

EIA FOR CONSTRUCTION OF K. VILLINGILI WEST HARBOUR & SLIPWAY PROJECT

November 2015



PROPOSED BY
MINISTRY OF HOUSING AND INFRASTRUCTURE

PREPARED BY
MEECO 

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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.


Ahmed Saleem (EIA03/13)



Declaration of the Proponent

The proponent has elected to submit an Environmental Impact Assessment for the proposed construction of K.Villingili West Harbour and Slipway, in accordance with Environmental Protection and Preservation Act (Act No. 4/93) and the EIA Regulations (2012).


Ministry of Housing and Infrastructure



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7. ඉංජිනේරු සේවාවන් සැපයීමේදී පවතින අහිමිකම් සහ අනවශ්‍ය වැයවිලියන් අවම කිරීම සඳහා ප්‍රවේශන ක්‍රම සකස් කිරීම;

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11. ව්‍යවස්ථාපිත සේවාවන් සැපයීමේදී පවතින අහිමිකම් සහ අනවශ්‍ය වැයවිලියන් අවම කිරීම සඳහා ප්‍රවේශන ක්‍රම සකස් කිරීම;

8. ව්‍යවස්ථාපිත සේවාවන් සැපයීමේදී පවතින අහිමිකම් සහ අනවශ්‍ය වැයවිලියන් අවම කිරීම සඳහා ප්‍රවේශන ක්‍රම සකස් කිරීම;

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NON TECHNICAL SUMMARY

1. The Ministry of Housing and Infrastructure requested the services of Maldives Energy and Environmental Company (MEECO) to provide an Environmental Impact Study (EIA) for the for the construction of a harbour and a slipway on the western side of Villingili Island, K. Atoll.
2. 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.
3. This EIA report was prepared for the fulfilment of the requirements of the Environmental Impact Assessment Regulations, 2012 with the purpose of conducting an assessment of possible impacts on biophysical and human environment arising from proposed development project.
4. The project is proposed by Ministry of Housing and Infrastructure, Maldives.
5. The main construction activities of the proposed project involve construction dredging of the existing harbour basin to a depth of 3m at mean sea level. The dimensions are 73m by 21m. A 73m long seawall made from rock boulders will be laid on the reef-flat on the western side of the island. The beach on the northern side of the harbour area will be filled and nourished. The construction activities will be completed within 150 days from the start of the construction phase. The project cost is estimated as MVR 09 million.
6. This development aims to improve the degraded western harbour with additional facilities with the objective of improving country's critical infrastructures. With the development of the western harbour at Villingili it is expected it would contribute alleviate the issues of the congestion at the Villingilli main harbour and make available critical facilities to the people living in Villingili to enhance their socio-economic development. Villingili with a sizeable population currently lacks a proper waste transfer arrangement. With the development of the slipway, it is expected a critical aspect of the waste management will be resolved thereby bringing environmental as well as health benefits to the community.
7. The consultants assessed the potential environmental impacts using sound scientific methodology, literature review and experiences from the past projects of similar nature. In addition views and opinions of the key stakeholders have been reflected in the report. The main findings have been summarised in the following sub-paragraphs.
 - a. Improving the harbour facility in Villingili will benefit boat owners, fishermen of Villingili in particular and those requiring boat maintenance service in general.
 - b. Environmental impacts assessment carried out for the project indicates that the project can be successfully implemented without an irreversible significant damages to the environment.
 - c. The project, however, has inevitable low magnitude negative impacts, including, sedimentation over parts of the reef, noise and vibration from construction activities, pollution from solid and hazardous waste. In addition, construction activities may result in temporary closure of the beach area with resulting loss of income to small businesses which depend commercial activities centered on the area. Additionally, boat owner who use western harbour may also face difficulties when its closed off for reconstruction. During the operational phase of the project, it is predicted with the proposed design of the harbour water stagnation within the harbour basin is likely to occur and that during southwestern monsoon floating litter could accumulate near the shoreline of the harbour.
 - d. All environmental and socio-economic impacts identified in the report are temporary, localised and can be mitigated with the actions proposed.

- e. The project is in line with the government's policies of developing access facilities, improve transport infrastructure and can be implemented in fully compliance with the relevant laws and regulations.
8. The Proponent has given full commitment to undertake mitigation measures and carryout the monitoring to ensure negative effects are effectively mitigated and corrective measures are taken in a timely manner.
9. It is thus concluded that the project's benefits outweighs its imposition on the environment and it can be implemented while giving due consideration to concerns related to the environment.

++++

1 INTRODUCTION

1.1 BACKGROUND

This EIA was prepared by Maldives Energy and Environmental Company (MEECO), upon the request of the project owner, the Ministry of Housing and Infrastructure (MHI), of the Government of Maldives. It addresses the dredging of the existing harbour on the western side of Villingili, North Malé Atoll, and the development of a slipway. This document has been prepared as a fulfilment of the requirements under the Environment Impact Assessment Regulations 2012 Environment Protection and Preservation Act of the Maldives (Law number: 4/93).

The document was prepared in accordance with the EIA Regulations (2012) and Regulation on Dredging and Reclamation (Regulation 2013/R-15) (Copy of the dredging permit is given in **Annex 1**). This EIA provides a focused assessment of the proposed dredging 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 2**).

1.2 PURPOSE OF THE EIA

This EIA report concerns the development of a slipway, deepening of the existing harbour on the western side and replenishment of the beach to the north of the proposed harbour at Villingili. As is the case with any developments involving dredging, reclamation and construction, negative impacts to the environment are expected from this project. Early identification of such impacts is necessary to put in place, appropriate mitigation measures to allow for the development to continue with minimal impact to the environment.

To this end, the main objectives of this EIA are:

- to fully comply with the Environmental Protection and Preservation Act (4/93) and EIA Regulations 2012;
- 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.
- To assess and recommend practical measures to mitigate the potential negative impacts arising from the development, based on the impacts predicted from this study. and
- To explore and make recommendations on the possible alternatives to the proposed methodologies that would be effective in minimising the impacts caused.

1.3 TERMS OF REFERENCE

The agreed Terms of Reference for this EIA is attached in Annex 1 of this report. This EIA has been conducted in accordance with the agreed Terms of Reference.

2 DESCRIPTION OF THE PROJECT

2.1 PROJECT LOCATION

The island of Villingili (also known as Villimale') is the fifth ward of the capital of the Maldives, Male'. Physically separated by sea from Male', Villingili is located approximately 1.4 km to the west Malé. The geographic location of the island is approximately at 4°10' 20.92"N (latitude) and 73° 29' 08.33"E (longitude) in North Male' Atoll in the central region of the Maldives. The island covers an area of approximately 31 ha with a width of 600m and 745m in length. Villingili sits on an isolated reef platform with the island almost saturated on its house reef. While Male' is the closest inhabited island lying to the east of Villingili, to its west is Gulhifalhu where an artificial island is being developed for housing and industrial development. Once a resort island, Villingili was developed as a residential island as part of Greater Male' in an attempt to solve the problem of population congestion in Malé. Location of Villingili is given in Figure 1.

2.2 THE PROJECT

The project “The Construction of K. Villingili Western Harbour and Slipway” was planned to improve the existing harbour facility on the western side of the island. In addition the project involves construction of a slipway on the southern side of the harbour.

The dredge material produced from the deepening of the harbour basin is proposed to be used to nourish the beach to the north of the harbour area. The locations and dimensions for the proposed development are outlined in Figure 2.

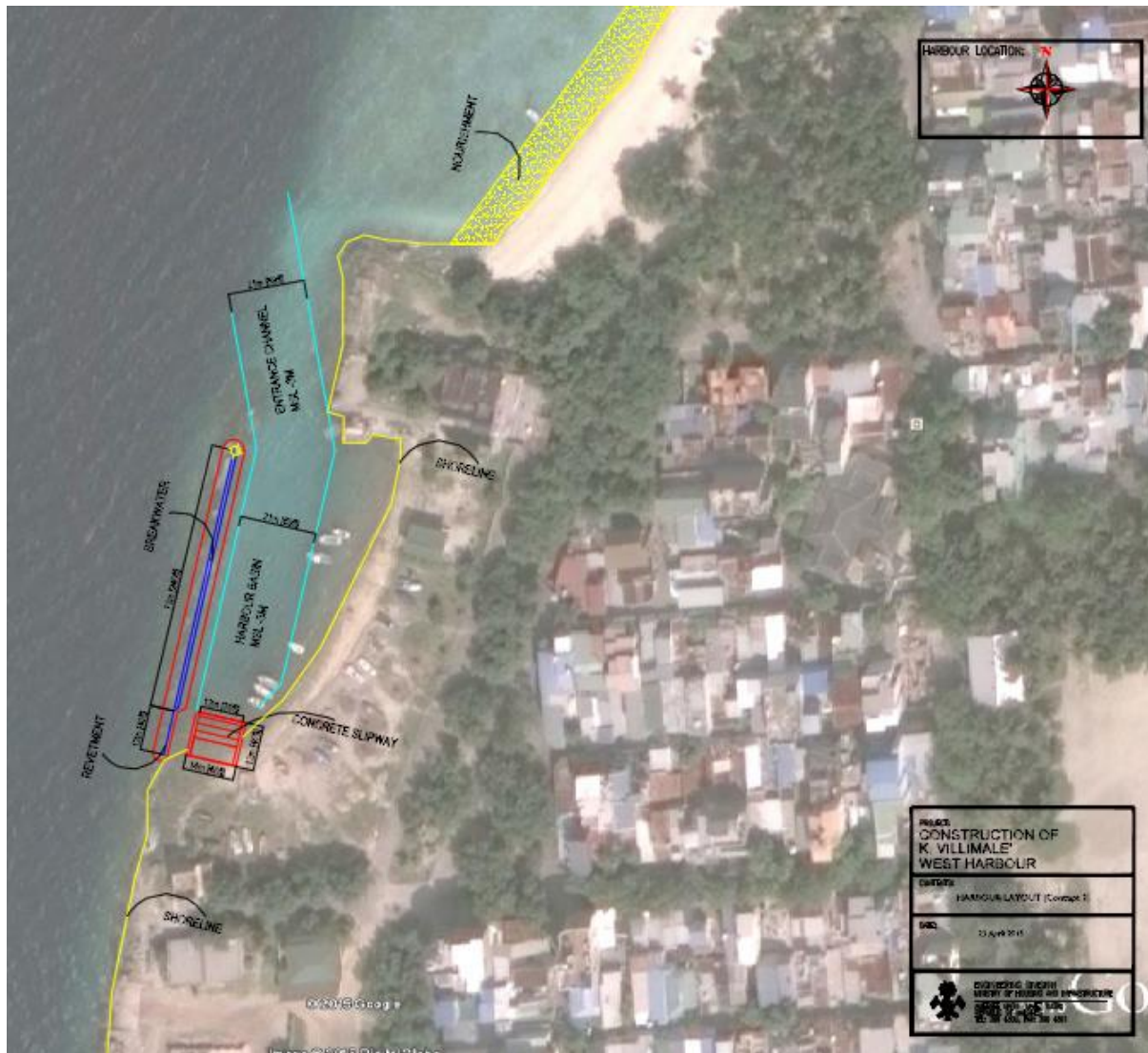


Figure 2: Proposed development

2.3 THE PROPONENT

The development of a slipway and the dredging of the existing western harbour was proposed by the Ministry of Housing and Infrastructure (MHI) to address the emerging requirement for harbouring larger vessels near Malé as well as to facilitate the easy movement of vessels to and from the water, to be used for their building and repair. The growing number of boats, and their increase in sizes, resulted in the need for adequate harbour facilities in and around Malé. The seawall surrounding the harbour has been badly damaged over the years, and in need of repair.

The Ministry of Housing and Infrastructure has over 25 years of experience in harbour development, reclamation and other infrastructure development in the country as the government authority mandated for infrastructure development in the country.

The contact details of the proponent is given below;

Ministry of Housing and Infrastructure.

Ameenee Magu,

Maafannu, Male', 20392, Republic of Maldives.

Tel: +(960)3004300, Fax: +(960)3004301

Email: mohamed.muizzu@housing.gov.mv

2.4 PROJECT COSTS

The cost of the proposed development of the West Harbour and Slipway in K. Villingili is estimated at MVR 9 million. This estimate is subjected to variations depending on the final scope of works. The project is financed by the government of the Maldives.

2.5 PROJECT SCHEDULE

The main activities to achieve the proposed development include, site mobilisation, demolition of existing seawall, disposal of demolition waste, re-construction of the new seawall, breakwater development, deepening of the harbour basin, construction of the revetment, construction of the slipway, beach nourishment, and finally demobilisation. The project is planned to be completed within 150 work days, including the time taken for the preparation of the EIA report and obtaining all necessary approvals required for the project. A detailed outline of the proposed schedule for the project is included in Table 1.

Table 1: Project schedule

Activities	Duration (days)					No. of days
	0-30	31-60	61-90	91-120	121-150	
Mobilisaiton	■					7
Demolition of existing sea wall	■	■				30
Disposal of material from demolished seawall	■	■				30
Re-construction of new sea wall		■	■	■		80
Breakwater construction			■	■	■	60
Dredging of harbour basin			■	■	■	75
Revetment				■	■	30
Construction of slipway		■	■	■		60
Beach nourishing				■	■	45
Demobilisation					■	7

2.6 NEED AND JUSTIFICATION OF THE PROJECT

The project has been planned under the government's policy on improving and developing the transport related infrastructure with the broad aim of achieving greater economic development at all levels. The project was proposed by the Ministry of Housing and Infrastructure (MHI), the institution mandated with the responsibility of implementing the infrastructure development strategies of the Government, to address the increasing need for safe harbour development in and around the Greater Malé Region. To this end, MHI has identified and proposed the existing western harbour of Villingili Island as an ideal location for developing a harbour and slipway.

Three harbours are currently functional in Villingili, two at the face and the other on the western side of the island. Of the two harbours at the face of Villingili, one is designated exclusively for the regular transport ferry system and small passenger vessels, and the other, a loading-unloading location as well as a location for the mooring of larger vessels. The harbour on the western side of the island is comparatively smaller and shallower that is currently being used to anchor small vessels. However, the breakwater constructed at this harbour has been destroyed for years, and no longer provides protection and shelter from waves during rough weathers. The harbour, in its existing state, does not provide for a safe mooring location, unless in very calm weathers. In addition the area is in a neglected state without proper management it is expected the conditions at both the harbour basin and the coastal areas around will further deteriorate. Land value in Greater Male' Region is the highest in the country and at its current state, the "land" area around the harbour space is underutilised and not made the best use of given the huge potential it possesses.

The development in transport networks between Malé and other islands has resulted in a general increase in the number of boats being moored at the Malé harbours. As a result, the harbours in Malé and Villingili have become congested and the need has arisen to explore other locations close-by that can be developed for this purpose. The existing harbour in Villingili has been used as an alternative mooring location for vessels arriving at Malé, and as a result has been known to get congested at times.

The proposed slipway development is expected to facilitate to resolve growing waste management issue faced to Villingili. Regular transfer of solid waste generated on the island is an absolute requirement to avoid potential environmental and health hazards. With the construction of the slipway regular waste transfer arrangement would become convenient and waste piling in the dump yard could be avoided. Regular arrangements to transfer residual waste to regional waste management facilities have been encouraged in the National Solid Waste Management Policy (2015). Development of such a facility in the existing harbours on the northern and eastern side will, in addition to having to make significant modifications to the existing facilities, affect the aesthetics of the face of the island. The development of a slipway elsewhere on the island will require the dredging of an entrance to access the slipway. The proposed location for the slipway is possibly the best possible option, in that, the area has already been dredged to form a shallow harbour that is currently in use, thus will receive the least impact from the development.

The proposed development is foreseen to bring numerous benefits to the Villingili community as well as the Greater Malé Region.

2.7 PROJECT COMPONENTS

The project has four main component as briefly described below;

A – Construction of a harbour - Deepening and expanding the existing harbour on the western side. harbour basin when completed would measure 73m in length and 21m in width, to a depth of -3m at MSL.

B – Construction of 73m long breakwater on the reef flat, on the western side of the island is one

of the most important intervention proposed under the project. The existing breakwater has almost completely collapsed and there is no barrier to serve the purpose of breaking incident wave energy offshore so that the harbour basin is protected from wave attack. The new breakwater will maintain appropriate height in par with the wave heights prevailing in the area. It will reduce the wave energy in the harbour, control infilling of the harbour due to sediments carried by the overtopping waves into the harbour basin.

C – Construction of a slipway: The project includes construction of a slipway at the southern end of the proposed harbour to facilitate transfer of waste from Villingilli to Thilafushi. This facility is particularly important given that there is no proper arrangement for regular removal of waste from the island. The slipway is believed to be carefully located with waste collection area located in the adjoining land plot of the proposed slipway. Slipway has been proposed to be developed using concrete measuring 14m in width and 12m in length.

D – Beach nourishment: materials excavated from the harbour basin will be used to widen the beach that is north of the harbour. Replenishment area would cover 80m in length and 9.5m wide. Approximately 1176m³ of sand will be used.

2.8 PROJECT INPUTS AND OUTPUTS

A brief overview of the project inputs and outputs are outlined in Table 2.

Table 2: Summary of project inputs and outputs

PROJECT INPUTS	Source/type	How to obtain resources
Project staff	Skilled and semi-skilled labour, Manager (1) Supervisor (1) Excavator Operator (2), Loader operator (1), Welder (1) Labourer (15) consisting of skilled and semi-skilled and unskilled labourers persons.	All workers will be sourced by the contractor. Contractor will ensure the workers hired for the project are capable and possesses necessary skills and in case of foreign workers that they have necessary documents
Machinery (excavator, barge, operational tools)	Excavator (01), dump trucks (02), loader (02), Concrete mixer (01), work barge (01), Crane (01), Survey equipments.	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.
Construction materials	Rock boulders, cement, aggregate, iron rods, fuel	Imported materials to be used for the project.
Resources for the workers	All staff support services will be arranged on the island. No workers camp or temporary accommodation/toilets have been planned for the project.	To be arranged by the contractor.
PROJECT OUTPUTS	Details	Comments
Harbour basin	21m wide 73m long harbour basin, deepened up to -3m from MSL	
Entrance channel	21m wide, deepened up to -3m from MSL.	
breakwater	73m in length on the western reef flat.	Constructed from rock boulders

slipway	14m in width and 12m in length	Constructed from concrete
Nourished beach	80m long 9.5m wide area to be added to the existing beach	
Dredged material	1176m ³	The dredge material obtained will be used to nourish the beach on the northern side of the harbour. The material will be transported from the dredge site to the fill site on trucks.
Hazardous waste	Minor amount	Hazardous waste generated such as waste oil, lubricants, chemicals, batteries etc shall be stored and disposed off in Thilafushi in fully in compliance with the waste management regulations
Solid waste	Minor amounts, solid wastes will be mostly packaging wastes, empty containers etc	All wastes generated on project site shall be collected and temporarily stored for transfer and disposal at Thilafushi at intervals determined by the Contractor. The site manager will require to maintain records of waste materials transferred from the project site.
Noise & light	Construction of the rock boulder breakwater can generate noise in addition to the noise generated from the operation of vehicles and machinery	Work will not be carried out late into the night to avoid disturbance to local population.

2.9 PROJECT WASTE MANAGEMENT

During construction phase small volumes of solid waste and construction waste is expected to be generated. Island's waste collection yard being very close to the project site, waste generated from the construction activities can be stockpiled in the same area for transfer to Thilafushi. This arrangement will be made during the mobilisation phase.

A paved area within this will be designated for hazardous waste such as waste oil, used batteries, chemicals, etc. These wastes will be placed in a separate container that is enclosed.

Waste material arising from the project activities shall not be allowed to burden Villingili's existing waste management system.

All residual solid waste and all hazardous waste will be regularly transferred to Thilafushi placed in a boat.

During the operations phase of the harbour waste collection bins will need to be placed around the harbour area to prevent littering.

It has been generally observed that harbours throughout the country have been constructed without basic toilet facilities in the vicinity of the harbour for the harbour users resulting human waste being directed at harbour with resulting pollution in the harbour. Although sanitation facility is not within the scope of the project it is highly advisable to have such basic services available at the harbour.

2.10 WORKERS' SAFETY

For all works the following safety measures will be required during the construction phase.

Appropriate PPE will be worn at all times. This will typically include hard hats, eye protection, protective trousers, and gloves. Hearing protection, masks and wet weather clothing will be available for use where necessary. In addition, the following safety measures will be in place;

- First aid kit shall be available on site at all times;
- All machinery shall be operated by competent certified operators;
- All machines and vehicles shall be serviced regularly;
- Manual lifting operations will be kept to minimum by the use of mechanical means; and
- Life buoy will be on site close to relevant work areas at all times.

2.11 PROJECT WORK METHODOLOGY

General construction methodologies that is widely used in the Maldives in harbour deepening, breakwater construction and beach replenishment will be applied in the project. The construction of the proposed harbour and slipway construction project will be carried out in a manner that will minimize the impacts during the construction phase. At project commencement, the remains of the existing breakwater will be demolished by excavator, followed by the deployment of a new breakwater. A silt screen will then be placed at the entrance to the harbour basin prior to the commencement of the dredging activity. Dredging will commence at the entrance to the harbour and be continued into the basin. The dredge material obtained will be moved to the designated fill site at the northern beach, just adjacent to the project site by trucks. A slipway will be constructed on the southern side of the harbour once the dredging activity is completed. Figure 3 illustrates the sequence of activities during the construction phase of the proposed development.

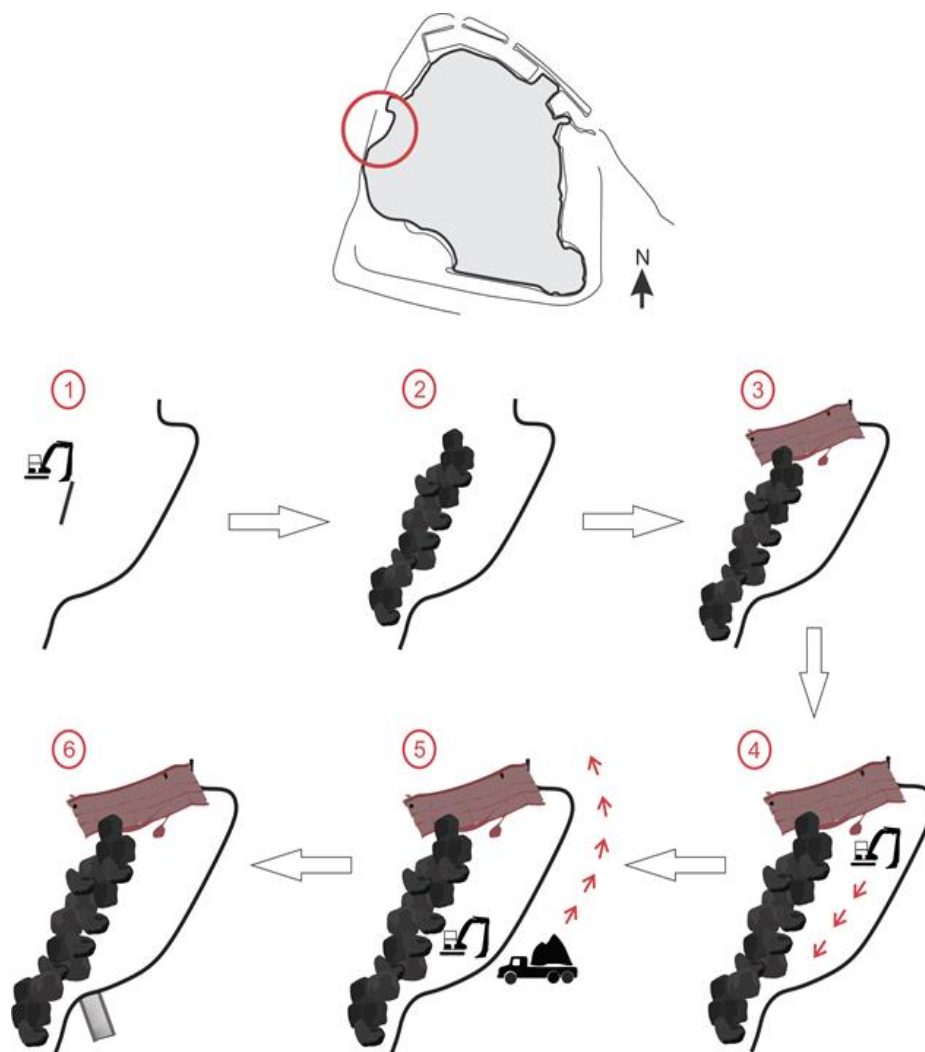


Figure 3: Illustration of the sequence of activities to be undertaken for the proposed harbour and slipway development. 1) demolition of the remains of the existing breakwater; 2) deployment of a new rock boulder breakwater; 3) placement of the silt screen at the entrance to the harbour basin; 4) Dredging of the harbour commencing from the harbour entrance; 5) transport of dredge material to the fill site; and 6) the construction of a slipway.

2.12 STUDY AREA & THE IMPACT ZONE

The development of the harbour and slipway is proposed to be located on the western side of the island, and the beach to the north of the proposed harbour will be nourished with the materials obtained from deepening of the harbour.

Boundaries of the study area and the likely impact zone is shown in Figure 4. The beach area as well as the proposed harbour and boat yard area are being used by locals residing in Villingili. In addition to the residents of Villingili people from Male' uses the existing beach within the project boundary for picnicking and for watersports (see Figure 4). The study area has been decided based on the locations where direct actions of the project have been targeted at and likely sediment movement impacts particularly during the easterly monsoon period.

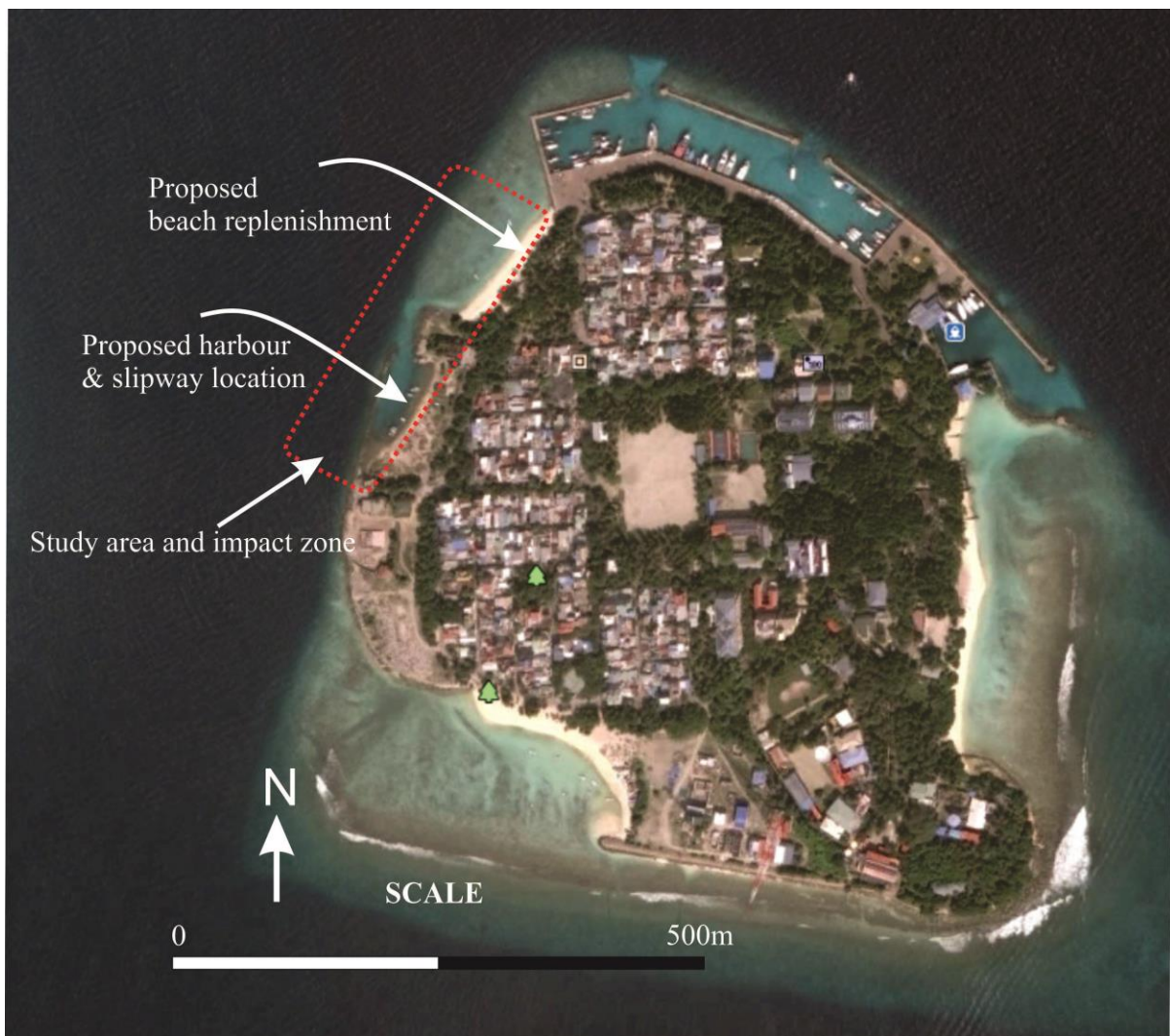


Figure 4: Boundary of the study area and the predicted impact zone

3 ADMINISTRATIVE AND REGULATORY FRAMEWORK

Due to the nature of the proposed development, as can be seen from the legal framework, a number of government agencies have a stake in the project. The project is planned and executed by the key government agency which is responsible for formulating and implementation of policies on infrastructure development in the Maldives which is the Ministry of Housing and Infrastructure. In addition, Ministry of Housing and Infrastructure is also responsible for the construction of harbours, revetments, dredging and reclamation projects on behalf of the government. This ensures that the proposed project is fully in line with the government's development policies and plans. The environment sector of the Ministry of Environment and Energy is granted the broad responsibility to assess development projects that may have a significant impact to the natural environment development and operations in the Maldives.

3.1 ADMINISTRATIVE FRAMEWORK

3.1.1 Ministry of Housing and Infrastructure

Ministry of Housing and Infrastructure is the primary government authority responsible for formulating and implementing policies related to housing, land, land use planning, construction industry development, and infrastructure development in the Maldives. In addition the Ministry is responsible for regulating dredging and land reclamation and planning and executing government projects of similar nature. Coastal protection and harbour development are also among the responsibilities of the Ministry. The proposed project is planned and executed by the Ministry of Housing and Infrastructure on behalf of the government of the Maldives

3.1.2 Ministry of Environment and Energy

The Ministry of Environment and Energy (MEE) is key Ministry in the government mandated with the protection of the environment. Environmental responsibilities assigned to MEE includes formulating environmental policies, coordinating, preservation and management of the environment throughout the country, and enforcing Environmental Protection and Preservation Act (EPPA) (04/93). Under Article 5(a) of EPPA, Environmental Impact Assessment (EIA) is mandatory for projects that may cause potential harm to the environment. The EIA report has to 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.

3.1.3 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.

3.2 POLICY FRAMEWORK

3.2.1 Strategic Economic Plan

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

3.2.2 Transport Master Plan

This document highlights the requirement for efficient maritime transport networks, including harbour facilities to sustain the country's economic growth. In addition the need to ensure efficient transport systems that systematically link Malé to the rest of the country has been identified as a crucial factor that will contribute to the socioeconomic development across the country.

3.2.3 National Environment Action Plan, 2009-2013 (NEAP III)

The third National Environment Action Plan (NEAP III) set forth the agenda for environment protection and management in the Maldives for the five year period 2009 – 2013. This instrument seeks to achieve the stipulated goals and targets through co-ordinated effort of the responsible government departments and following the introduction of a decentralised system of governance, through the engagement of local level governance arrangements.

The underpinning theme of the policy instrument is protection of the natural environment and making people and property resilient. NEAP III emphasised on the promoting healthy communities by improving solid waste management, hazardous waste management, safe use and disposal of chemicals, clean air.

3.2.4 National Waste Management Policy (2015)

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

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

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

The National Solid Waste Management Policy (2015) (NSWMP) was formulated taking cognizance of the changes in waste generation patterns resulting from the changing socio-economic conditions of the country. The main objectives of the NSWMP is to instil a uniform vision in policies, regulations, standards and plans formulated for waste management and to create and identify the responsibility for waste management at individual, household, community, regional and national levels, establish a policy basis for introducing charges for waste management, identify the role of private partners in the waste management hierarchy and identify key stakeholders.

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

- a) To reduce waste generation promote and inculcate 3R concept;
- b) Conduct sustained awareness building activities at all levels to create public awareness on safe waste management practices;
- c) Designate the MoE as the lead agency for the implementation of the national solid waste management policy and establish a mechanism to monitor island level waste management systems;
- d) Formulate solid waste management plans for each inhabited island and undertake waste management activities in accordance with such plans;
- e) Formulate the Waste Management Legislative framework and carry out waste management activities in accordance with the framework;
- f) Review medical waste management regulations and carry out waste management activities of the health sector in accordance with such regulations;
- g) Collect statistics on waste at island and national levels and disseminate such information;
- h) Establish a system to impose and collect fees/charges from waste producers/generators;
- i) In each inhabited island, establish a waste management system which is suitable for the needs of the island (to be determined based on the size of the island and the island population) and provide necessary tools and machinery and carry out waste management activities through the established system;
- j) In a sustained manner conduct training programmes on safe management of waste targeting stakeholders;
- k) Establish, maintain and update an inventory of waste management systems established in inhabited islands;
- l) Establish regional waste management facilities in all the designated regions of the Maldives;
- m) Transfer residual waste (after waste management at island level) to regional waste management facilities in accordance with the relevant regulations, and manage waste so transferred in the regional waste management facility;
- n) Conduct research on latest waste management technologies;
- o) Exhort preparation of waste management plans for islands designated and leased for industrial activities and conduct monitoring to ensure compliance with contents of such plans in the waste management activities; and
- p) Establish a “National Waste Management Trust Fund”

3.2.5 Saafu Raajje Initiative

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

3.3 LEGAL FRAMEWORK

3.3.1 Environment Act

Environment Protection and Preservation Act of Maldives (Law No: 4/93) was enacted in April 1993 as an umbrella law to protect and preserve the environment of the country. The articles and clauses of the law are given below. The clause 5 is directly related to the proposed project in Villingili and this study. As the Government authority with a mandate for the protection and preservation of the environment, Ministry of Environment and Energy has the responsibility of formulating policies, laws and regulations on environmental protection and conservation.

3.3.2 Environment Impact Assessment 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.

3.3.3 Dredging and Reclamation Regulations

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

Since any EIA submission shall be made only after successful clearance of the dredging and reclamation permit, the proponent has obtained clearance from EPA in advance as per this Regulation.

3.3.4 The Regulation on Environmental Liabilities (Regulation No. 2011/R-9)

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

3.3.5 Regulation on Sand and Aggregate Mining

This regulation addresses sand mining from islands and bird nesting sand bars. Sand and aggregate mining from beaches of any island whether inhabited or uninhabited is banned for protection of the islands. Permissions for sand and aggregate mining from other areas shall be obtained from the relevant authorities.

3.3.6 Regulation on Coral Mining

Coral mining from the house reef of islands and the atoll rim reefs is banned through a directive from the President's Office dated 26th September 1990. According to this policy coral mining shall not be carried out from house reefs of islands and atoll rim reefs and common bait fishing reefs. Coral and sand mining is only allowed for house construction from designated sites and approval from the concerned authorities is required prior to mining activities. Request for coral and sand mining from residents of inhabited islands are required to be submitted to the Atoll Offices through the respective island offices. The island office is required to estimate the quantities of coral or sand required for the applied construction work of houses to ensure that the permission is granted for minimum amounts required. Every island is required to maintain a log book of permissions granted and the amounts mined and the site where mining was carried out.

3.3.7 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 it 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.

3.4 POLICY AND REGULATORY COMPLIANCE

In summary, the proposed project fully complies with relevant government policies, initiatives, all applicable environmental legislation, and regulatory statutes. The proponent will ensure that the mitigation measures stipulated in the report is effectively implemented and that the monitoring program is conducted to ensure perceived impacts of the project is kept within acceptable levels.

4 METHODOLOGIES

This section in brief describes various methodologies adopted in assessing the existing environment of the proposed project site, surrounding environments and the environmental impacts. This section will also describe the methodology that the proponent intends to adopt in undertaking the works.

Data for assessment of environmental impact that may arise due to the proposed project were collected using methods most appropriate for specific environmental, social and economic conditions of the island and atoll environment. Quantitative, semi-quantitative and qualitative data were collected for this EIA study.

Assessment of the existing environment was conducted using standard methods that are internationally accepted and locally practiced.

4.1 MARINE ENVIRONMENT

Marine environment was surveyed to assess and to determine the baseline of the existing environmental conditions. The reef-flat of the affected area and the fish communities on the affected region of the reef flat was surveyed.

The quadrat method was used to quantify benthic substrate types.

Percentage cover of each of the benthic substrate was then calculated and presented.

This study was complemented with extensive underwater photographs of the areas in question. Methodologies adopted in the survey is described in detail by English et al. 1997.

4.1.1 Timed-Swim Surveys

In addition to quadrat survey timed-swims were carried out to collect additional information. Four swims on a straight path were done on the four selected sites. The duration of each swim was 15 minutes for benthic cover and an additional 15 minutes for assessing mobile organism such as fish. The abundance is given in relation to the occurrence of particular taxa in other similar habitats of the Maldives. There is a tendency to underestimate fish when using this method. This is due to rare species not being effectively sampled and failure to observe all the fish present. However, this method represents a quick and easy way of obtaining data in a limited time frame. The data obtained is valid and dependable and can be replicated.

4.1.2 Bathymetry Surveys

Aerial photographs, satellite images were used in planning for mapping and bathymetry assessment. Reef map and the bathymetric survey was conducted with a combination Real Time Kinematic (RTK) GPS system for location and single beam echo sounder for depth measurement. Permanent Station Mark (PSM) situated at Maafushi was used as the base station for the RTK system.

The rover GPS attached to the top of the transducer module provides the location with an accuracy of 0.003m and the height to the bottom face of transducer with an accuracy of 0.005m with reference to MSL. The depth is measured from the bottom of the transducer to the surface of the reef using ultrasound waves.

The software in the computer uses the GPS to navigate the boat to ride on the pre-determined lines to cover the area required. The data observed by the GPS and Echo Sounder are processed real time to deliver the coordinates (N, E, Z) of the reef.

4.1.3 Surface Currents

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

4.1.4 Beach Profiles

On shore survey was conducted using Real Time Kinematic (RTK) GNSS system and the off shore (depth) survey was carried out with the combination of HD370 echo sounder and RTK system through an advanced software to associate data from both devices. All the data were recorded with reference to PSM no. MLE005, situated near Villingili ferry terminal in Male'. Therefore all the data collected are with reference to WGS 84 datum and Mean Sea Level (MSL). All data files are then imported to Autodesk Civil3D to create an accurate model of the project area.

This model is used to analyze and prepare the beach profiles of the project area with the help of Civil3D.

4.1.5 Vegetation Surveys

The study area identified contained no trees and hence no survey was carried out.

4.1.6 Marine Water Quality

Water quality at the project location were assessed using Horiba multiparameter water quality meter. The parameters measured included ambient temperature in the water, conductivity, salinity, dissolved oxygen, oxidation reduction potential (ORP), pH and turbidity. The information collected was analysed, tabulated and presented.

4.2 IMPACT ASSESSMENT METHODOLOGY

Following data analysis and literature review and stakeholder consultations, a system called Rapid Impact Assessment Matrix (RIAM) was used to organize the EIA. RIAM methodology as described in detail by Jensen *et al* (1998) brings together the individual multi-disciplinary parts of an EIA in a transparent and semi quantitative manner. It keeps transparent control of the components in a distinct semi quantitative manner allowing direct comparison of different problems, and above all it allows a holistic and coherent anticipation of problems. This methodology has been found to be effective for EIA involving coastal development projects.

The process of defining the components, which are of importance in evaluating the possible changes due development, is called scoping. In the RIAM these components are considered in a holistic manner and fall into four groups. These groups represent the issues relating to the Physical/Chemical environment (P/C); those relating to Biological/Ecological (B/E) concerns; human issues defined as Social/Cultural (S/C); and issues dealing with the Economic/Operational (E/O) aspects of development.

In the RIAM analyses, all problems are analysed according to five characteristic criteria. Two criteria relate to properties that are of singular importance to the condition, and three criteria to properties that are of value to the situation. The first type of criteria is: the importance of the condition, which is assessed against the spatial boundaries or human interests it will affect; and the magnitude, which is defined as a measure of the scale of benefit/dis-benefit of an impact of a condition.

For the importance of condition (I) the scale is defined as:

- 4 = important to national/international interests
- 3 = important to regional/national interests
- 2 = important to areas immediately outside the local condition
- 1 = important only to the local condition
- 0 = no importance

For the magnitude of a change or effect (M) the scale is defined as:

- +3 = major positive benefit
- +2 = significant improvement in status quo
- +1 = improvement in status quo
- 0 = no change/status quo
- 1 = negative change to status quo
- 2 = significant negative dis-benefit or change
- 3 = major dis-benefit or change

Criteria that are of value to the situation are defined as permanence, reversibility and cumulative properties. Permanence defines whether a condition is temporary or permanent, e.g. an embankment is a permanent condition even if it may one day be breached or abandoned, whilst a coffer dam is a temporary condition, as it will be removed.

Reversibility defines whether the condition can be changed and is a measure of the control over the effect of the condition.

Cumulative property is a measure of whether the effect will have a single direct impact or whether there will be an accumulated effect over time, or a synergistic effect with other conditions.

Table 2: The scale used for the criteria that are of value to the situation

Score	Permanent (P)	Reversible (R)	Cumulative (C)
1	No change/not applicable	No change/not applicable	No change/not applicable
2	Temporary	Reversible	Non-cumulative/Single
3	Permanent	Irreversible	Cumulative/of indirect effect/synergistic

Table 3: Range bands used for RIAM

Environmental classification (ES)	Value of the class	Value of the class (numerical)	Description of the class
72 to 108	E	5	Extremely positive impact
36 to 71	D	4	Significantly positive impact
19 to 35	C	3	Moderately positive impact
10 to 18	B	2	Less positive impact
1 to 9	A	1	Reduced positive impact
0	N	0	No alteration
-1 to -9	-A	-1	Reduced negative impact
-10 to -18	-B	-2	Less negative impact
-19 to -35	-C	-3	Moderately negative impact
-36 to -71	-D	-4	Significantly negative impact
-72 to -108	-E	-5	Extremely negative impact

The assessment of the different problems that have been selected for evaluation by the scoping process gives a value ascribed (by the consultants) to each of these criteria. By the use of a simple formula a score (the environmental score) for the individual components was calculated:

$$ES = I * M * (P + R + C)$$

To use the evaluation system described, a matrix of cells showing the criteria used, set against each defined component, is produced for each project option. From the formulae given above each ES number is calculated and recorded. To provide a more certain system of assessment, the individual ES scores are banded together into ranges where they can be compared. The ranges cover impacts from a major positive change/impact (+5/E) to similarly negative effect (-5/-E). Conditions that have neither importance nor magnitude will score a zero and be banded together (0/N); and any condition in this band is either of no importance or represents the status quo, or a non-applicable situation.

5 EXISTING ENVIRONMENT

5.1 INTRODUCTION

This Section highlights the findings on the assessment of the status of the existing environment at the proposed project site at Villingili. This description has been produced based on data collected during field investigations, literature review and interviews with the stakeholders. Two trips were made to the field. During the first survey made on 4th October 2015 psychogeographical aspects were studied. While during the second trip made to the site on 16 November 2015 biological and physical oceanographic aspects were investigated.

5.2 CLIMATE AND OCEANOGRAPHIC REGIEME

Meteorological data obtained from the Maldives Meteorological Service (MMS) station at Hulhulé was used for the purposes of this study, as it was the closest station to the project site from which weather data could be obtained, and it is expected to provide a reasonable indication of the weather conditions at Villingili.

5.2.1 Monsoon and Winds

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

Wind speed and direction data obtained from Department of Meteorology for the year 2013 for Hulhule was studied for the detail analysis of the winds. The analysis of the winds indicates that the central region of the Maldives is pre-dominantly westerly and east-north-easterly. It also indicates that there is almost no wind from the quadrant between southeast and south. The analysis of the wind data for the two seasons indicate that during the Northeast monsoon the wind is predominantly from ENE and E. The wind direction changes distinctly from W, WSW and WNW throughout the Southwest monsoon (Figure 6&7). The average annual wind speed expected stands at 9 miles per hour (4 ms^{-1}) although significant variations in wind speed can be expected for various months of the year. From May through to the October wind speed seem to be generally stronger compared to the rest of the months of the year (Nov to Apr). Figure 6 also shows that months of May having the strongest wind speed compared to any other month of the year while March, April and November are characterised by lower wind speeds. Wind data analysis also show that the wind predominantly is from the western direction (45% of the time) followed by ENE (25% of the time), east and east-north-east (17% of the time for each direction) as shown in Figure 5 and 6. These findings are consistent with the long term weather data analysis for the Maldives by These results have been confirmed by Kench and Brander (2005).

Considering the predominant wind directions observed for Hulhulé the following predictions can be expected for wind directions at Villingili.

- a) November to March: Winds are primarily from the E to NNE.
- b) April to November: Winds are mainly from the W to WSW.

Accordingly it is predicted that for much of the year winds approaching the Villingili area to be from NW to NNW direction (67 percent of days of the year).

Wind speed data obtained from Hulhulé showed that the highest average wind speeds were observed in the month of May followed by June, during the SW monsoon, while the lowest average wind speeds were observed in the month of March (at 3.88 ms^{-1}), months between November - April appear to have wind speeds less than 10miles/hour 4.5 ms^{-1} (Figure 6).

5.2.2 Rainfall

Analysis of 39 years of rainfall data for Hulhule shows an average monthly rainfall of 165mm with significant variations in the total monthly rainfall. Based on the rainfall, the months of the year can be divided into two distinct halves; the dry period and the wet period. The first four months of the year (Jan – Apr) is characterised by significantly lower average rainfall registering rainfall below the monthly average value (orange line) compared to the rest of the year while the last four months (Sep – Dec) records highest average rainfall for an year that is above the monthly average value (see Figure 7).

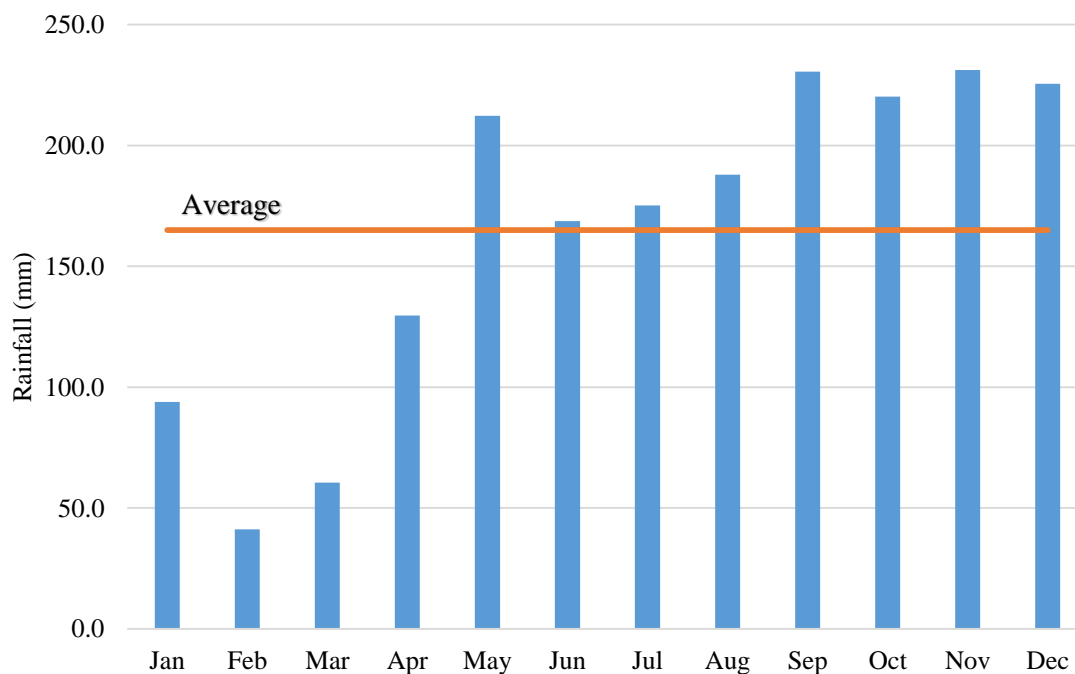


Figure 7: Monthly averages rainfall for Hulhule (solid line represents average for rainfall for a month based on 39 years of data)

5.2.3 Temperature

Minimum and maximum temperature analysis for 39 years (1975 -2013) of recorded data at Hulhule shows that February – May having the highest maximum and minimum temperatures while the lowest maximum and minimum temperatures were recorded for the last four months of the year (see Figure 10). Analysis showed a minimum monthly average temperature of 25.8°C while monthly maximum average temperature of 30.7°C (Figure 8).

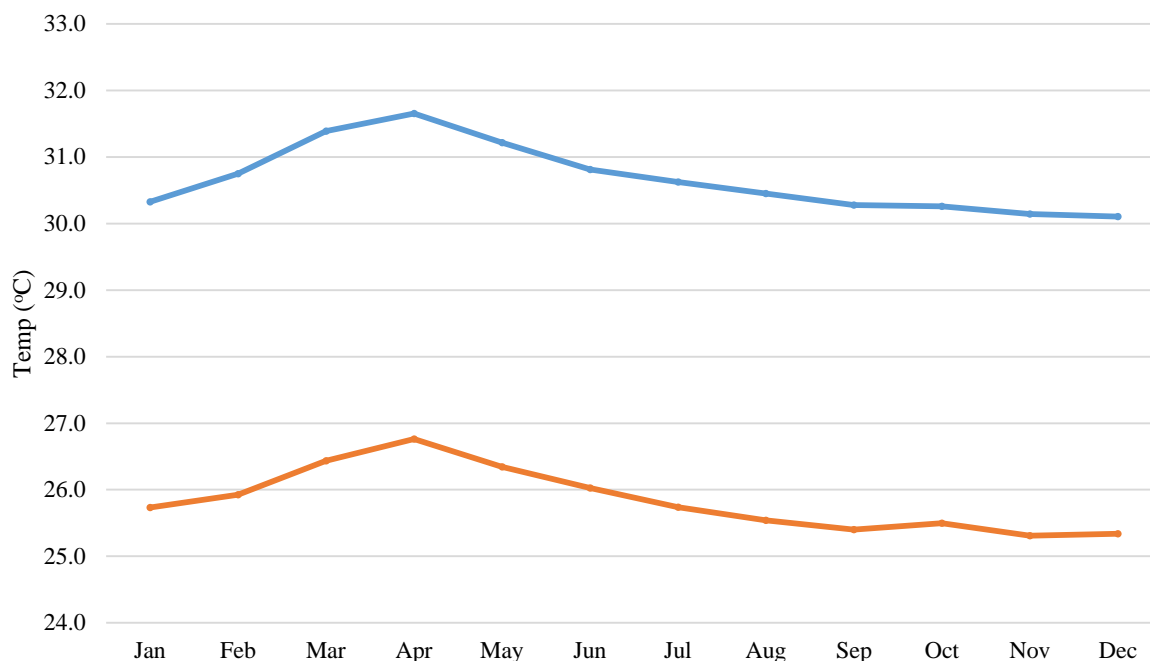


Figure 8: Monthly maximum and minimum temperatures

5.2.4 Tide

Astronomical tide levels recorded at the National Meteorological Centre at Hulhule, shows that the highest astronomical tide level is +0.64 m (MSL) and that the lowest astronomical tide level is -0.56 m (MSL) (see Table 4). It is assumed that the tide measurements at Hulhule will be the same as at Villingili due to the close distance between the two islands. Table 1 shows the tide levels at Hulhule. Tidal variation of 1.2 m from lowest to the highest tide levels were recorded in the country. Tidal fluctuations 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 generally very slow, therefore low tide period is considered to be a good time to conduct dredging and reclamation work.

Table 4: Tide levels at K. Hulhule

Tide characteristics	Water level referred to Mean Sea Level (MSL) [m]
Highest Astronomical Tide (HAT)	+0.64
Mean Higher High Water (MHHW)	+0.34
Mean Lower High Water (MLHW)	+0.14
Mean Sea Level	0.0
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MLLW)	-0.36
Lowest Astronomical Tide (LAT)	-0.56

5.2.5 Sunshine

According to annual sunshine hours recorded at Hulhule for the period 1975 - 2013, on average 232.9 hours of sunshine is expected for Villingili a month. Monthly averages show that first four months (Jan – Apr) receiving the higher sunshine compared to the rest of the year (see Figure 9).

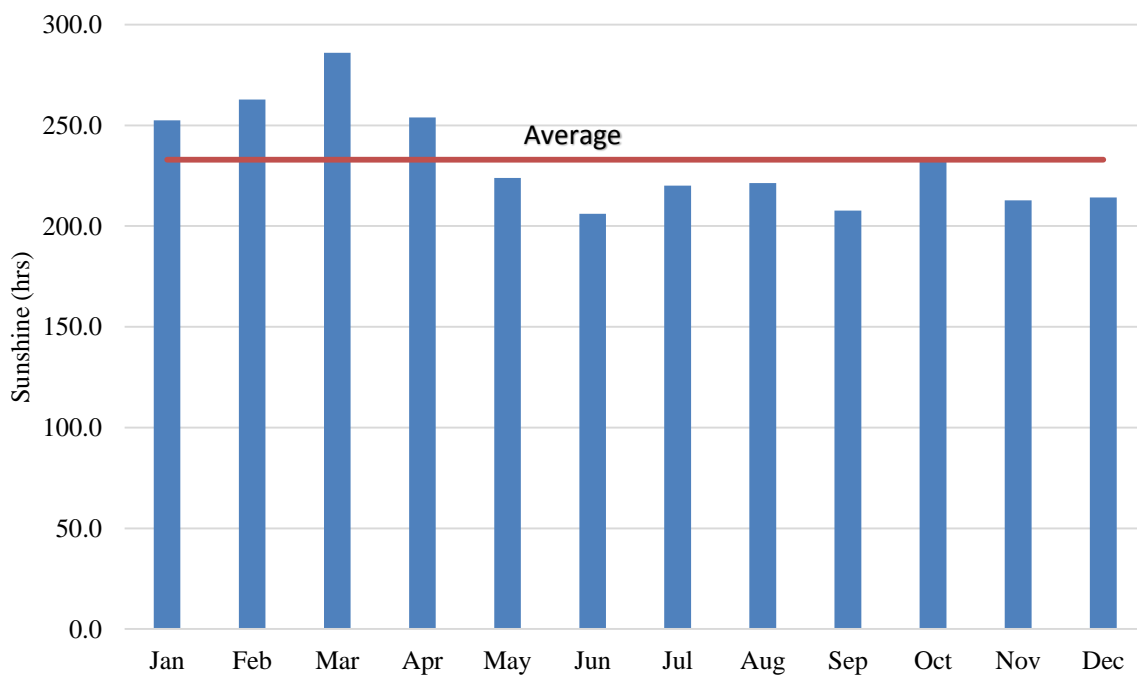


Figure 9: Average hours on sunshine received for Hulhule (solid line shows the average for a month based on 39 year annual total)

5.2.6 Waves

According to DHI, (1999) the significant height (H_s) in the southern regions of the Maldives exceeds 2.5 m in about 0.1 percent of the time. Figure 10 shows that the highest waves are from W and S. Significant wave heights exceeds 1 m in less than about one percent of the time from N, NW, NE and E.

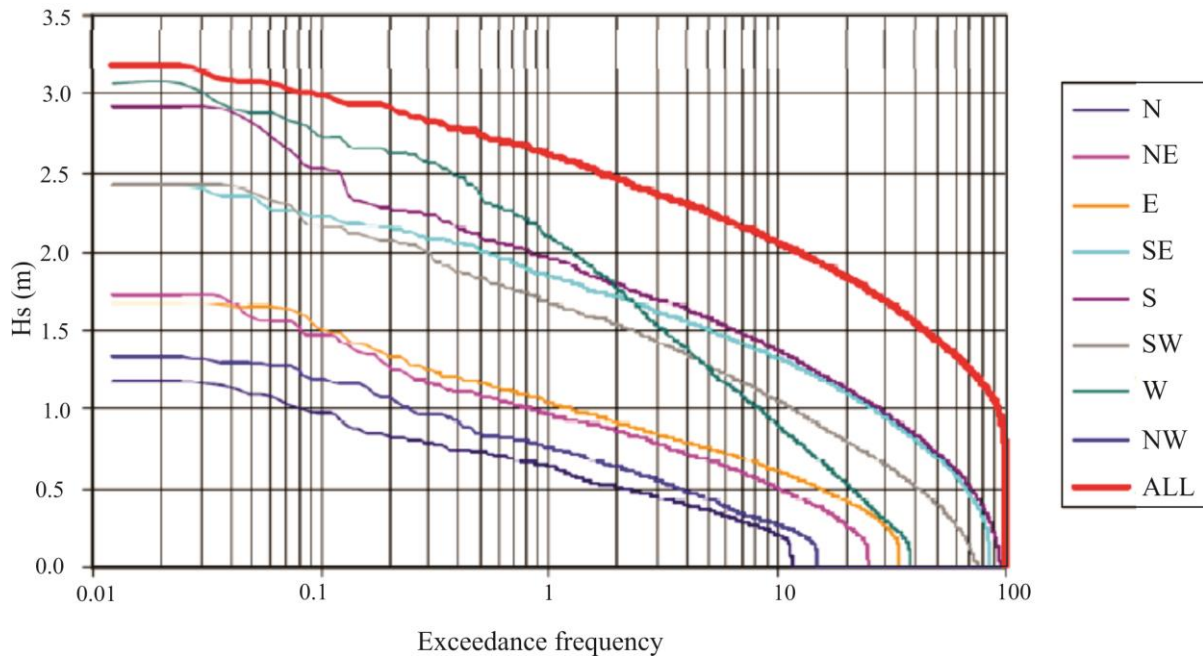


Figure 10: Wave height, H_s , exceedance curve for the southern region of the Maldives (source: DHI, 1999).

These results are fairly consistent with the satellite altimetry derived wave climate data over a ten-year period for the region (Kench and Brander, 2006) indicating that dominant swell approached from southerly directions, with some seasonal variations. Swells were predominantly from the south-southwest, between April to November, with a significant peak in wave height (H_s) of 1.8 m observed in June, and from south to south eastern directions between November and March, with a minimum H_s of 0.75 m being observed in March (Figure 11). Overall wave energy was greatest on all islands during the westerly monsoon (Kench and Brander, 2006).

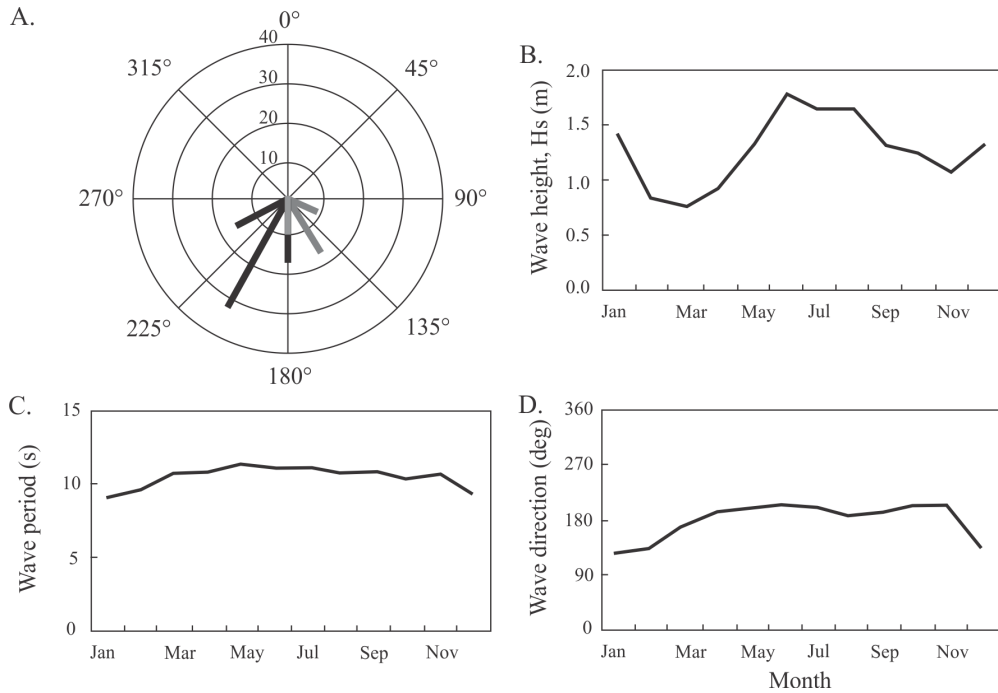


Figure 11: Mean monthly ocean swell for the Maldives showing (A) wave direction for April to November (black lines) and December – March (grey lines) (B) wave height (C) wave period (D) wave direction. Data from Young (1999) adapted from Kench and Brander, (2006).

The above analyses of waves showed that for much of the year (April to November) stronger wind-generated waves will approach the project location from a westerly to north-westerly direction. During December to March wind generated waves approached the project location mainly from the north easterly to easterly direction. Villingili is exposed to swell waves approaching from a south westerly direction and south easterly direction. This implies that Villingili is exposed to swells that generate in the inter-atoll channel between North and South Malé Atolls. Intensity of swells is estimated to be high due to the exposed nature and proximity of Villingili to the reef rim. Swell wave approaching on the southern side is expected throughout the year. Villingili is expected to receive some level of protection from the westerly wind generated waves due to the shelter provided by Gulhi Falhu to the west of the island. Waves generated by northeast monsoon is expected to be weakened due to the shelter provided by Malé, situated to the east of Villingili. Due to its geographic location, Villingili is reasonably sheltered from the wind generated wave impacts, although it will receive the southerly swells year-round (Figure 12).

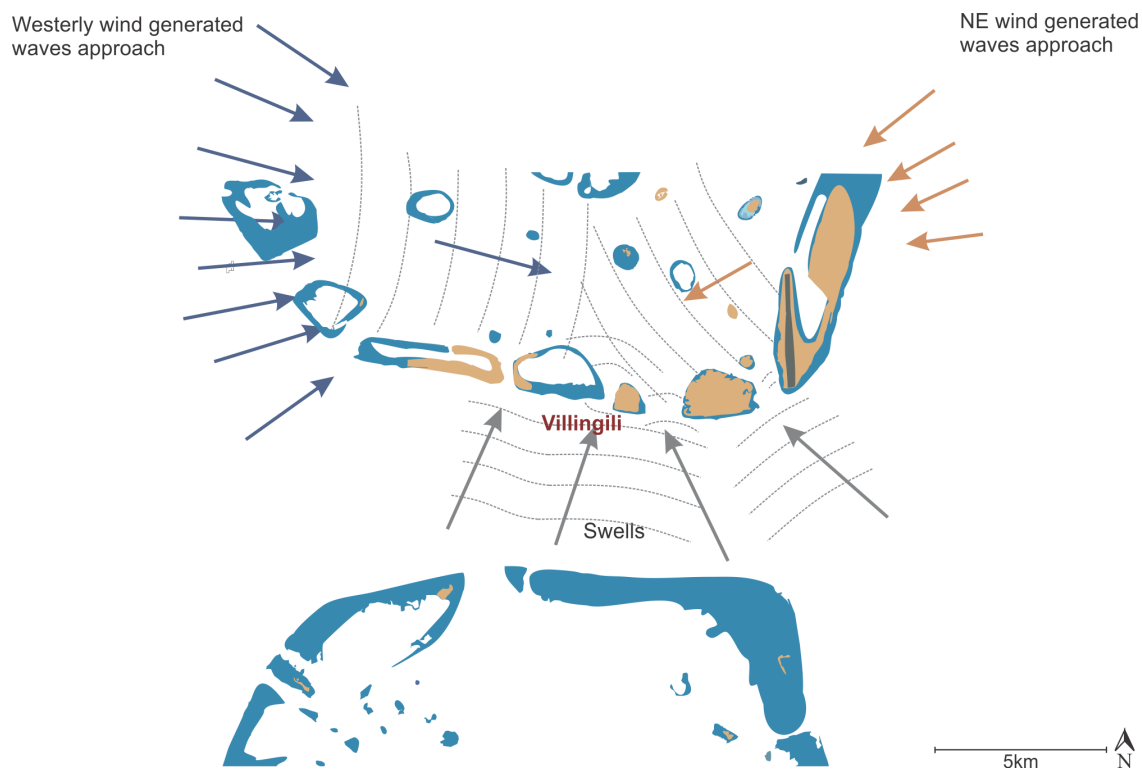


Figure 12: Estimated wave propagation pattern around the vicinity of K. Villingili

5.2.7 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

Because of its position in the vast Indian Ocean, Maldives is exposed to an immense body of water flowing constantly across the plateau on which the atolls are built. Approaching the equator, the effect of prevailing winds on the ocean surface currents become noticeably greater, in that the velocity and direction are driven, in a major way, by prevailing winds. The Maldives experience sea surface currents driven by two monsoonal winds – the westerly and easterly winds. The westerly currents tend to dominate from January to March, while the easterly currents dominate from May to November. Changes in current flow patterns are observed in April and December, at the interchange between the two monsoons. The average current velocities are approximately 0.5 ms^{-1} , except in the month of May these values may increase to 0.8 ms^{-1} .

Surface currents measured at 4 different locations of the project site showed very similar patterns at all locations. Currents were flowing west to east direction towards the shore. The average speed of the currents was measured to be 0.20 ms^{-1} . Figure 13 shows the direction of currents flow and Table 5 gives

the respective current values at 4 locations. Figure 14 gives currents measurement graphs at four locations.

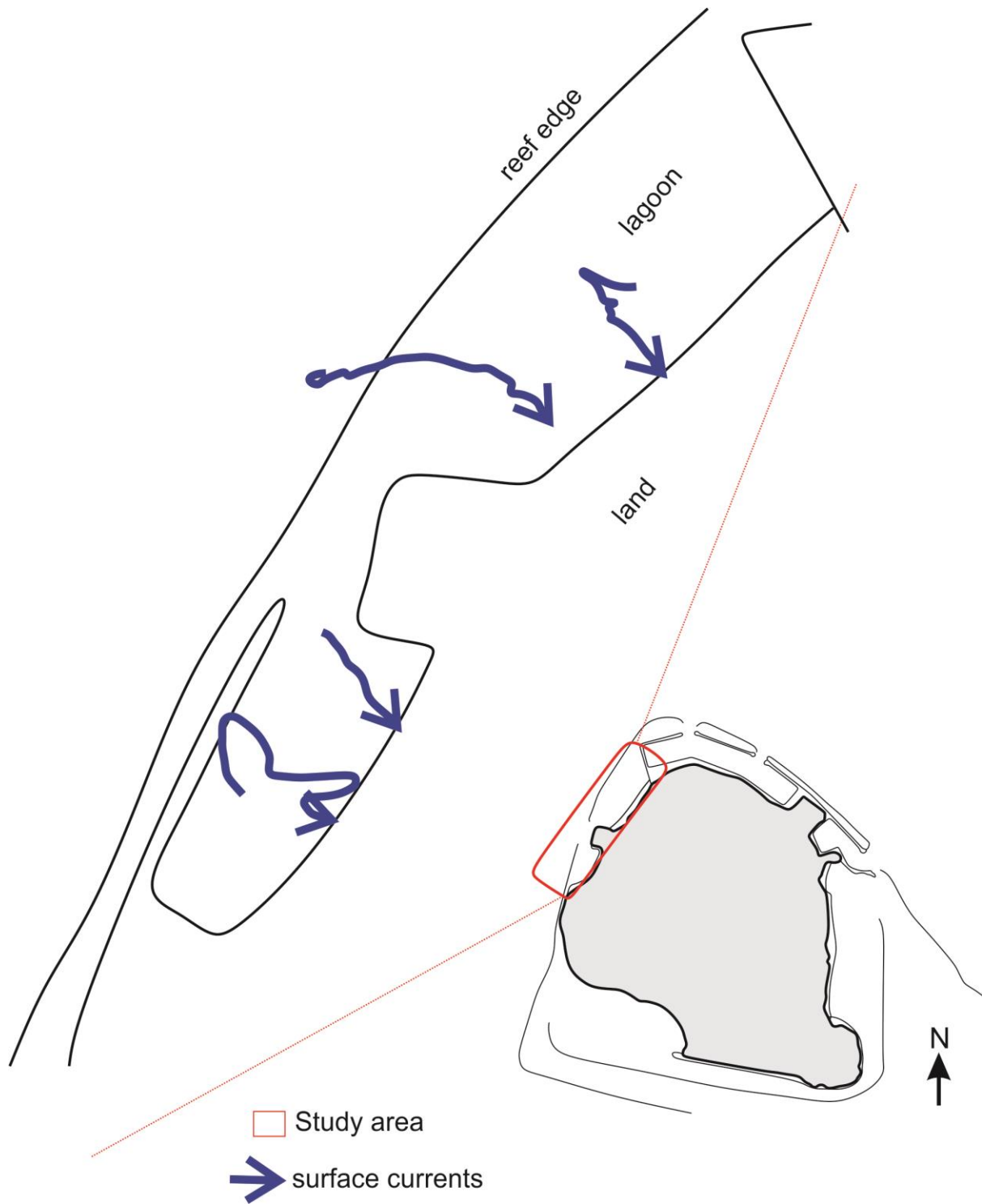
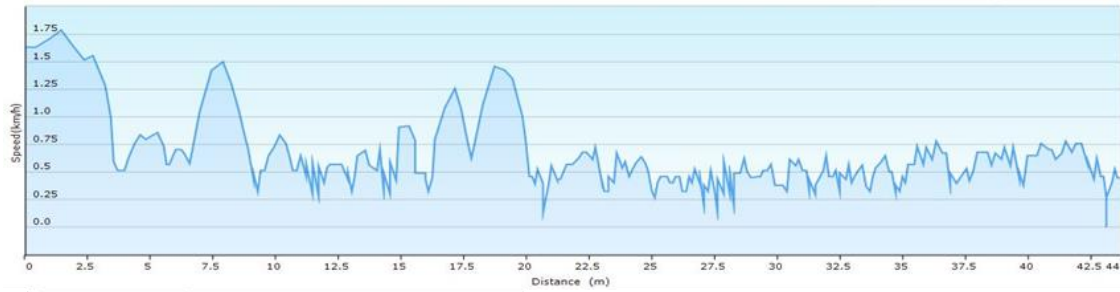


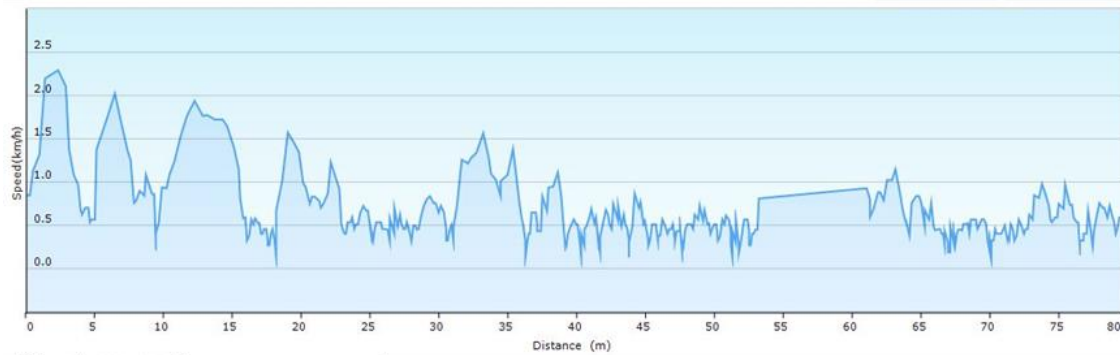
Figure 13: Surface currents patterns at project location

Table 5: Average surface current velocities

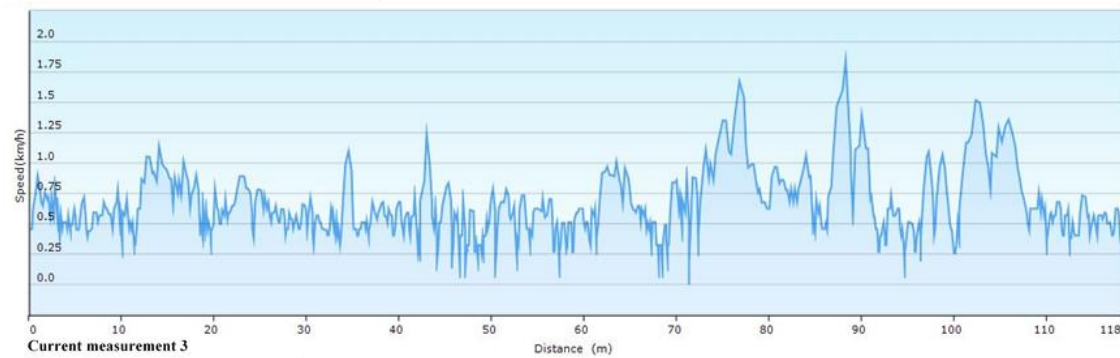
Measurement no	Average velocity (m/s)
1	0.18
2	0.21
3	0.18
4	0.21



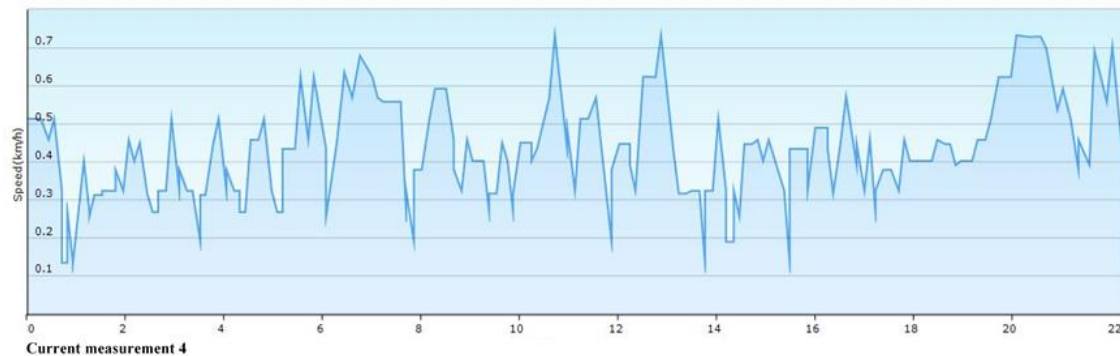
Current measurement 1



Current measurement 2



Current measurement 3



Current measurement 4

Figure 14: Surface currents at four locations in the project environment

5.2.8 Coastal Dynamics

Villingili is a relatively small island that has undergone extensive coastal modifications in the past. Due to heavy coastal modification, as such the construction of three harbours, coastal revetments and a number of groynes and coastal structures have resulted interruptions to natural sediment movement around the coast of the island. The coastal developments have also resulted in the loss of much of its natural beach which is now limited to small patches in three locations. Patches of natural beach can be seen on the eastern side, north western side and southwestern side of the island (See Figure 15).

Of the three beach segments the one on the northwestern side seem to be the most stable (Figure 15). Beach segment on the southwestern side has undergone noticeable erosion according to the residents while beach on the east has also experienced erosion. Due to the heavy modification of the coastal environment it is obvious the natural pattern of sediment movement around the island's coastline must have been long lost and the fragments of beaches that existed presently are somewhat trapped in their respective locations.



Figure 15: Fragments of beach found in Villingili

5.2.9 Beach Profiles

Beach profiles were measured at coastal area of the harbour location as well as beach to the north of it. Selected cross sections of the adjacent to the harbour are given in **Annex 3A** while the beach profiles of the beach to the north of the harbour is given in **Annex 3B**. The profiles were drawn with reference to existing shoreline. At the coastline of the harbour area, the slope was found to be consistent all along varying within 7.5% to 10%. Average ground level at 10m towards the land from the shoreline was found to be 1.48m. At the beach to the north of the harbour the slope varied between 9% to 9.5%. The

average ground level at 10m towards the land from the shoreline was 1.9m. Figure 15 shows the natural beach proposed for replenishment.



Figure 16: Stable natural beach on the northwestern side of Villingili

5.2.10 Bathymetry

The depth in the existing harbour basin ranged between - 0.25 m to -2 .0m. At the lagoon area proposed for beach replenishment the depth ranged between -0.20 to -0.38m. The detailed depth profile of the harbour area is given in **Annex 4A** and the depth profile of the area marked for beach replenishment is given in **Annex 4B**.

5.3 BIOLOGICAL ENVIRONMENT

This describes the existing environment of the project site. As the impacts of the proposed project are expected to be localised, the survey area defined for the purposes of this study were limited to the immediate vicinity of the project site.

5.3.1 Coastal Vegetation

The coastal vegetation was not quantitatively studied as no impacts are expected for the vegetation in the immediate areas. Project does not include removal of any plants from the coastal environment. Based on the visual observations plants in the area were listed and was found to be plants that have wide distribution across the Maldives in the coastal habitats. The natural coastal belt around the island has been found to heavily disturbed by the human activities. The coastal vegetation has been fragmented and exists in patches

5.3.2 Lagoon & Coral Reef Environment

Reef observations were carried out in three locations – the site proposed for dredging, the shallow reef edge at the existing channel and the lagoon area proposed for beach replenishment – on the western side of the island, where the proposed development is to occur.

The floor of the area proposed for dredging have already been dredged in the past to create the existing, shallow harbour. This area was observed to be completely covered with fine sand and silt, with no coral cover. It was also observed various types of waste materials have accumulated in the harbour floor (Figure 17).

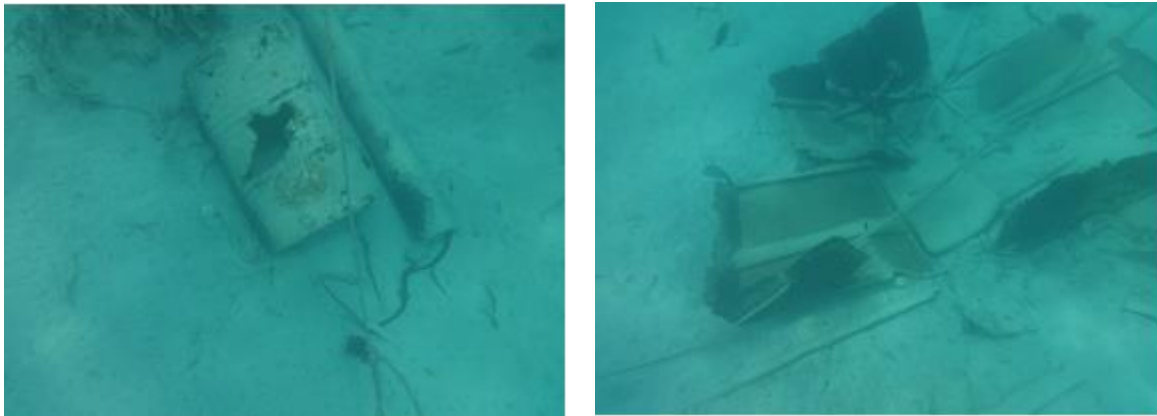


Figure 17: The benthic cover at the existing shallow harbour basin area at Villingili Island, showing rubbish accumulated in the area.

Few fish were encountered in this area, those found were mostly near the existing seawall. Fish types encountered is given in Table 3 (Table 6, Figure 18).

Table 6: Fish species and their relative abundance at the Survey Area 1 (R = rare).

Family	Species	Abundance
Acanthuridae	<i>Acanthurus triostegus</i>	R
Fistularidae	<i>Fistularia</i> sp.	R
Carangidae	<i>Caranx melampygus</i>	R
Gerreidae	<i>Gerres</i> sp.	R
Labridae	<i>Helichoeres scapularis</i>	R
Labridae	<i>Thalassoma hardwicke</i>	R
Mullidae	<i>Mulloidichthys vanicolensis</i>	R
Mullidae	<i>Parupaneus macronema</i>	R
Pomacentridae	<i>Abudefduf septemfasciatus</i>	R
Siganidae	<i>Siganus</i> sp.	R
Scaridae	<i>Scarus</i> sp.	R

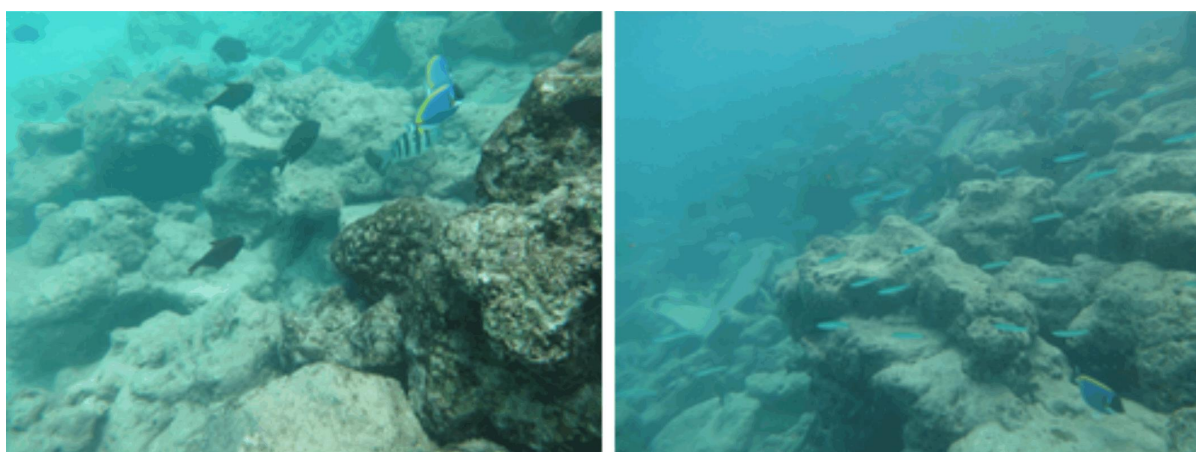


Figure 18: Some fish species observed in near the reef entrance

Second area surveyed was reef edge at the channel of the existing harbour. Three random quadrats were taken to estimate the benthic cover in the area. Quadrat surveys revealed that the survey area was predominantly composed of dead corals, sand and rubble (Figure 19). Live coral cover was found to be poor. Some *Halimeda* sp. Attached to the surface of dead corals were also observed in the area. As can be seen Figure 18 live coral cover in the area was extremely limited to a few colonies of massive type.

The lagoon area near the coast proposed for filled with sand for beach enhancement lacked any live corals and the benthic environment was composed of sand and rubble.

The part of the reef opposite to the beach proposed for reclamation was known to be popular among the snorkelers and divers. Although even there the reef has been considerably degraded. In order to improve the reef health of this area a pilot coral gardening project by Save the Beach has also been carried out. Representative of Save the Beach expressed concern that beach replenishment and dredging may result in sediment plume smothering the healthy patches of corals in the area (see Figure 19 and 20).

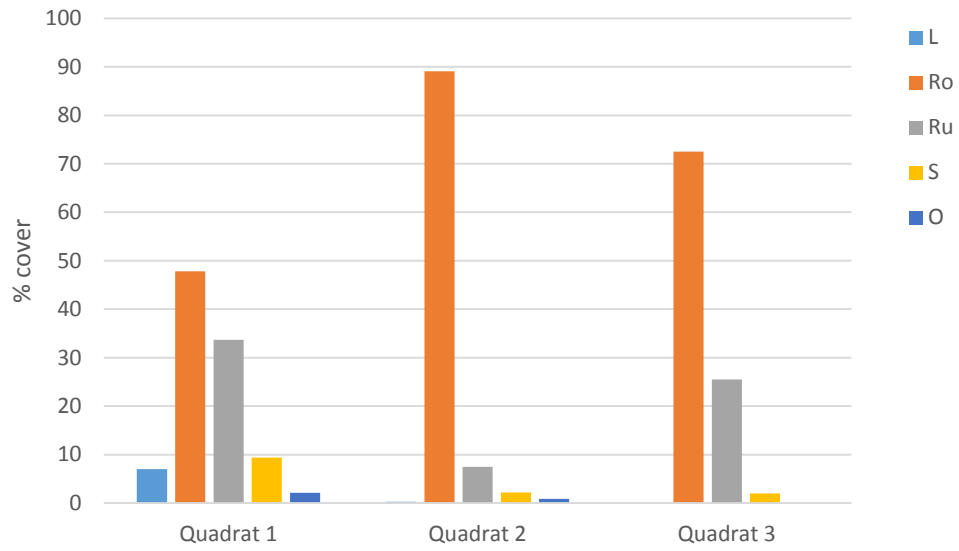


Figure 19: Benthic cover on the shallow reef edge at the channel of the existing harbour proposed for dredging (L = Live coral, Ro = Rock, Ru = Rubble, S = Sand, O = others).



Figure 20: Coral planting area (top) and the general state of the reef to the north of harbour area (bottom) (Source: Save the Beach).

Observations on fish species at this location revealed moderate numbers of fish types ().

Table 7), although the abundance was not too high. Dominant families observed were Acanthuridae, Labridae and Pomacentridae (Figure 21).

Table 7: Fish species and their relative abundance at the Survey Area 2 (R = rare, C = common).

Family	Species	Abundance
Acanthuridae	<i>Acanthurus leucosternon</i>	R
Acanthuridae	<i>Acanthurus triostegus</i>	R
Acanthuridae	<i>Zebrasoma scorpas</i>	R
Balistidae	<i>Suflamen bursa</i>	R
Carangidae	<i>Caranx melampygus</i>	R
Chaetodontidae	<i>Forcipiger flavissimus</i>	R
Clupeidae	<i>Spratelloides delicatulus</i>	R
Labridae	<i>Helichoeres scapularis</i>	R
Labridae	<i>Helichoeres hortulanus</i>	R
Labridae	<i>Labroides dimidiatus</i>	R
Labridae	<i>Thalassoma hardwicke</i>	C
Nemipteridae	<i>Scalopsis bilineatus</i>	R
Pomacentridae	<i>Chromis viridis</i>	R
Pomacentridae	<i>Chrysiptera biocellata</i>	R
Pomacentridae	<i>Pomacentrus chrysurus</i>	R
Serranidae	<i>Epinephelus merra</i>	R
Zanclidae	<i>Zanclus cornutus</i>	R

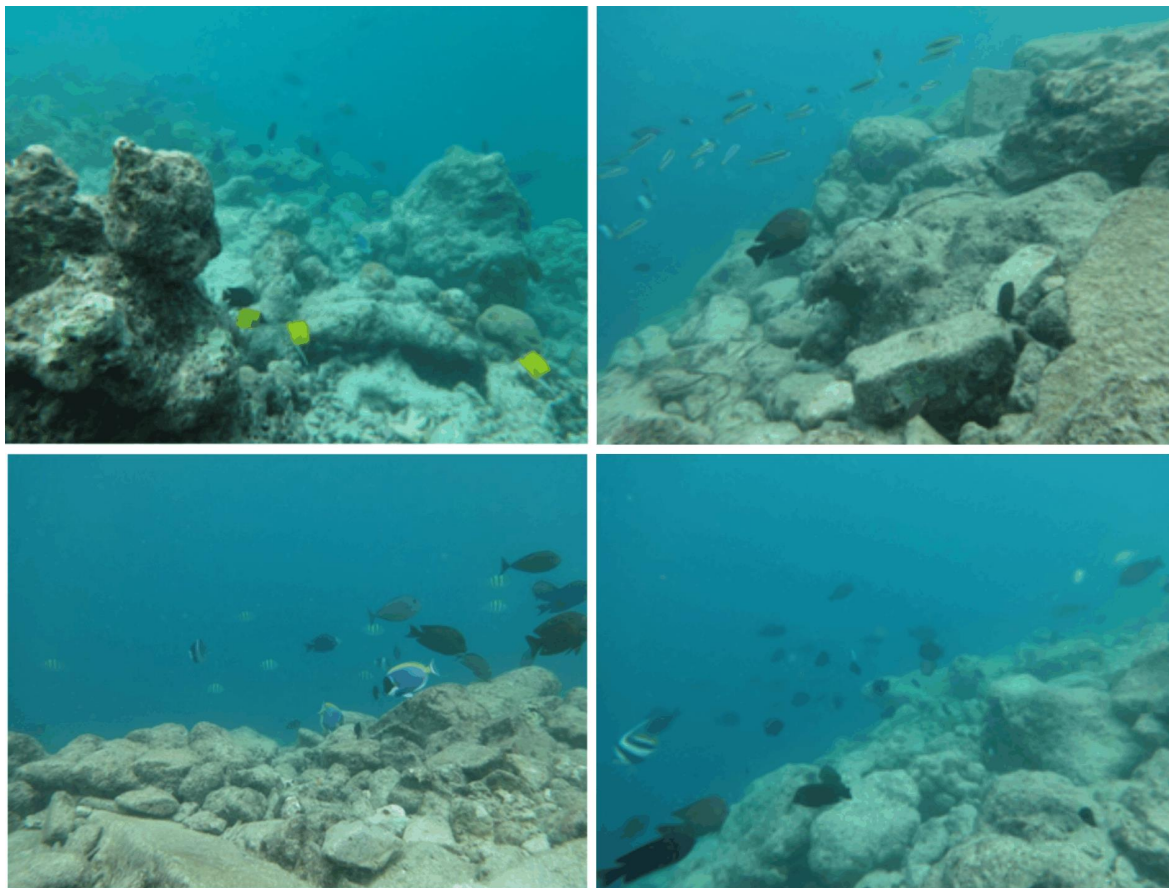


Figure 21: Some fish species observed near the harbour entrance

The third area studied was part of the lagoon near the beach proposed for beach extension. Visual observations of the benthic cover showed that the sea floor mainly consisted of fine sand up to approximately ten meters from the shore. Rubble was the most dominant cover type observed from ten meters from the shore up to the reef's edge. The reef slope was composed of fine sand and rubble.

Massive corals and branching corals were abundant in patches providing cover for a various species of fish including varieties of sand and reef gobies, grub fish, surgeon fish, trigger fish, unicorn fish, butterfly fish, banner fish, angel fish, trumpet fish and box fishes. Moray eels and stone fishes were common while eagle rays and sting rays were also observed. Juvenile schools and adult schools of fish was observed near the shore and the reef's edge respectively. The presence of algae and sea urchins was also observed.



Figure 22: Benthic cover at the lagoon to the north of the proposed harbour. Near the beach the lagoon bottom was exclusively of sand and some rubble (top pictures) while from centre towards the reef flat live coral cover increased (bottom pictures)

5.4 SEAWATER CHEMISTRY

The water quality test results revealed that the quality of water at the site of the proposed development, with respect to the parameters measured, were well within the acceptable range. Except in two locations, the turbidity levels were measured to be 0NTU (see Figure 23). Average salinity was found to be 34.6ppt and average pH of seawater was measured at 8.6. Average concentration of dissolved oxygen was found to be 15.35mg/L while electrical conductivity was 52.6mScm⁻¹. Average temperature was 29.52°C, average total dissolved solids (TDS) was 31.5mg/L and oxidation reduction potential of seawater in the area was measured to be 200.6mV. The locations and respective water quality measurements are given in Table 8.

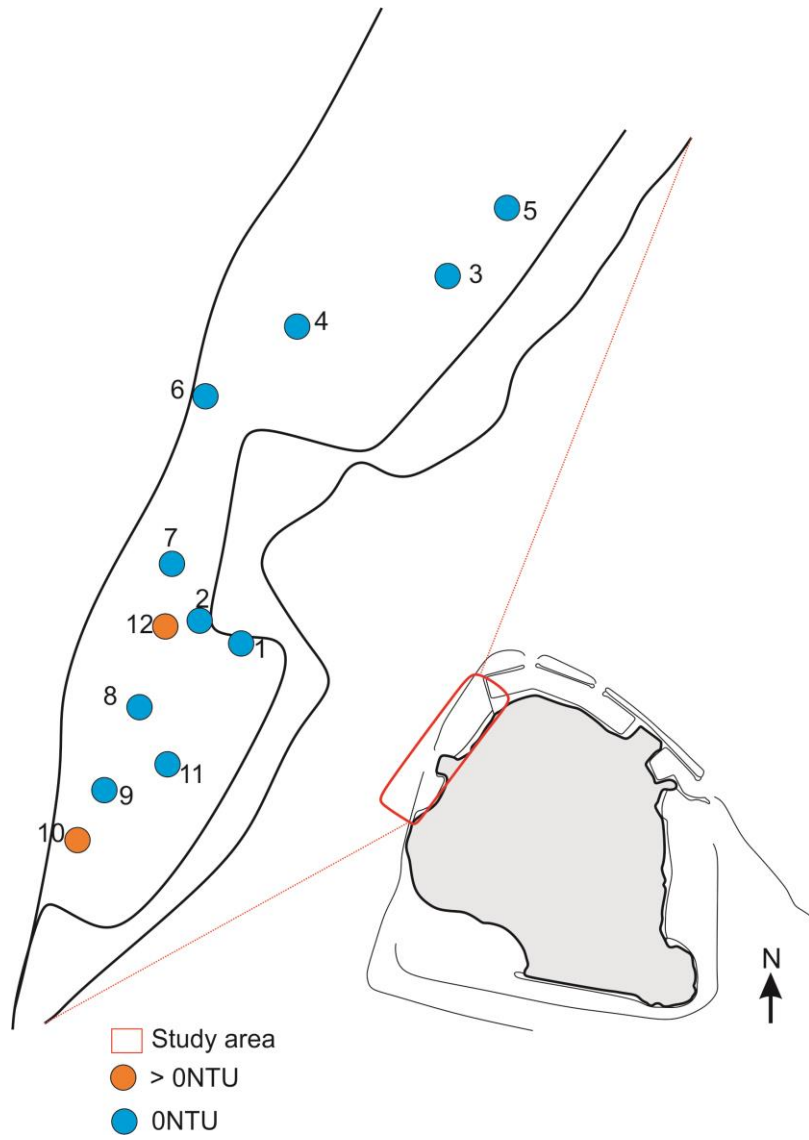


Figure 23: Turbidity measure at various locations of the study area

Table 8: Water quality test results obtained from two locations near the proposed project location.

Name	Location/ (GPS)	Salinity/ (ppt)	pH	Turbidity/ (NTU)	Dissolved Oxygen/ (mgL ⁻¹)	Conductivity/ (mScm ⁻¹)	Temperature/ (°C)	Specific gravity	TDS/(mgL ⁻¹)	ORP/(mV)
Site 1	N4° 10.481' E73° 28.970'	34.8	8.66	0	15.95	52.8	30.13	21.7	31.7	204
Site 2	N4° 10.481' E73° 28.963'	35	8.6	0	15.27	53.1	29.72	22	31.9	190
Site 3	N4° 10.532' E73° 29.000'	34.8	8.58	0	16.74	52.7	29.42	21.9	31.6	235
Site 4	N4° 10.525' E73° 28.978'	34.8	8.59	0	15.82	52.8	29.22	22	31.7	218
Site 5	N4° 10.542' E73° 29.008'	34.5	8.58	0	15.46	52.4	29.17	21.8	31.5	206
Site 6	N4° 10.515' E73° 28.964'	35.1	8.58	0	14.55	53.2	29.37	22.2	31.9	210
Site 7	N4° 10.490' E73° 28.959'	34.1	8.53	0	14.79	51.9	29.47	21.4	31.1	196
Site 8	N4° 10.470' E73° 28.955'	34	8.59	0	14.92	51.7	29.64	21.3	31	194
Site 9	N4° 10.457' E73° 28.949'	33.7	8.58	0	14.81	51.2	29.59	21	30.7	193
Site 10	N4° 10.450' E73° 28.946'	35.1	8.57	0.5	15.44	53.1	29.76	22	31.9	196
Site 11	N4° 10.462' E73° 28.959'	34.8	8.58	0	14.57	52.7	29.6	21.8	31.6	198
Site 12	N4° 10.480' E73° 28.958'	35	8.44	3.1	15.84	53.1	29.09	22.2	31.8	167

5.4.1 Protected Areas and Endangered Species

No rare or endangered species were encountered during the filed investigation. Villingili beach is not known for turtle nesting. No protected area is found around the project site. The nearest protected areas are Hans Haas Place located at a distance of 1.95km to the east and Lions Head at 7.1km also to the east of Villingili. With proper mitigation measures in place sediments affecting these areas can be considered very low.

5.5 HAZARD VULNERABILITY

Site specific data on historical natural hazards was not available for Villingili. Nevertheless, certain generalisations could be made with regards to potential natural hazards vulnerability to Villingili based on Detailed Island Risk Assessment in Maldives (DIRAM) carried out by UNDP (2006). Historical records have shown that swell surges, gravity waves (udha), wind storms, rainfall flooding as most common natural disasters affecting all islands in the Maldives. This being the case, the frequency and intensity of a given hazard may vary from island to island depending the geomorphic and geographic setting of an island. For instance, according to UNDP (2006) impacts of swell waves and udha events are expected to be highest on the western rim island due to the south westerly and westerly approach of these events. However, their impacts aren't totally reduced on the eastern rim islands due to the propagation of swell waves through reef passes and fetch within atoll lagoon. Factors such as location of the island with in the atoll, its shape, formation and orientation, the degree of protection offered to the island by surrounding reefs and other islands and wetlands at the coast, its natural and manmade coastal protection structures, are all contributors to the resiliency of the island to withstand natural hazards.

Based on the outcomes of the DIRAM 1 report, the hazard exposure and vulnerability of Villingili can be deduced from the Figure 24 below.

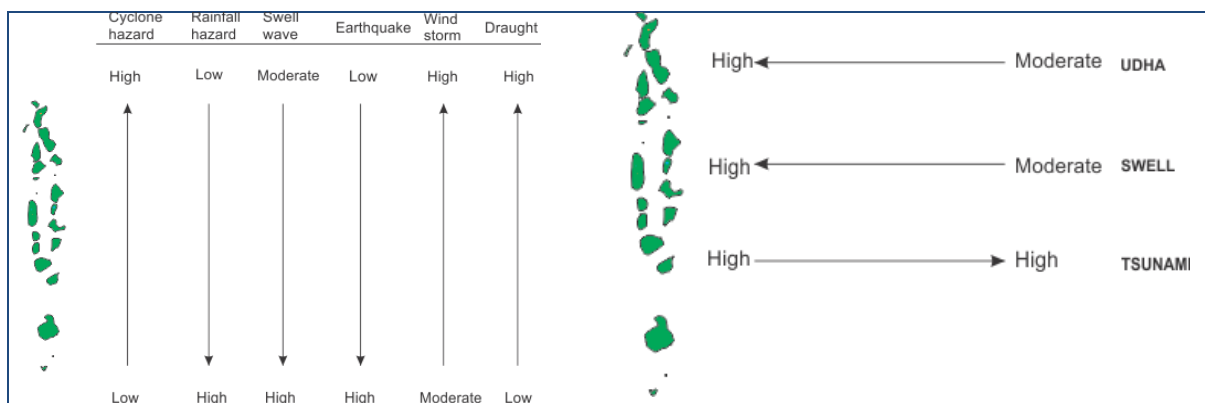


Figure 24: Hazard vulnerability assessment (UNDP, 2006)

Villingili being located on the eastern side of the double chain that makes up the islands of the Maldives, and being in the central region of the country makes it included among the islands that are most vulnerable to impacts of possible tsunamis. However, probability of occurrence of a tsunami being very low it is not considered a hazard of immediate concern. Whereas swell waves, Udha, rainfall flooding and strong wind storms are more likely to affect Villingili. During June to August southwest monsoon has the most potential for large waves with approach from south during rough times the wave height could reach up to 2.5m to 4m wave height. The location of the harbour is fairly protected from swells approaching in southerly direction through Vaadhoo Chanel. However, waves generated by strong winds could still hit from western side of the reef. Such high waves should be taken into consideration in determining the height of the breakwater.

6 STAKEHOLDER CONSULTATION

6.1 SCOPING MEETING

The stakeholder consultations were aimed at understanding the views and opinions of the people/organizations who have a stake in the project. The main stakeholders identified for the proposed project are the Ministry of Housing and Infrastructure, Ministry of Environment and Energy and the Environment Protection Agency. The most important stage of the consultative process is the scoping meeting conducted prior to the finalization of the Terms of Reference. The scoping meeting conducted on 6th August 2015 invited representatives from the Ministry of Environment and Energy, Male' City Council, Ministry of Housing and Infrastructure and the Environmental Protection Agency. Except for the Male' City Council, representatives from other organizations participated in the meeting. List of participants in the scoping meeting is given in Table 9. The scoping meeting was held at the Environment Protection Agency.

Table 9: List of attendees at the scoping meeting

Name	Designation	Organisation	contact
Aminath Mohamed	Environment Analyst	EPA	Aminath.m@epa.gov.mv
Nafha Aujaz	Environment Analyst	Ministry of Housing and Infrastructure	Nafha.aujaz@housing.gov.mv
Mahid	Assistant GIS Officer	EPA	
Shahula		EPA	
Fidaad Jaleel		EPA	
Mohamed Musthafa	EIA Consultant	MEECO	Mohamed.musthafa@meeco.com.mv
Mohamed Mahid	Consultant	MEECO	Mohamed.mahid@meeco.com.mv
Moosa			

The Ministry of Housing and Infrastructure (MHI) as the proponent of the project introduced the project at the stakeholder meeting. The importance that the government attaches to the project was also highlighted in the introduction. It was revealed as the implementing agency MHI is fully committed to the completion of the project as a priority of the government and the necessary financing for the project has been allocated in the government's fiscal budget for 2015 approved by the parliament. According to MHI the construction work of the harbour and slipway will start soon after approval of EIA study. MHI, as the proponent of the project, is fully committed to the EIA process and is willing implement the necessary mitigation measures to minimize the impacts arising during the construction of the project. MHI is of the view with the project fully implemented it would translate into the socio-economic development of Villingili in particular and the region in general. Following the introduction various environmental aspects that need to be considered in the EIA was discussed. No specific requirement was mentioned and no representative disapproved the project.

6.2 COMMUNITY CONSULTATION

In addition to the scoping meeting, opinion of the locals who have a stake in the project were sought during the field investigations. According to some of the boat owners who use the western side harbour this has been a very important facility for them. However since the breakwater fell off many years ago they have been desperately waiting for the authorities to put in place a breakwater. Without the breakwater in place, according to the locals, during rough weather the harbour has not been able to provide a safe anchorage, causing the boat owners thousands of Rufiya worth of damages. Additionally a lot of difficulties are also faced to them due to the shoaling of the harbour basin. For small boat owners, the west harbour is the only space available for them to maintain their boats and without the availability of this facility, they fear the income they generate through operation of the boats and fishing may be lost.

There has also been some concerns with regards to the proposed beach nourishment. The small beach proposed to be replenished is frequented by the locals as well as foreign tourists. Some were of the view that the natural appeal of the existing beach may be lost when dredged material is added to it. The portion of the reef opposite to the beach is popular among the snorkelers, divers and sea sport adventurers. Part of it is also used for a pilot project on coral gardening by Save the Beach NGO. In addition to losing natural appeal of the beach they fear that the sedimentation could spoil the reef and damage the coral garden. This would inevitably affect the small business such as the diver school and people who use the site for leisure and enjoyment.

7 POTENTIAL IMPACTS AND MITIGATION MEASURES

7.1 INTRODUCTION

Developmental projects involving coastal development and coastal modification in island environments are considered to generate a various levels of environmental impacts, some of which can be felt on the immediate environment and some impacts can be cumulative. Marine environment is directly affected from changes in hydrodynamics due to coastal modification from dredging and reclamation projects as coral reefs are very vulnerable to immediate changes that will be sustained from most of the development activities. Therefore, during the scoping, designing of the project activities and field surveys, consideration must be given to minimize the impacts felt on the environment. This Chapter describes in detail the potential environmental impacts and measures proposed to mitigate the impacts arising from harbour, slipway development and beach nourishment works both during construction and operation phases of the proposed project.

7.2 UNCERTAINTY

Environmental impact prediction itself involves a certain degree of uncertainty, as the predicted impacts may vary according to weather, ecological conditions and social conditions in the atoll or island. Furthermore, limited time allocated for conducting the EIA studies does not permit collecting adequate primary data on the existing environment of the project location. Data on environmental aspects such as currents, waves, and sediment transport regimes may require at least one full year of data collection to make informed judgments. Given the time and budgetary constraints, the impact predictions to a large extent had to be based on short term primary data and secondary information obtained from literature review and conducting interviews with the locals. However, the level of uncertainty, in the proposed project is considered to be low, as the project scope is small and experience from harbour construction work carried out in many islands and resorts in the Maldives is readily available.

7.3 POTENTIAL ADVERSE IMPACTS ON THE ENVIRONMENT

As this is a coastal development project, majority of the impacts of the project are expected during the construction stage. This phase includes mobilization of machinery and vehicles, workforce, dredging of the channel, harbour basin, and construction of the slipway, revetment, quay walls and beach nourishment.

This Section of the report identifies the potential environmental impacts and possible issues that could arise from construction and operational phase. Their identification of potential impacts does not mean that they would necessarily occur or that they could not be successfully mitigated.

The assessment of environmental impacts (positive and negative) had been carried out during EIA process and the resulting RIAM matrix is given in Table 10.

Table 10: The assessment of environmental impacts by RIAM methodology (construction phase)

			ES	RS	I	M	P	R	C
Physical/Chemical	PC1	Coastal morphology	-9	-A	1	-1	3	3	3
	PC2	Hydraulic conditions	-9	-A	1	-1	3	3	3
	PC3	Water quality	-7	-A	1	-1	2	3	2
	PC4	Natural disasters	0	N	0	0	1	1	1
	PC5	Pollutants	-6	-A	1	-1	1	2	3
Biological/Ecological	BE1	Coral reefs	-15	-B	1	-3	1	1	3
	BE2	Sea grass beds	0	N	0	0	1	1	1
	BE3	Mangroves	0	N	0	0	1	1	1
	BE4	Endangered species	0	N	0	0	1	1	1
	BE5	Sedimentation/Eutrophication	-7	-A	1	-1	2	2	3
	BE6	Terrestrial ecosystem	0	N	0	0	1	1	1
Social/Cultural	SC1	Aesthetic and cultural value	-9	A	1	-1	3	3	3
	SC2	Income	-12	-B	1	-2	2	2	2
	SC3	Fishery	0	N	0	0	0	1	1
	SC4	Recreational value	-16	B	1	-2	2	3	3
	SC5	Employment	6	A	1	1	2	2	2
	SC6	Public health and safety	-9	-A	1	-1	3	3	3
Economic/Operational	EO1	Infrastructure	0	N	1	0	2	2	1
	EO2	Navigation	-6	-A	1	-1	2	2	2
	EO3	Regional economy	0	N	1	0	1	0	1

Table 11: The assessment of environmental impacts by RIAM methodology (operations phase)

			ES	RS	I	M	P	R	C
Physical/Chemical	PC1	Coastal morphology	-9	-A	1	-1	3	3	3
	PC2	Hydraulic conditions	-9	-A	1	-1	3	3	3
	PC3	Water quality	-14	-B	1	-2	2	3	2
	PC4	Natural disasters	0	N	0	0	1	1	1
	PC5	Pollutants	-18	-B	1	-3	1	2	3
Biological/Ecological	BE1	Coral reefs	-10	-B	1	-2	1	1	3
	BE2	Sea grass beds	0	N	0	0	1	1	1
	BE3	Mangroves	0	N	0	0	1	1	1
	BE4	Endangered species	0	N	0	0	1	1	1
	BE5	Sedimentation/Eutrophication	-7	-B	1	-1	2	2	3
	BE6	Terrestrial ecosystem	0	N	0	0	1	1	1
Social/Cultural	SC1	Aesthetic and cultural value	9	A	1	1	3	3	3
	SC2	Income	32	D	2	2	2	3	3
	SC3	Fishery	0	N	0	0	0	1	1
	SC4	Recreational value	16	B	1	2	2	3	3
	SC5	Employment	32	E	2	2	2	3	3

	SC6	Public health and safety	9	P	1	1	3	3	3
Economic/ Operational	EO1	Infrastructure	36	D	2	2	3	3	3
	EO2	Navigation	18	B	2	1	3	3	3
	EO3	Regional economy	36	D	2	2	3	3	3

Range of values (RS) given in the Tables 10 and 11 in alphabetic are as follows:

- E = major positive change;
- D = significant positive change;
- C = moderate positive impact;
- B = positive impact;
- A = slight positive impact;
- N = no change/Status quo/not applicable;
- -A = slight negative impact;
- -B = negative impact;
- -C = moderate negative impact;
- -D = significant negative impact; and
- -E = major negative impact.

Class totals for four major categories are given in the Table 12.

Table 12: Class totals for major categories of environmental impacts

Phase	-E	-D	-C	-B	-A	N	A	B	C	D	E
Construction	0	0	0	2	7	8	2	1	0	0	0
Operations	0	0	0	4	3	6	2	2	2	2	0
Total	0	0	0	6	10	14	5	4	2	2	0

As Table 12 shows no extremely negative impact, significantly negative impact or moderately negative impacts are expected as a result of the proposed project (-E, -D, -C = 0) neither in construction phase nor in implementation phase of the project. During both construction and operational phase 5 types of less negative effects are foreseen (-B = 5). Ten slight negative impact is expected (-A = 10). On the other hand, the project is expected to generate significantly positive impacts (D=2), moderately positive impacts (C=2), less positive impacts (B=4) and reduced positive impacts (A=5) during construction as well as operational phase.

The following paragraphs elaborate negative and positive impacts identified in the RIAM assessment above predicted for the proposed project during construction and operational phase with proposed mitigation measures to further reduce the effects in the case of the negative impacts.

7.3.1 Impacts on Coastal Morphology

The project is expected to have moderately negative impact on the coastal morphology of the island during construction and operational phase as per the impact analysis. The project will inevitably impact the coastal morphology of Villingili largely due to proposed dredging and beach replenishment. The dredging has been proposed to be at location which has already been dredged and utilised as a harbour facility. In addition the exposed side of the harbour will be protected by a seawall constructed from rock boulders. The material excavated has been planned to be used for widening the beach to the north of the harbour. It is very likely that the texture and the particle size of the material dredged from the harbour basin not to match exactly with that of the material already found on the “natural beach”. Such mismatch may result in added material being rapidly getting detached and getting washed away from

the area. It should also be noted that the longshore currents in the area is interrupted by the coastal structures protruding from the coast. These structures are likely to act as sediment traps providing some degree of stability to the added materials (see Figure 25). The proposed harbour, seawall, the slipway and beach replenishment may have little or no effect on the littoral transport affecting erosion and accretion pattern due to the “contained” nature of the project interventions as well as heavy coastal modifications that had already taken place around Villingili coastal areas.

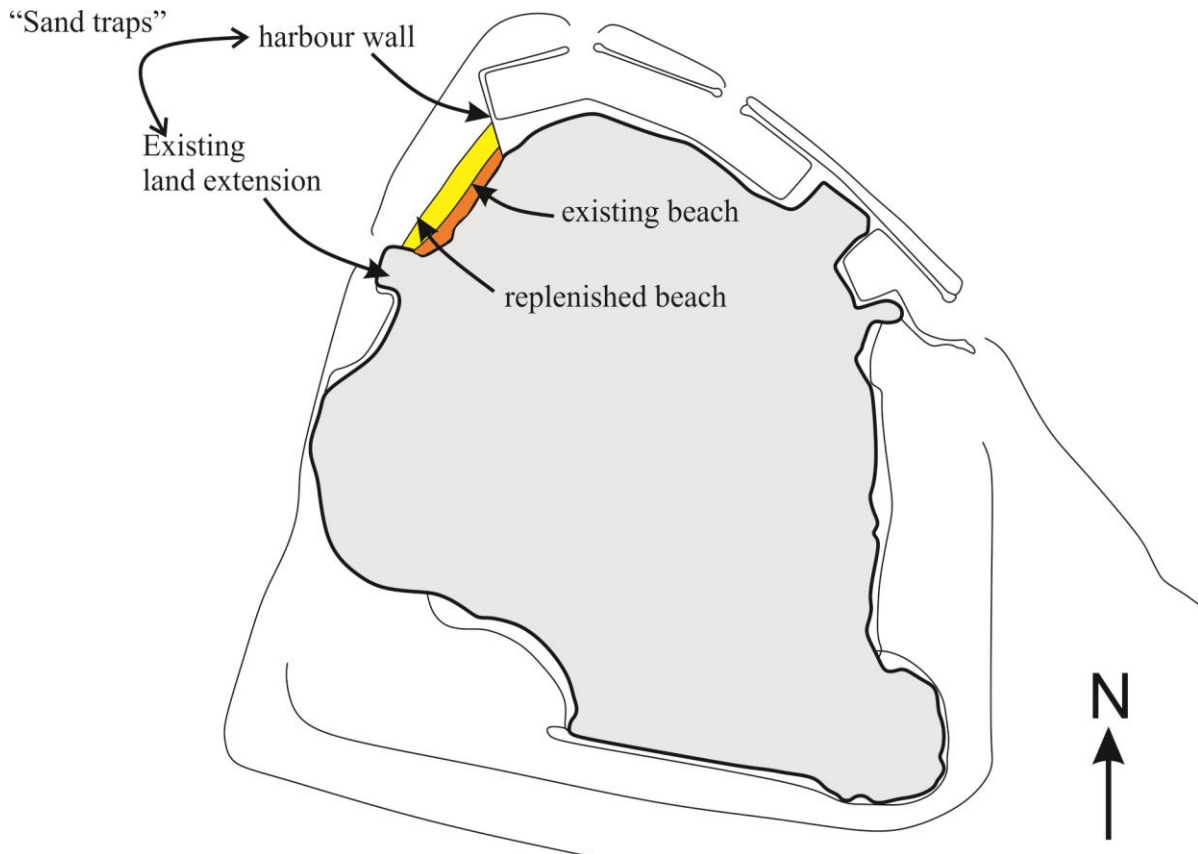


Figure 25: Beach stability at the replenished area

Mitigation

- Grading of the material will be required to ensure materials of similar size is used in replenishing the beach. The toe of the extended beach may also require some degree of protection for containment.

7.3.2 Impacts on Geomorphological Aspects

Coral reefs exhibit highly variable characteristics including zones of poorly consolidated material, zones of cementation coral cavities and voids. These geological aspects of the coral reefs became an important issue following series of house reef slope failure events that hit north eastern side of Male’ house reef in 2002. Given that the rock boulder breakwater is relatively small compared to the perimeter of the house reef, the construction of the breakwater on the reef flat is not expected to have a significant impact on the house reef. However, as precautionary measure the following mitigation measures have been proposed.

Mitigation

- The foot of the breakwater shall not sit directly on top of the reef edge just before the drop off; and
- No blasting of the reef to ensure reef structural integrity is intact and not affected by the project.

7.3.3 Impacts on coastal morphology

Modification of the beach can affect the coastal morphology and hydrological process around it. The actual changes and magnitude of the effect can be determined by long term monitoring of the coastline of the beach modified. Overall the effect during construction and operational phase is considered as a reduced negative effect.

Mitigation

- Beach profiles and shoreline changes of the beach modified shall be carried out on a regular basis as prescribed in the monitoring section.
- The foot of the beach can be secured using artificial cement block if loss of sediment becomes significant.

7.3.4 Impacts on Seawater Quality & Sedimentation

The toothed-bucket action of the excavator on the sea floor head will disturb the substrate and place sediments into suspension. In addition movement of the bucket while lifting the sediments out of the water will also place sediments into suspension. Additionally, during beach replenishment, loose material when placed on the shore without a barrier can be carried into the water by the action of the waves and currents. The suspended sediments may then smother nearby corals, bottom-living flora and fauna as and when they settle. This issue need to be given particular attention in the present case, since the basin planned for dredging has previously been dredged and very fine materials have already accumulated on the on the floor. Even minor disturbance could put these fine materials into suspension and may be carried away by the waves and currents.

The effect will be most severe if the dredging of the channel and the harbour and beach replenishment starts without sediment containment measures and if the work coincides with rough weather. The severity of the impact would also depend very much on the direction of the sediment plume which in turn would depend on the direction of the currents and wind. During the survey the currents were found to be towards the shore from west to eastward. This may however change when the monsoonal winds change in which case, the sediment plume may reach the section of the reef opposite to the beach replenishment area where coral gardening project is being undertaken and where the natural reef is believed to be improving following a coral regeneration program conducted by Save the Beach with financial support from Global Environmental Facility's Small Grant Program. This 2 year program is half way through and according to the NGO success have been satisfactory. Due to the heavy modifications brought to the coastal and marine environment of Villingili, preserving the reef in this area is particularly important as there are small businesses that rely of organising diving and sea sport events there. In addition snorkelers and swimmers will also be affected if this part of the reef is further degraded.

With the mitigation measures in place it is believed that the project will have minor negative impact on the seawater quality both during the construction and operational phase. During the dredging for harbour basin, channel deepening, as well as during beach replenishment works, siltation and sedimentation in the immediate vicinity is expected to increase, leading to increased level of turbidity in the water column. The open channel area and the materials put on the exposed beach surface will pave the way for escape of sediments into the marine environment. Such excessive sedimentation this may cut

sunlight and oxygen reaching the benthic environment and may affect the health of live coral cover in the house reef. Fine sediments settling on live corals can also deprive oxygen supply causing smothering of corals. As the deep channel between Villingili and Gulhifalhu is expected to have dynamic hydrological conditions sediment plume is expected to diffuse rather quickly. However, depending on the wave conditions and currents at the time of the works mitigation measures will be required to protect the reef.

During the operational phase water quality can be affected by sedimentation if the newly created beach erodes. Such erosion may result in increased turbidity in water column and if sediments settle on the reef it can cause smothering of reef. Water quality within the harbour can be affected due to pollution caused by the boats based activities and operations of the slipway. Anything spilled from the slipway based activities will eventually finds its way into the harbour. Waste spillages during lifting of waste through the slipway can be expected.

The proposed design of the harbour appear to limit the water exchange and flow in the harbour basin. Inadequate water flow from the harbour basin could create stagnation and accumulation of pollutants (See Figure 26). During the southwest monsoon

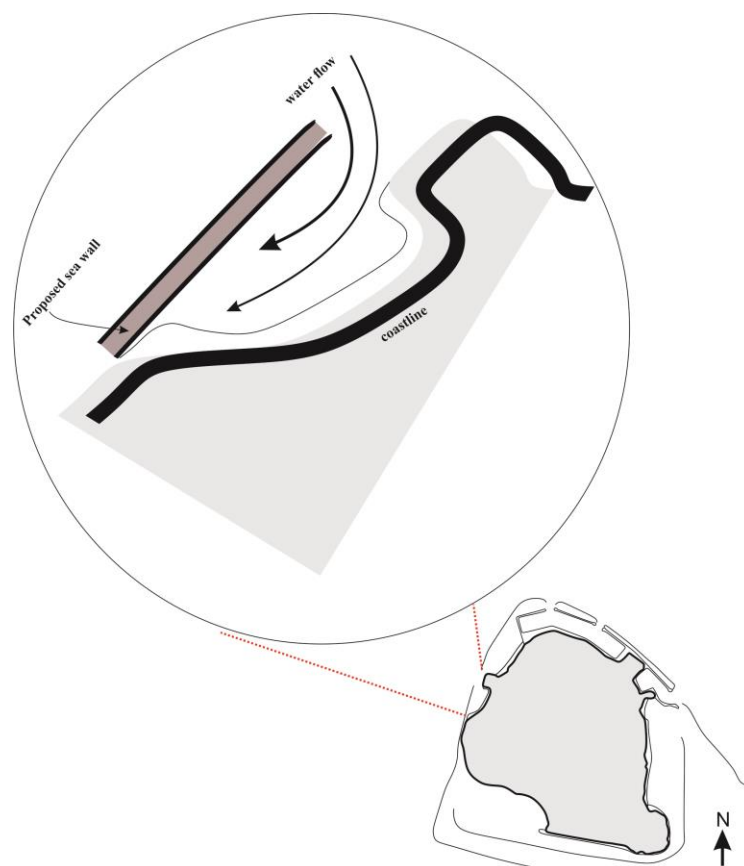


Figure 26: Expected water flow limitation

Mitigation

The followings mitigation measures would be used while dredging for harbour basin and channel deepening and beach replenishment works:

- Use silt screens at the mouth of the entrance channel while deepening the harbour basin as to restrict sediment dispersal;

- The breakwater shall be completed before the harbour basin dredging works could commence;
- Deposit dredged materials in the selected areas only;
- Sediment containment (sandbags or sand-bund) to be constructed prior to proposed land replenishment;
- The work to be carried out during normal weather and shall not proceed with works during very rough weather conditions;
- Dredging work is preferred to be carried out during the southwest monsoon when the currents from west to east;
- Contractor shall ensure that qualified and experienced workforce is utilised in the dredging, transport and disposal of sediments;
- The work should be properly supervised by a site supervisor and records shall be kept properly;
- Developing land-based facilities to receive wastes from vessels using the harbour. Proper waste collection bins need to be placed conveniently at the harbour to receive wastes from vessels especially during operational phase. In addition, toilet facilities shall be developed to prevent boat crew and harbour users from discharging human wastes into the marine environment;
- Strict guideline on the use of the harbour shall be on display to prevent spills of all kinds from vessel visiting the harbour and local crafts;
- The residual hazardous waste shall be collected properly and transported to Thilafushi;
- In order to prevent effects of spillage proper standard operating procedure shall be in place;
- All proper best practices should be strictly adhered and care should be taken not to dump anything to the marine environment of the project site and regular visual surveys would be undertaken during the construction and regular harbour area cleaning arrangement shall be in place during operation phase;
- In order to prevent water stagnation and enhance water circulation it is recommended to consider including culverts in the seawall (see Figure 27). The size and number of culverts shall be decided by the project engineer.

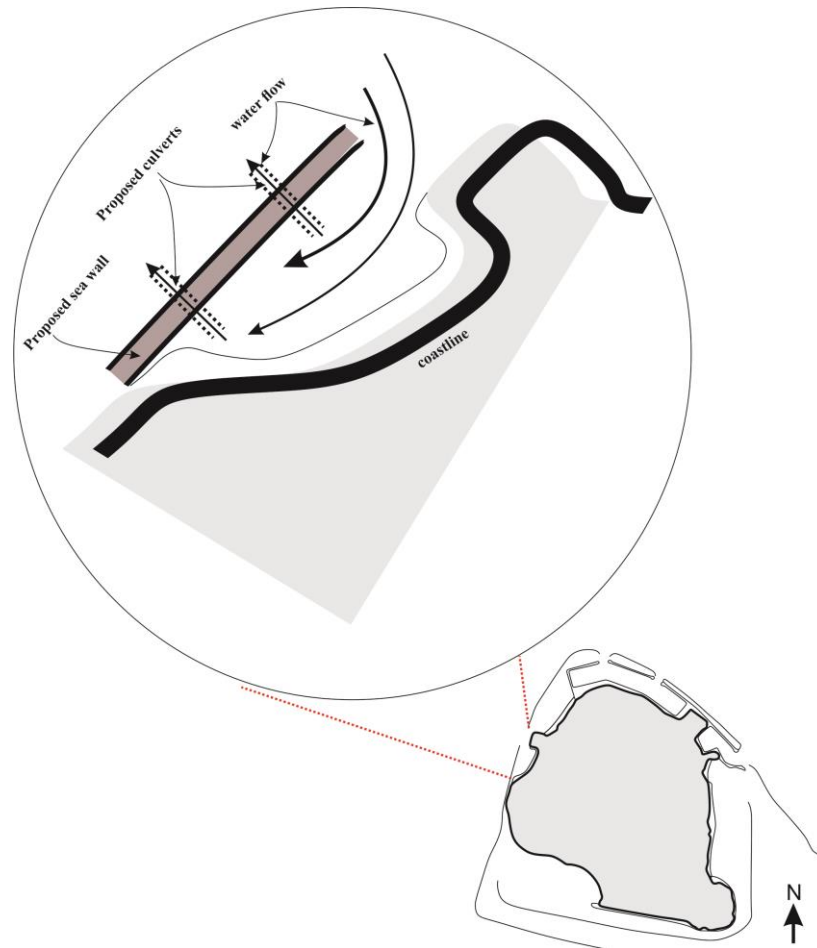


Figure 27: Insertion of culverts in the break water to channel water flow. Ocean water flow in through the channel while highly dense contaminated water from the harbour basin flow out, creating sufficient circulation

7.3.5 Impacts on Coral Reef

As explained in the Section on existing environmental condition of the site, no live corals are expected to be affected as a direct result of dredging and beach replenishment since the reef conditions in the immediate project area was found to be in a poor state. Few patches of massive corals were found in the proposed reef entrance area and live corals are almost non-existent in the footprints of planned harbour, the slipway and beach replenishment area. Fish life in the existing harbour basin was found to be poor although at the periphery of the house reef fish numbers were moderately good. The benthic environment of the harbour basin was in a heavily disturbed state due to the past dredging activities whereas, the benthic areas proposed for beach extension was found to be in a good state although no corals are found there. However, with the addition of fine materials at the toe of the existing beach very fine sediments may be carried further into the lagoon. When these sediments settle it may create a soft bottom at the seafloor making it uncomfortable for the shallow water swimmers to stand on it.

With the proposed breakwater placed on the footprint of the existing breakwater no new area on the reef is expected to be affected. However, as a result of the proposed project, approximately 760m² of benthic environment to the north of the proposed harbour where beach replenishment will take place will be permanently altered and the benthic life-forms in the area will have to be sacrificed. The loss of bottom habitats and direct and indirect loss of corals as a result of the project is expected to be moderately negative.

Lagoon bottom is a habitat to benthic organisms such as worms, molluscs, amphipods, crustaceans, etc, which are important food sources for reef fish communities. However, when the replenishment and dredging is over or when the disturbances ends, the lagoon dwelling organisms would re-establish themselves in the area.

Sedimentation, silt deposition on coral colonies, other benthic organisms at the receiving environment of borrow materials (areas proposed for reclamation) would lead to changes in the biotic composition and sometimes lead to the death of the coral reef in the house reef. This is due to the fact that coral and algae from a coralline reef ecosystem are very sensitive to change in environment and would suffer immediately from sedimentation. When the reef ecosystem become damaged some benthos such as molluscs, crustaceans and amphipods would leave the impacted area to another healthy reef area in the vicinity but the corals and algae will immediately die. It is expected, after the sediments from the dredging settle down, corals and other related marine life are expected to resettle given that no major changes in water quality are permanent.

As a result of dredging reef fish and other marine organisms will be affected in terms of habitat disruption and their free movement in the environment. Many of these impacts may be short-lived and is expected to be limited to the development phase of the Project.

Predicted areas of the reef flat that will be impacted directly and indirectly is show in Figure 28.

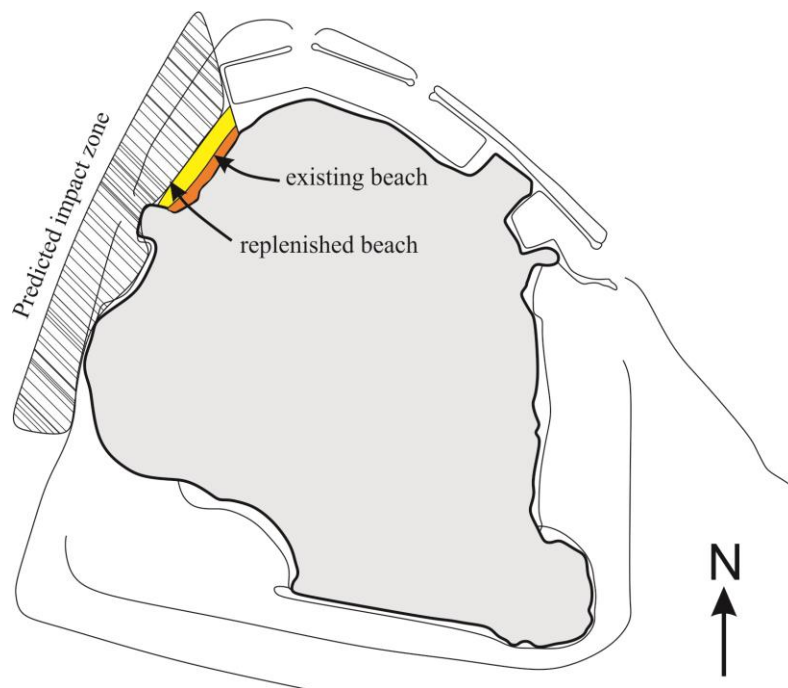


Figure 28: Predicted impact zone

Mitigation

In order to effectively mitigate potential impacts on lagoon benthic organisms, reef fishes and coral reefs the following measures shall be in place;

- Use turbidity barriers at the entrance channel when the lagoon basin dredging takes place and in front of the beach replenishment area when beach is nourished (Figure 29). Turbidity barriers or silt curtains are often used to limit the impact of turbidity. In the case of the beach replenishment area, temporary sandbags may be used to achieve the purpose.

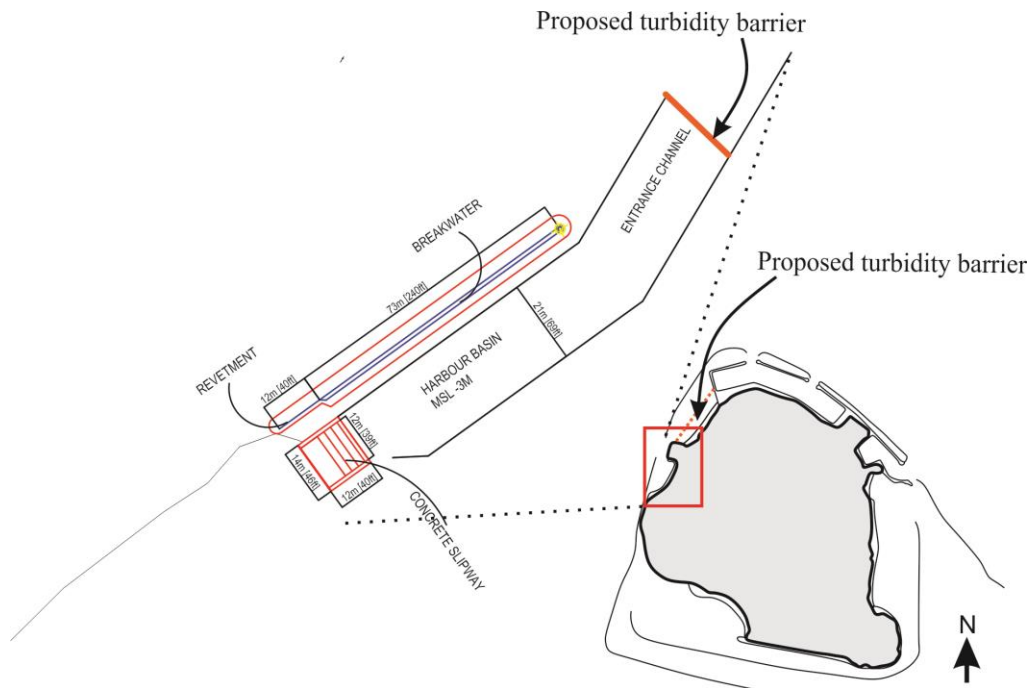


Figure 29: Proposed turbidity barrier to contain sediment escape

In some cases where relatively quiescent current conditions (0.06m/s or less) are present, turbidity levels in the water column outside the curtain can be 80 to 90 percent lower than the levels inside or upstream of the curtain. While there may be a turbid layer flowing under the curtain, the amount of suspended material in the upper part of the water column, as a whole, is substantially reduced. However, the effectiveness of turbidity barriers can be significantly reduced in high energy regimes characterised by currents and turbulence. Measured current levels at the site indicates an average velocity of 0.20m/s suggesting moderate currents in the area that's capable of transporting materials away from the point of disturbance (Figure 30).

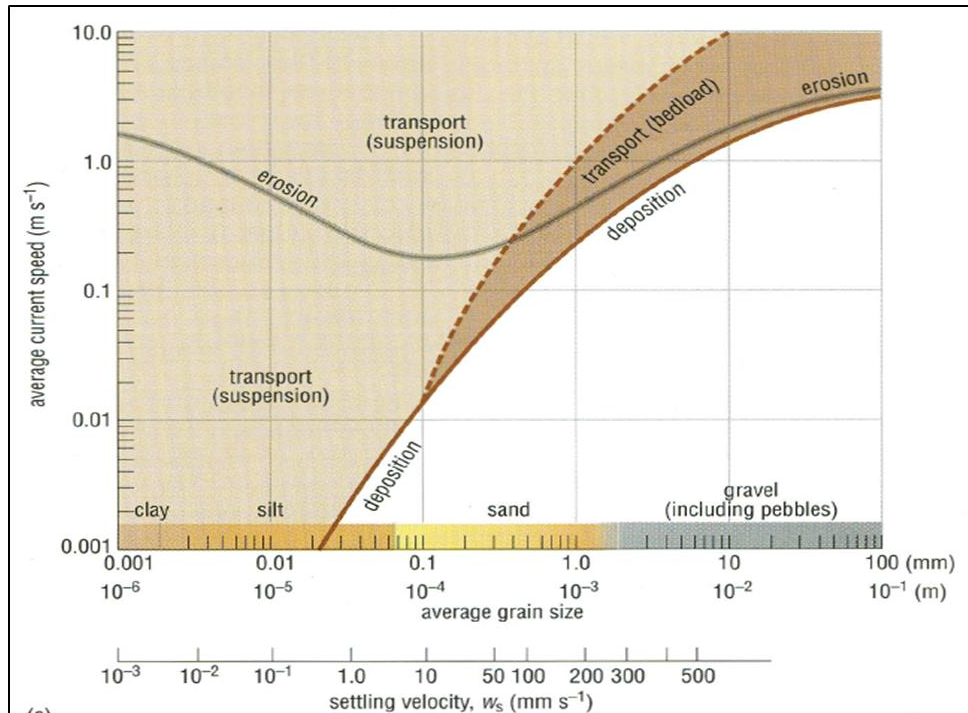


Figure 30: Range of average current speeds at which sediment particles of different sizes are eroded and transported. Broken line indicates the transition between bedload and suspension transport. Average settling velocities (W_s) for particles of different sizes deposited from suspension in still water are also illustrated (Adapted from Groud & Aubrey, 1985).

High currents cause turbidity barriers to flair, thus reducing the curtain's effective depth; in fact, in a current of 0.51m/s the effective skirt depth of a 5ft curtain is approximately 3ft. Increased water turbulence around the curtain also tends to suspend the fluid material layer and may cause the turbid layer flowing under the curtain to resurface just beyond the curtain.

However, even under moderate currents (up to 0.26m/s), a properly deployed and maintained center tension curtain can effectively control the flow of turbid water (under the curtain). In other cases, where anchoring is inadequate and particularly at sites where tidal currents dominate the hydrodynamic regime and may cause re-suspension of the fluid material as the curtain sweeps back and forth (over the fluid material) with changes in the direction of the current, the turbidity levels outside the curtain can be as much as 10 times higher than the levels inside the curtain. With respect to overall effectiveness and deployment considerations a current velocity of approximately 0.46m/sec appears to be a practical limiting condition for turbidity curtain use.

- Restrict dredging and reclamation to the areas specified and not to go beyond it;
- Controlling sediments shall be given the highest priority bearing in mind that there is no legislation in the Maldives with regards to permitted levels of turbidity, we propose under the project's monitoring program to set up geo-referenced monitoring stations. In this regard, at least 3 monitoring stations shall be set up. The Consultants will assist the proponent in setting up the monitoring station or the compliance station, sample collection and data analysis.

Samples is to be taken at a depth of 3 feet from the surface at each station and at a frequency of at least once a day during the dredging operations. Nephelometric Turbidity Units or NTU's so that during construction, the turbidity level to be maintained below 29 NTU's against the associated background turbidity levels as prescribed in the Monitoring Section. NTU upper limit has been set based on compliance limits set is based on practices in some countries.

Measurements will be taken prior to commencing dredging in order to determine the background turbidity level whilst turbidity is affected movement of vessels in the harbour. The pre-determined limit of turbidity levels at the compliance stations will therefore be [background turbidity] + 29 = [upper limit for turbidity] NTUs. Measured average turbidity levels at the time of the EIA study was found to be 0NTU hence it would be acceptable to take the upper limit as 28 NTU.

However, if background measurements exceed the pre-determined limit of 29 NTUs, the background measurement shall be used for comparison of compliance measurements. In other words, compliance measurements shall be compared with the daily background measurement or the pre-determined limit, whichever is higher. If monitoring reveals turbidity levels at the compliance sites in excess of the limit of 29NTUs or the background measurements, whichever is higher, construction activities shall cease immediately and not resume until corrective measures have been taken and turbidity has returned to an acceptable level. Any such occurrence shall also be immediately reported to the Project Manager.

- 29 NTU is the absolute maximum we recommend and any exceedance of this value must result in the suspension of dredging/disposal operations.
- Corals that can be manually removed from dredging and reclamation areas shall be removed and re-planted in unaffected area;
- Complete the project within the shortest time possible by putting in place measures to avoid idle time;
- There should be daily supervision by the contractor of the work progress and the work force should be properly trained on environmental awareness and best practices.

7.3.6 Impacts on Aesthetic and Cultural Value

Overall the impacts on aesthetic and cultural values due the project is considered to be less negative during construction phase but during operational phase due to the increased beach size and regular clearance of waste from the island, the project's impact on aesthetic and cultural value may be positive. Beach replenishment has been proposed at an area which is used by locals and tourists for picnicking and enjoyment. The natural façade of the beach may be lost when sediment is added to the area. Changes that take place to the natural façade of the beach as a result of beach replenishment may be interpreted as decline in natural appeal for some. However, the significance of this impact may vary from person to person. On the one hand having a wider beach with more space to accommodate more activities and more people could be perceived as a positive while losing the naturalness of the beach may be seen as a negative by others. The aesthetic quality of the house reef may be further degraded if the sediments blanket on top of it.

Sediment plume if uncontrolled may be visible from distance and has the chance to create a negative perception of the project. During the construction phase the work site with machines and equipments in operation may also not be appealing.

During the harbour dredging and construction, site bulldozers and excavators would be working non-stop and it is likely some noise would be generated from the work. Residents living close to the project site may find the construction noise annoying and unacceptable. Most of these impacts are however are limited to the construction phase and are considered to be short-lived. Considering long term visual impacts, the beach area will have to replenish to maintain the natural appeal as much as possible.

Since the beach segment proposed for replenishment is frequented by locals especially during the weekends will have to forgo using it during the construction period. Since there are other alternatives available for such activities for the locals, these issues are not considered significant.

Littering of waste during construction and operational phase of the project can lower the aesthetic quality of the project environment.

Mitigation

- Limit the noise generating works to day times as far as possible to avoid any potential noise impacts;
- Controlling sediment plume at the mouth of the entrance channel as well area where beach nourishment has been proposed as explained earlier;
- Design the beach so that the natural formational features are not lost, grading may be necessary to ensure particles of similar size are placed as replenishment materials, larger fragments that have sharp edges shall not be allowed to avoid unintended accidents occurring for the beach users;
- Provide necessary information to the locals on the project to alert and inform the public of the planned work to avoid unnecessary accidents and conflicts;
- Waste generated during the project shall be in accordance with the Section 2.9 to avoid pollution and degrading aesthetic quality of the area; and
- Records of any public complaints related to project shall be kept and resolved as soon as possible.

7.3.7 Impacts on Income and Employment

During construction phase, beach based activities and small businesses that run such activities may be negatively affected due to temporary closures during the construction phase. However during the operations phase, due to the improved coastal environment more people may visit the area creating more revenue as a result.

Mitigation

- Complete the project within the shortest time possible.
- Provide necessary information to businesses established in the area before the project begins and government could assist them in finding alternative arrangements during the construction period.

7.3.8 Impact on Navigation

During construction period, if small boats that use the western harbour may face difficulties should they continue to use the channel and the basin. Hence reduced negative is predicted for navigation during the construction period. The situation will be reversed when the project is complete as the approach channel, the harbour basin and the seawall would offer greater protection for the vessels.

Mitigation

- Temporary closure of the area during the construction period.
- Make alternative arrangement for the boat owners who uses harbour on the western side for the construction period.

7.3.9 Health and Safety Measures

During construction phase reduced negative effect is foreseen with regards to health and safety of the public due to the activities of the heavy machineries and movement of construction materials. Similarly workers are subjected to work-related risks from certain construction activities. During the operational phase, due to the project positive effects are expected as new slipway would facilitate regular removal of waste from the island thereby improving the general environment of the island as well as the harbour and the approach channel would become more secure and safe for the users.

Mitigation

- Temporary closure of the site for the public during the construction phase;
- Workers safety instructions shall be clearly made visible at the project site;
- Site accessibility shall be carefully controlled to avoid unauthorised access to the site;
- Protective gears shall be made available to the workers;
- First aid kit shall be available at the workers camp;
- Only certified workers shall be allowed to operate machineries and vehicles; and
- All marine based machineries such as excavators shall have fire extinguishers.

8 ALTERNATIVES

8.1 BACKGROUND

The development of harbour, slipway and beach replenishment in Villingili involved exploring various options during the planning process.

During the planning stage, relevant consultants have carefully analysed the possible alternatives taking into account aspects such as engineering feasibility, cost aspects, regulatory considerations, financial and environmental aspects. The professional judgments and opinion provided essential input into the planning process, enabling identification of various constraints and issues as well as identifying opportunities with regards to the proposed development. The professional input into the planning process was to assess the environmental acceptability of different options which led to a number of improvements in environmental performance of the project through avoiding and/or minimising impacts of the project on the environment.

8.2 NO DEVELOPMENT OPTION

Without the proposed harbour, slipway and the beach replenishment development project, western side of Villingili will retain the status quo with a degraded harbour of limited use while the area has huge potential to develop and reap benefits from. Additionally, without the project slipway will not be realized. This would mean regular waste transfer from the island would remain constrained leading to waste accumulation issue. The existing environment on the western side of Villingili is heavily modified and degraded. This implies that no-project option would not translate into preserving a pristine environment nor retaining a unique habitat. While Villingili has enormous potential to grow and prosper due to its strategic location, development of a proper harbour and slipway facility would definitely be of paramount importance and an added advantage for the development of the island and improve environmental quality of the island. No development option would also mean maintaining the neglected state of the existing harbour even though the impacts associated with project can be avoided without the project. Over time shoaling of the dredged basin has made it not safe for even medium sized vessels to use it. This situation is expected to exacerbate if the condition of the facility is not improved. In its current state, neither the government nor the public is able to make any economic benefit from the site. Whereas, the upgrading of the facility would mean better navigation, better making use of island infrastructure , improved waste management, better infrastructure, more job opportunities, and direct and indirect revenue to the community in addition to relieving space constraints faced to the existing main harbour of Villingili.

Given the range of benefits that the proposed development will bring to the environment, public health, economy and the people, and the apparent lack of any benefit of leaving the site in its current form, it is concluded that the proposed development option far outweighs the no development option.

8.3 DEVELOPMENT OPTIONS

As part of developing Villingili's west harbour, slipway, and beach replenishment alternative locations and options have been assessed as described in the following sub sections;

Harbour locations

Two alternative coastal locations were identified as potential sites for the harbour facility. Screening criteria applied to the identified locations of the harbour include:

- Natural protection;
- Environmental hazards;
- Swell surges;

- Wind storms (frequent during southwest monsoon);
- Tsunami (infrequent);
- Environmental impacts;
- Availability of space for the required footprint;
- Travel distance to reach the harbour;
- Aesthetic qualities and social acceptability;
- Maintenance costs;
- Potential changes to the coastal processes; and
- Development cost.

8.3.1 Overview of Options for Harbour Facility

Two locations were analysed for the placing of the harbour facility as shown in Figure 31. The four locations studied were:

- Option 1- Existing location of the west harbour.
- Option 2- South-western side of the island.

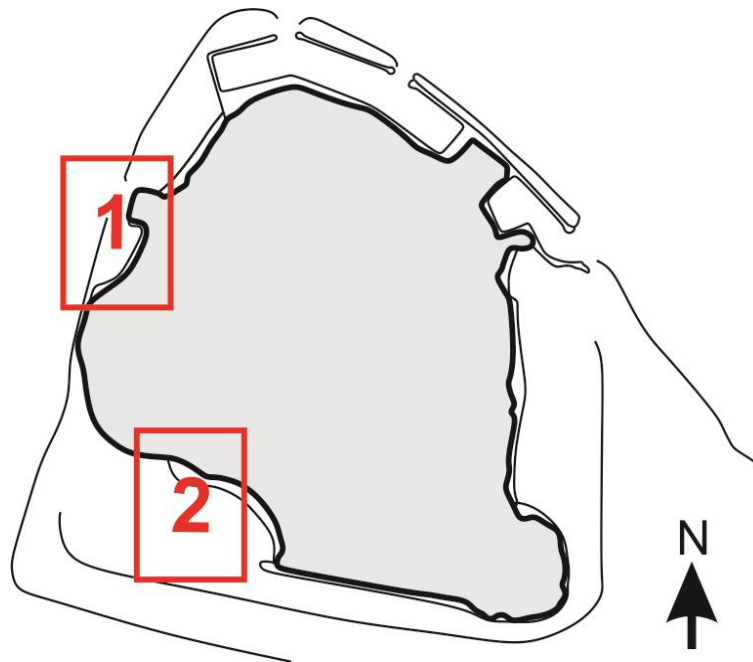


Figure 31: Location options assessed for placing the harbour

A matrix has been used to choose to make a pair-wise comparison. Matrix is drawn with all options listed above both horizontally and vertically. Each option is then compared with every other one and score of;

- 1 assigned to the preferred option; and
- 0.5 to both if no preference is agreed.

The option analysis is given in Table 12.

Table 13: Pair-wise comparison of site the two harbour locations

Evaluation Factors	Location 1	Location 2
Natural protection	1	0
Environmental hazards	1	0
Swell surges	1	0
Wind storms	1	0
Tsunami	0.5	0.5
Environmental impacts	1	0
Aesthetic qualities & social acceptability	1	0
Maintenance costs	0.5	0.5
Potential changes to coastal process	1	0
Development cost	1	0
TOTAL	09	1

8.3.2 Preferred Harbour Option

Placing the harbour at its current location has been found to be the most favourable in almost every aspects assessed.

8.3.3 Options for Entrance Chanel

Two options were assessed using the criteria described in Section 8.3 and it emerged that the existing location used as harbour entrance has more advantages over the second option (see Figure 32).

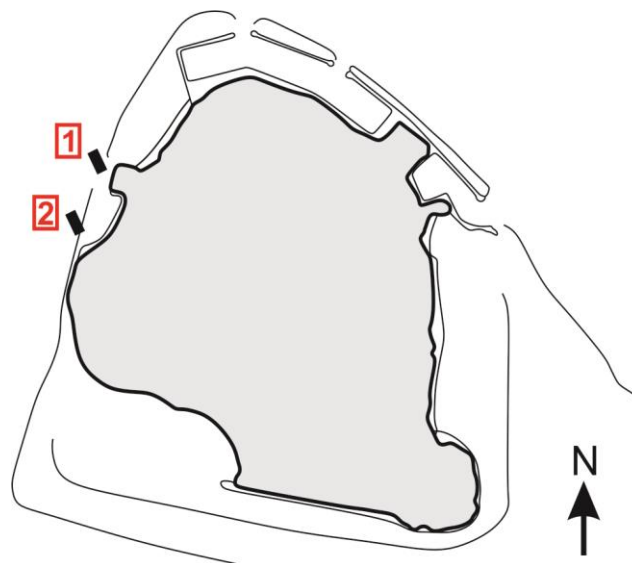


Figure 32: Harbour entrance options

8.3.4 Options for Dredged Materials

Three potential locations were identified for disposing dredged materials as shown in Figure 33. Of the three areas Option 1 appeared to be the most suitable. Option 2 and 3 have been left out mostly based on the fact that these areas are larger than the area 1 and would need bigger volume to make an impact. In addition, areas 2 and 3 are more exposed and hence the chances of losing materials to wave and currents actions are greater compared to area 1. Finally, addition of materials to a natural beach means modification to the natural state and hence modifying the smallest of the three would mean leaving aside larger areas in their natural form.

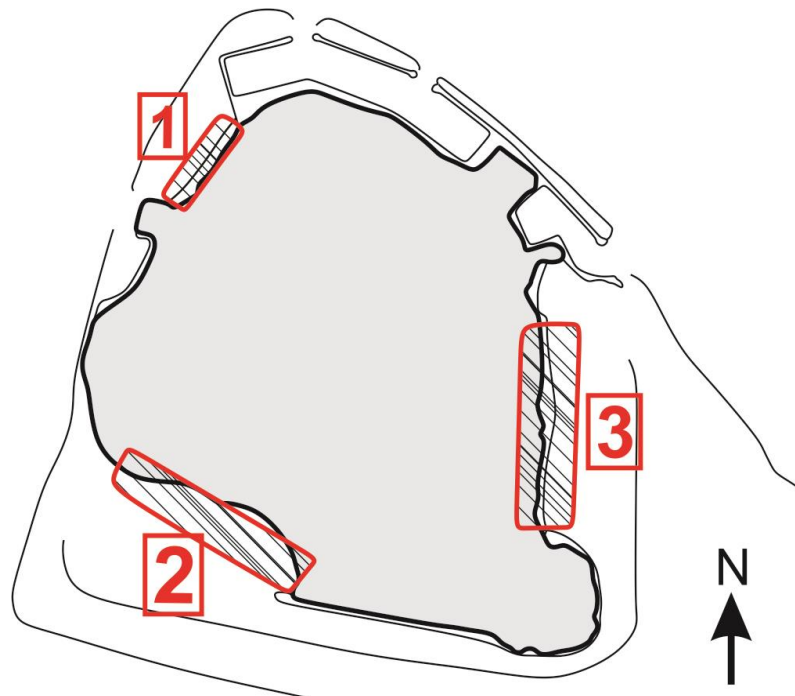


Figure 33: Location options for disposing dredged materials

8.3.5 Breakwater Design

The current breakwater design would trap the water body, within the harbor basin, restricting circulation of water within the basin. Pollution by birthing vessels and crew using the harbor, has been identified as a significant source for the pollution of the water body.

The possibility of pollution is expected to increase the concentration of nitrates, phosphates and poly anions, which would not only enhance algal growth but also increase the specific gravity of sea water within the basin. The highly dense contaminated water would most likely equilibrate at the bottom of the basin, which would further intensify contamination of water within the harbour basin. Moreover, it has been found that the bedload within the harbor basin is akin to siltation which increases the turbidity of water significantly. All these processes are going to contaminate the water body within the harbor basin significantly without proper circulation of ocean water and harbour basin water.

The proposed design consists of a single 21 m entrance channel through which currents can circulate. Based on the contamination potential of the harbour basin, the entrance channel would not be sufficient to circulate enough water by wind and gravity driven currents. Alternative design given in Figure 27 is hence proposed.

8.3.6 Dredging Methods

Bucket excavator is proposed for the planned maintenance dredging. The methodology and equipment to be used for the project is determined by the proponent based on extensive experience gained from years of experience from projects of similar nature. Alternative technology would be using cutter suction dredger which may be more suitable in terms of controlling the sediment. However, using cutter suction dredger over bucket dredger would mean additional costs. Funding available to the project does not allow change in dredging technology. On the other hand limited dredging that is required and small working space available for the dredger, cutter suction may cause logistical and operational difficulties. Based on these, a small bucket dredger is chosen over cutter suction for the project.

9 THE SOCIO-ECONOMIC SETTING

9.1 POPULATION

Villingili Island has been developed as the fifth ward of Malé, since the 1990s, in an effort to address the increasing problem with the population density in Malé. Villingili is an inhabited island roughly 600 m in width and 750 m in length. As of 2014, the island is inhabited by a total of 7,790 people including both locals and foreigners. A population growth rate of 0.57% was evident between 2006 and 2014 (National Bureau of Statistics, 2014). A breakdown of the population distribution in Villingili is provided in Table 14.

Table 14: Breakdown of population in Villingili as of 2014

	Male	Female	Total
Local	3,642	3,662	7,304
Foreign	387	99	486
Total	4,029	3,761	7,790

9.2 SOCIO-ECONOMIC ENVIRONMENT

Villingili, the fifth ward of Malé, has been developed as a garden island, with a limited number of allocated residential properties, in an attempt to address the issue of population congestion in Malé. Since populating the island in the mid-nineties, the Government of Maldives has invested in multiple development projects in Villingili, and the population now enjoys the luxuries of a city life, while maintaining an island atmosphere. Malé City Council, the authority with a mandate to implement important policy decisions toward the development of the areas it covers, has representation from the Villingili community.

Villingili Island is situated in a strategic location where a series of islands in the Greater Malé Region may be linked together in future (Figure 34). Gulhi Falhu, situated less than 1 km away from Villingili is planned to be developed into the Eye of Maldives. A link between Villingili and Gulhi Falhu as proposed in the Eye of Maldives masterplan (Figure 35), is expected to provide additional income and employment opportunities to the residents of Villingili. This development is also expected to attract further transport between the Greater Malé Region and the rest of the country, creating additional requirements for the provision of safe harbour facilities in the region. Further, being part of the planned Greater Malé Region link, Villingili will also enjoy the conveniences of being linked to the international airport in terms of additional income and employment opportunities and the generation of additional economic activities within the island.

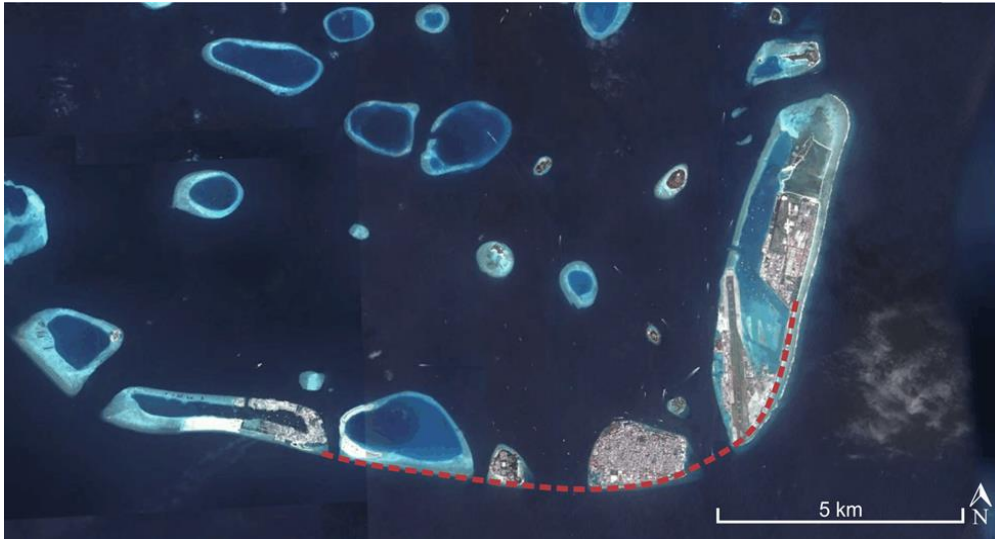


Figure 34: Greater Male' region



Figure 35: Eye of Maldives showing the link between Gulhi Falhu and Villingili Island (source: GAD International Ltd., 2011)

Despite the developments in Villingili to reduce the population tension in Malé, a wide majority of the resident population of Villingili commute to Malé for employment, suggesting a limitation of employment opportunities for the residents of the island. The proposed development is foreseen to bring with it, further employment opportunities for the locals through an increase in local trade. In addition, the development of the proposed slipway is expected to increase employment through the development of a small-scale boat repair and maintenance sector in the island. In addition, the proposed harbour and slipway development project will provide important support facilities for improving waste management problem faced to the island.

A regular ferry system is in operation, where scheduled ferries operate at 15 minute intervals between Malé and Villingili. The existing harbour to facilitate this operation has been completed and in operation since 2009. Villingili has all the basic facilities of a functional island community, such as primary health care through the Health Centre, education to the 12th standard, a functional sewerage system and 24 hours of electricity supply, with a power generation capacity of 2800 kW (Shaig, 2014). However, the island's waste management system is still under-developed and it is expected with the new slipway and the improved harbour on the western side, regular waste transfer from Villingili to Thilafushi would become operational and that this would contribute to alleviate the growing waste problem on the island.

Further developments undertaken in Villingili Island include the establishment of a police station and stations of the telecommunications service providers, a drugs detoxification centre operated by the Department of Drug Prevention and Rehabilitation Services and a Family and Children Services Centre operated by the Ministry of Law and Gender. In addition, a Youth Centre operated by the Ministry of Human Resources Youth and Sports has been functional since the year 2010. Further, the establishment of an Adolescent Drug Rehabilitation Centre is planned by the Ministry of Health and Family (Isles, 2015). These facilities, in addition to the thriving local businesses, are expected to create employment opportunities to the residents of Villingili Island.

Villingili, being a location nearby Malé that has preserved a natural atmosphere, has become a social hub in recent years, where both the Villingili community as well as people from Malé enjoy the different facilities it provides. A considerable amount of social activities take place on the island, especially at the three beach locations. The eastern beach is usually used by families and friends as a picnic area. A significant number of residents of Malé visit this beach on the weekends to enjoy a natural area for a leisurely swim or picnics. The southern beach is generally used by elderly folk residing on the island, due to its shallow, and reasonably calm conditions. This area is also a designated barbecue and picnic area. The western beach, the one proposed as a fill site, is possibly the area that has the most diverse use. The area is being used by the water sports groups and dive schools for a bulk of their activities. A significant number of people also use this area for swimming as well as snorkelling. In addition, the recently established coral garden toward the northern end of this beach by a local NGO (Save the Beach) operating in Villingili has increased the popularity of this beach. A lot of volunteers who are deeply concerned about the state of the country's environment, and work toward raising environmental awareness among communities are active at this site. Figure 36 highlights the current social uses of the different areas of Villingili Island.

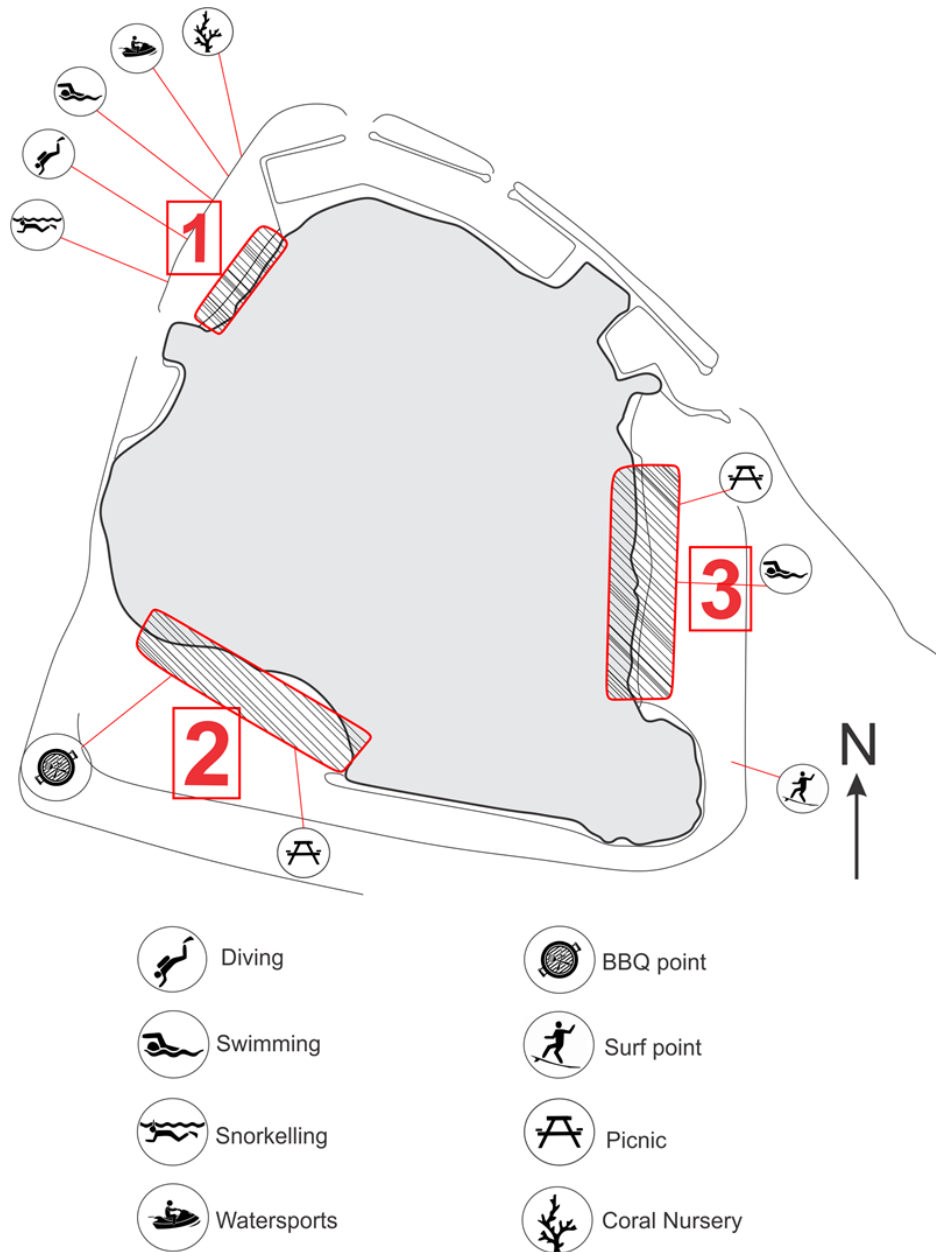


Figure 36: The current usage of the existing beach areas of Villingili

9.3 ISLAND'S WASTE MANAGEMENT

Villingili's waste collection yard is located very close to the proposed harbour and slipway; located just south of the proposed slipway (Figure 37). Mixed waste collected from the island is dumped at the waste yard which from where it is sent to Thilafushi. The waste collection vessel docs near the seawall on the western side for collecting the waste. During rough weather however it becomes a daunting task due to lack of any protection to vessel. With the proposed harbour waste collection barge can safely collect the waste by travelling through the protected harbour and finally landing near the slipway from where lorries can move into the barge which will then carry it to Thilafushi dumpsite. With the proposed facilities developed, waste management of the island is expected to significantly improve.



Figure 37: Waste collection yard in Villingili

9.4 SOCIAL IMPACTS

The project is expected to result in some short-term socio-economic negative impacts. As the beach and lagoon area proposed for replenishment is an area frequented by locals for picnicking and swimming. Temporary closure of the beach and lagoon during the project implementation may negatively affect those who use the area.

There are also small businesses who organise sea sport activities in the same locations. Their business is likely to be affected during the project implementation period.

Some opposition to beach replenishment can be expected from the community due to the perception that the naturalness of the beach may be lost when fine sediment is added that may create soft bottom in the lagoon. There is also concern that the reef may be affected due to sedimentation. The reef in the area has already been degraded probably due to past developments and there has been efforts to rejuvenate the reef.

These negative socio-economic effects can be mitigated and effectively addressed by implementing the relevant mitigation measures proposed in the EIA report.

10 ENVIRONMENTAL MONITORING & MANAGEMENT PLAN

10.1 AIMS AND OBJECTIVES

The section would present in detail the management and monitoring measures put in place by the proponent and the contractor to manage and monitor the environmental impacts that would arise from the project activities. The assessment of impacts and mitigation measures that would be put in place had been discussed in detail in the previous chapter. The focus of this plan would be on the boundary of the project, which is the western side of Villingili Island where the dredging for harbour would be carried out and where slipway and beach replenishment would be located. The main scope or objectives of the environmental management plan are to:

- a) Monitor and manage any major impact on the project environment, any unmanaged and not mitigated impact would have major impacts on the species and ecosystem that it might not be able to recover from;
- b) Produce a framework for anticipated impacts, including practicable and achievable performance requirements and systems for monitoring, reporting and implementing corrective actions during pre-construction, construction and operational phase;
- c) Manage environmental matters in a synchronized manner and to collect information that can be used for documentation and verification of environmental impacts;
- d) Collect information that can be used for evaluating the effectiveness of implemented mitigation measures so it can provide information for better decision making and future improvement of environmental quality for similar projects;
- e) Ensure that these impacts are eliminated in a timely manner; and
- f) Provide evidence of compliance assurance to laws and regulations and requirements of enforcement agencies.

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

- Live coral cover and marine ecosystem;
- The amount of sedimentation on the reef; and
- Pollution of the harbour and surrounding environment.

10.2 PROJECT ENVIRONMENTAL MONITORING PLAN

Monitoring would begin from prior to the construction or the dredging phase to record any possible changes to the environment from the activities of the project and would continue into the operational phase until the very end of the project. Marine water quality and monitoring of the marine ecosystem has to be conducted on a regular basis and beach stability of the replenished area will have to be monitored.

The monitoring programme targeted at monitoring the coastal and marine environment is given in Table 11. This programme would commence from the beginning of the project. The Proponent is committed to undertake this monitoring programme for at least one year from the end of the project.

10.3 PROJECT ENVIRONMENTAL MONITORING REPORT

Reporting will be carried out on a timely manner to implement the environmental management plan and will cover details of site conditions, operations and environmental monitoring data. Reporting will be carried out by the environmental consultant assigned for the purpose by the proponent. The report will include details of the site, methodology of data collection and data analysis, quality control measures that would be implemented based on the monitoring. A detailed environmental monitoring report is

required to be compiled and submitted to the EPA or the enforcement authority at the end of the project and final report at the end of the one year monitoring period.

In addition to this, regular site monitoring would be carried out the contractor and site supervisors during construction. Enforcement officers from Ministry of Housing and Environment would also visit the site for inspection based on their routine schedules when even the need arises. The required consultation and communication would be carried out among the environmental consultant; the contractor (site supervisors) and project proponent to ensure possible negative impacts are mitigated appropriately during and after the project work ends.

10.4 PROJECT MONITORING COST & TIME FRAME

This monitoring should be commenced during the preparation stage and continued at least one year after the completion of the project. In addition to this, visual inspection of marine areas around the harbour and slipway areas would also be carried out. The monitoring would costs approximately USD 8000 for the duration including the preparation of the monitoring report by the consultant. The monitoring plan and the schedule and parameters given in Table 14.

Table 15: Monitoring framework - parameters, cost and frequency

Environmental aspect	Parameters and Methods of Monitoring	Monitoring and Reporting Frequency	Cost (USD)
Coastal morphology	Changes to the coastline at the beach replenishment location every four months starting from the end of the replenishment works using standard surveying method and equipments.	Beach profile surveys and coastal boundary surveys every 4 months for one year	Approx. USD 3000 for all surveys
Water quality	<p>Sediment levels in the water column shall be monitored daily by the contractor at the reef boundary opposite the beach replenishment areas. Samples from at least 4 locations shall be tested for turbidity levels. Daily records shall be kept in order to demonstrate compliance. Weekly summary reports shall be prepared and be made available to the proponent. Visual surveys and sediments deposited on reef substrates by the Consultant.</p> <p>Sediment monitoring reports will include the following information for each sample: a) time of day; b) antecedent weather conditions; c) tidal stage and direction of flow; and d) wind direction and velocity. Reports shall be complied daily even when no sampling is conducted. When sampling is not conducted, a brief statement shall be given to explain the rationale, such as “dredge not working” or “no sampling due to high seas”.</p>	<p>Daily during construction and monthly after completing the project till the end of an year of monitoring.</p> <p>Report shall be prepared every 4 months.</p>	Approx. USD 5000

	Weekly summaries of the daily turbidity monitoring data will be submitted to the Project Manager within one week of analysis with documents containing the following information: 1) dates and times of sampling and analysis; 2) state plane coordinates (X and Y) of the sampling stations and the dredge and discharge locations, and the distance between the sampling stations and the dredge/discharge for each sample to demonstrate compliance with the above required distances; 3) a statement describing the methods used in collection, handling, storage, and analysis of the samples, as well as the authenticity, precision, limits of detection, and accuracy of the data; 4) results of the analysis; and 5) a description of any factors influencing the dredging or disposal operation or the sampling program. The summaries shall be submitted in Excel Spreadsheet.		
Coral reef	Live coral cover at reef in front of the beach replenishment area using line intercept method. Visual inspection of fish abundance. Visual inspection photography of sediment impact on the reef.	Every three months beginning the onset of construction works	No additional costs since the survey can be done simultaneously with other studies.
Aesthetic cultural values	Littering, floating wastes, dumping of wastes in the marine and terrestrial environment shall be monitored by visual inspection during the survey trips.	Information collected shall be included in the monitoring report.	No additional costs required

10.5 REPORTING

Based on the monitoring program described above, two monitoring reports shall be prepared and submitted to EPA. The first one shall be submitted at the end of the construction phase and the final report at the end of the one year of monitoring.

10.6 COMMITMENT TO UNDERTAKE MITIGATION AND MONITORING

The proponent's commitment to undertake the proposed mitigatory measures and to undertake the monitoring is given in **Annex 5**.

11 CONCLUSIONS & RECOMENDATIONS

This EIA has been undertaken to assess the proposed project, evaluate various alternatives, and to determine potential impacts and respective mitigation measures. The EIA was carried out in a participatory manner where views collected from stakeholders have been incorporated in to the EIA where appropriate.

This Project would provide the much needed infrastructure development at Greater Male' Region to cater for the growing number of ocean-going vessels and would convert currently a non-functional harbour into a fully functional infrastructure at Villingili thereby contributing to socio-economic development.

This EIA has found no evidence of any major significant negative environmental impact or disbenefit or change that are of importance at national/international level. Nevertheless even with the implementation of design and planning strategies, due to the inherent constraints and limitations of the Project site, negative environmental impacts due to the project are still expected. These potential impacts have been assessed in a comprehensive manner under this EIA with effective and practicable mitigation measures recommended to maintain the impacts at an acceptable level. All social and environmental effects identified can be effectively mitigated with the measures recommended in this report. In addition to the environmental and social mitigation measures, the following recommendations have been proposed in order to enhance project acceptability and smooth implementation of the project.

- Ministry of Housing and Infrastructure to brief the main stakeholders such as the small boat owners, dive school operators and the NGOs on the objectives of the proposed infrastructure to clear some of the doubts they raised during community consultation as such small boat owners were worried that with the development of the harbour, small boats may not find berthing space.
- The design of the breakwater may limit the water exchange between the harbour basin and open sea and therefore it is recommended to incorporate culverts into the breakwater to enhance water flow;
- Make available waste collection bins near the harbour area and a basic toilet to avoid polluting the harbour and the surrounding areas
- Since no seawall has been planned, fixing mooring buoys or similar arrangement will aid fastening small boats near the shore.

Based on the results of the assessments, the EIA study concludes that the Project would be environmentally acceptable and in compliance with the relevant environmental legislation and regulations. With implementation of the recommended environmental mitigation measures, no unacceptable adverse residual impacts from the project are anticipated. A comprehensive monitoring programme will be implemented to check the effectiveness of mitigation measures and necessary steps will be taken to control unforeseen negative effects.

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13 ANNEXURES

ANNEX 1: TERMS OF REFERENCE

ANNEX 2: DREDGING APPROVAL

ANNEX 3A: PROFILES OF THE HARBOUR SHORELINE

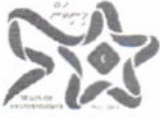
ANNEX 3B: PROFILES OF THE BEACH – NORTH OF THE HARBOUR

ANNEX 4A: BATHYMETRY OF THE HARBOUR AREA

ANNEX 4A: BATHYMETRY OF NEAR-SHORE BEACH AREA

ANNEX 5: COMMITMENT LETTER

ANNEX 6: CVS OF CONTRIBUTING AUTHORS



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 "Dhivehin" - Always Maldivian, Forever Independent

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ



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Environmental Protection Agency



EPA

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EPA/ToR/2015/130

Terms of Reference for Environmental Impact Assessment for the proposed Slipway Development in K. Villingili

The following is the Terms of Reference (ToR) following the scoping meeting held on 6th August 2015 for undertaking the EIA of the proposed slipway in K. Villingili

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

- 1. Introduction and rationale** –Describe the purpose of the project and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific and if possible quantified. Define the arrangements required for the environmental assessment including how work is to be carried out within the project boundary. Identify the project client, donors and the institutional arrangements relevant to this project. .
- 2. Study area** – Submit a minimum A3 size scaled plan with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size. The study area should include adjacent or remote areas, such as relevant developments and nearby environmentally sensitive sites (e.g. coral reef, sea grass, mangroves, marine protected areas, special birds site, sensitive species nursery and feeding grounds). Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.
- 3. Scope of work**– The report should be categorised into the following components:

Task 1. Description of the proposed project – Provide a full description and justification of the proposed project, using maps at appropriate scales where necessary. The following should be provided

- Adequate justification for the project
- Excavation methods, if required for construction purposes including machinery and scheduling;
- Details of activities: location of burrow site (if required), justification, and volume needed, extraction methods, type of sediment, man power, scheduling.
- Environmental monitoring during development;
- Measures to protect environmental during construction and operation phase
- Project management (include scheduling and duration of the project, material storage).

Coastal structure construction



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- Details and justification of location, number, size and materials of coastal structures; construction methods, materials, equipment.

Dredging (if included as part of the project):

- Location and size of sand burrow areas (s) on a map;
- Justification for the selection of this location;
- Quantity, quality and characteristics of fill material;
- Method and equipment used for dredging;
- Justification for selecting the methods and equipment;
- Duration of dredging activity;
- Copy of dredging approval

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

The baseline data shall be collected before construction. All survey locations shall be referenced with Geographic Positioning System (GPS) including water sampling points, reef transects, vegetation transects and manta tows sites for posterior data comparison. Information should be divided into the categories shown below:

Climate

- Temperature, rainfall, wind, waves

Geology and geomorphology

- Offshore/coastal geology and geomorphology (use maps);
- Beach profile;
- Vegetation line and shoreline;

Hydrography/hydrodynamics (use maps)

- Sea water quality measuring these parameters: temperature, pH, salinity, turbidity, TSS

Marine Ecology

- Assessment of marine environment of the project site.
- 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), if any involved in the project site.
- Benthic and fish community monitoring around the project site.

Socio-economic environment

- Demography: total population, sex ratio, density and growth of project island



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INTERNATIONAL YEAR OF FORESTS - 2011



- Economic activities of both men and women (e.g. fisheries, home gardening, fish processing, employment in industry, government)

Hazard vulnerability:

- Vulnerability of area to flooding and storm surge.

The report should outline the detailed methodology of data collection applied to describe the existing environment.

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

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

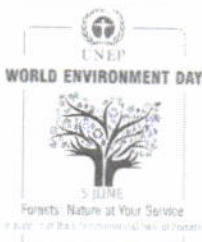
Impacts on the natural environment

- Changes in flow velocities/directions, resulting in changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology;
- Loss of marine bottom habitat, both in the borrow area as well as due to enlargement of the islands, resulting in (temporary) loss of bottom life, which may impact fish stocks and species diversity and density of crabs, shellfish etc.;
- Sediment dispersal in water column (turbidity at the dredging site (overflow) and related to shore protection activities), possibly resulting in changes in visibility, smothering of coral reefs and benthic communities and affecting fish and shellfish etc.;
- Impacts of noise, vibration and disturbance;
- Impacts on unique or threatened habitats or species (coral reefs, sea turtles etc.), and
- Impacts on landscape integrity/scenery.

Impacts on the socio-economic environment

- Impacts of the dredging and construction works on the public, stakeholders and tourism ventures (nearby resorts and dive sites);
- Impacts on employment and income, potential for local people to have (temporary) job opportunities (and what kind) in the execution of the works;
- Long term job opportunities
- Direct and indirect socio-economic benefits

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.



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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.

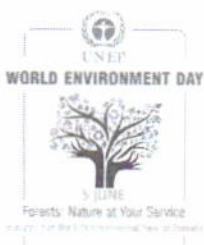
Task 6. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These should include both environmental and socio-economic mitigation measures with particular attention paid to sedimentation control and future changes in coastal processes. Mitigation measures to avoid or compensate habitat destruction caused by the development shall be considered, e.g. temporal sediment control structures. Measures for both construction and operation phase shall be identified. The confirmation of commitment of the developer to implement the proposed monitoring, 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 shall 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 programme 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.

- Coastal erosion and accretion changes in the vicinity of the project location;
- Water quality, especially turbidity;
- Impacts from sedimentation on nearby coral reefs, benthic system, sea grass beds and fish and invertebrates communities;
- Environmentally sound site clearance;

Task 8. Stakeholder consultation – EIA report should include a list of people/groups consulted and what were the major outcomes. Identify appropriate mechanisms to supply stakeholders and the public with information about the development proposal and its progress. The report should include the methodology of consultation with justification, details of the date, time and place of the consultation and the summary outcomes of the consultative meetings. The EIA report should include a list of those consulted with their contact details. Major stakeholder consultation shall include Male' City Council and the general public of villingili.

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



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CURRICULAM VITAE

H.H.H. Gunaratna

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Ambagahalanda watta,
Gampaha Road,
Yakkala,
11870,
Sri Lanka.



Phone: Home: - +94332237108, Mobile: +-9607949301/+94773762925

Email: hashikahimal@gmail.com

Objective:

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

Personal Details:

- **Full Name :** Hettiarachchige Hashika Himal Gunaratna
- **Birthday :** 23rd August 1984
- **Gender :** Male
- **Current Position :** Survey Engineer
- **Nationality:** Sinhalese
- **Country:** Sri Lanka
- **National Identity Card No.:** 842360439V
- **Passport No.:** N 5478963
- **Marital Status:** Married

Education:

- **Bachelor of Surveying Sciences (Surveying and Geodesy) Special Degree (FGPA 2.42/4.00)**

Sabaragamuwa University of Sri Lanka, November 2008.

- Which included following theory subjects:
 - *Land Surveying*
 - *Construction Surveying*
 - *Geodesy*
 - *Land Valuation*
 - *Cadaster and Land Law*
 - *Remote Sensing*
 - *GIS*
 - *Photogrammetry*
 - *Computer Programming*
 - *Mathematics*
- Following practical sessions
 - *DGPS (Trimble 5700, Leica 500 GPS Units)*
 - *RTK GPS (Trimble 5700)*
 - *Total Station Surveys (Sokkia)*
 - *Theodolite and chain Surveys*
 - *Triangulation (Precise Theodolite & Star Observation)*
- And following Academic Research Projects
 - *For foundation course*
 - *“Geodetic Triangulation”*
 - *For Specialization Course (Specialization in Surveying and Geodesy) Project*
 - *“Determination Of Geoidal Model For Sabaragamuwa University Area”*

Experience:

June 2015 – Up-to-date:

Chief Surveyor – Maldives Energy and Environment Company (Pvt.) Ltd. (MEECO), Maldives.

- Preliminary hydrographic survey for EIA study of reef near K. Maafushi
- Preliminary hydrographic survey for EIA study of reef ADh. Heenfaru
- Preliminary survey on shore and off shore for EIA study of road expansion in K. Thilafushi.
- Preliminary hydrographic survey for EIA study of reef K. Galufalhu
- Preliminary hydrographic survey for EIA study of reef K. Guraidhoo
- Setting out survey of Hibalhidhoo Resort Development Project
- Preliminary study hydrographic survey for EIA at West Harbor Expansion Project at K. Villingili

January 2015 – June 2015:

Self Employed

- Topographic Survey for Proposed Inter-Change at Heyiyanthuduwa
- Setting out survey for Proposed Biomass Based Combined Power Plant at Meerigama
- Setting out survey of Center line of canal of Kosgulana Mini-hydro power station

December 2014 – January 2015:

Chief Surveyor – China National Aero-Technology International Engineering Co. Ltd.

Special Projects: - Extension of Southern Highway Project (*Traversing, Control Network, Pile Setting out etc.*)

June 2012 – November 2014:

Surveyor – Lanka GPS (Pvt.) Ltd

Setting out surveys and progress surveys for Embankment filling and slope cutting (Southern Transport Development Project – Package III (*Sub Contract under KSJ Constructions (Pvt.) Ltd.*))

Power line surveys: - Planning and preparation of route using satellite images and Google Earth, Profile surveys using Total Station for Longitudinal Sections, Preparation of Survey Drawings,

Data Sheets and Detailed Reports (*for Ceylon Electricity Board from Galmaduwa (Ampara) Gantry to proposed Pothuvil Gantry via Akkaraipatthu*)

Special Projects: - Surveyor at Earth work section (*Filling and Cutting work, Drainage Construction Setting out, Setting out work from Subgrade to Wearing Course Top, Progressive Surveys, etc.*) in Outer Circular Highway for the City of Colombo – Section II (Kaduwela to Kadawatha) under man-power supply contract between TAISEI Corporation and Lanka GPS (Pvt.) Ltd.

April 2011 – June 2012:

Surveyor – CML-MTD Constructions (Pvt.) Ltd

Setting out surveys for Embankment filling and slope cutting (Southern Transport Development Project)

Setting out surveys for Earth filling, ABC work, Lane marking Slope cutting, Utility points (Galle Port Access Road – STDP)

Control Traverse Surveys, Fly-back Leveling for vertical control, Detail Surveys for Designing, Setting out Center line and Structural details (UVA - 05 Madithale – Pathanawatta – Thannapanguwa-Kiriwehera Road project, Badulla)

August 2008 – March 2011:

Surveyor – Gamini B. Dodanwela Associates (Pvt.) Ltd., 213C 2/2, Anagarika Dharmapala Mawatha, Dehiwala, Sri Lanka.

Special Projects: - Surveyor at Bridge over Benthara-Ganga river, Drainage Construction Section, Embankment Filling Section in Southern Transport Development Project under man-power supply contract between TAISEI Corporation and G.B. Dodanwela Associates (Pvt.) Ltd.

General Detail Surveys: - Cadastral Surveys and Legal Surveys for subdivision and deed transferring (Island wide)

Detail Surveys for Large scale Projects: - Road Expansion Project in Kottawa area – RDA, Developing C Class Roads in Muthur area – RDA, Bridge Survey at Mahaoya – Chenkaladi Road, Coal Power Plant Project for CEB in Sampoor (800 Acre – Both Total Station and RTK GPS methods were used in this Project).

Setting out surveys for Nawaloka Piling (Pvt.) Ltd. (Medical College Building - PunchiBorella, Sethsiripaya Building Project, Wild Life Conservation Department Building - Battaramulla, D.A. Rajapaksha Memorial Conference Hall - Battaramulla, Army Hospital at Narahenpita)

Setting out surveys for Attis Piling Site at Thimbirigasyaya

GPS Surveys :- Control Point re-establishment for Upper Kothmale Hydro Power Project, Control Point Establishment for Kanthale Banana Cultivation Project, Control Point Establishment for Road Expansion Project in Kottawa area – RDA, Control Point establishment for Developing C Class Roads in Muthur area – RDA), Control Point Establishment for Coal Power Plant Project for CEB in Sampoor , Control Point Establishment for Detail Survey of water path identification in Laggala-Pallegama (Moragahakanda Tank Project).

Familiar with:

- Sokkia Total Stations (Power Set Series, Set 50x Series, C10x Series, SRX Robotic Series)
- Leica Total Stations (TS 06 Plus) and GNSS (Leica 500)
- Sokkia GNSS (GRX1, GRX2, GSR2700IS, Alan Osborne Rascal)
- Sokkia Digital Level
- Trimble Robotic Total Stations and GNSS Systems
- Hi-Target GNSS systems
- Single-beam and multi-beam echo sounders (ODOM, SonarMite, Hi-Target, South)

Computer Skills:

- Hands on experience in Trimble Geomatic Office, Leica SKI Pro, AOA Rascal GrafNET, AOA Rascal GrafNAV, Sokkia Spectrum Survey and Sokkia Spectrum Survey Office.
- Proficient with AutoCAD, ZW CAD, TopoCAD, Autodesk Land Desktop, Autodesk Civil 3D, Esri ArcGIS, eye4software HydroMagic, Microsoft Word, Excel, and PowerPoint
- Hands on experience in 3dsMax, Adobe Premier, Adobe AfterEffects and MS Project.

Other Qualifications:

- Possess a valid Sri Lankan Driving license.
- Distinctions in Australian Chemistry Quiz competition (Junior & Senior Levels)

None Related Referees:

Mr. P.M.C. Dharamapriya.

Surveyor

Gamini B. Dodanwela Associates (Pvt.) Ltd.,

213C 2/2, Anagarika Dharmapala Mawatha,

Dehiwala,

Sri Lanka.

Mobile: +94773038907

Mr. S.B.B.P. Munidasa.

Registered Licensed Surveyor

Gamini B. Dodanwela Associates (Pvt.) Ltd.,

213C 2/2, Anagarika Dharmapala Mawatha,

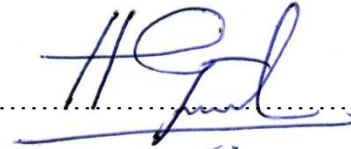
Dehiwala,

Sri Lanka.

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I hereby certify that above details provided by me are true and accurate for the best of my knowledge.

17th November 2015



H.H.H. Gunaratna.

Ali Hammadh

Address:

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Personal statement

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

Key Skills

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

Employment History

Townsville Atmospherically deposited Dust Metal Study

(August 2014 – December 2014)

Responsibilities

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

Media report:

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

Laboratory Demonstrator At MQ University Study Labs

(June 2014 – July 2014)

Responsibilities:

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

Note Taker for Unit: PHYS 159

(August 2012 – December 2012)

Responsibilities:

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

Ministry Of Tourism

(February 2011 – March 2011)

Responsibilities:

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

Education

Macquarie University

(January 2012 – December 2014)

Award: Bachelor of Environment

Major: Chemistry

Environmental Management

- GPA 3.3

CHSE

(June 2008 – June 2010)

Four Edexcel Subjects

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

Majeediyya School

(2004 – 2007)

Six Cambridge GCE Subjects

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

Jammaluddin School

(2000 - 2007)

Achievements

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

Hobbies & Interests

- Sea
- Diving
- Fishing
- Sports

References

Attachments include:

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



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

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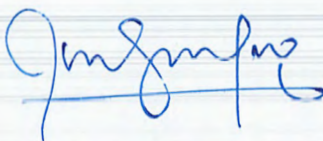
Date: 06th December 2015

No: 138-PIS2/203/2015/276

Environmental Protection Agency
Ministry of Environment and Energy,
Ameenee Magu, Maafannu, Male', 20392,
Maldives.

Sub: EIA to the Proposed Construction of West Harbour and Slipway in K.Villimale':

As the proponent of the project, we guarantee that we have read the report and to the best of our knowledge all non-technical information provided here are accurate and complete. Also we confirm our commitment to finance and implement all construction mitigation and the monitoring program as specified in the report.

Signature: 

Name: Fathimath Shana Farooq

Designation: Director General