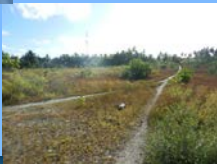


# **ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED LEVELLING AND EARTHWORKS OF FOOTBALL ARENA IN NADELLA, SOUTH HUVADHU ATOLL**



PREPARED FOR  
GDH. NADELLAA COUNCIL.

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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.



Mahmood Riyaz (EIA03/07)  
August 2016



### **Acronyms used in the text**

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
FOH	Front of the House (guest rooms, reception restaurant, arrival pavilion etc)
DNP	Department of National Planning
EPA	Environmental Protection Agency
EPAA	Environmental Protection and Preservation Act
MHTE	Ministry of Housing, Transport and Environment
MSL	Mean Sea Level
NPC	National Planning Council
MYS	Ministry of Youth and Sports







## 2 NON TECHNICAL SUMMARY

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- 1- This is the Environmental Impact Assessment (EIA) report carried out for Gdh Nadellaa Island Council to undertake earthwork and ground leveling of Gdh Nadellaa football ground. The project is funded under the sports arena development project carried out by the Ministry of Youth and Sports in all inhabited islands. The project involves dredging of 50x144.4 area in front of the boatyard in Gdh Nadellaa lagoon and sources the material for ground leveling and earthwork of the football field. The EIA was prepared as fulfillment of the requirement by the Environmental Protection Agency under the dredging and reclamation regulation (Regulation 2013/R-15) for granting permission for the project. Environmental Impact Assessment (EIA) of development projects is a requirement by the Environmental Protection and Preservation Act (EPPA) (law 4/93) of the Government of the Republic of Maldives.
- 2- This report has been prepared in accordance with the Environmental Impact Assessment Regulations published by the Ministry of Environment and Energy 2012 and covers both negative and positive environmental and socio-economic impact arising from the proposed project in Gdh Nadellaa Island. Major findings of this report are based on information gathered during the field inspection of both the existing environment and possible effects of the project activities, through extensive literature review and experiences gained from similar projects elsewhere in the Maldives.
- 3- The proposed project activity will take place in Gdh Nadellaa Island. Gdh Nadellaa is an inhabited island and lies in Huvadhu Atoll in a 30 km long elongated reef located on the south western periphery of Gdh. Atoll. Nadella is rectangular in shape, oriented NW-SE, and is found in a huge reef that contains over 85 islands of various sizes and shapes. The vegetated area of Gdh Nadellaa is 44 hectares the island is approximately 817m long and 526m wide. Total area of the house reef is 5615 ha (56 km<sup>2</sup>). The island occupies 0.007 % of the total reef area. Average depth of the reef flat greatly varied along the reef platform ranging from 20-0.2m from MSL. The distance between the island shoreline and ocean-ward reef rim is 250m and on the atoll-ward side is approximately 1.2km
- 4- The terrestrial environment is similar to other inhabited islands across the Maldives. The topography of the island is almost flat and the relative variation in ground level in different parts. Existence of Kulhi on the northern part of the island indicates that the island slants northwards. Gdh Nadellaa has lush tropical vegetation around the island dominated by coconut palms but *Scaevola taccada* (magoo) Kuredhi boashi, Halaveli and coconut palms surrounding the island. *Hibiscus tiliaceus* (dhigga) is abundant throughout the island followed by *Thespesia populnea* (hirundhu). Occasionally, *Cordia subcordata* (kaani) can be seen in the wooded area and rarely mature *Ficus benghalensis* (nika).
- 5- The northern shoreline of the island has been altered after the harbour development in 2009. Large area of the island was reclaimed adjacent to the harbour area. Semi enclosed water body which has openings to the lagoon was completely reclaimed by filling with dredged material from harbour and access channel development process. The playground has been developed on the lowest part of the island that seems to be the main reason for exposure for flooding during the rainy season.
- 6- The proposed project involves dredging 50x144.4 area adjacent to the dredged area in front of Nadellaa boatyard to a depth of -3m and source the dredged material, approximately 21675m<sup>3</sup> sand, for earthworks and leveling of Nadellaa playground. The area proposed for

dredging and sources material for earthwork and leveling is a very shallow (0.5 at high tide, exposed at low tide) sand accretion zone in Nadellaa lagoon. The area is covered with sand and seagrass. Coral reef on the northern side, atoll ward side, is approximately 1.2km away from the shoreline. Comparison of historical photographs shows that seagrass developed on Nadellaa lagoon after the harbour development work. There are numerous coral patches and individual coral patches in the lagoon.

- 7- During the preparation of the EIA report an impact matrix, which is a standard tool for identifying the possible impacts of project activities, has been created for proposed development project in Gdh Nadellaa Island. The activities carried out during the construction and post-construction or operational phases are arrayed against a selection of environmental factors that may be affected directly or indirectly as a result of project activities.
- 8- The report has identified and described in detail possible change that would occur to the existing environment during the construction phase and have suggested appropriate mitigation measures for each and every impact identified in the report. Lagoon dredging has been identified as the most significant negative environmental impact that could be associated with the proposed project. Post development impact of the project, after the earthwork and leveling, has been identified very minor. Also the report found, based on similar project activities elsewhere in the Maldives, the island and the lagoon environment will recover from the expected impacts rapidly and will re-establish a new ecological balance soon. However the report has come-up with an extensive monitoring programme to monitor, mainly beach dynamics and ground water quality that will keep on monitoring the environmental changes associated with the development and make necessary adjustment to the activities of the project based on the findings of various measured environmental parameters suggested in the monitoring plan
- 9- The study has evaluated alternative options for some components of the project and discussed alternative location for the football ground, alternative sources of fill material and alternatives location to dredge and source fill material. On the basis this environmental impact assessment study and the impact mitigation measures proposed in the report will be duly implemented and recommendations are given due consideration, it is concluded that the activities of the project could go ahead as proposed. As the project is expected to bring numerous social benefits and minimize its negative impact on the environment.

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### **3 INTRODUCTION**

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#### **3.1 BACKGROUND**

One of the most important and key pledges of the current PPM Government was Securing a brighter future for the Maldivian youth through the creation of vast socio-economic opportunities. The Governments focus is to empower youth, which is the 52% of the total voting population of the country, through creation of jobs and opportunities for skill development, education, entrepreneurship, sports, music and entertainment. One of the main targets of the government is to develop youth through development and improvement of sports related infrastructure. As such the Government has pledged to develop a sports arena in each inhabited island during these 5 years period. President inaugurated the sports arena development project in July 2015. Since then sports arena development projects, mainly footsal ground and football field, are taking place large number of islands. Therefore the aim this project is to improve the existing football ground of Gdh. Nadellaa Island located on the south western side of Gaafu Dhaalu Atoll.

The football ground of Gdh Nadellaa Island was developed on a reclaimed low land. The land was developed after reclamation of semi enclosed water body that existed on the northern part of the island. Therefore the football ground of Gdh Nadellaa Island is exposed for frequent flooding during the rainy season. To overcome this problem the Ministry of Youth and Sports decided to improve the existing football ground under the on-going sports arena development project. The football ground will be improved by adding sand and levelling the ground and construction of drainage system on both sides of the playground.

#### **3.2 PURPOSE OF THE EIA**

Given the potentially adverse environmental impacts associated with mining sand required for levelling of the island the sports area development in Gdh Nadellaa, the proponent has requested the consultant the preparation and submission of an Environmental Impact Assessment (EIA) report to EPA to comply with the Environmental Protection and Preservation Act (4/93) and EIA Regulations 2012.

The objective of the EIA study is:

- a) To provide an assessment of the potential environmental effects of the proposal and to determine which of these, if any are likely to result in a significant effect on the environment and to propose ways and means of avoiding, mitigating and or compensating the perceived negatives effects of the project;
- b) To provide necessary information to EPA applicable to the proposed development; and
- c) To assess how the proposals have been developed to achieve a satisfactory level of environmental performance in line with the EIA Regulations

#### **3.3 EIA REPORT AND EIA IMPLEMENTATION PROCESS**

In general the objective of an EIA report is to address the environmental concerns of the development project. The EIA will help to achieve efficient planning, aid in identifying impacts and their potential mitigation measures. The EIA report will also help to promote informed environmental and sound decision making during the development of the project.

The aim of the EIA is to identify, describe and assess in an appropriate manner, proposed development, in accordance with the provisions of guidelines and regulations of the GoM, the direct, indirect and residual effects of the project on the following factors:

- Physical and chemical characteristics of the earth (soil, landform, unique physical features), water (marine and underground), atmosphere (air quality and climate),
- biological conditions including flora (trees/shrubs and endangered species), fauna (birds, land animals, coral and endangered animals) habitats (environmentally sensitive areas protected area etc);
- cultural factors including aesthetic and human interest (scenic views and vistas, wilderness qualities, landscape design, historical and archaeological sites and objects), and cultural status (employment); and
- ecological relationships including eutrophication, disease and insect vectors, and introduction of alien species etc..

This EIA report has been prepared by Dr. Mahmood Riyaz a registered EIA consultants (Registration no 03/07) at EPA was selected by the proponent through an open bidding process. EIA preparation process is as follow:

- 1- The consultant prepares EIA application form with necessary relevant documentations for the proponent for submission to EPA, and the proponent submits the application along with project brief and a draft TOR.
- 2- EPA calls for a scoping meeting with proponent, consultant and relevant stakeholders from government agencies to finalise the draft TOR of the EIA study
- 3- The consultant undertakes literature review and gathers relevant data and information on the project.
- 4- Consultant undertakes the field assessment work
- 5- The consultant analysis data and information gathered and identify environmental impacts, determine mitigation measures, rationally evaluate and suggest alternatives and limitations and propose a monitoring plan.
- 6- The consultant discusses major findings with the proponent and suggest possible changes to the project/project component.
- 7- Based on the discussion with the proponent the consultant reviews the EIA and makes necessary changes to the document.
- 8- The proponent should provide written commitment to undertake mitigation measures and post-development environmental monitoring as per the EIA report.
- 9- The consultant submits the final EIA to the proponent who subsequently will submit to EPA for review and to issue decision note.

Once the decision note is issued from EPA the proponent is obligated to implement the EIA and matters highlighted in the decision note. Also the proponent shall implement the periodic monitoring programme during construction and operational phase of the project and submit monitoring report as indicated in the EIA report.

### 3.4 SCOPE OF THE EIA

The scope of this EIA is based on the consultations held during the scoping meeting at the Environmental Protection Agency on 9<sup>th</sup> June 2016. The approved ToR highlighted 9 major tasks to be covered including;

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

A copy of the ToR is attached in Annex 1. The EIA report closely followed the approved ToR for the assessment.

### 3.5 PROJECT SETTING

Gdh. Nadellaa Island lies in a 1.2-3km wide and 33km long reef system that forms the south western periphery of Gaafu Dhaalu Aoll. The reef system hosts over eighty five island of different sizes. There are 5 inhabited islands in the reef system, Rathafandhoo and Fiyori are on the southern part the reef and South of Nadellaa while Hodhedhdho and Madaveli are on north and Northern part of the reef. Nadellaa located on the central part of the reef (Figure 1) . Nadellaa Island is rectangular in shape approximately 817m long and 526m wide. Vegetated area of Gdh Nadellaa is 44 hectares. According to the 2014 census the total population of Nadellaa is 725, Male population is 338 and female population is 337. Over 30 foreigners are residing in the island.

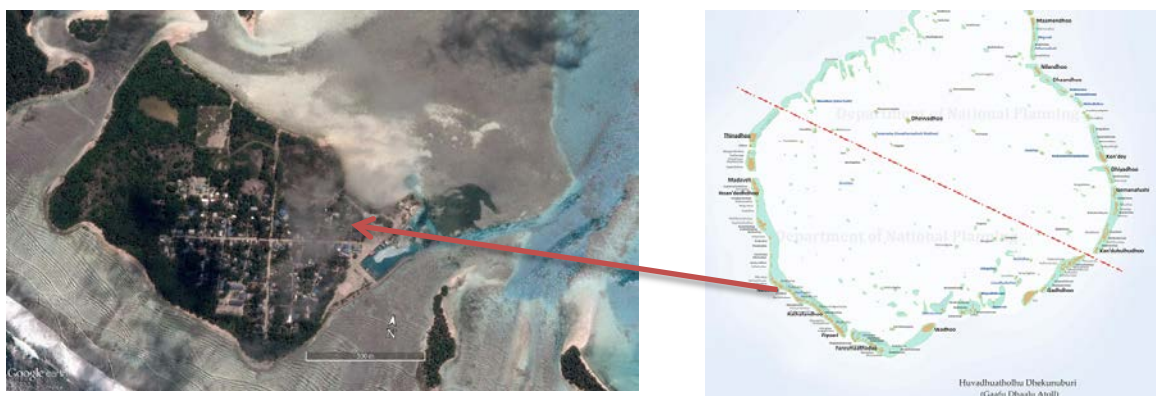


Figure 1: Map showing the location of Gdh. Nadellaa in Gaafu Dhaalu Atoll

### 3.6 PROJECT JUSTIFICATION

Empowerment of youth, through creation of jobs and opportunities for skill development, education, entrepreneurship, sports, music and entertainment is an important youth development policy of the present Government. Creation of sports facilities and infrastructures will contribute to create a healthy population physically fit to serve the nation and the community. Also the development will contribute to overall social cohesion of the island community and create a solid social bonding between the island communities near and far through organization of island and inter-island, atoll and nationwide sports tournaments and youth gatherings. Therefore the proposed sports arena development project in Gdh Nadellaa is a platform and a vehicle for youth development and empowerment, creation of healthy community, physically and mentally fit population for nation building, establish and maintain social cohesiveness and it will serve as a solid foundation that will unite the island community. The main target of the government is to develop youth through development and improvement of sports related infrastructure. The proposed development is a fulfillment of the government's pledged to develop a sports arena in each inhabited island during these 5 years period.

At present the only football ground in Gdh Nadellaa Island is exposed to frequent flooding during the rainy season. The football ground is an import youth and sports infrastructure which is also used for multiple purposes such as community gatherings, school activities etc. To overcome flooding problem the Ministry of Youth and Sports has decided to improve the existing football ground under the on-going sports arena development project. The proposed development is an important need of the community particularly the youth to maintain their physical and mental fitness also a necessary basic need for the general population to sustain a healthy life.

### 3.7 PROJECT SCOPE SUMMARY

The project mainly involves the levelling of the football ground of Gdh Nadellaa using excavated material from the shallow lagoon area located adjacent to the deep area in front of the boatyard. The proposed project covers the following activities

- Mobilisation
- Dredging 144.4m long and 50m wide area to a depth of -3m at low tide;
- Extract dredged material volume, 21660m<sup>3</sup>
- Football field; earthwork and levelling area approximately 10,000m<sup>2</sup>
- Demobilization;

### 3.8 REVIEW OF RELAVANT STUDIES

As part of relevant literature review and preparation of the report, the following EIA studies on dredging and reclamation conducted for football ground development in various parts of the Maldives have been reviewed and used as reference;

*EIA for playground reclamation project for Ga Dhaandhoo by Energy Consultancy Pvt. Ltd, February 2013*

*1<sup>st</sup> Addendum, to the EIA Report for restoration of AA Mathiveri Harbour under construction of harbours for Tsunami victims Project by: Husain Zahir and Shahma A Sattar, February 2013*

Most reports on dredging and reclamation could be considered as relevant and appropriate reference material to understand the types, degrees and magnitudes of environmental impacts and potential mitigation measures for the proposed levelling and earthworks of football arena in Gdh Nadellaa..

### **3.9 EIA IMPLEMENTATION METHODOLOGIES**

This study was based mainly on data collected during a field investigation mission from 3-5 June 2016 by the consultant. Field studies have been undertaken using methods generally employed for EIA studies in the Maldives. Environmental impacts are predicted by use of widely used descriptive checklists and its significances are evaluated by the use of Leopold matrices. Expert judgment and professional opinion as well as review of relevant EIA studies have also been widely used throughout the impact assessment and evaluation process. These methods are described in detail at the relevant section of this EIA Report.

## 4 DESCRIPTION OF THE PROJECT

### 4.1 THE PROPONENT

The proponent of the project is Gdh Nadellaa Council. The island council is the responsible body for the development and coordination of infrastructure development project that is developed for the general public. Also the council has the mandate to look after and maintain the public facilities. The proposed project will be funded by the Ministry of Youth and Sports. The developmental activities will be carried out by a contractor. The process of selection of the contractor is going on at present. The main responsibility of the island council would be to overall coordination of the project activities during the construction period and maintain the facility after development.

### 4.2 PROJECT LOCATION AND BOUNDARY

Gdh Nadellaa is located on the south western side of Gdh Atoll. The island is located at latitude 0.292579° and longitude 73.042035° (Figure 1). The Island is rectangular in shape oriented NW-SE and is found in a huge reef that contains over 85 islands of various sizes and shape. There are 5 inhabited islands in the reef system, Rathafandhoo and Fiyori are on the southern part the reef and South of Nadellaa while Hdhedhdho and Madaveli are on north and Northern part of the reef. Gdh Nadellaa is located on the central part of the reef. Nadellaa island is rectangular in shape, vegetated area of Gdh Nadellaa is 44 hectares approximately 817m long and 526m wide (Figures 2-4).

The proposed development will take place on the football ground where excavated material from the shallow lagoon area located adjacent to the dredged area in front of the boatyard will be used for levelling the ground.



Figure 2: Project Boundary. The project boundary is confined to Nadellaa Island and the reef and lagoon environment in which the island is found.



Figure 3: Project impact footprint, excavator path and material transport route

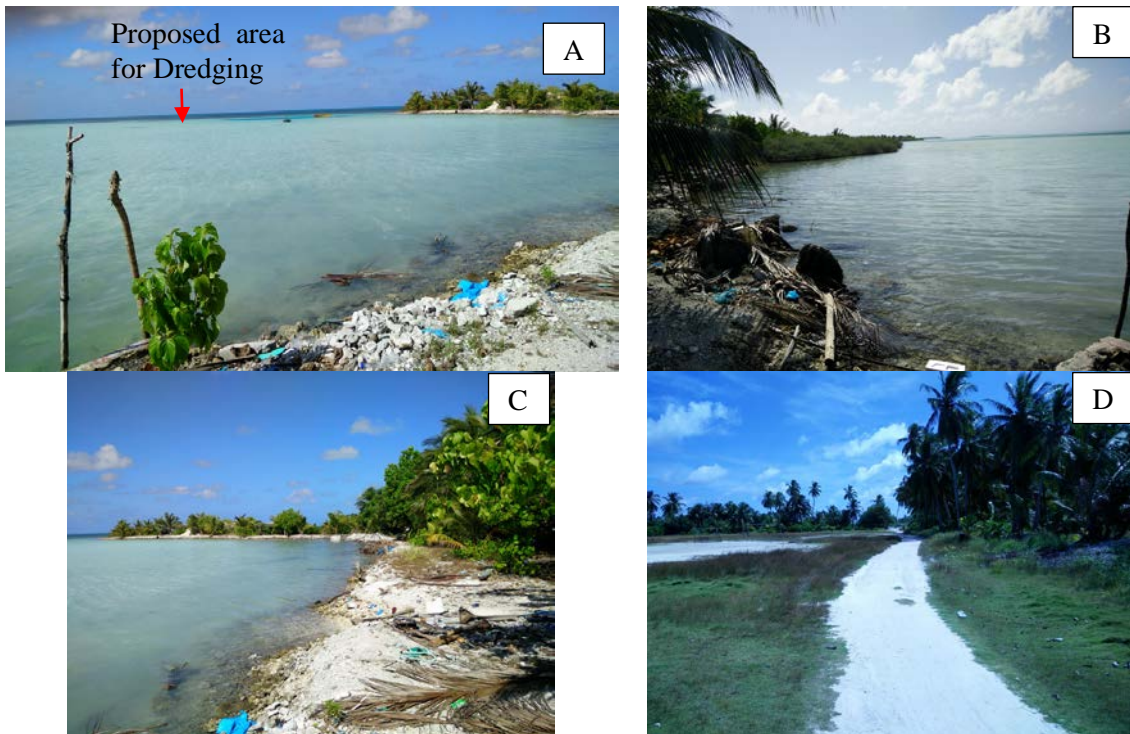


Figure 4: showing the proposed dredging area and condition of the shoreline (A, B, C) the football ground where dredged material will be used for ground levelling and earth work

### 4.3 MAIN DEVELOPMENT FEATURES OF THE PROJECT

The proposed football arena development project in Nadellaa Island involves dredging 50x144.4m area and use the extracted sand for football ground levelling. The levelling for the football ground will follow the general guideline used by the Ministry of Youth and Sports (Annex 2). The general playground levelling and dredging procedure involves the following:

#### 4.3.1 Playground levelling procedure and standards

- Excavation of the football ground to a depth of two feet
- Sieve the sand extracted from excavation to remove hard material and rock and rubble particles and remains of trees and shrubs.
- During the ground levelling procedure play ground will be sloping side wards (high in the center). Sides of the playground will be at same level of the adjacent road.
- The sloping ratio is 200:1 ft
- The top most layer of the playground should be fine sandy material that can be used for compaction of the ground
- Ground compaction will be carried-out by using a 5kg roller (Figure 5).

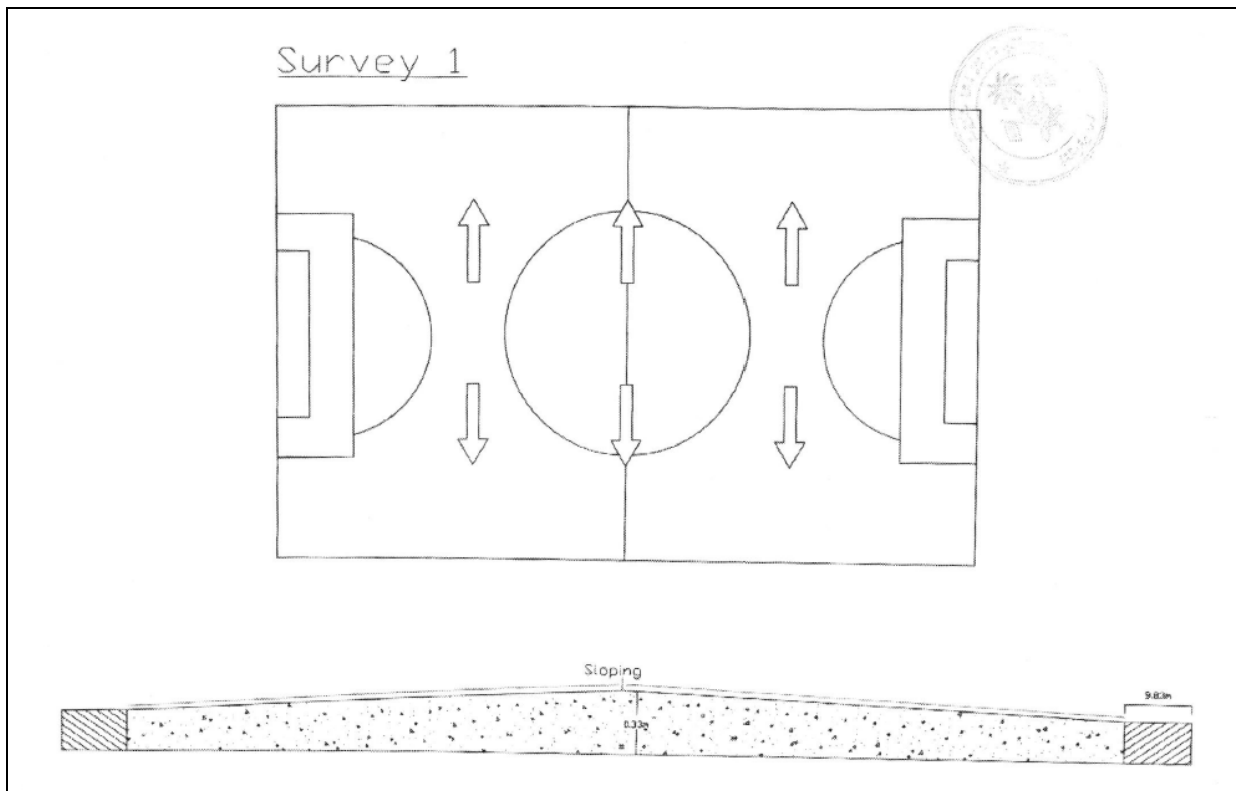


Figure 5: Engineering drawing showing the ground levelling details of the playground.

#### 4.3.2 Dredging

- Location of dredging: 50m away from island shoreline (low water mark) adjacent to the dredged area in front of the boatyard
- Size of dredge area: 144.4m long X 50m wide, area 7225m<sup>2</sup>
- Volume of dredged material: 21,660m<sup>3</sup>
- Equipment use: Excavator 1.5m bucket size, loader and two Lorries
- First the exactor will build excavator path (2.5m wide 60m long) from sand, which will also be used for loading the excavated material to the lorries (Figure 3)

- Loaded excavated material will be transport through the island road network to the playground using lorries (Figure 3)

#### 4.4 MAJOR CIVIL WORKS

##### 4.4.1 Initial mobilisation and site preparation

Site mobilisation of the construction equipment, can be easily brought into the island through the existing harbour. The proposed construction work requires use of heavy machinery and special equipment. Some of these include excavators, lorries, trucks, loaders and the like (Figure 6). Since this is a very small project the workforce involved with the project would be very small within the range of 10-15. The workforce can be accommodated on the island in the existing houses.



Figure 6: Typical heavy machinery and equipment that will be used for football ground levelling work

##### 4.4.2 Dredging

The proposed dredging to obtain the material needed for football ground levelling involves dredging a 50x144.4 m<sup>2</sup> area from 50m away from the shoreline (low tide line). Total volume of the dredged material is 21,660m<sup>3</sup>. Conditional approval for dredging and playground levelling in Gdh Nadella has already granted by EPA on September 2015 Annex 3.

The dredging will be undertaken by using an excavator. The excavator will work from an excavator bed that will be eventually moved to the final fill material disposal site at the playground. The dredged material will be directly transported to the playground levelling site using lorries through the routes shown in Figure 3. This helps in the retention of the dredged material due to the high level of compaction that would be achieved. It is planned to complete all activities within the scope of this project within 60 days.

#### 4.5 VOLUMES AND TYPES OF SEDIMENT TO BE DREDGED

From existing depth information for the proposed dredging area a total of 21660m<sup>3</sup> of dredged material will be generated by the proposed works. The dredged material will be mostly composed of fine and medium sized coral sand with minor mount of coral rubble.

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

## 4.6 TIMING

Timing of the dredging is proposed to be coincided during the NW monsoon period to allow the sediment plume to move westward influenced by the predominant wind direction and ocean currents and out of the reef with minimum distance required to crossing over the reef flat before the plume reaches the deep ocean. The proposed dredging schedule is given below in Table 1

## 4.7 PROJECT SCHEDULE

The project is expected to take 2 months to complete including the time needed for seeking necessary approvals. The main milestones include; obtaining approvals, mobilization, and onset of work, dredging and levelling. Table 1 shows the project schedule.

Table 1: Project Schedule – Indicative

### Project - Gdh Nadellaa Football arena development project

Today's Date: 06/25/16 0  
Start Date: 06/09/16

Ser.	Tasks	Start	End	Duration days																	
					5-Jun-16	12-Jun-16	19-Jun-16	26-Jun-16	3-Jul-16	10-Jul-16	17-Jul-16	24-Jul-16	31-Jul-16	7-Aug-16	14-Aug-16	21-Aug-16					
1	EIA preperation and approval	06/09/16	06/29/16	20	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
2	Contract award preliminary survey	06/29/16	07/04/16	5																	
3	Mobilisation	07/04/16	07/14/16	10																	
4	Start dredging work	07/14/16	07/29/16	15																	
5	Excavation and earthworks of the playground	07/28/16	08/12/16	15																	
6	Levelling	08/12/16	08/22/16	10																	
7	Demobilisation	08/22/16	08/27/16	5																	

Table 2: Matrix of major inputs to the project

Input resource(s)	Source/type	How to obtain resources
Workers	Skilled and semi-skilled labour, Manager (1) Supervisor (1) Excavator Operator (2), Loader operator (1), , Driver (2), Labourer (4) total of 11 people, skilled and semi-skilled 7 and unskilled labourers 4.	Trained and licensed staff of the contactor
Machinery (excavator, , operational tools)	01 excavator 01 loader 02 Lorries 02 diesel tank 1000 litre 01 small dinky	To be obtained and operated by the contractor. Contractor will be required to bring to the site machines in good working conditions to avoid loss of time due to breakdown of machines, vehicles and equipment.
Output	Anticipated quantities	Comments

Dredged material	21,660m <sup>2</sup> sand	To be used for playground levelling
Wastes	Minor amount	No wastes during the excavation will be allowed to be dumped into the sea. Solid wastes and human wastes will be managed through the existing wastewater and solid waste management system on the island
Waste oil and lubricants	Minor amount	Gathered in a barrel and sent to Thilafushi through existing waste management system
Noise and light	Localized	Excavator and truck operation will generate some noise during the project execution. If work is carried out in the night lights will be necessary in the dredging area. Work will not be carried out late into the night to avoid disturbance to local population.
Plastics and packaging waste	Minor amount	Managed through existing waste management system of the island

## **5 REGULATORY CONSIDERATIONS**

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

### **5.1 MINISTRY OF ENVIRONMENT, ENERGY & WATER**

The Ministry of Environment and Energy (MEE) is key Ministry in the government mandated with the protection of the environment. Environmental responsibilities assigned to MEE includes formulating environmental policies, coordinating, preservation and management of the environment throughout the country, and enforcing Environmental Protection and Preservation Act (EPPA) (04/93). Under Article 5(a) of EPPA, Environmental Impact Assessment (EIA) is mandatory for projects that may cause potential harm to the environment. The EIA report has to be submitted to the EPA for approval before commencement of a project. As per this legislation, any project that has any undesirable impact on the environment can be terminated without compensation by MEE.

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

EPA is the key regulatory body on environment, which is an autonomous body formed under the umbrella of MEE. It is mandated with implementing the EIA process in the Maldives, implementing the Environment Act and subsequent regulations on behalf of MEE, regulating water and sanitation, biodiversity conservation, waste management and coastal zone management. Also, it is responsible for developing environmental standards and guidelines in the country.

### **5.3 LEGAL FRAMEWORK**

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

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

#### **5.3.1 EIA Regulations 2012**

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

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

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

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

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

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

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

Environment Impact Regulations, 2012 & other relevant regulations

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

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

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

### **5.3.2 Regulation on Cutting down Trees**

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

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

- The coastal vegetation growing around the islands extending to about 15m into the island
- All trees and palms growing in mangroves and wetlands spreading to 15m of land area
- All trees in Government protected areas
- Trees that are being protected by the Government in order to protect species of animal / organisms that inhabit on such trees
- Trees / palms those are unusual in nature.

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

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

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

### **5.3.3 Regulation on Dredging and Reclamation**

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

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. A copy of the permit is given in Annex 3.

### **5.3.4 Regulation and Waste Management**

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

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

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

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

## 6 METHODOLOGIES

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

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

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

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

In undertaking baseline studies using available data, knowledge and experience have been used. Key issues have been identified during scoping as given in the TOR. Based on the scoping need for further in-depth studies and additional data requirement were identified. A checklist was used to define both coarse information requirement and further baseline studies required for impact prediction and monitoring. Local knowledge was used as much as possible to ensure key questions are addressed in the assessment. Ideally full year of data is desirable for a study of this nature to understand seasonal variability and environmental change. However to avoid delay in decision making and to provide a conservative estimate of environmental impacts a short term data collection and use of existing data were adopted.

### 6.1 DREDGING REQUIREMENTS AND WORK METHODOLOGY

#### 6.1.1 Dredging Method

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

#### 6.1.2 Excavation

It involves dislodgement of and removal of sediments and/or rocks from sea bottom of the dredge areas. An excavator will be used to dredge the material by mechanical actions. The dredging will be performed utilizing a CAT 330 hydraulic excavator equipped with Young's 1.5-yd<sup>3</sup> hydraulic bucket. The excavator will work from an excavator bed that will be eventually moved to the final fill material disposal site. Dredging will be conducted from the excavator bed and the dredged material will be loaded into dump truck to transport to the ground levelling site.

#### 6.1.3 Transport of Excavated Material

Transporting materials from the dredging area to the playground levelling site will be achieved as follows. Sediments will be dumped into dump trucks in the excavator bed; when the truck is full, the truck will transport the sediment to the location levelling site. Excavator with appropriate bucket size has been recommended due to the relatively small size of the area requiring dredging and due to relative simplicity of the methodology for not having to do much pre-work preparation and to shorten the job schedule.

#### **6.1.4 Disposal Site**

Dredged material transported by dump trucks will be disposed off to the designated playground levelling sites through the existing route shown in Figure 3. Once the material is disposed off to the site proper ground levelling and spreading of the load is carried out by manually and using various equipment.

### **6.2 MARINE ENVIRONMENT**

#### **6.2.1 Lagoon Surveys**

Equipment and tools used

- Handheld Global Positioning System (GPS)
- Still photograph camera
- Underwater writing sheets
- Satellite data

The lagoon bottom and seagrass bed is classified using broad composition categories which provide a morphological description of the reef community. These categories were recorded on data sheets by snorkelling along the reef line which was placed roughly parallel to the reef crest on the reef-flat at a depth of about 1-5m.

#### **6.2.2 Waves and Currents**

Generalised wave predictions and wave pattern predicted using hindcast for the Indian Ocean was obtained from weather information providing sites. Wave height for Gdh Nadellaa was estimated using wind frequency data for Kaadedhdhoo island.

#### **6.2.3 Coastal Dynamics**

Combination of remote sensing and GIS technology and field mapping and ground truthing were used to assess the long term coastal and morphological changes of the islands. Google earth sequence was co-georeferenced and comparatively evaluated using GIS technology to assess the long term geomorphological developments of the island. Changes in the shoreline prior to harbour development work in 2009, after development and recent photographs were compared and evaluated to document the morphological changes in shore line.

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

Due to the homogenous nature of the geological characteristics of Maldivian Atolls, site specific investigation for reef and lagoon geomorphology was not conducted whereas coring studies conducted elsewhere in the Maldives was reviewed. Visual observations were also made during the field on the geomorphological aspects of the island lagoon and reef. Coral communities and the coral reefs at the entrance channel and within the dredging area were assessed by combination of boat patrolling, exploratory grab sampling, and underwater visual observations and underwater transects.

Since undertaking of EIA is mandatory for dredging projects under EIA Regulations a scoping was held at EPA with the stakeholders to determine the TOR for the EIA study. The level of details contained within this document is based on the agreed TOR. The TOR is contained in the Annex 1.

## **6.3 TERRESTRIAL ENVIRONMENT**

### **6.4 CLIMATE**

Official meteorological observations services in Maldives are limited to airports. A total of 10 airports are in operation, however meteorological observation takes place only on 5 airports. They are Hanimaadhoo in the north, Ibrahim Nasir International Airport in the centre, Kahdhoo, in the south centre, Kaadeddhoo, in the south, and Gan Island in the extreme south. Observation routinely monitored and measured include, wind speed and direction, daily minimum and maximum temperature, humidity, cloud cover. Monitoring of sea-level height takes place only in Hulhule (central), Hanimaadhoo (North) and in Gan Island (in south). Apart from the official meteorological observations, number of resort islands and individuals are installing portable mobile weather stations. Such weather stations are providing real time measurements to famous weather forecasting sites such as [www.wunderground.com](http://www.wunderground.com) and [www.windfinder.com](http://www.windfinder.com). Data collected from these stations are now publicly available from those internet sites.

In the absence site specific weather data the normal procedure is to obtain whatever is available from the nearest weather station in an airport and apply it to the site assuming that average climate conditions do not show much variation between different islands. For the purposes of Nadellaa EIA meteorological observations from the Kaadeddhoo, which is located approximately 22km north of Nadellaa was used for description of the general weather conditions on the northern part of the Maldives.

### **6.5 IMPACT ASSESSMENT METHODOLOGY**

The environmental impacts that may be associated with the proposed dredging and playground levelling project on Gdh Nadellaa Island are predicted by using a simple matrix. Dredging for various reasons such as harbour development, extract sand and reclamation, beach nourishment etc., is very common in the Maldives. People are very familiar with the environmental impacts associated with the development. Due to its necessity socio economic benefit of the proposed sports arena development always overweight environmental concerns. Impacts from various activities of the proposed project both construction and operational phases have been identified through consultation with the project management team, field surveys, observations and assessment, as well as based on field experience and expert opinion on similar development projects in the country.

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

## 7 EXISTING ENVIRONMENTAL CONDITIONS

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### 7.1 GEOLOGY AND GEOGRAPHY

Gdh Nadellaa Island is situated on the south western Periphery of Gaafu Dghaalu (Gdh) Atoll, at latitude  $0.292579^{\circ}$  and longitude  $73.042035^{\circ}$  (Figure 7). The island forms part of the natural atoll in the country called Huvadho Atoll, which is believed to be the second biggest atoll of the world.

Nadellaa was formed on an elongated reef platform measuring a length of over 33 km is shared by large number of islands. Gdh Nadellaa is rectangular in shape oriented NW-SE and is found in a huge reef that contains over 85 islands of various sizes and shapes. There are 5 inhabited islands in the reef system, Rathafandhoo and Fiyori are on the southern part the reef and South of Nadellaa while Hodhedhdho and Madaveli are on north and Northern part of the reef. Gdh Nadellaa is located on the central part of the reef. Nadellaa island is rectangular in shape, vegetated area of Gdh Nadella is 44 hectares approximately 817m long and 526m wide.



Figure 7: Location of the Project

Total area of the house reef is 5615 ha ( $56 \text{ km}^2$ ). The island occupies 0.007 % of the total reef area. Average depth of the reef flat greatly varied along the reef platform ranging from 20-0.2m from MSL. The distance between the island shoreline and ocean-ward reef rim is 250m and on the atoll-ward side is approximately 1.2km

### 7.2 OBJECTIVES

The purpose of this was to assess the existing environmental conditions of the island, including marine and land environment. Further, study of existing environment also involved undertaking review of available literature to understand long term trends in climatological regime and natural hazard incidents. These assessments would not only enable avoiding impacts to the environment as a result of the project but also would contribute to better planning recommendations for the proposed project. This is critical in assessing potential impacts and to determine the actual extent of damage should an unforeseen impact occur during the implementation phase.

The main aim of surveys and assessments was to establish the existing baseline environmental conditions of Gdh Nadellaa Island. The objectives of the present assessment were to:

1. Determine the general abiotic and biotic conditions of the marine and terrestrial environment of the project area;
2. determine the general abiotic and biotic conditions of the marine environment of the project area;
3. determine the geological and geomorphological characteristics of the project area;
4. assess the changes that will be associated with the proposed project;
5. propose mitigation measures to avoid, minimise potential effects from the proposed project; and
6. Propose monitoring arrangements to measure effectiveness of the proposed mitigation measures

### 7.3 STUDY AREA AND SURVEY LOCATIONS

Figure 8 below shows, ground and sea water sampling locations, beach profile and reef survey locations with their respective GPS co-ordinates of profile locations and water samples are given in respective sections of the report.



Figure 8: study area, sampling locations important components of coastal environment

### 7.4 GEOLOGY AND GEOMORPHOLOGY

Digital globe, Google earth and island surveys are comparatively evaluated using GIS technology to assess the developments of the island. The northern shoreline of the island has been altered after the

harbour development in 2009. Large area of the island was reclaimed adjacent to the harbour area. Semi enclosed water body which has openings to the lagoon was completely reclaimed and by filling with dredged material from harbour and access channel development process (Figure 9).

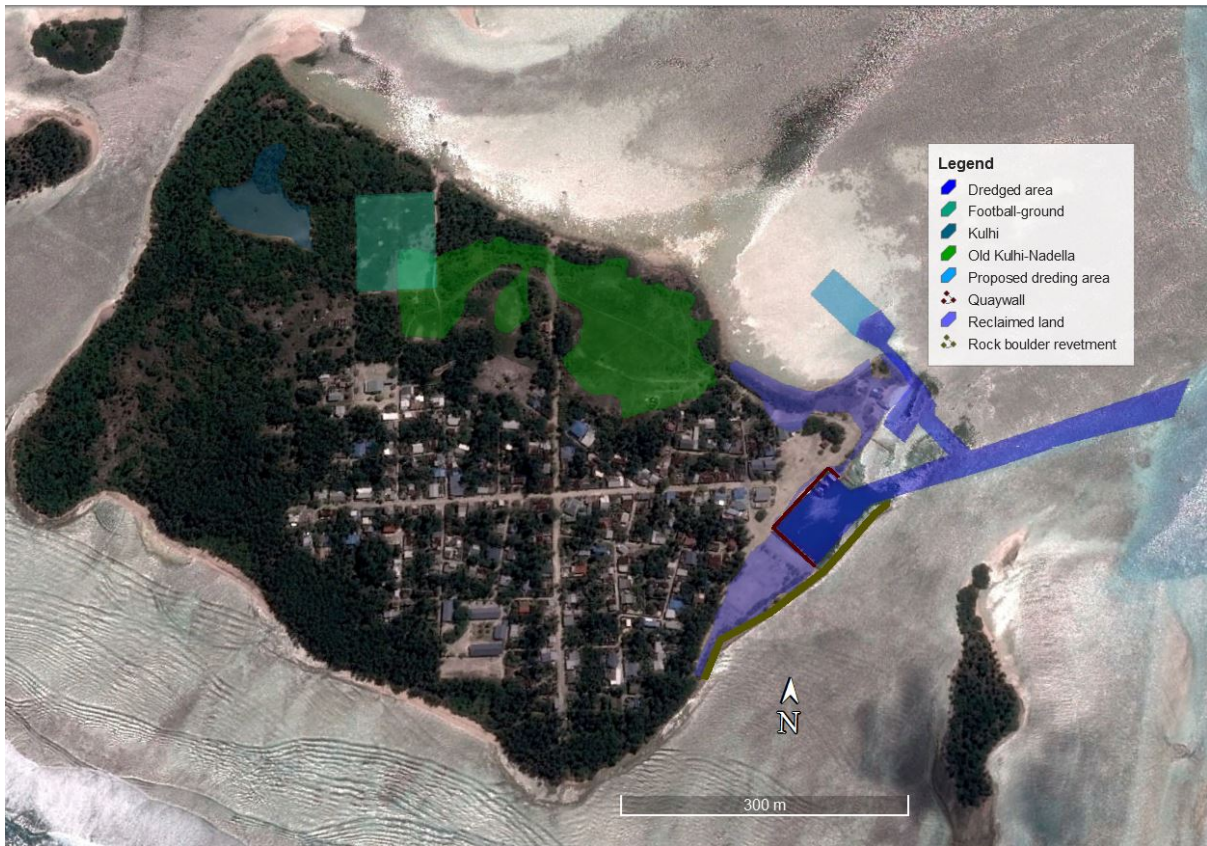


Figure 9: coastal development features of Gdh Nadellaa

The playground which will be levelled under this project is located between the low land area within the old Kulhi (semi enclosed water body) and the existing small Kulhi. The playground has been development on the lowest part of the island that seems be the main reason for exposure for flooding during the rainy season.

## 7.5 BATHYMETRY

Bathymetric survey of the proposed area for dredging was carried out by using echo sounder and a GPS. Differential GPS technique is used for correction of GPS locations points. Echo sounder measurements are corrected and related to the mean sea-level for the area. The area proposed for dredging has a shallow depth within the range of 0.2-0.5m. The bottom is covered with fine to medium grained sand



Figure 10: Nearshore depth around the area proposed for dredging.

## 7.6 METEOROLOGY AND CLIMATE

### 7.6.1 Temperature

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

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

### 7.6.2 Rainfall

Nadellaa is located in a high rainfall zone of the country. Rainfall data from the three main meteorological stations, HDh Hanimaadhoo, K. Hulhule and S. Gan shows an increasing average rainfall from the northern regions to the southern regions of the country. The southern atolls receive, on average, 2,277 mm of rainfall annually, while the relatively drier northern atolls receive 1,786 mm (MMS, 2006). The nearest meteorological station to Nadellaa is at Kaadedhoo airport which became operational relatively recently in 1993. Rainfall data for the period 1994 – 2012 from Kaadedhoo has been used to determine rainfall pattern for Nadellaa Island.

The mean annual rainfall for Kaadedhoo is 2186.6 mm with a Standard Deviation of 398.1 mm and the mean monthly rainfall is 182 mm. Mean rainfall varies throughout the year with mean highest rainfall during October, November and December and lowest between February and March (See Figure 11).

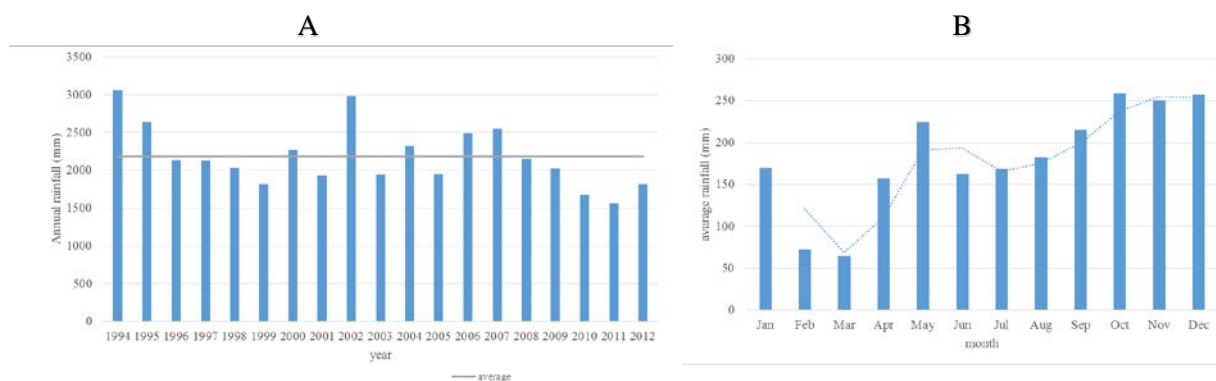


Figure 11: Variation in average rainfall at Kaadedhdhoo Island (A) annual (B) monthly from (1991 to 2012).

### 7.6.3 Monsoons

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

### 7.6.4 Winds

The climate of the Maldives can be divided into two monsoon periods marked by strong seasonal reversals in wind direction that are confined to a narrow range of wind angles. Summary wind data since 1964 (Figure 12) indicate that the Maldives experience west to northwest winds ( $225^{\circ}$ – $315^{\circ}$ ) from April to November during the *Hulhangu* monsoon with a mean wind speed of  $5.1 \text{ m s}^{-1}$ . In contrast the *Iruvai* monsoon, from December to March, is characterized by winds from the east-northeast ( $45^{\circ}$ – $90^{\circ}$ ) with a mean wind speed of  $4.9 \text{ m s}^{-1}$ . Wind strength is most variable during the crossover between northeast and westerly monsoons with mean wind speed falling to  $3.5 \text{ m s}^{-1}$  in March (Department of Meteorology, 1995) (see Figure 12).

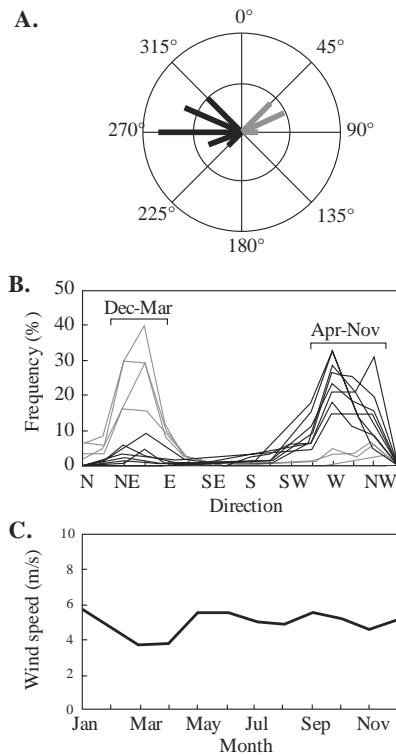


Figure 12: Summary of wind data for the Maldives showing A) 30-year mean percent frequency wind direction B) 30-year mean monthly percent frequency wind direction; C) 30-year mean monthly wind speed. Climate data from Government of Maldives, Department of Meteorology, 1995 adapted from Kench et al; (2009).

## 7.6.5 Hydrology

### 7.6.5.1 Waves

Satellite altimetry derived wave climate data over a ten-year period for the region (Young, 1999) indicates the dominant swell approaches from southerly directions. On a seasonal basis, swell is from the south-southwest from April to November with a peak significant wave height ( $H_s$ ) of 1.8 m in June, and from the south to southeast directions from November to March with minimum  $H_s$  of 0.75 m in March (Figure 13). Overall wave energy was greatest on all islands during the westerly monsoon (Young, 1999).

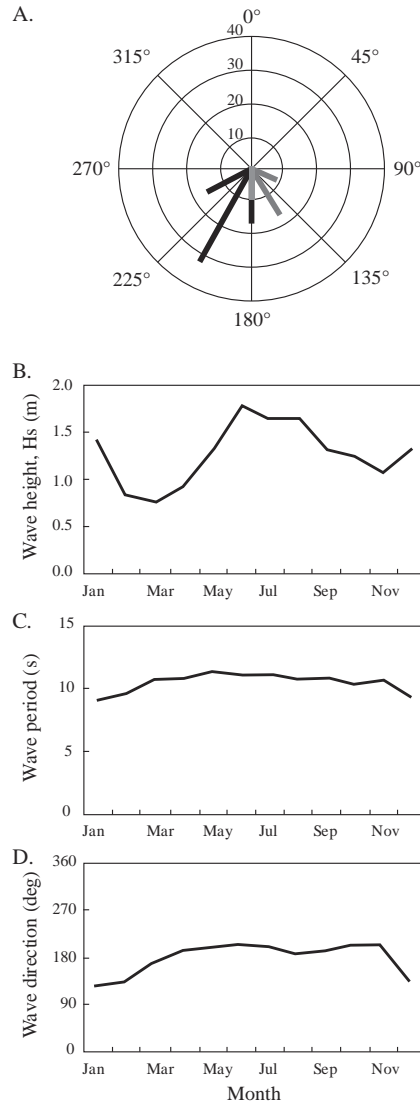


Figure 13: Ten year mean monthly ocean swell for the Maldives showing (A) wave direction for April to November (black lines) and December – March (gray lines) (B) wave height (C) wave period (D) wave direction. Data from Young (1999) adapted from Kench and Brander, (2006).

### 7.6.5.2 Tide

The Maldives is subjected to a semidiurnal microtidal regime with spring and neap tidal ranges of 1.2 m and 0.6 m respectively. The highest astronomical tide was recorded as 0.64 m above the mean sea level and the lowest astronomical tide was recorded as 0.56 m below the mean sea level. Tidal variation of 1.2 m from lowest to the highest tide levels were recorded in the country (see Table 3). This suggests that there is a maximum clearance of structures of 0.9 m above maximum tidal limit. Tidal fluctuations (rise and fall of tides) cause changes in current flow pattern around the island and bring subsequent changes in physical aspects of the shoreline. At low tide water movement is very slow, therefore low tide period is considered to be a good time to conduct dredging and reclamation work.

Table 3: Tidal variations for the Maldives with respect to mean sea level

<i>Tide Level</i>	<i>Referred to MSL</i>
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highest astronomical tide (HAT)	+0.64
mean higher high water (MHHW)	+0.34
mean lower high water (MLHW)	+0.14
mean sea level (MSL)	0.00
mean higher low water (MHLW)	-0.16
mean lower low water (MHLW)	-0.36
lowest astronomical tide (LAT)	-0.56

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### 7.6.5.3 Currents

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

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

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

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

## 7.7 TERRESTRIAL ENVIRONMENT

The terrestrial environment of Gdh Nadellaa is similar to other inhabited islands across the Maldives. The island is wide and rectangular shape in the NW to SE orientation. The topography of the island is almost flat and the relative variation in ground level in different parts. Existence of Kulhi on the northern part of the island indicates that the island has a general slop northwards. Ground level of the project areas is found to be less than 0.6m . The roads are unpaved and the two main roads have widths within the range of 8-10 meters and width of smaller road is less than 7m.

Nadellaa has lush tropical vegetation around the island dominated by coconut palms but *Scaevola taccada* (magoo) Kuredhi boashi, Halaveli and coconut palms surrounding the island. *Hibiscus*

*tiliaceus* (dhigga) is abundant throughout the island followed by *Thespesia populnea* (hirundhu). Occasionally, *Cordia subcordata* (kaani) can be seen in the wooded area and rarely mature *Fiscus benghalensis* (nika).

Vegetation on the playground area has already been cleared and the land have been used by the people to play football for over 5 years now. Part of the playground is covered with grass other parts with fine sand. Total area proposed for ground levelling is approximately 10,000m<sup>2</sup> (1 Hectares). The proposed development will not require removal of any mature tree. The following Figure 14 shows the vegetation cover in the area proposed for ground levelling.



Figure 14: Vegetation cover near the football field

## 7.8 COASTAL ENVIRONMENT

The north eastern part of Gdh Nadellaa coast has been modified during the harbour development project. Large area has been reclaimed. Harbour has been protected by rock boulder breakwater and a quaywall has been constructed to protect the harbour. Also the southern side of the shoreline has been protected by rock boulder revetment.

The semi enclosed water body that existed on the western side of the harbour has been reclaimed by using the dredged material from harbour development activity.

With these changes on the northeastern part of Gdh Nadellaa most of the coastline is well protected. Therefore it is very unlikely that the proposed dredging will have a significant physical change on the shore dynamics. Since the western side of the harbour is not protected most of hydrodynamic changes associated with the dredging will take place on the western shoreline. The western side seems to be a sediment accretion area, where large amount of sediment that moves around the island is accreted due to the shore perpendicular harbour structure. Hence the most important impact for the proposed dredge area would be filling with sediment quickly. Since this area would not be used as part of harbour eventual filling up and will not be a major concern. But the concern would be if the filling up will cause erosion elsewhere on the north western shoreline.



Figure 15: Coastal environment showing modification and coastal protection structures and the Kulhi  
 For future monitoring of the impact of coastal change associated with the proposed dredging activity a beach profile was taken from the north western part. The beach profile shows a fairly steep sloping 5m wide beach. The difference between top and bottom of the island ridge (berm) is 0.4cm. Ground height at the inner vegetation line is 0.41cm above mean sea level. This indicates that ground topography on this part of the island is fairly low (Figure 16). The location of the profile is shown in Figure 8.

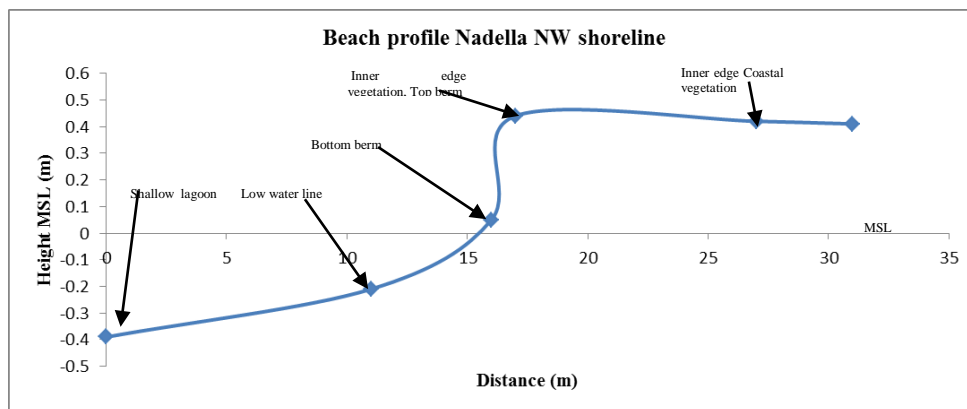


Figure 16: Beach profile north western part of Gdha Nadellaa

## 7.9 WATER QUALITY

Two water samples one from the existing Kulhi adjacent to the playground and the second sample from the lagoon were taken and Water quality was assessed at the Male Water and Sewerage Company's Water Quality Assurance Laboratory using standard methodologies. Sampling locations are shown in Figure 8. The results are given in Table 4 and the original tests results are given in Annex 5. It is recommended to use the monitoring data during the project implementation against the baseline information in assessing the environmental impacts

**Table 4: Water quality laboratory analysis results**

	Kulhi Water	Sea water
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Physical appearance	Pale yellow with particles	Clear
Electric Conductivity (µS/cm)	489	55200
pH	7.99	8.17
Nitrate(mg/l)	7.6	4.2
Nitrogen Ammonia(mg/l)	0.20	-
Sulphate(mg/l)	13	-
Hardness Calcium(mg/l)	55.0	-
Phosphate(mg/l)	0.12	-
Total Dissolved solids (mg/l)	244	27600
Salinity (mg/l)	0.24	36.5
Turbidity	-	0.709

## 7.10 MARINE ENVIRONMENT

The main focus of this assessment is the nearshore lagoon area where the proposed dredging activities will take place. The area proposed for dredging is on the northern of the island. The whole area is covered with medium to fine grained loose coral sand. It seems that this area has been accreting sand. Part of the area is exposed at low tide (Figure 17). Coral reef on the atoll ward side is approximately 1.2km away from the dredging are. Large part of the lagoon, from the dredging are to the island entrance, is covered with seagrass. According to the locals seagrass started to grow on Nadellaa after the reclamation of semi enclosed water body that existed on the island. The lagoon area has many patch reefs and live coral colonies.



Figure 17: Substrate composition nearshore lagoon area proposed for dredging

Healthy coral reef is essential for island ecosystems to maintain its integrity, structure and proper functioning of its ecosystem services. Reefs provide the physical protection to the island from waves and nourishes the beach by the sand its produces. The composition and its abundance of live forms on coral reefs is an indication of the health of the reef. In its simplest form substrate cover and composition and abundance of fish is a good starting baseline amenable for rapid forms of assessment.

Coral reef adjacent to the island entrance was surveyed by snorkelling and taking underwater pictures after every 5 kicks. The reef was under lot of stress from the ongoing coral bleaching event. Large part (approximately 60%) of the live corals was dead and the dead corals were covered with Halimeda

(Algae, produce flaky disk shape calcareous sand). The following figure shows the overall condition and status of the reef (Figure 18).

The proposed dredging activity will take one kilometre away from the reef, therefore it is very unlikely that sedimentation from the dredging activity will reach the reef.

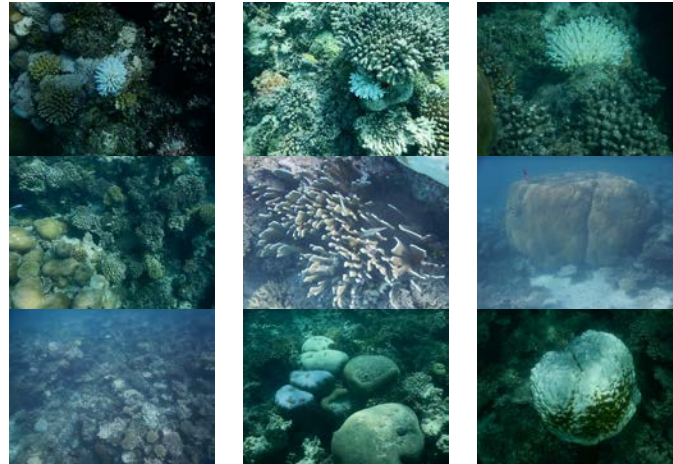


Figure 18: status of coral reef located 1.2m away from the dredging area, 60% is bleached, and extensive algal growth on dead corals was observed

## **8 SOCIO-ECONOMIC ENVIRONMENT**

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### **8.1 INTRODUCTION**

As part of outlining general socio-economic environmental condition for the proposed sports arena development project in Gdh Nadellaa , socio-economic conditions of the Atoll in general and more specifically that of Gdh Nadellaa has been looked into since the project impact is expected to be on this island as it is located on the island.

### **8.2 POPULATION**

The total registered population of South Huvadho Atoll in 2014 was 13152, 11765 Maldivian and 1387 expatriates. The total enumerated population of the Atoll, from Maldives population and housing census of 2006 is reported as 11013 (Ministry of Planning and National Development, 2008). At present there are 7240 males and 5912 females (MPND, 2008) in the atoll represents 3.41 % of the national population. Annual population growth is 0.70/ year. Nadellaa is the least populated 725 island in the atoll and represents 0.05% of the total population of the Atoll. Population migration to Male' and Thinadhoo for various purposes was considered high for the island.

Expatriate population are on a growing trend throughout the island of the Maldives and the islands of Gdh are a no exception. Many foreigners are employed by the government in education and health sector in Nadellaa Island. The total number of foreigners on Gadhdho is estimated to be close to 33.

#### **8.2.1 Poverty**

The Maldives Vulnerability and Poverty Assessment of 2004 (VPA II) reported that 10% of the island population have an income less than MVR 15 per day and 4% have an income less than MVR 10 per day. The figure 10% population below Rf 15 per day is much lower than the national average of 21% and outer atoll average of 28%. There was no observed abject poverty on the island. (UNDP, 2009). Multi-dimensional poverty index MPI for Ga and Gdh atoll is 0.0105 and the average monthly household income and expenditure is 8,833, and 10,233 respectively (HIES 2009). Per capita income and expenditure for both Ga and Gdh is 1639 and 1894 respectively.

### **8.3 UTILITY SERVICES HELTH AND EDUCATION**

According to the information from the island council 98.9% households have access to drinking water and over 97% households have access to electricity in Gdh Nadellaa. Private sewerage system has been established in the island and most of the household population of the island is either connected to the system or directly connect to a sea outfall. Nadellaa referral health center provides health services during official working hours for the island community. The health center has one resident medical doctors and three nurses. Serious and advance health cases are taken to Thinadhoo regional hospital.

Lower secondary level School with a preschool is established in Nadellaa. Total number of students is 194 According to the Nadellaa council data 98% of the population is literate.

Key infrastructures in the island includes Health center, power house, island harbour, local sewerage network, primary and pre -schools, road networks, two telecom sites and public administration building.

## **8.4 ECONOMY**

According to Human Development Report 2014 the human development index of Ga and Gdh atoll is nationally the lowest with an HDI values of 0.594 and Gross national income per capital GNI 4589 US Dollar. Economically active population in both in Ga and Gdh is 7825 out of which 6066 are employed and 1759 are unemployed. The unemployment rate of the two atolls is 22% and the labor force participation rate is 66%. Male employment percentage in the Atoll was found to be 76 % while 58% of female were employed. Important industries for the Atoll include, wholesale and retail trade, public administration, agriculture and forestry, health and social work, construction, and community social and personal services.

One tourist resort and one guest house with 20 beds is operational at present and the total tourist bed capacity of Gdh Atoll is 220 which accounts for only 0.8% of the total bed capacity of the country. Three resort development projects are currently underway in the Atoll.

The main economic activity of Gdh Nadellaa in terms of estimated income is fishing. It is followed by employment in agriculture civil service, and wholesale and retail trade. The mainstay of Nadellaa economy are the basic sectors involved in the export of goods and services – fishing, manufacturing and wholesale trade. The rest of the non-basic sectors such as transport, retail trade, hotels and other small business activities are dependent on the economic functioning of the basic sectors. Hence, a lowering of income from fisheries will reverberate through the economy. For example, a decline in fishery may lead to a reduction in demand for new housing construction and transport activities (UNDP, 2014).

Despite the availability of important facilities, the local economy of Nadellaa Island's economy appears to be extremely narrow based and is subjected to external shocks such as market prices of fish

## **8.5 SOCIO-ECONOMIC BENEFITS**

The primary target of the proposed sports arena development project in Gdh Nadellaa is to empower of youth, through sports and recreation. Creation of sports facilities and infrastructures will contribute to create a healthy population physically fit to serve the nation and the community. Also the development will contribute to overall social cohesion of the island community and create a solid social bonding between the island communities near and far through organization of island and inter-island, atoll and nationwide sports tournaments and youth gatherings. Therefore the proposed sports arena development project in Gdh Nadellaa is a platform and a vehicle for youth development and empowerment, creation of healthy community, physically and mentally fit population for nation building, establish and maintain social cohesiveness and it will serve as a solid foundation that will unite the island community. The proposed development is a fulfilment of the government's pledged to develop a sports arena in each inhabited island during these 5 years period

## 9 STAKEHOLDER CONSULTATION

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As part of the consultation process the consultant has discussed the development with the atoll council representative who attended the scoping meeting held at EPA on 9<sup>th</sup> June 2016 also members of the island council and general public during the field visit to the island. Since the council is the proponent of the project they are very much in favor of the project and they want the sports arena development project to go ahead in Gdh Nadellaa and start the work soon as possible. They believe that the island community particularly the youth population in Nadella will greatly benefit the development directly and indirectly through creation of short term employment opportunities during construction phase of the project, improved sports and recreational services and other socio economic benefits and attribute to create peace and harmony in the island. As part of the EIA regulation requirement the proponent has shared the final EIA report with Gdh Atoll council.

List of people met during scoping meeting and the stakeholder consultation

Name	Designation	Contact No
Faisal Najeeb	Council President	7783004
Mohamed Qadir	Deputy President	7778878
Mohamed Moonis	Member	9704087
Ali Niyaz	Member	9972005
Ahmed Amir	Member	9884654
Ibrahim Abdul Kareem	Assistant Director (council)	7866299
Ishaaq Naseer	EPA	<a href="mailto:isaac.naseer@epa.gov.mv">isaac.naseer@epa.gov.mv</a>
Yazeed Ahmed	EPA /Director	<a href="mailto:Yazeed.ahmed@epa.gov.mv">Yazeed.ahmed@epa.gov.mv</a>

## **10 POTENTIAL IMPACTS AND MITIGATION MEASURES**

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This section of the report identifies the potential environmental impacts and possible issues that could arise from implementation of the dredging works using an excavator. Their identification of potential impacts does not mean that they would necessarily occur or that they could not be successfully mitigated. The proposed other works include transportation of dredged material, earthwork and ground levelling of the sports arena.

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

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

Severity of impact is assessed by reviewing the engineering design, detailed site plan as well as comparison of development with the existing environment and construction methodologies employed. Mitigation measures are derived based on the site specific assessment as well as similar project elsewhere in the Maldives. Impact identification matrix is provided in Table 5. Potential impacts and their mitigation measures and detail discussion is the following sections. Table 6 gives a summary of impacts their magnitude reversibility and duration.

### **10.1 IMPACT IDENTIFICATION**

The following section describes in detail and discusses the main potential environmental impacts that have been identified and predicted for the proposed sports arena development in Nadellaa. Identified potential impacts are divided into construction phase and operation phase environmental impacts.

### **10.2 LIMITATION/UNCERTAINTY OF IMPACT PREDICTION**

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

Table 5: Impact identification matrix

Impact	Construction phase Activities						Operational phase Activities	
	Site setup and mobilization	Work force	Dredging	Ground leveling and earthwork	Equipment and vehicle maintenance	Demobilization	Use of Sports arena	Dredged area use
Noise	-	-	-	-	X	-	-	X
Dusting -Air Quality	-	X	-	-	-	-	-	X
Coastal process	X	X	-	X	X	-	X	-
Terrestrial flora	X	X	X	X	X	X	X	X
Ground water	X	X	X	-	-	X	X	X
Soil	X	X	X	-	-	-	X	X
Marine water	-	X	-	-	-	-	X	-
Hydro dynamics	-	X	-	X	X	X	X	-
Marine habitat and Fauna	-	X	-	X	X	-	X	-
Socio-economic	+	+	+	+	+	-	+	X

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

### 10.3 IMPACTS AND MITIGATION MEASURES

Construction phase can be considered as the period in any developmental project that causes major direct and indirect long and short-term impacts on the environment. Anticipated potential direct and indirect environmental impacts from the proposed lagoon dredging and sports arena development project in Gdh Nadellaa include the following:

- Mobilization of Equipment and Labour
- Dredging, and subsequent sedimentation
- Hydrodynamic regime
- Marine habitat and coastal environment
- Noise, Vibrations and Air Pollution
- Earthwork and levelling
- Equipment & vehicle maintenance

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

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

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

### **10.3.2 Lagoon Dredging, and subsequent sedimentation**

Lagoon dredging to obtain sand from the northern side of Gdh Nadella Island for levelling of football ground will have a direct irreversible negative impact to the ecological habitat in the area. Direct impact of this activity is limited to Gdh Nadellaa lagoon and may extend to the reef depending on the weather conditions and work methodology.

Given below are relevant impacts that should be considered:

1. Physical damage on lagoon benthic fauna and loss of habitat: The effect of this would be in the immediate to medium term with the loss of substrate and its fauna.
2. Disturbance to the area during dredging activity: Release of sediments and potential loss of the faunal composition underneath sediment material will undoubtedly occur.
3. Dredging will change in the flow patterns. The unexpected outcome may be erosion or accretion of the island or coastal areas particularly on the north western side of the island.

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

## **10.4 IMPACTS TO CORAL REEF AND SEAGRASS**

The coral reef flat of Gdh Nadellaa is approximately 1.2km away from the area proposed for dredging. However within the lagoon there are isolated coral patches and coral colonies within the lagoon. The seagrass bed is adjacent to the dredging area therefore the sedimentation impact from the dredging activity will be more severe for the seagrass than the coral reef. Dredging will result in the short-term irreversible loss of the existing coral patches live colonies on the affected area. The potentially negative impacts on the associated fish species are thought to be less severe given that there are adequate reef ecosystems on the island house reef to which they may retreat. Thus, the immediate negative impact of dredging would be reversed over the long-term period.

Without turbidity barriers the currents and the wave action mostly generated by wind particularly during the North East monsoon would promote rapid sediment transport of turbid waters away from the immediate area and into and spread in the shallow lagoon.

Dumping of dredged material on the playground will not result in having to lose any significant vegetation or habitat as a direct result since the area consists only of grass. Noticeable numbers of insect have been observed to live on the green grass. Since they are highly mobile creatures they will move away from the disturbed area and retreat into elsewhere.

### **10.4.1 Hydrodynamic regime**

Dredging the proposed area will increase the depth and is likely to change the overall hydrodynamic regime within of the nearshore due to increase in water depth. Further, the dredged areas are likely to

act as sediment sinks and therefore lagoon conditions may take a number of years to stabilize against the prevailing conditions.

Proposed dredging will in general increase wave heights and reduces currents in and near the proposed dredged area.

Dredging and deepening of nearshore may slightly increase the amount that wave energy is expended on the north western shore, resulting in a slight increase in the amount of wave energy reaching the beach. This increase is considered minor and is not expected to affect the beaches. However, it is proposed to have in place a beach monitoring program against the baseline set up for this study should an unforeseen changes occur to the beach especially during unusual weather.

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

The turbidity associated with the excavation will probably be restricted largely to the bottom, and the immediate vicinity of the dredging area. A plume will still be visible around the dredging operation. It is possible that the visual impact will be moderately severe and localised. The overall significance of this impact will vary from person to person, but on a precautionary basis is regarded as being moderate. Modifications to the lagoon will result in the lowering of the aesthetics of the island compared to the baseline conditions.

## **10.6 DREDGED SAND DISPOSAL**

The dredged material will be used for earthwork and levelling of the playground. Dump trucks will carry dredged materials on the existing road network on the island. One of the main concerns with regards to the dredged material disposal is the impacts on ground water quality. Infiltration of wet salty water into the ground water aquifer will increase the salinity of the ground water table. This is a short tem impact, the salinity of the will decrease once the area is recharged with rain water.

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

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

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

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

## **10.8 POTENTIAL POSTIVE IMPACTS**

Potential positive impact of the project would be creation of short term employment opportunities for the locals. Creation of a sports facilities and infrastructures will attribute to create a healthy population physically fit to build the nation and the community. Also the development will contribute to overall social cohesion of the island community and create a solid social bonding between the

island communities near and far through organization of island and inter-island, atoll and nationwide sports tournaments and youth gatherings. Therefore the proposed sports arena development project in Gdh Nadellaa is a platform for youth development and empowerment, creation of healthy community, physically and mentally fit population for nation building, establish and maintain social cohesiveness. The proposed development is a fulfillment of the government’s pledged to develop a sports arena in each inhabited island during these 5 years period

**10.9 NEGATIVE IMPACTS**

- 1- Loss of benthic biota at the dredging area in the lagoon.
- 2- Short-term sedimentation and turbidity over seagrass and corals due to suspension and dispersal of fine sediments.
- 3- Possible impacts on pelagic environment due to suspended sediments.
- 4- Impaired visual/seascape impacts from the presence of the dredging equipment.
- 5- Increased noise levels due to dredging and earthwork operations.
- 6- Potential increase in salinity of ground water aquifer due to infiltration of salty water into the ground

**10.10 IMPACT MITIGATION MEASURES**

Table 6 below lists the potential impacts identified above in Section 10 and describes the corresponding mitigation measures that should be put in place during implementation of the proposed dredging and sports arena development project at Gdh Nadella. In summary the impact mitigation measures proposed should entail:

- 1) Good dredging practice to minimise sediment suspension and dispersal at the dredging sites.
- 2) In order to minimize the impact from sediment, dredging should be completed in shortest time possible. Dredging ought to take place during low tides or slack tides to minimize the release of sediment to the area.
- 3) Coinciding the dredging activity for SW monsoon period to force the plume to move away from the house reef by allowing the sedimentation to island shore.
- 4) Environmental monitoring of the project to ensure use of turbidity barriers and turbidity level do not exceed the standard levels.
- 5) The contractor shall be mandated that appropriate turbidity barriers be deployed at all times during dredging. The type of barriers selected should take into consideration the shallowness of the area and the prevailing wave and current conditions.
- 6) During the project activities and operational phases, all efforts should be made to prevent the intentional or accidental spill of oil, waste oil and hazardous materials release into the environment which could lead to further damage to the marine environment.
- 7) Contractor should take steps to ensure that there is no dumping of oily waste from dredging vehicles or land-based activities related to the project. Careful consideration should be given to the requirements for storage and appropriate disposal of waste oil.

**10.10.1 Mitigation Cost Elements**

The mitigation measures associated with significant costs, beyond those of dredge equipment rental and deployment, and good dredging practice, is identified below in Table 14 along with the major cost elements. Costs are based on the estimation of the magnitude activity

Table 6: Significant impacts, mitigation measures and associated costs

ACTIVITY	IMPACTS	IMPACT PREDICTION			MITIGATION MESURES	Mitigation cost (MVR)
		Magnitude	Reversibility	Duration		
1. Dredging	Loss of benthic	L	R	M		

and Excavation	biota					
	Modification of current and pattern	L	R	S		
	Settlement of suspended solids on seagrass and benthic organisms	M	R	M	Deploy turbidity barriers to prevent sedimentation on seagrass and coral colonies  Dredging should be completed in shortest time possible.  Dredging during low tides or slack tides	20,000 cost of barrier
	Attenuation of light in water column	L	R	S	Apply above measures to control sediment dispersion	
	Increased ambient noise level	L	R	S	All construction work that produces significant noise should be undertaken during day time to minimize noise pollution.  Provide ear muffs for construction workers to wear when using machinery that produce significant noise.	2,000 cost of earmuffs
2. Dredged material disposal	Increased ground water salinity	L	R	S	Leave the material in rain prior to disposal	
	Leakage of sediments during transport to disposal site	L	R	S	Containing the sediment in the truck to minimize leakage	10,000 cost of leak proof rubber sheet
3. Social impact: the people	Improvements in quality of life Healthy community	H	R	M	Major positive impact of the project	
	Employment	M	R	S	Short term employment	

**Key**

Magnitude

H=High

M=Medium

L=Low

Reversibility

I=Reversible

R=Reversible

Duration

L= Long Term (Over 10 years)

M=Medium term (Over 5 years)

S=Short term (Below 5 years)

## **11 ALTERNATIVES**

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### **11.1 NO DEVELOPMENT OPTION**

It is believed that a number of environmental impacts will be generated from the proposed sports arena development project in Gdh Nadella. Although no impacts on the environment will be associated if the proposed development does not go ahead, the development of sports arena will bring numerous socio-economic and health and wellbeing impacts to the livelihood of the local community. Also the development will contribute to overall social cohesion of the island community and create a solid social bonding between the island communities near and far through organization of island and inter-island, atoll and nationwide sports tournaments and youth gatherings. Therefore the proposed sports arena development project in Gdh Nadellaa is a platform for youth development and empowerment, creation of healthy community, physically and mentally fit population for nation building, establish and maintain social cohesiveness and unity.

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

### **11.2 DEVELOPMENT OPTION**

Having decided and followed the development option of the proposed project one has to consider the alternative options in Gdh Nadella that would have least environment impact. Following have been considered for the alternatives.

### **11.3 ALTERNATIVE LOCATION FOR FOOTBALL GROUND**

Present location of the football ground is in low land, part of the land was reclaimed Kulhi area. This seems be main reason for exposure of the playground for flooding. One of the alternative option would be to relocate the playground elsewhere in the island. Nadella being a densely vegetated island clearing trees and levelling ground in other part of the island would have much higher environmental and economic cost. As the relocation would require land clearance and removal of large trees and ground levelling. Also there is no very high ground in the island that will be flood free during the rainy season. Therefore it is recommended to maintain the playground at the current location.

### **11.4 ALTERNATIVE SOURCE FOR MATERIAL**

Since the dredging to extract sand for ground levelling will have some amount of negative impact on the coastal and marine environment of the island, one of the option that could be considered is to bring imported river sand for levelling. This option will be very expensive as well as the environmental impact of it would be more severe. Imported sand would include insect and other organisms that are alien to the Maldives. Also the important sand would not be homogenous with the calcareous sand and soil that exists in the playground. Therefore inhomogeneity, presence of alien insects and organism in the sand will be environmentally more harmful option than sand from lagoon dredging. Also the economic cost of the imported river sand would be much higher. Therefore the imported river sand is not an attractive option to fill and level the playground in Gdh Nadella.

## **11.5 ALTERNATIVE DREDGING AREA**

Alternative dredging areas has been evaluated during the screen process and prior to the submission of the EIA application. The present location to source the filling material for the playground is the best location that has been agreed by the EPA. Therefore it can be considered as the most viable option to source the material required for ground levelling work for Gdh Nadella sports arena development.

## 12 MONITORING

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

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project are included in the monitoring plan. These include ground water (pH, dissolved oxygen, electrical conductivity, and faecal coliforms), water quality (turbidity, dissolved oxygen, phosphates, nitrates and BOD), sediment deposition. Monitoring the shoreline changes that may occur due to the medium to long term impacts from the changes in coastal processes.

Table 7: Shoreline, Beach Profiles and Coastal Process monitoring schedule

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

Table 8: Coral reef monitoring schedule

Parameter / Method	Frequency of Monitoring	Purpose	Estimated cost (USD)
Benthic cover by major life forms (live, dead, rock rubble, seagrass and sand)	Annually	Indicative of the changes in the live coral cover	150/trip
Fish population / visual census	Annually	To assess broad scale change in the ecological status of the coral reefs (increase / decrease of herbivores, etc)	

Table 9: Water Quality monitoring schedule

Type	Parameters	Locations	Frequency	Estimated cost (USD)
<i>In situ</i> monitoring / sampling and testing from a laboratory	Dissolved oxygen Turbidity (NTU) Nitrates Sulphates COD TDS	All locations marked	Bi-annually	400/ set of tests

### 12.1 MONITORING COSTS

It is understood that costs of monitoring be borne by the proponent. It is also understood the mitigation measures would be accommodated in the contract costs. A commitment letter confirming compliance on mitigation measures is given in Annex 4.

### 12.2 MONITORING REPORT

A detailed environmental monitoring report is required to be compiled and submitted to the Environment Protection Agency annually, based on the data collected for monitoring the parameters included in the monitoring programme given in this report.

The report will include details of the site, strategy of data collection and analysis, quality control measures, sampling frequency and monitoring analysis and details of methodologies and protocols followed.

## 13 CONCLUSIONS

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The environmental impact assessment study for levelling, earthwork and development of sports arena in Gdh. Nadella Island shows there are two main activities that would cause significant negative environmental impacts. Those, in order of significance, are:

1. Lagoon dredging to source fills material for levelling and earthwork.
2. Use of dredged material for earthwork and levelling of playground

Of these a long term impact would be from lagoon dredging activity to source the fill material for levelling and earthwork of the playground . Potential erosion/accretion and adjustment of dredged area to create a new equilibrium with the surrounding environmental conditions are likely to extend to medium to long term. These impacts would be cumulative occurring over long period of time and so can be managed through proper monitoring and addressing them in a timely manner. Based on the scale of dredging work projects that is taking place in Maldives at the time of this writing, impacts associated with this dredging activity is insignificant.

Use of dredged material for earthwork and ground levelling will temporarily increase the salinity of the ground water aquifer but with increased rainfall and infiltration of rainwater into the ground is expected to balance the salinity to the predevelopment level. However, the positive socio economic impacts from the proposed development outweigh the temporary increase in salinity level and impacts of lagoon dredging.

The study has evaluated alternative options for the project activities and evaluated potential option of alternative fill material, alternative location for playground and dredging area. Based on the similar project activities elsewhere in the Maldives the report found, that the lagoon will recover from the impacts of dredging rapidly and will re-establish a new ecological balance soon. Even though there is no very significant impact from this project after the report has come-up with an extensive monitoring programme that will keep on monitoring coastal and marine environmental changes associated with dredging and make necessary adjustment based on the findings of various measured environmental parameters suggested in the monitoring plan.

Therefore on the basis of this environmental impact assessment study and the impact mitigation measures proposed in the report will be duly implemented and recommendations are given due consideration, it is concluded that the benefits of the proposed for levelling, earthwork and development of sports arena in Gdh. Nadella Island will substantially outweigh its imposition on the environment.

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## **15 ANNEXES**

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Annex 1: EIA Terms of Reference (ToR) Approved by EPA

Annex 2: Football ground leveling guidelines and standards by MHRYS

Annex 3: Dredging permit Gdh Nadellaa


Annex 4: Commitment letter from the proponent


Annex 2: Water laboratory results


Annex 3: Relevant document on the project

Annex 7: Letter from Gdh. Atoll Council indicating that they have received the EIA report

Annex 1. EIA Terms of Reference (ToR) Approved by EPA







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Environmental Protection Agency

203-EIARES/418/2016/1

## Terms of Reference for Environmental Impact Assessment for the Proposed Leveling and Earthworks of Football Arena in Nadella, Gaaf Dhaal Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on 09/06/2016 for undertaking the EIA for the proposed leveling and earthworks of Football Arena in G.dh. Nadella. The proponent of this project is G.Dh. Nadella Council.

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

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

**Task 1. Description of the proposed project-** Provide a full description of the relevant components and nature of the project, using maps at appropriate scales where necessary. This is to include: brief description of the proponent, justification of the proposed project, a detailed description of how the project activities will be undertaken including work method for uprooting and transportation, a matrix of project inputs and outputs, details of transplanted site with a detailed project schedule. The boundaries of the study area for the EIA shall be provided. Details of the following project components should be provided:

The main activities of the reclamation and coastal works are:

- Dredging material from burrow area and transporting it into the football arena development area;
- Construction of bunds; and excavator pathways
- Environmental monitoring during construction activities;
- Waste Management

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- Measures to protect environmental values during construction and once the new football arena has been established
- Project management (include scheduling and duration of the project and life span of facilities; communication of construction details, progress, target dates, construction/operation/closure of labour camps, access to site, safety, equipment and material storage, fuel management and emergency plan in case of spills)

**Dredging:**

- Location and size of sand borrow areas (s) on a map;
- Justification for the selection of this location;
- Quantity, quality and characteristics of fill material;
- Indication of guarantees for sufficient availability of fill material;
- Method and equipment used for excavation, and operational control procedures;
- Justification for selecting the methods and equipment;
- Duration of excavation activity;
- Labour requirements and (local) labour availability;
- Housing of temporary labour, and
- Emergency plan in case of spills (diesel, grease, oil)

**Task 2. Descriptions of the environment – Assemble, evaluate and present the environmental baseline study/data regarding the study area and timing of the project (e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they will be usefully applied to future monitoring. The report should outline detailed methodology of data collection utilized.**

The baseline data will be collected before construction and from at least two benchmarks.

All data must be collected as per the requirements of the EPA Data Collection Guidelines (published on [www.epa.gov.mv](http://www.epa.gov.mv)). The report should outline detailed methodology of data collection utilized.

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:

Following field investigations must be provided for baseline data collection:

Climate

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

Geology and geomorphology

- Offshore/coastal geology and geomorphology (use maps);
- Bathymetry (bottom morphology) (use maps) of borrow area;
- (Seasonal) patterns of coastal erosion and accretion (see appendix for monitoring details), and

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- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during construction;

Hydrography/hydrodynamics (use maps)

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

Ecology

- Identify marine protected areas (MPAs) and sensitive sites such as breeding or nursery grounds for protected or endangered species (e.g. coral reefs, spawning fish sites, nurseries for crustaceans or specific sites for marine mammals, sharks and turtles). Include description of commercial species, species with potential to become nuisances or vector.
- Benthic and fish community monitoring around the island (see appendix for monitoring guidelines);
- Landscape integrity, and
- Include ground water monitoring (See appendix for parameter healthy ranges);

Socio-economic environment

- Demography: total population, sex ratio, density, growth and pressure on land and marine resources;
- Income situation and distribution
- Economic activities of both men and women (e.g. fisheries, home gardening, fish processing, employment in industry, government);
- Seasonal changes in activities;
- Land use planning, natural resource use and zoning of activities at sea;
- Accessibility and (public) transport to other island;
- Services quality and accessibility (water supply, waste/water disposal, energy supply, social services like health and education);
- Community needs;
- Sites with historical or cultural interest or sacred places (mosques, graveyard).

Hazard vulnerability:

- Vulnerability of area to flooding and storm surge.

Absence of facilities in the country to carry out the water quality tests will not exempt the proponent from the obligation to provide necessary data. The report should outline the detailed methodology of data collection utilized to describe the existing environment.

**Task 3. Legislative and regulatory considerations** – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project.

- Land use plan OR approval from Ministry of Housing and Infrastructure for the football Arena
- Dredging and Reclamation Permit

**Task 4. Potential impacts (environmental and socio-cultural) of proposed project, incl. all stages** – provide an assessment of the impacts including the impacts of transplantation, backfilling, pest control, movement of

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vehicles within or close to inhabited areas, demolition waste (if any), transportation and carbon emissions from vehicles, etc. needs to be considered. The socio-economic impacts of the project including any benefits to the local community, benefits to the project proponent and end-users, as well as any costs to local community, proponent and end-users including the costs of potential pest control.

**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), the reclamation areas 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 ground water table and quality as a result of use of dredged material for leveling and earthworks areas (leaching of salts in the deposited sediments and change in ground water quantity);
- 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 works in fishing activities (disturbance);
- Impacts of the excavation, island levelling and earthworks on tourism (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;
- Impacts of the reclamation works (diminished) access to groundwater and risks of covering up hazardous materials, and
- Level of protection against hazards like sea level rise, storm surges, etc.
- Impacts on food and nutrition security (fisheries, agricultural activities, supply of other food);
- Social services like health and education;
- Employment and economic opportunities and diversification;
- Impact equity (economic activities, employment, income);
- Social destabilization of the island community, and
- Monitoring of socioeconomic and demographic development.

**Construction related hazards and risks**

- Pollution of the natural environment (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste);
- Risk of accidents and pollution on workers and local population, and
- Impacts on social values, norms and belief due to presence of workers of dredging company on local population.

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

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Identify impacts that are cumulative and unavoidable. Use interaction matrices (E.g. Leopold Matrix) to assess the magnitude and significance of the impacts.

**Task 5. Alternatives to proposed project** – This section must include the proposed development scenario evaluated against the no-project option and other alternatives. These could include alternative work methods and alternative locations. The report should discuss how the recommended alternative was selected.

**Task 6. Mitigation and management of negative impacts** – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to minimising the number of trips to transport the trees pest control and work methods such as the use of appropriate equipment and tools.

**Task 7. Development of monitoring plan (see appendix)**– Environmental monitoring shall focus on the vegetation clearance process as well as the performance of the transplanted trees in their new environment. The number of trees removed the areas from which trees were removed, number and type of machinery used and any grievances of the public shall be documented during the project implementation. Once transplanted, a monitoring programme shall assess the health of the transplanted trees, their survival rate and watering needs of the trees shall be assessed for a period of one year from the day the trees were transplanted. The report should also provide a detailed cost breakdown for implementing the monitoring plan and the commitment of the Proponent to conduct the monitoring programme and submit a report at the end of the one year monitoring.

- Water quality, especially turbidity;
- Sedimentation rates on nearby coral reefs, benthic system and seagrass beds;
- Condition of the sensitive ecosystems and marine resources;
- Re-colonization of the benthic organisms in the borrow areas;
- Erosion and accretion;
- Environmentally sound site clearance;
- Environmentally sound removal of dredging and other equipment including construction materials

**Task 8. Stakeholder consultation, Inter-Agency coordination and public/NGO participation)** – Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders, government. The EIA report should include a list of people/groups consulted, their contact details and summary of the major outcomes. The following parties should be consulted

- a) Public consultation
- b) HPA

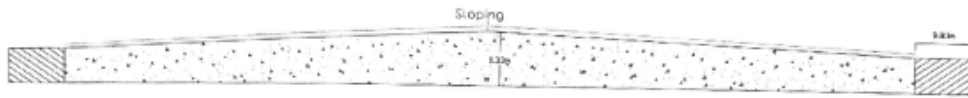
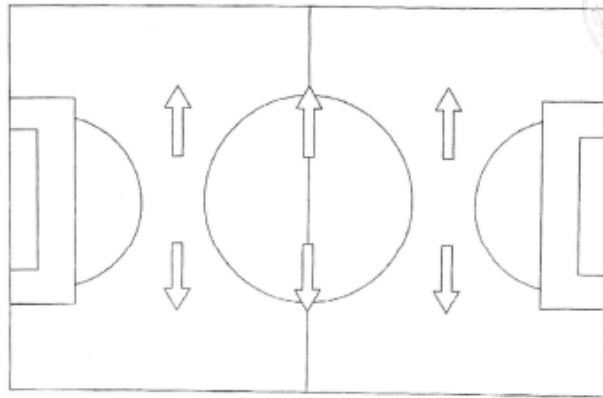
**Presentation**- The environmental impact assessment report is to be presented in digital format; will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations of any references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

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

09<sup>th</sup> June 2016



Survey 1








Annex 4: Environmental monitoring commitment letter from the proponent



## Annex 4: Water laboratory results

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**Water Quality Assurance Laboratory**  
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### WATER QUALITY TEST REPORT



Test Report No: 301226/2016/03

**Customer Informations :** *Mr. Mahmood Riyaz*  
*H. Hithifaiy,*  
*Hithah Finvaa magu,*  
*Male'*  
*Rep. of Maldives*

Date: 03/07/2016

Sample Description / Location	Sea water	TEST METHOD	UNIT
Sample Type	Sea water		
Sampled Date	24/6/2016		
Sample Received Date	26/6/2016		
Test Requisition Form No.	900165369		
Sample No.	825330		
Date of Analysis	26/6/2016 - 27/6/2016		
<b>PARAMETER</b>	<b>ANALYSIS RESULT</b>		
Physical Appearance	Clear	Visual	-
Conductivity	55200	Method 2510 B. (Adapted from Standard methods for the examination of water and waste water, 22nd edition)	µS/cm
Nitrate	4.2	Method 8171 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
pH	8.17	Method 4500 H+ B. (Adapted from Standard methods for the examination of water and waste water, 21st edition)	-
Salinity	36.50	Method 2520 B. (Adapted from Standard methods for the examination of water and waste water, 21st edition)	‰
Total Dissolved Solids	27600	Electrometry	mg/L
Turbidity	0.769	HACH Nephelometric Method (Adapted from HACH 2100N Turbidimeter User Manual)	NTU

**Keys:**  
 %: Parts Per Thousand, mg/L: Milligram Per Liter, µS/cm: Micro Siemens per centimeter, NTU: Nephelometric Turbidity Unit  
 LoQ: Limit of Quantification


Checked by:  Afnan Farooq Laboratory Executive	Approved by:  Mohamed Eyman Senior Technical Officer
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**Notes:**  
**Sampling Authority:** Sampling was not done by MWSC Laboratory  
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 This test report is ONLY FOR THE SAMPLES TESTED.  
 ~ Information Supplied by the customer

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

Page 1 of 1 WQA/LAB/F-14, Rev 05

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### WATER QUALITY TEST REPORT


Test Report No: 301226/2016/04

**Customer Informations :** *Mr. Mahmood Riyaz*  
*H. Hithifaiy,*  
*Hithah Finvaa magu,*  
*Male'*  
*Rep. of Maldives*

Date: 03/07/2016

Sample Description / Location	Kulhi Water	TEST METHOD	UNIT
Sample Type	Ground water		
Sampled Date	24/6/2016		
Sample Received Date	25/6/2016		
Test Requisition Form No.	900165369		
Sample No.	825331		
Date of Analysis	26/6/2016 - 27/6/2016		
<b>PARAMETER</b>	<b>ANALYSIS RESULT</b>		
Physical Appearance	Pale yellow with particles	Visual	-
Conductivity	489	Method 2510 B. (Adapted from Standard methods for the examination of water and waste water, 22nd edition)	µS/cm
Nitrate	7.6	Method 8171 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
pH	7.99	Method 4500 H+ B. (Adapted from Standard methods for the examination of water and waste water, 21st edition)	-
Nitrogen Ammonia	0.20	Method 8098 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphate	13	Method 8051 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Hardness, Calcium	55.0	HACH Method 8204	mg/L
Salinity	0.24	Method 2520 B. (Adapted from Standard methods for the examination of water and waste water, 21st edition)	‰
Phosphate	0.12	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Total Dissolved Solids	244	Electrometry	mg/L

**Keys:**  
 %: Parts Per Thousand, mg/L: Milligram Per Liter, µS/cm: Micro Siemens per centimeter  
 LoQ: Limit of Quantification

Checked by:  Afnan Farooq Laboratory Executive	Approved by:  Mohamed Eyman Senior Technical Officer
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**Notes:**  
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\*\*\*\*\*END OF THE REPORT\*\*\*\*\*

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Annex 7: Letter from Gdh. Atoll Council indicating that they have received the EIA report



ދިވެހިރާއްޖޭގެ ޖުމްހޫރިއްޔާ

ސަރުކާރުގެ ގެޒެޓް - ސަރުކާރުގެ ބަޔާން



ދިވެހިރާއްޖޭގެ ދެކުނު ހުވަދްނުތޮލްހު ޅަތޮލް ކައުންސިލް  
 SECRETARIAT OF THE SOUTH HUVADHUATHOLHU ATOLL COUNCIL  
 ގަޑްހު ތިނަދޯ، ރިޕްލިކް ޕްލިއުމާލްޑީވްސް  
 Gdh.Thinadhoo, Rep.Of Maldives

ޞަފްހާ 4/2016/418/242(MSG)

މުޢާލިމު ސަރުކާރުގެ ފަރާތްޗެހިން.

ދިވެހިރާއްޖޭގެ ޖުމްހޫރިއްޔާގެ ސަރުކާރުގެ ފަރާތްޗެހިން

އިދާރާތަކީ: ސަރުކާރުގެ ފަރާތްޗެހިން ޖަހާފައިވާ ސަރުކާރުގެ ފަރާތްޗެހިން  
 Environmental Impact Assessment for Proposed leveling and earthworks of Football Arena in Nadella South Huvadhu Atoll

# ސަރުކާރުގެ ފަރާތްޗެހިން ޖަހާފައިވާ ސަރުކާރުގެ ފަރާތްޗެހިން

# ސަރުކާރުގެ ފަރާތްޗެހިން ޖަހާފައިވާ ސަރުކާރުގެ ފަރާތްޗެހިން

# ސަރުކާރުގެ ފަރާތްޗެހިން ޖަހާފައިވާ ސަރުކާރުގެ ފަރާތްޗެހިން

# ސަރުކާރުގެ ފަރާތްޗެހިން ޖަހާފައިވާ ސަރުކާރުގެ ފަރާތްޗެހިން 10:35 2016 30



# ސަރުކާރުގެ ފަރާތްޗެހިން ޖަހާފައިވާ ސަރުކާރުގެ ފަރާތްޗެހިން

ދިވެހިރާއްޖޭގެ ޖުމްހޫރިއްޔާގެ ސަރުކާރުގެ ފަރާތްޗެހިން

2016 30

