

# **ENVIRONMENTAL IMPACT ASSESSMENT FOR ISLAND ACCESS AND JETTY CONSTRUCTION PROJECT IN FEHENDHOO, BAA. ATOLL**

Prepared For:  
Ministry of Housing and Infrastructure

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## **Declaration of the Consultant:**

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



Dr. Mahmood Riyaz (EIA03/07)  
12<sup>th</sup> July 2017

## **Declaration of the Proponent**





תכנית נתיב הליכה לפרוייקט נתיב הליכה. סכום הוצאות תכנית הליכה נתיב הליכה נתיב הליכה  
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## 2 NON TECHNICAL SUMMARY

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1. The proponent of B. Fehendhoo Island access and Jetty development project is the Ministry of Housing and Infrastructure (MHI). The Ministry is the government's responsible body for the development and regulate the housing and infrastructure of the country. Maldives Road Development Cooperation (MRDC) has been contracted to undertake the jetty and access channel construction work in B. Fehendhoo.
2. Two freelance EIA consultants has been contracted through public bidding process to provide preparation services of an Environmental Impact Study (EIA) by (MHI) for the jetty and access channel construction work project in B. Fehendhoo Island.
3. The assessment addresses specific key issues stated in the Terms of Reference (ToR) as agreed between EPA and the Proponent following the scoping meeting held on the matter.
4. The island community constructed a Jetty and an access channel in B. Fehendhoo in early 2010 on the northern side of the island. They have always been using the northern side to access the island. Access from the southern side is extremely rough and far from the remaining islands in B. Atoll. Even though an access channel through the reef flat has been developed, island access issue has never been solved as the lagoon on the northern side is very shallow covered with thick seagrass which is exposed at low tide also the approach channel exposed to strong swells particularly during the onset of SW Monsoon. Due to this, boats and Dhonies that carry goods and people (island and atoll ferries) don't access Fehendhoo directly. They usually dock at the harbour in Goidhoo, then people and goods are transported to Fehendhoo is small Dinghy's through the manually deepened pathways in the lagoon.
5. The need for an access for the island has been recognised by the government and decided to develop a jetty and cut an access channel on the northern side to provide safe access for the vessels operating to and from B. Fehendhoo Island.
6. The study investigates impacts associated with the channel dredging and jetty construction of B. Fehendhoo and areas for disposal of dredged material. The proposed access channel will have a width of 24m and a length of 417m and the entrance channel which will be cut through the reef into the ocean ward will lead to a small rectangular shaped dredged area (harbour basin ) 40m wide and 40m long, for vessel turning and temporary mooring purposes. The proposed mooring basin and the access channel will be dredged to maintain an average depth of -3m with respect to the MSL. A total of approximately 28280m<sup>3</sup> of dredged material is expected to be produced. This material will be used for jetty backfill and the excess will be used for the nourishment of the beach on the northern coast of the island which at present is undergoing severe erosion.
7. Main focus this reports is to document the general baseline condition surrounding island and particularly the proposed area for channel dredging and jetty construction. The following studies have been carried out as part of this assessment.
  - a. Assessment of the marine and coastal species and habitats in surrounding impact areas.
  - b. Coastal beach profiles to set baseline conditions of coastal processes.

- c. Wave and shoreline assessment study to evaluate the potential for the proposed channel dredging and jetty construction to impact adjacent shorelines.
  - d. Climatic and oceanographic conditions of the project site.
8. Findings from the environmental studies are summarized as follows;
- a. Access to the island is extremely difficult from the southern side sea roughness and long distance from the remaining islands in B. Atoll.
  - b. Northern side is very shallow covered with thick seagrass which is exposed at low tide
  - c. Approach channel exposed to strong swells particularly during the onset of SW Monsoon.
  - d. Due to this, boats and Dhonies that carry goods and people (island and atoll ferries) don't access Fehendhoo directly. They usually dock at the harbour in Goidhoo, then people and goods are transported to Fehendhoo in small Dinghy's through the manually deepened pathways in the lagoon.
  - e. Fehendhoo probably is the only island without a primary school. At present there are primary 12 students in Fehendhoo who are attending the Primary school in Goidhoo located two Kilometres west. Students and their parents commute between the Goidhoo and Fehendhoo twice a day on small Dinghies.
9. This EIA has been carried out on the basis that it is necessary to carry out the jetty construction and island access project at the northern side of B. Fehendhoo to facilitate socio-economic development and easy access to the island.
10. During the preparation of the EIA report an impact matrix, which is a standard tool for identifying the possible impacts of project activities, has been created for proposed development project in B. Fehendhoo Island. The activities carried out during the construction and post-construction or operational phases are arrayed against a selection of environmental factors that may be affected directly or indirectly as a result of project activities.
11. The environmental impact assessment study shows there are two main activities that would cause minor to moderate negative environmental impacts. Those, in order of minor to moderate impact, are:
- 1. Channel and mooring basin dredging
  - 2. Jetty construction and backfilling
12. Of these a long term impact would be from dredging and beach backfilling of jetty area and nourishment of Kattihuraa at the East of entrance channel and the excess to replenish the eroding areas on the northern side of the island. These impacts would be cumulative occurring over long period of time and so can be managed through proper monitoring and addressing them in a timely manner. Based on the scale of dredging and beach nourishment work projects that is taking place in Maldives, impacts associated with the proposed dredging activity is insignificant. The positive socio economic impacts from the proposed development outweigh the temporary negative impacts of dredging.
13. The study has evaluated alternative locations for the jetty and suggested shifting the jetty 20m east of the existing one for the convenience of the island community. Even though there is no significant impact from this project particularly with the recommended T-jetty construction,

the report has come-up with an extensive monitoring programme that will keep on monitoring coastal and marine environmental changes associated with the development to make necessary adjustment based on the findings of various measured environmental parameters suggested in the monitoring plan.

14. Therefore, on the basis of this environmental impact assessment study and the impact mitigation measures in the report will be duly implemented, it is concluded that the benefits of island access development project in B. Fehendhoo will substantially outweigh its imposition on the environment.

\*\*\*\*\*

## 3 INTRODUCTION

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### 3.1 BACKGROUND AND CONTEXT

This Environmental Impact Assessment (EIA) addresses the proposed harbour development in B. Fehendhoo. Two freelance EIA consultants prepared this document in accordance with the EIA Regulations (2012) and Regulation on Dredging and Reclamation (Regulation 2013/R-15) of the Environmental Protection Agency (EPA). This EIA provides a focused assessment of the proposed dredging and subsequent reclamation in terms of existing environmental conditions and potential environmental impacts to the surrounding near shore marine environment and shorelines as detailed in the Terms of Reference (TOR) for undertaking EIA for this project. TOR is given in Annex 1.

Studies conducted to evaluate the proposed island access and jetty construction project in Fehendhoo include coastal mapping, assessment of the marine habitat, assessment of existing environment of the area proposed for development, assessment of island dynamics using satellite image aerial photography, wave and shoreline impact assessment studies of the area.

The island community constructed a Jetty in B. Fehendhoo in early 2010 on the northern side of the island. They have always been using the northern side to access the island. Access from the southern side is extremely rough and far from the remaining islands in B. Atoll. Direct access to the island has been extremely difficult to Fehendhoo. To overcome this issues the small population in the island attempted to develop an alternative access point on the northern side of the island. The community people used equipment (excavator) brought into the island by some contractors to uproot palm trees from the island to be transplanted in Reethirah resort during the time of Reethirah Resort development. Making use of the opportunity they managed to cut a channel through the reef flat on the Northern eastern tip of the island (*Figure 1*).

Even though an access channel through the reef flat has been developed, island access issue has never been solved as the lagoon on the northern side is very shallow covered with thick seagrass which is exposed at low tide also the approach channel exposed to strong swells particularly during the onset of SW Monsoon. Due to this, boats and Dhonies that carry goods and people (island and atoll ferries) don't access Fehendhoo directly. They usually dock at the harbour in Goidhoo, then people and goods are transported to Fehendhoo in small Dinghy's through the manually deepened pathways in the lagoon.

Fehendhoo probably is the only island without a primary school. At present there are primary 12 students in Fehendhoo who are attending the Primary school in Goidhoo located two Kilometres west. Students and their parents commute between the Goidhoo and Fehendhoo twice a day on small Dinghies.

Developing a proper harbour facility in Fehendhoo Island is a desperate need for the community. In an attempt to develop a harbour they have approached some local private businessman to get financial assistance. They also have prepared an EIA report by Zuhair (2016) and obtained environment clearance in March 2016 to cut an access channel and deepen 150x200ft harbour area adjacent to the existing jetty and construct short quaywall adjacent to the land. Since the EIA approved a year ago, practical work did not commence yet. The council has recently renewed the EIA approval hoping to start the work sometime this year.

The first priority for the people of Fehendhoo has always been the development of an appropriate harbour and island access and they have been requesting and demanding assistance from the Government to develop access to the island in every occasion and opportunity they get. As a response

for this request the Government proposed this project to develop access channel with a small mooring area for Fehendhoo on the northern side. The project involves development of a 31.15m long 4m wide T-jetty, dredging 24m wide, 417m long an access path and dredging 40x40m small mooring basin in front of the T-section of the jetty (**Figure 2** and **Figure 3**). This is a standard island access development package that is provided by the government for the islands with access difficulties. Therefore, this This EIA has been carried out on the basis that it is necessary to carry out the jetty construction and island access project in B. Fehendhoo to facilitate socio-economic development and easy access to the island

The people of Fehendhoo are hoping to get a reasonably good island access and harbour facility by merging the proposed island access development project from the Government the private investor who has promised to for a harbour in the island.



*Figure 1: Existing access channel B. Fehendhoo northern side, note the height of the breaking wave*



*Figure 2: Existing Jetty B. Fehendhoo northern side*



*Figure 3: People and goods are transported in small Dinghies to B. Fehendhoo through manually dredged inter lagoon pathway between B.Fehendhoo and Goidhoo. Most commonly used access to the island*



Figure 4: Small Dinghies used for transportation between Fehendhoo-Goidhoo and Fulhadhoo

The government has proposed to develop an alternative access to the island through construction of a 31m long T-jetty with 4m wide walkway with 24m wide, 417m long access channel and 40m X 30m dredged area at the end of the T-Jetty, enough for vessel manoeuvring, turning and temporary mooring. The T-jetty is proposed to be developed 50m west of the existing Jetty on the northern side of the island (**Figure 5**). Both the access channel and the small mooring basin will be dredged to have a depth of -3m at low tide.

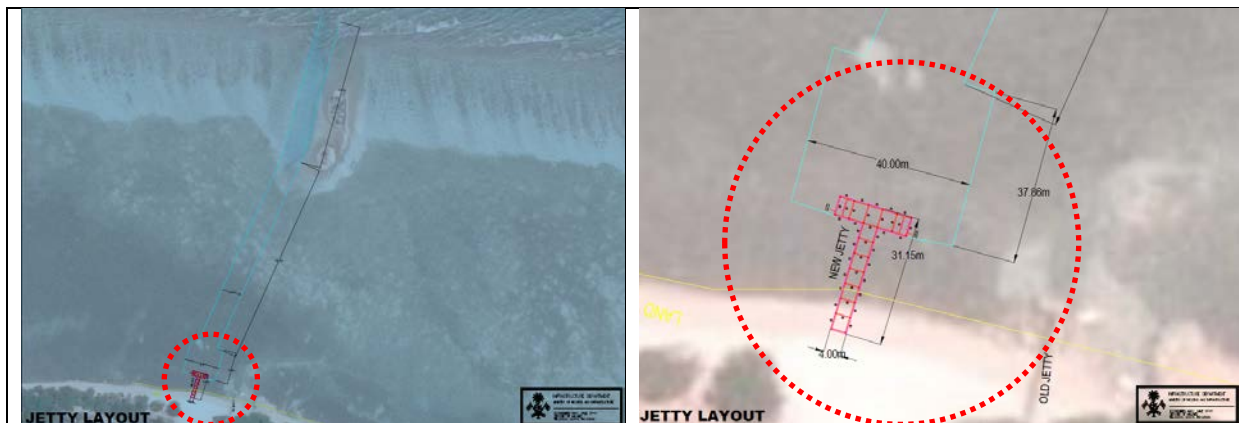


Figure 5: Proposed location for the new access channel and jetty development, a magnified map will be provided in Annex 2.

### 3.2 PURPOSE OF THE EIA

Given the potentially adverse environmental impacts associated with dredging and the other works in the marine environment at B. Fehendhoo, the proponent has hired a freelance EIA consultant through public bidding process and assigned the preparation and submission of an Environmental Impact Assessment (EIA) report to EPA to comply with the Environmental Protection and Preservation Act (4/93) and EIA Regulations 2012.

The objective of the EIA study is:

- a) To provide an assessment of the potential environmental effects of the proposal and to determine which of these, if any are likely to result in a significant effect on the environment and to propose ways and means of avoiding, mitigating and or compensating the perceived negatives effects of the project;
- b) To provide necessary information to EPA applicable to the proposed development; and

- c) To assess how the proposals have been developed to achieve a satisfactory level of environmental performance in line with the EIA Regulations

### **3.3 PROJECT SETTING**

B. Fehendhoo is administratively located in Baa Atoll which is formed of geographically three atolls separated by narrow deep channels. The Central part of B. Atoll (Geographic Baa atoll) consist of most of the inhabited islands and the northern B. Atoll has only one inhabited island (Kudarikilu) and the Southern B atoll which is Goidhoo atoll has three inhabited islands. Fehendhoo is one of the three islands in Goidhoo Atoll. The two remaining islands are Goidhoo and Fulhadhoo islands. The proposed jetty and entrance channel dredging will take place on the north side of the island at the ocean ward side.

Visual observations and studies conducted for similar environment suggested to be dredged the substrate to be consisted mostly of medium hard consolidated calcareous reef limestone/conglomerate that forms the reef flat. Usually the hardness of coral rock on the reef flat on ocean ward side are greater than the lagoon wards side of the island due to continued exposure to ocean swells. Entrance channel dredging is planned to be undertaken by cutting through the hard reef flat on the northern side. Some of the reef flat areas earmarked for dredging is expected to be hard and may require special tools and equipment to crush the hard reef flat to obtain the targeted minimum depth of -3m with respect to MSL.

### **3.4 SCOPE OF THE EIA**

The scope of this EIA is based on the consultations held during the scoping meeting at the Environmental Protection Agency on 11<sup>th</sup> June 2017. Following the scoping meeting, the Consultant drafted a ToR which was finalized and endorsed by the EPA. The approved ToR highlighted 8 major tasks to be covered including;

1. Description of the proposed project;
2. Description of the existing environment;
3. Legislative and regulatory considerations;
4. Potential impacts of the proposed project;
5. Alternatives to the proposed project;
6. Mitigation and management of negative impacts;
7. Development of monitoring plan; and
8. Stakeholder consultation.

A copy of the ToR is attached in Annex 1. The EIA for the island access and jetty development project in B. Fehendhoo closely followed the approved ToR for the assessment.

The scoping meeting was attended by the representatives of the following organisations;

1. Ministry of Housing and Infrastructure;
2. Environment Protection Agency; and
3. B. Fehendhoo Council members (attendance list is attached in Annexes)

### 3.5 PROJECT JUSTIFICATION

B. Fehendhoo is an inhabited island with a registered population of approximately 300 people, out of which only 107 people are residing in the island located on Baa Goidhoo Atoll. The island shares single atoll reef with Goidhoo and Fulahdhoo islands and four more uninhabited vegetated islands. No proper access to the island has been developed. Island Ferries and Atoll ferries travel only to Goidhoo, people and goods from Fehendhoo are transported in small Dinghies to Goidhoo.

Access to the island is considered to be a basic need for all the inhabited islands in the Maldives. At present only handful of islands are without appropriate island access. People in the islands without proper island access consider themselves as people locked in an island. Hence people of Fehendhoo and Fuulhadhoo consider themselves deprived with a fundamental basic need. Due to unavailability of proper access to the island, People of Fehendhoo has been requesting the government to transfer them to another island they have submitted number of letters and petitions to the government in this regard. Local has been covering the plight of the people in news headlines (**Figure 6**).



Figure 6: A recent report in local news papers on the plight and grievances of Fehendhoo people requesting to relocate in another island.

Therefore the people of the island have been opting for harbour and/or access to the island. Since this is an inhabited island the access to the island is considered as a basic right. Island access related developments such as harbours, access channel and jetties, in an inhabited island, are considered to be the most important infrastructure everyone craves for and viewed as a necessity for the development of the island to open up to the rest of the country. Therefore such development projects are socially-driven project to improve the livelihoods of people who have been waiting impatiently for a proper harbour. The primary objective of the project is to provide appropriate access to the island, and provide safe mooring facilities especially for the vessels operating to and from the island. Access to the island is envisaged to bring economic growth and will improve living conditions of people of Fehendhoo Island.

Even though there is a narrow access channel on the northern side, island access issue has never been solved as the lagoon on the northern side is very shallow covered with thick seagrass which is exposed at low tide. Also the approach channel exposed to strong swells particularly during the onset of SW Monsoon. Due to this, boats and Dhonies that carry goods and people (island and atoll ferries) don't access Fehendhoo directly. They usually dock at the harbour in Goidhoo, then people and goods are transported to Fehendhoo in small Dinghy's through the manually deepened pathways in the lagoon.

Location of the proposed jetty and access channel is on the northern side of the island. This is the ocean ward side where the area is exposed to ocean swell throughout the year and particularly strong swells during the NE monsoon.

In terms of the design, the proposed design is a standard island access facility infrastructure with an access channel, jetty and a small dredged area for vessel manoeuvring at the end of T-Jetty. Consultation with the island council and elders has suggested relocate the proposed jetty 30 east of the existing jetty.

Fehendhoo Island is an elongated island. Therefore any shore perpendicular structure or dredged basin (channel and dredged area) will disrupt the natural longshore sediment transport regime. Also leaving the dredged area and the channel unprotected will result in sedimentation and infilling of dredged basin. The proposed design will therefore disrupt the sediment movement around the island and may cause sediment starvation in another part of the island or a neighbouring island which may consequently lead to severe erosion, which needs to be addressed at a later stage. Therefore coastal changes and dynamics should be closely monitored after the development to address erosion issues appropriately. Given the specific circumstances of B. Fehendhoo a compromise need to be made between environment and peoples need.

### **3.6 PROJECT BOUNDARY**

Major construction and B. Fehendhoo island access infrastructure development activities will take place in the boundary shown in **Figure 7**. Project impact boundary is shown in **Figure 7** study area in **Figure 8** and project impact foot print **Figure 9**.



*Figure 7: B. Fehendhoo island access and Jetty construction project boundary*



*Figure 8: B. Fehendhoo island access and Jetty construction project study area*

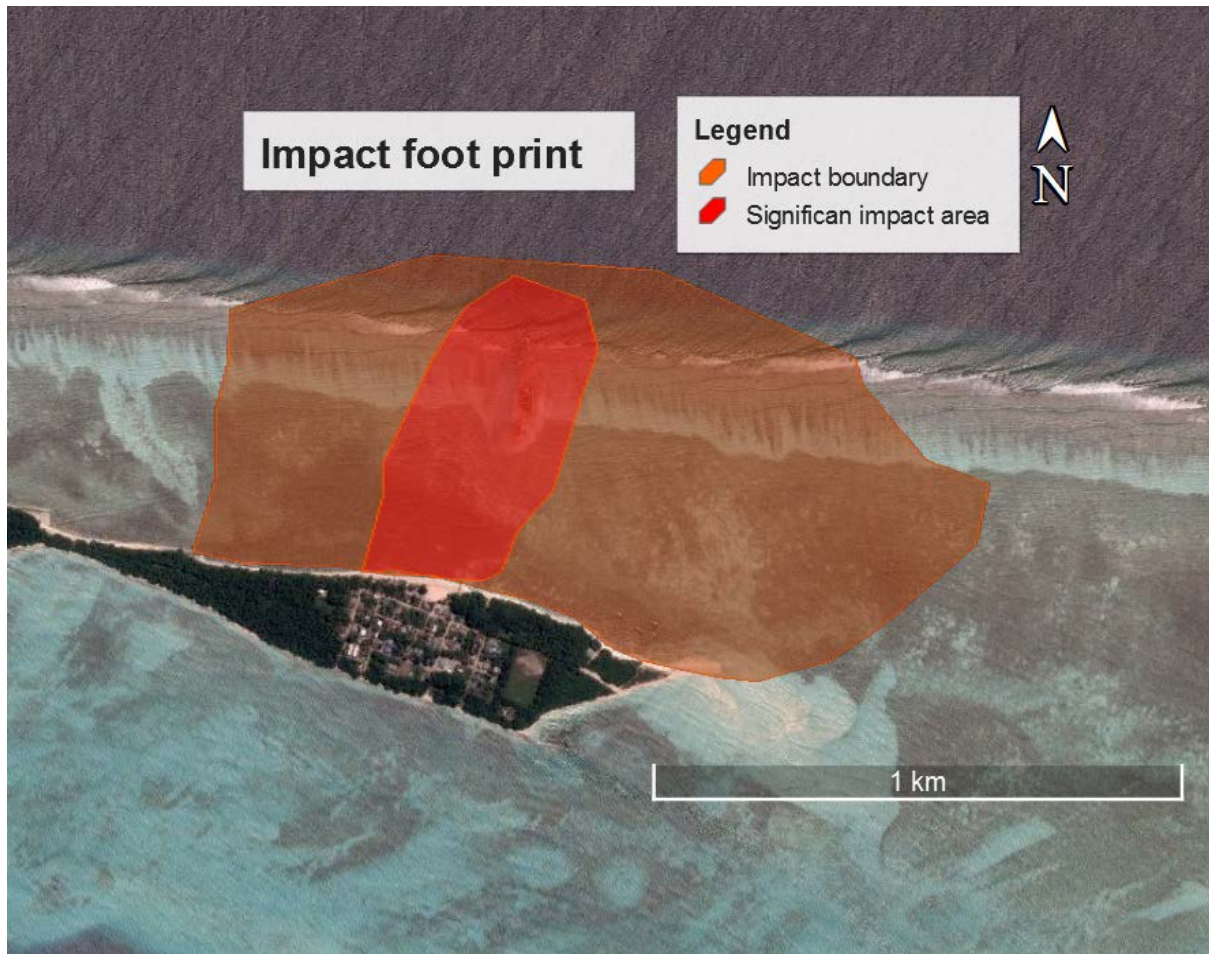


Figure 9: B. Fehendhoo island access and Jetty project impact boundary

### 3.7 METHODOLOGY

Field studies have been undertaken using methods generally employed for EIA studies in the Maldives. This study was based mainly on data collected during a field investigation mission from 1-8-10 June 2017, by the consultant. Field studies have been undertaken using methods generally employed for EIA studies in the Maldives. Environmental impacts are predicted by using descriptive checklists and its significances are evaluated by the use of matrices. Expert judgment and professional opinion as well as review of relevant EIA studies have also been widely used throughout the impact assessment and evaluation process. These methods are described in detail at the relevant section of this EIA Report.

### 3.8 REVIEW OF RELEVANT STUDIES

As part of relevant literature review and preparation of the report, the following EIA studies on dredging, reclamation and coastal protection related work in various parts of the Maldives have been reviewed and used as reference;

*Environmental impact assessment for proposed access channel and boat mooring basing development in B. Fehendhoo, Baa. Atoll by Zuhair M (2016).*

*Environmental impact assessment for harbour development in R. Fainu island, Raa. Atoll by Riyaz M (2014).*

*Environmental Impact Assessment For Proposed Levelling And Earthworks Of Football Arena In Nadella, South Huvadhu Atoll by Riyaz M. (2016).*

*Environmental impact assessment for beach nourishment and maintenance dredging of access channels and harbour in Thulhaagiri island by Riyaz M. and M. Shiham (2014)*

## **4 DESCRIPTION OF THE PROJECT**

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### **4.1 THE PROPONENT**

The proponent of B. Fehendhoo harbour development project is the Ministry of Housing and Infrastructure. The Ministry is the government responsible body for the development and regulate the housing and infrastructure of the country. Jetties and access channels being a public infrastructure the Ministry's mandate in relation to infrastructure development projects is at three levels.

- National Harbour and Reclamation Programme, which involves the construction of major harbours and reclamation projects in the country
- Access Improvement Programme, which was initiated in 2004 with a scope to provide a minimum access to all islands that had no means of a proper access
- Repair and Rehabilitation Programme, which was initiated following the catastrophic event of December 2004 tsunami that damaged a large number of harbours and jetties. This programme was initially implemented by National Disaster Management Centre (NDMC) and later handed over to the Ministry of Housing and Environment.

Harbour development project of all the inhabited islands fall under access improvement programme of which Fehendhoo has been current government's campaign promise.

Maldives Road Development Cooperation (MRDC) has been contracted to undertake the jetty and access construction work in B. Fehendhoo.

### **4.2 PROJECT LOCATION AND BOUNDARY**

B. Fehendhoo is located on the northern side of Goidhoo Atoll. The island is located at the north eastern rim of the atoll at Longitude 72.973563°, Latitude 4.880015° (Figure 10) at the eastern half of the atoll. The Island is elongated looks like three triangles are joined together at the apex pointing west wards. The overall orientation of the island is E-W and is found in a single reef ( Atoll) that shares three inhabited islands and two uninhabited vegetated small sand cays. The island has approximately 2.3km in length and the width varies the widest part 230m. The approximate land area of Fehendhoo is 26 ha. Closest inhabited island located within the vicinity of Fehendhoo Island include Goidhoo on the east and Fulhadoo to the west.

The proposed mooring basin and entrance channel dredging will take place on the northern side near the exiting jetty.

The project boundary is confined to B. Fehendhoo Island and the reef and lagoon environment in which the island is found (*Figure 9*).

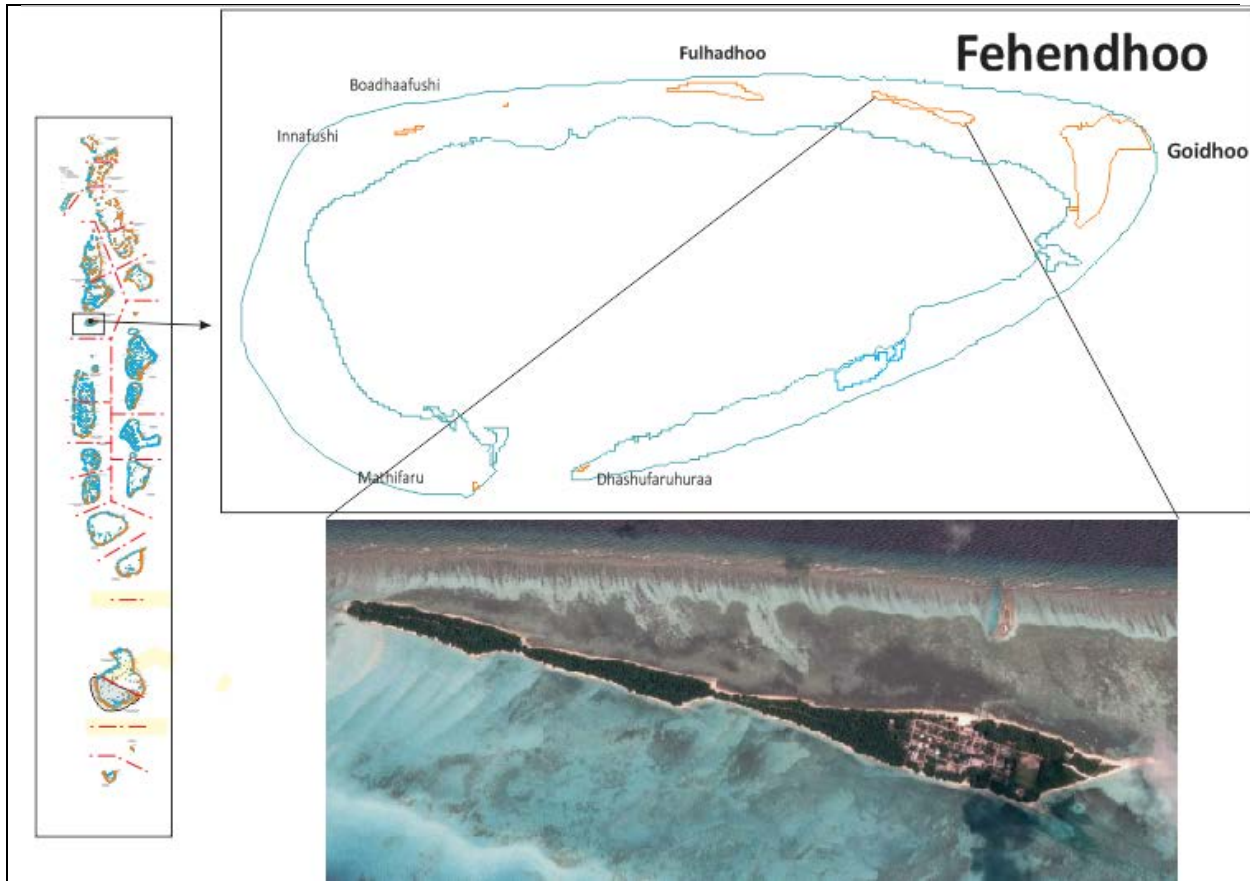


Figure 10: Location of B. Fehendhoo Island in Raa Atoll

### 4.3 PROJECT OUTLINE AND SITE PLAN

The proposed design is a standard island access related infrastructure government develops in islands with the population size of Fehendhoo. Island access related structures include an access channel, small mooring area and a T-jetty. Fehendhoo access is designed to allow for safer access and turning of marine vessels and to accommodate slightly larger vessels (*Figure 11* and *Figure 12*). To do so the initial proposal of the Government includes the following components

- Construction of 31.15m long T-jetty with 4m width walkway
- Ground levelling the jetty area.
- Dredging near Jetty area 40m width & 38m length
- Dredging new entrance channel 24m width & 417m length

Dredging would seek to achieve depths of up to -3m with respect to the MSL in the entrance channel and similar depth within the mooring basin.



*Figure 11: Conceptual drawing and location of the proposed access channel and jetty*

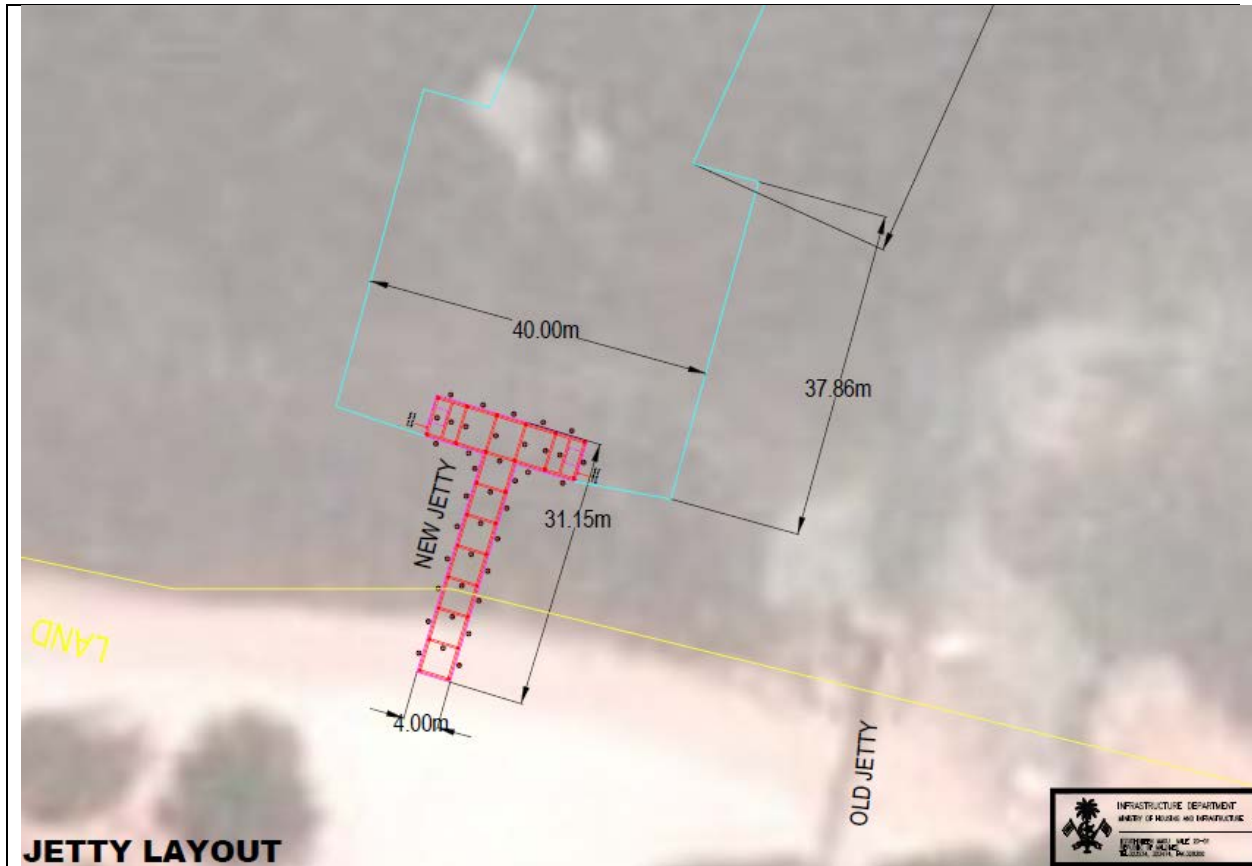
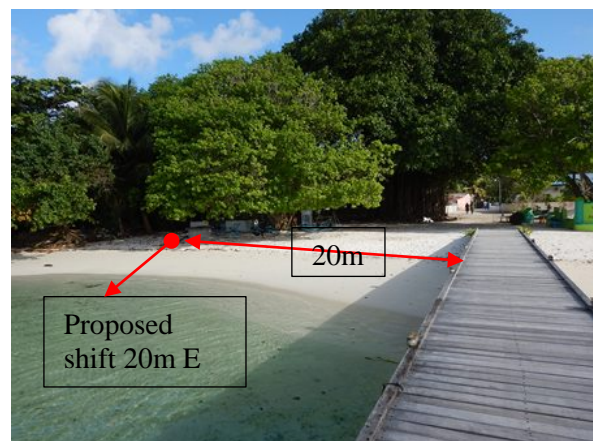


Figure 12: Details of the proposed access and jetty development in Fehendhoo

Field verification of the project site has revealed that proposed jetty is located approximately 50m west of the existing jetty (Figure 13). Due to the location of the jetty the access channel is aligned in an angle to the jetty. Discussion with the people of the island has suggested shifting the location of the jetty to 30m east of the existing jetty to be aligned with the existing channel. This option will be discussed in detail in the alternatives section of this report which would be the preferred location to develop island access in Fehendhoo.



*Figure 13: Showing the location of the proposed jetty and suggested shift in relation to the existing jetty (left) jetty shift suggested by the people (right)*

#### **4.4 MAIN DEVELOPMENT FEATURES OF THE PROJECT**

The following are main development features of Fehendhoo access and jetty development project:

1. Dredging of a small turning basin (40m length X 38m wide) located at the tip of the T-jetty achieve -3m with respect to MSL
2. Dredging a 24m wide 417m long entrance channel through the reef flat into the ocean to a depth of -3m
3. Construction of 31.15m long T-jetty with 4m width walkway
4. Use the dredged material for ground levelling of the jetty area, replenish Kattihuraa (man-made island at the east of existing entrance) and beach erosion areas

Above features are depicted in the (*Figure 12*). Since this is the main access point for the island to be used for transport and access to the island. The proposed size is considered to be adequate for the current traffic volumes as well as estimated future traffic to the island. The people of the island are hoping to increase the size of the mooring area to a size of a small harbour to create enough space for their vessels to be anchored. Therefore, they have suggested increasing the size of the mooring area to be at least 150ftx200ft 1 which will be enough for the vessels in the island.

#### **4.5 MOORING AREA BASIN**

An excavator on barge will be used to dredge proposed areas to obtain the desired depths. The excavator will transfer the dredged material on the dump truck which finally ends up on the stockpile location. A detailed bathymetry of the basin will be compiled by contractor before work commencement. Areas that need to be excavated will be identified and marked with floating buoys. It is planned to complete all activities within the scope of this project in 365 days.

##### **4.5.1 The Entrance Channel**

The proposed dredging project intends to excavate the existing entrance channel to achieve the required depth of -3m with respect to MSL at low tide. At present the average depth of the reef flat is 0.7- 1m during mid-tide and hence will not be suitable to provide access for vessels.

##### **4.5.2 Jetty Works**

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. Existing roads of the island would be used for this purpose whenever possible. Once the concrete columns are in place, in-situ beams will be cast to receive timber deck. Detail drawings of the jetty are provided in Annex 3.

##### **4.5.3 Ground levelling of Jetty area**

Dredged material will be used for ground levelling of the jetty excess material will be used to replenish Kattihuraa and eroding beach on the northern side of the island.

#### **4.6 VOLUMES AND TYPES OF SEDIMENT TO BE DREDGED**

From existing depth information for the small mooring area entrance development has been estimated that a total of 28280m<sup>3</sup> of dredged material will be generated by the proposed works.

The disadvantages of dredging are potential short-term impacts to water quality. During dredging operation, some sediment becomes suspended into the water column. This sediment can then be carried by the current until it settles out of the water column. However, it is not possible to control sediments entirely because the work is done underwater and every dredge leaves some residual material on the bottom. Figure 14 shows proposed areas for dredged material use and disposal.



Figure 14: B. Fhendhoo dredged material use and disposal

#### 4.7 TIMINING

Timing of the dredging is proposed to be coincided during the period between August and November to allow the sediment plume to move east ward influenced by the predominant wind direction and ocean currents to the plume to reach the deep ocean. The proposed dredging schedule is given below in *Table 1*

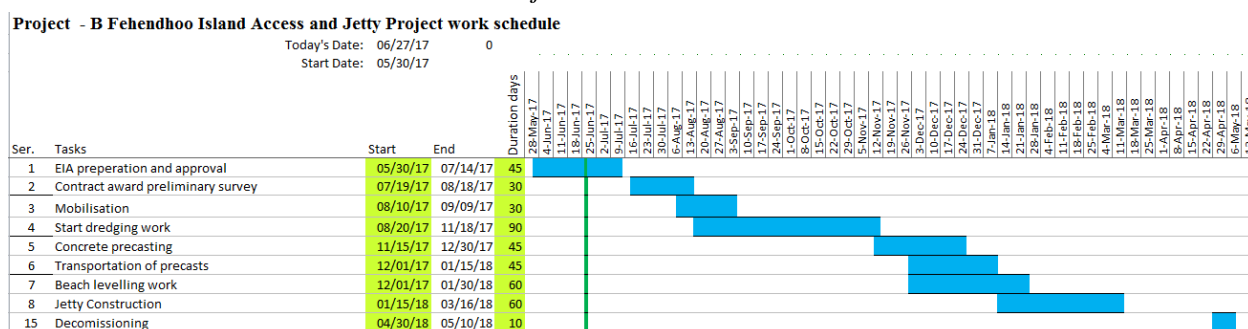
#### 4.8 ACCIDENTS AND HAZARDS

A major risk associated with the project is the impact on marine environment from the proposed island access and T- Jetty construction work. The construction works will be carried out using excavators placed on a barge, which will be floating during the entire operation. It is a possibility that the barge may run on to the reef flat during low tide, however, this can be avoided with work scheduling at high tide. There will be excavation involved so possibility of sedimentation of coral during construction is inevitable. Deployment of precast pad-column units will replace the natural seabed at direct construction footprint of the proposed structures, which cannot be avoided.

#### 4.9 PROJECT SCHEDULE

The project is expected to take 365 days to complete including the time needed for seeking necessary approvals. The main milestones include; obtaining approvals, mobilization, and onset of work, jetty works and entrance channel dredging works, and demobilization. *Table 1* shows the project schedule and project inputs and outputs are given in *Table 2*.

Table 1: Project Schedule – Indicative



#### 4.10 PROJECT INPUT AND OUTPUTS

Table 2: Matrix of project major inputs and outputs

Input resource(s)	Source/type	How to obtain resources
Workers	Skilled and semi-skilled labour, Manager (1) Supervisor (1) Excavator Operator (2), Loader operator (1), Welder (1), Driver (2), Carpenter (2), Bar bender (2), Mason (2) Labourer (11) Cook (1) Cook helper (1) total of 27 people, skilled and semi skilled 16 and unskilled labourers 11.	Trained and licensed staff of the contactor
Machinery (excavator, barge, operational tools)	02 excavator 02 dump trucks 01 loader 01 Concrete machine 01 Barge 01 Workshop container 01 Office Container 03 Diesel tank 5000l 01 Welding Genset 20KvA	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.
Output	Anticipated quantities	Comments
Mooring basin	Small mooring area basin 40m x 30m average depth of -3m will be achieved	
Entrance channel	28m long and 417m wide with an average depth of -	Dredged material will be used for jetty area levelling and the excess to replenish Kattihuraa

	3m, channel	and the eroding beach on the northern side of the island
T-Jetty	Total length of the jetty sections 31.15m	Built using concrete, jetty columns will be pre-cast on land and transported to the site
Dredged material	Major quantity 28280m <sup>3</sup> approximately	Levelling the jetty base and excess material will be used to replenish Kattihuraa and the eroding beach on the northern side of the island
Wastes	Minor amount	No wastes during the excavation will be allowed to be dumped into the sea. Solid wastes and human wastes will be managed through the existing wastewater and solid waste management system on the island
Waste oil and lubricants	Minor amount	Gathered in a barrel and sent to Thilafushi through existing waste management system
Noise and light	Localized	Excavator and truck operation will generate some noise during the project execution. If work is carried out in the night lights will be necessary in the harbour area. Work will not be carried out late into the night to avoid disturbance to local population.
Plastics and packaging waste	Minor amount	Managed through existing waste management system of the island

## **5 ADMINISTRATIVE AND REGULATORY FRAMEWORK**

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This section highlights relevant government stakeholders, their roles and reviews relevant legal framework applicable to the proposed project.

### **5.1 MINISTRY OF ENVIRONMENT, 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 be submitted to the EPA for approval before commencement of a project. As per this legislation, any project that has any undesirable impact on the environment can be terminated without compensation by MEE.

### **5.2 ENVIRONMENTAL PROTECTION AGENCY (EPA)**

EPA is the key regulatory body on environment, which is an autonomous body formed under the umbrella of MEE. It is mandated with implementing the EIA process in the Maldives, implementing the Environment Act and subsequent regulations on behalf of MHE, 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.

### **5.3 MINISTRY OF HOUSING AND INFRASTRUCTURE**

The Ministry of Housing and Infrastructure is mandated to undertake reclamation, harbour development and coastal protection infrastructures as per the government policies. The Ministry of Housing and Infrastructure has a harbour and jetties development programme where there are minimal requirements for harbours and jetties in local inhabited islands. The Access Improvement Programme, which was initiated in 2004, had a scope to provide minimum access to all islands that had no means of a proper access. The Ministry undertakes all coastal infrastructure projects except those specifically focused on shore protection. Depending on the environmental conditions of specific islands, breakwaters or side quay walls would be provided to make the harbour basin safe from adverse conditions.

Although there are no published local guidelines the Ministry uses British standards for coastal structures specifications. The environmental requirements considered are those provided by Ministry of Environment and Energy such as that of Dredging and Reclamation Regulation. The environmental criteria for each project are, however, defined according to the findings of the Environmental Impact Assessment, which is required to be undertaken for each and every harbour project.

### **5.4 LEGAL FRAMEWORK**

Four regulations pertaining to the proposed project have been reviewed and the project's conformity to these has been assessed.

- a) EIA Regulations 2012
- b) Regulations on cutting down of Trees
- c) Regulation on Dredging and Reclamation
- d) Regulation and Waste Management

### **5.4.1 EIA Regulations 2012**

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

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

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

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

The law also gives power to the relevant Government authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation.

According to the EPPA waste disposal, oil and poisonous substances any type of waste, oil, poisonous gases or any substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives.

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

#### **Environment Impact Regulations, 2012 & other relevant regulations**

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

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

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

### **5.4.2 Regulation on Cutting down Trees**

Cutting down and relocating of mature trees is regulated in Maldives under the by-law on cutting down, uprooting, digging out and export of trees and palms from one island to another. In the preamble of the law, made in pursuant to Law No. 4/93, it states the purpose of the law is to educate citizens and developers about the importance of trees including sound management to maintain trees and provide standards for the preservation of trees in the Maldives.

Under the law certain tree are prohibited to remove from island. They include:

- The coastal vegetation growing around the islands extending to about 15m into the island
- All trees and palms growing in mangroves and wetlands spreading to 15m of land area
- All trees in Government protected areas

- Trees that are being protected by the Government in order to protect species of animal / organisms that inhabit on such trees
- Trees / palms those are unusual in nature.

The law states that prior permission must be obtained for removal and/or relocation of 10 or more trees or palms. For indiscriminate removal and land clearances and EIA Decision Note is required. The size of the trees and palms that are allowed to be relocated should have more than 15feet from lowest point to the crown spread for palms and 8 feet from the lowest point to the trunk to tip of the highest branch for trees other than palms.

The law also states that cutting down and uprooting of the trees shall be made under supervision of the island / atoll offices (in the current context Atoll / Island Councils).

The project does not involve removal of any tree from the island hence the regulation will be fully complied to.

#### **5.4.3 Regulation on Dredging and Reclamation**

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

According to the new enforcement arrangement made since November application for Dredging and Reclamation Permit for the projects has to be submitted along with the EIA/Addendums to the Environmental Protection Agency. Therefore the application for Dredging and Reclamation Permit for this project is submitted together with the EIA report.

#### **5.4.4 Regulation and Waste Management**

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

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

EPA is the implementing agency of environmental law and the implementing agency of the EIA regulation.

Wastes produced from the project will be disposed in compliance to this regulation.

#### **5.4.5 Summary**

In summary, the proposed project will comply with all applicable environmental regulations requirements, relevant legislation, and legal and regulatory statutes. The EIA process ensured that this project has followed relevant laws and regulations and the scoping meeting and the stakeholder consultations enabled all related stakeholders participate in the process.

## 6 METHODOLOGIES

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The study approach involved undertaking data collection through field surveys and literature review.

The project scoping was carried out to narrow down the project issues to those requiring detailed analysis. The process involved discussions with stakeholders on key project issues. The primary data was collected through the qualitative and quantitative methods of data collection. Qualitative data was collected through field visits/site walks, public and stakeholder consultations and direct consultation with the people of the island. Stakeholder discussions were conducted to collect as much relevant information and views. Specific methodologies adopted to assess various aspects of the environment have been discussed in details in the respective sections of this report.

The secondary data was collected through literature reviews which included a study of the following:

- Policies, Acts and Regulations;
- Aerial photographs and satellite images; and
- Previous project study documents

In undertaking baseline studies using available data and knowledge have been used. Key issues have been identified during scoping as given in the TOR. Based on the scoping need for further in-depth studies and additional data requirement were identified. Local knowledge was used as much as possible to ensure key questions are addressed in the assessment. Ideally minimum of two monsoon periods (NE and SW) of data is desirable for a study of this nature to understand seasonal variability and environmental change. However to avoid delay in decision making and to provide a conservative estimate of environmental impacts a short term data collection and use of existing data were adopted.

### 6.1 DREDGING REQUIREMENTS AND WORK METHODOLOGY

#### 6.1.1 Dredging Method

Dredging works under this project involves the following three steps; excavation, transport and disposal.

#### 6.1.2 Excavation

It involves dislodgement of and removal of sediments and/or rocks from sea bottom of the dredge areas. An excavator on a barge 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 3.3-yd<sup>3</sup> hydraulic bucket. The excavator will transfer the dredged material on the dump truck which finally ends up on the site of utilisation. A detailed bathymetry of the basin will be compiled by contractor before work commencement. Areas that need to be excavated will be identified and marked with floating buoys. Dredging will progress from entrance into the shallow areas.

#### 6.1.3 Transport of Excavated Material

Transporting materials from the dredging area to the site of utilisation, will be achieved as follows. Sediments will be dumped into dump trucks to transfer into utilisation site; 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.

#### 6.1.4 Disposal Site

Dredged material transported by dump trucks will be disposed off to the designated areas for levelling jetty base, Kattihuraa and eroded beach replenishment areas on the northern side (*Figure 14*). Once

the material is disposed off to the site proper ground levelling and spreading of the load is carried out by manually and using various equipment.

## **6.2 MARINE ENVIRONMENT**

### **6.2.1 Reef and Surveys**

Equipment and tools used

- Handheld Global Positioning System (GPS)
- Still photograph camera
- Underwater writing sheets
- Digital globe multispectral and Panchromatic satellite data

Status of coral reef was assessed from area proposed for the development. Due to time limitation photographic assessment was made. The reef flat on the northern side is extremely shallow hence not suitable for snorkelling or swimming due to the shallow depth of the area. Photographs are taken from the reef edge and which has an average depth of 0.7-1.5 meter.

### **6.2.2 Bathymetry**

Bathymetric survey of the area proposed for island access and jetty construction in Fehendhoo, reef were 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. Bathymetry of the surveyed area is in shown *Figure 27*

### **6.2.3 Waves and Currents**

Generalised wave predictions and wave pattern predicted using hindcast for the Indian Ocean was obtained from weather information providing sites. Site specific near shore wave characteristics for B. Fehendhoo was measured using a RBR wave Gauge location shown in *Figure 15*.

### **6.2.4 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 2002-2016 was documented using Google earth images. Beach profiles are taken from the shoreline of the area proposed for development.

### **6.2.5 Geology, Sediment, Marine Benthic Assessment**

Due to the homogenous nature of the geological characteristics of Maldivian Atolls, site specific investigation for reef and lagoon geomorphology was not conducted whereas coring studies conducted elsewhere in the Maldives was reviewed. Visual observations were also made during the field on the geomorphological aspects of the island lagoon and reef. Coral communities and the coral reefs at the entrance channel and within the proposed access channel and jetty development area were assessed by combination of boat patrolling, and underwater visual observations. The proposed site for development of the jetty and the access channel is homogenous consists of medium hard consolidated calcareous rock/conglomerate reef platform that is usually found ocean ward side reef-flats. The lagoon behind the reef-flat is covered with thick seagrass bed which usually grow on sandy bottom.

## **6.3 TERRESTRIAL ENVIRONMENT**

### **6.4 CLIMATE**

Official meteorological observations services in Maldives are limited to airports. A total of 13 airports are in operation, however meteorological observation takes place only on 5 airports. They are Hanimaadhoo in the north, Ibrahim Nasir International Airport in the centre, Kahdhoo, in the south centre, Kaadehoo, in the south, and Gan Island in the extreme south. Observation routinely monitored and measured include, wind speed and direction, daily minimum and maximum temperature, humidity, cloud cover. Monitoring of sea-level height takes place only in Hulhule (central), Hanimaadhoo (North) and in Gan Island (in south). Apart from the official meteorological observations, number of resort islands and individuals are installing portable mobile weather stations. Such weather stations are providing real time measurements to famous weather forecasting sites such as [www.wunderground.com](http://www.wunderground.com) and [www.windfinder.com](http://www.windfinder.com). Data collected from these stations are now publicly available from those internet sites.

In the absence site specific weather data the normal procedure is to obtain whatever is available from the nearest weather station in an airport and apply it to the site assuming that average climate conditions do not show much variation between different islands. For the purposes of B. Fehendhoo EIA meteorological observations from the Velana International Airport, which is located approximately 100km south east of Fehendhoo was used for description of the general weather conditions on the northern part of the Maldives. Data obtained from portable weather stations installed in N. Irufushi Islands, approximately 104km north east of Fehendhoo, was used for description of specific local climate condition of Fehendhoo Island.

### **6.5 IMPACT ASSESSMENT METHODOLOGY**

The environmental impacts that may be associated with the proposed island access and jetty construction project on B. Fehendhoo Island are predicted by using a simple matrix. Island and access development is a very common and necessary infrastructure development that is needed in almost all the islands of the Maldives. People are very familiar with the environmental impacts associated with the development. Due to its necessity socio economic benefit of harbour development always overweight environmental concerns. Impacts from various activities of the proposed project both construction and operational phases have been identified through consultation with the project management team, field surveys, observations and assessment, as well as based on field experience and expert opinion on similar development projects in the country.

Other sources of information have been used wherever possible. Data collected during field surveys can be used to predict outcomes of various operational and construction activities on the various related environmental components. Data presented in this report can also be used as a baseline for environmental monitoring of the project activities.

### **6.6 DATA GAPS**

In the Maldives it is common to expect a detailed environmental analysis for an EIA to be undertaken in a relatively short period of time. Therefore, limitation of the time spent on site has been the key limiting factor to get a more detailed assessment on all environmental aspects surrounding the island. Given the seasonal climatic variations in Maldives and the differences in island dynamics and climate settings in individual islands such a short time frame is too little to assess selected aspects of the environment. This problem is compounded by the absence or extreme difficulty in obtaining grey literature (held in technical reports in some government officers) and of long-term studies in other parts of Maldives. Hence, most EIA's end up being based on an environmental snapshot of specific

point in time. However, experienced EIA specialists can deliver a close match to reality based on a number of similar assessments and expert judgments of the team. In this regard, the following gaps could be identified in information.

- Absence of long-term site specific or even regional data (at least 1- 2 years). Most critical data include current, wave and coastal dynamics.
- Absence of historical and long-term records on reef and lagoon environment.

These gaps are seriously considered in the assessment and care has been taken to address the issue in designing mitigation measures and the monitoring programme. Nonetheless, most of the assessments, including sea water quality, island dynamics, reef health, bathymetry were done in accordance with the TOR and other relevant information are collected through literature review to reflect closest match to existing environment of the island at the time of these assessments.

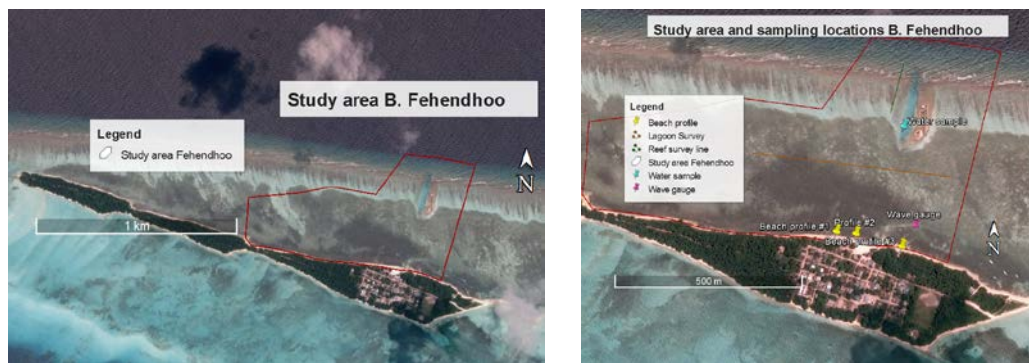


Figure 15: Mapping and survey area and magnified view of sampling locations of Fehendhoo (right)

## 7 EXISTING ENVIRONMENTAL CONDITIONS

### 7.1 OBJECTIVES

The purpose of this was to assess the existing environmental conditions of the coastal environment of the area proposed for island access and jetty construction in Fehendhoo Island. This is critical in assessing potential impacts and to determine the actual extent of damage should an unforeseen impact occur during the implementation phase. The current assessment is more focussed on locations planned for entrance channel dredging, jetty construction and associated activities.

### 7.2 METEOROLOGY AND CLIMATE

#### 7.2.1 Temperature

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

The cool periods lasts from October/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 is recorded to be around 29-30°C.

The annual average rainfall is approximately 1,950mm. As Maldives lies on the equator, Maldives receives plenty of sunshine throughout the year. Significant variation is observed in the climate between the northern and the southern atolls. The annual average rainfall in the southern atolls is higher than the northern atolls. In addition, greater extremes of temperature are also recorded in the southern atolls. On average southern atolls receive 2,704 hours of sunshine each year. *Table 3* provides a summary of key meteorological findings for Maldives.

*Table 3: Key meteorological features of the Maldives*

Parameter	Data
Average Rainfall	9.1mm/day in May, November 1.1mm/day in February
Maximum Rainfall	184.5mm/day in October 1994
Average air temperature	30.0 C in November 1973 31.7 C in April
Average wind speed	3.7 m/s in March 5.7 m/s in January, June
Maximum wind speed	W 31.9 m/s in November 1978
Average air pressure	1012 mb in December 1010 mb in April

Seawater surface temperatures (SST) are usually 28-29°C, but can reach 30 or more in shallow near shore areas. The Maldives are reported to experience a mixed layer of relatively saline water (36 ‰) from Arabian Sea which mixes with occasional intrusion of 34 ‰ waters from Bay of Bengal.

#### 7.2.2 Monsoons

The climate of Maldives is characterised by the monsoons of Indian Ocean. Monsoon wind reversal significantly affects weather patterns. Two monsoon seasons are observed in Maldives: the Northeast (*Iruvai*) and the Southwest (*Hulhangu*) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns. The southwest monsoon is the rainy season while the northeast monsoon is the dry season. The southwest monsoon occurs from May to September and the

northeast monsoon is from December to February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.

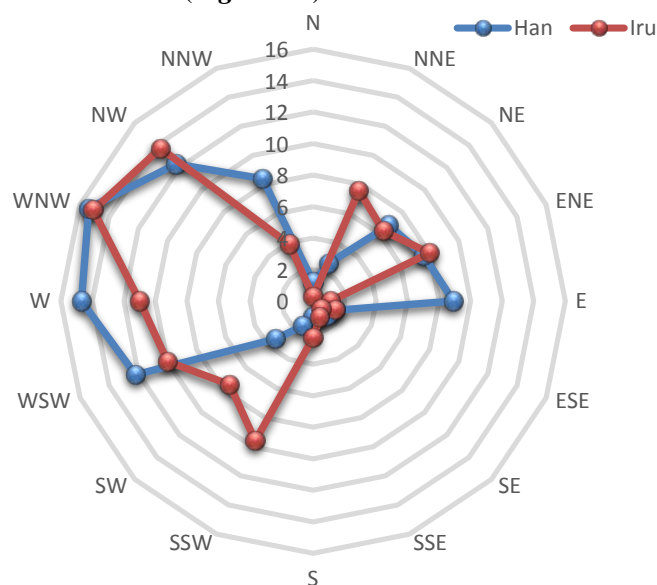
### 7.2.3 Winds

The wind conditions for the islands are dominated by monsoons. These winds approach with great constancy, primarily from the northeast and southwest directions. Some seasonal changes occur within this pattern, as a result of the relative position of the sun and the earth's surface. In general, these seasonal changes in the annual wind regime may be described as follows:

Strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to October. During stormy conditions gusts of up to 60 knots have been recorded at Malé (data from Maldives Meteorological Services).

Wind speed is usually higher in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms-1 for the period 1975 to 2001. Mean wind speed is highest during the months May and October in the central region. Wind analysis indicates that the monsoon is considerably stronger in central and northern region of Maldives compared to the south (Naseer, 2003). Annual averages shows that wind directions are mostly in W (32%) and E (11%) and NW (10%).

Wind data obtained from Hdh. Hanimaadhoo has been compared with the local conditions recorded in Irufushi Island 35 km south east of Fehendhoo to see the wind direction and speed variation that can take place over a considerable distance (*Figure 16*).



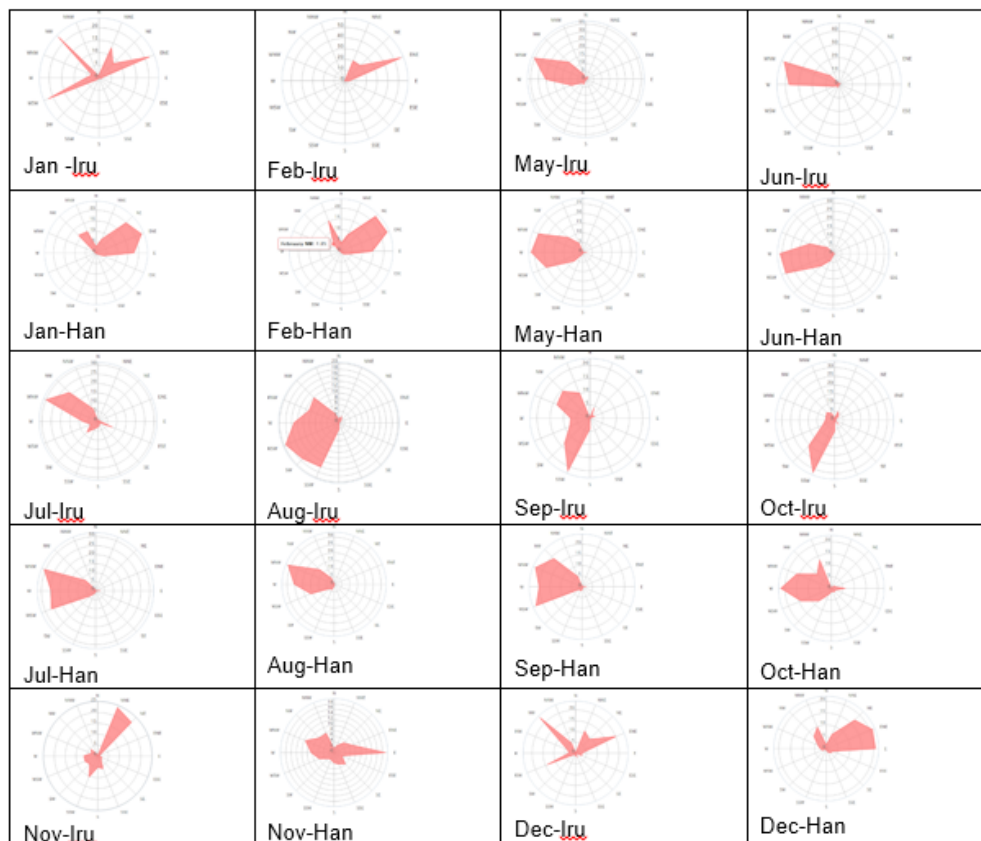
*Figure 16: Wind data analysis for N.Irufushi Island and HDh Hanimaadhoo Island; closest islands to B. Fehendhoo for which weather data is available*

The comparison showed significant variation between the wind records from Hanimaadhoo and Irufushi Island in dominant wind direction and speed.

Wind data comparison shows that 73% of the wind is blowing between SSW and NW directions in Irufushi while 69% of the wind direction is concentrated between SWS- NNW directions in Hanimaadhoo Island. Also 15% of the westerly wind has WNW direction in Irufushi while 15-12% of the dominating wind direction in Hanimaadhoo is W and WNW direction. Wind speed recoded from Iruvushi shows that the average wind speed is lower than Hanimaadhoo throughout the year

except in June and July, where wind speed is similar or very close between the two islands during this period.

**Figure 17** shows monthly local variations in wind characteristics between Hdh. Hanimaadhoo and N. Irufushi which is 104 km south east of B. Fehendhoo. Considering the distances between B. Fehendhoo and Hanimadhoo and Irufushi weather conditions is R. Irufushi is more likely to prevail in B. Fehendhoo.



*Figure 17: Monthly local variations in wind characteristics between Hdh. Hanimaadhoo and N. Irufushi (Han=Hanimaadhoo, Iru=Irufushi).*

Considering the predominant wind directions for both islands studied, the following can be generalised for the expected wind directions prevailing in B. Fehendhoo.

- a) January to July: Winds are primarily from the NW to ENE.
- b) August to October: Winds are mainly from the North West to SSW.
- c) November to December: Winds are primarily from the NNE to ENE.

Accordingly it is proposed to carry out the excavation activities during the period between the month of August and October considering the existing location of the harbour.

#### **7.2.4 Rainfall**

The wet season- southwest monsoon runs from mid-May to November. In this season Maldives experiences torrential rain. Central, Southern and Northern parts of the Maldives receive annual average rainfall of 1924.7mm, 2277.8mm, and 1786.4mm, respectively. The highest rainfall ever

recorded in the Maldives with in 24 hour period was recorded on 9th July 2002 at Kaadedhdhoo Meteorological Office and amounts to 219.8mm of rainfall. The fact that the Maldives is located at the equator, Maldives receives plentiful of sunshine throughout the year. On average Southern atolls (Gan) of the Maldives receives 2704.07 hours of sunshine each year. Furthermore, on average central (Hulhule) parts of the country receives 2784.51 hours of sunshine per year (MMS).

The probability that precipitation will be observed at Hulhule varies throughout the year. Precipitation is most likely around September 9, occurring in 57% of days. Precipitation is least likely around March 1, occurring in 18% of days (See Figure 18).

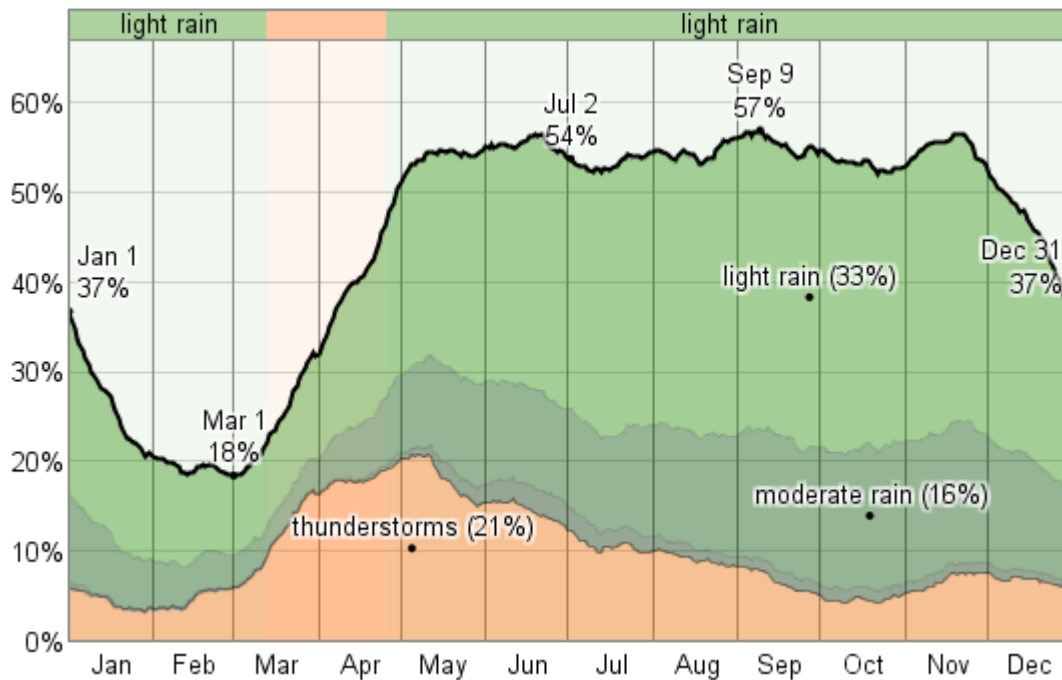


Figure 18: Probability of Participation at some point in the day for Hulhule, Maldives (weatherspark.com).

Wind and rain fall pattern expected for B. Fehendhoo show that the higher wind speed during southwest monsoon is coincided with higher precipitation. Since the dredging has been proposed to be undertaken during the period between September – December, planning for dredging should expect rough weather conditions that may occur during the period.

### 7.3 TIDES, CURRENTS AND WAVES

#### 7.3.1 Tides

Tides experienced in Maldives are mixed and semi-diurnal/diurnal. Typical spring and neap tidal ranges are approximately 1.0m and 0.3m, respectively. Maximum spring tidal range in the central atolls is approximately 1.1m. There is also a 0.2m seasonal fluctuation in regional mean sea level, with an increase of about 0.1m during February to April and a decrease of 0.1m during September to November. Like in most other atolls, semidiurnal tides are experienced in Baa Atoll - that is two high tides and two low tides a day. The tide varies from place to place, depending on the location and on the shape and depth of the basin, channels and reefs and also time of the year. Tidal variations in Maldives are presented in **Table 4**.

*Table 4: Tidal variation observed at Velaaanaa International Airport (Mean levels reported by the Maldives Meteorological Services).*

<b>Tide Level</b>	<b>Referred to MSL</b>
Highest Astronomical Tide (HAT)	+0.64
Mean Higher High Water (MHHW)	+0.34
Mean Lower High Water (MLHW)	+0.14
Mean Sea Level (MSL)	0.00
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MLLW)	-0.36
Lowest Astronomical Tide (LAT)	-0.56

Astronomical tides are related to the motion of the earth-moon-sun system, and have a range of periodicities. The highest astronomical tide was recorded as 0.64 m above the mean sea level and the lowest astronomical tide was recorded as 0.56 m below the mean sea level. Tidal variation of 1.2m from lowest to the highest tide levels were recorded in the country. Tidal fluctuations (rise and fall of tides) cause changes in current flow pattern around the island and bring subsequent changes in physical aspects of the shoreline. At low tide water movement is very slow, therefore low tide period is considered to be a good time to conduct dredging and reclamation work.

### **7.3.2 Currents**

Currents which affect the sea area around the Maldives are caused by one or more of the following systems:

- a) Oceanic currents
- b) Tidal currents
- c) Wind-induced currents
- d) Wave-induced currents

The oceanic currents flowing across the Maldives are notorious for their strength. The exposure of the Maldives to the vast Indian Ocean ensures that an immense body of water is constantly flowing across the plateau on which the atolls are built. In the Arabian Sea, as one gets closer to the equator, the prevailing winds become more and more indicative of the oceanic surface current. Thus, wind (especially during monsoons) can be a major factor affecting current velocity and direction, and currents can be of great strength (wind-induced currents). For example: currents in the channels near Malé have been recorded at 4 knots or more. Inside an atoll, current speeds are more settled. Oceanographic currents are driven by two monsoonal winds, namely the westerly and easterly wind. The westerly flowing current tend to dominate from January to March while the easterly currents dominate from May to November. The changes in current flow patterns occur in April and December. The current velocities are about 0.5 m/s, only in May values may increase to 0.8 m/s.

The vertical water movements associated with the rise and fall of the tide are accompanied by horizontal water motion termed tidal currents. These tidal currents have the same periodicities as the vertical oscillations, but tend to follow an elliptical path and do not normally involve simple to- and-from motion. Generally the tidal currents are eastward in flood and westward in ebb. Tidal currents, which flow according to the height of the tide, are generally not strong. There is a strong diurnal influence, which governs the tides in the Maldives, but in general the tidal range is less than 1m.

On a more local scale, especially on the reef flats, wave-induced currents (cross-shore and/or long-shore) also form an important factor affecting the current regime.

### 7.3.3 Waves

The swell and wind waves experienced on the Maldives are governed mainly by the two monsoon periods. Swell caused by cyclonic storms in the area west of Australia may also reach the southern atolls of the Maldives on occasion.

The swells and wind waves experienced by the Maldives are conditioned by the prevailing biannual monsoon wind directions, and are typically strongest during April – July in the south-west monsoon period. During this season, swells generated north of the equator with heights of 2-3m with periods of 18-20 seconds have been reported in the region.

The Maldives also experiences swells originating from cyclones and storm events occurring well south of the equator. It is reported that the swell waves from southeast to south-south-east occur due to strong storms in the southern hemisphere in the area west of Australia with direction towards the Maldives.

Local wave periods are generally in the range 2-4 seconds and are easily distinguished from the swell waves. Due to the shallow depths on the reef flat, significant wave breaking (energy dissipation) will take place at the reef's edge, reducing the wave height of waves, which pass over the reef flat. A general swell forecast and swell periods are available from various weather related websites. These forecasts are very general and it does not reflect local variations in wave period and wave height (*Figure 19*).

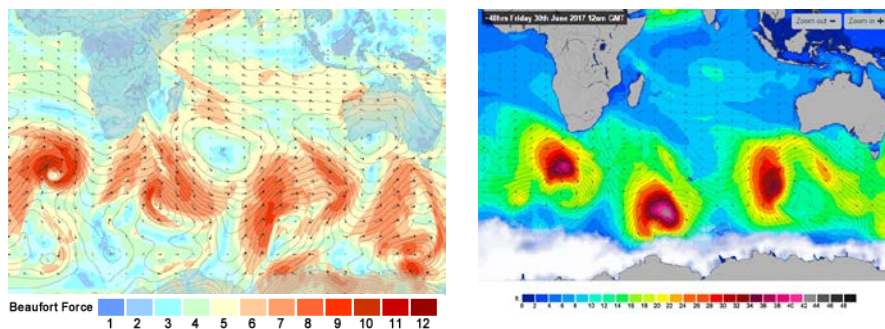


Figure 19: Generalised wave height (right) and wind direction and speed (left) prediction for the Indian Ocean on 28<sup>th</sup> June 2017 (<http://magicseaweed.com/>, accessed 28<sup>th</sup> June 2017)

As per the wind record observations Fehendhoo Island is subjected to average wind speed of 4-10 knots. Wind speed of 4-6 knots can generate small wavelets with glassy appearing crest without breaking. Wind speed of 7-10 knots can generate large white-capped fetch waves. Irufushi Island shows that wind speed around Fehendhoo and Irufushi area could reach 20-40 knots at gale, rain and thunderstorms periods. This means that Fehendhoo region has potential to generate medium-high waves with long wave lengths. The proposed site for development of island access and jetty is exposed to residual oceanic swells throughout the year. The western side experiences wind-induced regenerated waves originating from atoll lagoon during SW monsoon and residual waves approaching the reef from the western side.

Site specific wave measurement was conducted for 24 hours (8-9 June 2017) in the near-shore area on the northern side of Fehendhoo, by installing a RBR Solo wave gauge in the area proposed for island access and jetty construction (*Figure 20*). A total of 345 samples with a burst rate of 2Hz at 0.05 minutes interval were taken. General specification and wave statistics on the northern side of Fehendhoo is shown in *Table 5*. Wave height (*Figure 22*), average & 1/10 wave height, and wave energy is shown in *Figure 21*. The wave gauge was installed at 0.7m depth during the low tide the

water level was below the reach of the gauge therefore no records were obtained. Extreme peaks shown in the record is probably due to waves created by passing boats.



Figure 20: RBR Solo wave measurement device (Wave Gauge) deployed in shallow water

Table 5: Measured near-shore wave statistics, northern side B. Fehendhoo refer to for location of wave gauge

Channel	Value	Average	Std	Period m/s	unit
Pressure	10.21117	10.33946	0.099373		dbar
Sea pressure	0.078672	0.20696	0.099373		dbar
Depth	0.078188	0.205688	0.0987624		m
Tidal slope	-0.15089	-0.02267	0.0908128		m/hour
Significant wave height	0.021379	0.034689	0.0116822	4.578	m
Maximum wave height	0.033302	0.061227	0.0295683	1	m
Average wave height	0.012921	0.020912	0.0063952	2.629	m
1/10 wave height	0.029492	0.046271	0.0173311	6.611	m
Wave energy	0.850487	2.453689	1.9322808		J/m <sup>2</sup>

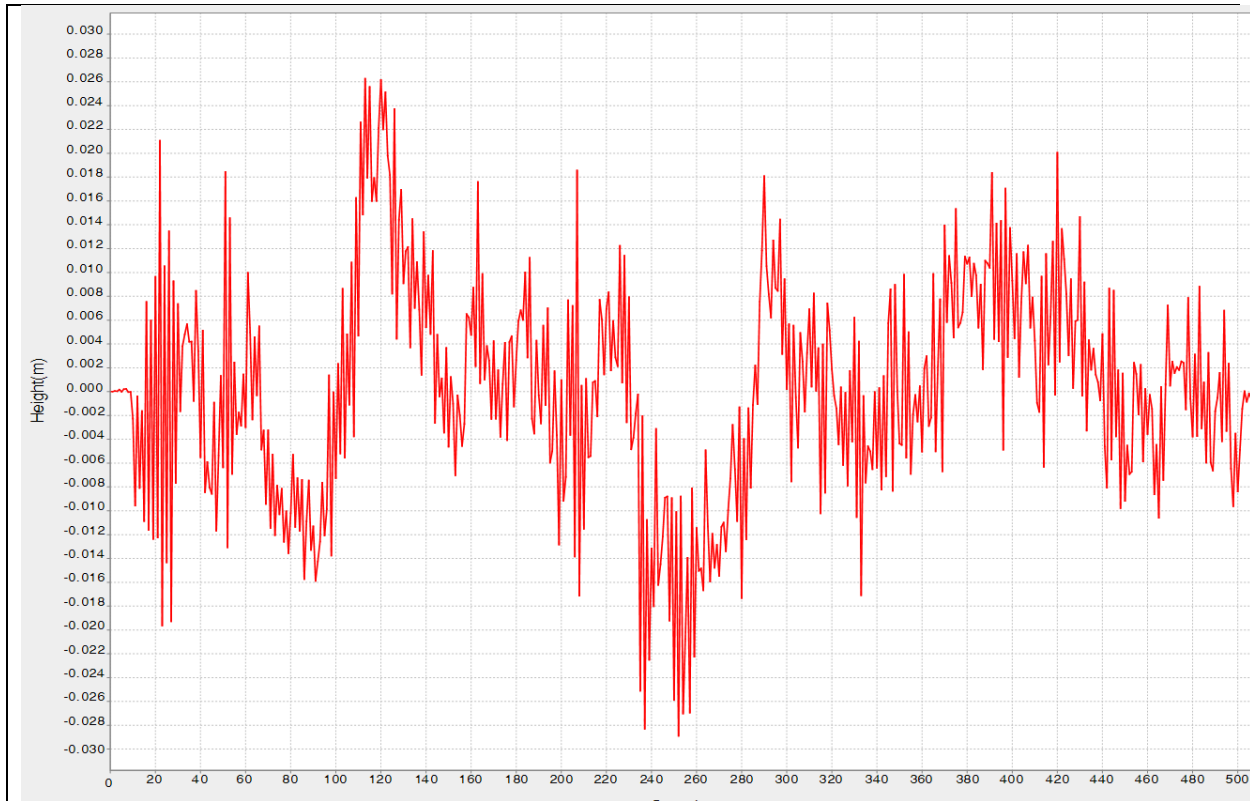


Figure 21: Near-shore wave heights northern side of Fehendhoo

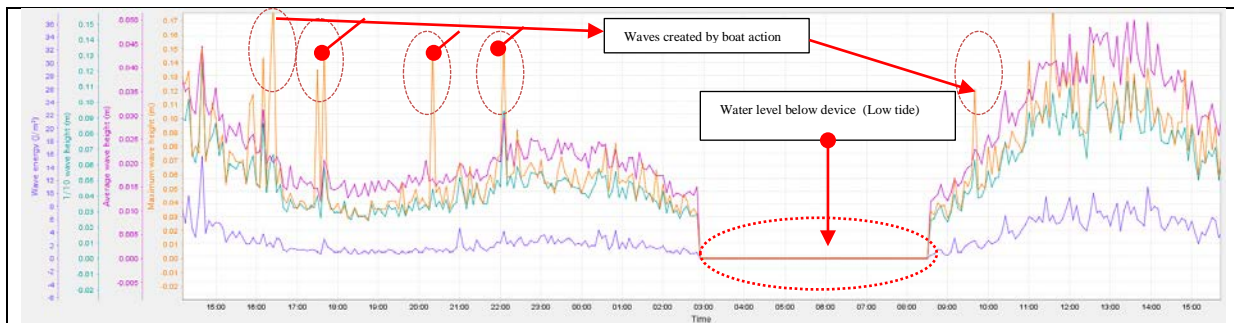


Figure 22: Average, 1/10 wave height and wave energy at Fehendhoo Northern side.

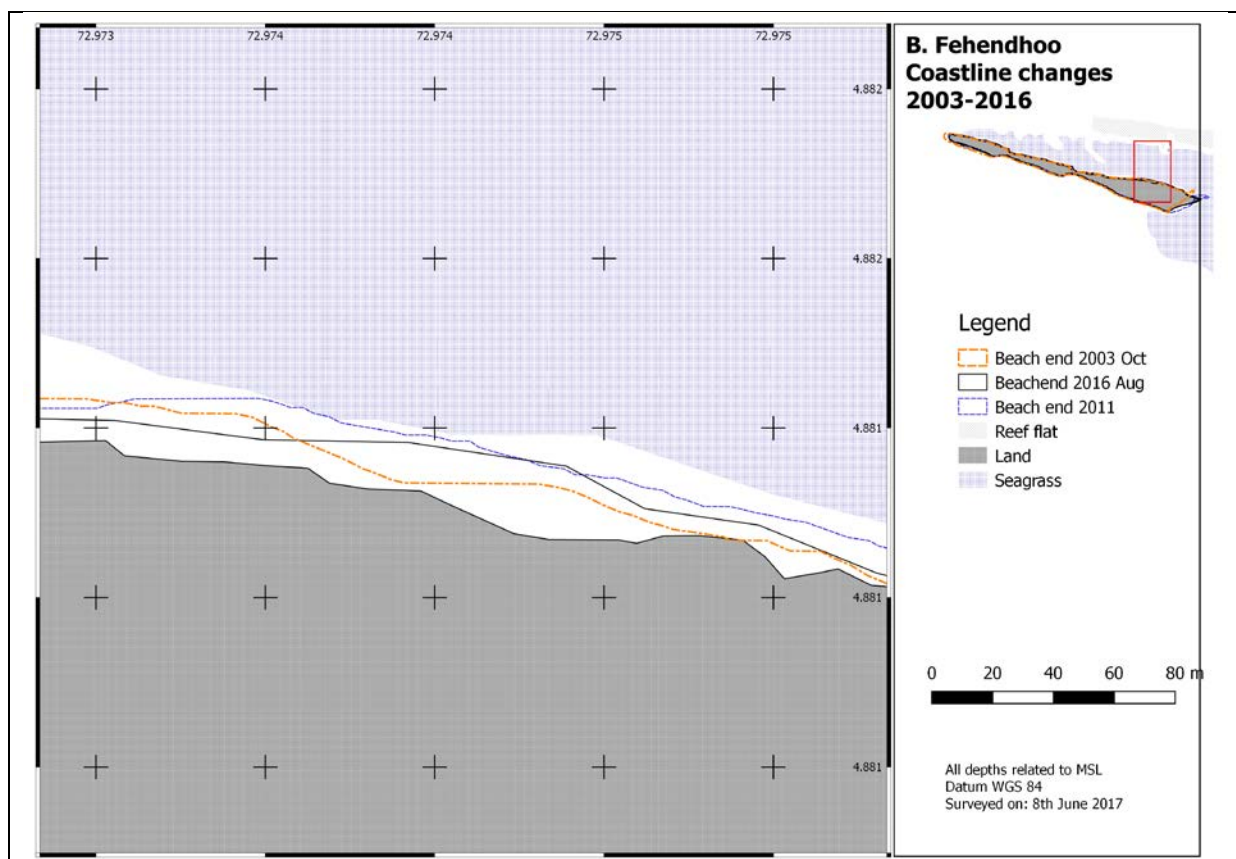
#### 7.4 ISLAND MORPHOLOGY AND COASTAL ENVIRONMENT

Historic Digital Globe, Google Earth images (2003-2016) and island surveys are comparatively evaluated using GIS technology to assess the beach dynamics of the island. Co-georeferencing technique of historical digital globe images taken in various months of the year was used to map the beach end of the island and overlaid to quantify long term changes in island area. Both seasonal and monthly changes in beach erosion, accretion and sediment dynamics were quantified using this technique.

Figure 23 shows beach end change and dynamics over time in the island and a magnified view of the designated beach area for the proposed development. A comprehensive sequence of digital globe images are available from 2003-2016. The result shows that the overall area of the island in 2003 and

2016 remained very close (27. ha in 2002 and 24. 4 ha in 2016). Sequence of images of also shows that there is no access channel in 2003. Also the seagrass cover on the northern side of Fehendhoo is significantly less than the present. The sequence of images shows a very dynamic sand spit at the eastern end of the island. The sand spit moves back and forth seasonally. Also the eastern end of the island shows significant accretion on in 2011 compared to 2003 and then the beach retreated 20-30m in 2016. The vegetation line of the island seems to have extended to occupy the accreted area and extended east wards (**Figure 24** and **Figure 25**).

Comparison of beach dynamic and the prevailing wind condition in B. Fehendhoo it could be presumed with great degree of certainty that at the end of SE monsoon the sand spit on the eastern end accretes and gets elongated eastwardly. Also on the northern side the beach gets wider at the onset of transition period and SW monsoon, beach formed on the southern side of the island becomes narrower with net shift in sediment eastward of the island. Beach width is more evenly distributed around the island during SW monsoon period.



*Figure 23: B. Fehendhoo beach dynamics (2003-2017) showing beach change, magnified view of the proposed project site.*

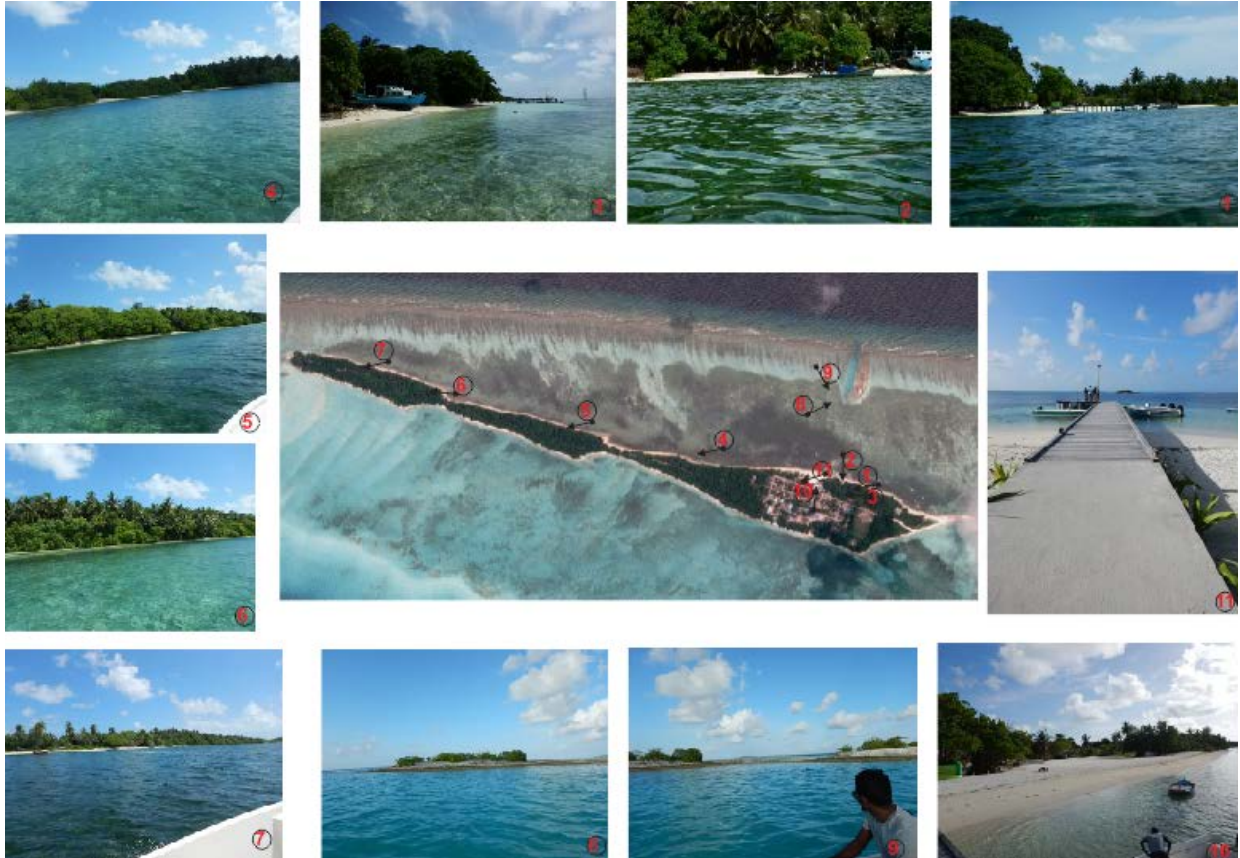


Figure 24: Beach condition around the island



Figure 25: Northern coast of Fehendhoo beach material consist of fine- medium grained white coral sand.

From the observed sediment movement pattern, island geomorphology, and beach dynamics it is very likely that if a channel is dredged on the proposed area will get filled with sand and become shallower in both SW and NE monsoon periods during the sediment transportation process. But the presence of seagrass on the northern side of the island will dampen the sediment deposition process. However there is a risk of seagrass invasion if the water around the area becomes stagnant and the flow movement is slow. Coastal erosion may take place on the northern side as the sediment that goes into the dredged area does not return back seasonally as has been the case in similar settings in the past. Therefore the natural process that has been taking place in Fehendhoo beach will be disrupted with the change in near shore hydrodynamics of the island. Therefore in order to sustain a long term access to the island, it seems the best option in Fehendhoo would be to extend the proposed jetty to midway between reef flat and the beach end to have “satellite harbour” as suggested in (Kench, 2009).

This will reduce the subsequent coastal erosion that may be associated with the proposed development.

Composition of beach material on the eastern coast of B. Fehendhoo is fairly uniform consists of medium to fine grained wahite sand indication low energy environment deposits **Figure 25**. Beach rock, which is considered to be an indicator of erosion, is exposed on the northern side of the island. The northern side is exposed to strong surf wave action throughout the year.

The beach profile #1 shows relatively high elevated island ridge followed by a gently sloping beach and the lagoon approximately 10m wide beaches slope consist of coral sand up to the beach toe. Beach profile #2 is taken from the location of the proposed jetty where there is a loose soft sandy dip. Because of the looseness of the sand this area is used by the island community as a playground of cultural games such as baiballaa Vaadhemun during the festivals such as Eid etc. The profile shows a very low area with big depression (dip) the is slightly higher than the dip with gently sloping 15m wide beach(**Figure 26**). Beach Profile #3 was taken from the location where the islanders have shown preference to locate the proposed jetty. The profile shows a relatively elevated ridge and narrow steep sloping 7m wide beach seagrass is slightly higher than beach toe. Beach material consists of medium to fine grained white coral sand, typical low energy deposits. Geographic coordinates of the beach profiles are given **Table 6** and the location is shown in **Figure 15**.

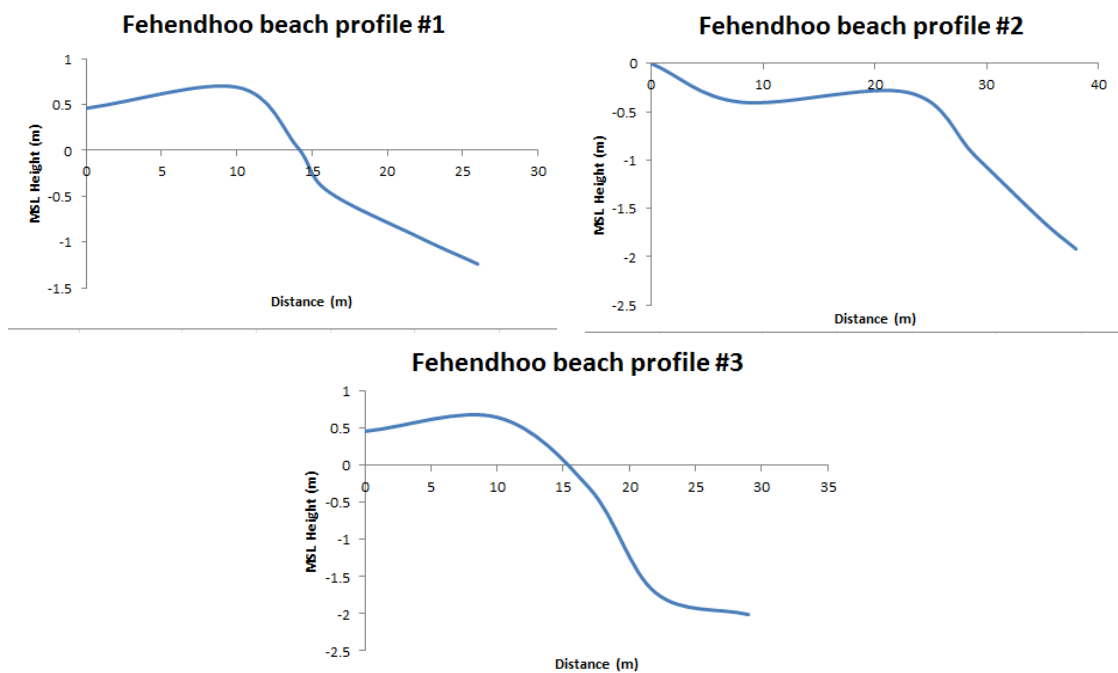


Figure 26: Beach profiles of B. Fehendhoo Island eastern side

Table 6: Geographic coordinates and bearing direction of beach profiles.

Profile No	Latitude	Longitude
Profile #1	4.881443°N	72.973507°E
Profile #2	4.881389°N	72.973975°
Profile #3	4.881071°N	72.975071°E

## 7.5 BATHYMETRY

Bathymetry of the area proposed for island access channel and jetty construction work in Fehendhoo was measured by using handheld 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. Depth of the reef-flat, and the lagoon on the northern side of Fehendhoo is fairly uniform ranged within 0.5 to -1.5m. The depth of the area proposed for access channel and jetty development in Fehendhoo is within the range of -0.6 to -1.5m **Figure 27**. The reef flat proposed for access channel and jetty development totally exposed at low tide and the lagoon area has a depth of -0.5to -0.9m at mid tide.

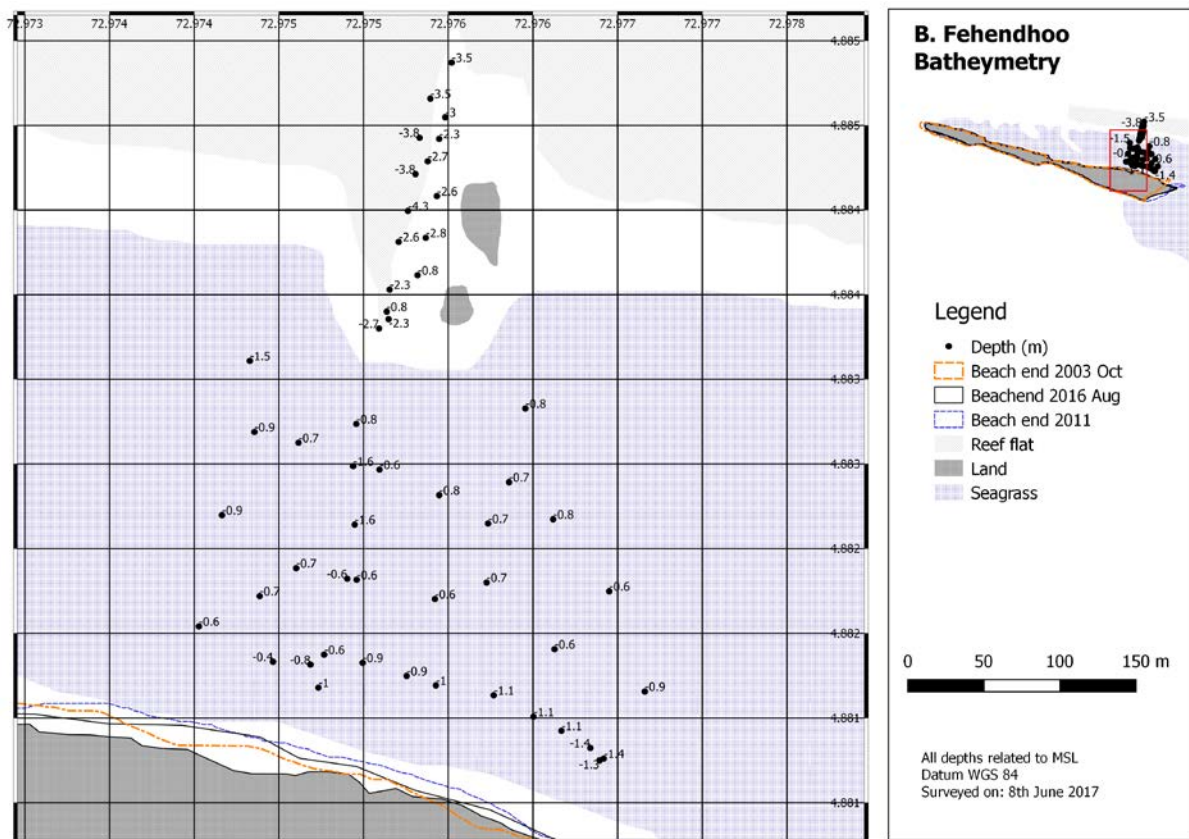


Figure 27: Bathymetry of the area proposed for access channel and jetty construction work in B. Fehendhoo.

## 7.6 MARINE ENVIRONMENT

The island of Fehendhoo is in the Goidhoo atoll of in the southern section of administrative Baa Atoll. The island is on the northern side of the oval shaped atoll. The long-axis of the atoll is oriented east-west tapering to east. There is a well-developed atoll reef going all round except for the natural opening into the atoll in the south. The islands of Goidhoo, Fehendhoo, Fulahdhoo, Innafushi and small islets all located on the atoll reef itself.

Fehendhoo is elongated and formed as three segments. The largest and the widest of the segment is on the eastern side where the community lives. Entry to the island from the northern side is through a man-made opening on the atoll-reef. Two little islets exist on the eastern side of the channel created from excavated material. Passed the entrance and up to the shoreline is the shallow reef flat with extensive seagrass meadow close to the shore.

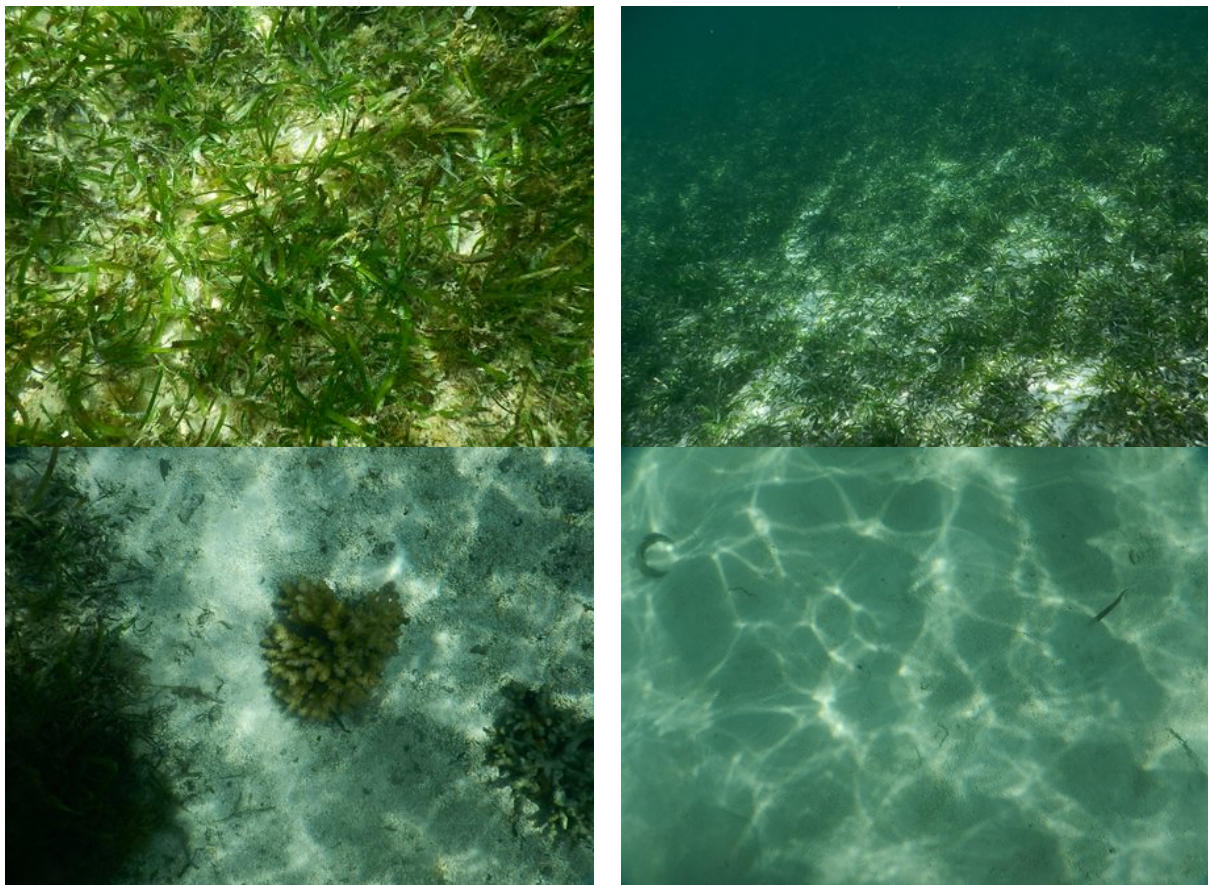
### 7.6.1 Methods and Approaches

Standard approaches were used to obtain qualitative and quantitative information on the existing marine environment. Timed swims were conducted along the channel area starting from the shallow to the reef edge. Fish in the visual field were noted. Since there is relatively poor visibility it is assumed that field width of the sampling belt would be 8 m wide. Swims were done for 10 mins. Two such swims were performed and the data were pooled to give an aggregated count to provide general feel of the faunal composition of the area.

Images were captured at third stroke of the swim maintaining the camera in a horizontal plan as much as possible. Using the images, a coarse relative cover of 5 categories (live coral, dead coral, soft coral, sand, rock/rubble) were estimated.

### 7.6.2 Substrate Cover

Image analysis was not done since most of the images show with extensive seagrass meadow, sandy bottom mixed rubble and sand (Figure 28).





*Figure 28: Images showing the substrate cover from the northern sections of the proposed development site*

## 7.7 MARINE WATER QUALITY

Water quality was assessed at the Male Water and Sewerage Company’s Water Quality Assurance Laboratory using standard methodologies. Marine water samples are collected and water quality has been assessed to establish the baseline condition for Fehendhoo Island during field visit . The results would be useful for future monitoring and comparison Table 8.

*Table 7: Baseline for Fehendhoo seawater*

Location	72.975169°, 4.883990°
pH	8.05
Salinity	34.09
Temperature	20.6
TDS	26000
Turbidity	0.258

## 7.1 PROTECTED AREAS

The Whole of Baa atoll is within the core area of Baa Atoll Biosphere reserve. There are 9 Core areas in the biosphere reserve. Two areas are within Goidhoo Atoll. They are Goidhoo Koaru and Mathifaru huraa on the south western natural entrance of the atoll (**Figure 29**). These two areas are far from the proposed project in Fehendhoo and unlikely to be impacted from the project activities.

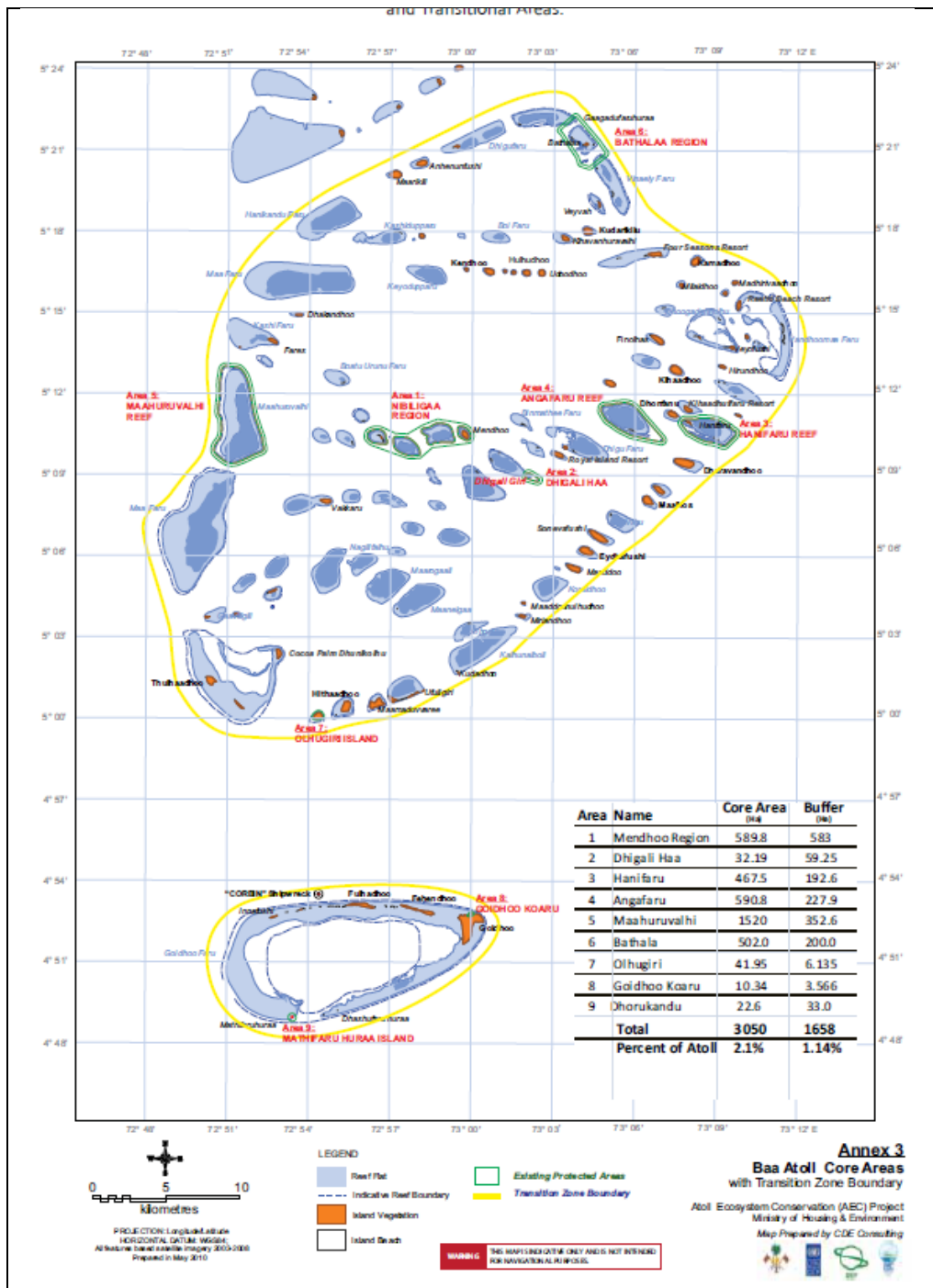


Figure 29: A map of Baa atoll including the Core Area, Buffer Zones and Transitional Areas.(source: Zonation System for the Baa Atoll Plan of Management, 2011)

## **8 SOCIO-ECONOMIC ENVIRONMENT**

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B. Fehendhoo is administratively located in Baa Atoll which is formed of geographically three atolls separated by narrow deep channels. The Central part of B. Atoll (Geographic Baa atoll) consist of most of the inhabited islands and the northern B. Atoll has only one inhabited island (Kudarikilu) and the Southern B atoll which is Goidhoo atoll has three inhabited islands. Fehendhoo is one of the three islands in Goidhoo Atoll. The two remaining islands are Goidhoo and Fulhadhoo islands. Registered population of the island is approximately 300 and the residing population of the island is 107 people only. Island accessibility is the main issues that need to be addressed as a matter of priority.

### **8.1 HISTORY**

French yacht Cobin is grounded on Goidoo atoll closer not far from Fehendhoo island. Famous historian Pyrad de Lavel travelled and came to Maldives onboard that yacht. The yacht ran aground on July 2nd 1902. The Cobin wreck is located on the shallow reef between Fulahdhoo and Innafushi island.

Historically Fhendhoo island used for lifetime banishment for criminal offender particularly men.

### **8.2 ECONOMY AND POPULATION**

Major economic activities of Fehendhoo are fisheries, ornamental fisheries, employment in resorts and other parts of the country and construction, trade and tourism. The island has two guest houses operational at present. The island has reasonable fleet of seagoing vessels approximately 20 boats and Dhoni are operating from the island. The island is famous for cultural and traditional activities such as Boduberu, Langiri, Maafathi neshun and Dhandijehun

### **8.3 EDUCATION**

Only nursery and Kindergarten level school are available and there is only no primary school in the island. Thirteen primary school students are going to school in Goidhoo island. They commute between Fehendhoo and Goidhoo in small dinghy's on daily basis. Ministry of Education compensates these children by given MVR 1,000 per month. Majority of the primary and secondary students from the island are studying either in Eydhafushi or in Male.

### **8.4 HEALTH**

Health services started in the island in October 2008, where a private house was rented by the government and service of family health officer and community health officer was provided for the island. Fulhadhoo Health Center was established on 23<sup>rd</sup> October 2010. A family health officer, community health officer and a nurse are providing the health services to the island. Simple and most basic health care such as dressing, wounds, diabetes test, IV and injection fluid for patients. Also some very basic medicines are available in the Health Centre.

## **8.5 ELECTRICITY**

Electricity for the island is provided by FENAKA. There are two generator sets each with 24 KVA capacity. Monthly average usage is 6,900 kWh and approximately 36,000 litre of diesel fuels is consumed to generate electricity in the island. (Maldives energy outlook MEE, 2013).

## **8.6 SOCIO-ECONOMIC BENEFITS**

Island access related developments such as harbours, access channel and jetties, in an inhabited island, are considered to be the most important infrastructure everyone craves for and viewed as a necessity for the development of the island to open up to the rest of the country. The primary objective of the project is to improve access to the island, and provide safe mooring facilities especially during rough weather. Access to the island is envisaged to bring economic growth and will improve living conditions of people of Fehendhoo Island. Therefore the proposed development project in B. Fehendhoo is an important infrastructure development project that will open-up the island and improve travel and trade to and from the island in all weather conditions.

## 9 STAKEHOLDER CONSULTATION

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The scoping meeting to determine the scope of the EIA report was held on 11<sup>th</sup> June 2017 at EPA. During the meeting the stakeholders were identified and the scope of the EIA report was determined. Methods used for stakeholder consultation include direct communication and interviews with locals in B. Fehendhoo, formal meeting such as the scoping meeting, island council and the people of B. Fehendhoo.

### 9.1 KEY STAKEHOLDER

As per the TOR the key stakeholders identified are

- 1- Fehendhoo islands council
- 2- People of Fehendhoo and boat owners island
- 3- Ministry of Housing and Infrastructure
- 4- Environmental Protection Agency

### 9.2 EIA SCOPING MEETING

EIA scoping meeting was held on the 11<sup>th</sup> June 2017. Most of the stakeholders were present in the meeting (meeting attendance is in Annex 4). The meeting was chaired by Ms. Fathimath Reema, Director EPA. The consultant gave a briefing on the proposed development of access channel and a jetty on the northern side of B. Fehendhoo and explained the difficulty the people of island is going through due to unavailability of proper access to the island.

The consultant visited the island prior to the scoping meeting on 8-10 June 2017 and shared his first-hand experience he had on access to the island. He also stressed about the importance of visiting the islands during the difficult time particularly during rough weather conditions to see and experience the difficulties people are facing in islands. He said that usually government authorities and agencies visit islands during calmer periods, so they have difficulties to assess and comprehend the real situation in the islands, no matter how hard people explain to them. He also pointed out some of the minor changes proposed by the island community for the concept design of island access and jetty. He pointed out that island council has prepared an approved EIA decision statement for a report prepared in 2016 for development of an access channel and mooring basin. The report was prepared by the council to secure funding for the project from private sources. The project could not start because they could not secure the promissory finance and when the EIA decision note expired last month, they have renewed and recently extended the validity of the approval for another year. As per the discussion in the meeting, the EIA was prepared for another project, even though same type of development, preparation of this EIA report will not be related with the existing decision note and it will be dealt separately.

The newly elected President of B. Fehendhoo council present in the meeting reiterated the view of the consultant and mentioned that the location of the proposed jetty is currently 50m west of the existing one and they want shift that 20m E of the existing jetty. The advantage of doing this, as he explained, is that access path will be straight. In the one proposed by the MHI the access path is slightly an angle (straight) to the mooring basin. They also requested to have slightly longer T section of the jetty (currently it is 20m long) and possible merging with the existing jetty to provide wider mooring area for the vessels.

MHI noted the concerns of the island council and mentioned that they have no objection of making minor changes to the proposed plan as long as the changes does not increase the project budget, or within the limitation of the budget. They also requested further discussions with the council straight after the scoping meeting.

In the light of the discussions held in the scoping meeting, EPA requested to provide options for alternative location for the access and jetty and recommend the preferred locations in the EIA report.

### **9.3 CONSULTATION WITH MHI**

Formal consultation with MHI, the proponent of the project, was held on the 11<sup>th</sup> June prior to the EIA scoping meeting to give a briefing about the main findings from the field visit to B. Fehendhoo and the consultations held with the people and island council. The consultant conveyed concerns of the people and council and their need to relocate the jetty 20m further east of the existing jetty also the consultant conveyed other adjustment to the jetty that has been requested by the people, such as the length, width and extent etc. As a matter of principle MHI expressed their willingness to accommodate people's need and had no objection to fulfill the people's request as long as the adjustment proposed is within the budgetary limitations. They also expressed that they will discuss the matter further with council to ensure that people's needs fulfilled.

### **9.4 CONSULTATION WITH FEHENDHOO COUNCIL AND PEOPLE**

Stakeholder consultation with Fehendhoo Island Council was held on the 8<sup>th</sup> June 2017 night 10:00 pm at the Council Office during the field visit (*Figure 30*). The meeting was held after the field visit and survey of the proposed location for island access and jetty construction in B. Fehendhoo and also exploration of the potential alternative locations. Representatives of the general public, a selected group of youth, senior citizens, former boat owners, present council members, women's committee etc., are invited for the meeting (*Figure 30*). A list of attendees to the meeting is given in Annex 4. Council president gave a brief introduction about the meeting. He briefed about the EIA report the council has prepared for the island access and mooring basing development project funding promised by a private investor in the island. The location of the access channel and the mooring basin proposed by the Government and the one proposed in the EIA report prepared by the island council is very similar except the size of the mooring basin in the latter is larger approximately 150x200ft. Then the consultant gave a briefing about the project and the proposed dimensions of the channel, small mooring area and the jetty. He also briefed about the EIA process and the role of stakeholder consultation in environment related decision making. The consultant explained the process and shared some of the observations from the field assessment. Then the floor was open for discussions. Main points of discussions are given below:

- 1- Shift the location of the jetty 20m east of existing jetty
- 2- Extend the T section of the jetty
- 3- The approach to the access channel is suggested to be wider should at least have 100ft
- 4- The length of the proposed jetty is too short
- 5- Ideally the people of the island are opting for a full-fledged harbour.
- 6- Dredged material will be used for replenishment of Kattihura (island at the entrance) and eroded areas on the northern side
- 7- To discuss with MHI on possibilities of merging the proposed harbour by the council and the access and jetty construction work by the Government to develop a larger mooring area and potential coastal protection (quawall) along the mooring basin.



Figure 30: Stakeholder consultation B. Fehendhoo Council members and representation of general public

## 9.5 MAIN CONCLUSION FROM THE STAKEHOLDER DISCUSSIONS

Everyone agrees that access to the island is the most urgent need for the island.

The most appropriate for the island would be to have a full-fledged harbour and access on the northern side of the island

Everyone agrees to relocate the proposed jetty 20m East of the existing Jetty

MHI has no objection for the proposed changes to project and expressed willingness to accommodate people's need and fulfill the people's request as long as the adjustment proposed is within the budgetary limitations.

Table 8: list of stakeholder consultation

Name	Designation/ address	Contact No
Mariyam Nuha		9126476
Ali Shaufan		7978432
Muhamad Iatheef		9880185
Yousuf Idhrees		7667524
Husen Fayaz	Ornamental Fisheries	7913906
Ibrahim Adam		7953766
Ibrahim Fazeel		7767351
Mohamed Aslam	DP island Council	7566835
Ahmed Saleem		7948788
Ahmed Akram		7902091
Aishath Waseema		7736055

Fathimath Zuhuraa		7609383
Ahmed Faisal		7944278
Dr. Mahmood Riyaz	Consultant	7890307
Ms. Nafha Aujaz	Environment Analyst (MHI)	7721554
Aroosha Hashim	Assit. Project Office (MHI)	
Mariyam Shidha	Snr Research Officer (EPA)	
Aiminath Mohamed	Asst. Project Officer (EPA)	
Moosa Naseem	Ffehenthoo Council (president)	
Ali Azhar	Asst. Director (Fulhadhoo Council)	
Ahmed Asif	Fulhadhoo Council (member)	7787992
Hussain Rashad	Fehenthoo Council (President)	
Fathimath Reema	Director (EPA)	
Hashim Nabeel	Project officer (EPA)	

## 10 POTENTIAL IMPACTS AND MITIGATION MEASURES

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This section of the report identifies the potential environmental impacts and possible issues that could arise from implementation of the access channel dredging works using an excavator. Their identification of potential impacts does not mean that they would necessarily occur or that they could not be successfully mitigated. The proposed other works include nourishment Kattihuraa and the eroded areas of northern coast, construction of jetty and deepening a small mooring basin.

Possible impacts arising from the construction and operation works are categorized into reversible and irreversible impacts. Reversible and irreversible impacts are further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken. Below are the impact categories

- **Negligible:** the impact is too small to be of any significance (Reversible)
- **Minor:** the impact is undesirable but accepted (Reversible)
- **Moderate:** the impact give rise to some concern but is likely to be tolerable in short-term, or will require value judgment as to its acceptability (May or may not be Reversible)
- **Major:** the impact is large scale giving rise to great concern; it should be considered unacceptable and requires significant change or halting of the project (Irreversible)

Severity of impact is assessed by reviewing the engineering design, detailed site plan as well as comparison of development with the existing environment and construction methodologies employed. Mitigation measures are derived based on the site specific assessment as well as similar project elsewhere in the Maldives. Impact identification matrix is provided in **Table 9**. Potential impacts and their mitigation measures and detail discussion is the following sections. Table 10 gives a summary of impacts their reversibility significance and cost.

### 10.1 IMPACT IDENTIFICATION

The following section describes in detail and discusses the main potential environmental impacts that have been identified and predicted for the proposed island access and jetty construction project in B. Fehendhoo. Identified potential impacts are divided into construction phase and operation phase environmental impacts.

### 10.2 LIMITATION/UNCERTAINTY OF IMPACT PREDICTION

The methods used to predict and evaluate the environmental impacts that may be associated with the cutting the access channel, dredging and jetty construction work on B. Fehendhoo Island may not be the most comprehensive. The main shortcoming of these methods is that impacts are predicted by reviewing the survey data collected during the field visits and information revealed by the designers engineers and the island community, therefore the assumptions have been made to predict the impacts which may or may not be accurate. Also, the data collected during the field visit is limited, which subsequently limits the overall understanding of even the short term environmental conditions (wave condition, currents, and littoral movement). Nonetheless, within the time limitation of EIA field data collection and report preparation the methods used are concise and provide a general overview as well as the range of impacts that can affect the environment.

Table 9: Impact Identification matrix

Impact	Construction phase Activities							Operational phase Activities
	Site setup and mobilization	Work force	Dredging	Jetty construction	Jetty base leveling	Equipment and vehicle maintenance	Demobilization	Operation of access Channels and jetty
Noise	-	-	-	-	-	X	-	-
Dusting -Air Quality	-	X	-	-	-	-	-	-
Coastal process	X	X	-	-	-	X	-	X
Terrestrial flora	X	X	X	X	X	X	X	X
Ground water	X	X	X	X	X	-	X	X
Soil	X	X	X	X	X	-	X	X
Marine water	-	X	-	-	-	-	-	-
Hydrodynamics	-	X	-	-	-	X	X	-
Marine habitat and Fauna	-	X	-	-	-	X	-	-
Natural hazard risk and safety	X	X	X	+	X	X	X	+
Employment	+	+	+	+	+	+	-	+

(-) Negative impact (+) Positive impact (X) no impact

### 10.3 IMPACTS AND MITIGATION MEASURES

Construction phase can be considered as the period in any developmental project that causes major direct and indirect long and short-term impacts on the environment. Anticipated potential direct and indirect environmental impacts from the proposed entrance channel and harbour dredging project in B. Fehendhoo is includes the following:

- Mobilization of Equipment and Labour
- Access channel dredging, and subsequent sedimentation
- Hydrodynamic regime
- Marine habitat and coastal environment
- Noise, Vibrations and Air Pollution
- Greenhouse Gas Emissions
- Equipment & vehicle maintenance

The following paragraphs will provide detailed impacts and mitigation measures during the construction phase of the project.

### **10.3.1 Impacts from Mobilization of Equipment and Labour**

Mobilization of dredging set Excavator and other heavy equipment and machinery needed for the project in B. Fehendhoo will have minor impact on the marine and coastal environment. The major impact of the mobilization would be aesthetic unattractiveness of the vehicles and equipment camp site. Disposal of minor amounts of hazardous waste and sewage may be a concern but use of the existing systems in the island, e.g., sewerage system, water and waste disposal mechanism will make the impact negligible

### **10.3.2 Dredging, beach nourishment and subsequent sedimentation**

Cutting and dredging of entrance channel and the small mooring area 40x30m on the northern side of B. Fehendhoo Island and jetty levelling work on the northern side of the island will have a direct irreversible negative impact to the ecological habitat in the area. Direct impact of this activity is limited to B. Fehendhoo reef only.

Given below are relevant impacts that should be considered:

1. Physical damage on live coral and loss of live coral: The effect of this would be in the immediate to medium term with the loss of substrate and its fauna.
2. Disturbance to the area during dredging activity: Release of sediments and potential loss of the faunal composition underneath sediment material will undoubtedly occur.
3. Dredging and jetty construction will change in the flow patterns. Tidal flows can be quite significant on the shallow reef flats and deeper areas will dampen the flow. The unexpected outcome may be erosion or accretion of the island or coastal areas.

In order to minimize the impact from sediment, dredging should be completed in shortest time possible. Dredging ought to take place during low tides or slack tides to minimize the release of sediment to the area.

## **10.4 IMPACTS TO CORAL REEF**

Cutting an access channel through the reef flat and dredging a mooring area will result in the short-term irreversible loss of the existing coral communities living on the affected area. It should be borne in mind that less than 5% of the corals on the reef-flat are presently comprised of live corals. The potentially negative impacts on the associated fish species are thought to be less severe given that there are adequate reef ecosystems on the island house reef to which they may retreat. Over time, recruits of the same coral species are likely to recolonize the fresh rock face of the now deepened plateau and a similar ecosystem would become established. Thus, the immediate negative impact of the proposed activities would be reversed over the long-term period.

Without turbidity barriers the currents and the wave action mostly generated by wind particularly during the North East monsoon in and around are would promote rapid sediment transport of turbid waters away from the immediate area and into the ocean. This will tend to reduce the time period over which undisturbed coral species would have to endure deteriorated water clarity.

The construction of jetty columns on the reef flat and the surrounding seagrass bed will have an impact on corals. The construction would kill some of the coral and seagrass that fall on the foot print of the structure however the installation of columns will create new hard substrate suitable for new coral growth.

Use of dredged material for jetty level and replenishment of Kattihuraa and northern coast will not result in having to lose any live corals as a direct result since the area consist only of dead corals and debris. Noticeable numbers of crabs have been observed to live the coral crevices. Since they are

highly mobile creatures they will move away from the disturbed area and retreat into elsewhere on the coast. However, sedentary organisms falling in the area of beach replenishment will be negatively impacted.

#### **10.4.1 Hydrodynamic regime**

The proposed development on the northern part of the island can influence the shoaling characters and wave energy in and around the eastern coast island through refraction and redirection of the incident waves. Cutting channel through the reef flat and dredging a mooring area will increase the depth within the area and is likely to change the overall hydrodynamic regime within B. Fehendhoo northern coast due to increase in water depth. Further, the dredged areas are likely to act as sediment sinks and therefore lagoon conditions may take a number of years to stabilize against the prevailing conditions.

Proposed activities on the northern coast of Fehendhoo will in general increase wave heights and reduces currents in and near the dredged areas. The following identifies these changes more specifically to their areas;

Dredging of the entrance channel will have a limited impact on the wave conditions. The mooring basin may slightly increase the amount that wave energy is expended on the northern shore, resulting in a slight increase in the amount of wave energy reaching the beach. This increase may bring more filling material into the deep areas result frequent maintenance dredging of the channel and the mooring area basin. However, it is proposed to have in place a beach monitoring program against the baseline set up for this study should an unforeseen changes occur to the beach especially during unusual weather.

The proposed construction jetty on pad-and-column structures will not obstruct the long shore currents transporting sediment around the island.

### **10.5 IMPACTS TO COASTAL MORPHOLOGY AND AESTHETIC VALUE**

The wave direction, wave height and current changes are expected to change the beach slightly under normal conditions but not significant. Fehendhoo eastern beach is highly dynamic and will respond to changes in the hydrodynamic conditions. The changes that are expected to occur due to the dredging will likely remain within.

The turbidity associated with the excavation will probably be restricted largely to the bottom, and the immediate vicinity of the dredging area. A plume will still be visible around the dredging operation. It is possible that the visual impact will be moderately severe and localised. The overall significance of this impact will vary from person to person, but on a precautionary basis is regarded as being moderate. Whilst there is a lack of residential island near the dredging site and people will be not be able to see the equipment and the dredging area and associated plume could be not become visible to the people.

### **10.6 DREDGED SAND DISPOSAL**

The dredged material is proposed to be used for backfilling the jetty base, replenish Kattihura and the excess will be used to replenish the eroded areas on the northern side of the island. With supply of sand to the eroded coast beach will be created. Trucks will carry dredged materials on the existing road network on the island. The material to the site will be supplied by trucks. 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 dissolved oxygen levels, and visual impacts.

Dredged material disposal typically has a short term (several hours to days) impact on the water column following discharges of solids and solutes during the transportation process and excavations. The greatest proportion of dredged material consists of negatively 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 descent.

## **10.7 NOISE, VIBRATIONS AND AIR POLLUTION**

During the mobilisation of equipment and operation of heavy machinery for dredging and beach nourishment work, it is anticipated that significant noise will be generated. Minor ground vibration is anticipated during movement of excavators and heavy vehicles. Furthermore, noise vibrations may alter species behaviour. In addition, dust and emissions from vehicle and machinery exhausts will degrade the air quality. However, these impacts will be short term and can be mitigated to avoid nuisance to the locals in the island. With proper mitigation measures, it is unlikely that noise, vibration and air pollution impacts will cause long term effects such as human health risks leading to increased public and private health costs.

### **10.7.1 Equipment & vehicle maintenance**

All sorts of motorized equipment, requiring fuel, lubrication and maintenance will be used on the site. Many will be fitted with lead batteries. Therefore the potential accidental spillage and contamination of the soil and the sea by hydrocarbons as well as the careless disposal of batteries exists during the construction period.

## **10.8 POTENTIAL POSTIVE IMPACTS**

Potential positive impact of the project would be on creation of employment during construction period particularly for locals. The project will have a noticeable impact economically to B. Fehendhoo Island as it will resolve the difficulties faced by the islanders to access the island and safe mooring areas for vessels and reduce the transportation cost through smooth access and operations of boats and launches and minimize damage by accidental grounding to the boat caused by shallow water depth of the area. This in turn will contribute to overall economic growth of B. Fehendhoo and islands in the region.

1. Improved island accessibility opening of the island
2. better income generating opportunities
3. Better employment opportunities in the region
4. Improved navigational safety and transport at local level
5. Improved regional economy as a result of the improved facility

## **10.9 NEGATIVE IMPACTS**

- 1- Loss of coral head, sessile benthic biota and seagrass at lagoon and its entrance channels and mooring area basin in the reef flat.
- 2- Short-term sedimentation and turbidity over coral along harbour due to suspension and dispersal of fine sediments.
- 3- Possible impacts on pelagic environment due to suspended sediments.
- 4- Impaired visual/seascape impacts from the presence of the dredging equipment.
- 5- Increased noise levels in the area due to dredging operations.

## 10.10 IMPACT MITIGATION MEASURES

Table 10 below lists the potential impacts identified above describes the corresponding mitigation measures that should be put in place during implementation of the proposed dredging works at B. Fehendhoo. In summary the impact mitigation measures proposed should entail:

- 1) Good dredging practice to minimise sediment suspension and dispersal at the dredging sites.
- 2) Coinciding the dredging activity for the period September and December is important to avoid the rough weather condition of the SW Monsoon and to force the plume to move away from the house into the ocean.
- 3) Deployment of a turbidity barrier across the beaches and the work site as appropriate depending on location and currents.
- 4) Environmental monitoring of the project to ensure use of turbidity barriers, disposal of dredged material only at approved sites, and turbidity level do not exceed the local standards.
- 5) The contractor shall be mandated that appropriate turbidity barriers be deployed at all times during dredging, disposal and construction to ring each and all of the dredging, construction and water disposal activities. The type of barriers selected should take into consideration the shallowness of the area and the prevailing wave and current conditions. The extent of each area ringed should also be carefully determined in order to maximise the effectiveness of the barrier, especially during the proposed dredging activities.
- 6) Blasting shall be avoided.
- 7) Sand-bag bund shall be constructed associated with the use of the dredged material for the replenishment of eroded beach area on the east coast.
- 8) During the project activities and operational phases, all efforts should be made to prevent the intentional or accidental spill of oil, waste oil and hazardous materials release into the environment which could lead to further damage to the marine environment.
- 9) Contractor should take steps to ensure that there is no dumping of oily waste from vehicles or land-based activities related to the project. Careful consideration should be given to the requirements for storage and appropriate disposal of waste oil.

## 10.11 MITIGATION COST

The mitigation measures associated with significant costs, beyond those of dredge equipment rental and deployment, and good dredging practice, is identified below in Table 11 along with the major cost elements. Costs are based on the estimation of the magnitude activity

*Table 10: Significant impacts, mitigation measures and associated costs*

ACTIVITY	IMPACTS	IMPACT PREDICTION			MITIGATION MESURES	Mitigation cost (MVR)
		Magnitude	Reversibility	Duration		
1. Cutting entrance channel Excavation of channel and mooring areas	Loss of sessile benthic biota and seagrass	L	R	M		
	Modification of current and wave pattern	L	R	S		
	Sedimentation from dredging	M	R	M	Deploy turbidity barriers to prevent sedimentation on seagrass and coral colonies Dredging should be	10,000 cost of barrier

					completed in shortest time possible. Dredging during low tides or slack tides	
	Attenuation of light in water column	L	R	S	Apply above measures to control sediment dispersion	
	Increased ambient noise level	L	R	S	All construction work that produces significant noise should be undertaken during day time to minimize noise pollution. Provide ear muffs for construction workers to wear when using machinery that produce significant noise.	1,000 cost of earmuffs
2. Dredged material disposal	Increased ground water salinity	L	R	S	Leave the material in rain prior to disposal	
	Leakage of sediments during transport to disposal site	L	R	S	Containing the sediment in the truck to minimize leakage	2,000 cost of leak proof rubber sheet
3. Social impact: the people	provide island accessibility	H	R	M	Major positive impact of the project	
	Employment	M	R	S	Short term employment	

**Key**

**Magnitude**

H=High

M=Medium

L=Low

**Reversibility**

I=Reversible

R=Reversible

**Duration**

L= Long Term (Over 10 years)

M=Medium term (Over 5 years)

S=Short term (Below 5 years)

## **11 ALTERNATIVES**

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### **11.1 NO DEVELOPMENT OPTION**

Not implementing the proposed island access channel small mooring area and the jetty implies that the local population of Fehendhoo will not be able to access to the island easily. The locals face considerable challenges as to basic need of accessing the island. There is no alternative to achieving socio-economic development without proper safe access to the island and developing an access channel mooring area and jetty to access the island is considered to be a necessity.

It is believed that a number of environmental impacts will be generated from the proposed development access channel, small mooring area and jetty in Fehendhoo. Although no impacts on the environment will be associated if the proposed development does not go ahead, the development will improve and ensure accessibility to the island throughout the year in all weather conditions. The project will open up more economic opportunities and contribute directly and indirectly to health and well-being of the community.

Given the range of benefits that the proposed development will bring the project has been considered important and “No-Development” Option has been considered not favorable for the proposed development and decided to go ahead with the proposed development.

Development can take place only within the limits of the environment and the society. Hence, the aim is to ensure that all project activities are undertaken without any adverse long term irreversible environmental damages that cannot be mitigated. Preferred alternatives discussed below has been selected based on the above broad development concept.

### **11.2 DEVELOPMENT OPTIONS**

#### **11.2.1 Relocation of Jetty**

The main reason for relocating the island access is that the proposed location is to keep the jetty closer to the existing ferry terminal and save the soft sandy area west of the existing jetty where the new jetty proposed to be constructed (*Figure 12*). The main advantage of the proposed new location is more appropriate and closer to the relevant infrastructures.

MHI in principal have agreed to relocate the proposed island access to the new location during the scoping meeting.

#### **11.2.2 Existing environment of the proposed new location for island access**

Existing environment of the proposed new location for jetty is similar to the old location ( *Figure 13*)

##### **1.1.1 Mitigation measures for the preferred alternative**

The mitigation measure for this option would same as the mitigation measure analysed for the project in the relevant section.

## 12 ENVIRONMENTAL MONITORING PLAN

Environmental monitoring is essential to ensure that post-construction and operational impacts are known and eliminated in a timely manner. Dealing with impacts earlier would save money and also help planning and operationalize the process.

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project are included in the monitoring plan. These include sea water (turbidity, sulphate, phosphates, nitrates, and BOD), sediment deposition. Monitoring the shoreline changes that may occur due to the medium to long-term impacts from the changes in coastal processes.

The purpose of environmental monitoring plan (EMP) is to monitor or control the environmental effects of the proposed project. It should be based on compliance, verification, feedback, and know-how. It is therefore suggested that the Contractor carries out the EMP. The EMP should be able to provide responses to the following three questions:

- a) Why is monitoring being conducted?
- b) What specifically is being carried out?
- c) How are the data and information to be used in planning and decision-making?

**Table 11, Table 12** and **Table 13** shows the details of the proposed monitoring aspects including the monitoring parameters, indicators, baseline, proposed methods, frequency and estimated costs

*Table 11: Monitoring of the shoreline, beach profiles and coastal environment*

Parameter	Indicators	Baseline Reference Values	Method Technique	Frequency	Estimated cost in USD
Shorelines (high / low tides)	Beach morphology	Baseline to be re-established immediately after construction is complete	Differential GPS	Bi-annually in the first two years after completing the dredging activities.	100/ trip
Beach profiles	coastal changes	Requires to re-establish the baseline following the construction	Beach profile surveys	Bi-annually in the first two years after completing the dredging activities.	100 / trip
Currents	Nearshore currents	Baseline to be collected immediately constructions are over, especially on Northern side	Drogue survey	Bi-annually in the first two years after completing the dredging activities.	100/trip

Table 12: Monitoring of the reef environment

Parameter / Method	Frequency of Monitoring	Purpose	Estimated cost (USD)
Benthic cover by major life forms (live, dead, rock rubble and sand)	Once six months after dredging	Indicative of the changes in the live coral cover	200/trip
Fish population / visual census	Once six months after dredging	To assess broad scale change in the ecological status of the coral reefs (increase / decrease of herbivores, etc.)	

Table 13: Monitoring of the sea water quality

Type	Parameters	Locations	Frequency	Estimated cost (USD)
<i>In situ</i> monitoring / sampling and testing from a laboratory	Dissolved oxygen Turbidity (NTU) Nitrates Sulphates TDS	All locations marked	Bi-annual	200/ set of tests

## 12.1 MONITORING COSTS

It is understood that costs of monitoring be borne by the proponent. It is also understood the mitigation measures would be accommodated in the contract costs. A commitment letter confirming compliance on mitigation measures is given in Annex 6.

## 12.2 MONITORING REPORT

Based on the data collected, a detailed monitoring report will be compiled annually and submitted to the relevant government authorities for compliance. The report will include methodologies and protocols followed for data collection and analysis, quality control measures and indicate the uncertainties. The report would also include remedial measures deemed necessary

Table 14: A tentative schedule for submission of EIA monitoring report to EPA

	2017	2018				2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Monitoring report, Operational Phase													

## 13 CONCLUSIONS

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This EIA has been carried out on the basis that it is necessary to carry out the reef entrance cutting, channel and mooring basin dredging and T- jetty construction work in B. Fehendhoo and to maintain the required depth to provide safe navigation, access accommodate vessels travelling to the island. The environmental impact assessment study shows there are two main activities that would cause minor to moderate negative environmental impacts. Those, in order of minor to moderate impact, are:

1. Channel and mooring basing dredging
2. Jetty construction and backfilling

Of these a long term impact would be from dredging and beach backfilling of jetty area and nourishment of eroded beach on the northern side of the island. Potential erosion/accretion and adjustment of the existing beach to create a new equilibrium with the surrounding environmental conditions are likely to extend to medium to long term. These impacts would be cumulative occurring over long period of time and so can be managed through proper monitoring and addressing them in a timely manner. Based on the scale of dredging and beach nourishment work projects that is taking place in Maldives, impacts associated with the proposed dredging activity is insignificant. The positive socio economic impacts from the proposed development outweigh the temporary negative impacts of dredging.

The study has suggested alternative locations for the jetty and recommended shifting 20m east of the existing jetty. Even though there is no significant impact from this project the report has come-up with an extensive monitoring programme that will keep on monitoring coastal and marine environmental changes associated with the development to make necessary adjustment based on the findings of various measured environmental parameters suggested in the monitoring plan.

Therefore, on the basis of this environmental impact assessment study and the impact mitigation measures in the report will be duly implemented it is concluded that the benefits of island access development project in B. Fehendhoo northern coast will substantially outweigh its imposition on the environment.

## 14 REFERENCES

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## **15 ANNEXURES**

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Annex 1: Approved Terms of Reference (ToR) for the Project

Annex 2: Approved site plan

Annex 3: Jetty construction detail plans

Annex 4: List of participants in council meeting and scoping meeting

Annex 5: Seawater quality test

Annex 5: Commitment letter from the proponent

Annex 6: Letter from B. Fehendhoo Atoll Council

Annex 8: Details of consultant's contributions to the report

Annex-9 Bathymetry





No: 203-EIARES/138/2017/87

## Draft Terms of Reference for Environmental Impact Assessment for Jetty construction and island access project, B Fehendhoo South Maalhosmadulu Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on 11/06/2017 for undertaking the EIA of the proposed Jetty development a Project at B. Fehendhoo South Maalhosmadulu Atoll. The proponent if 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 proposed artificial beach development project and, if applicable, the background of the project and the tasks already completed. Clearly identify the rationale and objectives to enable the formulation of alternatives. Define the arrangements required for the environmental assessment and how coordination between other consultants, project engineers, contractors and government institutions will be carried out.

2. **Study area** - Submit a minimum A3 size scaled plan with indications of the proposed infrastructure. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location, size and important elements of the proposed jetty development project. The study area should include adjacent or remote areas, such as relevant developments and nearby environmentally sensitive sites ( e.g. coral reef, sea grass, marine protected areas, special birds site, sensitive species nursery and feeding grounds). Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.

3- **Scope of work**- Identify and number tasks of the project including site preparation, construction and decommissioning phases. The following tasks shall be completed:

**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 following should be provided (all inputs and outputs related to the proposed activities shall be justified):

The main activities of the proposed development are:

- Construction of 31.15m long T-jetty with 4m width walkway.
- Ground levelling the jetty area.
- Dredging near Jetty area 40m width 38m length area.
- Dredging new entrance channel 24m width & 417m length
- Measures to protect environmental values during construction and operation phase;

- Project management (include scheduling and duration of the project and life span of facilities; communication of construction details, progress, target dates, construction/operation/closure of labour camps, access to site, safety, equipment and material storage, fuel management and emergency plan in case of spills)

jetties, and lagoon area:

- Justification for the selection of these locations;
- Labour requirements and (local) labour availability;
- Housing of temporary labour, and
- Emergency plan in case of spills (diesel, grease, oil)

The EIA report should investigate possibilities for alternatives:

- Operation and positioning options;
- Alternative locations: have these been considered and if so, give arguments why these alternatives have not been selected, and

Power water, and sewerage:

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

Waste management:

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

Ground levelling and beach nourishment activities:

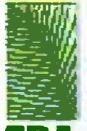
- Access channel and mooring area size, location, including oceanographic justification and map;
- Quantity of dredged material;
- Beach nourishment details including locations and width
- Ground levelling work

**Task 2. Description of the environment** – Assemble, evaluate and present the environmental baseline study/data regarding the study area and timing of the project (e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they will be usefully applied to future monitoring. 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 for posterior data comparison. Information should be divided into the categories shown below:

Climate

- Temperature, rainfall, wind, waves, evaporation rates (including extreme conditions)
- Risk of hurricanes and storm surges;



**Geology and geomorphology**

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

**Hydrography/hydrodynamics (use maps)**

- Tidal ranges and tidal currents;
- Wave climate and wave induced currents;
- Wind induced (seasonal) currents;
- Sea water quality measuring these parameters: temperature, pH, salinity and turbidity.

**Ecology**

- Identify marine protected areas (MPAs) and sensitive sites such as breeding or nursery grounds for protected or endangered species (e.g. coral reefs, spawning fish sites, nurseries for crustaceans or specific sites for marine mammals, sharks and turtles). Include description of commercial species, species with potential to become nuisances or vector.
- Benthic and fish community monitoring around the impact area ;

**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 (e.g. fisheries, home gardening, fish processing, employment in industry, government);
- Seasonal changes in activities;
- Land use planning, natural resource use and zoning of activities at sea;
- Accessibility and (public) transport to other island;
- Services quality and accessibility (water supply, waste/water disposal, energy supply, social services like health and education);
- Community needs;
- Sites with historical or cultural interest or sacred places (mosques, graveyard).

**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. Include permits and approvals in the EIA document.

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



**Impacts on the natural environment**

- Impacts on marine habitats including damages to coral reefs and seagrass communities, fish stocks, protected areas and protected species;
- Changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology;
- Temporary sediment dispersal in water column (turbidity at the dredging site, beach nourishment areas and jetty construction areas), possibly resulting in changes in visibility, smothering of coral reefs and benthic communities and affecting fish and shellfish etc.;
- Impacts on landscape integrity/scenery.

**Impacts on the socio-economic environment**

- Impacts on employment and income, potential for local people to have (temporary or long term) job opportunities (and what kind) in the execution of the works;
- Disturbance to local natural resource users such as fishing areas, other tourism ventures;
- Impacts to nearby industrial establishments;
- Impact equity (economic activities, employment, income);

**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.

**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”. The report should highlight how the location was determined. All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

**Task 6. Mitigation and management of negative impacts** – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures. Mitigation measures to avoid or compensate habitat destruction, e.g. temporal sediment control structures, coastal protection structures to reduce erosion. Measures for both construction and operation phase shall be identified. Cost the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. 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;
- Erosion and accretion changes;
- Temporal sedimentation rates on nearby coral reefs, benthic system and seagrass beds;
- Condition of the sensitive ecosystems and marine resources;
- Environmentally sound removal of dredging and other equipment including construction materials, and
- Employment of available local labour force.


**Task 8. Stakeholder consultation, Inter-Agency coordination and public/NGO participation) –** Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders, government authorities such as Ministry Environment and Energy, Ministry of Housing and Infrastructure, Island and Atoll Council, local community, government agencies, engineers/designers, development managers and members of the general public. The EIA report should include a list of people/groups consulted, their contact details and summary of the major outcomes.

**Presentation-** The environmental impact assessment report, 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 for 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 6 months from the date of this Term of Reference.

18 June 2017






INFRASTRUCTURE DEPARTMENT  
MINISTRY OF HOUSING AND INFRASTRUCTURE

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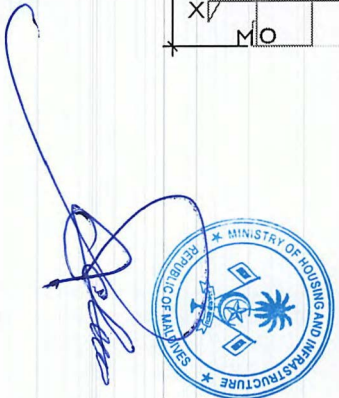
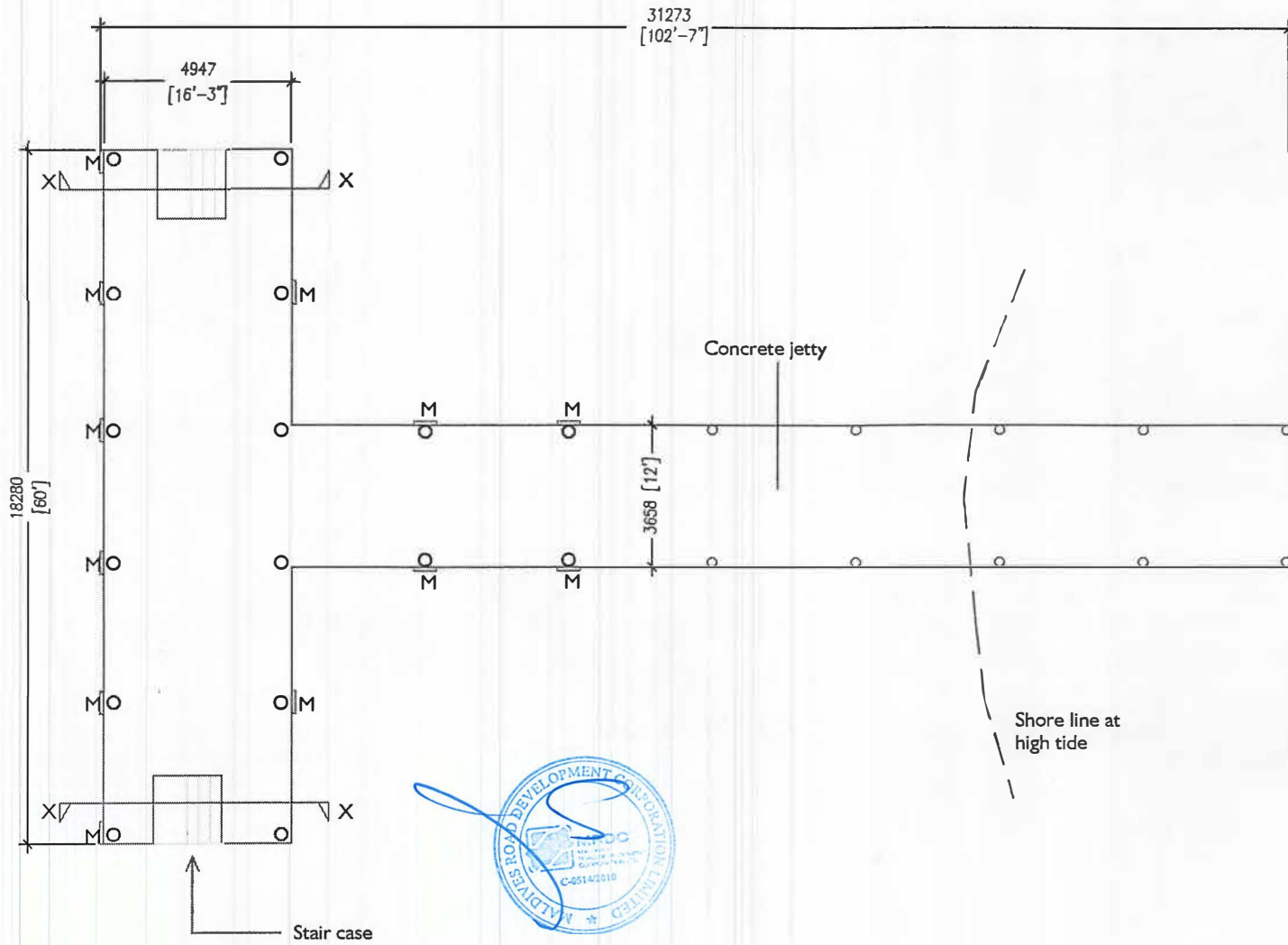
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REPUBLIC OF MALDIVES  
TEL:323034, 323474, FAX:328300

# JETTY LAYOUT



INFRASTRUCTURE DEPARTMENT  
MINISTRY OF HOUSING AND INFRASTRUCTURE

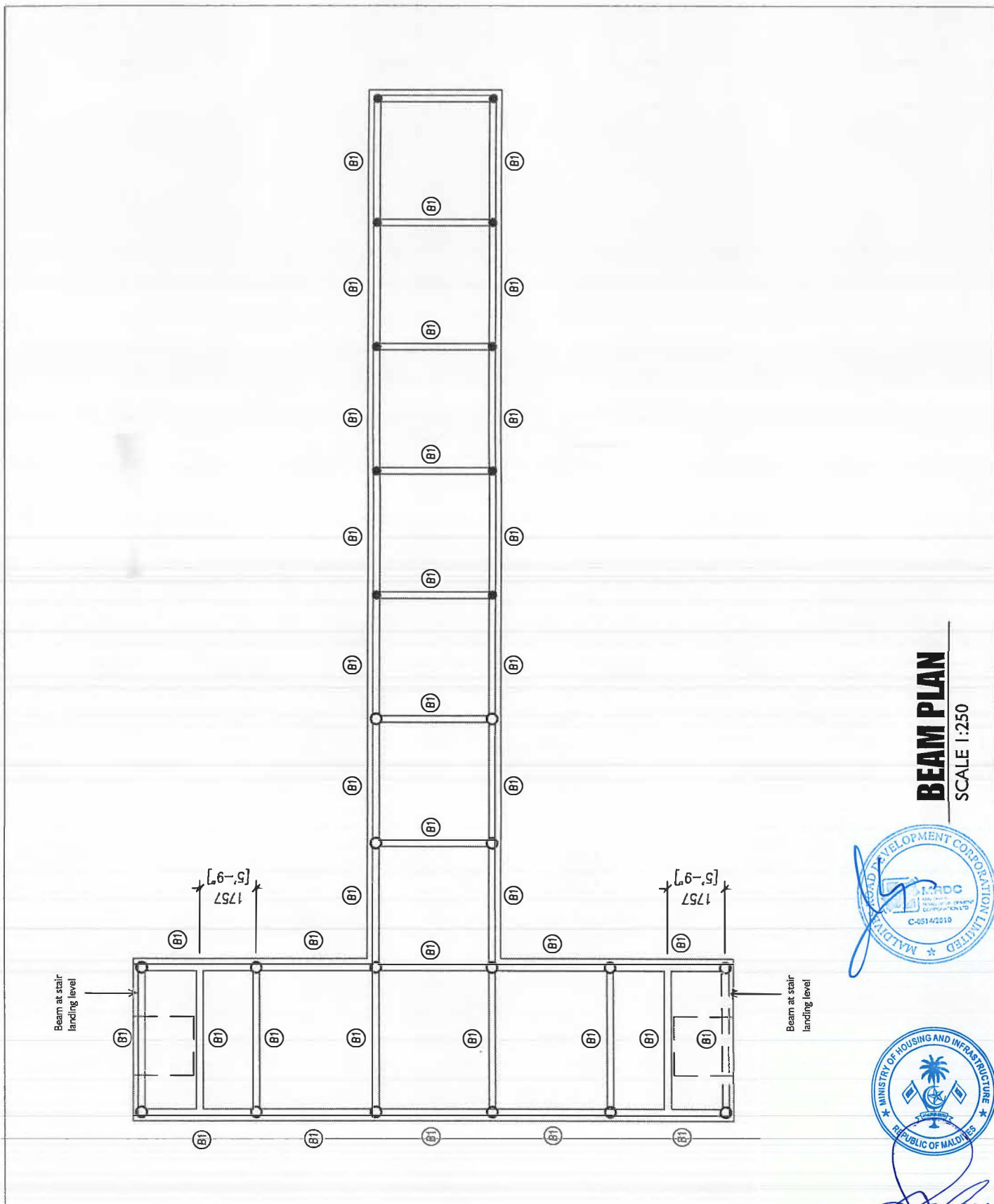
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REPUBLIC OF MALDIVES  
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**JETTY PLAN**  
SCALE 1:250

Note;  
M-Mooring Hook

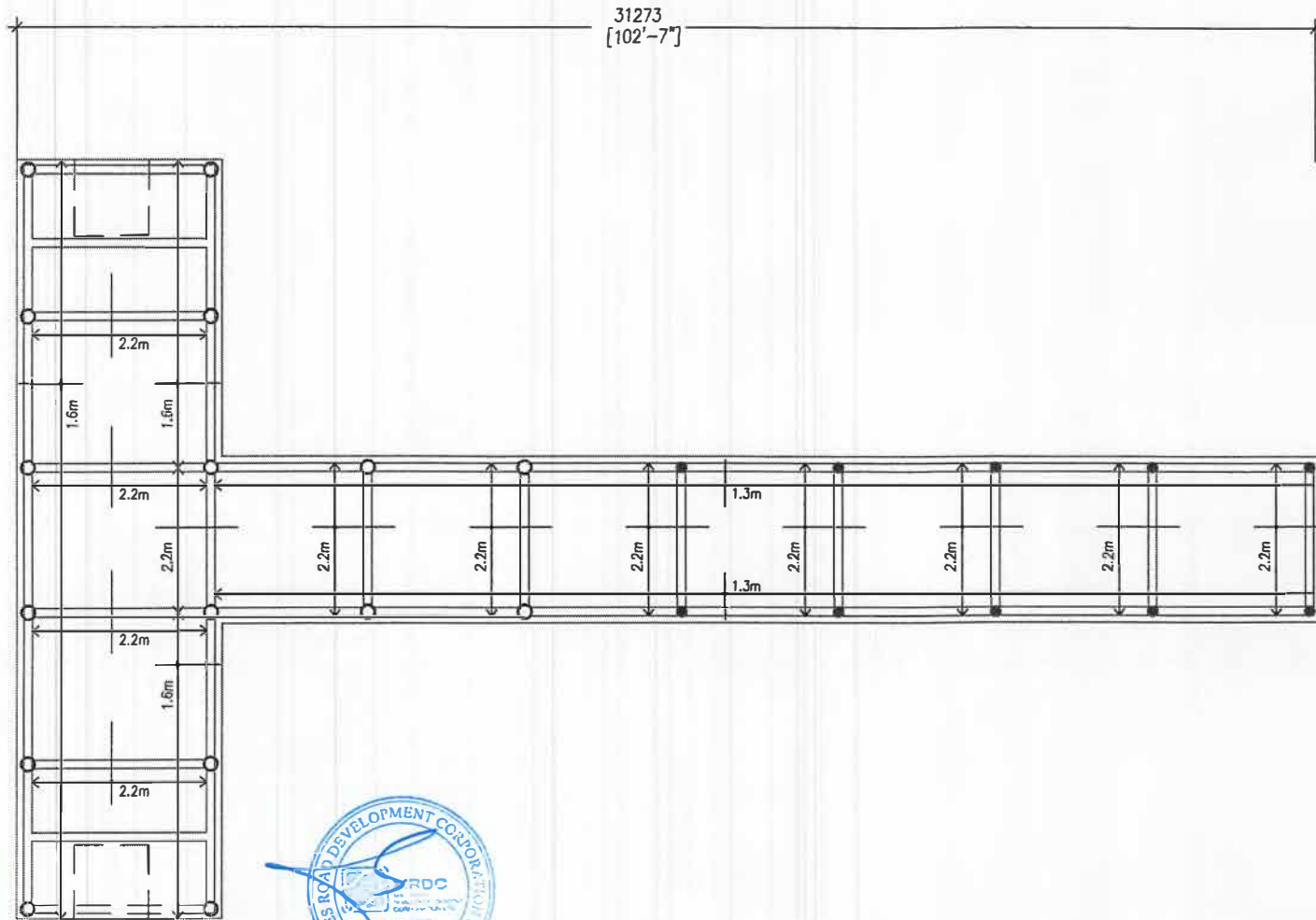




**BEAM PLAN**  
 SCALE 1:250



*[Handwritten signature]*



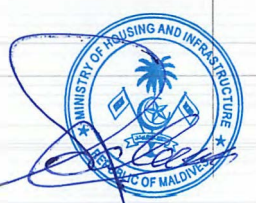
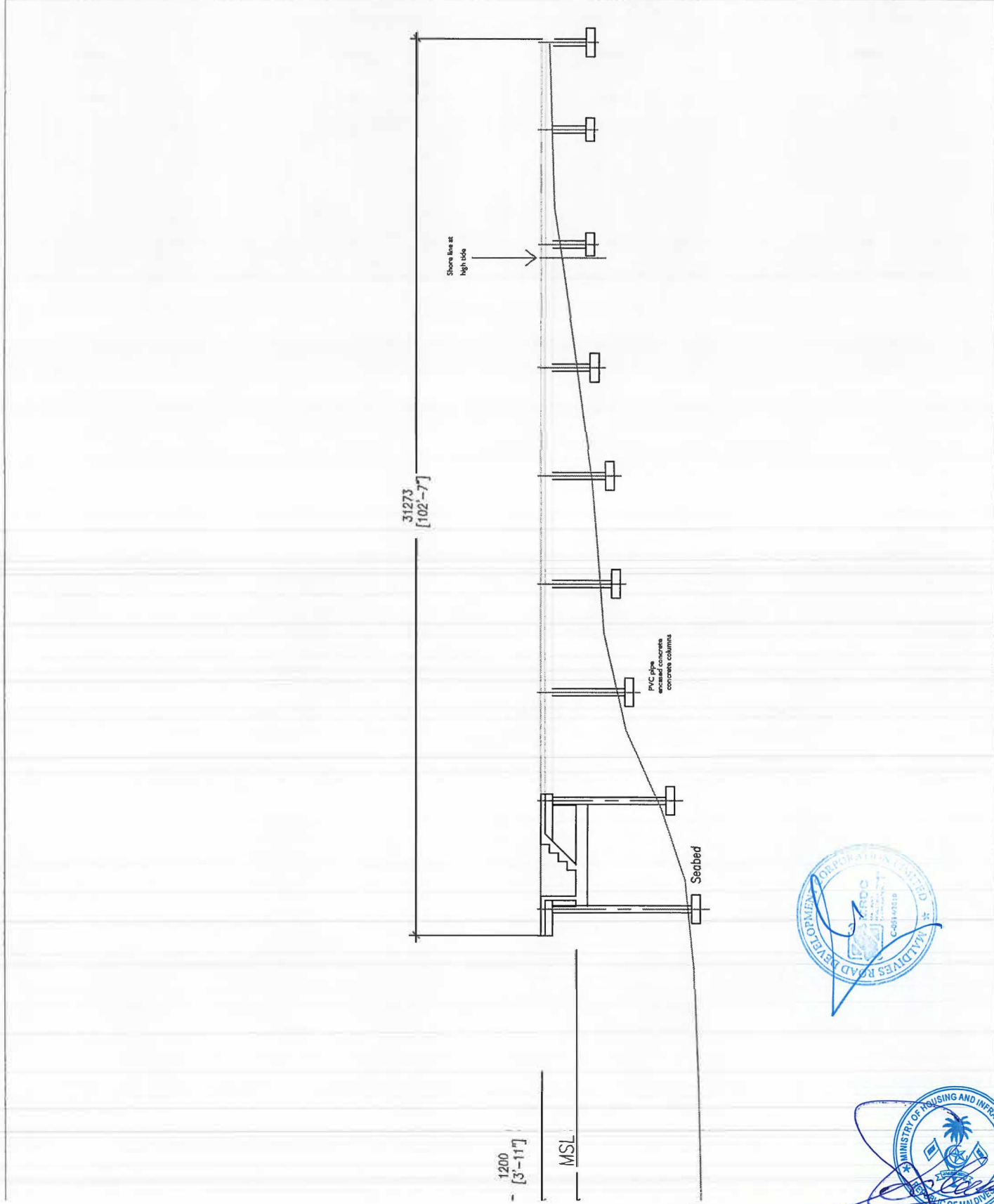
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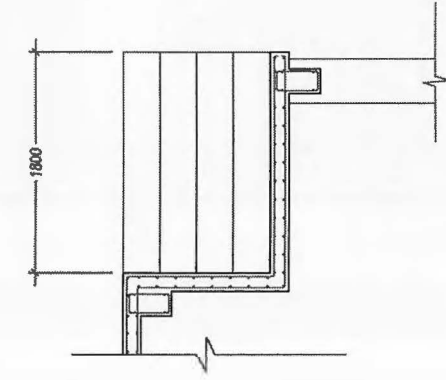


**SLAB REINF. PLAN**  
SCALE 1:250

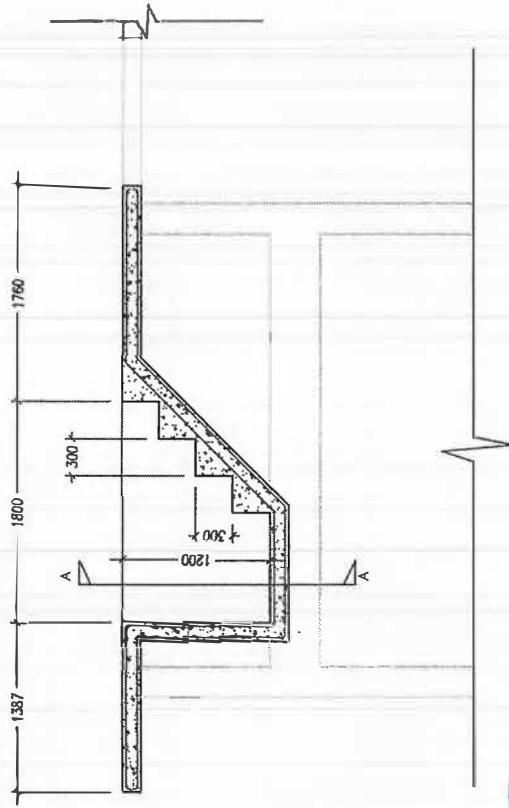
SLAB  
150MM THICK  
BOTTOM T12 @ 150 B/W  
TOP T12 @ 200 B/W + T12 @ 200 AS SHOWN  
COVER 35mm







SECTION A-A

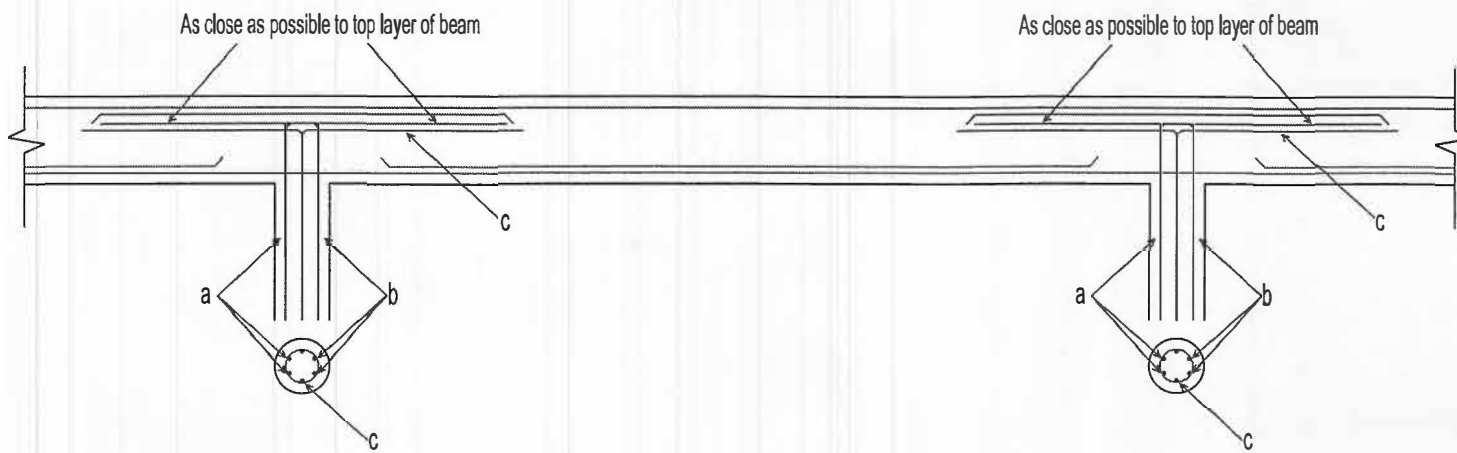


SECTION X-X

**STAIR CASE DETAIL**

SCALE 1:50

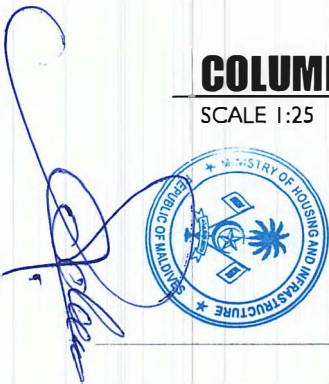


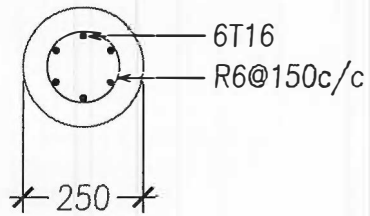


Note: Shear links not shown for clarity

# **COLUMN - BEAM FIXED CONNECTION DETAIL**

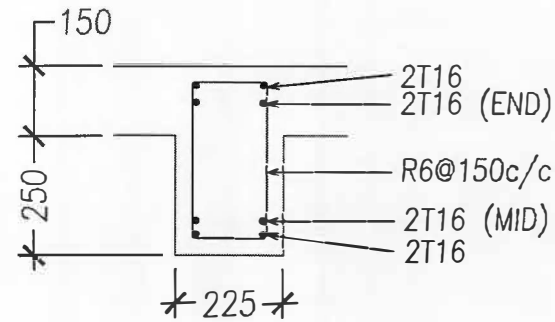
SCALE 1:25





CIRCULAR COLUMNS

All enclosed in PVC pipes



B1

NOTE:

COLUMN CONCRETE COVER = 50mm

BEAM CONCRETE COVER = 40mm

Foundation for circular columns are

1200 x 1200 x 300

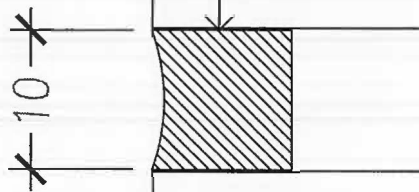
T12@150 BW at bot

**STRUCTURAL DETAIL**

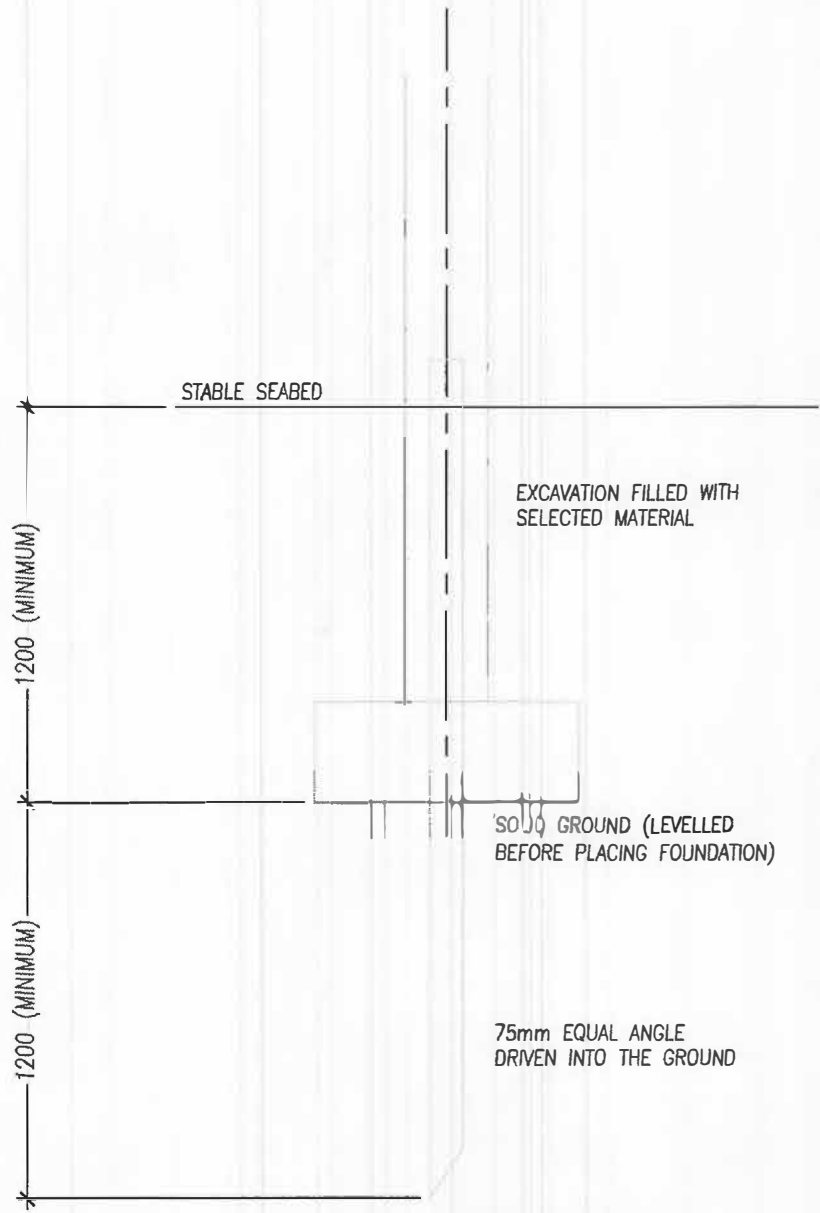
SCALE 1:20



Adhesive material as per  
BS 8007 and BS 8110



**EXPANSION JOINT**



### FOUNDATION PAD DETAIL

SCALE 1:20



Environmental Protection Agency  
Male', Rep of Maldives

Meeting: Dirty construction in ADH. Mandhoo, 12. Rasgathoom, B. Fehendhoo and B. Fulhadhoo

Date: 11/06/2017

Time: 13:00

MEETING ATTENDANCE

	Name	Designation	Office	Email	Phone No.	Signature
01	Mahmud Fiqz	Consultant		Mahmud.Fiqz@gmail.com	781037	
02	Nafsa Anjuz	Environment Analyst	MHI	enaf@housing.gov.mv	7721554	
03	Arasha Hashim	A. Project officer	MHI	enaf@housing.gov.mv		
04	Mariam Suidha	Sur Research Officer	EPA	maryam.suidha@epa.gov		
05	Aminath Mohamed	Asst. project officer	EPA	aminath.mohamed@epa.gov		
06	MOOSA NASEEM	President	Fehendhoo Council			
07	ALI AZUHTAR	Asst Director	Fulhadhoo Council	ali.azuhtar@gmail.com	7775808	
08	AHMED ASIF	Council	Fulhadhoo Council	"	7787992	
09	HUSSAINI RASHID	COUNCIL RAOS	R. RASGATHOON	RASHIDTHEEMOFFICE@gmail.com	777409	
10	Fathima Fahmy	Senior Research officer	EPA	fathima.fahmy@epa.gov.mv	9874988	

11. Fathimath Reem

12. Hashim Nabeel



**WATER QUALITY TEST REPORT**  
 Report No: 500173891

Customer Information:  
 Mahmood Riyaz  
 H.Hithifaay

Report date: 15/06/2017  
 Test Requisition Form No: 900175736  
 Sample(s) Recieved Date: 13/06/2017  
 Date of Analysis: 13/06/2017 - 13/06/2017

Sample Description	Rasgatheem	Fehendhoo	Fulhadhoo	TEST METHOD	UNIT
Sample Type	Sea Water	Sea Water	Sea Water		
Sample No	83187020	83187021	83187022		
Sampled Date	05/06/2017	05/06/2017	05/06/2017		
PARAMETER	ANALYSIS RESULT				
Physical Appearance	Clear with particles	Clear with particles	Clear with particles		
pH	8.21	8.06	8.22	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	-
Salinity	34.43	34.09	34.22	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	‰
Temperature	20.9	20.6	20.8	Electrometry	°C
Total Dissolved Solids	26200	26000	26100	Electrometry	mg/L
Turbidity	0.763	0.258	0.353	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU

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

Checked by

Afnan Farooq  
 Laboratory Executive Gr.1

Approved by

Mohamed Eyman  
 Assistant Manager, Quality

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

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

## Proponents Declaration

### Re: EIA for Island access and Jetty project in B.Fehendhoo

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


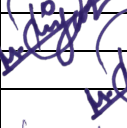
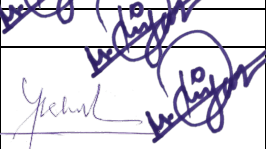
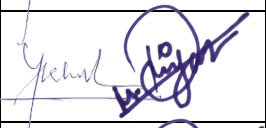
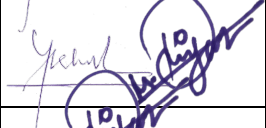
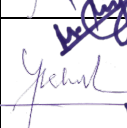
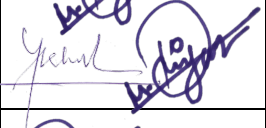
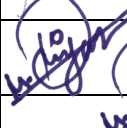

Designation: Director General

On behalf of: Ministry of Housing and Infrastructure

Date: 09 July 2017



## Annex-8.

Chapter	Name of Consultant	Registration No.	Signature
Introduction	Dr. Mahmood Riyaz	(EIA 03/07)	
Project Description	Dr. Mahmood Riyaz	(EIA 03/07)	
Administrative and regulatory framework	Dr. Mahmood Riyaz Dr. Mohamed Shiham Adam	(EIA 03/07) (EIA 01/07)	
Methodology	Dr. Mahmood Riyaz Dr. Mohamed Shiham Adam	(EIA 03/07) (EIA 01/07)	
Existing Environment	Dr. Mahmood Riyaz Dr. Mohamed Shiham Adam	(EIA 03/07) (EIA 01/07)	
Stakeholder consultation	Dr. Mahmood Riyaz	(EIA 03/07)	
Potential impacts and mitigation measures	Dr. Mahmood Riyaz Dr. Mohamed Shiham Adam	EIA 03/07) (EIA 01/07)	
Alternatives	Dr. Mahmood Riyaz	(EIA 03/07)	
Environmental Monitoring plan	Dr. Mahmood Riyaz	(EIA 03/07)	
Conclusions	Dr. Mahmood Riyaz	(EIA 03/07)	