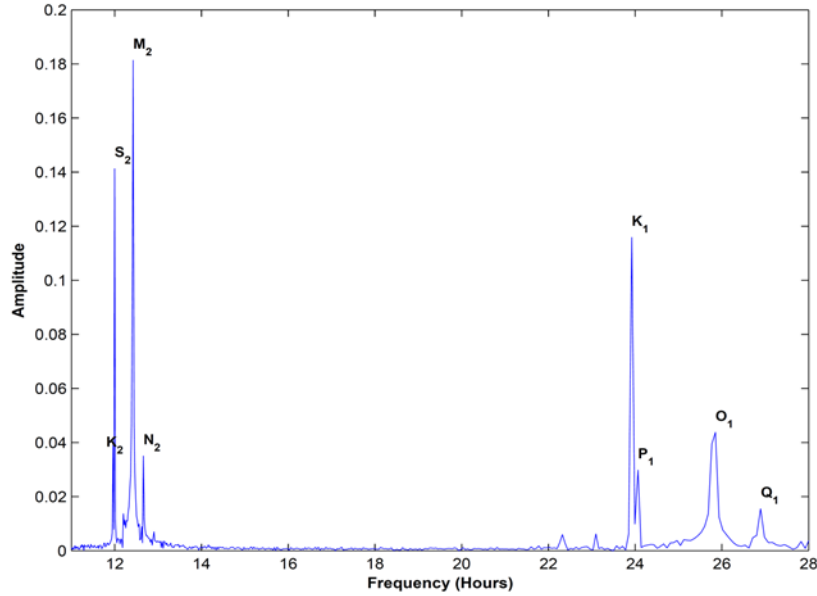


Figure 14: Spectral analysis of the tide.

Table 6: Water levels at Hulhule tide station

Water level from MSL (m)	Levels with respect to MSL (m)
Highest High water (HHW)	0.62
Mean Highest High water (MHHW)	0.34
Mean High water (MHW)	0.33
Mean Low water (MLW)	-0.36
Mean Lowest Low water (MLLW)	-0.37
Lowest Low water (LLW)	-0.72

Tides have significant influence on the formation, development, and sediment movement process (coastal processes) around the islands. Tides play an important role in the flushing of the water from lagoon. This has an influence of on the sedimentation during the excavation process.

5.5 Currents

Ocean currents play a significant role in sediment movement. Currents could be wind driven or tide driven. No site-specific current was measured. Available satellite information is used to draw information about the climatology of the currents around the Maldives region. This climatology is based on 23 years (1992-2014) data and the general pattern is show for the NE monsoon in Figure 15.

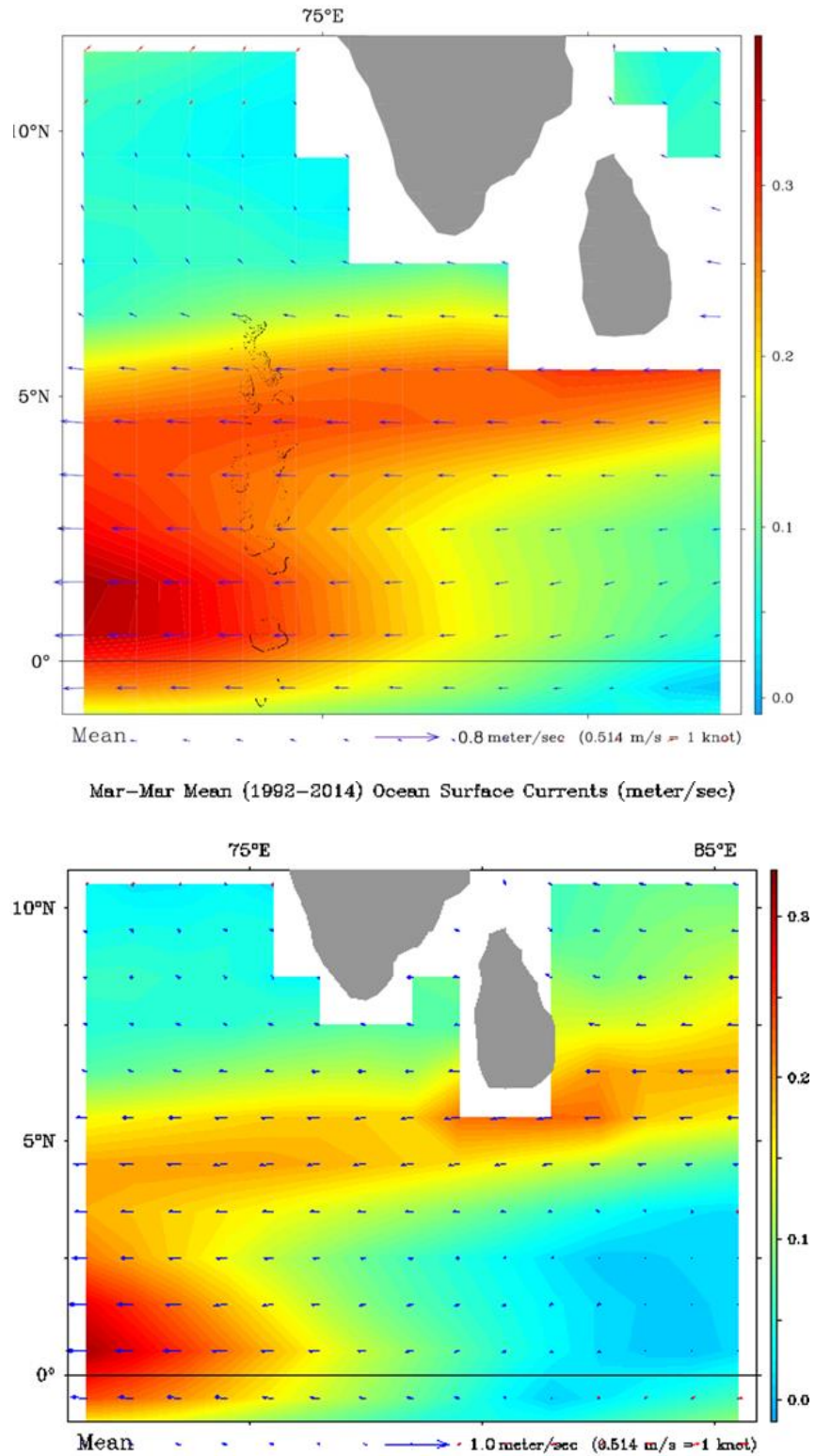


Figure 15: Average current regime around Maldives in NE monsoon (top) and SW monsoon (bottom).

The long-term average current speeds during NE monsoon varies between 0.08-0.2 ms⁻¹ which is typical current speeds around the island (Figure 9). However, it can attain speeds between 0.3 to 0.6 ms⁻¹ in the SW monsoon.

5.5.1 Currents at the project site

During the field visit, the current at the project site were measured using drogues. It was found that the current at the 0.11 m/s to 0.12 m/s and is in the direction towards the east. The Figure 9 illustrates the findings of drogue runs and direction and speed of current at various location in the south side of V. Fulidhoo.

5.6 Waves

The coastal dynamics such as accretion and erosion of islands depends on wave energy. Waves play a significant role in the modification of the beach environment and the surrounding. There are two major types of waves; wind generated waves and swell waves. Wind waves generated by the monsoon wind usually have a period of 3-8 seconds. Swell waves in Maldives are experienced by the swells generated by distance storms and have a period of 14-20 seconds (Kench et. al 2006, DHI 1999, Lanka Hydraulics 1988a and 1998b). Assessment done by Lanka Hydraulics shows that significant wave height (Hs) for the Male' region was 1.23m which a mean period (Tm) of 7.53s. Maximum Hs was 1.51 with a Tm of 7.74s.

Swell waves in Maldives are generally experienced by swells generated by distance swells generated due to storms. Occasional flooding has occurred in Maldives due to swells and distance storm generated swells were associated with these flooding.

5.7 Risk of Hurricanes, Storm surges and Hazard Vulnerability

An islands inherent vulnerability to environmental and climatic conditions lies in its geographic and geomorphic characteristics. Factors such as location of the island within the atoll, its shape, formation and orientation, the degree of protection offered to the island by surrounding reefs and other islands, presence of mangroves and wetlands at the coast, its natural and manmade coastal protection structures, are all contributors to the resiliency of the island to withstand natural hazards.

There are no extreme events of hurricanes or storm surges recorded in V. Fulidhoo in recent past. However, it is important to estimate the risk of hurricanes and storm surges for V. Fulidhoo.

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 Detailed Island Risk Assessment for the Maldives (DIRAM) (UNDP 2008), the following hazards have been predicted to be particularly relevant to the project site in relation to the project components:

- Windstorm
- Flooding due to heavy rainfall/storms
- Gravity waves (Swell waves and udha); and

- Tsunami

UNDP’s Detailed Risk Assessment (DIRAM – Thulusdhoo) carried out for Thulusdhoo Island which 81 km North east of V. Fulidhoo has been applied to predict natural hazards of V. Fulidhoo. According to the DIRAM that the major natural hazards in the Maldives are strictly controlled by the geophysical and climatic settings and show quite different patterns in their distribution as shown in Figure 16.

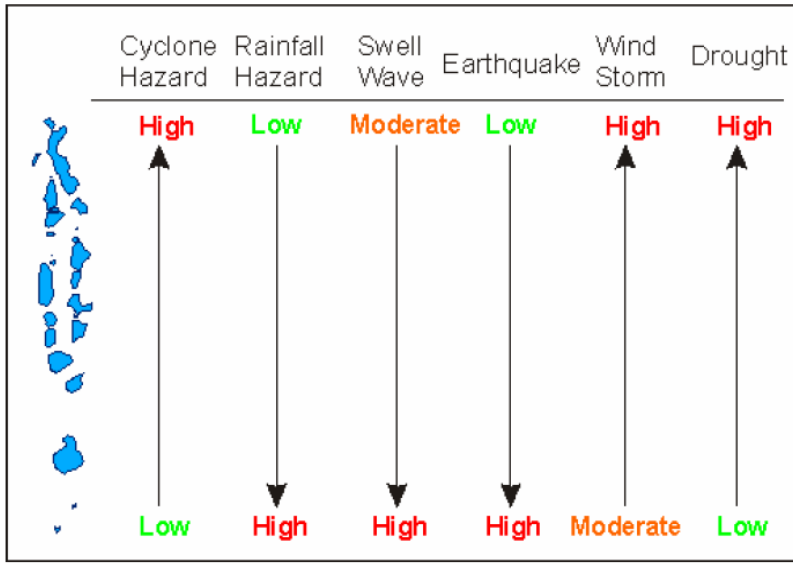


Figure 16: Major natural hazards distribution patterns in the Maldives including Latitudinal variation of major natural hazards (Adopted from UNDP 2008)

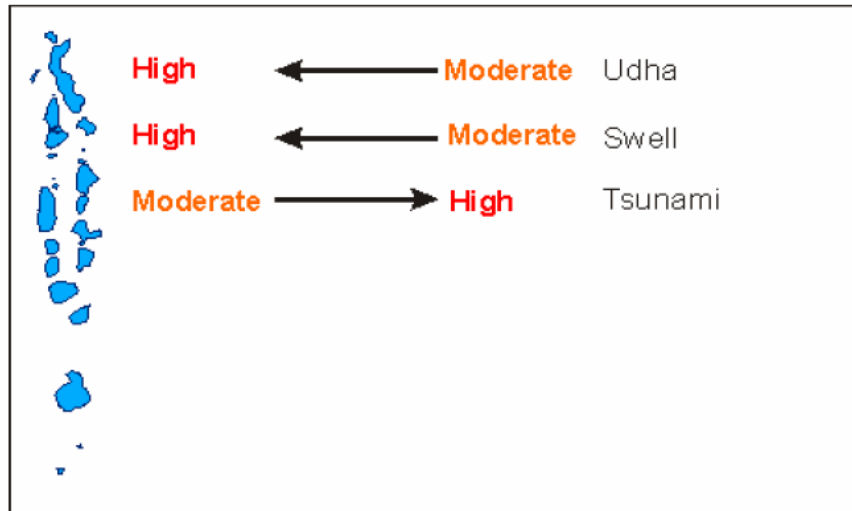


Figure 17: Longitudinal variation of major natural hazards across the Maldives (Adopted from UNDP 2008)

As can be seen in Figure 16, the tropical cyclones and correspondingly storm surges predominantly prevail in the north of the Maldives. In contrast, swell waves and heavy rainfalls are prominent in the southern and western islands of the Maldives. The southern islands of the Maldives are threatened by earthquakes from the seismic zone of Carlsherg Ridge. Considering the longitudinal variations in hazard distribution the eastern rim islands are subjected to tsunamis and waves of a higher intensity due to their direct exposure to these hazards, whereas the western rim and atoll lagoon islands are protected by the atoll formation patterns. Islands in the south are more exposed to southwest monsoon related surges and long-distance swells originating from the southern Indian Ocean. Islands in the north are more exposed to storm events and their impacts including storm surges and strong wind (UNDP 2008). Hazard severity and frequency of major natural hazards are shown in Figure 18.

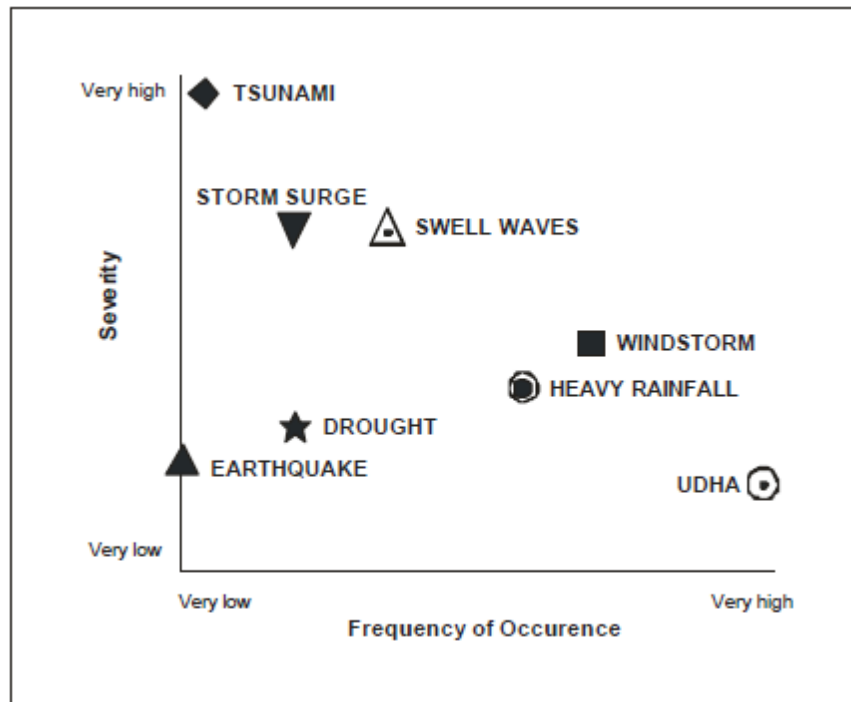


Figure 18: Relationship between hazard intensity and frequency of major natural hazards in the Maldives (Adopted from UNDP 2008)

Hazards, frequencies and damage potential for the Maldives is summarized in Table 7 (UNDP 2008)

Table 7: Hazards, frequencies and damage potential for various natural hazards in Maldives

Hazard	Tsunami	Swell waves or Storm Surges	Rainfall flooding	Strong winds
Frequency	Once in 200 years	Once in 10 years	Once in 1 year	Several times a year

Potential Damage	Very high	High	Moderate	Low
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5.8 Water quality

Due to the nature of project which only involves construction of a jetty and accompanying dredging works only the sea water quality will be discussed in this section. Water samples were obtained from locations directly impacted by the project interventions and from a control site. The primary objective is to establish a baseline condition for the marine water quality. This is established to be used in future monitoring of the environment as the environment is supposed to undergo significant changes and to see if there are any significant changes on the marine water quality. All the test samples were tested at the MWSC laboratory. Table 8 shows the marine water quality respectively sampled from three different locations. Original result sheet is attached in the Annex 04 of this report.

The parameters are well within the acceptable ranges for marine water quality. A pH range of 8.06 – 8.12 which is within the optimal range for pH in marine water. The level of turbidity was found between 0.204 to 0.221 NTU which is within the acceptable range for sediment level in marine waters. The level of the nutrients and the Biological Oxygen Demand (BOD) in the water sample analysed were found to be within the acceptable limits and indicated very low level of marine water pollution. The nutrients analysed include phosphate (0.11 – 0.36 mg/L), nitrate (3.3 to 4.0 mg/L) and Sulphate (2650 – 2750 mg/L). The BOD level for the analysed water sample were 1 mg/L for all the three samples analysed.

Table 8: Result of marine water quality analysis

Parameter	M1	M2	M3
GPS Coordinates	3 ^o 40'43.55166" N 73 ^o 24'54.01123" E	3 ^o 40'44.34576" N 73 ^o 24'56.09163" E	3 ^o 40'44.75098" N 73 ^o 24'59.32976" E
Physical Appearance	Clear with particles	Clear with particles	Clear with particles
Temperature (° C)	21.3	21.3	21.3
pH	8.06	8.09	8.12
Salinity (%)	33.59	33.66	33.53
Phosphate	0.15	0.11	0.36
Nitrates	4.0	3.6	3.3
Turbidity (NTU)	0.204	0.215	0.221
Sulphate	2750	2700	2650
Biological Oxygen Demand	1	1	1

5.9 Bathymetry

Bathymetric survey was undertaken during the field visit. Figure 19 shows the bathymetry of the lagoon and the reef system. The depth on the southern side lagoon near the shoreline varies between 1m to 4m. The proposed area to be dredged had a depth 4m to 8 m. Therefore, no dredging will be required during the construction phase of the project. The depth of the proposed access channel was found to be in the range between 5m to 10m. Hence there will be no requirement for dredging the access channel. The Figure 19 shows the vegetation line and the shoreline of V. Fulidhoo and bathymetry of the project area.

5.10 Coastal Environment

5.10.1 Historical Coastal Changes

The islands of the Maldives are known to be dynamical in nature. An analysis of the historical changes of the island was undertaken using remote sensing techniques. Aerial images of 2011 and 2014 were compared to assess the significant changes undergone by the island. This years were chosen since these were the years historical images were available on Google Earth. A simple comparison of the shorelines of the island during these two years were made. Figure 20 & Figure 21 shows the images used in the imagery analysis of the shorelines.



Figure 20: The aerial photograph from 2014



Figure 21: The aerial photograph from 2011

The Figure 22 shows an overlap analysis of the historical images and pattern of erosion and accretion in V. Fulidhoo Shoreline. The analysis of the shoreline shows that there is a chronic shoreline recession on the western and south-eastern side of the island. These shoreline recessions may be due to the existing jetty in V. Fulidhoo. The existing jetty has the potential to act as a barrier which obstructs the longshore sediment transport. This obstruction has led to accretion of the sediments on the southern beach of the island. This southern beach has increased in width over the period of time.

In terms of the seasonal patterns in erosion and accretion, the western and south-western beach face erosion during the South-west monsoon. This is due to the direction of the currents which play a significant role in long-shore sediment transport. The current during the south-western monsoon is from west to east direction in V. Fulidhoo.

Environmental Impact Assessment for Jetty Works Project in V. Fulidhoo

During the North-east monsoon, the south-eastern and eastern beach of the island face erosion. This is due to reversal of current direction in the North-east monsoon. The current travel from east to west direction during this monsoon season.

However, the shoreline in the southern beach of the V. Fulidhoo face accretion of sediments during both seasons. This is due to the aforementioned barrier in longshore sediment transport namely the existing old jetty.

A total of 0.69 Ha of land was eroded during 2011 to 2014 from V. Fulidhoo while only 0.09 Ha of land under went accretion thus it can be inferred that the sediment budget in the reef system has been affected by the coastal modification in V. Fulidhoo.

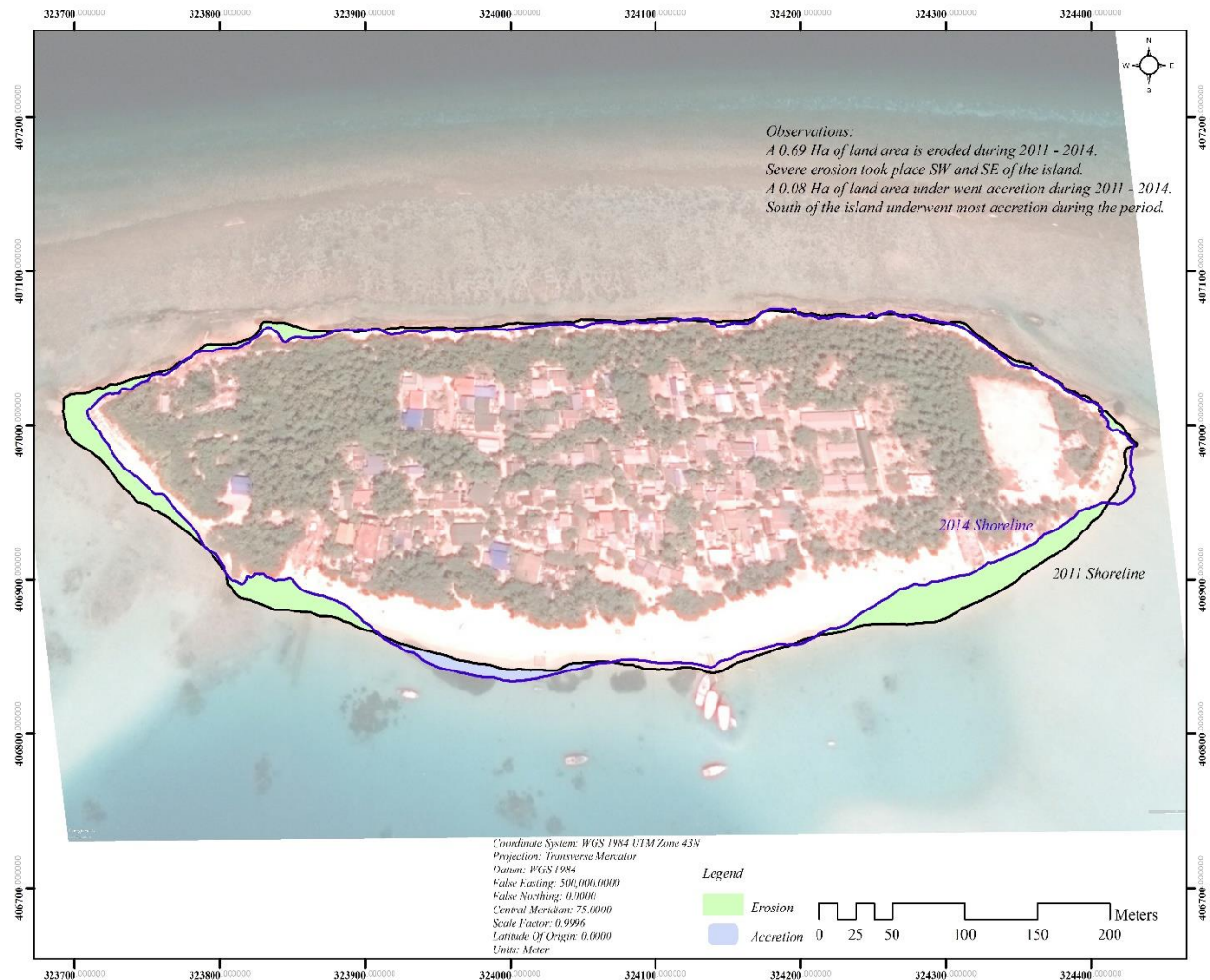


Figure 22: The analysis of erosion and accretion patterns between year 2011 to 2014 in V. Fulidhoo Island

5.10.2 Beach Environment

The beach environment was assessed using standard technologies of using beach profiles and visualization.

5.10.2.1 Beach composition and characteristics

Most of the beach areas were found on the southern side of the island. As the northern side of the island is closer to the surf zone, there were beach rock and no beaches were found. The material of sand found in all places where beach was observed compose of fine sand material.

5.10.2.2 Beach Profile

Beach profiles provide information about the beach characteristics such as the beach slopes, steepness of the beaches, sediment volumes and how the topography changes around the island. In addition this could be used to assess erosion prone areas. Generally, less steep slopes and wide areas show characteristics of low wave energy with low erosion. However, this would be very much restricted to the time of the survey. Strong gradients of the slope indicate that they are zones of higher energy and more erosion prone zones. Figure 23 shows the locations where the beach profiles were taken. The Figure 24, Figure 25 and Figure 26 show the corresponding beach profiles.

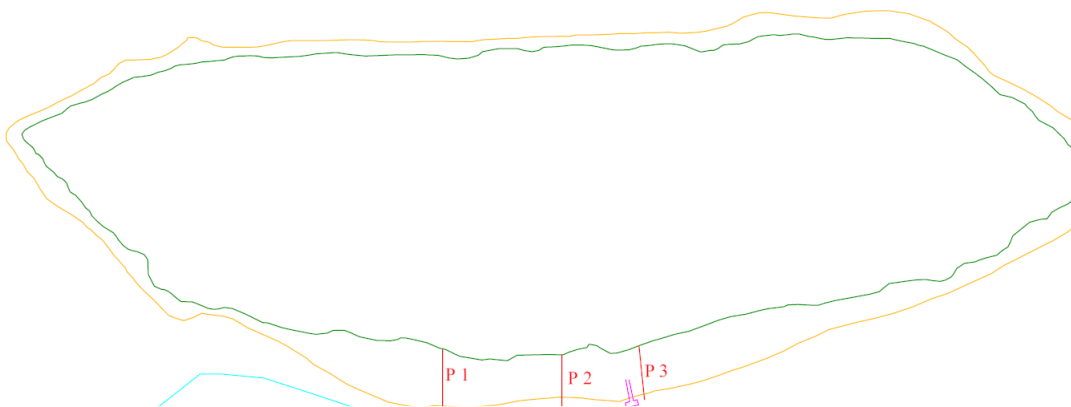


Figure 23: Locations of the beach profiles

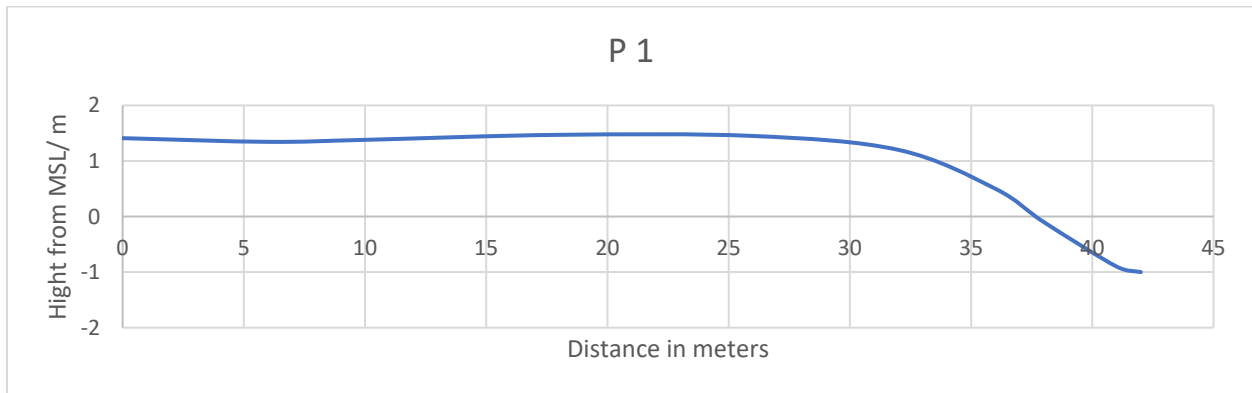


Figure 24: Beach profile at the P1 location (West of the jetty construction location)

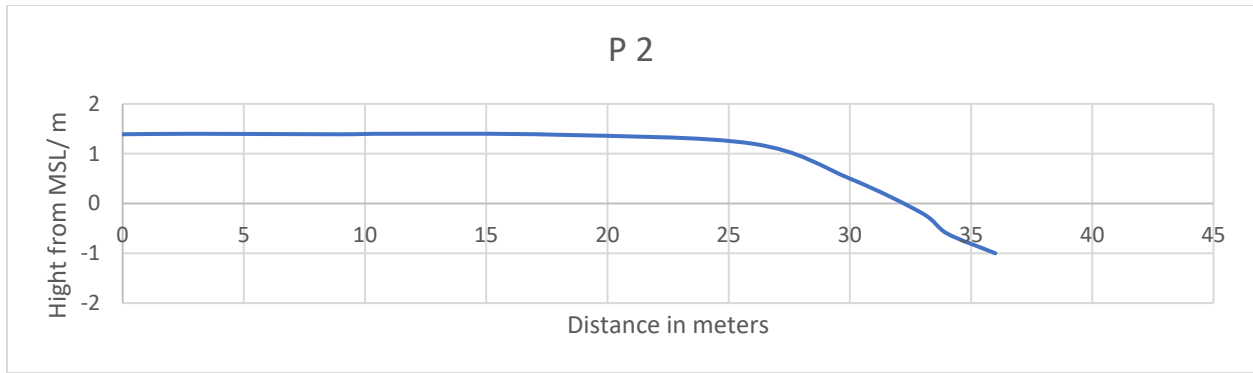


Figure 25: The beach profile at P2 location (location of the new jetty construction)

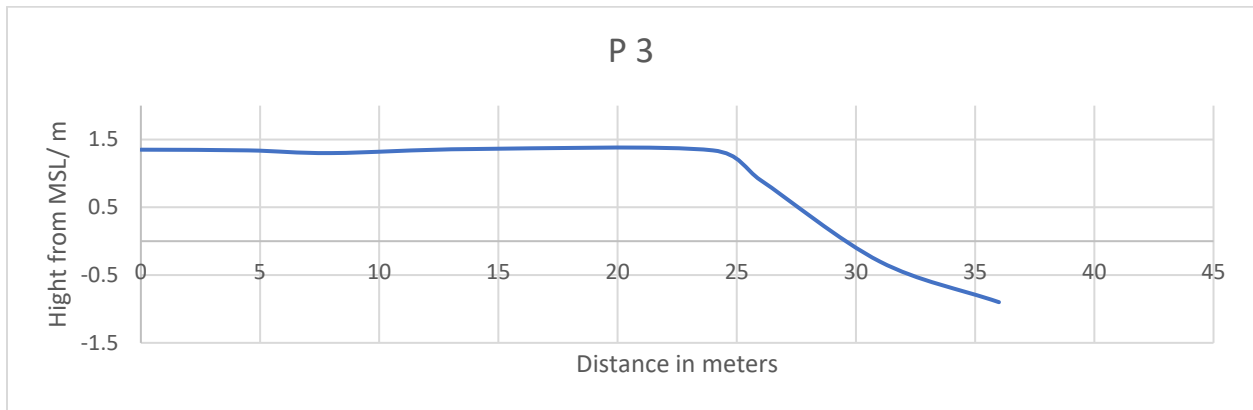


Figure 26: The beach profile at the location P3 (Just east of the existing old jetty)

5.10.3 Vegetation Line and the shoreline of the impact area

The Figure 27 is a map showing the vegetation line and the shoreline of the impact area with the location of the proposed new jetty.

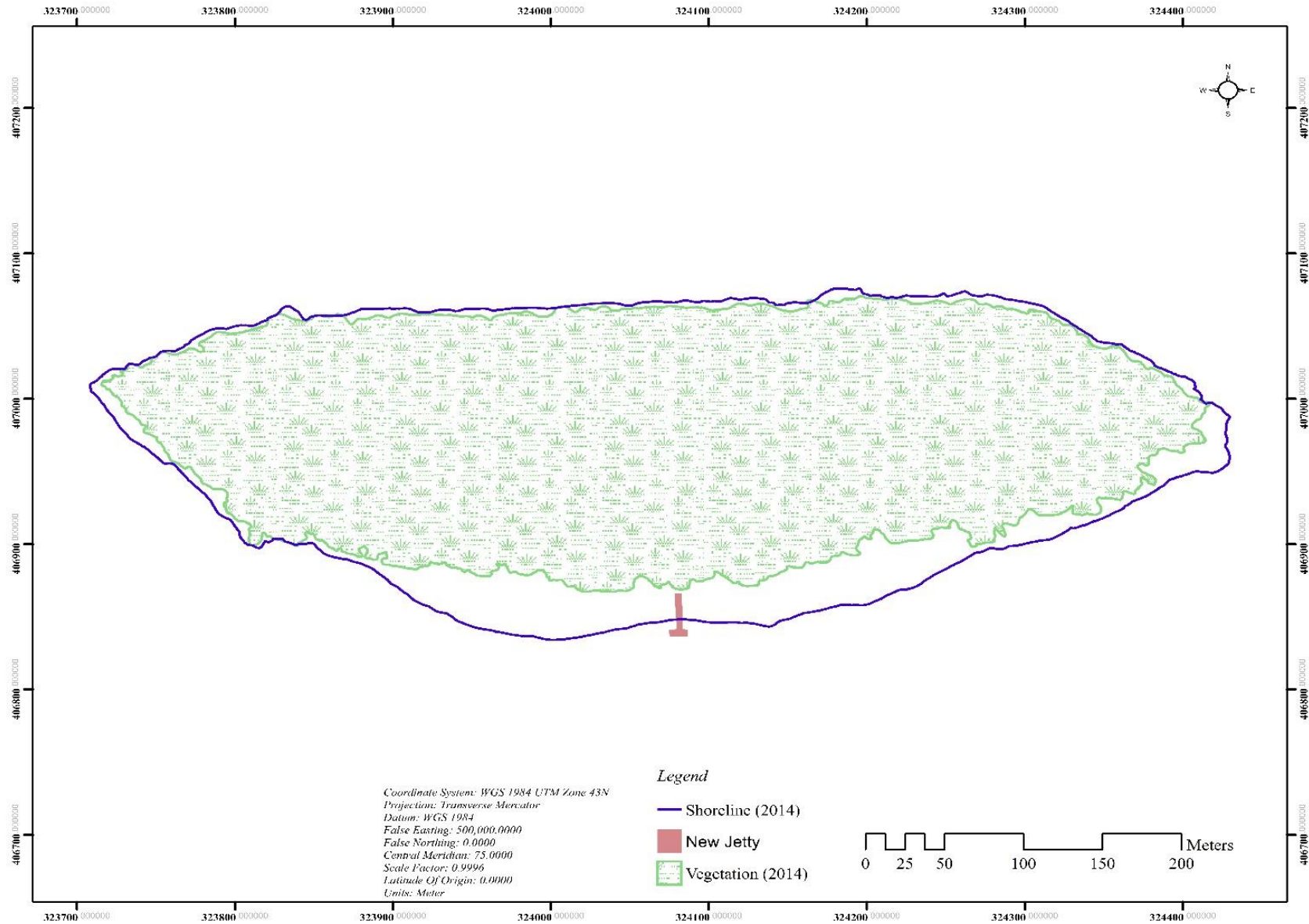


Figure 27: The vegetation line and the shoreline of the project impact area

5.11 Marine Environment

5.11.1 Qualitative Survey

This site is located on the southern side of the island. The average depth of the site varied from 4 – 7 m in depth. The lagoon bottom is mainly made up of sandy bottom with patches of dead corals with algae. The main fish species observed were *Acanthurus nigricauda* (white-tailed surgeon fish), *Parupeneus macronemus* (Kalhu oh), *Gerres longirostris* (Strongspine silver-biddy or Uniya) and *Lutjanus gibbus* (Humpback red snapper or Ginimas). The Figure 28 illustrates the types of sediments found at the surveyed locations within the project boundary.

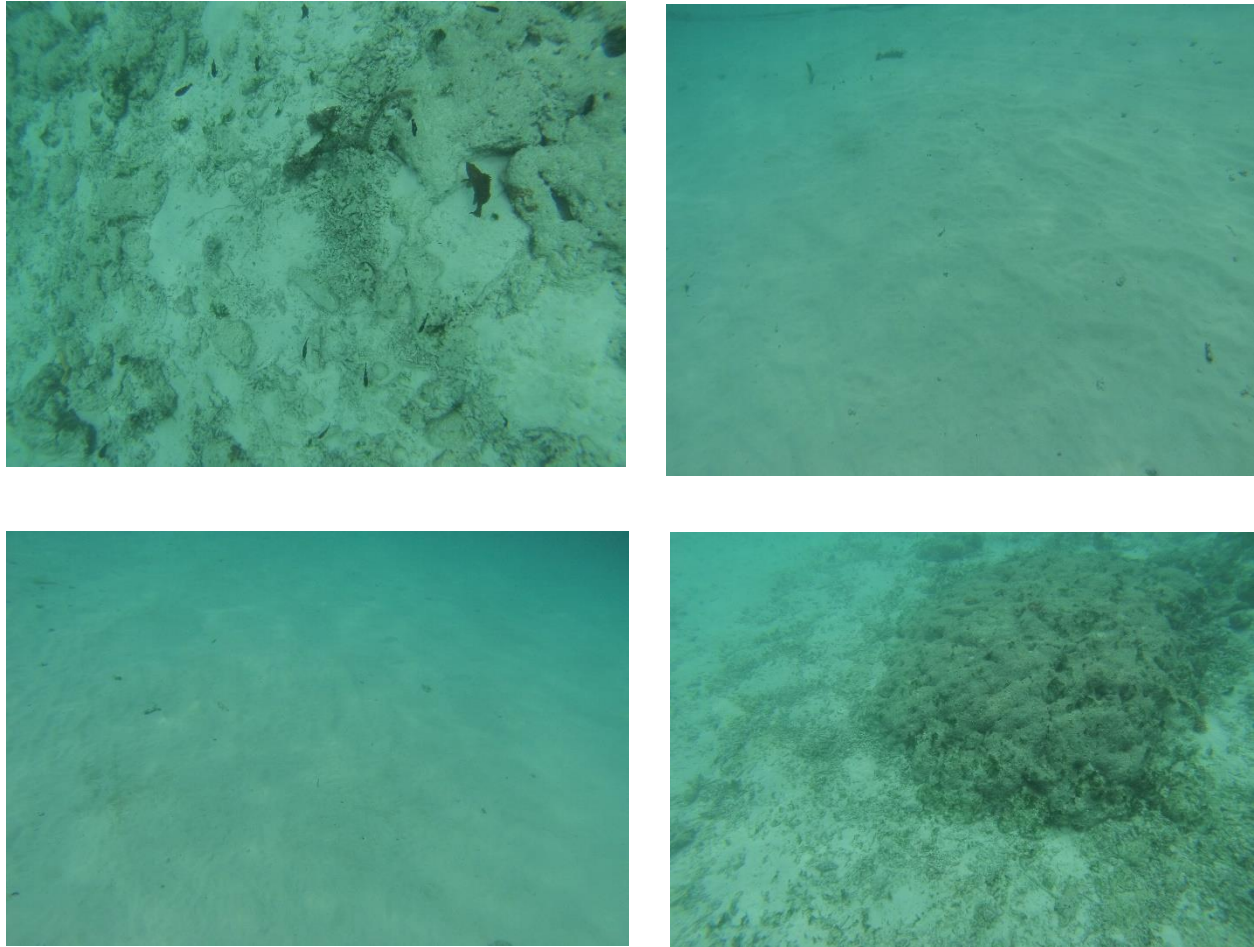


Figure 28: The seabed sediments at the project location

antitative Survey

5.11.1.1 Sediment Bed Characteristics and Coral Cover

The sediment bed characteristic and coral cover was analyzed for three sampled location (see Figure 9). All the sites surveyed had predominantly the cover of Sand, Pavement and Rubble (SPR) which accounts for 68.00 to 93.88% of the transects. Some of the surveyed site had Dead Coral with Algae which accounted for 6.12 to 30.00% of the cover. The percentage of the live coral at the surveyed site were found to only 0.67% to 2.00%. The Figure 29 is a bar graph which shows the percentages of various sediments found in the surveyed locations.

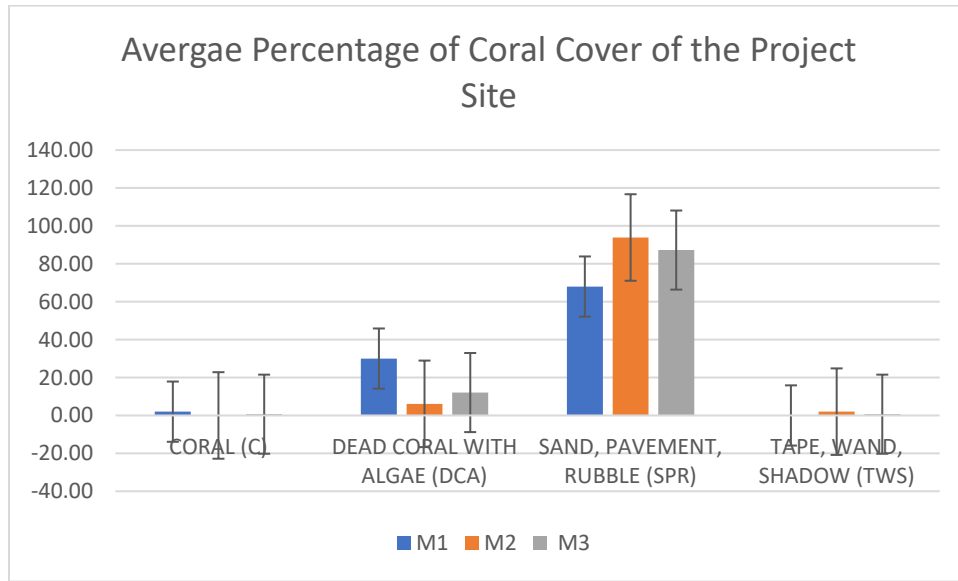


Figure 29: The percentage cover of various seabed sediments found at the surveyed locations

5.11.1.2 Fish & Benthic organism

Dominant fish types observed across all sites were *Acanthurus nigricauda* (white-tailed surgeon fish), *Parupeneus macronemus* (Kalhu oh), *Gerres longirostris* (Strongspine silver-biddy or Uniya) and *Lutjanus gibbus* (Humpback red snapper or Ginimas). A summary of fish species recorded at each survey location is presented in Table 9 below.

Table 9: Fish Species Abundance at M1, M2, M3 sites (S: 1, F: 2-10, M: 11-100, A: > 100)

Fish Species	Abundance Category		
	M1	M2	M3
<i>Lutjanus gibbus</i>	S	Nil	S
<i>Gerres longirostris</i>	Nil	S	Nil
<i>Parupeneus macronemus</i>	Nil	M	M
<i>Acanthurus nigricauda</i>	Nil	S	Nil
<i>Rhinecanthus aculeatus</i>	Nil	Nil	S
<i>Paracanthurus hepatus</i>	S	Nil	S

5.12 Proximity to environmentally sensitive and protected sites

There are three environmentally sensitive trees in V. Fulidhoo. All 3 trees were *Ficus benghalensis L.* out of which one of the tree is protected by the Environmental Protection Agency (EPA). The locations of these trees are shown in Figure 9. However, these trees would not be affected due to the project intervention. The location of the Marine Protected Areas (MPAs) & ESAs (Environmental Sensitive Areas) close to the project site is given in Annex 09.

The MPA which is closest to the project area is *Miyaru Kandu*. The *Vahttaru Kandu* and *Embudhoo Kandu'olhi* are other MPA within 20km radius of the project site. Due to the distance between the project site and the nearest MPA and ESA the likelihood of affecting these area is very highly unlikely. Furthermore, no dredging will be done during the construction phase of the project and the proposed mitigation measures will reduce the adverse impacts of the sedimentation hence, no significant adverse impacts on the nearest MPA and ESA are envisaged due to the project interventions.

5.13 Socio-economic environment

5.13.1 Demography

2014 Census Data (Source: Maldives Bureau of Statistics)

Resident Population			Maldivian Population			Foreigners		
Total	Male	Female	Total	Male	Female	Total	Male	Female
372	219	153	323	182	141	49	37	12

2014 Registered Population – Secretariat of V. Fulidhoo Island Council

Total	Male	Female
469	225	214

Population Growth Rate as of 2014 - Secretariat of Vaavu Fulidhoo Island Council

2015	2018	2022	2026	2030	2034
469	486	503	520	537	554

5.13.2 Economic Activities

Fishing	1 fishing vessel goes for reef fishery
Civil service	Powerhouse, court, council,
Tourism	In season 2-3 safari boats come every night and 50-60 tourists come per day Most people in resorts, closest is Dhiggiri resort 9 guest houses in operation, 9 upcoming 1 diving center 10 ppl capacity lunch 2, under 5 people capacity 4
Economic activities of men and women	Men mostly in resorts, women in civil service and teaching
Seasonal changes in activities	No change

5.13.3 Amenities

Electricity	24-hour electricity service provided
Water	Bottled water for drinking, rainwater also use, groundwater used for washing,
Sewer	Proposed
Shops	5 local shops, 18 souvenir shops,
Restaurants	2 local restaurant,
Vehicles	No vehicles, only bicycles, and wheelers (gaadiyaa)
Industries	Proposed 100 bed city hotel development,

Education	Up to grade 10 only business stream,
Travels	MTCC ferry MVR 53/- Individual Launch ferry MVR 250/- ; 2 nos big dhoani (72 feet) 1 which ferries between Male' Need to go to Felidhoo for banking services and health care but most people are dependent on Male' for these services.
Gas	STO and Villa gas brought by local boat,
Food	3 shops selling food items
Historical sites	None
Health	Health centre, STO pharmacy
waste	Waste management center established. Operation; Waste burning, unburned sent to Thilafushi
telecommunication	Media net available, broadband internet will be available soon,

5.13.4 Community Needs

Sewer	First priority, guest houses need sewer services as the bed capacity is limited to 7 in islands without sewer systems. The community wants to have bigger guest houses
Water	Second priority, the ground water of the island is mostly saline. The island community wanted to have a sustainable water solution that would also cater towards the guesthouse tourism of the island.
Pressure on land and marine resources	Tourism induced pressure on beach, Almost all houses on the North side of the island have plastic pipelines discharging sewer to the beach, and all houses on the middle and South side have junctions which drain sewer into the ground

6. Environmental Impacts

6.1 Introduction

This section of the report provides a detail description of the methodology used to identify, predict and assess the environmental impacts due to construction phase and the operation phase of the proposed Jetty works project in V. Fulidhoo. First, the potential impact will be identified and then the identified impact will be evaluated to determine its level of significance. This section consists of the method used for impact assessment, the limitation and uncertainties, the justification for the method used for impact prediction and description of impacts during both construction and operation phase of the project.

6.2 Method Used for Impact Prediction

The impacts on the natural and social environment that may be caused due the project interventions are predicted and is distinguished from construction and operation phases of the project. A simple descriptive matrix has been utilized to predicted the aforementioned impacts. The impact prediction was done using expert judgement and professional opinions of the EIA consultant and also the based on the information provided in the reviewed EIAs mentioned earlier in this report. Once the impacts have been predicted, a detailed description has been given for the purpose of understanding the nature and type of the impact.

An impact is any change to a resource or receptor brought about by the presence of a project component or by the execution of a project related activity. The evaluation of baseline data provides crucial information for the process of evaluating and describing how the project could affect the biophysical and socio-economic environment.

Impacts are described as a number of types as summarized in **Error! Reference source not found.** Impacts a re also described as associated, those that will occur, and potential, those that may occur;

Table 10: Types of Impacts (adapted from ERM 2008).

Nature or Type	Definition
Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (e.g. between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
Indirect	Impacts that result from other activities that are encouraged to happen as a consequence of the project (e.g. in-migration for employment placing a demand on resources).
Cumulative	Impacts that act together with other impacts (including those from

	concurrent or planned future third-party activities) to affect the same resources and/or receptors as the project.
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6.3 Analysis for Significance of the predicted impacts

The analysis of environmental impacts is done in terms of their level of significance. According to Environmental Resource Management 2008, Significance is a function of the magnitude of the impact and the likelihood of the impact occurring. Impact magnitude (sometimes termed severity) is a function of the extent, duration and intensity of the impact. The criteria used to determine significance are summarized in Table 11. Once an assessment is made of the magnitude and likelihood, the impact significance is rated through a matrix process as shown in Table 12. For ease of review, the significance rating is colour-coded in the text according to Table 13. Outlined in Table 14 are the various definitions for the significance of an impact.

Significance of an impact is qualified through a statement of the degree of confidence. Confidence in the prediction is a function of uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence is expressed as low, medium or high.

Table 11: Criteria used to assign level of significance

Magnitude – the degree of change brought about in the environment	
Extent	<p>On-site: impacts that are limited to the Site Area only.</p> <p>Local: impacts that affect an area in a radius of 20 km around the development area.</p> <p>Regional: impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystems.</p> <p>National: impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences.</p> <p>Transboundary/International – impacts that affect internationally important resources such as areas protected by international conventions.</p>
Duration	<p>Temporary: impacts are predicted to be of short duration and intermittent/occasional.</p> <p>Short-term: impacts that are predicted to last only for the duration of the construction period.</p> <p>Long-term: impacts that will continue for the life of the project, but ceases when the project stops operating.</p> <p>Permanent: impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the project lifetime.</p>
Intensity	<p>BIOPHYSICAL ENVIRONMENT: Intensity can be considered in terms of the sensitivity of the biodiversity receptor (E.g.: habitats, species or communities).</p>

	<p>Negligible: the impact on the environment is not detectable.</p> <p>Low: the impact affects the environment in such a way that natural functions and processes are not affected.</p> <p>Medium: where the affected environment is altered but natural functions and processes continue, albeit in a modified way.</p> <p>High: where natural functions or processes are altered to the extent that it will temporarily or permanently cease.</p>
	<p>SOCIO-ECONOMIC ENVIRONMENT: Intensity can be considered in terms of the ability of project affected people/communities to adapt to changes brought about by the project.</p> <p>Negligible: There is no perceptible change to people’s way of life.</p> <p>Low: People/communities are able to adapt with relative ease and maintain pre-impact livelihoods.</p> <p>Medium: Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.</p> <p>High: Those affected will not be able to adapt to changes and continue to maintain pre-impact livelihoods.</p>
Likelihood - the likelihood that an impact will occur	
Unlikely	The impact is unlikely to occur.
Likely	The impact is likely to occur under most conditions.
Definite	The impact will occur.

Table 12: Significance Rating Matrix

SIGNIFICANCE		LIKELIHOOD		
		Unlikely	Likely	Definite
MAGNITUDE	Negligible	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Table 13: Significance Color Scale

Negative Ratings	Positive Ratings
Negligible	Negligible
Minor	Minor
Moderate	Moderate
Major	Major

Table 14: The definition of difference level of significance

Significance definitions	
Negligible significance	An impact of negligible significance is where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background levels.
Minor significance	An impact of minor significance is one where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value.
Moderate significance	An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that “moderate” impacts have to be reduced to “minor” impacts, but that medium impacts are being managed effectively and efficiently.
Major significance	An impact of major significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. A goal of the EIA process is to get to a position where the project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a development. It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors, such as employment, in coming to a decision on the project.

6.4 Limitations and the uncertainties of the impact assessment methodology

The following aspects are considered as limitation and the uncertainties which may be involved in the impact assessment process;

- All the potential environmental aspects have been predicted and assumed for the proposed project development hence they may differ in the natural context such as site conditions and uncertainties in scales and magnitude.
- The baseline data for the existing environmental conditions were taken in a very short period of time hence may affect the accuracy in prediction of the environmental impacts.

- The aforementioned baseline data for the existing environmental condition were collected for one monsoonal season (*Iruvai* season) and inferred based on that seasonal data hence the predicted environmental impacts may vary on the other (*Hulhangu*)season.
- Expert judgement and professional opinion of the EIA consultant were enhanced using the existing EIA reports of similar nature, however due to the unique nature of coastal processes, lagoons and reef system in the Maldives each island is unique. Hence the predicted environmental impacts may vary from island to island.

6.5 Justification for the Methodology used

There are many various methodologies used for impact assessment in environmental context. One of the most commonly used methodologies include check lists and matrices such as Leopold Matrix (Lohani et al., 1997) The Leopold matrix was conceived by geologist Luna B. Leopold and his colleagues in 1971, as a response to the US Environmental Policy Act of 1969, which didn't give clear instructions to the Federal Government agencies for preparing an impact report or for examining the environmental effects of the projects that an agency plans. The Leopold matrix addressed this challenge by 'providing a system for the analysis and numerical weighting of probable impacts' (Josimovic et al., 2014).

According to the Leopold matrix method, EIA should consist of three basic elements:

1. a listing of the effects on the environment that the proposed development may induce, including the estimate of the magnitude of each of the effects;
2. an evaluation of the importance of each of listed effects (e.g., regional vs. local); and
3. a summary evaluation, which is a combination of magnitude and importance estimates.

The impact assessment method used in this report is a matrix which is derived from the Leopold Matrix however this method uses a colour code to assign the significance level of each predicted impact. This method has been adapted from the Environmental Resource Management (2008).

Leopold Matrix is an effective impact assessment methodology which has been extensively used by EIA practitioners across the world. The colour coding enhance Leopold Matrix further. Since EIA is a technical report which are read by both technical experts of different field as well as the general public, the colour coding of the significance level will enhance the report in a manner which would be easily comprehended by general public and people with no technical expertise in this field.

6.6 Impact Prediction

The environmental impacts of the proposed Jetty works at V. Fulidhoo project are predicted in this section of the report by using a simple descriptive matrix. The following matrix distinguishes the types of environmental impacts that may be associated with various project actions on key environmental components and distinguishes whether these are impacts during construction period or during post-construction and operations period.

The following Table 15 predicts the nature and types of environmental impacts based on the existing environmental condition of the islands and the surrounding environment;

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Table 15: Impact Identification matrix for Jetty works project in V. Fulidhoo

Project Activities	Natural Environment				Social Environment			
	Reef and Coastal Environment	Soil and groundwater	Lagoon and seawater	Air/Noise	Services and Infrastructure	Health and Safety	Employment	Costs to consumer/tax payer
Construction Phase								
Excavation for placement of the pre-cast concrete footings	Sedimentation on immediate reef and turbid seawater for short term. Physical damage on benthic sessile fauna in proposed jetty area.	No significant impact	Direct affect to the habitats such as corals due to removal. Furthermore, sedimentation in lagoon and changes in hydrodynamics of immediate area leading to increase in turbidity of sea water.	No significant impact	Constraints in utilization of the existing jetty is anticipated.	No significant impact	Local contractors will be used for the excavation work hence employment opportunities will increase in the island.	No significant impact
Ground Leveling of the Jetty Area	Sedentary organism and burrowing organism such as crabs may be affected.	Salinity of the groundwater may increase due to leveling works.	No significant impact	No significant impact	Since the existing old jetty is in close proximity to the proposed jetty construction location there may be some disruption for utilization of old jetty during leveling works.	No significant impact	Local contractors can be used for the ground leveling works	No significant impact
Operation of barges and excavators on the lagoon Dumping trucks on the land for transportation	No major damages to the reef	No significant impact	Sedimentation impacts on the coral found in close vicinity of the project site.	Localized noise pollution at the project site. However, this noise levels will be short term and only during the	The fuel used for the machinery and equipment if obtained from the island will create a demand for fuel which may affect	The operation of machinery will increase sooty smoke which can decrease the air quality in the	No significant impact	No significant impact

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			A short-term turbidity of lagoon water.	construction activities. Emission of GHG and other air pollutants since the machinery will burn fossil fuels.	services and infrastructure.	vicinity of the project site.		
Impacts of workforce	Waste produced by the workforce may be affect reefs if not properly disposed via existing solid waste management regime. However, this impact is anticipated to be short term and work force will be few expatriate workers due to small nature of the project.	Increased burden on groundwater resources since workforce will utilize groundwater for various purposes. However, this impact is anticipated to be short term and work force will be few expatriate workers due to small nature of the project.	No significant impacts	No significant impacts	The expatriate workers and workers from other islands will relay of the existing services and infrastructure to meet their basic needs hence extra burden of the existing services and infrastructure. However, this impact is anticipated to be short term and work force will be few expatriate workers due to small nature of the project.	No significant impacts	Expatriate workers and workers from other island will decrease the chance of employment for residents of V. Fulidhoo	No significant impact
Potential of oil spills from excavator	Damage to the reef habitat due to toxic effect of the oil and the marine water quality would be deteriorated.	No significant impact	Damage to the reef habitat due to toxic effect of the oil and the marine water quality would be deteriorated.	No significant impact	No significant impact	Indirect impacts due to deterioration of marine water quality	No significant impact	No significant impact
Operational Phase								

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<p>Construction and Operation of the new jetty</p>	<p>Minor accretion at the south-western side of the island</p>	<p>No significant impact</p>	<p>Impacts from the construction phase and sedimentation impacts from the maintenance dredging.</p>	<p>No significant impact</p>	<p>The new jetty will have positive impact on the island community as they will have better accessibility to the island.</p>	<p>The newly constructed jetty will provide easy accessibility to the island hence reduce potential accidents using small boats for accessing the island.</p>	<p>The newly built jetty will provide some employment opportunities for maintenance of the jetty. The newly constructed jetty will also increase the economic opportunities for the island community and thus indirect employment opportunities.</p>	<p>No significant impacts.</p>
<p>Maintenance dredging of jetty area and access channel</p>	<p>Sedimentation due to maintenance dredging may affect the coral communities on the reef. Turbidity would increase in the marine water.</p>	<p>No significant impacts</p>	<p>Sedimentation due to maintenance dredging may affect the coral communities on the reef. Turbidity would increase in the marine water. The maintenance dredging is expected to increase the wave height since the dredged area will have a greater height.</p>	<p>No significant impact</p>	<p>No significant impact</p>	<p>The operation of machinery will increase sooty smoke which can decrease the air quality in the vicinity of the project site. Use of heavy vehicles such as trucks in close proximity to local community will increase chances of accidents involving small children and elderly.</p>	<p>No significant impact</p>	<p>No significant impact</p>

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Stockpiling of the dredged material	The stockpiling of dredged material will be in close proximity to the shoreline hence some of the sedimentation and impact may occur.	Salinity of the groundwater may increase.	The stockpiling of the dredged material will be in close proximity to the shoreline hence some turbidity of lagoon water is expected.	No significant impacts.	No significant impacts	No significant impacts	No significant impacts	No significant impacts
Solid waste management and disposal	Inadequate solid waste management practices during the operational phase contribute to marine pollution hence affect the coral reef.	No significant impact	Inadequate solid waste management practices during the operational phase contribute to marine pollution hence affect the coral habitats found in the lagoon and deteriorate the marine water quality.	No significant impact	No significant impact	The degraded water quality due to disposal of waste by the jetty users will affect the aesthetics and also public health of the users of lagoon.	Island council could employ staff to clean the jetty area hence increasing the employment opportunity.	Island council could take jetty maintenance fee from regular jetty users such as tourist facilities such as guest houses and recreational divers.

The above table illustrates project activities both during the construction and operational phase. The impacts of these project activities are predicted both for the biophysical and the socioeconomic environment of V. Fulidhoo is also shown the Table 15. The following Table 16 is a summary of project activities which has the greatest impact on both natural and social environment respectively. It can be noted that some of these impacts are considered to be positive.

Table 16: Summary of project activities with the most significant impact on both natural and social environment of V. Fulidhoo

Phase of the project	Natural Environment	Social Environment
Construction Phase	Excavation for placement of the pre-cast concrete footings (Negative Impacts) Impacts due to Machinery and Equipment (Negative Impacts) Impacts of Workforce (negative impacts)	Excavation for placement of the pre-cast concrete footings (Negative Impacts) Operation of barges and excavators on the lagoon (Negative Impacts) Impacts of Workforce (negative impacts)
Operational Phase	Maintenance dredging of jetty area and access channel (Negative Impacts) Solid waste management and disposal (Negative Impacts) Stockpiling of the dredged material (Negative and Positive impacts)	Maintenance dredging of jetty area and access channel (Negative Impacts) Solid waste management and disposal (Both Positive & Negative Impacts)

6.7 Description of the impacts

6.7.1 Construction Phase

6.7.1.1 Excavation for placement of the pre-cast concrete footings

As discussed in the project description section (2), excavation will be conducted on the southern side lagoon of the island in order to place the pre-cast concrete footings. This pre-cast concrete footing will act as the foundation for the concrete columns which will be the footing of the jetty.

The main predicted impacts on the biophysical environment include the following;

- Sedimentation on immediate reef and turbid seawater for short term;
- Direct affect to the habitats such as corals due to removal. Furthermore, sedimentation in lagoon and changes in hydrodynamics of immediate area leading to increase in turbidity of sea water.
- Physical damage on benthic sessile fauna in proposed jetty area. The effect of this would be in the immediate to short term with the migration of benthic sessile and burrowing fauna living on sand.
- Constraints in utilization of the existing jetty is anticipated.

A total of 38 concrete columns will be placed into the sea bed as a footing structure for the concrete deck of the jetty. The diameter of the concrete column will be 0.25 m and they will have place in a foundation

of 1.2 m x 1.2m x 0.3 m concrete foundation. The excavations will be done into a depth of 1.2m below the sea bed. During the excavation process, minor sedimentation to the surrounding environment especially lagoon will be generated. The key environmental impact will be loss of lagoon habitats such as removal of isolated corals found on the southern side of V. Fulidhoo, however, the analysis of marine survey suggest that the project area is mostly consist of sand, rubble and pavement. Furthermore, excavation is believed to release sedimentation into the lagoon environment whereby corals in close vicinity to the project area will be affected. The marine water quality of the lagoon is expected to affected due to turbidity, however this impact is expected to be short-term and confined within the project boundary.

The main socio-economic impacts include the following;

- Constraints in utilization of the existing jetty is anticipated.
- Local contractors will be used for the excavation work hence employment opportunities will increase in the island.

These impacts on the socio-economic environment of the V. Fulidhoo is expected to be minimal. However, during the field visit it was brought to the attention of the consultants that there are existing constraints in utilization of the existing jetty in V. Fulidhoo. There is significant accretion of the sediments of the southern side of the island hence utilization of the jetty is difficult particularly during the low tide. In addition to this, any construction work within the vicinity of the existing jetty will give rise to additional constraints in using the existing jetty in V. Fulidhoo. However, this impact will be only during the construction phase of the project.

One of the positive impact of the project in terms of socioeconomic impacts include potential employment opportunities for the local contractors for different works associated with the construction of the new jetty in V. Fulidhoo.

6.7.1.2 Ground Levelling at the Jetty area

The jetty area will be levelled from the excavated material from the excavation to place the concrete footing. This will lead to some impacts on both the biophysical and socio-economic environment of V. Fulidhoo Island.

The following are the anticipated impacts on the bio-physical environment of V. Fulidhoo Island;

- Sedentary organism and burrowing organism such as crabs may be affected.
- Salinity of the groundwater may increase due to levelling works.

The following are anticipated impacts on the socio-economic environment of V. Fulidhoo Island;

- Since the existing old jetty is in close proximity to the proposed jetty construction location there may be some disruption for utilization of old jetty during levelling works.
- Local contractors can be used for the ground levelling works.

The impacts on the burrowing organisms such as crabs is expected to be minimal. These organisms are highly mobile and expect to move and take refuge on other areas of the beach environment. Furthermore, no beach vegetation will be affected as a result of the ground levelling work. The proposed jetty area as a large dune without any dune vegetation hence no vegetation clearance will be involved.

6.7.1.3 Impacts due to Machinery and Equipment

The proposed jetty works project will involve utilization of barges and excavation during the dredging and excavation required for the jetty construction. The barges will be used for the transport of pre-cast material to the island and provide a platform for the excavators during the dredging works. Furthermore, dumping trucks will be used for collection and transport of the dredged material. The dredged material will be placed into these dump trucks which will be used for transport to the stockpile location. Due to small scale of the dredging required for the project it is anticipated that only one dump truck will be utilized for the purpose.

The following impacts are predicted to affect the biophysical environment of V. Fulidhoo;

- Sedimentation impacts on the coral found in close vicinity of the project site.
- A short-term turbidity of lagoon water.
- Localized noise pollution at the project site. However, this noise levels will be short term and only during the construction activities.
- Emission of GHG and other air pollutants since the machinery will burn fossil fuels.

The excavators will be mainly used during excavation which is required to place the footing of the proposed jetty. This excavation is expected to be in small scale since the foundation required to place the footing will be just 1.2 m x 1.2m x 0.3 m. There will not be any direct removal of habitats for the benthic organisms found in the project area since the project area is mostly consisted of sand, rubble and pavement (See Section 0).

The main social impacts associated with this project component include;

- The fuel used for the machinery and equipment if obtained from the island will create a demand for fuel which may affect services and infrastructure;
- The operation of machinery will increase sooty smoke which can decrease the air quality in the vicinity of the project site.

Any infrastructure project such as this, may have some social impacts particularly due to use of heavy machinery either on lagoon or on the land. The equipment to be used in the proposed project such as barges and excavators will require utilization of fossil fuels which if obtain from the bunkered stock in the island may create a demand of fuel in the island.

The aforementioned equipment and machinery used by contractors are often old and poorly maintained which may lead to emission of sooty smokes which may affect the localized air quality resulting in health impacts on the community living in the vicinity of the project site. However, this impact is expected to be minimal and short-term.

6.7.1.4 Impacts of the Workforce

Migration of a group of workers will have some impacts on the biophysical and the social environment of an island. For the purpose of this project it is expected to have a workforce of 10 expatriate workers and 1 supervisor. Despite of the small number of workforce expected, the impacts of this workforce is significant on the biophysical and socioeconomic environment of V. Fulidhoo Island.

The main impacts on the biophysical environment of the V. Fulidhoo include the following;

- Waste produced by the workforce may be affect reefs if not properly disposed via existing solid waste management regime;

- Increased burden on groundwater resources since workforce will utilize groundwater for various purposes;

The above-mentioned impacts on the biophysical environment is expected to be in small scale due to the small nature of the project which is expected to have a workforce of only 10 workers and 1 supervisors.

The main impacts on the socioeconomic environment of the island include the following;

- The expatriate workers and workers from other islands will rely on the existing services and infrastructure to meet their basic needs hence extra burden on the existing services and infrastructure;
- Expatriate workers and workers from other island will decrease the chance of employment for residents of V. Fulidhoo.

These impacts on the socio-economic environment are also expected to be minimum just as the impact on the biophysical environment. The main reason being the small number of the workforce employed by the project.

6.7.1.5 Potential of oil spills from excavator

The project is expected to utilize excavators which will be placed on a barge. During the excavation works, oil may spill from the excavator and impact the marine organisms found on the lagoon. However, this impact is expected to be localized to the project site and may involve contamination of the marine water thus affecting the marine organisms.

The main impacts on the biophysical environment include the following;

- Damage to the reef habitat due to toxic effect of the oil and the marine water quality would be deteriorated;
- Damage to the reef habitat due to toxic effect of the oil and the marine water quality would be deteriorated.

The only socio-economic impact expected include the following;

- Indirect impact on the health and safety of the island community living close to the project area due to contamination of the marine water.

Both of the identified impacts on the biophysical environment and the socio-economic environment are expected to be short-term.

6.7.2 Operational Phase Impacts

6.7.2.1 Construction and Operation of a Jetty

The construction of a coastal infrastructure such as jetties and harbours are expected to have some impacts on the shoreline morphology and sediment transport within the reef system. Many coastal structures such as jetties have the potential to act as a barrier preventing sediment transport within the reef system. This restriction in sediment transport will affect the accretion and erosion pattern of the island. However, the proposed jetty will allow flow of current under the jetty when there will be minimal restriction of sediment transport as a result of the jetty construction.

The following impacts are expected on the biophysical environment as a result of construction and operation of a jetty in V. Fulidhoo;

- Minor accretion on the southern western beach of the island.
- No major modification of the wave and current pattern are expected as the proposed jetty will allow current to pass through.
- The wave height of the waves may increase after maintenance dredging of the jetty area and the access channel was the depth of the proposed dredging area(s) for the maintenance dredging will increase.

The socio-economic impacts of a construction and operation of the new jetty include the following;

- The new jetty will have positive impact on the island community as they will have better accessibility to the island;
- The newly constructed jetty will provide easy accessibility to the island hence reduce potential accidents using small boats for accessing the island;
- The newly built jetty will provide some employment opportunities for maintenance of the jetty;
- The newly constructed jetty will also increase the economic opportunities for the island community and thus indirect employment opportunities.

6.7.2.2 Maintenance dredging of jetty area and access channel

The bathymetry conducted during the field visit survey shows that there are no requirements for dredging in the jetty area or an access channel during the construction phase of the project. However, there will be requirements for maintenance dredging during the operational phase of the project. Furthermore, the analysis of shoreline and observation made during the field visit suggest that there will be requirements for maintenance dredging. The location for the construction of the jetty faces accretion of sediments and will create constraints in using the jetty in low tide.

The toothed-bucket action of the excavator on the sea floor head will disturb the substrate and place sediments into suspension. In addition, movement of the bucket while lifting the sediments out of the water will also place sediments into suspension. These suspended sediments may then smother nearby corals, bottom living flora and fauna when they settle. The effect will be greatest in those areas with fine sediments, which are more easily placed into suspension.

The severity of the impact would also depend very much on the direction of the sediment plume which in turn would depend on the direction of the currents and wind. The direct impacts of sedimentation, could be moderate to severe on those communities close to the dredging site. It is unlikely that the coarse sediments brought into suspension in the dredged area would be carried very far to adversely impact reef as these would be expected to settle fairly rapidly.

The suspension of fine sediments in the water column creates turbidity, which scatters and alternatives light levels and potentially affects the growth of plants and corals indirectly by reducing the availability of light and consequently the photosynthetic process in plants and coral symbionts. High levels of localized turbidity can be expected during dredging.

Most of the turbidity generated by dredging operations is usually found in the vicinity of the toothed bucket. The levels of turbidity are related to the type and quantity of material dislodged by the excavator, but not picked up. The ability of the dredger to pick up bottom material determines the amount of dislodged material that remains on the bottom or suspended in the water column. In addition to the dredging equipment used and its mode of operation, turbidity may be caused by inefficient operational techniques, poor workmanship, carrying out dredging in rough weather.

This maintenance dredging will have the following impacts on the biophysical environment of V. Fulidhoo Island;

- Sedimentation due to maintenance dredging may affect the coral communities on the reef;
- Turbidity would increase in the marine water;
- Sedimentation due to maintenance dredging may affect the coral communities on the reef.
- The maintenance dredging is expected to increase the wave height since the dredged area will have a greater height.

The main impact on the socio-economic environment due to maintenance dredging include the following;

- The operation of machinery will increase sooty smoke which can decrease the air quality in the vicinity of the project site;
- The operation of machinery will increase the noise level near the project area;
- Use of heavy vehicles such as trucks in close proximity to local community will increase chances of accidents involving small children and elderly.

The main socio-economic impacts due to maintenance dredging is mainly due to use heavy machinery which will have indirect impact on the air quality and the noise level in the vicinity of the project area. However, these impacts are limited to the duration of the maintenance dredging.

6.7.2.3 Solid waste management and disposal

Due to mainly economic activities of V. Fulidhoo such as tourism related activities and other activities such as fisheries leads to extensive utilization of the newly constructed jetty. This increase in utilization of the newly constructed jetty will generate solid waste which may be dumped to the lagoon if improperly disposed.

The main impacts on the biophysical environment due to improper disposal of the solid waste generated during the operational phase include the following;

- Inadequate solid waste management practices during the operational phase contribute to marine pollution hence affect the coral reef;
- Inadequate solid waste management practices during the operational phase contribute to marine pollution hence affect the coral habitats found in the lagoon and deteriorate the marine water quality;

These predicted impacts are mainly due to improper disposal of solid waste generated in the *dhonis* and speed boats during the utilization of the jetty. However, these impacts can be easily mitigated by using proper solid waste management techniques.

The main impacts on the socio-economic environment due to improper management of solid waste during the operational phase include the following;

- The degraded water quality due to disposal of waste by the jetty users will affect the aesthetics and also public health of the users of lagoon;
- Island council could employ staff to clean the jetty area hence increasing the employment opportunity;
- Island council could take jetty maintenance fee from regular jetty users such as tourist facilities such as guest houses and recreational divers.

Out of the three predicted impacts of solid waste management and disposal at the jetty area, two are considered as positive impacts as they can be explored as economic opportunities. The island council which will have the main responsibility of the maintenance of the jetty in the island. The council could explore taking a maintenance fee from the recreational users of the jetty such as diving vessels and tourist facility operators. The revenue from this maintenance fee can be used to proper maintenance of the jetty such as painting and other services required for efficient usage of the jetty.

The main negative impacts on the social environment arise if the solid waste disposal are inadequately done which will have indirect impact on the economy of the island. The aesthetics of the jetty area will be unappealing if the solid waste generated in the jetty area is not managed adequately, which is a critical issue since the island depend on local tourism as a main source of income. Furthermore, the improper management of solid waste in the jetty area can lead to public health issues since the southern beach of the island is used for recreational swimming by both the island community as well as the tourists.

6.7.2.4 Stockpiling of the dredged materials

Predominantly, the main content of the dredged material is expected to Sand, Pavement and Rubble. The dredged material will be stockpiled in a location just south west to the project location (see Figure 7). Due to the proximity of this location to the shoreline some environmental impacts are expected to occur due to stockpiling of the dredged materials.

The main impacts on the bio-physical environment include the following;

- The stockpiling of dredged material will be in close proximity to the shoreline hence some of the sedimentation and impact may occur;
- The stockpiling of the dredged material will be in close proximity to the shoreline hence some turbidity of lagoon water is expected.
- Salinity of the groundwater may increase as a result of stockpiling of the dredged material during maintenance dredging.

6.8 Indirect Impacts

The most significant indirect impact will be the impact on the reef fish fisherman who will be relying on the reefs for their catch. The short-term sedimentation during the jetty construction and during the maintenance dredging will affect the coral reefs thus affect the population of the fish communities which rely on coral reef as habitats.

The tourist facilities in the island which relay on the coral reefs for snorkelling trips and recreational diving in the vicinity of the project site would have similar indirect impacts due to expected sedimentation. However, as discussed earlier the impacts due to sedimentation is localized within the project boundary and are expected to be for a short period of time.

6.9 Cumulative Impacts

From the public consultation for the purpose of this EIA study, it was found that the local residents of V. Fulidhoo require a longer jetty than the proposed jetty. If this longer jetty option is considered there will be some cumulative impacts associated with the project. More excavation will be required to place the foundations for the footings of the jetty and a larger area will be excavated during the maintenance dredging as proposed in the operation of the project.

The impacts discussed in this section will be cumulative if a harbour is constructed in the project location in order to meet the ever-increasing demand for accessibility to V. Fulidhoo Island. However, the proponent currently has no plans of developing a harbour instead of a jetty in V. Fulidhoo Island.

6.10 Impact Analysis and Evaluation

The following section will provide an analysis and evaluation of the previously described impacts on the biophysical and socio-economic environment in order to identify their significance.

The Table 17 is an impact analysis table. From the Table 17 it can be inferred that magnitude of the most of the negative impacts on the natural and social environment is moderate, minor or negligible.

The most significant impact during the construction phase of the proposed jetty construction in V. Fulidhoo is excavation for the placement of the concrete footing of the jetty.

For the operational phase of the proposed jetty construction in V. Fulidhoo, the most significant negative impacts will be caused by maintenance dredging of the jetty area and the access channel. The maintenance dredging is expected to have a medium impact while this moderate significance level impact is most certain to happen. The improper solid waste disposal is have a moderate significance level however, it is unlikely to occur to the existing solid waste management regime in the V. Fulidhoo Island.

The indirect impact of this project was found to have a moderate impact as these indirect impacts are most certain to occur during the operational phase of the project due to maintenance dredging. However, the cumulative impact of this project was found to have a minor significance level since it is highly unlikely to occur in a near future. The overall, socio economic impacts of the proposed Jetty Construction project in V. Fulidhoo was found to be moderate significance level and most importantly positive in nature.

Environmental Impact Assessment for Jetty Works Project in V. Fulidhoo

Table 17: Impact Analysis Matrix for proposed jetty construction project in V. Fulidhoo

Project Activity/ Impact	Extent	Duration	Intensity	Likelihood	Significance	Color Scale
Construction Phase						
Excavation for placement of the pre-cast concrete footings	Local	Short-term	Medium	Definite	Moderate	
Ground levelling works at the Jetty Area	Onsite	Short-term	Low	Likely	Minor	
Machinery and Equipment	Onsite	Short-term	Low	Likely	Minor	
Impact of workforce	Local	Short-term	Negligible	Unlikely	Negligible	
Potential of oil spills from excavator	Onsite	Short-term	Medium	Unlikely	Minor	
Operational Phase						
Maintenance dredging of jetty area and access channel	Local	Long-term	Medium	Definite	Moderate	
Solid waste management and disposal	Local	Long-term	Medium	Unlikely	Minor	
Construction and operation of a new jetty	Local	Long-term	Low	Definite	Minor	
Stockpiling of the dredged material	Local	Short-term	Medium	Unlikely	Minor	
Both Phases						
Indirect impacts	Regional	Long-term	Medium	Likely	Moderate	
Cumulative impacts	Local	Long-term	Medium	Unlikely	Minor	
Socio-economic impacts	Local	Long-term	Medium	Definite	Moderate	

7. Mitigation Measures

The main objective of the following section is to provide environmental management and mitigation measures that will be undertaken and monitored in order to minimize and offset previously described environmental impacts of the proposed Jetty construction project in V. Fulidhoo.

7.1 Justification for the proposed mitigation measures

The following factors were considered in order to evaluate the appropriateness of the proposed mitigation measures;

- Costs;
- Benefits;
- required manpower;
- equipment;
- expertise;
- timing and
- technology

The proposed mitigation measures will be the most cost-effective, have the maximum benefits and requires minimum utilization of manpower and equipment. Furthermore, the practicality of the proposed mitigation measures will be given a high priority. The technical aspects of the different project components were considered when evaluating the proposed mitigation measures.

7.2 Limitations of the proposed mitigation measures

The main limitation of the proposed mitigation measures is that these mitigation measures are proposed for an impact which is predicted. Since the impact has been predicted, there is an uncertainty regarding how the impact will affect the natural environment when the actual project is implemented. The nature of impacts even from similar project activities undertaken in a different location in the country could generate in a totally different manner.

7.3 Construction Phase

7.3.1 Excavation for placement of the pre-cast concrete footings

As can be seen from the previous section on environmental impacts from the proposed project, sedimentation impacts on the coral community in close vicinity of the project site and changes to lagoon water quality due to increased turbidity are identified as key environmental impacts from this project impact.

The following measures will be undertaken in order to reduce the impacts discussed in the impacts section from the above-mentioned activities. Since the proposed excavation will be conducted at a very shallow depth of about 0.5 to 1 m hence the expected impact of sedimentation can be easily mitigated by taking the following mitigation measures. These include;

- Undertaking the excavation during the low tide and on calm days in order to minimize the spread of the sediments to the immediate vicinity;
- Clearly marking the area which require excavation which will enable to prevent the spreading of the sediments and impacting large area;

- Undertake excavation activity in the shortest time possible so that presence of the environmental impact will be short-lived due to short exposure period.
- Vessel owner and jetty users will have to be informed of the ground levelling and jetty works schedule. The maintenance dredging will have to be carried out in a manner that does not result in total closure of the existing old jetty;
- Excavator positioned to minimize disruptions to jetty users.
- Workers shall be provided with safety gears.

The following are key considerations for the most significant mitigation measure for reduction of impacts of excavations.

Mitigation Measure	Carry out the work at low tide (Reduce sedimentation naturally)
Cost	Zero
Benefits	At low tide the corals and other marine life will be visible hence the impacts on these marine organisms can be reduced. The impacts of sedimentation will be reduced.
Expertise	Local Knowledge, Environmental Protection & Sediment control
Required Manpower	2 - 4
Responsibility	Contractor
Equipment and Technology	Project Management
Timing	Low tide period depending on the day of construction work.

7.3.2 Ground Levelling Works at the Jetty Area

The main impacts which is anticipated to arise from the ground levelling works for the proposed jetty works in V. Fulidhoo are physical damage to the sedentary organism and burrowing organism such as crabs may be affected and salinity of the groundwater may increase due to levelling works.

The following are the mitigation measures which will be undertaken during the ground leveling works at the jetty area;

- The excavated material will be rinse in rain in order to remove salinity of the excavated material so that the impact of the salinity will decrease prior to ground levelling works;
- Vessel owner and jetty users will have to be informed of the ground levelling and jetty works schedule. The maintenance dredging will have to be carried out in a manner that does not result in total closure of the existing old jetty;

The following are key considerations for the most significant mitigation measure for reduction of impacts of ground levelling at the jetty area.

Mitigation Measure	Exposure of the excavated materials to rain prior to using for ground leveling
Cost	Zero
Benefits	The salinity of the soil will be decrease.
Expertise	Sediment management
Required Manpower	2 - 4
Responsibility	Contractor

Equipment and Technology	Project Management
Timing	Rainy days during construction period

7.3.3 Machinery and Equipment

The main heavy machinery and equipment to be utilized during the construction phase includes excavators, lorries, dumpers and barges. The impacts due to usage of these machinery are due to burning of fossil fuel for the operation of these machineries and potential accidents in utilization of these heavy machineries.

The following are the mitigation measures which will be undertaken during utilization of machinery and equipment;

- Efforts must be made to avoid accidental spillages from machinery including overtopping leading to severe spillages;
- Machines must be operated by experienced operators and made sure machines are clean all the time;
- Do not throwing of cleaning materials and changed oils into the environment.
- Safety measures during the construction phase will have to place on a sign board near the jetty to avoid potential accidents.

The following are key considerations for the most significant mitigation measure for reduction of impacts of machinery and equipment;

Mitigation Measure	Machines must be operated by experienced operators
Cost	Salary of Experienced operators
Benefits	Accidental damage to reef and critical infrastructure such as sewerage network and cable TV internet can be avoided. The accidental spillage of fuel and lubricant oil can be avoided.
Expertise	Technical and Experience in operation of heavy machinery and vehicles
Required Manpower	Two to Three staff
Responsibility	Contractor
Equipment and Technology	Not required
Timing	Construction phase during the operation of heavy machineries

7.3.4 Impact of workforce

As discussed in the impact prediction section (see Section 6), it is anticipated to have an influx of semi-skilled workers to the island. These workers may be mostly expatriates and some workers from other

islands. The main impacts on the environment will be that these workers will be utilizing the resources available in the island. However, most of the impacts is expected to be short term and mostly social impacts.

The following are the mitigation measure which will be undertaken in order to minimize the impacts of workforce;

- Educate and create awareness amongst the workers regarding potential environmental impacts;
- As much as possible, employ local residents from the island of V. Fulidhoo.

The following are key considerations for the most significant mitigation measure for reduction of impacts of workforce;

Mitigation Measure	Employ local residents from the island of V. Fulidhoo
Cost	Budget allocated for semi-skilled workers
Benefits	No additional burden on the resources of the island. No social problems will arise since employee will be from local island. These problems may arise if mostly expatriate workers are employed.
Expertise	Local connection with residents of
Required Manpower	Existing human resource person of contractor
Responsibility	Contractor
Equipment and Technology	Not required
Timing	Construction phase

7.3.5 Potential of oil spills from excavator

Accidental spill of oil from excavator is a significant risk both during the construction phase and also during the maintenance dredging in operational phase. The risk of oil spill will be reduced by avoiding storage of oil in the excavator itself. The required fuel for the operation of the excavator will be transported from oil storage facilities in V. Fulidhoo. Furthermore, the operation of the excavator will be ceased during rough weather in order to reduce potential oil spills.

In case of the accidental spill, oil confinement equipment such as oil boom will be used to control spread of the oil spill. Also, during the emergency all the operations will be stopped and all manpower will be diverted to resolve the oil spill issue.

The following mitigation measures will be taken in order to prevent any environmental impact associated with oil spillage from the excavator and barge.

- Take precautionary measures such as not storing any fuel in the excavator or the barge and transport only the quantity of the oil required for the operation of the excavators.
- No excavation will be conducted during rough weather so that the possibilities of oil spill will be reduced.
- Oil confinement equipment such as oil boom will be made available in a case of oil spill.

The following are key considerations for the most significant mitigation measure for reduction of impacts of potential oil spill from excavator;

Mitigation Measure	Take precautionary measures and make oil confinement equipment available
Cost	Around USD 10,000
Benefits	Risk mitigation and control potential oil spillage
Expertise	Oil spill remediation and control
Required Manpower	2 - 4 workers
Responsibility	Contractor
Equipment and Technology	Oil confinement equipment such as oil boom
Timing	During oil spill accidents

7.4 Operational Phase

7.4.1 Maintenance dredging during the operational phase of the jetty

Maintenance dredging is one of the project activity which is expected to have the most significant impacts on the bio-physical environment of the V. Fulidhoo. The maintenance dredging is expected to have impact such as direct loss of habitat for the corals found in the dredged area and sedimentation impact on the coral communities found in the vicinity of the project area. Furthermore, the maintenance dredging will increase the turbidity of the sea water in close vicinity of the project site hence a short-term decline in water quality is expected.

The following regime will be followed during the maintenance dredging in order to mitigate the environmental impacts of the maintenance dredging;

Activity	Potential Impacts	Impact Mitigation Measures
Excavation	Disturbance to benthic environment Disturbance to marine organism Accidental spills from dredger	<ul style="list-style-type: none"> • Planning to conduct dredging during the calm weather. • Deploying double layer silt curtain system around dredging work areas where necessary. • Good dredging practices by engaging skilled operators to ensure minimizing sediment suspension and dispersal at the dredging location. • Seawater quality monitoring program as given in the Monitoring Section shall be fully implemented in order to maintain the TDS level close to the background level. • Proper protocols developed to attend in case of emergency spills.
	Modification of current and wave behavior	<ul style="list-style-type: none"> • At the entrance channel this would be a positive impact since the wave activities and current patterns makes it extremely difficult for the boats to pass through during rough weather. • Wave height will slightly increase within the jetty area basin due to dredging but is expected to be of no concern.

Sediment disturbance	Settlement of suspended solids on corals and benthic organisms	<ul style="list-style-type: none"> Do not allow overfilling of dredger bucket to control spillage. Deploy turbidity barrier to prevent sedimentation on corals.
	Attenuation of light in water column	<ul style="list-style-type: none"> Apply above measures to control sediment dispersion.
	Potentially unstable edges to dredged channel	<ul style="list-style-type: none"> Dredge sides of channel at an angle to be determined by geotechnical engineer that will prove stable.
	Increase ambient noise level	<ul style="list-style-type: none"> Movement of vehicles and handling of rock boulders during construction phase will generate noise. Given the adequate separation of the work areas from the resident population noise may not be concern to most people. However, work shall be planned to stop after 11pm in order to avoid complaints from sensitive population.
Dredged material disposal		<ul style="list-style-type: none"> Material shall only be stockpiled at designated site as given in the EIA report.
Leakage of sediments during transport to disposal site	Increased turbidity over lagoon	<ul style="list-style-type: none"> Not overloading the trucks with sediments. Employing good practices and good workmanship in transporting sediments.
Socio-economic	Service disruptions to jetty	<ul style="list-style-type: none"> Vessel owner and jetty users will have to be informed of the maintenance dredging schedule. The maintenance dredging will have to be carried out in a manner that does not result in total closure of the jetty. Dredging equipment positioned to minimize disruptions to jetty users. Safety measures during the construction phase will have to place on a sign board near the jetty to avoid potential accidents. Workers shall be provided with safety gears.
	Potential accidents	

7.4.1.1 Monitoring as a mitigation measure during the maintenance dredging

- There is no legislation in the Maldives with regards to permitted levels of turbidity, we propose under the project’s monitoring programme to set up geo-referenced monitoring stations. In this regards at least 3 monitoring station shall be set up. The consultants will assist the proponent in setting up the monitoring station or the compliance station, sample collection and data analysis.
- Samples is to be taken at a depth of 3 feet from the surface at each station at a frequency of every six daytime hours during initial operations (no more than 10 days) and once per day thereafter. Nephelometric Turbidity Units or NTU’s so that during construction, the turbidity level to be maintained below 29 NTUs against the associated background turbidity levels as prescribed in the Monitoring Section. NTU upper limit has been set based on compliance limits set is based on practices in some countries.

- Measurements will be taken prior to commencement of dredging in order to determine the background turbidity level whilst turbidity is affected movement of vessels in the harbour. These measurements will be taken over a two-day period and averaged to determine a background turbidity level of 2.3 NTU against which the 29 NTU rule is to be applied during dredging. The pre-determined limit of turbidity level at the compliance stations will therefore be $2.3 + 29 = 31.3$ NTUs.
- However, if background measurements exceed the pre-determined limit of 31.3 NTUs, the background measurement shall be used for comparison of compliance measurements. In other words, compliance measurements shall be compared with the daily background measurements, whichever is higher, construction activities shall cease immediately and not resume until corrective measures have been taken and turbidity has returned to an acceptable level. Any such occurrence shall also be immediately reported to the Project Manager.
- It must be clear that 29 NTU above background is the absolute maximum we recommend and any exceedance of this value must result in the suspension of dredging/disposal operations. In an attempt to prevent instituting serious mitigatory measures to avert exceeding the NTU (above background) maximum being exceeded, a graded system of turbidity concentrations is recommended. Instead of relying on a single turbidity concentration, a maximum at the monitoring sites of 20 NTU (above background) should be used as an early warning indicator. The contractor would thus be in more of a position to initiate mitigatory measures to avert exceeding the 29 NTU (above background) level is attained or exceeded, the contractor should ensure that the necessary mitigatory steps are taken and documented to prevent a further increase in suspended solids concentration, which could lead to suspension of the operation when 29 NTU (above background) is exceeded.
- Mitigatory steps would normally involve a slower rate of progress to control the over flow from the bucket. It should be noted that these mitigation measures will add to the cost of dredging. If 29 NTU (above background) is attained or exceeded there should be no debate and dredging operations must be immediately suspended until levels are reduced to below the threshold mark. A report on the exceedance incident should be prepared and only after the environment officer is satisfied that the situation has been rectified should the operation be resumed.
- Turbidity barriers or silt curtains are often used to limit the impact of turbidity. In some cases where relatively quiescent current conditions (0.2 ft/sec or less) are present, turbidity levels in the water column outside the curtain can be 80 to 90 percent lower than the levels inside or upstream of the curtain. While there may be a turbid layer flowing under the curtain, the amount of suspended material in the upper part of the water column, as a whole, is substantially reduced. However, the effectiveness of turbidity barriers can be significantly reduced in high energy regimes characterized by currents and turbulence. High currents cause turbidity barriers to flair, thus reducing the curtain's effective depth; in fact, in a current of 1 knots the effective skirt depth of 5ft curtain is approximately 3 ft. Increased water turbulence around the curtain also tends to suspend the fluid material layer and may cause the turbid layer flowing under the curtain to resurface just beyond the curtain. However, even under moderate currents (up to 0.5 knots), a properly deployed and maintained center tension curtain can effectively control the flow of turbid water (under the curtain). In other cases, where anchoring is inadequate and particularly at sites where tidal currents dominate the hydrodynamic regime and may cause re-suspension of the fluid material as the curtain sweeps back and forth (over the fluid material) with changes in the direction of the current, the turbidity levels outside the curtain the curtain can be as much as 10 times higher than the levels inside the curtain. With respect to overall effectiveness and deployment considerations a current

velocity of approximately 1.5 ft/sec appears to be a practical limiting condition for turbidity curtain use.

- The statistical reliability of the monitoring data set is improved with increased monitoring frequency. To determine if guidelines have been exceeded during dredging, ideally, for long-term exposures, initially, measurements should be taken every six daytime hours during initial operations (no more than 10 days), less frequent monitoring may commence once the likely levels of turbidity during operations have been established and found to be within the guidelines. Measurements can then be taken on a gradually less frequent period though never be less than once daily during operations.
- Daily monitoring reports will include the following information for each sample: a) time of day; b) antecedent weather conditions; c) tidal stage and direction of flow; d) wind direction and velocity. Reports shall be compiled daily even when no sampling is conducted. When sampling is not conducted, a brief statement shall be given to explain the rationale, such as “dredge not working” or “no sampling due to high sea”. Weekly summaries of the daily turbidity monitoring data will be submitted to the Project Manager within one week of analysis with documents containing the following information: 1) dates and times of sampling and analysis; 2) state plane coordinates (X and Y) of the sampling stations and the dredge and discharge locations, and the distance between the sampling stations and the dredge and discharge locations and the distance between the sampling stations and the dredge/discharge for each sample to demonstrate compliance with the above required distance; 3) a statement describing the methods used in collection, handling, storage and analysis of the samples, as well as the authenticity, precision, limits of detection and accuracy of the data; 4) results of the analysis; 5) a description of any factors influencing the dredging or disposal operation or the sampling program. The summaries shall be submitted in Excel Spreadsheet.

7.4.2 Construction and Operation of the Jetty

The construction and operation of the jetty is expected to have significant positive impacts on the socio-economic environment of the island. However, there are some minor impacts on the sedimentation pattern and current flow rate around the southern beach of the island. The footings of the proposed jetty is designed in an alignment that would reduce the barrier effect on the long-shore sediment transport. The field assessments suggest that the current speed on the southern side is around 0.11 m/s to 0.15 m/s. The proposed jetty is expected to reduce these current speeds insignificantly.

However, it is estimated that the sediment accretion will take place on the south western and southern side of the island if the existing old jetty is not removed. This will result in requirement for maintenance dredging of the area. Concurrently, the erosion of the south-eastern and western side of the island is expected take place as it occurs now.

Removal of the old existing jetty will enhance the long-shore sediment transport thus reduce the accretion of the sediments on the southern beach and replenish the eroded zone on the southeastern side of the island and the western side of the island. The following Figure 30 shows the accretion and erosion pattern of the island between the year 2011 to 2014.

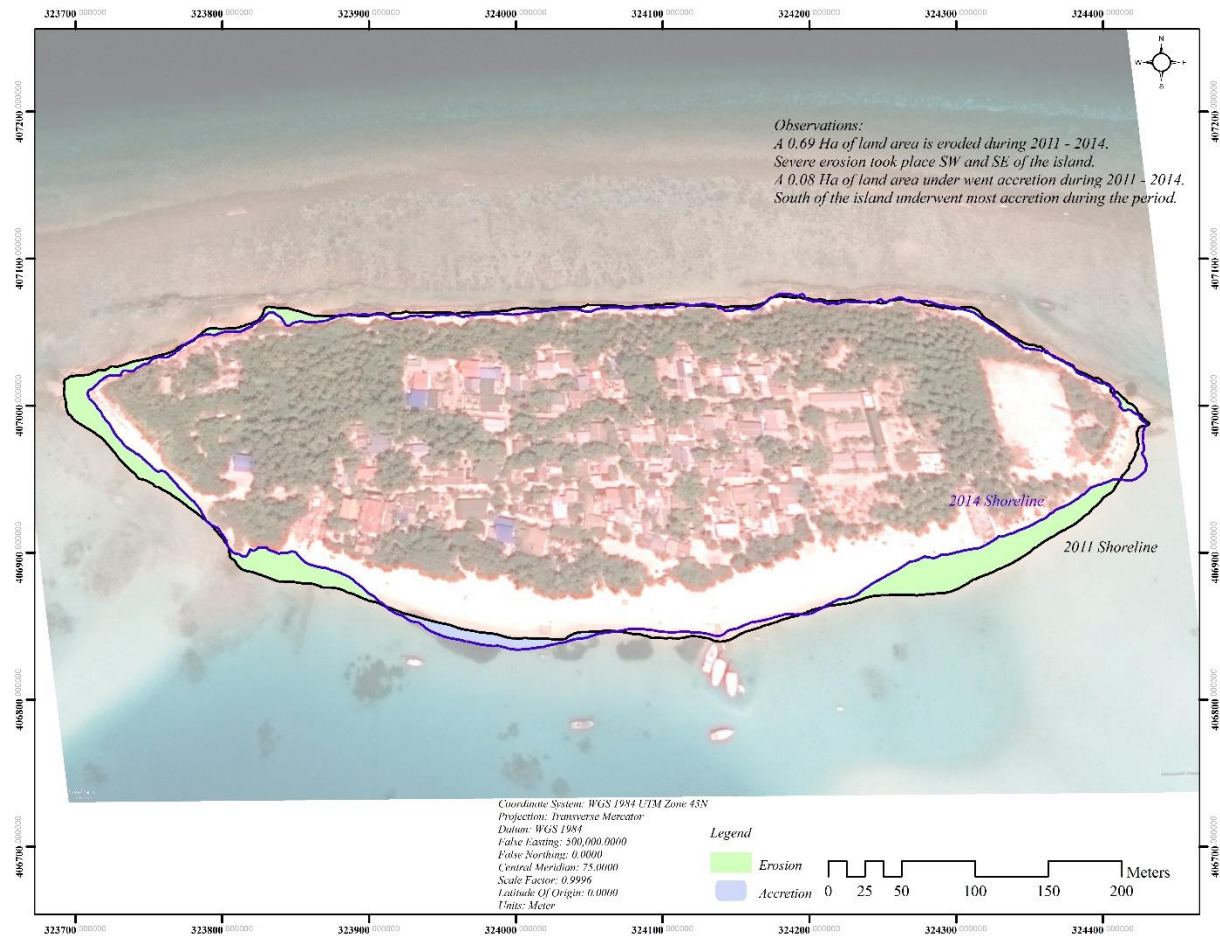


Figure 30: Accretion and erosion patterns in V. Fulidhoo from 2011 to 2014

The following mitigation measures will be taken to mitigate the adverse impacts of the construction and operation of proposed jetty in the V. Fulidhoo;

- Construction of concrete footing (pad and column structures) so that the proposed jetty will not obstruct the long shore currents transporting sediment around the island.

The following are key considerations for the proposed mitigation measure for reduction of impacts of construction and operation of a new jetty in V. Fulidhoo;

Mitigation Measure	Construction of concrete footing (pad and column structures so that the proposed jetty will not obstruct the long shore currents transporting sediments around the island.
Cost	Cost of the footings and foundation
Benefits	Erosion and accretion due to the project intervention will be reduced.
Expertise	Structural engineering
Required Manpower	1 Engineer and 2 to 4 workers

Responsibility	Contractor
Equipment and Technology	Structural engineering and project management
Timing	Construction phase

7.4.3 Solid waste management and disposal

Construction and operational phase of the jetty would generate waste. The major waste types that would be generated by construction activities would include materials from excavation works, marine sediments excavated from the foundation/piling, small quantity of chemical waste from the maintenance and servicing of construction equipment and general refuse from the workforce.

During the operational phase anchored vessels and people using the jetty will generate waste and marine sediments dredged.

The following mitigation measures will be taken during both construction and operational phase of the project in order to mitigate the environmental impacts raised from solid waste management and disposal;

- The approach for development of the project is to avoid or to reduce the volume of waste generated and to re-use where possible and disposal according to the legislative requirements. No waste generated from the project will be add to the waste stream of the island. Project waste management protocol shall be developed in line with the Regulation and will be strictly followed and monitored.
- Arrangements will be made for handling temporary storage and final disposal. Waste transfer vessel shall be available for the timely removal of waste from the site.
- No large-scale recyclable waste material (e.g. metal) are expected from the project. Priority will be given for segregation of such waste from the non-inert construction waste for stockpiling at a designated site which has the potential for selling to vendors re-exporting such materials. The remaining non-recyclable waste materials will be disposed of at Thilafushi. Similarly waste generated from the workforce shall be managed giving priority to waste separation to maximize the diversion of construction waste from being sent to Thilafushi. Non-recyclable waste will be disposed of at Thilafushi landfill sites.
- It is expected that small quantity of chemical waste will be generated during construction, which would be properly handled, stored, labelled and disposed of in accordance with the Waste Disposal Regulation at Thilafushi.
- Provided that all the identified waste materials are handled, transported and reused/disposed of in strict accordance with the relevant legislative and recommended good site practices and mitigation measures are properly implemented, no unacceptable environmental impacts are expected during the construction and operational phase.
- Floating wastes that may accumulate in the jetty area will regularly collected and managed by the Island Council during the operational phase.

The following are key considerations for the most significant mitigation measure for reduction of impacts of solid waste management and disposal issues due to the project;

Mitigation Measure	Waste transfer vessel shall be available for the timely removal of waste from the site.
Cost	Rental and Operational cost of a waste transfer vessel
Benefits	Proper management of solid waste during the construction phase.

Expertise	Logistics
Required Manpower	Captain & crew member
Responsibility	Contractor
Equipment and Technology	Waste collection equipment and transfer vessel
Timing	Construction phase

7.4.4 Stockpiling of the dredged material

Sea disposal of sediments shall be completely avoided and uncontrolled spread of sediments shall be checked through appropriate mitigation measures and through responsible workmanship. The dredged material is recommended to be utilized as much as possible for various purposes related to the project. Certain coastal areas around the jetty being lower than the average elevation of the island, some dredged sediment can be used for levelling. Usage of dredged materials for levelling can eliminate flood prone areas and therefore expected to have a beneficial impact. Following the sieving and sorting dredged material will be stockpiled at locations where area for use by the island community for construction and backfilling purposes. The areas where dredging materials were stockpiled during the maintenance dredging will be used for placing sediments (See Figure 7).

Deep sea disposal is an alternative for disposal of the dredged material. One of the main concerns with regards to the dredged material disposal is the impacts on water quality, which include those associated with increased turbidity, decreased oxygen levels, and visual impacts. Dredged material disposal typically has a short term (several hours to days) impacts on the water column following discharges of solids and solutes from a barge. The greatest proportion of dredged material consists of negative buoyant solids that sink as a turbid suspension through the water column to the sea floor. Dissolved constituents of dredged material are entrained in the turbulent water associated with the convective decent. For this reason, deep sea disposal is not recommended.

The following mitigation measures will be taken in order to minimize the impacts of the stockpiling of the dredged materials during maintenance dredging;

- The excavated material will be rinse in rain in order to remove salinity of the excavated material so that the impact of the salinity will decrease prior to stockpiling in the proposed location.
- Coastal protection measures such as off-shore breakwater or on-shore revetments will be deployed in order to minimize impacts of the wave activity on the stockpiled location, thus reducing potential sedimentation impacts.

The following are key considerations for the most significant mitigation measure for reduction of impacts of stockpiling of the dredged materials.

Mitigation Measure	Exposure of the excavated materials to rain prior to using for ground leveling
Cost	Zero
Benefits	The salinity of the soil will be decrease.
Expertise	Sediment management
Required Manpower	2 – 4 workers
Responsibility	Contractor

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Equipment and Technology	Project Management
Timing	Rainy days during maintenance dredging period

8. Alternatives

This section of the report contains the alternative means for the project in terms of alternative location for the jetty construction, alternative accessibility infrastructures and alternative construction materials for jetty construction. Furthermore, the no project option was also explored in this section.

8.1 No Development Option

It is believed that the proposed jetty construction project in V. Fulidhoo to have some environmental impacts. If the project does not go head the existing environment will be as it now.

However, not having the proposed jetty construction project implemented will have many unfavorable social impacts to the island community of V. Fulidhoo. The existing jetty is too short and sediment accretion in the vicinity of the existing jetty has caused a lot of constraints for the jetty users as the depth is not enough for the boats to utilize the existing jetty. The Figure 31 is a picture showing the level of accretion of the sediments around the existing jetty.



Figure 31: The level of sediment accretion around the existing jetty in V. Fulidhoo

Construction of a new jetty will improve the accessibility of the island. More boats can utilize the newly constructed jetty and this will enhance various economic activities in the V. Fulidhoo Island. The newly constructed jetty will be safer and more reliable during the rough weather hence significantly reducing accidents. The newly constructed jetty will be using pre-caste concrete hence the jetty will be durable compared to the existing jetty.

8.2 Alternative Location for the jetty

Alternative location for the jetty was determined during the stakeholder consultation. However, the community consultations show that the residents of V. Fulidhoo approve the location of the proposed jetty construction. However, as a part of the EIA process and alternative location is proposed.

8.2.1 Alternative location for the jetty construction

The alternative location for the jetty construction is in the south-western side of the island. The Figure 32 shows the alternative location for the jetty construction.

8.2.2 The existing environment of the alternative location for jetty construction

The alternative location does not have beach front dune so the vegetation line is very close to the shoreline. The beach area is very small when compared with the proposed location for the jetty construction. There are some hard bedrocks found near the beach area. The Figure 33 is a picture of the beach area in the proposed alternative location. The main reason for proposing this as an alternative location is that it is far away from the residential houses and tourist facilities in the island, thus the noise impacts will be less during construction phase. However, there are roads through which the location can be accessed.

In terms of the marine environment, the alternative location had some dead corals with algae and sparsely separated live coral colonies. It can be inferred from the aerial analysis of maps using GIS, that this location is prone to erosion. Sediments such as sand, pavement and rubble dominated this location as well. The Figure 33 are underwater photographs taken from the proposed alternative location for the jetty construction.



Figure 32: The alternative location for jetty construction in V. Fulidhoo



Figure 33: The beach and marine environment at the proposed alternative location for jetty construction

8.2.3 Potential Impacts & Mitigation measures for the proposed alternative location for jetty construction

When the considering the existing environment of the proposed alternative location for jetty construction the following environmental and social impacts can be envisaged;

- The alternative location is susceptible for erosion during the northeast monsoon. This will lead to extra levelling of the jetty area thus increasing the environmental and socio-economic impacts of ground levelling the jetty area as discussed in the Section 6.7.1.2.
- The construction works such as excavation of the footings of the jetty will be more energy intensive and will lead to more severe environmental and socio-economic impacts discussed in Section 6.7.1.1. The main reason being the presence of hard bedrock the proposed alternative location for jetty construction.
- More coral communities and benthic organisms will be affected since the marine environment of the alternative location is more diverse in terms of the coral communities when compared to the proposed construction location.

The following mitigation measures need to be taken in addition to the mitigation measures described in the chapter 7.

- Measures to prevent any destruction to the geomorphological integrity of the island since heavy machineries such as drop-hammer would be used to remove the bedrock found in the alternative location.

8.2.4 Evaluation between the alternative and the proposed location for the jetty construction

The environmental impacts of construction of the jetty in the alternative location will be more severe when compared with jetty construction at the current proposed location. The additional mitigation measures required if the jetty is constructed in the alternative location would create additional financial burden for the proponent and the island community.

The noise pollution impacts during the construction phase will be in the alternative location as alternative location is situated away from the residential houses and tourist facilities.

However, this remote location will cause difficulties for the jetty users during the operational phase of the jetty. Considering these factors, the current proposed location for the jetty construction is the most ideal location for this project.

8.3 Alternative accessibility infrastructure for V. Fulidhoo

Any accessibility infrastructure developed on a coastal environment has the potential to cause environmental and socio-economic impacts. This report describes the potential impacts of jetty construction in V. Fulidhoo. This section evaluates the environmental and social impacts which may arise from construction of a harbor in V. Fulidhoo.

8.3.1 Environmental and Social Impacts arising from construction of a harbor

The following are some potential impacts which may arise from harbor construction. These impacts were adopted from the Environmental Impact Assessment studies conducted for harbor construction projects in islands of Maldives with similar biophysical and social environment as V. Fulidhoo.

- Solid waste and hazardous waste generated during the construction phase has the potential to pollute the environment;
- Short-term sedimentation and turbidity over coral along harbor due to suspension and dispersal to fine sediments;
- Minor damages to the corals during breakwater construction and maintenance dredging.
- Impaired visual/seascape impacts from the presence of the dredging equipment; and
- Increased noise levels in the harbor due to dredging and rock boulder breakwater construction.

From the aforementioned impacts, it is clearly apparent construction of harbors are usually accompanied by construction of coastal protection structures such as breakwater or off-shore revetments in order to avoid effects of waves inside the harbor basin. Hence, construction of these structures would result in greater environmental impacts. Furthermore, dredging is a main component of any harbor construction as dredging is required to obtain the desired depth inside the harbor basin. Dredging is an activity which leads to serious environmental impacts such as habitat destruction for benthic marine organisms and sedimentation impacts for the coral reefs. Hence, the environmental impacts of a harbor construction is expected to be more severe than the environmental impacts associated with construction of a jetty.

In terms of the socio-economic impacts, the harbor will have a better positive impact as a large area can be used by boat owners and other users of harbor for various economic activities. Some of the positive socio-economic impacts associated with a harbor include the following;

- Better income to the island due increase economic activities facilitated by a harbor;
- Improvement to fishery due to improved access and navigational safety and transport at local level;
- Better employment opportunities in the island;

- Improved safety due to avoided accidents causing damages to boats and to the people;
- Improved infrastructure
- Improved regional economy as a result of the improved facility and reducing loss of productive time; and
- Reliable and predictable transport arrangements to and from the island.

8.3.2 Evaluation of the different types of accessibility infrastructure for V. Fulidhoo

Despite of these positive impacts, construction of a harbor will require a lot of financial resources. Since, the Maldives is a country with very limited financial resource, budget allocation for development of key infrastructure is prioritized in such a way that maximum number of population could benefit from these infrastructure project. V. Fulidhoo being a small island with a population of just 469 (Registered Population in the year 2014) it is highly unlikely to have economies of scale to support such huge investments for a harbor.

Due to the aforementioned reasons, it can be inferred that jetty is the most suitable accessibility infrastructure for the V. Fulidhoo Island.

8.4 Alternatives for the jetty length and fate of the existing old jetty

8.4.1 Alternative length of the jetty

As discussed in the project description section, the dimension for the proposed jetty is 31.15-metre-long and 4 metre width. According to the community consultations this length is insufficient as sediment accretion would lead to unfavorable depth near the jetty area during the operational phase of the project. The community propose to increase the length of the jetty for 60m where the depth would be -5 to 7 meters from the mean sea level. However, this extension would increase the environmental impacts associated with pilling of foundation and the excavation for placement of the concrete footing, since mitigation of sedimentation will be challenging as the depth of water increases. Furthermore, extension of this length of the jetty will require additional funding from the national budget. Conversely, this extension of the jetty length will reduce the environmental impacts and also cost associated with maintenance dredging.

8.4.2 Fate of the existing jetty

As discussed earlier, any intervention such as a jetty will have a significant impact of the shoreline morphology of an island. The existing jetty in V. Fulidhoo is expected to be operational for commercial uses such as loading and unloading of goods to the island. However, this existing old jetty is acting as a obstructive barrier for the long shore sediment transport. It is highly recommended to remove this existing old jetty in order to restore the normal longshore sediment transport around the island. This removal of the existing jetty is expected to improve the chronic erosion of the western and southeastern side of V. Fulidhoo.

Removal of this jetty will also reduce the need of the maintenance dredging during the operational phase of the project. However, as mentioned earlier the community of V. Fulidhoo need the existing old jetty for commercial purposes. Furthermore, some of the residents especially guest house owners, highlighted the significance of the sediment accretion at the south beach area as it improves the scenery and aesthetics of the island. The southern beach is one of the main tourist attraction in V. Fulidhoo.

8.4.3 Recommendations regarding jetty length and the fate of the existing old jetty

The EIA consultants recommend reconsideration of the jetty length and extend the jetty length to 100m and remove the existing old jetty. This will reduce the impacts of maintenance dredging and also dramatically increase the cost of the project.

However, when considering the fact that maintenance dredging can be done at a low cost by Ministry of Housing and Infrastructure (MHI), the decision should be made by the proponent whether to carryout maintenance dredging or just extent the length of the jetty for 60 meters and remove the existing old jetty.

8.5 Alternative construction material

It is a general consensus that the pilling will be required in order to erect a coastal structure such as jetty on an area with high wave activity. Also, concrete is the best material for pilling and also construction of the footing of the jetty. However, alternate to the material used for construction of the deck is considered in this section.

Timber is one of the predominant material used on decks of jetties across the Maldives. Some of these decks are constructed using locally available wood while others are made using imported timber. Timber deck are usually susceptible for corrosion due to salinity, termites and mold fungus. Since, these infrastructure project have a long operational period, it is highly important to utilize construction materials which are durable and suitable for marine conditions.

The proposed project will utilize a pre-caste concrete deck which will have minimal environmental impact as pre-casting will be done at the project site and no vegetation clearance is required for transport of this pre-caste deck. Furthermore, the concrete deck will be more durable and less susceptible for corrosion in a marine environment.

9. Monitoring Program

9.1 Introduction

Environmental monitoring is the systematic measurement of key environmental indicators over time within a particular geographic area (Joseph et al 2015). It is an integral part of any EIA. It shows how the project has or is impacting the baseline environmental conditions that have been assessed as the part of the EIA. It identifies the degree and magnitudes of the predicted environmental impacts for the project are felt on the environment as a result of project implementation. Thus, it will help in implementing the mitigation measures that are already identified in this report or implement further measures if the impacts are identified to be bigger than anticipated.

9.2 Aim and Objectives of the Monitoring Program

The aim of the proposed environmental monitoring program is to provide information which would enable effective impact management. Furthermore, the monitoring program is aimed to better understand how the predicted impacts have actually impacted the baseline environmental condition hence the impact prediction and effectiveness of mitigation measures can be better understood.

The objective of the proposed monitoring program is to measure the following environmental indicators

- Shorelines
- Beach profiles
- Currents
- Water Quality

The proposed monitoring will ensure that these measured parameters are kept within the baseline limits and predicted impacts are accurate and mitigation measures has been taken effectively.

9.3 Monitoring Report

9.3.1 Reporting Format

The Environment Monitoring Report will be developed in accordance with the following format;

- i) Introduction
- ii) Aims and Objectives
- iii) Environmental Conditions
 - Shorelines
 - Beach profiles
 - Currents
 - Water Quality
- iv) Comparison of data from the monitoring survey and the baseline
- v) Conclusion and Recommendations

A detailed environmental monitoring report will be compiled and submitted to the Environment Protection Agency during construction and post-construction periods of the project based on the data collected for monitoring the parameters included in the monitoring plan outlined below.

9.3.2 Frequency of Reporting

It is critical that monitoring of the environmental parameter mentioned in the report format will be initiated during construction periods, and continued throughout the operational phase of the project.

- During Construction Phase (Once)
- During Operational Phase (Yearly for 2 years)

9.4 Monitoring Plan and Cost

The following monitoring plan will be utilized during the construction phase and the operational phase of the proposed jetty works project in V. Fulidhoo.

Table 18: Environmental Monitoring Plan

Monitoring Requirement	Environmental Indicator	Baseline Data	Technique	Frequency	Cost (USD)
Seawater Quality (3 Locations)	All parameters analyzed in this EIA report	Baseline Data of EIA	Qualitative and Quantitative Laboratory Techniques	Once during construction once a year during operation phase	300
Shoreline (low tide and high tide)	Coastal Morphology	Baseline should be re-established after the construction phase.	Differential GPS	Once a year during operation phase	500
Beach Profiles	Changes in coastal environment	Baseline Data of EIA	Beach profile survey	Once a year during operation phase	1000
Currents	Nearshore currents	Baseline to be collected immediately constructions are over, especially on southern side of V. Fulidhoo	Drogue survey	Once a year during operation phase	200
Total Cost					2000

9.5 Quality Control Measures

The following Table 19 are the geographical locations of the sampled points which were used for different parameter during the determination of baseline environmental conditions.

Table 19: The geographical positions of the surveyed locations

M1	M2	M3
3°40'43.55166" N 73°24'54.01123" E	3°40'44.34576" N 73°24'56.09163" E	3°40'44.75098" N 73°24'59.32976" E

These geographical coordinates shall be used for sampling sea water during the monitoring surveys. This will assure that any impacts of the project intervention will be identified via the proposed monitoring plan.

Furthermore, M1 is a control site where no project interventions are present hence a clearer picture of the project impacts can be determined during the monitoring surveys.

9.6 Commitment from the proponent

A commitment letter from the project proponent (Ministry of Housing and Infrastructure) has been attached in the annex 7 of this report which clearly states the commitment of the proponent to undertake the monitoring program outline in this report.

10. Stakeholder Consultation

This section outlines the major findings of the consultations undertaken with regards to the proposed jetty works project in V. Fulidhoo.

10.1 List of Stakeholder

As per the approved Terms of Reference (TOR) for the EIA, the following key stakeholders have been identified;

- V. Fulidhoo Island Council
- Vaavu Atoll Council
- Project Proponent

10.2 Communication channel among the stakeholders

The following section outlines mechanisms as requested in the TOR with regards to providing necessary information to key stakeholders that have been identified above. In this regard, the following mechanisms will be practiced throughout the process of the proposed development of Jetty in V. Fulidhoo.

10.2.1 V. Fulidhoo Island Council

V. Fulidhoo Island Council is a key stakeholder of the project. The island council was met during the field visit for data collection. The different aspects of the project were discussed with the island council. The report will be shared with the island once the report is completed for their comments and inputs.

10.2.2 Island Community of V. Fulidhoo

The key beneficiary of the proposed Jetty Works project at V. Fulidhoo is the island community. The key findings of the EIA study will be shared with the island community through island council. Arrangements will be made via island council to provide a copy of EIA report for any resident upon request.

10.2.3 Vaavu atoll council

The EIA report has been shared with Vaavu Atoll Council for information. They do not have a major role in the proposed development such as providing permits and inspections.

10.2.4 Project Proponent

The proponent, Ministry of Housing and Infrastructure, is responsible for preparing the EIA and all the contents including environmental monitoring and mitigation measures outlined in the EIA. They have formally communicated to relevant government agencies regarding the project.

10.3 Means of Stakeholder Consultation

There is no formal method for undertaking stakeholder consultation with regards to addressing concerns and issues relating to the project, hence a number of methods have been used to collect information from key stakeholders identified above. These include; formal communication with V. Fulidhoo Island Council, and informal communication Vaavu Atoll Council.

10.4 Summary of key outcomes

10.4.1 V. Fulidhoo Council

Date: 06th July 2017

Time: 15:00 to 16:00 hrs

Venue: Secretariat of V. Fulidhoo Council

Type: Formal Meeting

10.4.1.1 Main Discussion and Outcomes

The team also had a discussion with the island council separately to understand their views on the jetty project. The same questions that was used in the community consultation was explored during the meeting with the Island Council. The following are the main outcomes of the discussion.

- Concerns with the jetty length – The council highlighted that the proposed jetty length does not solve any issues the community has in accessing the island. The council also highlighted the sand activity in the lagoon area and jetty needs to be lengthy enough to go up to the deep lagoon area. In this aspect the council highlighted that any jetty shorter than 200ft wouldn't solve their concern and noted this has been raised in a number of meetings they have regarding the jetty with government officials.
- Concerned with the jetty dredging- The island council highlighted that they don't support dredging the lagoon area. They noted that continuous dredging very year or so would be needed if the current shallow lagoon area is dredged as part of the jetty project. They stressed that the dredging issue can completely be solved if the jetty is extended into the deep lagoon area.
- During rough weather in both monsoons it's very difficult to lodge boats as the lagoon area gets very rough - the council highlighted they have had issues in lodging boats to the jetty during high rough seas in the rainy monsoon. They also highlighted boat owners have had issues in anchoring boats in the lagoon area which have resulted in boats getting dragged onto the beach or towards the seas.

10.4.1.2 Participants and Contact Details

Table 20: Participants of the meeting with V. Fulidhoo Island Council

Name	Designation	Contact
Abdulla Jaleel	Senior Finance Officer	9907788
Sana Ali Waafir	President	9994808
Imthinaan Abdul Qafoor	Vice president	7544941
Mahfooz Abdul Wahhab	Consultant	9994467
Umaru Moosa Fikry	Consultant	9728085

10.4.1.3 Photographic evidence



Figure 34: Photographic evidence of meeting with V. Fulidhoo Island Council

10.4.2 V. Fulidhoo Community representatives

Date: 06th July 2017

Time: 20:00 to 21:00 hrs

Venue: Secretariat of V. Fulidhoo Council

Type: Formal Meeting

10.4.2.1 Main Discussion and Outcomes

Island level stakeholder consultation and public consultation was undertaken together due to the small population size of the island. The public consultation included members from island level stakeholder agencies and community groups including elderly, youth, informal sector workers, boat owners, shop owners and guesthouse operators. The council when choosing these participants noted that they are the active community members that can give a good snapshot of the island and its perspective towards the access to the island.

10.4.2.2 Consultation Questions

The consultants developed and used the following questions to explore during the community consultation.

- what do they think about the proposed jetty
- is it sufficient for their needs
- what should be improved based on the existing jetty
- would vulnerable groups (women, children, disabled) have any problems accessing the Jetty
- What are the plans for the existing jetty

10.4.2.3 Main discussions and outcomes

- No need to deepen the channel – It a common understanding that the current jetty area has both shallow and deep lagoon areas. The community and stakeholders noted that the island has gained

land on the jetty side of the island due to this natural activity. Therefore, the community stressed that they only needed a jetty that extends into the deeper part of the lagoon.

- Concerns with the proposed jetty length – The community had concerns with the length of the proposed jetty. They highlighted that they have put forwarded this concern numerous times during consultation with Ministry of Housing and Infrastructure staff and other relevant organizations that have visited the island. The community noted that another 100ft (31.5m) size jetty would still place it in the shallow area of the lagoon and as they have experienced with existing jetty they newly built jetty area would also in return get shallow due to the sand activity. Due to this experience over the years the community strongly noted that they won't accept a jetty that is shorter than 200ft. They also highlighted that they raised the same concern when Minister of Finance and Treasury visited the island to launch the new jetty project.
- The existing jetty is the 7th jetty now in operation - In order to further highlight their concerns with the length of the jetty the community noted that the current jetty is the 7th iteration of a jetty in the island. They noted all these jetties was too short to go beyond the shallow area of the lagoon. Due to this they have had to extend the jetties many times during their lifespans.
- The community also noted that the existing jetty has been extended three times to overcome the shallow depth, but due to the sand activity in the lagoon area they have not been able to completely solve the issue.
- Difficulty in accessing the jetty during low tide – The community noted that they had existing problems in accessing the jetty during low tide, where speed launch sides would be much lower than they jetty deck. Due to this issue elderly, pregnant women and other vulnerable groups have had difficulties in accessing the jetty to come on the island. In these situations, they have used small dingy boats to transport people to the beach area. This practice as it is very difficult and possibly dangerous to the people as the lagoon becomes pretty rough during monsoon season.
- During rough season, it is very rough - Community highlighted that the lagoon area is very rough during rough season in the rainy monsoon. The boat owners highlighted that they have had events where anchored boats in the lagoon area getting dragged onto the beach or towards the seas. The community highlighted that new jetty should be designed in a way that its easier to dock even during rough seas.
- Proposed use of the new jetty – The community noted that their vision for the island is to make it a tourist island. The jetty and access to the island contributes immensely towards their vision of tourist friendly, easier to access island. They highlighted they would use the new jetty solely for ferries that would bring in people (mainly tourists) to the island. They also noted that they would use the existing jetty to bring cargo and materials on the island.
- The community strongly stressed that they have been promised a 200ft (60 m) jetty by government officials in a number of time and any jetty shorter than that wouldn't solve any existing issues they have in accessing the island.

10.4.2.4 Participants and contact details

Table 21: Participants of the public stakeholder consultation

Name	Representation	House	Contact
Ishaah Abdul Rahman	Worker (informal sector)	East Corner	7972264
Abdulla Athif	Youth	Hazaarmaage	7755572

Naseeru Ali	Elderly	Ahigasdhoshuge	7593868
Abudl Rasheed Abbas	Council Member and Guesthouse operator	Sosunge	7707195
Ahmed Saleem	Guesthouse operator	Thundiraiymaage	9896446
Ibrahim Solih	STELCO	Gulchampaage	9990199
Abdul Majeed Muhammed	Boat Owner	Daisymaage	7751223
Abdul Raheem Muhammed	Shop owner/Business Operator	White Rose	9709838
Liusha Jaleel	Vaavu Atoll Madharusaa	Zenit	
Aishath Dhifla	Vaavu Atoll Madharusaa	Blue Heaven	
Muhammed Azmee	Health Centre	Huvadhumaa Aage	9191736
Azmeen Ahmed	Health Centre	Hudhufinifenmaage	9898588

10.4.2.5 Photographic Evidence



Figure 35: Photographic evidence of the public consultation meeting

10.4.3 Ministry of Housing and Infrastructure (Proponent)

Date: 10th August 2017

Time: 11:00 to 12:00 hrs

Venue: Ministry of Housing and Infrastructure (MHI)

Type: Formal Meeting

10.4.3.1 Main Discussion and Outcomes

Environmental Impact Assessment for Jetty Works Project in V. Fulidhoo

The EIA consultant discussed and conveyed the main concerns raised by island community representatives from V. Fulidhoo. The Table 22 is the main concerns and their respective response from the proponent. The Table 23 is the contract details of the participants of the meeting.

Table 22: Main concerns regarding Access Jetty Project in V. Fulidhoo and their response from the proponent (MHI)

Main Concern	Response from Proponent (MHI)
Concerns with the proposed jetty length – The resident wants to extend the jetty length to 60 m (around 200 ft).	The jetty length shall be adjusted to an appropriate length with consideration to the marine surveys.
Difficulty in accessing the jetty during low tide	The jetty length shall be adjusted to minimize this issue.
Difficulty in using jetty area during rough weather	Among other factors, the proposed location is expected to provide considerable shelter from the rough weather.
The new jetty to be used only accessing island and keeping existing old jetty for commercial purposes	As the old jetty has not been constructed within a government project, the fate of the jetty shall be left for the discretion of the islanders.

10.4.3.2 Participants and contact details

Table 23: Contact details of the participants of the meeting with MHI

Name	Designation & Organization	Contact Details
Hamdhoon Mohamed	EIA consultant	7845332
Ms. Nafha Aujaz	Environment Analyst/ Ministry of Housing and Infrastructure	3004110
Ms. Anoosha Hashim	Assistant Project Officer/ Ministry of Housing and Infrastructure	3004110

11. Summary and Conclusion

Following are the summary and conclusions with regards to the proposed Jetty Works project in V. Fulidhoo;

- The project has been proposed by Ministry of Housing and Infrastructure (MHI) to construct and operate a jetty and accompanied maintenance dredging in Fulidhoo Island in Vaa atoll.
- The proposed project involves construction of 31.5 m long T- jetty with 4 m width walkway, ground leveling the jetty area, dredging near Jetty area 40m width and 30 m length area, dredging a new entrance channel 24 m width & 181 m length.
- The initial assessments suggested that there will be no requirement of dredging during the construction phase of the project.
- However, this EIA report is used for the proponent to determine the best option for jetty length and the provision of the dredging was not removed from the project scope as dredging may be required during the operational phase of the project.
- As a result of the proposed project during the construction phase it is expected to have turbidity of lagoon some direct damage to coral due to excavation to place the footing of the jetty. Some minor impacts are anticipated due to work force and equipment and machineries used in the project. Furthermore, some minor impacts are anticipated due to potential of oil spill from excavator and ground leveling works at the jetty area.
- During the operational phase of the proposed project the main impacts predicted include impacts due to maintenance dredging, stockpiling of the dredged material and solid waste management and disposal during the operational phase of the project.
- The proposed mitigation measures include carrying the excavation for placement of the footing during the low tide, ensuring proper monitoring during the maintenance dredging works and treating the dredged material with rain in order to decrease salinity prior to stockpiling of these dredged materials.
- Some alternative locations for the jetty site have been proposed. Based on evaluation, it was found that the proposed location for jetty construction is the preferred option. Furthermore, alternative to the length of the jetty and fate of the existing old jetty was proposed. It is recommended to increase the jetty length from 31m to 60m which will significantly reduce the requirement of the maintenance dredging and meet the need of the island community of V. Fulidhoo. The existing old jetty could be removed with best environmental practices so that accretion of the sediments will decrease in the jetty area.
- Environmental monitoring during both construction and operation stages has been given serious consideration in order to assess the degree and magnitude of environmental changes in the biophysical environment, through a follow-up monitoring of established baseline data.
- During construction, monitoring of construction will be undertaken once and during operation monitoring once yearly for two years will be undertaken.
- Although there are some environmental impacts from the proposed project, most of these impacts can be reduced and mitigated by use of appropriate methodology and timing.
- The effectiveness of these methodologies can be documented by implementing a comprehensive monitoring programme. Also, with the need of the project to provide the population of V. Fulidhoo with better accessibility infrastructure, it is concluded that the project should go ahead with slight modification to the length of the jetty.

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13. List of Annex

Annex 1: Terms of Reference (TOR)

Annex 2: Schematic diagram of the project interventions

Annex 3: Structural Diagrams of the Jetty Construction

Annex 4: Water Quality Testing Reports

Annex 5: EIA report contributors

Annex 6: CVs of Unregistered Consultants

Annex 7: Commitment Letter from the Proponent

Annex 8: Receipt of EIA report from V. Fulidhoo Council

Annex 9: The Maps of Environmentally Sensitive Areas (ESAs) and Marine Protected Areas (MPAs) near the project site.

Annex 10: Site plan of the project area

Annex 9: Bathymetry Map

Annex 1: Terms of Reference (TOR)



No: 203-EIARES/138/2017/118

Terms of Reference for Environmental Impact Assessment for Jetty construction and dredging new entrance channel for island access in V. Fulidhoo

The following is the Terms of Reference (ToR) following the scoping meeting held on 18th July 2017 for undertaking the EIA of the proposed jetty works in V. Fulidhoo. The proponent of the project is Ministry of Housing and Infrastructure.

While every attempt has been made to ensure that this TOR addresses all of the major issues associated with development proposal, they are not necessarily exhaustive. They should not be interpreted as excluding from consideration matters deemed to be significant but not incorporated in them, or matters currently unforeseen, that emerge as important or significant from environmental studies, or otherwise, during the course of preparation of the EIA report.

- 1. Introduction to the project - Describe the purpose of the jetty and, if applicable, the background of the project and the tasks already completed.
2. Study area - Submit a minimum A3 size scaled plan with indications of all the proposed infrastructures.
3. Scope of work - Identify and number tasks of the project including site preparation, construction and operational phases.

Task 1. Description of the proposed project - Provide a full description and justification of the relevant parts of the project, using maps at appropriate scales where necessary.

- The main activities of the jetty work in V. Fulidhoo are:
- Construction of 31.15 m long T-jetty with 4 m width walkway
- Ground leveling the jetty area
- Dredging near Jetty area 40 m width & 30 m length area
- Dredging new entrance channel 24 m width & 181 m length

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Handwritten signature and official stamp of the Environmental Protection Agency, including contact information for the secretariat.



Construction of the T-Jetty

- Dimensions and characteristics of construction material for T-Jetty;
- Method and equipment used for construction and operational control procedures;
- Justification for selecting the methods and equipment;
- Duration of the construction activity;
- Labor requirements and (local) labor availability;
- Housing of temporary labor;
- Site location for the concrete works;
- Emergency plan in case of spills (diesel, grease, oil)

Dredging of Jetty area and new entrance channel

- Location and size of dredged area (s) on a scaled map;
- Justification for the selection of the location, depth and size of burrow area(s);
- Equipment used for dredging and justification, including equipment capacity and description of positioning system (where appropriate), depth control system and operational control procedures;
- Exact method and process(es) of dredging/excavation (eg: details of the use of sand beds or use of barge mounted excavation)
- Dredged material disposal/usage details, e.g. for land reclamation, beach replenishment or coastal protection works;

Waste management:

- Materials to be collected and management, waste reduction and recycling;
- Transportation mechanisms and costs;

Power water, and sewerage:

- Sources of power and water during the construction phase ;
- Detail solid waste disposal mechanisms, equipment used and periodicity (how often?).

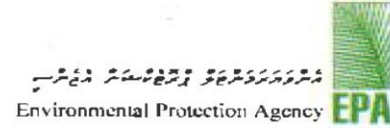
Project management: Include communication of construction details, progress, target dates and duration of works, construction/operation/closure of labor camps, access to site, safety, equipment and material storage, water supply, waste management from construction operations, power and fuel supply for backup generators;

Task 2. Description of the existing environment – Assemble, evaluate and present the environmental baseline studies/data regarding the study area and timing of the project (e.g. monsoon season). Identify baseline data gaps, 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

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Male*, Rep. of Maldives, 20392

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Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv



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

The baseline data will be collected before construction and from at least two benchmarks. All survey locations shall be referenced with Geographic Positioning System (GPS) including water sampling points, reef transects and vegetation transects for posterior data comparison. information should be divided into the categories shown below:

Climate

- Temperature, rainfall, wind, waves,
• Risk of hurricanes and storm surges.

Geology and geomorphology (localized maps)

- Bathymetry (bottom morphology proposed area) (use maps);
• Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during construction.
• Shoreline of the impact area
• Vegetation line of the impact area
• Offshore/coastal geology and geomorphology (use maps);
• (Seasonal) patterns of coastal erosion and accretion (see appendix for monitoring details), and
• Offshore/coastal geology and geomorphology (use maps);

Hydrography/hydrodynamics (localized maps)

- Tidal ranges and tidal currents;
• Sea water quality measuring these parameters: temperature, pH, salinity, turbidity,

Ecology

- Identify marine protected areas (MPAs) and environmentally sensitive sites
• Benthic and fish community monitoring around the island

Socio-economic environment

- Demography: total population, sex ratio, density, growth and pressure on land and marine resources;
• Income situation and distribution
• Economic activities of both men and women including seasonal changes in activities;
• Land use planning, natural resource use and zoning of activities (an approved land use plan needs to be provided);
• Accessibility and (public) transport to other islands;
• Service quality and accessibility (water, waste/water disposal, energy, social services like health and education);
• Community needs;
• Sites with historical or cultural interest or sacred places (mosques, graveyard).

Hazard vulnerability

- Vulnerability of area to flooding and storm surge.

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*All water samples shall be taken at a depth of 1 m from the mean sea level or mid water depth for shallow areas. The report should outline the detailed methodology of data collection utilized to describe the existing environment.

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. Show that the proponent has applied for all necessary permits. Specifically show how the proposed project meets the required legislative and regulatory requirements.

Legal requirements:

- Dredging and coastal modification permit from EPA

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

Impacts on the natural environment

- Changes in erosion/sedimentation patterns flow velocities/directions, which may impact shore zone configuration/coastal morphology;
- Loss of marine habitat in the dredged site;
- Impacts of noise, vibration and disturbance
- Impacts on landscape integrity/scenery

Social impacts:

- Noise impacts on local population during construction phase, if any;
- Aesthetics on-land and underwater impacts from sedimentation due to dredging
- Land use displacement and economic opportunities.

Construction related hazards and risks

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

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.

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 Fax: [+960] 333 5953

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4 of 5

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 ވިލިމާލެ، 3^{ވަނަ} ފެޓަރ، ހަންދުވަރާތިންގުނު
 20392
 ފޯން: 333 5949، 333 5951
 ފެކްސް: 333 5953
 އިމެއިލް: secretarial@epa.gov.mv
 ވެބްސައިޓް: www.epa.gov.mv



Task 5. Alternatives to proposed project Describe alternatives including the "no action option "should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". This should include alternatives for environmental, social and economic considerations such as alternative location for jetty construction, alternative type of accessibility infrastructure and alternative construction material.

Task 6. Mitigation and management of negative impacts - Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. Mitigation measures must also be identified for both construction and operation phase. Cost of the mitigation measures, equipment and resource(s) required to implement those measures should be specified. The confirmation of commitment of the Proponent/Developer to implement the proposed mitigation measures shall also be included. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

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

- Water quality, especially turbidity;
- Condition of the sensitive ecosystems and marine resources;
- Erosion and accretion;

Task 8. Stakeholder consultation – EIA report should include a list of people consulted and what were the major outcomes. Identify appropriate mechanisms to supply stakeholders with information about the development proposal and its progress. Stakeholders should include island council and the general public.

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

Timeframe for submitting the EIA report – *The developer must submit the completed EIA report within 3 months from the date of this Term of Reference.*

Date: 23rd July 2017

Environmental Protection Agency
Green Building, 3rd Floor, Handhuvees Hingun
Male', Rep. of Maldives, 20392

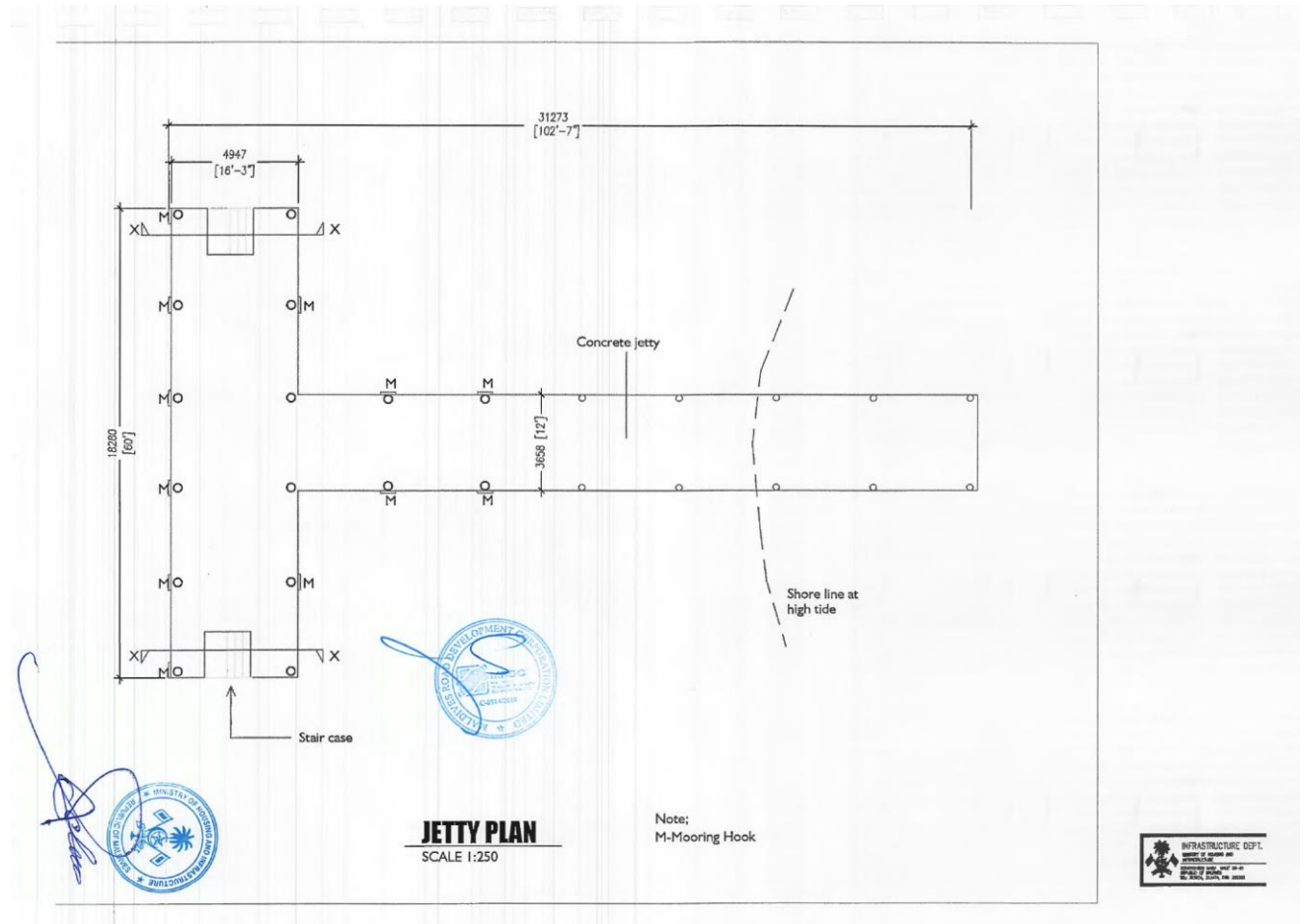
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Fak: [+960] 333 5953 ފެކްސް 333 5953

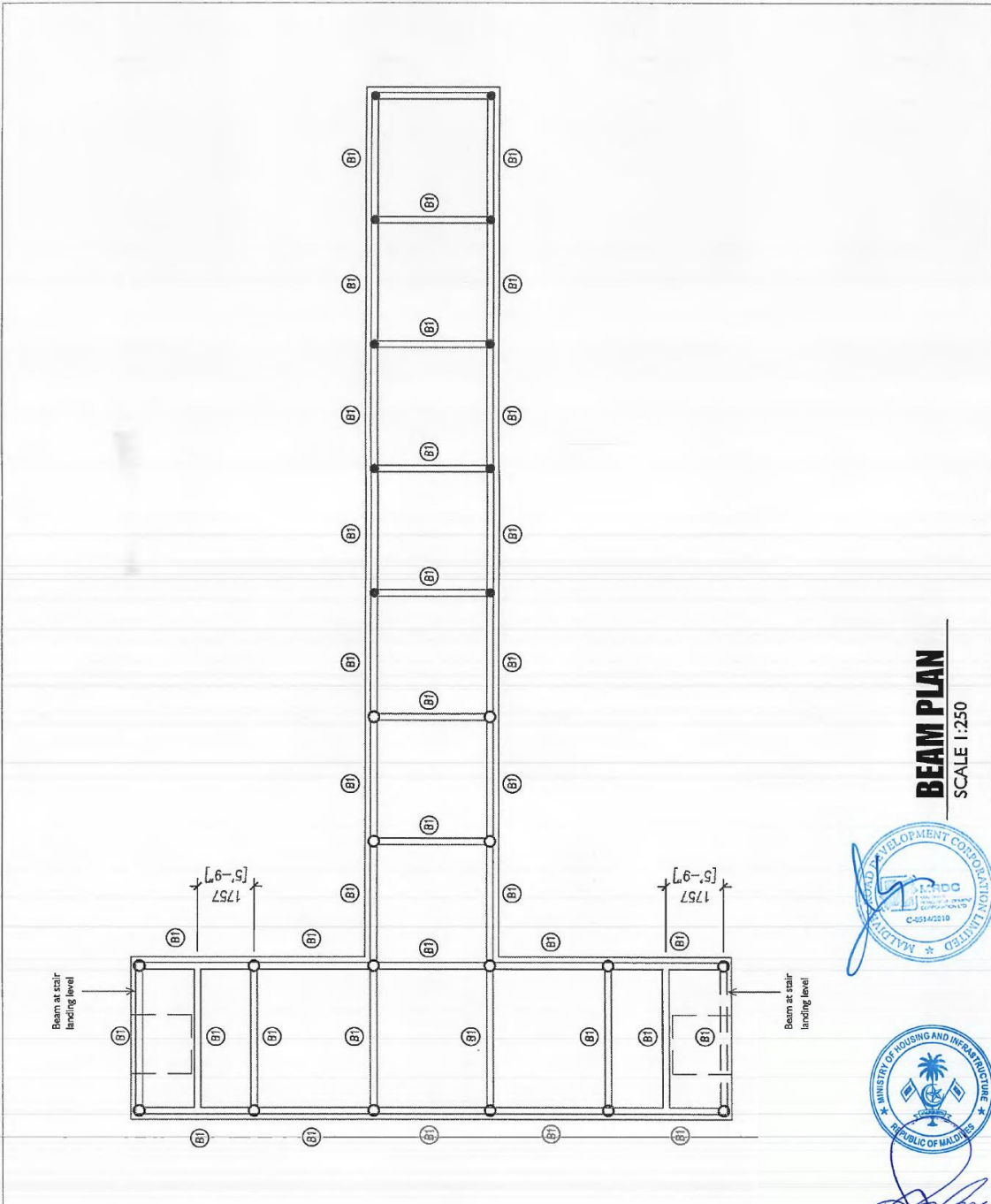


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Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv

Annex Two: Schematic Diagram for the project invention

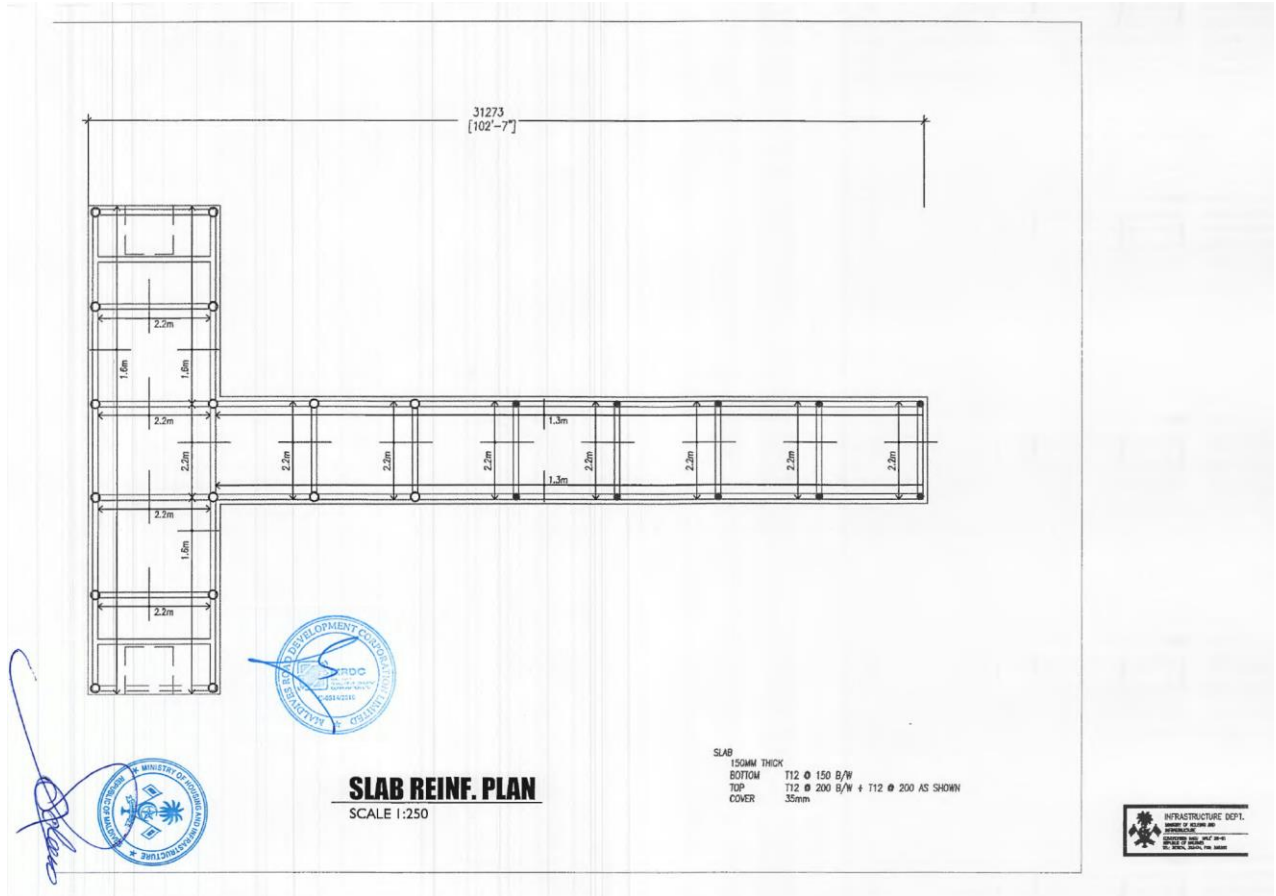


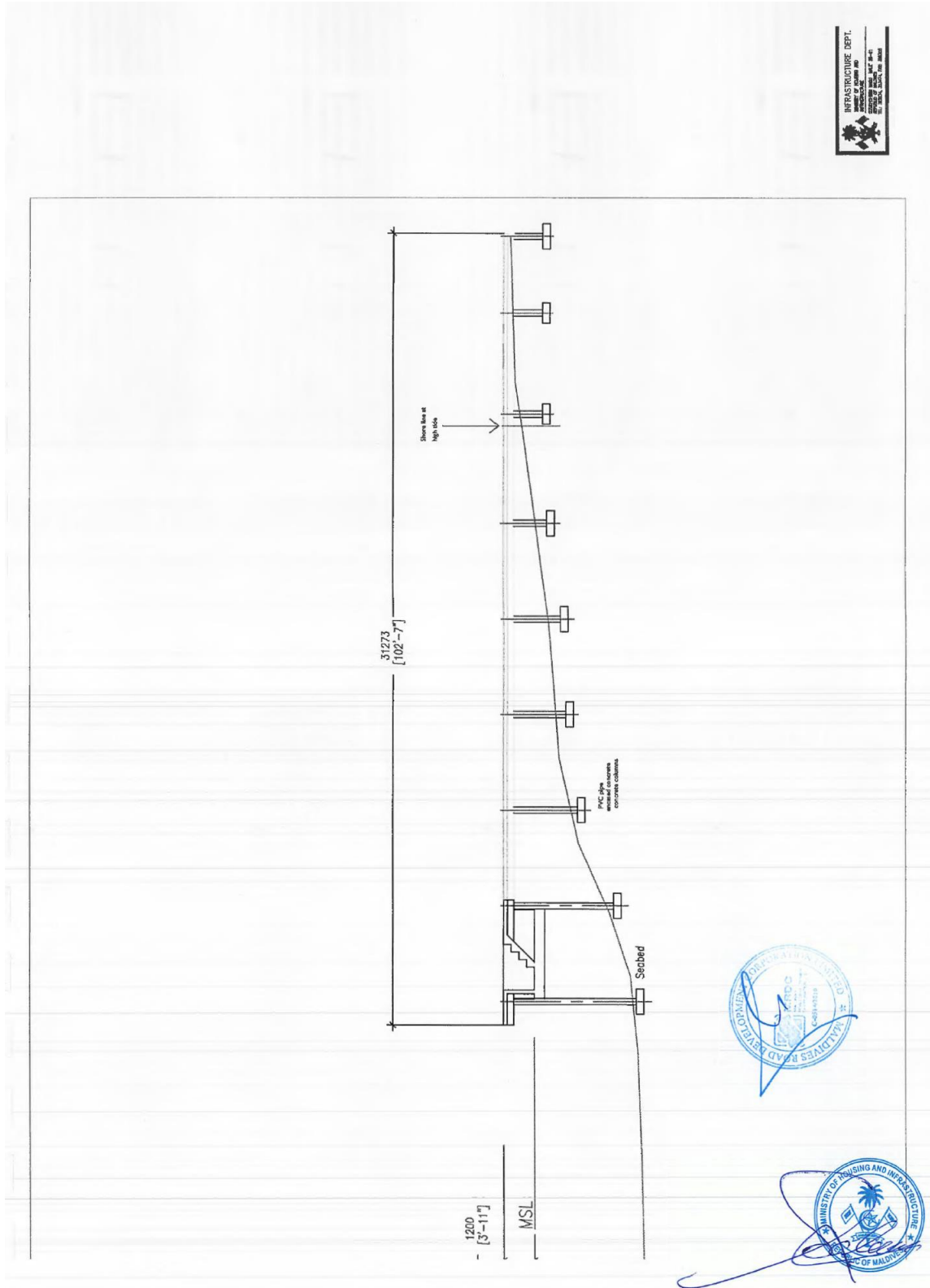


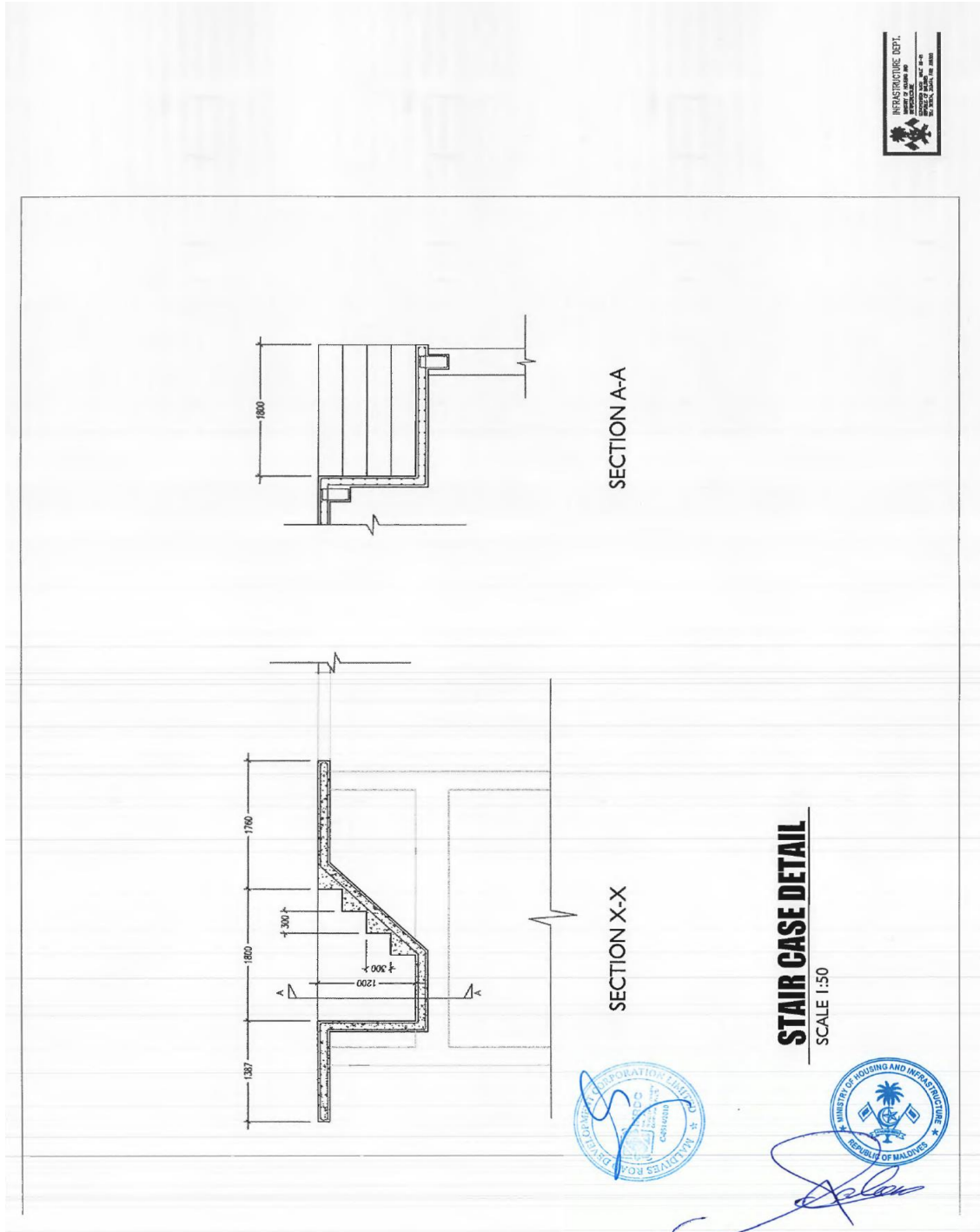
BEAM PLAN
SCALE 1:250

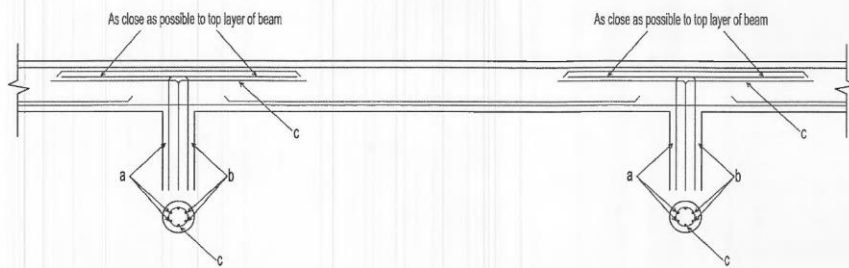


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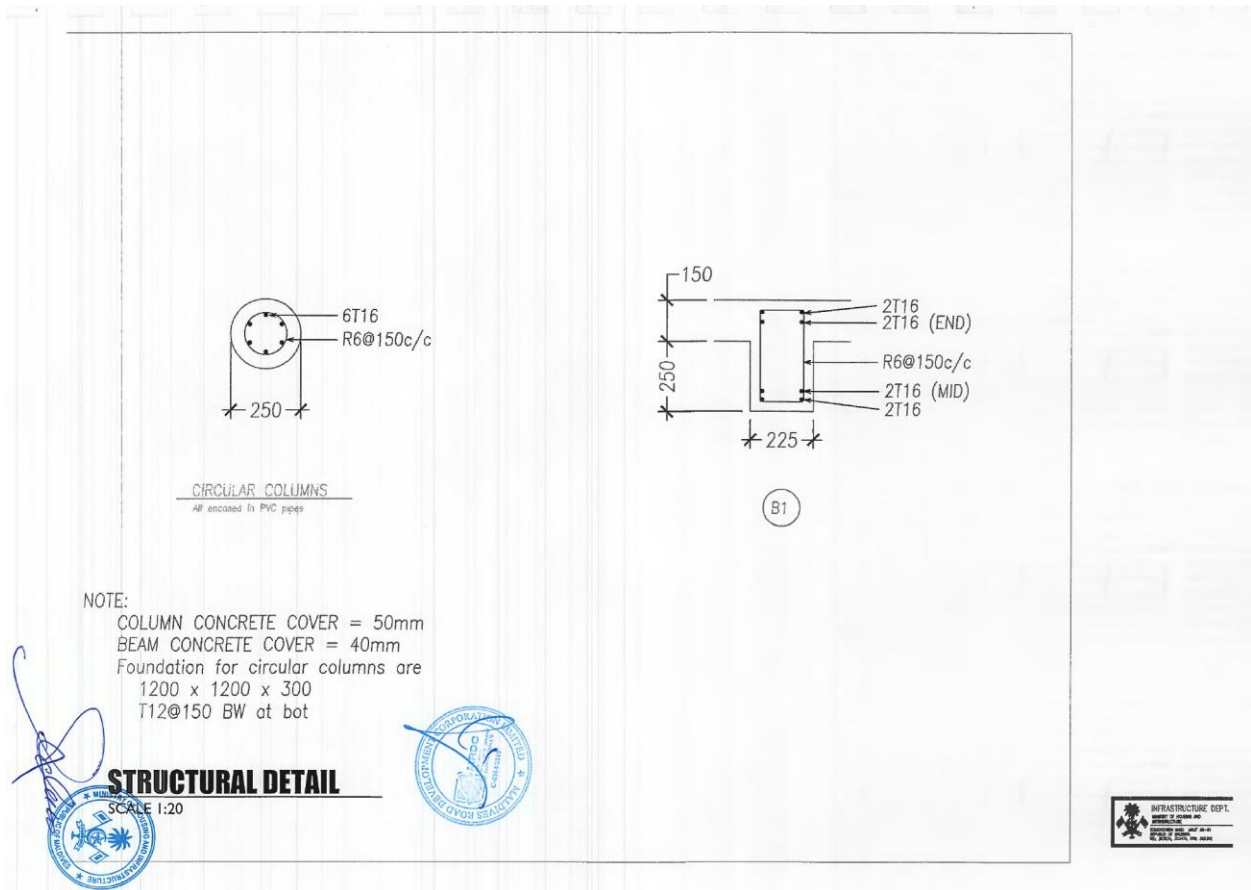


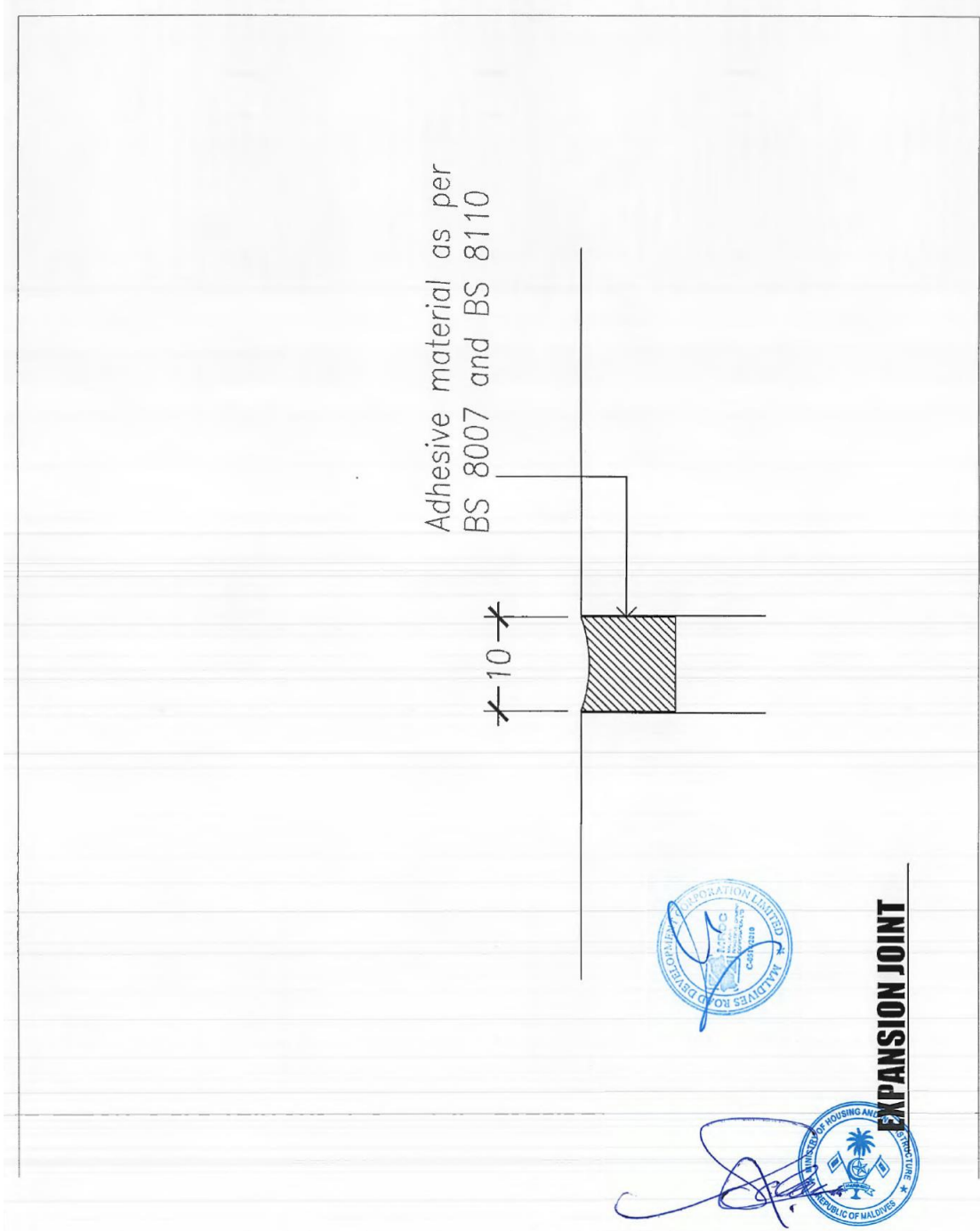
Note: Shear links not shown for clarity

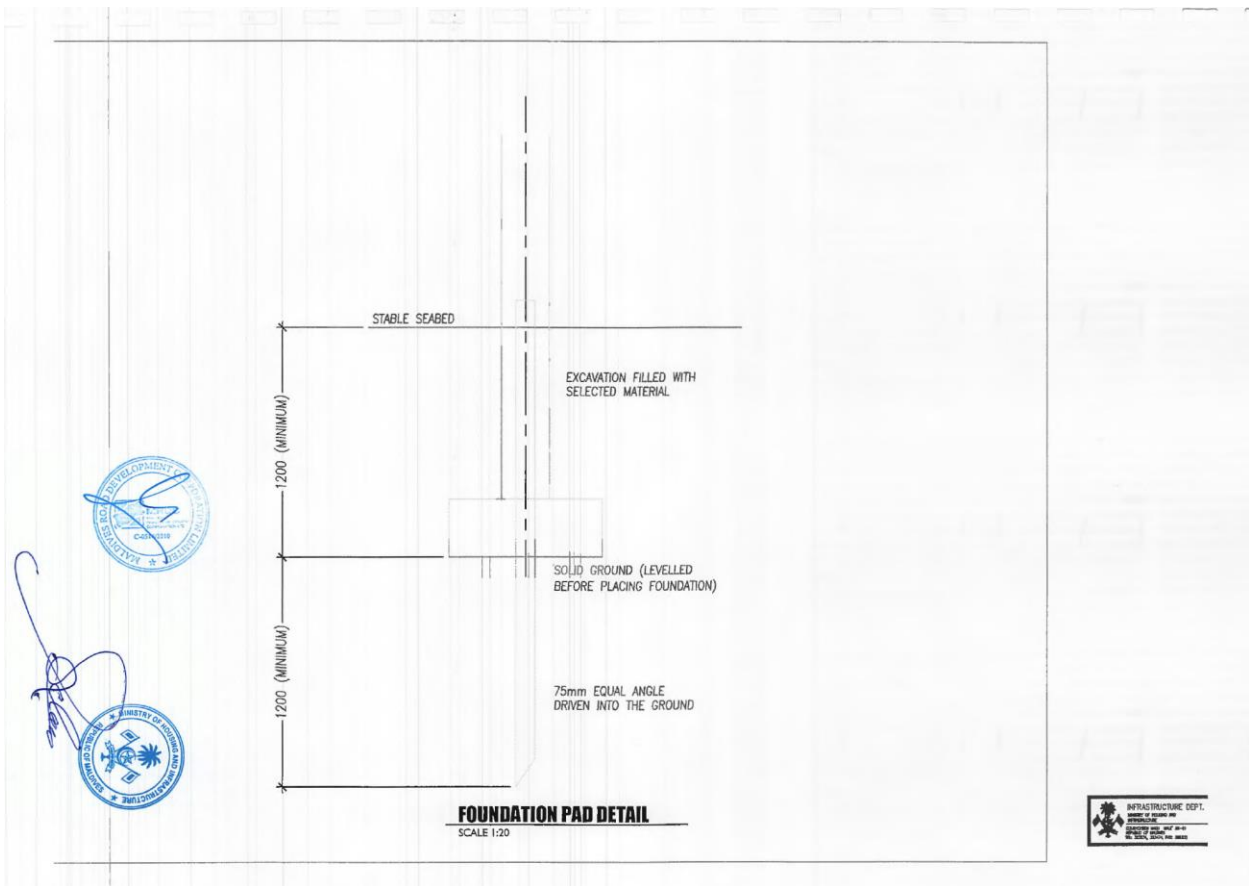
COLUMN - BEAM FIXED CONNECTION DETAIL

SCALE 1:25









Annex 4: Water Quality Testing Reports



Male Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
 Plot No. 10, Seaside Magni, Male', Maldives
 Tel: +9603323209, Fax: +9603324306, Email: wqa@mmsc.com.mv

WATER QUALITY TEST REPORT
 Report No: 500175069

Report date: 16/07/2017
 Test Requisition Form No: 900177832
 Sample(s) Received Date: 09/07/2017
 Date of Analysis: 09/07/2017 - 15/07/2017

Customer Information:
 Mahfooz Abdull Wahhab
 A293039
 K.villingili -

Sample Description	Fulidhoo M1	M2	M3	TEST METHOD	UNIT
Sample Type	Sea Water	Sea Water	Sea Water		
Sample No	83189337	83189338	83189339		
Sampled Date	06/07/2017	06/07/2017	06/07/2017		
PARAMETER	ANALYSIS RESULT				
Physical Appearance	Clear with particles	Clear with particles	Clear with particles		
pH	8.06	8.09	8.12	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	-
Salinity	33.59	33.66	33.53	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	%
Temperature	21.3	21.3	21.3	Electrometry	°C
Turbidity	0.204	0.215	0.221	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU
Nitrate	4.0	3.6	3.3	Method 8171 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphate	2750	2700	2650	Method 8051 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Phosphate	0.15	0.11	0.36	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Biological Oxygen Demand (BOD)	1	1	1	HACH Method 8043	mg/L

Keys: % : Parts Per Thousand, °C : Degree Celsius, NTU : Nephelometric Turbidity Unit, mg/L : Milligram Per Liter

Checked by

Afnan Farooq
 Laboratory Executive Gr.1



Approved by

Mohamed Eymann
 Assistant Manager, Quality



Notes: Sampling Authority: Sampling was not done by MMSC Laboratory
 This report shall not be reproduced except in full, without written approval of MMSC
 This test report is ONLY FOR THE SAMPLES TESTED.
 - Information provided by the customer

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

Annex 5: EIA report contributor

Chapter	Page	Chapter Contributor (including data collection)	Consultant Registration Number	Signature
1. Introduction	15	Hamdhoon Mohamed	EIA P03/2017	
2. Project Description	18	Hamdhoon Mohamed	EIA P03/2017	
3. Policy and Legislative Framework	30	Hamdhoon Mohamed	EIA P03/2017	
4. Survey Methods	35	Hamdhoon Mohamed	EIA P03/2017	
5. Existing Environment	37	Hamdhoon Mohamed Umar Moosa Fikry	EIA P03/2017	 
6. Environmental Impact	61	Hamdhoon Mohamed	EIA P03/2017	
7. Mitigation Measures	80	Hamdhoon Mohamed	EIA P03/2017	
8. Alternatives	92	Hamdhoon Mohamed	EIA P03/2017	
9. Monitoring Program	98	Afsal Hussain Hamdhoon Mohamed	EIA P03/2017	 

Environmental Impact Assessment for Jetty Works Project in V. Fulidhoo

10. Stakeholder Consultation	101	Umar Moosa Fikry		
11. Summary and Conclusion	106	Hamdhoo Mohamed	EIA P03/2017	

Annex 6: CVs of unregistered consultants

Umar Fikry

Email: umarey@gmail.com

Mobile: +960 9728085

G. Nilandhoo
Buruza Magu, Male' 20134,
Maldives

ACADEMIC QUALIFICATION

Master of Human Rights Law and Policy 2014
University of New South Wales, Sydney, Australia

Bachelor of Social Work 2007 – 2010
St. Joseph's College(Autonomous), Bangalore, Karnataka, India

IELTS 14 March 2013
Overall Band Score: 8.0
Centre Number: LK001

CAREER HISTORY

Project Manager June 2016 - Present
Project "Scaling up the National Capacity for Disaster Risk Reduction and Management in the Maldives 2016 – 2018" – NDMC/UNDP Maldives Joint Project

- Manage the realization of project outputs through activities;
- Provide direction and guidance to project team(s)/ responsible party (ies);
- Liaise with the Project Board and Project Assurance on the overall direction and integrity of the project;
- Identify and obtain any support and advice required for the management, planning and control of the project;
- Responsible for project administration;
- Liaise with any suppliers;
- May also perform Team Manager and Project Support roles;

Senior Programme Officer 2012 - 2016
National Disaster Management Centre, Government of Maldives, Maldives

- Manage the realization of outputs of the workplan of NDMC and perform Team Leader duties
- Provide direction and guidance to staff of the Disaster Risk Reduction Section
- Identify and obtain any support and advice required for the management, planning of the Disaster Risk Reduction Section
- Delivery of the projects and programmes
- Liaise with stakeholders, government institutions, national and international organizations.

Senior Social Service Worker 2010 -2012
Child and Family Protection Services, Ministry of Health and Family
• Case management of the reported cases.

Research Assistant(internship) April 2010
Equitable Tourism Options(EQUATIONS), Bangalore, Karnataka, India
• Conducted a research on Tourism Development, Tourism Policies and Climate Change in Lakshadweep Islands with lessons and learning's from the Maldives

Programme Assistant 2005 - 2007
Disaster Risk Management Programme, Tsunami Recovery Programme, United Nations Development Programme, Male', Maldives
• Implementation of project outputs
• Conducting Community Based Disaster Risk Management Programmes at island level

Research, Publications and Professional Experience

Mapping and Analysis of Sexual and Reproductive Health Policies, Strategies and Stakeholder Involvement 2012
International Planned Parenthood Federation and Society for Health Education

Translation of National Disaster Management Bill 2013
National Disaster Management Centre, Maldives

Review, update and translation of Procedure Manual on Deliver of Services 2016
Ministry of Law and Gender, Maldives

Development of a Domestic Violence Perpetrator Rehabilitation Programme Ongoing
Family Protection Authority, Maldives

Skills

Advance level skills with Microsoft Office Suite including MS Word, MS Excel and MS PowerPoint

LANGUAGES

Fluent in written and spoken English
Fluent in written and spoken Dhivehi(Mahal)

REFERENCE

Maria Gemma Perez

Disaster Management Specialist
United Nations Development Programme, Rwanda
Email: gemma_mgdp@yahoo.com
Mobile: +250 782 220 027

Fathmath Thasneem
Deputy Minister
Ministry of Defense and National Security
Email: fathmath.thasneem@ndmc.gov.mv
Mobile: +960 778 1126

Afsal Hussain

Flat No. 5-1-02, HulhuMale', Republic of Maldives
Email – episthmh@gmail.com
Mob +(960)786-2959

A diligent, committed and ambitious individual. Keen on learning and acquiring knowledge. Excellent communication, organizational and time management skills.

ACADEMIA

First Degree, 2006-2009 Yuvaraja's College, Mysore
University of Mysore, India
Bachelors of Science (First Class with Distinction) Core Subjects: Environmental Science, Chemistry, Geology
London Examination Center for Higher Secondary Education
General Certificate of Education, 2003 -2005 Republic of Maldives
Core Subjects: Chemistry, Biology, Physics

International General Certificate of Secondary Education, 2000 - 2002 Majeediyya School
Republic of Maldives
Core Subjects: English, Mathematics, Chemistry, Biology, Physics

REFEREES

Dr. S. Suresh
Head - Department of Environmental Science
Yuvaraja's College, University of Mysore, 57005
Sureshakumar12@yahoo.in (Associate Professor)

Dr. M.R.Janardhana
Department of Earth Science & Resource Management
Yuvaraja's College, University of Mysore, 57005
drmrjanardhana@rediffmail.com (Asst. Professor)

PERSONAL DOSSIER

Date of Birth 5th May 1986
Sex Male
Marital Status Single
Nationality Maldivian
Passport No. E0404067
Present Address Flat No. 5-1-02,
HulhuMale', 23000,
Republic of Maldives
Permanent Address Male' Municipality (6139)
Email Address episthmh@gmail.com

SKILLS

Languages	Speaking	Writing	Reading
Dhivehi	Good	Good	Good
English	Good	Good	Good

- Proficient in the use of applications such as Concepts of ICT, MS Windows XP, Window Vista, Windows , MS Word, Excel, Power Point, Internet, Accent Express (Thaana)
- Good Managerial Experience

EMPLOYMENT HISTORY

Assistant Director 2013 - Present

**Water and Sanitation Department
Ministry of Environment and Energy**

- *Project Development – Drafting of Proposals to Funding Agencies, Enroll in Appraisal Missions, Negotiations.*
- *Management of Implementation Works – Supervise the project implementation on a day to day basis with the aid of project coordinators.*
- *Administrative works of the sector such as formulation of sector annual budget*

Environment Analyst, 2009 -2013

**Water and Sanitation Department
Ministry of Environment and Energy**

- *Drafting Proposals for Funding to Donor Agencies.*
- *Prepare, Review and Enroll in Evaluation Reports.*
- *Assist in preparing procurement documentation.*
- *Assist in preparing contract documentation.*
- *Coordinate and Monitor Project Implementation*
- *Assist in preparing the Annual Sector Budget*
- *Prepare Monthly and Quarterly Review Reports.*
- *Assist in preparing presentation to Mission Meetings.*

Specific Project Enrollment

- *2009-2013, Project Coordinator for Design Consultancy and Design and Build Tender Stage of Agence Française de Développement (AFD)*
- *2009-2013, Project Coordinator for Regional Development Project Phase 2*
- *2009-2013, Programme Manager for WHO and UNICEF Work plans.*

Secretary, 2005-2006

**Administration
Ministry of Environment, Energy and Water**

**Environment Consultant
2010 – 2012
CDE Consulting
(Part Time)**

Contributed in the Development Environment Impact Assessment (EIA)

- Contributed to EIA for reclamation of *Gulhifalhu* Phase I
- Contributed to EIA Addendum for Beach Replenishment in *Vilamedhoo Resort and Spa*
- Contributed to EIA for the development of Picnic island facility in *Rahflahu Huraa*
- Contributed to EIA for the construction of *Gulhifalhu* Phase I
- Contributed to Household Income Expenditure Survey for Foreign people residing in the Maldives
- Contributed to Environmental Audit (EA) for registration of powerhouse and Desalination plant in *Olhuveli Beach and Spa Resort*
- Contributed to EA for registration of desalination plant and improvement to the existing football ground in *Kurehdhoo Island Resort and Spa*
- Contributed to Environmental Baseline Assessment of *Thilafushi* for the construction of regional waste facility by IFC
- Contributed to EIA for the development of picnic island at *K. Madivaru*
- Contributed to EA for registration of desalination plant and construction of sea wall in *Helengili Island Resort*
- Contributed to EA for registration of desalination plant located in *Meeru Island* Resort
- Contributed to EIA for the redevelopment of resort at *Giraaavaru Islands*
- Contributed to Resort Environmental Safety and Management

SHORT COURSES & TRAINING

- Certificate in Basic Office Management, Year 2005
- International Language Testing System (IELTS), March 2012
- Training Seminar on Capacity Building on Renewable Energy
,25-29 Dec 2005
- Professional Training on Integrated Solid Waste and Waste Water Management, 11-20 October 2010
- Water Safety Plan Training, 28th May- 4th June 2013
- Practical Use of FIDIC Conditions of Contracts, 26th and 27th November 2014.

WORKSHOPS & CONFERENCES

- 2nd Provincial Workshop on Environmental Awareness, 25-28 Feb 2010
- Regional Conference for SAARC Countries - Household Water Treatment and Safe Storage (HWTS), 4-6 May, 2010
- Regional Workshop on Climate Services at the National Level for the Least Developed Countries in Asia, 8-10 October 2012
- Regional Consultant Meeting to Finalize an Actionable Framework to Address the Common Challenge of Sanitation in South Asia, 8-9 May 2013

Annex 7: Commitment Letter from Proponent

Environmental Impact Assessment Report, Proposed jetty in V.Fulidhoo

2017

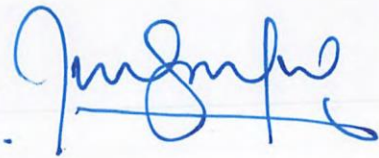
PROPONENTS DECLARATION AND COMMITMENT

Re: EIA for the proposed Jetty project in V.Fulidhoo

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

As the Proponent of the project; we assure you our commitment to undertake the proposed mitigation measures and monitoring programme given in the report.

Signature:



Name: Fathimath Shaana Farooq

Designation: Director General

On behalf of: Ministry of Housing and Infrastructure

Date: 15 August 2017

Annex 8: Receipt of the EIA report from V. Fulidhoo Council



Hamdhoon Mohamed <hamdhoon.mohamed@gmail.com>

EIA report for council approval for Access Jetty Project

Hamdhoon Mohamed <hamdhoon.mohamed@gmail.com> Tue, Aug 15, 2017 at 11:51 AM
To: fulidhoo@vaav.gov.mv
Cc: "Environment Monitoring Unit | Ministry of Housing, MV" <emu@housing.gov.mv>, Umar Fikry <umarey@gmail.com>, Afsal Hussain <episthmh@gmail.com>, Fathimath Shaana Farooq <shaana.farooq@housing.gov.mv>, Nafha Aujaz <nafha.aujaz@housing.gov.mv>

Dear Imthinaan & Faiz,

Attached please find the EIA report which is ready to be submitted to EPA for final approval.

Before this, I would need to get a letter form the Council mentioning that the Council and received this report.

I would appreciate if such a letter could be provided by the council.


Regards

--

Hamdhoon Mohamed
Mobile Number: +(960) 7845332
Email: hamdhoon.mohamed@gmail.com
Linkedin profile: <https://www.linkedin.com/in/hamdhoon-mohamed-695b5146/>



Please consider the environment before printing this email.

 **V. Fulidhoo Jetty Works EIA - Final.pdf**
9782K



Hamdhoon Mohamed <hamdhoon.mohamed@gmail.com>

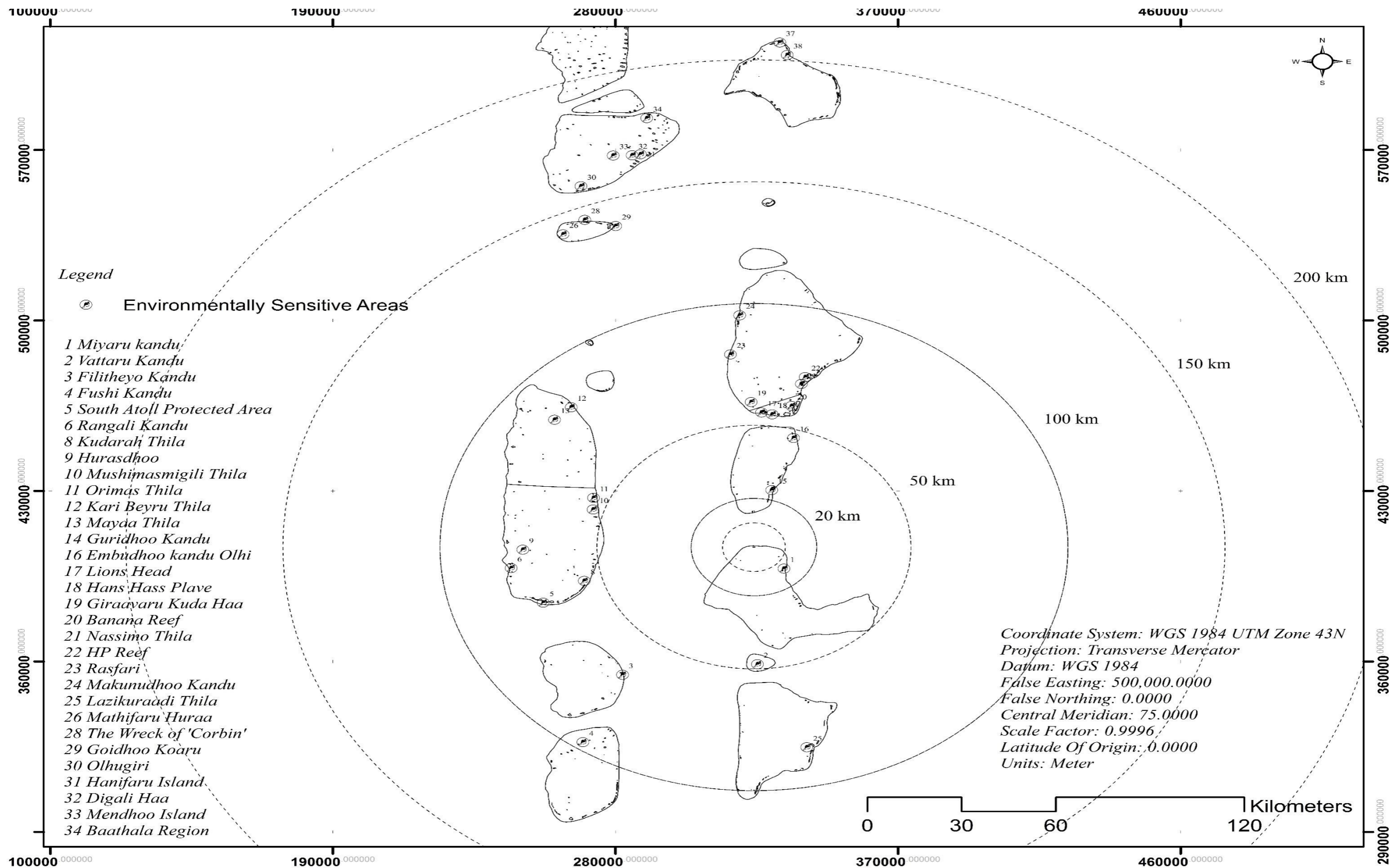
(no subject)

fulidhoo@vaav.gov.mv <fulidhoo@vaav.gov.mv> Wed, Aug 16, 2017 at 8:15 AM
Reply-To: fulidhoo@vaav.gov.mv
To: hamdhoon.mohamed@gmail.com

EIA riport libijje

Message sent via Atnail Open - <http://atmail.org/>

Annex 9: Environmentally sensitive Areas (ESAs) and Marine Protected Areas (MPAs) close to the project site





Annex 10: Site plan of the project area

Annex 11: Detailed Bathymetry Map of Project Area

