FIRST ENVIRONMENTAL IMPACT ASSESSMENT ADDENDUM

For the

Proposed Reclamation of Himmafushi, Kaafu Atoll, Maldives

Change of Borrow Area

Proponent:

Ministry of Housing and Infrastructure

Consultant:

Amir Musthafa (EIA01/13)

June 2016

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Consultants Declaration

This EIA has been prepared according to the EIA Regulations. I certify that the statements in this Environmental Impact Assessment study are true, complete and correct to the best of my knowledge and abilities

Amir Musthafa (EIA 01/13)

3rd July 2016

Proponents Declaration

(attached in the following page)

Proponents Declaration

Re: EIA Addendum for K.Himmafushi Reclamation

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

Signature: 

Name: Fathimath Shaana Farooq

Designation: Director General

On behalf of: Ministry of

Housing and Infrastructure Date:

03 July 2016

Non Technical Summary

This report is the Addendum to the EIA undertaken for the Proposed Reclamation of K. Himmafushi, Maldives. This addendum is based on the change of borrow area after the sand search campaign has been undertaken.

An Environmental Impact Assessment was necessary for the works outlined in this report as they fall under the 'Jadhuvalu R' of the Environmental Impact Assessment Regulations 2012 of the Maldives. This report would further conform to the Dredging and Reclamation regulation. In addition to meeting the regulatory requirements, the report would further assist the proponent and important stakeholders to make decisions in an environmentally sound manner.

Potential borrow areas in Kaafu Atoll was originally investigated and subsequently Ari Atoll area was also studied. The dredging location chosen is about 10 km west of the proposed borrow area 1, area 2, and area 3 given in the original EIA. The overall environmental impacts of the project have been assessed using frameworks found on literature and the results indicate that the proposed project has minimum negative impact and have an overall net positive outcome. The main environmental positive impacts due to this change comes from the fact that it is relatively closer to some resort islands and sensitive areas than the originally proposed areas. However, the dredging location is still over 500m away from any location of importance. Dredging activities will no doubt increase sedimentation impacts in the area, although lasting impacts are not envisaged. Bait fishing in the vicinity of the borrow area will have an impact for the duration of the project. There are no additional impacts due to reclamation as there is no change in scope with regards to this component. Furthermore, it is important to note that the approved dredge locations in the initial EIA were closer to the "Havza Thila" a popular diving spot.

Important new stakeholders for the project include Atoll council, AA. Ukulhas council, AA. Mathiveri council and AA. Bodufulhadhoo council in addition to resort islands. The main reservations by the stakeholders is the fact that sand is borrowed from Ari Atoll for a reclamation in Kaafu atoll. All the stakeholders expressed their disapproval at this. Moreover, they expressed their concerns on the impact of dredging works on the fisheries and tourism of the Atoll. AA. Bodufulhadhoo council especially did note that the shallow reef North of the borrow area was used for bait fishing, and fishermen from Mathiveri and Bodufulhadhoo use the general area and channel for fishing. The stakeholders were informed of the previous islands reclaimed under the same project and how the impacts were minimal.

Alternative borrow area options are not viable as the sand search campaign concluded that there are no other significant sand depots within either North Male' Atoll or North Ari Atoll. Alternative areas are those that have already been excluded. The only other viable alternative is to source sand from even further away, which was not feasible at all. Importing sand from abroad will be very costly and will have further negative impacts at the reclaim site.

It is recommended to continue to monitor the impacts of the proposed project by regular monitoring of marine water quality. The monitoring plan proposed in the original EIA is slightly updated to include more monitoring locations, near borrow area. A two stage monitoring plan is given, which recommends quarterly monitoring during the 1st year and less frequent monitoring for the next 5 years. Undertaking the monitoring, along with the mitigation measures is necessary to ensure the sustainable development of the project with minimum harm to the environment.

It is thus recommended that since the project has major socio-economic benefits and environmental benefits as detailed in the initial EIA, it is advisable to allow the project to proceed as proposed. Moreover, since the change in scope is relatively small, and since the initial EIA has been approved, and also considering the fact that the sand search campaign resulted in only one location within reasonable distance from Himmafushi to obtain sand, there is no viable reason to postpone or cancel the project due to this change. However, mitigation measures should be in place and continuous monitoring should be undertaken.

ސާރާ ޚުލާސާ

މި ރިޕޯޓަކީ ކ. ހިއްމަފުށި ބިންހިއްކުމުގެ މަޝްރޫއަށް ކަނޑުން ވެލި ނަގަން ހަމަޖެހިފައިވާ ސަރަހައްދު ބަދަލުވުމާއި ގުޅިގެން މިމަޝްރޫއަށް ހަދާފައިވާ އީ.އައި.އޭ ރިޕޯޓުގެ ފުރަތަމަ އެޑެންޑަމް ރިޕޯޓެވެ. މިމަސައްކަތަށް އީ.އައި.އޭ އެޑެންޑަމް ބޭނުންވަނީ މިމަސައްކަތަކީ ތިމާވެށްޓަށް އަސަރު ފޯރާނެ މިންވަރު ބަޔާންކުރާ ރިޕޯޓު ހުށަހެޅުމާއި ބެހޭ ގަވާއިދު 2012 ގެ 'ޖަދުވަލު ރ' ގައި މިފަދަ ރިޕޯޓު ހުށަހަޅަންޖެހޭ މަޝްރޫޢުތަކުގެ ލިސްޓުގައި މިފަދަ މަސައްކަތްތަކަށް ހިމެނިފައިވާތީއެވެ. މިމަޝްރޫޢު ތިމާވެއްޓާއިބެހޭ ޤަވާއިދާއި ޤާނޫނާ ފުށުއަރުމުގެ އިތުރުން، މި އީ.އައި.އޭގެ ސަބަބުން މިމަޝްރޫޢުގެ އޮތޯރިޓީއާއި ކަމާބެހޭ އެހެން ފަރާތްތަކަށް މަޝްރޫޢާއި ބެހޭ ނިންމުންތައް ނިންމުމަށް އެހީއަކަށް ވެގެންދާނެއެވެ. އަދި ދެފެރެއްޖެހިވި ގޮތަކަށް މިމަޝްރޫޢު ކުރިއަށް ގެންދިއުމަށް އޮތް ވަސީލަތަކަށް ވެގެންދާނެއެވެ.

މިރިޕޯޓުގެ ހޯދުންތައް ބިނާކުރެވިފައިވަނީ ޖޫން 2016 ގައި މަޝްރޫޢުގެ ކޮންސަލްޓަންޓް، ހާމިދު [illegible] މަޝްރޫޢުގެ ކޮންޓްރެކްޓަރ ފެން ޑްރެޖްގެ ޗީފުން މިމަޝްރޫޢުގެ ސަރަހައްދު ބަލާފައެވެ. އަދި މަޝްރޫޢުގެ އޮޕަރޭޓަރު، މިނިސްޓްރީ އޮފް ހައުސިންގ އެންޑް އިންފްރާސްޓްރަކްޗަރ ފަރާތުން ވެސް ގިނަގުނަ މައުލޫމާތު ފޯރުކޮށްދީފައެވެ.

މި ބަދަލު ގެންނަން ޖެހުނު މައިގަނޑު ސަބަބަކީ މިސަރަހައްދުގައި ވެލި ހޯދުމަށް ހެދުނު "ސާންޑް ސަރވޭ ކޮމްޕެނީ"އަށް ބަލާއިރު، ކުރިން އީ.އައި.އޭގައި ފާހަގަކޮށްފައިވާ ސަރަހައްދުން ވެލި ނުލިބޭނެކަމަށް ހޯދުން ހޯދުންތަކުގެ ސަބަބުންނެވެ. އެހެން ކަމުން އެކަށީގެންވާ މިންވަރަކަށް ވެލިލިބޭ ސަރަހައްދުތަކަށް މަސައްކަތް ބަދަލުކުރަން މަޖުބޫރުވެފައެވެ. މިބަދަލުގެ ސަބަބުން އަދި އަލުގެ ބައެއް މަޝްރޫޢު ޖެހިލާނާ ސަރަހައްދުތަކާއި އަދި ނޫޅޭ ސަރަހައްދުތަކުގައި ފާހަގަކުރެވިފައިވާ ބައެއް ތަންތަނާއި ކަނޑުގެ އޭރިޔާތަކާއި ކަނޑުފަށް ފެނިފައިވާނެއެވެ. މީގެ އިތުރުން، މިސަރަހައްދުތަކުގައި ގޮތަކަށް އެންމެ ކައިރިވެގެން ފުދޭ 500 މީޓަރު ދުރުމިން ހުރުމުގެ ސަރަހައްދު ފެނިގެންދާ މިސަރަހައްދުތަކުން ދާއިރާ ގޮތުގެމަތިން ވަނީކަމަށް ނިޔާކުރެވިއެވެ. ނަމަވެސް ފުރަތަމަ އީ.އައި.އޭ ގައިވެސް ފާހަގަކޮށްފައިވާ ފަދައިން، މަސައްކަތް ކުރުމުން ހިނގާ "ސެޑިމެންޓް ޕްލޫމް"ގެ ސަބަބުން ފަރުގެ "ކޯރަލް ރީފް" އަށް ބޮޑެތި އަސަރުތަކެއް ކުރުވާނެކަމަށް ބެލެވެއެވެ. ޚާއްޞަކޮށް ފަރުތަކަށް ކުރާނެ މަޝްރޫޢުގެ އަސަރު ކުޑަކުރުމަށް ފިޔަވަޅުތަކެއް އެޅުމަށް ހުށަހަޅާފައިވާ މަޝްރޫޢުގެ ބޮޑު އަސަރުތައް ކުޑަކުރެވޭނެއެވެ. މިގޮތުން މަސައްކަތް ކުރެވޭ ސަރަހައްދު އަދި ފަރުތަކާ ދެމެދު ދުރުމިން ބޭއްވުމަށް ބާރުއަޅާފައެވެ. މީގެ އިތުރުން، ފަރުގެ ސަރަހައްދުތަކާއި ކައިރިން ވެލި ނުނެގުމާއި، ވެލި ދޫކުރުމުގައި 2 ހަފްތާ ތެރޭ މިމަސައްކަތް އެހެން ނިމޭނެއެވެ. މިގޮތުން ފުރަތަމަ އީ.އައި.އޭގައި ފާހަގަކޮށްފައިވާ ކުރަމުންދާ މިކޮންސެން މަސައްކަތްތަކާ ގުޅޭ ފިޔަވަޅުތައް ހިންގުމަށް ކުރިއަށްދާނެއެވެ.

އެހެން ކަމުން މިއައި ބަދަލުގެ ސަބަބުން ކުރާނެ އަސަރުތަކަށް ބަލައި، އަދި މިނޫންސަރަހައްދުތަކުން އައްޑޫ އަތޮޅުން ވެލި ލިބެންނެތްކަމަށް ރިޢާޔަތްކޮށް މިމަޝްރޫޢު ކުރިއަށް ގެންދިއުމަކީ އެންމެ ރަނގަޅުގޮތްކަމުގައި ފެނެއެވެ. ނަމަވެސް މަޝްރޫޢު ކުރިއަށް ގެންދަންވާނީ މިރިޕޯޓުގައި ހުށަހަޅާފައިވާ ގޮތަށް މޮނީޓަރިންގ މަސައްކަތްތައްވެސް އެކުލެވޭ ގޮތަށެވެ.

1. Introduction

1.1 Background

This Addendum to the Environmental Impact Assessment (EIA) report has been prepared in order to meet the requirements of Clause 5 of the Environmental Protection and Preservation Act of the Maldives to assess the impacts of the proposed change in borrow area for K. Himmafushi. It is also an objective of the report to conform to the Regulation set by the Environmental Protection Agency.

The report will look at the justifications for the change in borrow area and it will identify and determine the significance of the potential impacts of the proposed works. It would also give more details on how the sand will be placed during reclamation. Alternatives to proposed components or activities in terms of location, design and environmental considerations would be suggested along with measures to mitigate any negative impact on the environment. Environmental monitoring programme is vital in order to demonstrate the long-term sustainability of the proposed project as well as to undertake mitigation measures before any impact leads to long-term significant effects. Long term monitoring helps to understand uncertainties in impact analysis improving future impact predictions and project implementation.

The major findings of this report are based assessments undertaken on 20th to 30th June 2016. Available long-term data were collected from available sources, such as long-term data on meteorology and climate from local and global databases. Long term data on the project site is lacking.

1.2 Literature Review

Existing studies undertaken for similar projects were reviewed in the initial EIA. For this addendum, the previous EIA addendums for S. Feydhoo reclamation EIA (2016) and GDh. Thinadhoo reclamation EIA (2016) was referred to.

1.3 Aims and Objectives of the EIA

This report addresses the environmental concerns of the dredging works. The report attempts to achieve the following objectives.

- Clarify the change in project scope

- Allow better project planning and decision-making based on sustainable development.
- Identify environmental impacts that will occur and gauge their significance due to this change
- Mitigating impacts caused due to the change in scope
- Promote informed and environmentally sound decision making
- To demonstrate the commitment by the proponent on the importance of environmental protection and preservation.

1.4 Methodologies

This EIA has been prepared by Amir Musthafa, a registered permanent EIA consultant with years of experience in Environmental Impact Assessment in the Maldives and has been involved in numerous coastal protection projects, and water works projects undertaken in the country.

Data was obtained from the contractor, Van Oord, which were collected as part of the environmental monitoring works.

Internationally recognized and accepted methods have been used in this environmental evaluation and assessment. This EIA is based mainly on data collected during a field investigation mission for the initial EIA and one 8th June 2016. The data collection methods are described in detail under the following Section.

1.5 Methods of data collection

Conditions of the existing environment of the study area were analysed by using various surveying techniques and scientific methods. Field surveys were carried out to get a further understanding of the existing conditions at the project location. Most of the data required had already been presented under the original EIA for the report.

The following new investigations were carried out on site.

- Bathymetry of the borrow area
- Water Quality measurement
- Socio-economic environment assessment

1.5.1 Bathymetry

Bathymetry of the borrow area was undertaken using a multi beam mounted on the Push buster 'Black bird', which was the same vessel used for the sand search campaign.

1.5.2 Water Quality Measurement

Water quality measurements were undertaken on 1st, 2nd and 7th May using onsite equipment YSO EXO sonde.

1.5.3 Marine environment

Marine environment survey was not required by the regulator from the borrow area and was not part of the original EIA. Marine environment surveys were undertaken at 6 points, the results of which have not been obtained at the time of compiling the report. The results would be submitted as part of the original EIA environmental monitoring program. Monitoring methodology is as given in the original EIA.

1.5.4 Socio-economic environment assessment

Socio economic assessment was carried out by surveying the relevant stakeholders on site. The surveys were carried out by the contractor's team as part of the environmental monitoring program they need to adhere to.

1.6 The Proponent

The project is being proposed by Ministry of Housing and Infrastructure. It is the same proponent as for the original scope of works.

1.7 The Project Location and Impact Area

The originally proposed borrow areas as well as the final borrow area is shown in the figure below. The previously proposed borrow areas are circled in Yellow place marks and other borrow areas that were investigated in Ari Atoll are given in Green place marks.

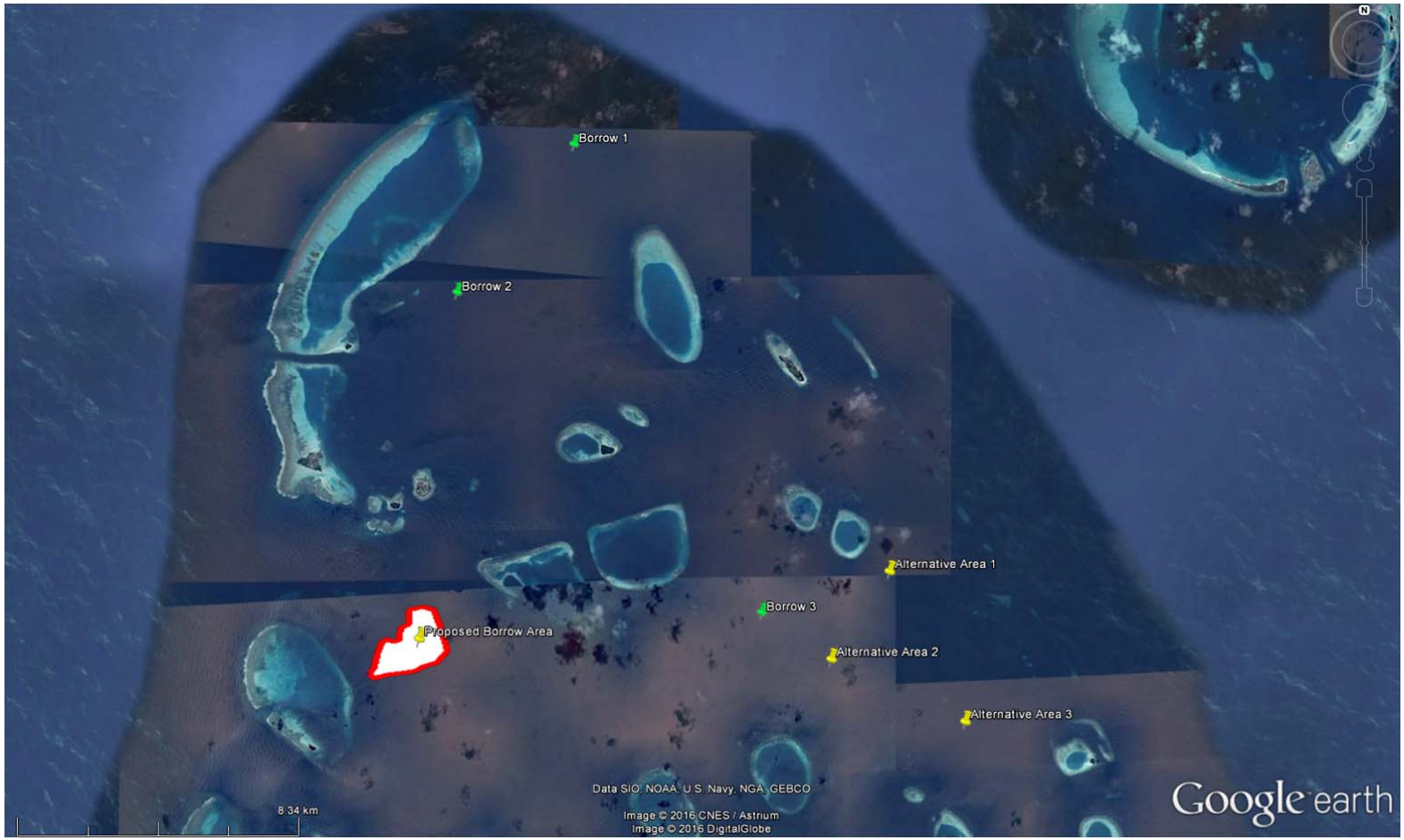


Figure 1 Study area including the previously declared borrow areas and the final borrow area

1.8 Need and Justification

The change in borrow area is simply due to the results of the sand search campaign undertaken by the contractor for the project, Van Oord. The campaign showed that sufficient volume of sand is only to be borrowed in the new location given. The sand search campaign report is given in the Annex.

2. Project Description

The scope of works for this EIA is the change in borrow area. There were 3 borrow area proposed in the approved EIA. However, the sand search campaign results did not show any potential sand depots in the exact area, while such required amount of sand was available more than 10 km west of the area as shown in the following Figure.

Additionally, it was attempted to find sufficient sand depots in Kaafu Atoll, which was unsuccessful. Details of the areas studied are provided under 'Alternatives'

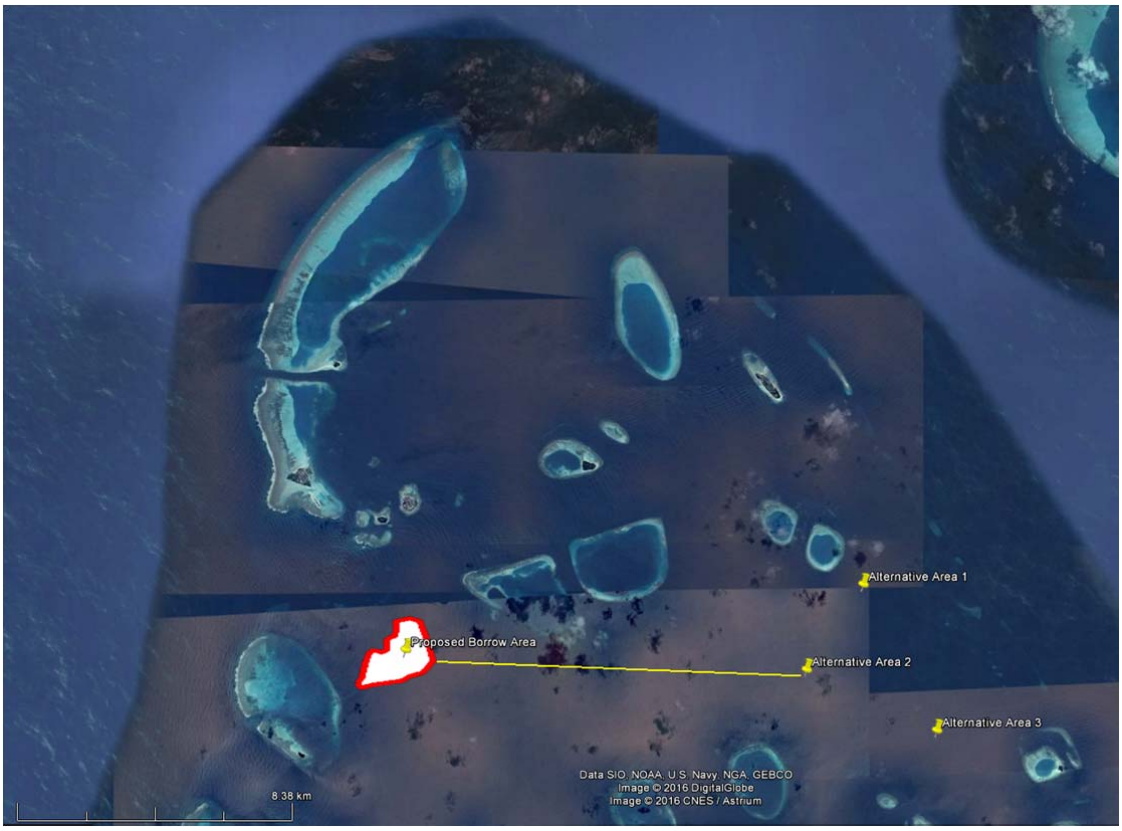


Figure 2 Proposed borrow area compared to areas provided in intiial EIA

The GPS coordinate of the borrow centre of the borrow area as given in the above figure is 4°08'51"N - 72°46'26"E. Surface area of the entire area is 3,400,000 sqm. Minimum bottom depth of the area is 40m from MSL, while maximum bottom depth is at 50m from MSL. Average sand particle sizes found on site is 658mm. From this area, the sailing distance to the reclamation area is 126km.

The Figure below shows wide areas that were studied as part of the sand search campaign. Four broad areas were studied, from which, only one area yielded sufficient quantities of quality sand required for the reclamation.

Figure 3 Locations studied within Ari Atoll for sand availability

2.1 Work Undertaken

Sand search campaign has been undertaken and successfully concluded. All equipment and machinery required for the project, including the pipelines have been transported to the Maldives in April 2016. The equipment and machinery was offloaded Gulhifalhu. Pipelines have been assembled and is currently operational in Male'. All equipment is ready to mobilise to site to commence construction.

Sand bunding works had commenced soon after initial EIA had been approved. Bunding works had been fully completed. The wall is being constructed using excavators and material on site from the proposed reclamation area.

Dredging vessel, HAM 318 arrived in the Maldives in May 2016 and is currently in Male' area.

2.2 Work Methodology

The work methodology has been provided in the initial EIA.

The proposed borrow area was identified by undertaking a rigorous sand search campaign. The methodology adopted for the sand search campaign is given in the Annex.

The reclamation works are to be carried out by the contractor's vessel, HAM 318, which is able to carry approximately 35,000 cbm of sand.

2.3 Project Management

The project is undertaken by the contractor, Van Oord Pvt. Ltd, which was not contracted to during the initial EIA. Founded in 1868, Van Oord is among the largest dredging companies in the world with years of experience. The group has worked internationally in different regions of the world.

2.4 Work Schedule

There is no proposed change in work schedule as part of this change in scope. The work plan given in Table 1 of the approved EIA will be in place.

Work is set to commence on 4th or 5th July 2016 and will be completed within 2 weeks.

2.5 Hazards Prevention and Safety on site

Accident and hazard during reclamation include those relating to health risks on the vessel and implementation of civil works at project site, oil spills and pollution.

Health and safety risks arising from construction work is high, especially due to the use of specialized equipment and machinery. There may be situations of man overboard from vessels. Accidents related to equipment use can lead to injury, and fatalities. Materials used in construction, in addition to the equipment and machinery, also involve risks to health and safety. Accidental spills/ leakage of hazardous substances can contaminate the site and pose

risks to human health, including workers on the site. The project activities include measures to minimize risks to health and safety of workers.

One of the major accident and hazard scenarios for the overall project is those related to fire accidents. There is potential for such accidents in both the operation stage and in construction stage.

An emergency response plan will be developed with details of equipment, human resource and procedures. The following will be considered in the emergency response plan:

- Setting up an emergency response team
- Emergency contacts
- Route to treatment site, i.e. the closest health facility/hospital
- Level of protection to be provided;
- Setting up eequipment - fire fighting equipment on site
- Response time;
- Emergency access and evacuation procedures;
- Personnel and training requirements;

All the machinery and equipment are to be properly tuned and maintained to reduce emission leakage and spill. Before mobilizing to site, status/condition of all equipment and machinery should be checked.

2.6 Project Inputs and Outputs

Project inputs and outputs are generally the same as provided in the original EIA as there is no such change in scope.

3. Description of the Existing Environment

This section covers the existing environmental conditions of the project site. Since this is an addendum to the original EIA, most the of the environmental conditions on site has already been discussed and provided, including marine environment, terrestrial environment, and socio-economic environment. Moreover, since this is a small project, which includes only a slight change in the borrow area, the key components with respect to the project are few. However, as per the TOR, the following conditions on site have been discussed:

- Bathymetry
- Marine environment visual inspection
- Marine water quality

Data was collected using methods discussed in Section 1.4.

3.1 Bathymetry

Bathymetry is provided in the Annex. The minimum bottom depth is 40m from MSL, while maximum bottom depth is 50m from MSL.

3.2 Marine Water

Water quality monitoring at the Northern reefs started from the 25th of June 2016. The quality was tested at the diving area, 'Manta Point', 'Dive reef' and 'Havza Thila'. The areas were chosen in order to monitor the water quality for the divers and the coral reefs.

Table 1 Marine water at Manta point

Location	Date	Depth [m]	Acidity [pH]	Salinity [psu]	Temperature [deg C]	Turbidity [NTU]
M1	25-06-2016 10:33	2.032	8.18	36.47	29.433	0.01
M2	25-06-2016 13:31	2.015	8.17	36.47	29.435	0.01
H1	25-06-2016 15:29	2.083	8.11	36.03	29.452	0.572

Figure 4 Water quality measurements, M1 - Manta points, M2 - Dive reef, H1 - Havza Thila

Marine Environment

General marine environment for the project has been declared in the original approved EIA.

Observation of the marine environment took place at 3 critical locations around the borrow area. The survey was undertaken by a team of the contractor, Van Oord and local NGO 'Save the Beach'. The results of the survey are currently being compiled and will be presented to EPA.

The general conditions at the site were good. Some effects of coral bleaching could be observed.

Figure 5 Locations in which Marine environment surveys were undertaken

3.1 Marine Environment

Marine Environment was investigated by observing biodiversity check using line transects. The divers took notes along the transect regarding Fish species, Invertebrates and Coral cover. The results are currently being processed and will be provided to EPA once finalised.

It can be stated however, that no Mantas were observed during the survey.

Figure 6 Marine environment survey photos

4. Stakeholder consultation

Consultations with the councils were undertaken on 22nd June 2016. Information about the project was provided, and the concerns of the councils were noted. While the councils have significant concerns, they were not based on documented evidence. The developer gave assurances that their concerns can be alleviated, and all stakeholders can observe that the impacts would be at a minimum when the project commences. Since there were recent similar reclamations undertaken under the same project, the contractor stated with confidence that there would not be long lasting impacts from the projects and the turbid area will be only within 100 – 200m from the dredging area.

Consultation with AA. Atoll Council

The meetings was coordinated by Ministry of Housing and Infrastructure (MHI). To begin with, all participants introduced to each other. Subsequently the purpose and agenda of the meeting was briefed to the participants.

Purpose of the meeting was to share information on the technical aspects of the preferred borrow location identified from AA. Atoll for the K.Himmafushi reclamation project and discuss the associated socio-economic and environmental impacts and identify the views and concerns of the island council and community on the matter.

Hence, first the Environmental Engineer of the Contractor (Van Oord) gave a presentation on how the currently identified location was arrived and the detail surveys conducted within

the process, the associated potential socio-economic and environmental impacts of the methodology that would be employed, mitigation measures in place for the specific project and anticipated impacts based on the methodology, weather and mitigations. Moreover, anticipated impact boundaries and their relative distances from the nearby islands, reefs, key dive points and sensitive areas were discussed and the tentative dates and

The council expressed concern regarding the impacts the dredging activity might have on tourism and fisheries which are the two main industries on which the livelihood of the atoll relies on. It was noted that location that shows the availability of sand is a famous fishing point of the atoll where vessels from other atolls also frequent. Furthermore, it was informed that just northwest to the concerned area also lies a manta point and dive points are abundantly distributed within the atoll. Especially, AA. Bodufulhadhoo and AA. Mathiveri nearby the location depends heavily on guest house business and fisheries. Hence, the extent of a guarantee on the level of impacts that this operation might have on these activities were questioned.

It was explained that the nature of impacts from deep sea dredging is relatively temporary in nature than the usual shallow lagoon dredging activities and the main environmental impact associated is sedimentation. Given the distances maintained from the key locations, the sedimentation was not anticipated to reach the sensitive areas. Daily water quality monitoring is planned to be conducted during the operation to ensure that the water quality remains within acceptable standards. In case if the quality level exceeds the standards thresholds, the work would proceed only after the approach is altered to rectify the situation. Furthermore, the same contractor has undertaken the reclamation of S.Feydhoo and GDh.Thinadhoo under the bundle project that includes K.Himmafushi. The same methodology is applied the noted projects and so far the mitigation measures in place are showing good results and the conditions are being monitored closely. The borrow locations of those projects were within the deep lagoon in close vicinity of the island.

Moreover, as noted by the contractor's Environmental Engineer during the presentation, the fish in the vicinity would scatter for the operational time period due to underwater noise generated from the propellers and pump. Once the sound subsides, the movement of the fish will return to normal. Since air and noise pollution would be negligible on above the surface, the operation is not expected to have an aesthetic impact on tourist activities. The sedimentation from the activity is not expected to reach any reef and estimated to settle in about 3 to 6 hours. The dredging activity as explained would be conducted once during the night and once during the day with operational hours being approximately 3 hours. The projected impact boundaries, weather and methodology is not expected to inflict a permanent adverse impact on either tourism or fishery activities.

Then the council stated that consultations were not satisfactorily undertaken with the Atoll representatives during the decision making stage of choosing AA. Atoll as a borrow option. It was noted that the AA. Atoll community itself is in much need of land and hence is much concerned regarding shipping the sand away for other Atolls without guarantee of a sufficient sand budget for the Atoll itself. Also the view that the Atoll resources should be prioritized for Atoll needs were reiterated. Although the current procedure does not offer a decisive say of the Atoll council in such matters with the central government being responsible for it, the council would prefer this operation not to be undertaken in AA.Atoll .

It was noted that as explained in the presentation, options within AA.Atoll was only explored due to the unavailability of the required amount of sand from Kaaf Atoll. It was assured that the concerns and views regarding the socio-economic and environmental aspects of the operations would be fully taken into consideration and other concerns would be relayed to the relevant decision makers.

AA.Ukulhas Council

MHI gave a brief introduction. Presentation on the borrow area details including methodology and why AA Atoll was chosen for this project by the contractor.

MHI further elaborated the details highlighted in the presentation assuring there won't be much impact on the fisheries and tourism industry as the sands will be borrowed from deep sea detailing the difference of dredging sand from shallow lagoons and deep sea. Also, explained the use of green valves to minimize the impact of sedimentation

Council showed their concern on dredging approximately 21 ha of sand and the impact of this on the Havza (Hafsa) Thila

Environment Engineer from Contractor and MHI explained that the sediments will settle in 6hrs time depending on the current movement and the second dredging starts the sedimentation caused from the first dredging will be settled. Also explained the sand borrowing area as and the approximate distance from the sedimentation will occur assuring that there will not be any impact on the coral reefs

Council highlighted that the dredging location falls to a diving and a fishing spot and many diversity high points are in this area for instance the Maavaru thila and Gangehi.

Mostly bait fishing is done here and consultations have been done with fishers and with tourism representatives

The general public has been consulted and they believe there will be negative impacts from the dredging and the council also shares the same opinion.

MHI assured that mitigation measures will be taken and monitoring of the water quality and coral reefs will be done daily.

MHI also discussed the Feydhoo and Thinadhoo's scenario explaining that in these cases the sand has been dredged within the atoll and as far there has been no complaints regarding it. And for this atoll 500m distance is considered which would surely have a very low impact on the diving sites.

For instance slight sedimentation could be found and the noise and vibration will be the only nuisance for the divers. And for the fisheries there would not be much impact as it does not do any harm to the fishing grounds but scare the schools of fish away during the operation of time of the dredger

Council showed their concerns stating that in the long run their natural resources may get depleted if such activities are carried out and in there are plans for reclamation within the atoll and will need the sand for such development and enquired about having a certain amount of volume that could be borrowed.

MHI explained that there are no systemic studies done and how much volume of sand that could be used by other atolls.

Council requested to shift the borrow area to another atoll where there is low demand for fishing and diving spots. MHI explained of the cost issues arising with the increase in distance.

Council also discussed the importance of having economic and social studies for such projects and argued that environmental perspectives alone should not be included for projects. MHI agreed with it and said works are being done to improve them and for a sustainable development environment, social and economics should be included.

Council acknowledged and concluded saying there are no technical issues but social and economic issues as this atoll relies on tourism and fisheries and any damage to this zone may have a great impact on their livelihood

AA.Mathiveri Council

MHI began the meeting with a brief introduction of the purpose of the meeting.

Environmental Engineer of the contractor of this project showed a short presentation of the borrow area detail, methodology and the mitigation measures for this project.

MHI further elaborated the details of the presentation and briefing the difference of cutter suction and hopper dredging highlighting that cutter suction on shallow areas does more harm to fisheries and tourism.

In tourism perspective, noticeable impacts would be noise, temporary air pollution and vibration. In the fisheries sector the impacts will be due to sedimentation which is also a temporary impact.

Council briefed that the proposed location falls to a bait fishing area and apart from the highlighted diving spots there are other locally famous diving spots and fishing zones. Roughly about 40-60 vessels could be found fishing form these zones and the mostly caught bait are rin' mas and mushimas.

Also members of the council questioned about the availability of sand form Male' Atoll and feared that the sands may get depleted for reclaiming lands within their atoll if sand is extracted from the atoll.

MHI elaborated that every Km is an added cost that the proponent has to bear. And AA atoll was chosen only after surveying the Male' Atoll.

The Environmental Engineer explained that in the case of S.Feydhoo the turbidity rose to 2.5 TSD from 0.1 and 0.2 TSD and shared pictures taken during the unloading of the vessel. The travel time between the Male' and AA atoll would be 9hours and the sediment is expected to be settled in 6hrs.

The council also enquired about the area the sand s will be suspended to which the contractor and MHI had said that a distance of 200m from the dredging area will have sedimentation effects

MHI assured that the sediments will not have any impact on the diving area as there is enough distance considered from those areas. The council highlighted that there are Manta points and in some seasons the reef fish sharks is also spotted in these zones. Environmental Engineer and MHI were certain the pattern of the current in this season will minimize the sediment dispersal.

However, the council members highlighted that the currents will be moving towards the Hafsa Thila and sedimentation may occur in the Thila showing great concerns on the impact on tourism and Fisheries since the borrow area falls near to Hafsa Thila and Reethi Thila.

The council enquired about the meeting with Bodu Folhudhoo Council stating that it is reef fishery island and reef fishing is done form these zones.

The Environmental Engineer and members of the council went through the maps provided in the presentation highlighting the important zones near the borrow area.

The council members pointed out that Area 1 is a fisheries area, Area 3 Manta point and diving point and, Area 4 is fishing site.

Choosing area 1 and 3 are highly disregarded by the council members

Afterwards, a member from the council enquired about the overflow water to which MHI had explained the role of green valves. Also MHI further detailed about the dredger working 3hrs per trip and before the second dredging is started the sand will be settled.

In addition to this MHI stated that based on all the environmental and technical knowledge the mitigation measures will be taken.

Council narrated incidents of a reclamation project in a Finolhu which had speeded up the process of the erosion. The council detailed that Mathiveri has been eroding since from 5 years but due to this incident in 2 years' time the island has been eroding extraordinarily at a faster pace. However, this could not be substantiated. The council feared though fisheries may have a temporary impact that this project may have a permanent destruction on tourism sector and stressing that AA.Atoll is a touristic atoll.

The members recommended to shift the borrow area slightly towards the southern side in order to save the diving sites which is very near to the proposed location. Environmental Engineered informed that internal meetings with the experts will be done regarding it and will see to it.

The council again stressed not to dredge from area 1 and 3. MHI declared that sands will not be dredged from those areas as the sand does not have the preferred characteristics in those regions.

The meeting was concluded after the council stating that they have no issue on sand extraction however they requested that no damages be caused to these diving points.

AA.Bodufolhudhoo Council

Next, a short presentation by the Environment Engineer of the Contractor was given on the borrow area details, methodology and preventive measures that would be used in the process.

After the presentation, the members of the council raised their concerns regarding fisheries and tourism.

MHI briefed the difference of dredging in shallow and deep area and explained the magnitudes of the impact on shallow areas are higher than that of deep areas and of cutter suction dredger and hopper dredging. Further explained on the possibility of enhancing the nutrient level of the borrow area due the dredging activity. In addition to this MHI discussed on the likely impacts that would be caused due to the dredging process such as visual unattractiveness that may cause from the presence of the vessel to tourism sector.

The green valves as explained by the Environment Engineer would minimize the amount of sedimentation caused. MHI also assured that daily monitoring will be done for the water quality and highlighted concerns will be considered in the EIA report.

The council explained that they are facing land issues and the general public strongly disapproves borrowing sand for another atolls development. Councils showed great amount of concerns regarding the location stating that the area near to Mathiveri is a naturally rich diverse area and specifically the islanders of this island does reef fishing which is imported to nearby resorts.

The council showed their disapproval for not involving the council in the initial phase of the project. Moreover, the council fears that the public may cause hindrance to the vessel's operation as the public demonstrated their lack of support for this project. The council also disagrees with the project and enlightened about lack of land availability in the island stating that 20- 25 people are living under an area of 2000m3.

The council elaborated on the importance of the area detailing that fisheries and tourism are the backbone of the island and any impact on it may have a great impact on their livelihood.

The meeting was wrapped up after MHI illustrating that mitigation measures come with cost and all the mitigation measures associated with technical will be addressed in this project and also gave explained that with increase in distance the cost is also added.

Ministry of Tourism

Ministry of Tourism (MoT) was informed of the project via an official letter from the developer. MoT was also informed before the recent MIV reclamation and they had provided information giving their no objection to reclamation projects, provided that proper mitigation measures are in place. The letter sent to MIV for this project, for which the response has not been obtained is attached in the Annex. Therefore, the response from MoT for a similar project, the MIV reclamation is provided in the Annex as a reference.

5. Impacts and Mitigation Measures

This section is based on the potential environmental impacts due to the change in scope of the project. The section further describes the mitigation measures for each identified impact. Other impacts and mitigation measures due to the dredging and reclamation works are as approved by EPA in the initial EIA.

Methods of identification of potential impacts and assessing the significance of the impacts are described in the following sections.

5.1 Identification of Impacts and their Significance

Impacts on the environment from various activities of the proposed project have been identified through:

- Using decision frameworks for assigning significance to impacts
- Existing environmental studies carried out similar developments in other similar environments
- Research data that has been accumulated specific to the Maldivian context.
- Baseline environmental conditions collected.
- Past experience of the consultants with similar projects.

Possible negative impacts on the environment have been considered in worst-case scenario to recommend mitigation measures in the best possible ways so that these impacts would be minimized and perhaps eliminated in the implementation phase.

The impacts highlighted in the TOR for this EIA has been used as a guideline in identifying important impacts. However, this was not used as a strict instruction for the identification. Once new impacts not highlighted in the TOR were foreseen, they were given equal importance.

Following are the major types of possible negative impacts foreseen due to the implementation of the project

- Loss of visual amenity during drilling and construction
- Groundwater degradation
- Noise Pollution
- Generation of waste

- Impact on adjacent structures
- Health and safety of workers
- Health and safety of water consumers

Impact on vegetation and terrestrial environment is also a possibility. However, since the area is already heavily built with no vegetation, this will be negligible.

5.2 Impact Evaluation

This section provides a summation of the impacts of the project components discussed above. The impacts of the project have been evaluated based on the criteria proposed by Posford Haskoning (2004). The decision framework is given in Figure 5.

In order to make the evaluation quantitative, the framework proposed by Haskoning has been modified. Spatial distribution of impact is also added in order to make the significance of the impacts more realistic. Scores are given for each impact once it is identified that the resource is vulnerable to the impact. Scores are based on the following factors.

- Sensitivity of Receptor
- Recoverability of Receptor
- Importance of Receptor
- Spatial Distribution of impact

The scales associated with the above criteria are given in the Table 6.

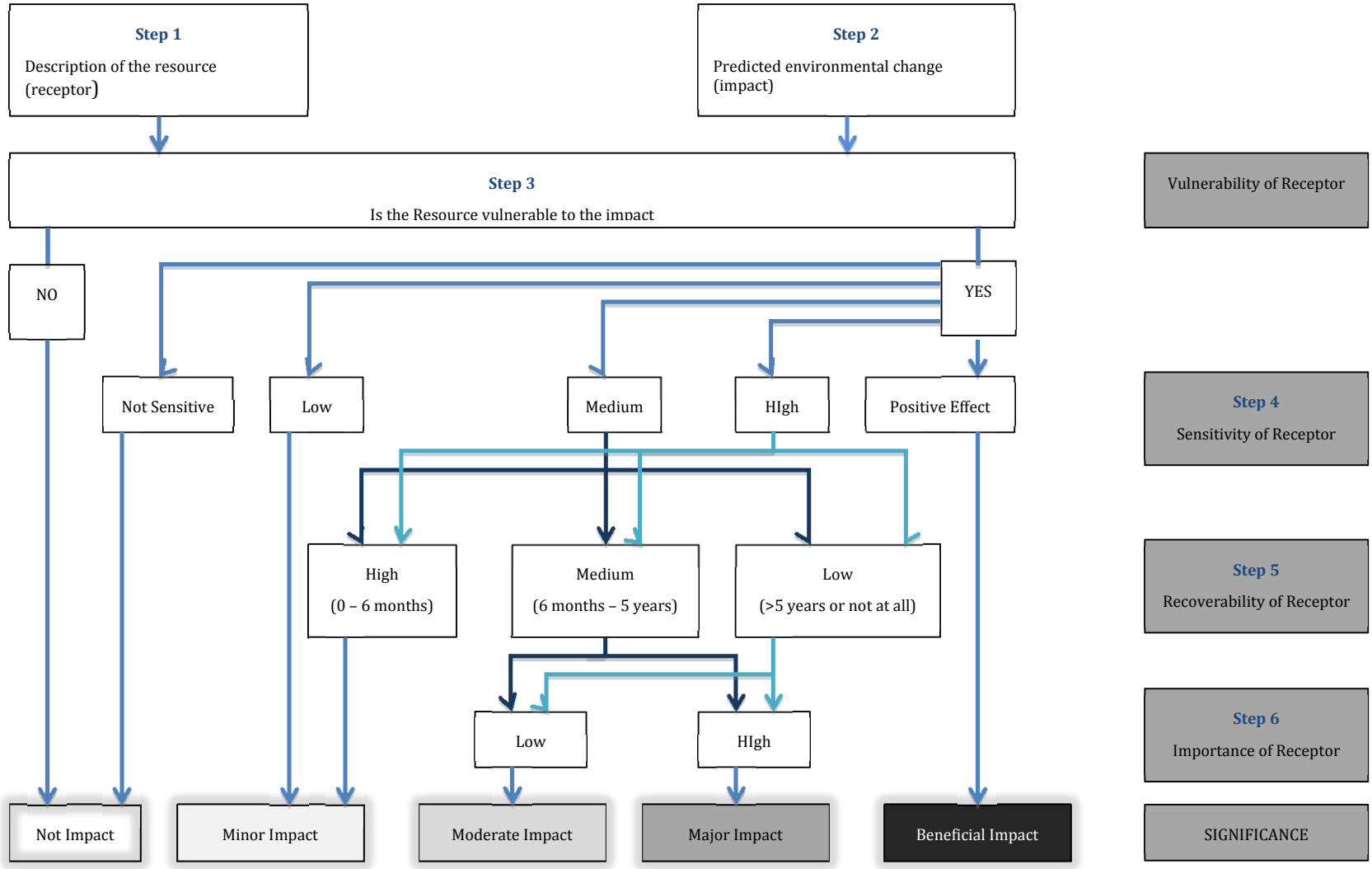


Figure 5 Decision framework to assess the significance of impacts

Table 2 Impact Evaluation Criteria

Criteria	**Scale**	**Attribute**
Sensitivity *How sensitive the receptor is to the impact*	-1	Positive Effect
	0	Not sensitive
	1	Low
	2	Medium
	3	High
Recoverability *How long it would take for the receptor to recover from the impact*	1	Short
	2	Medium
	3	Non-recoverable
Importance *The importance of the receptor to the environment*	1	Low
	2	Medium
	3	High
Spatial Distribution *Distribution of impact*	1	local scale
	2	regional scale
	3	global scale

If the impact receives a -1, it deems the impact to have a positive effect on the receptor and the other criteria is then not applied. The impact is referred to as a Beneficial impact as is done by the Haskoning framework.

The significance of the negative impacts will be given based on the following range:

- 1 – 5 : Minor Impact
- 6 – 9 : Moderate Impact
- 10 – 12: Major Impact

Justification for Impact Evaluation Method

The framework was chosen as it provides a comprehensive methodology to evaluate impacts, which is not overly technical. The advantage of this is that it will be easily understandable to the public and especially the client, who are not well versed in environmental management jargons and methodologies. It had also been successfully used in many other projects in the Maldives.

Table 3 Analysis of potential impacts for the impacts

Potential Impact	**Sensitivity**	**Recoverability**	**Importance**	**Spatial Distribution**	**Significance**
Direct impact on benthos in borrow area and fisheries in the area	3	2	3	1	9 (Moderate)
Sedimentation impact on Manta Point (North)	2	2	2	1	7 (Moderate)
Sedimentation impact on Dive Reef (East)	2	2	2	1	7 (Moderate)
Sedimentation impact on Havza Thila (East)	1	1	3	1	6 (Moderate)
Sedimentation impact on Inhabited Islands	1	1	3	1	6 (Moderate)

Impact on the notes areas due to the project is inevitable, whether the dredging occurs in the current proposed borrow area or the previous borrow area. The currently proposed area is only 1.5km away from the previous area, and this does not constitute a significant difference considering the relative distances in deep sea.

It's important to note that the initial EIA had proposed several borrow areas that were in similar proximity to sensitive areas as shown in the figure below.

Figure 7 Distances from the project area to the sensitive areas

The change in works, by its scope, is very small compared to most projects for which an EIA is normally required.

There is a sufficiently safe distance from the Protected or sensitive areas and/or resorts to the borrow area. Thinolhu finolhu is about 3.0 km away from the borrow site, and as stated previously recent sand borrowing for S. Feydhoo and GDh. Thinadhoo clearly shows that there will not be any significant impact within this distance. Mathiveri finolhu is greater then 4km away from the borrow site. While Bodufulhadhoo is about 3.0 km away. The closest site of note is Nika Island resort, which is about 2.5 km away from the northern tip of the borrow area, and still a considerable distance away from the impact zone.

From the consultations, further 3 sites were identified of importance to the tourism in the area. These were the Manta point north of the borrow area, a reef popular for diving east of the borrow area and Havza Thila, also east of the borrow area, slightly south.

Van Oord has demonstrated during the previous two island reclamations in S. Feydhoo and Thinadhoo, that the turbidity levels during dredging can remain very low (between 0 and 3.5 NTU) while dredging course grain size sand. Below graph shows the turbidity (NTU) measured during dredging in Thinadhoo next to the borrow area. As can be seen the levels vary between 0 and 3.5 NTU.

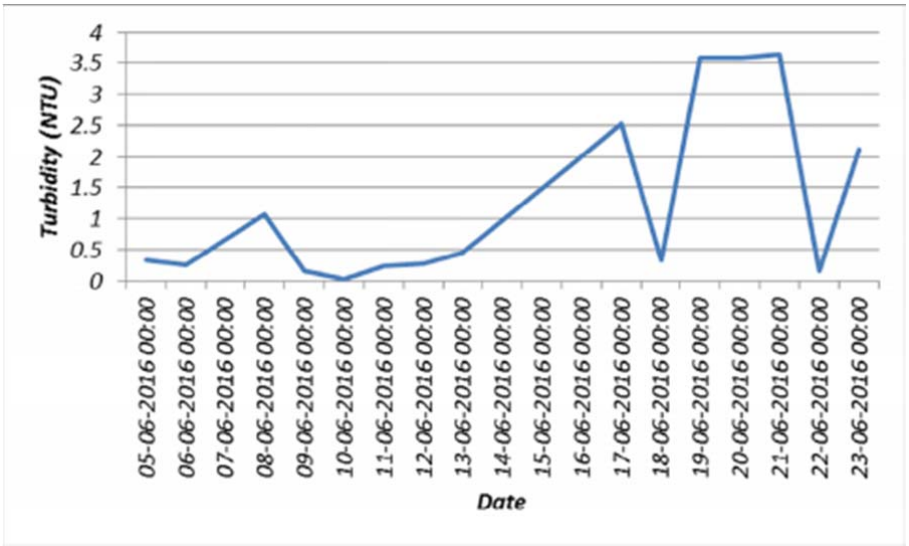


Figure 8 Turbidity values at Thinadhoo borrow area during the dredging works

Quick settlement of the course grained sand has been noticed on the borrow area as well as at the reclamation area. The turbidity has already been significantly reduced 4 hours to 6 hours after dredging, where the turbidity values are already reduced to 0 and 1 NTU, which is comparable to the baseline conditions.

The environmental impact expected by the dredging activities in the North Ari atoll are very low / negligible due to the above mentioned facts: 1. minor turbidity increase measured during previous dredging when dredging course sand; 2. quick settlement seen during previous dredging when dredging course sand; 3. only 2 dredging trips a day with approximately 9 hours absence of the dredger in the borrow area due to long sailing distances; 4. short total duration of the entire Himmafushi project, approximately 14 days, where effects are only temporarily

5.3 Uncertainties in Impact Prediction

The impact prediction has been carried out based on existing similar projects, literature and tested methods. However, the prediction relies heavily on the judgement of the consultant, and would therefore lead to uncertainties. The uncertainties for this project will be considerably less compared to other similar projects. This is mainly due to other similar projects being undertaken recently, which had been referred to. The uncertainties would therefore most result from uncertainties in determining on site conditions.

6. Mitigation Measures

Mitigation measures are proposed where significant impacts are expected. Once an impact is identified to have 'moderate' or 'major' impact, appropriate mitigation measures are given for the project. Successful implementation of the measures given would lead to a major reduction and/or nullification of the impacts on the environment and thereby ensuring that the project is environmentally sustainable.

The general impact from the project is due to sedimentation issues, which may result in disturbances of the marine fauna at best and mortality at worst.

Following measures are recommended:

- Complete the works within the least duration as possible. Ensure all dredging works are fully completed within 2weeks.
- Ensure sediments do not overflow to the surrounding environment.
- Concentrate more on the central to southern areas of the large borrow area identified
- Prior notification to all stakeholders before commencing dredging works
- Regular monitoring of water quality of the identified location as given in Section 6.

The Figure below illustrated impact area from the borrow area. From recent experience, any location greater than 200m will not endure a significant impact, and all sensitive locations are much greater than 500m away from the borrow site.

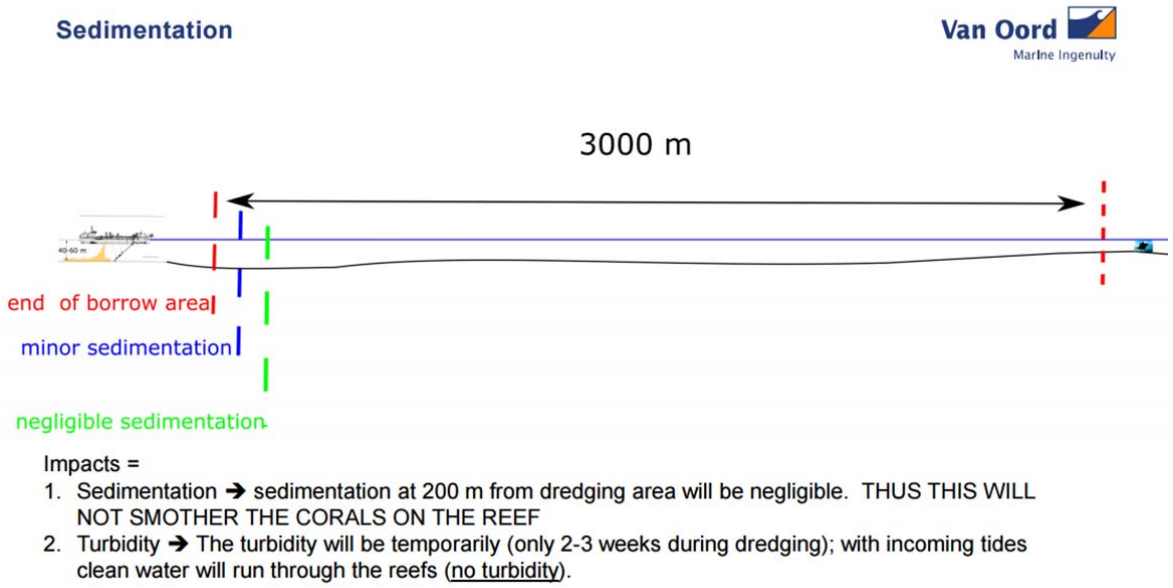


Figure 9 Sedimentation impact area from borrow area

Due to these justifications, no additional mitigation measures will be employed at the borrow area. However, mitigation measures that are always in place under this project will be implemented as part of this dredging as well.

This includes the practice is overflow discharging at the bottom of the vessel instead of on the water surface. More importantly, a 'green valve' is utilized on the dredger as a major mitigation measure to prevent sedimentation issues from over flow. The Green Valve results in a major reduction of turbidity. The water overflow typically consists of water, sediments and fines and last but not least, air. The larger sediments will be discharged to the sea but as the air rises from the underwater outlet to the surface of the water, it takes the fines with it. As a consequence, the fines spread over a much larger area which increases turbidity. The Green Valve reduces the air entrainment and sediments and fines will sink to the sea and therefore reduce the turbidity resulting in less turbidity and less environmental impact.

Furthermore, environmental monitoring at the sensitive sites are also proposed. As such, baseline monitoring will be undertaken before dredging commences, and daily monitoring will be undertaken for the duration of the works. The dredging operation is expected to complete before 4th July 2016.

7. Alternatives

This section looks at different alternatives for the proposed works. As the proposed works is a change in borrow area, alternatives based on this would be discussed. The main alternative is the no project option.

These alternatives are not as intensively investigated as the original scope of the project. However, investigating and discussing alternatives is important so that it is ensured that the best available option(s) is/are chosen to solve the issues/problems of the project.

7.1 No project option

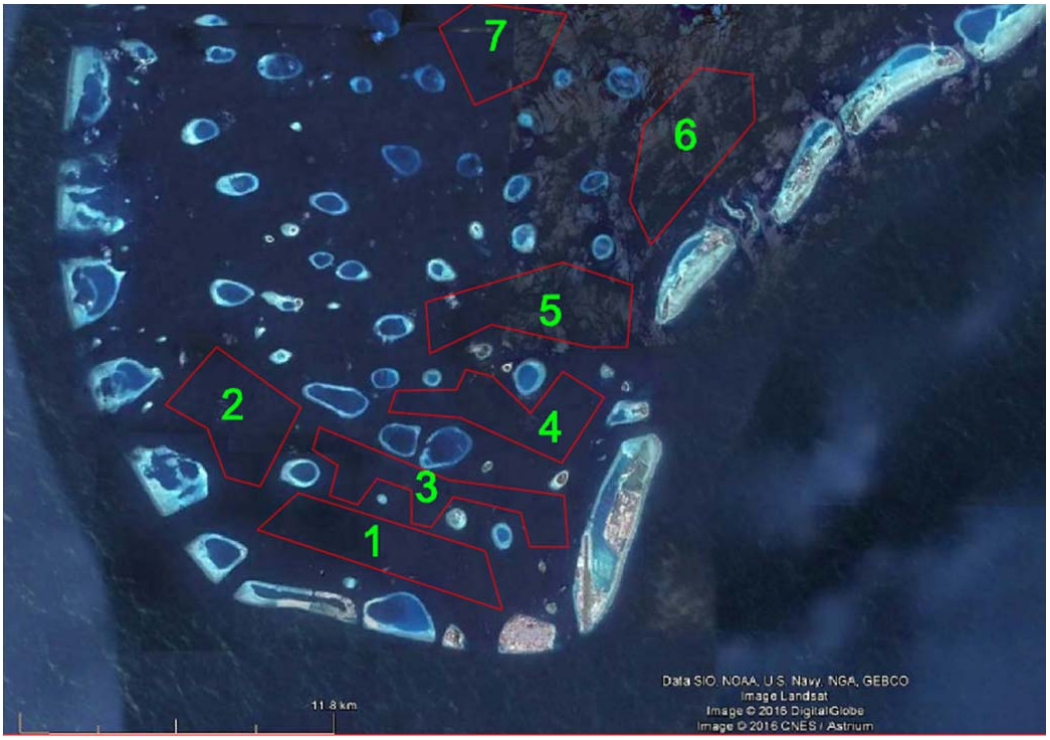
Initially the no project option is discussed in order to hypothesise whether the project should be taking place first of all. With regards to this project, the no project option would entail not borrowing sand from the proposed area.

The only advantage of the no project option is that the possible increase in environmental impacts on the northern part of the atoll can be avoided. The disadvantage is that this would result in not having any viable area to dredge close to the project location. Thus, the developer would either need to import sand and dredge sand further away, both of which have been regarded as not feasible by the developer for the case of Himmafushi Reclamation.

Therefore, based on the information provided by the developer, if the proposed location is not borrowed, the Himmafushi reclamation project will not take place for the foreseeable future.

7.2 Project Alternatives

Initially, Kaafu Atoll was investigated to obtain sand for the project. Kaafu Atoll was favourable as it would result in the least travel distance for the Hopper and therefore the least financial burden to carry out the project. This was the most feasible option. However, the investigations for the Male' Industrial Village project showed that there was no sand available from Kaafu Atoll. The areas studied under this are shown in the figure below.



The coordinate of the borrow areas are given below.

Male' Area 1:
4°12'10.32"N
73°28'7.41"E

Male' Area 2:
4°14'46.10"N
73°23'52.98"E

Male' Area 3
4°13'14.43"N
73°28'23.93"E

Male' Area 4
4°14'41.70"N
73°30'14.80"E

Male' Area 5
4°17'0.90"N
73°30'30.00"E

Male' Area 6
4°20'50.16"N
73°33'39.31"E

Male' Area 7
4°22'27.25"N
73°29'34.24"E

The sand search campaign results for this area is provided in the Annex.

Two alternative borrow areas have been considered in the initial EIA, which were further east from the current proposed location as shown below.

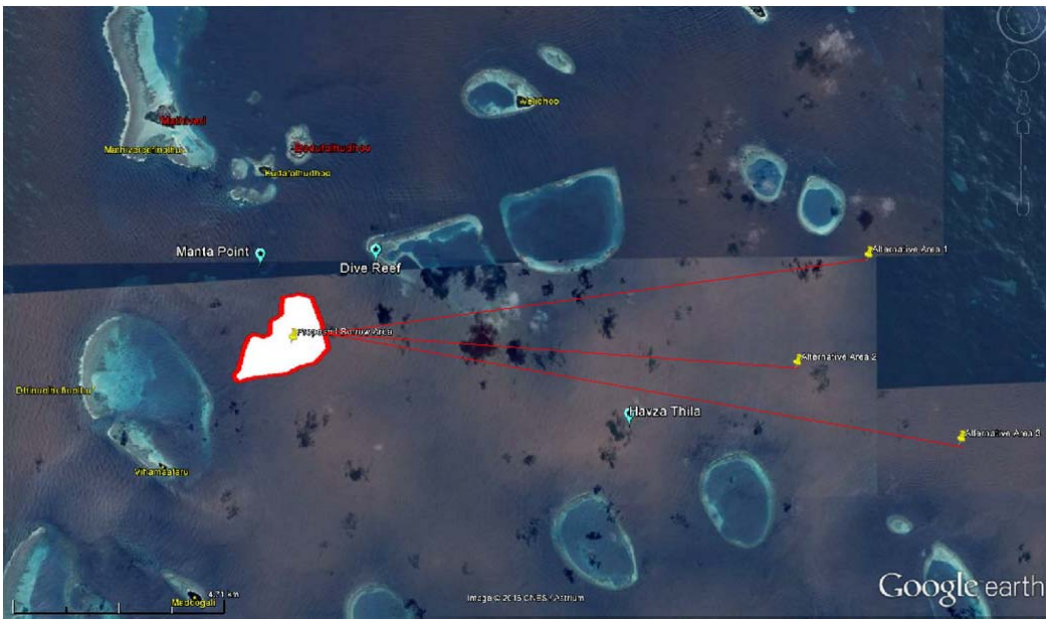


Figure 10 Alternatives as proposed in original EIA

These locations are over 15km away from the current proposed borrow area, and none of these areas yielded sufficient quality sand volumes.

The Figure below shows wide areas that were studied as part of the sand search campaign as previously discussed. Four broad areas were studied, from which, only one area yielded sufficient quantities of quality sand required for the reclamation.

The coordinates of these other areas considered in the sand search are given below:

Ari Area 1:
4°16'4.65"N
72°48'36.78"E

Ari Area 2:
4°13'54.29"N
72°46'53.48"E

Ari Area 3:
4° 9'11.98"N

72°51'22.55"E

Therefore there was no other realistic alternative as part of the project. The other options is to carry out further sand search campaigns, which were also not feasible under this project due to the wide area the contractor had already covered.

Figure 11 Initially proposed borrow locations

7.3 Recommended Alternatives

In conclusion, No project option is not an option, since the project needs to be feasible and doable. The option would very likely lead to the cancellation of the project, which would defeat the purpose of providing much needed land to the residents of Himmafushi, as was justified in the initial EIA.

The only realistic option based on the surveys and studies undertaken and data obtained, is the currently proposed area in Ari Atoll.

8. Environmental Monitoring

This section deals with the Environmental Management and Monitoring plan for Himmafushi with respect to the changes in scope from the original EIA. The data collected for this assessment and previous assessments will be used as baseline data while undertaking the monitoring plan. Undertaking environmental monitoring is essential for several reasons including:

- To ensure that potential impacts are minimized and to mitigate unanticipated impacts.
- To aid in impact management,
- To improve impact prediction and mitigation methods.
- To gather long term data to minimise uncertainty
- To ensure sustainable development

The proposed monitoring programme will yield beneficial results if it is undertaken for a long period. As required in the TOR, the monitoring is to take place during the construction phase up to 1 year, and then on an annual basis for 5 years.

The proponent expressed their full commitment to carry out the monitoring program outlined in this report. The proponent's commitment to undertake the environmental monitoring and mitigation measures is given in the **Proponents Declaration.**

8.1 Monitoring Methodology and Costs

The methodology used for monitoring will be similar if not the same as those used in this environmental assessment. However, field water quality testing equipment can be employed to decrease the uncertainties of the results.

The costs given in Table 11, and Table 12 are calculated for monitoring to be undertaken by hiring environmental consultants for each monitoring program.

Additionally, it is a requirement that the annual environmental monitoring report needs to be compiled and formulated by a registered environmental consultant with a **permanent** EIA consultant license.

The parameters that are most relevant for monitoring the impacts that may arise from the project are included in the monitoring plan. Therefore, the monitoring programme will cover the following aspects of the project:

- marine water quality

- coral monitoring

The monitoring program can be undertaken together with the main monitoring program for the entire reclamation project, which would make the proposed program more feasible and cost effective.

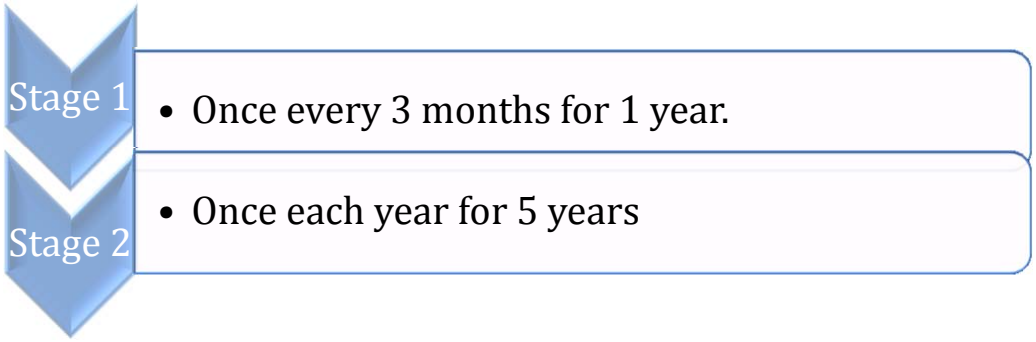
Figure 12 Proposed points for water quality monitoring in North Ari Atoll borrow area

Due to the limited water depth at the house reef of Himmafushi it is not possible to access the water by boat during low tides and thus to perform water quality monitoring. Therefore it is proposed to shift the water quality monitoring points which are given in the Water Quality Monitoring Plan of Van Oord to areas which are accessible, these new points are shown in the Figure below. In this way the monitoring can be executed more frequently and without any safety issues.

Figure 13 Proposed points for water quality monitoring at Reclamation site

8.2 Recommended Monitoring Programme

As instructed in the TOR, the monitoring programme will be divided into 3 stages.



Stage 1

- Marine water quality for pH, EC/salinity, temperature and turbidity at locations given in the EIA.
- Observation and monitoring condition of marine environment from the locations given in the EIA

Stage 2

- Marine water quality for pH, EC/salinity, temperature and turbidity at locations given in the EIA.
- Observation and monitoring condition of marine environment from the locations given in the EIA.

8.3 Cost of monitoring

The following tables outline the cost estimate for each stage of the monitoring plan given. The costs are calculated assuming the monitoring will be undertaken by hiring environmental consultants on a project basis.

Table 4 Estimated cost of Stage 1 of the Monitoring Program

Item No.	Details	Unit cost (US$)	Frequency	Total (US$)
1	Field allowance for 2 consultants for 1 day	50.00	4	200.00
2	Surveying and monitoring equipment depreciation	20	4	80.00
4	Compliance reporting (annual report) *done along with original EIA monitoring	0	0	0
	Total			**280.00**

The monitoring is for a period of 1 year, where data is collected quarterly.

Table 5 Estimated cost of stage 2 of the monitoring program

Item No.	Details	Unit cost (US$)	Frequency	Total (US$)
1	Field allowance for 2 consultants for 1 day	50.00	5	250.00
2	Surveying and monitoring equipment depreciation	20	5	100.00
	Total			**350.00**

It should be noted that the costs are subjective. It may vary depending on the consultant and also due to changes in price with time. Also, in the case that a long-term arrangement is made with a consultant, the price may considerably decrease and may be more feasible for the proponent. Moreover, the costs will further reduce if the monitoring is undertaken along with the monitoring program proposed in the original EIA.

8.4 Monitoring Report

Monitoring report should be compiled based on the baseline data collected. This report should be submitted to the Environment Protection Agency and any other relevant government agencies for compliance. The report structure may include but not limited to;

- Introduction
- Details of the site at the time of investigation,
- Data collection and analysis,
- Details of methodologies and protocols followed
- Quality control measures,
- Sampling frequency and monitoring analysis
- Conclusion and recommendations

9. Conclusion

The new dredging location is about 14km north of the proposed borrow areas discussed in the original EIA. The overall environmental impacts of the project have been assessed using frameworks found on literature and the results indicate that the proposed project has minimum negative impact. However, the change results in the borrow area being located relatively close to the manta point, a popular dive spot in the Atoll. The area is closer to a reef popular for diving and inhabited islands of Mathiveri, Bodufulhadhoo and Nika Island Resort. However, all these locations are out of the impact boundary.

Important new stakeholders for the project include resorts and island councils whose community may use the surrounding region of the borrow area. While some dive centers may have significant reservations and the island communities also expressed concern due to the proximity of the borrow area to dive locations and fishing areas. They were informed that from recent past experience, it can be concluded that all these areas are away from the impact area, which is only about 200m from the borrow location.

Alternative borrow area options are not viable as the sand search campaign concluded that there are no other significant sand depots within Male' Atoll or Ari Atoll. The only other alternative is to source sand from another region. Importing sand from abroad will be very costly and will have further negative impacts at the reclaim site.

It is recommended to continue to monitor the impacts of the proposed project by regular monitoring of marine water quality. The monitoring plan proposed in the original EIA is slightly updated to include more monitoring locations, near borrow area. A two stage monitoring plan is given, which recommends quarterly monitoring during the 1st year and less frequent monitoring for the next 5 years. Undertaking the monitoring, along with the mitigation measures is necessary to ensure the sustainable development of the project with minimum harm to the environment.

It is thus recommended that given the positive socio economic impacts from the project far outweighs the minor negative impacts, and since the project has major socio-economic benefits and environmental benefits, it is advisable to allow the project to proceed as proposed. Moreover, since the change in scope is relatively small, and since the initial EIA has been approved, and also considering the fact that the sand search campaign resulted in only one location within Himmafushi Atoll to obtain sand, there is no viable reason to postpone or cancel the project due to this change.

10. References

Gourlay, M.R. 1988. Coral Cays: Products of wave action and geological processes in a biogenic environment. Proceedings 6th International Coral Reef Symposium

Leatherman, S.P. 1997. Sea-level rise and small island states: an overview. Journal of Coastal Research, Special Issue,

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Morris P & Therivel, R (ed.) 2009, *Methods of Environmental Impact Assessment*, 3rd edn, Routledge, London; New York.

Sandcays Pvt. Ltd 2012, *Environmental Monitoring reports for the expansion and modernisation of Ibrahim Nasir International Airport*

Annex 1 – Terms of Reference

بسم الله الرحمن الرحيم

Environmental Protection Agency EPA

TOR Number: 203-EIARES/138/2016/125

Terms of Reference for First Addendum to the Environmental Impact Assessment for Reclamation of Himmafushi, Kaafu Atoll

The following is the Terms of Reference (ToR) following the EIA Addendum Application submitted on 9/5/2016 for undertaking the Addendum 1 for the EIA for the proposed *Reclamation at Himmafushi, Kaafu Atoll*

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 and rationale** – Describe the purpose of the change in scope to the original project and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific. 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 minimumA3 size scaled plan with indications of the proposed changes in scope. 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. 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 preparation, construction and decommissioning phases.
Task 1. Description of the proposed project – Provide a full description and justification of the relevant parts of the proposed changes to the scope of the project.
The main changes to the scope are:
   - Dredging from an alternative borrow area from those proposed in the original EIA

Dredging:

- Location and size of sand burrow areas (s) on a map;
- Justification for the selection of this location;
- Quantity, quality and characteristics of fill material;
- Indication of guarantees for sufficient availability of fill material;
- Duration of dredging activity;
- Emergency plan in case of spills (diesel, grease, oil)

Task 2. Description of the environment – This component will be based on the existing environment that is significant due to the change in project scope. 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.

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

Geology and geomorphology

- Bathymetry (bottom morphology) (use maps) of the proposed borrow area;
- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during construction;

Ecology

- Identify marine protected areas (MPAs) and sensitive sites such as breeding or nursery grounds for protected or endangered species

Socio-economic environment

- The socio economic environment that may have an impact due to the change in scope

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

Impacts on the natural environment

- Changes in flow velocities/directions, resulting in changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology;
- Loss of marine bottom habitat, both in the borrow area as well as due to enlargement of the islands, resulting in (temporary) loss of bottom life, which may impact fish stocks and species diversity and density of crabs, shellfish etc.;
- Sediment dispersal in water column (turbidity at the dredging site (overflow), 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 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 dredging and reclamation works on tourism (nearby resorts and dive sites);

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

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

Task 5. Alternatives to proposed project – Describe alternatives including the *"no action option"* should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". This should include but not limited to alternative borrow sites, alternative equipment/machinery for dredging, alternative disposal sites and alternative containment measures. The

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

Task 6. Mitigation and management of negative impacts – Identify possible new measures to prevent or reduce significant negative impacts to acceptable levels due to the change in scope. These will include both environmental and socio-economic mitigation measures with particular attention paid to sedimentation control and future changes in coastal processes. Cost any such mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

Task 7. Development of monitoring plan (see appendix)– Identify the critical issues requiring monitoring with regards to the change in scope to ensure compliance to mitigation measures and present impact management and monitoring plan.

Task 8. Stakeholder consultation, Inter-Agency coordination and public/NGO participation) – Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders, government authorities that is required due to the change in scope and has not been consulted in the original EIA. Stakeholders to be consulted:

- Ari Atoll Council
- Nearby resorts and islands
- Himmafushi Council

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

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

24 May 2016

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Annex 2 – Commitment Letter

بسم الله الرحمن الرحيم

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

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ދަތުރު، ތިމާވެއްދޭ.

Date: 03 July 2016

No: 138-PIS1/203/2016/131

Mr. Ibrahim Naeem
Director General
Environmental Protection Agency,
Ministry of Environment and Energy,
Green Building, Male',
Maldives.

Dear Sir,

This is in reference to the EIA Addendum report for the proposed reclamation at K.Himmafushi. As the Proponent of the project, we assure you our commitment to undertake the proposed mitigation measures and monitoring programme as given in the report.

Thanking you

Sincerely,

Fathimath Shaana Farooq
Director General.

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Annex 3 – Stakeholder consultation list

بسم الله الرحمن الرحيم

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

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ދާދި، ދިވެހިރާއްޖެ.

Meeting Attendance

AGENDA

[illegible] Regarding the sand extraction from AA.Atoll- AA.Ukulhas

Date: 22nd June 2016	Time: 12:20

ATTENDENTS

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ABDULLA FIRAGU	COUNCIL V. PRESIDENT	〃		7943727	
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Meeting Attendance

AGENDA

Regarding the sand extraction from AA.Atoll- AA.Bodu Folhudhoo

Date: 22 - June 2016	Time: 13:43

ATTENDENTS

NAME	DESIGNATION	OFFICE	EMAIL ADDRESS	CONTACT	SIGNATURE
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Anoosha Hashim	Asst. Project officer	MHI	anoosha.hashim@housing.gov.mv	7509191	
Tymen Smolders	Env. Engineer	Van Oord	tsm@vanoord.com	766 2790	

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Meeting Attendance

AGENDA

- Regarding the sand extraction from AA.Atoll- AA.Mathiveri

Date:	Time:

ATTENDENTS

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Imran	members	Mathiveri		9900274	
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بسم الله الرحمن الرحيم

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

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ދާދި، ދިވެހިރާއްޖެ.

Meeting Attendance

AGENDA

- Regarding the sand extraction from AA.Atoll- AA.Atoll Council

Date: 22 - June - 2016	Time: 11: 00 am

ATTENDENTS

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Tyman Shuaib	Env Engineer		Esm@vmoored.com	766 2790	
Nafha Aujaz	Environment Analyst	MHI	nafha.aujaz@housing.gov.mv	7721554	
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Ministry of Housing and Infrastructure
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މާލެ، ދިވެހިރާއްޖެ.

ނަންބަރު: 138-PIS1/88/2016/30

މިނިސްޓަރ އޮފް ޓޫރިޒަމް އަލްފާޟިލް މޫސާ ޒަމީރު،
ވެދުން ސަލާމަށްފަހު ދަންނަވަމެވެ.

ކ.ހިންމަފުށި ބިން ހިއްކުމުގެ މަޝްރޫޢުގެ އީ.އައި.އޭ އެޕްރޫވްކުރުމާ ގުޅޭ:

ސުރުހީގައި ދަންނަވާފައިވާ މަޝްރޫޢަކީ މިމިނިސްޓްރީއިން ވަރަށް ބޮޑު އިސްކަމެއް ދީގެން ކުރިއަށް ގެންދާ މަޝްރޫޢެކެވެ. މިމަޝްރޫޢުގެ ބިންހިއްކުމުގެ މަސައްކަތް ވަރަށް އަވަސް ދުވަސްކޮޅެއްގެ ތެރޭގައި މަސައްކަތް ފުރި 2 ހަފްތާއެއް ތެރޭގައި ބިން ހިއްކުމުގެ މަސައްކަތް ނިމޭނެއެވެ. މިމަސައްކަތަށް ފަހު ނެގުމަށް ހަމަޖެހިފައިވަނީ އއ.އަތޮޅުގެ [illegible] ފެށިގެން [illegible] 2 ބޮޑު ޑްރެޖަރު [illegible] [illegible]. މި ސަރަހައްދުގެ ތަސްވީރު މި ސިޓީއާއި އެކު ހުށަހަޅައިލާނަމެވެ.

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ވީމާ، [illegible] [illegible] [illegible] ސަރަހައްދުން ކަނޑައެޅިފައިވާ ވެލި ނަގާ [illegible] [illegible] [illegible] މިނިސްޓްރީގެ [illegible] [illegible] ނުވަތަ އިޢުތިރާޒް [illegible] ނުވަތަ [illegible] ވީ އެންމެ އަވަހަކަށް ފުރުޞަތެއްގައި މި މިނިސްޓްރީއަށް އަންގަވައިދެއްވުން އެދި ދަންނަވަމެވެ.

އިޙްތިރާމް ޤަބޫލުކުރުއްވުން އެދެމެވެ.

28 ރަމަޟާން 1437ހ.
03 ޖުލައި 2016މ.

ޚާދިމުކުމް

ޢަބްދުﷲ މުއްތަލިބް
މިނިސްޓަރުގެ ނައިބު

މިނިސްޓްރީ އޮފް ޓޫރިޒަމް
މާލެ، ދިވެހިރާއްޖެ

بسم الله الرحمن الرحيم

ޓޫރިޒަމް ޕްރޮމޯޝަން ބورޑް
ފާރުގަ،
ދިވެހިރާއްޖެ

ނަންބަރ: 88-PS/138/2016/28

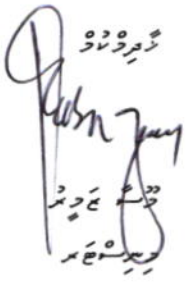
ޓޫރިޒަމް ޕްރޮމޯޝަން ބورޑުގެ ބޯޑް ސެކްރެޓަރ ޢަބްދުﷲ ދީދީ،

ވަނީ ހުށަހެޅުމަށް ދަންނަވަމެވެ.

ތިރީގައި ބަލައިގަންނަވާ ނަންބަރ 138-PIS1/88/2016/28 (26 ޖޫން 2016) ސިޓީ ގައި ބަލައިގަތުމަށް ފާހަގަ ކުރަމެވެ.

ކުރިން ހިންގާ ހަ ދުވަހުގެ ކޮންފަރެންސް ކަމަށް ބުނެ ދިވެހިރާއްޖެ ޓޫރިޒަމް ކޮންފަރެންސް ސިޓީ ގައި ބަލައިގަތުމަށް ފާހަގަ ކުރަމެވެ. ކޮންފަރެންސް ހިންގާ ތަނުގެ ދަށުގައި ހުންނަ ކާރ ޕާކް ބޭނުންކުރާ ގެސްޓުންގެ ވާހަކަ ދައްކާ ކަމަށް ބުނެ ދިވެހިރާއްޖެ ޓޫރިޒަމް ކޮންފަރެންސް ސިޓީ ގައި ބަލައިގަތުމަށް ފާހަގަ ކުރަމެވެ.

ތާރީޚް ދެއްކެވި ގޮތަށް ވާ ކަމަށް.
23 ރަމަޟާން 1437ھ
28 ޖޫން 2016ء



ޢަބްދުﷲ ދީދީ
ބޯޑް ސެކްރެޓަރ
ދިވެހިރާއްޖެ ޓޫރިޒަމް ޕްރޮމޯޝަން ބورޑް
ފާރުގަ، ދިވެހިރާއްޖެ.

Annex4 – Borrow Area


Borrow 1
Borrow 2
Proposed Borrow Area
Alternative Area 1
Borrow 3
Alternative Area 2
Alternative Area 3


Mathiveri
Mathivereefinolhu
Bodufolhudhoo
Kudafolhudhoo
Velidhoo
4000m
3000m
3300m
Manta Point
Dive Reef
1000m
2300m
Proposed Borrow Area
700m
7500m
Dhinnolhufinolhu
Havza Thila
2700m
Vihamaafaru

Annex 5 – Bathymetry

249000E 249500E 250000E 250500E 251000E 251500E 252000E 252500E 253000E 253500E 254000E 254500E 255000E 255500E 256000E 256500E

461000N 460500N 460000N 459500N 459000N 458500N 458000N 457500N 457000N 456500N

Ari Borrow Area

Legend	Notes	Depths and dimensions in m Navigational Water Depths are related to CD Reclamation Depth are related to MSL (CD + 0.66m)	Revision 0: Pre survey results, survey date: March - April 2016 1: 2: 3: 4: 5: 6:

-15 -20 -25 -30 -35 -40 -45 -50

Source Ellipsoid: WGS '84
Target Ellipsoid: WGS '84
Datum Shift: None
UTM: 43 South

Client
INFRASTRUCTURE DEPARTMENT MINISTRY OF HOUSING AND INFRASTRUCTURE
MALDIVES LAND AND SURVEY AUTHORITY

Dredging Contractor
Van Oord

Head Office
Postal Address: PO Box 8574, 3006AN Rotterdam, The Netherlands
Visiting address: Watermanweg 64, 3067GG Rotterdam, The Netherlands
T. +31 88 826 00 00
F. +31 88 826 50 10
E. info@vanoord.com

Borrow area Pre Survey
Pre survey date: March - April 2016.

Depths are related to CD

Project Name: Himmafushi

Issue Date: 14/05/2016	Scale: 1: 10000
Survey Date: 06/05/2016	Drawn By: NZU
Drawing No.: Himmafushi-Pre-01	
Project No.: 34.3295	Draw. Type: In Survey
	Revision: 0

Annex 6 – Sand Search Report

Maldives Three Island reclamation

Himmafushi Sand Search

Author Roel Nagtegaal
Department E&E - GEOLOGY

Date 04-04-2016
Project 34.3295

Project:	Maldives Three Island reclamation	Page:	2 of 21
Project nr:	34.3295	Date:	05-04-2016
Location:	Male Atoll and Ari Atoll.	Prep.:	NAG
Title:	Himmafushi sand search, The Maldives		

1 INTRODUCTION

Himmafushi Island is part of the Male Atoll which is located in the central part of the Maldives. The island is located approximately 17km north of the capital Male. For a reclamation on the north-east side of Himmafushi approximately 600.000m^3 of sand is required. Between 15-03-2016 and 28-03-2016 Van Oord conducted a sand search campaign to find a borrow area containing the required amount of suitable sand. The primary objective was to locate sand in the Ari Atoll as extensive dredging took place in Male over the last years and sand resources will likely be depleted. As requested by the client an extensive sand search was also conducted in male in order to verify if any suitable material still remains close to the project location.

Figure 1. The red squares indicates the location of the Ari Atoll (west) and Male Atoll (east).

Figure 2. Himmafushi reclamation indicated in red square.

2 METHODS

Himmafushi is located in UTM zone 43N.
The geodetic settings used during the sand search are listed in Table 1.

Table 1. Geodetic settings used during the Feydhoo Sand Search

Projection type	Universal Transverse Mercator
Description	UTM zone 43 (Northern Hemisphere)
Latitude of origin	00°00'00.00000"N
Longitude of origin	075°00'00.00000"E
Scale Factor	0.99960000
False Easting	500 000
False Northing	0 000 000

The vessel used for the Sand search was the Blackbird, a Pushbuster type vessel belonging to Van Oord, see Figure 3. Initially the inside of the Ari And Male atolls were surveyed using a SES 2000 Standard, a parametric echosounder produced by Innomar. Based on this data borrow areas were selected. For obtaining samples in the borrow area the crane of the blackbird was used to deploy a high power electric vibrocorer constructed and operated by Marine Sampling Holland (Figure 4). The retrieved material was logged and selected samples were sent to the Fugro lab in Dubai for lab analysis.

Figure 3. The Van Oord pushbuster "Blackbird"

Figure 4. High power electric vibrocorer being deployed.

3 RESULTS

3.1 MALE ATOLL

In figure 5 the lines that were surveyed in order to find a suitable borrow areas inside the Male Atoll are marked in green. The exploration lines sailed through the atoll yielded 5 areas of interest which were further investigated. The areas are shown in figure 5 and will be discussed individually below.

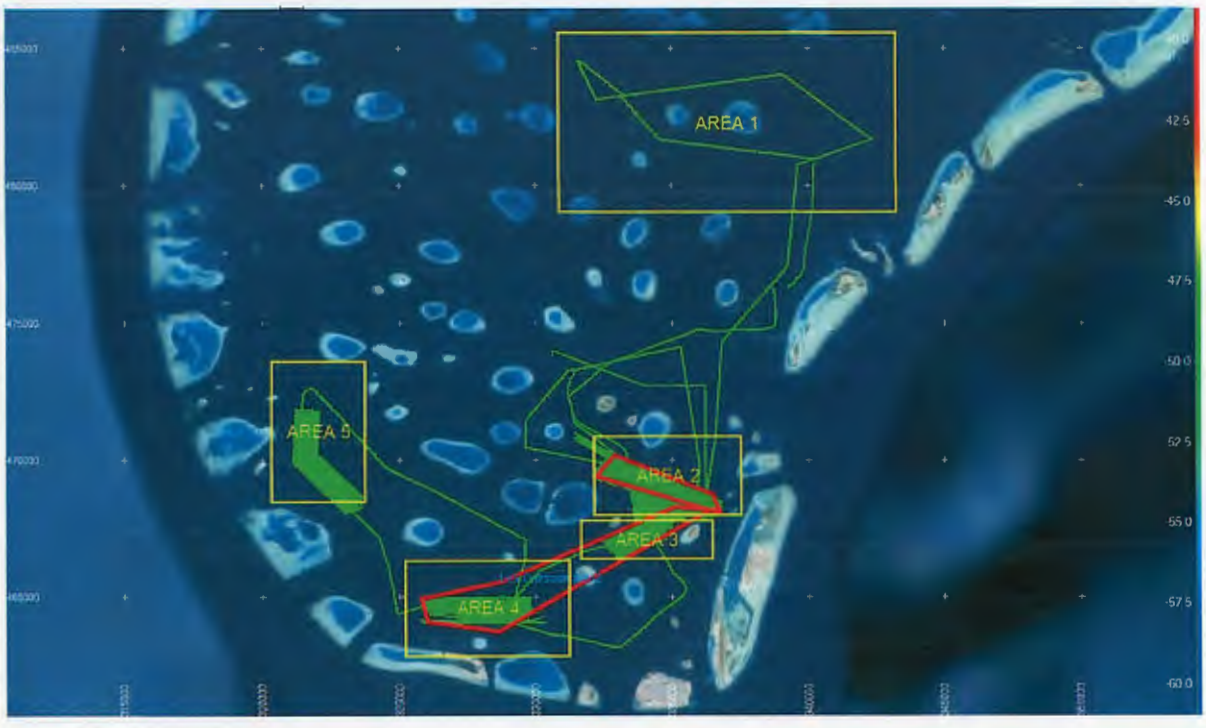


Figure 5. overview of sailed lines in Male Atoll.

3.1.1 Area Male 1.

Several exploration lines were sailed in area 1.
The pes profiles clearly show the presence of a thick sedimentary layer on top of what appears to be bedrock. In order to test the nature of the sediment layers two vibrocores were deployed. Both returned unfavorable results as the sediment are fine grained and consists of SILT.

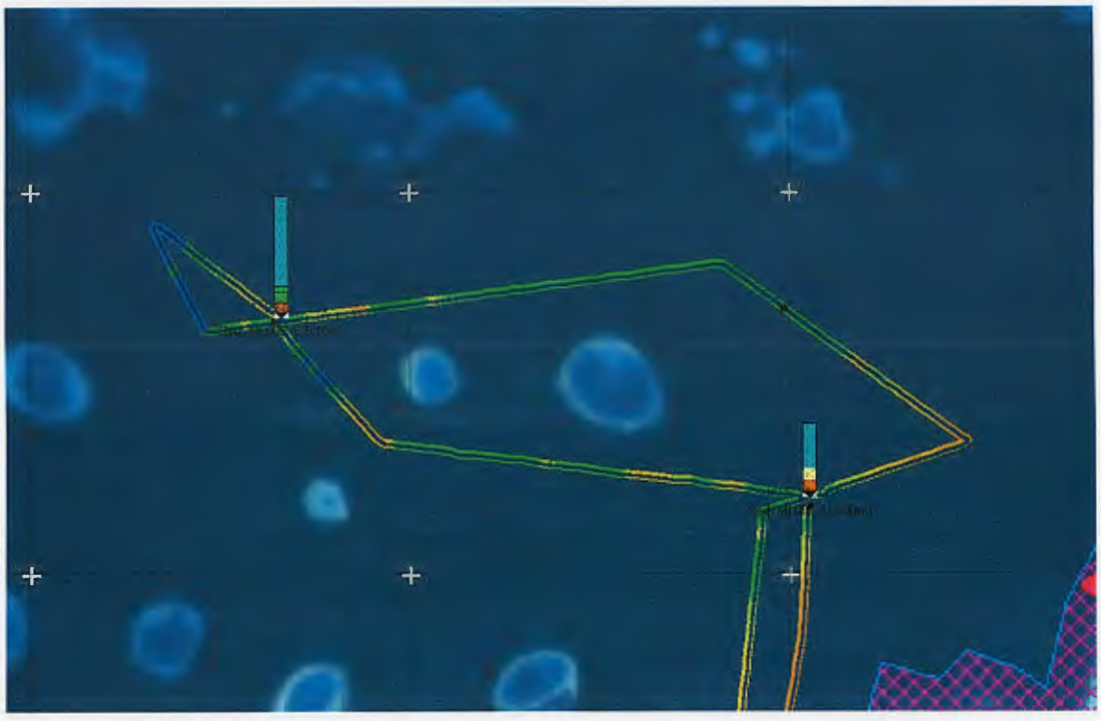


Figure 6. Sailed lines in area 1 and vibrocore locations both cores recovered a thick layer of medium dense SILT.

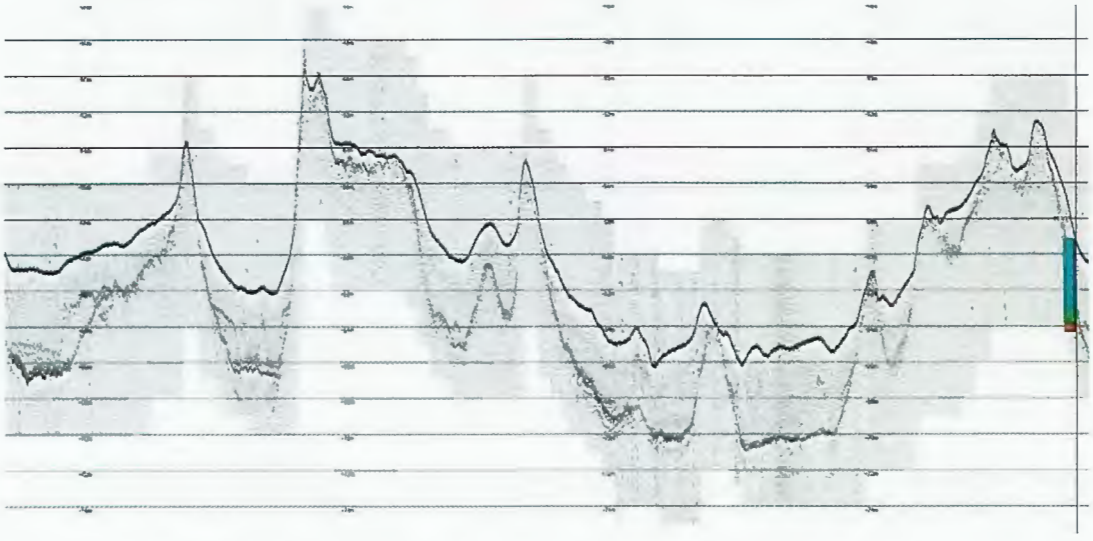


Figure 7. Typical Pes profile area1. Clearly visible is the bedrock which is covered by a thick "blanket" of silt

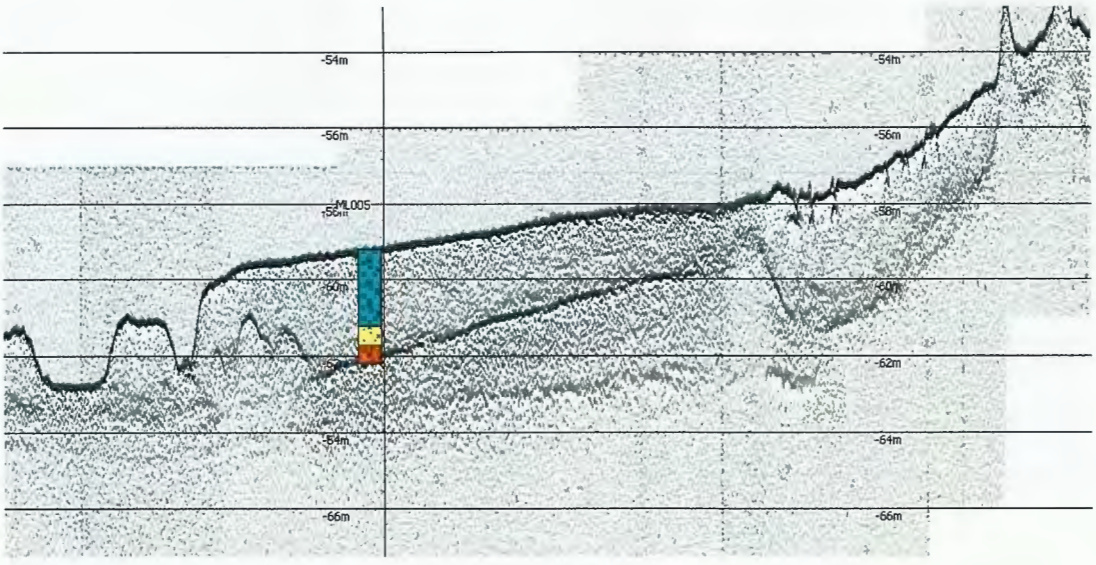


Figure 8. PES profiles showing a thick sedimentary SILT deposit in area 1.

3.1.2 Area Male 2.

Area two is located in the northern former dredge area of the Leiv Eriksson.
Figure 9 clearly shows the dredging tracks. The Pes data shows that most of the area is depleted and only small sand dunes remained after dredging. In the central part a small lump of sand remains as well as the most eastern edge where some sand is still available. Unfortunately these areas are unreachable for large hopper dredgers due to rock outcrops in the vicinity of the sand patch.

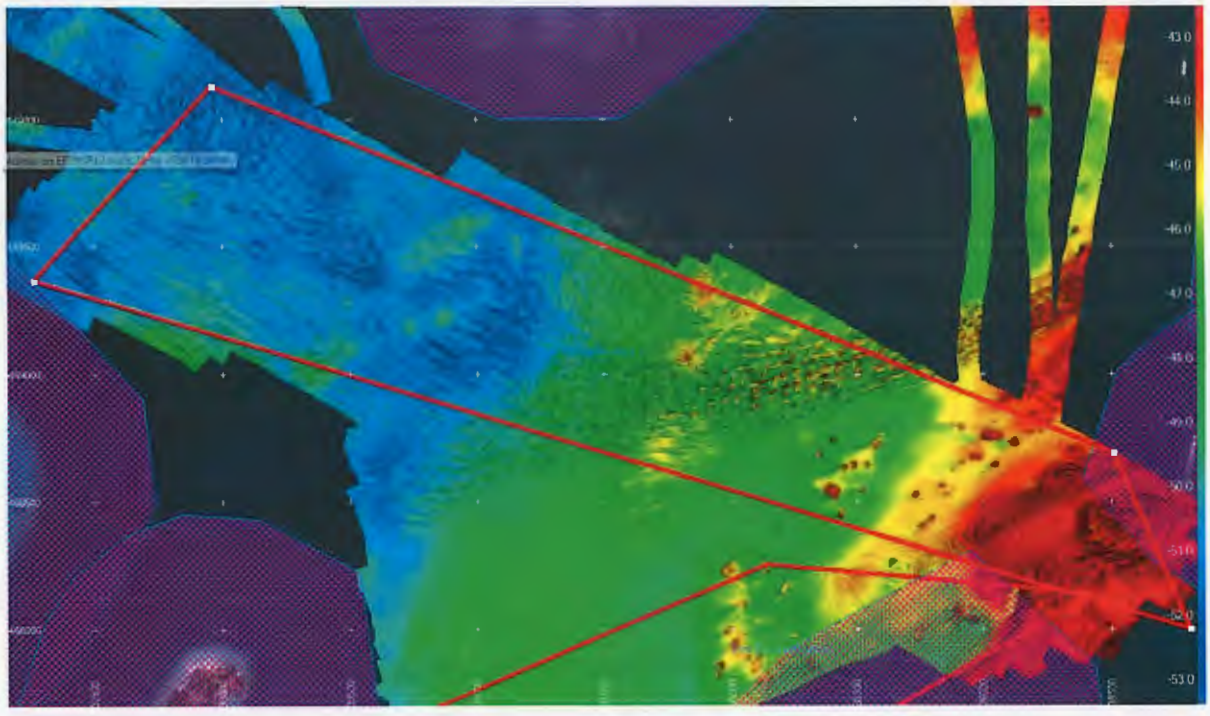


Figure 9. Former dredge area of the Leiv Erikson. The dredge tracks are clearly visible.

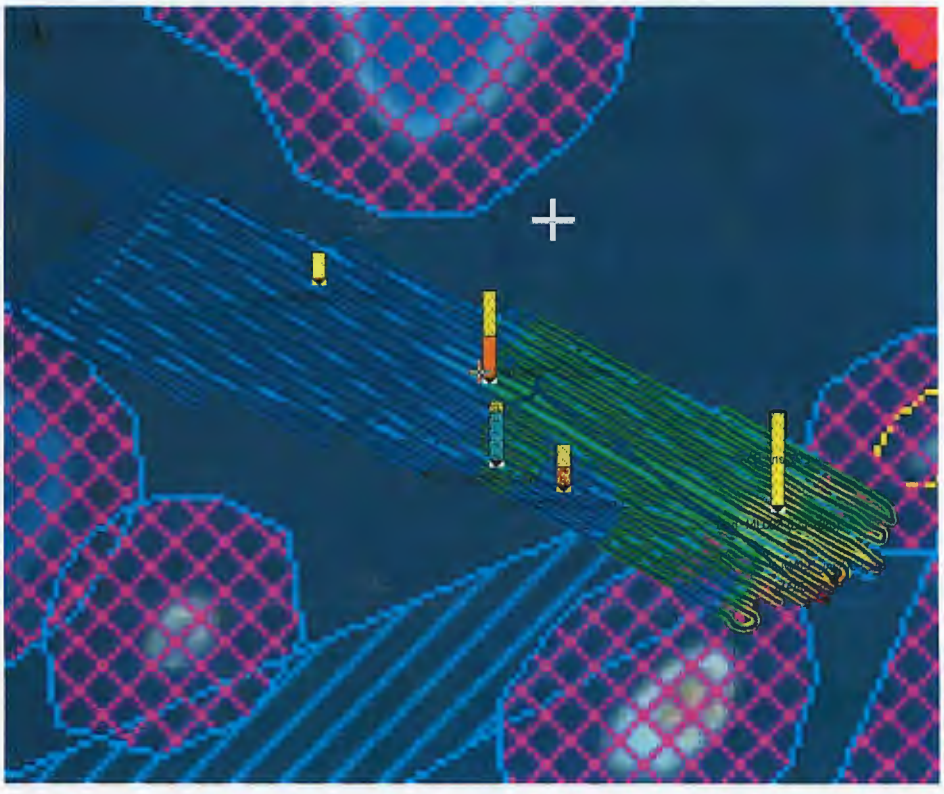


Figure 10. Sailed lines in Area 1. Vibrocores showed small sandbar in the east and central part.

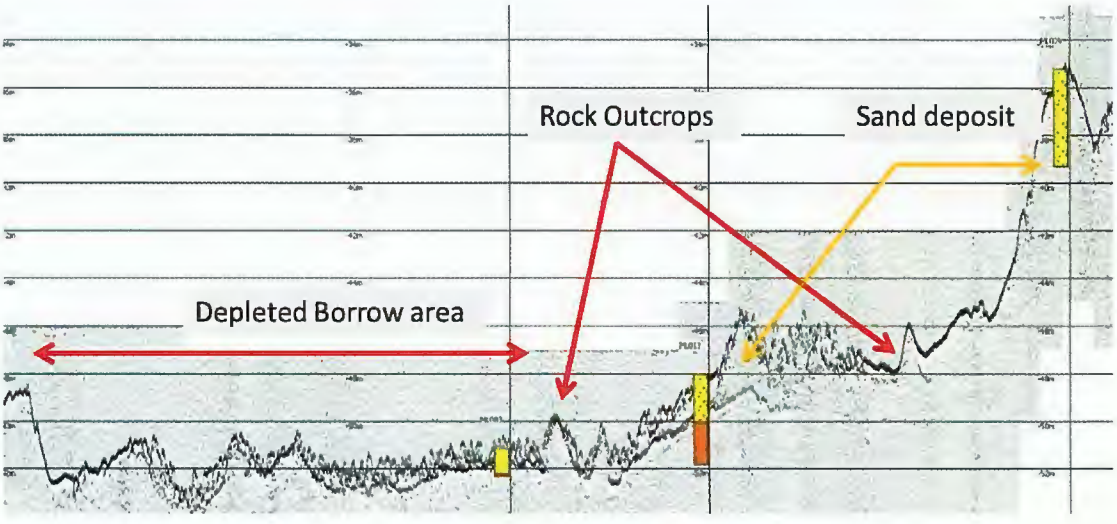


Figure 11. Pes profile across area 2 clearly shows the depleted area in the west, some small pockets of sand remain in the east

3.1.3 Area Male 3.

A fairly small area located in the northern end of the large dredge area of the Leiv Eriksson directly east of the presidential island was identified. No dredging took place in this area. The Bathymetry from the multi beam and PES data shows an small stretch of SAND on an elevated area. This was confirmed by 4 vibrocores. The area is just over 200 meters wide and about 1km in length. The small width of the area could cause difficulties maneuvering in the area. It should also be taken into consideration the area is crossing a busy fairway with heavy traffic which might complicate dredging operations. During the site investigation we were requested by the coast guard and navy to abandon our operations in the area due to the close proximity of the presidential island.

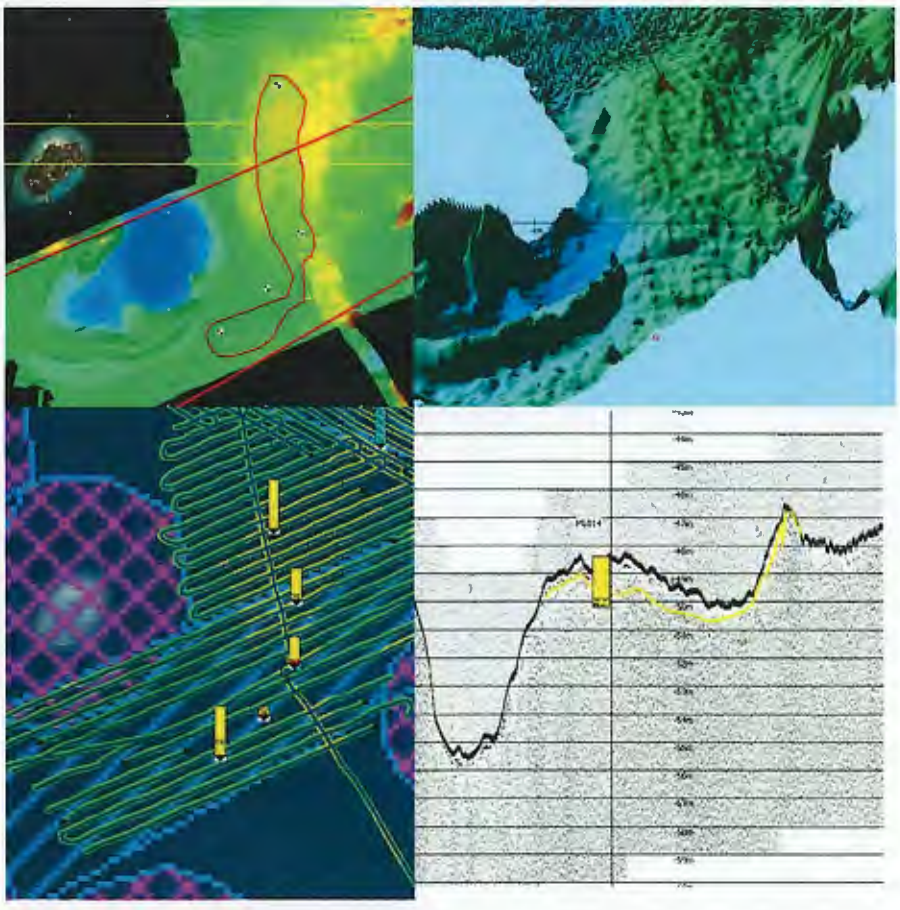


Figure 12 Upper left: top view of vibrocores locations and potential borrow area. Top right: 3d view of ridge. Bottom left. Sailed Pes lines. Bottom right PES profile of sand deposit.

3.1.4 Area Male 4

Area 4 is located in the southern extend of large dredge area of the Leiv Eriksson just south of the major anchorage areas. Due to anchored ships located outside the designated anchorage area some part could not be surveys (area just south of anchorage). Extensive dredging took place in the surveyed area as can been seen in figure 13. Large part of area are depleted. The central part however still shows a sediment layer between 1 to 3 meters in thickness. Six vibrocores have been deployed in the area which all return very silty very fine sand. The quality of the material is not considered suitable for reclamation due to the high fine content which will result in large sediment plumes. This is likely the reason the material has not been dredged in this part of the borrow area.

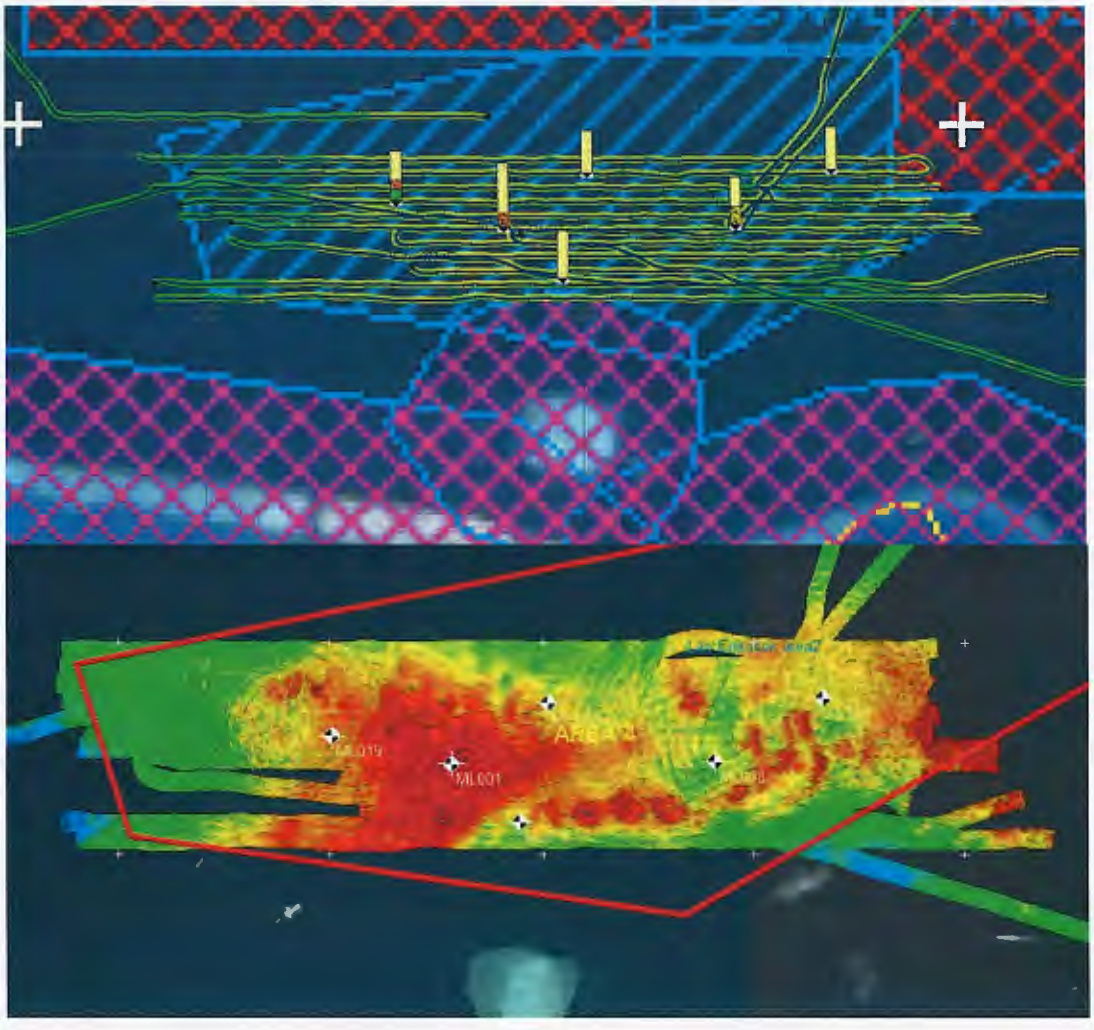


Figure 13. Overview of Vibrocores, sailed lines and bathymetry.

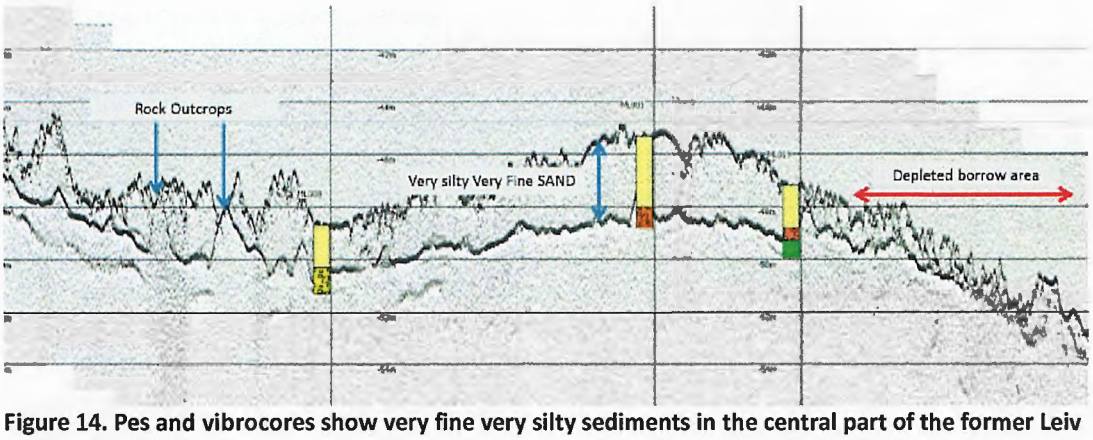


Figure 14. Pes and vibrocores show very fine very silty sediments in the central part of the former Leiv Eriksson Borrow Area.

3.1.5 Area Male 5

Area 5 is located in the south west corner of the Male Atoll about 15km west of the airport. No dredge tracks were encountered in the area. At several locations a 0.5 to 2.5 meter thick sediment deposit was found on top of what appears to be bedrock. Vibrocores confirmed that the investigated areas contained sediments consisting of fine to medium and occasionally coarse SAND. The deeper areas which are clearly visible on the multibeam survey contain silt and organic clays and were hence omitted as potential borrow area. The multibeam did also reveal several areas with rock outcrops. Based on the multibeam, PES and vibrocore data 2 small potential borrow areas can be appointed and are indicate in pink hatched polygons. The northern area has a surface area of 0.31km^2, the southern area has a surface area of 0.39km^2. Due to relative small size of the areas dredging will not be optimal.

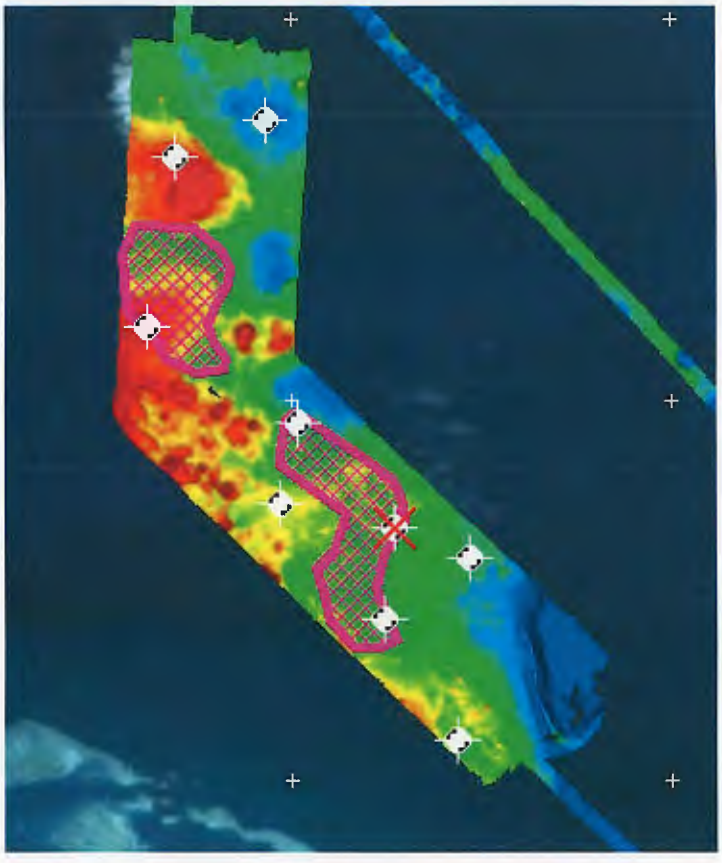


Figure 15. Bathymetric survey and multibeam locations.

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Location:	Male Atoll and Ari Atoll.	Prep.:	NAG
Title:	Himmafushi sand search, The Maldives		

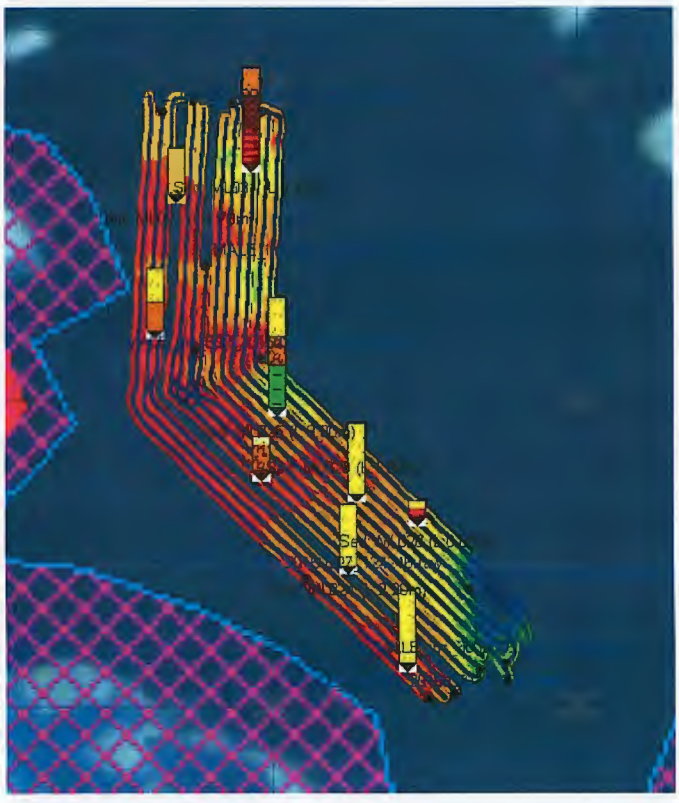

Figure 16. Area 5 sailed PES lines

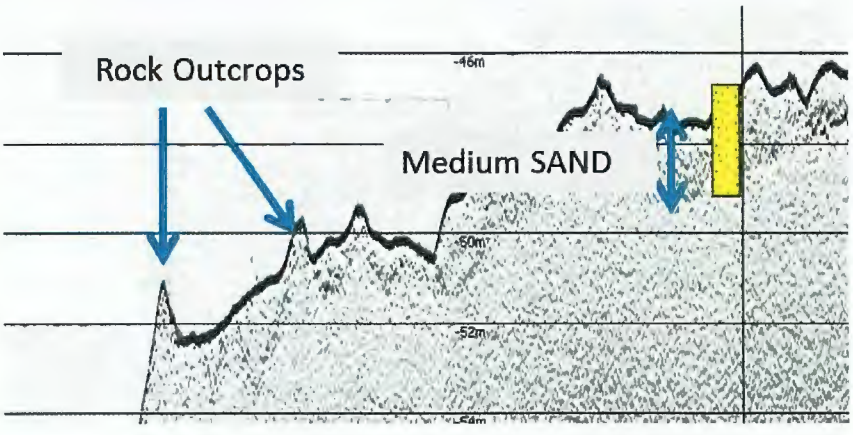

Figure 17. Pes profiles show a sediment layer of between 0 and 2.6 meters in thickness.

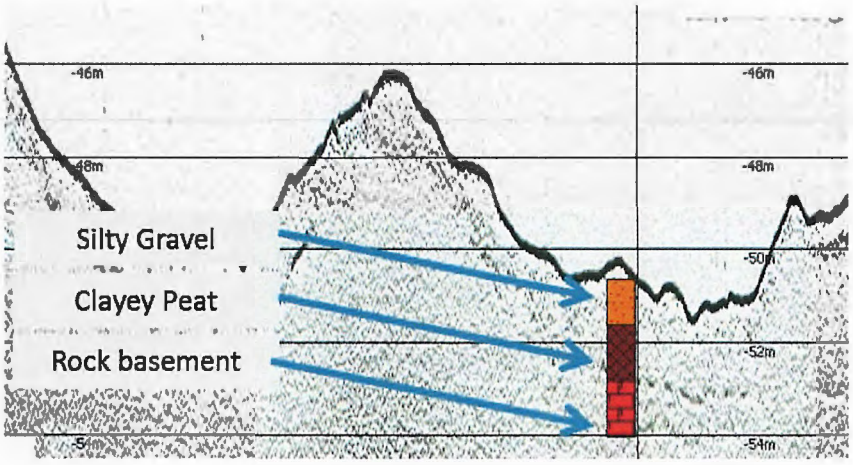

Figure 18. The deeper areas with in the survey area revealed a thin layer of silty gravel on to of clayey peat deposits.

3.2 ARI ATOLL

Figure below shows the lines that were surveyed in order to find suitable borrow areas inside the Ari Atoll in green. The exploration lines sailed through the atoll yielded four areas of interest which were further investigated by PES and vibrocores.

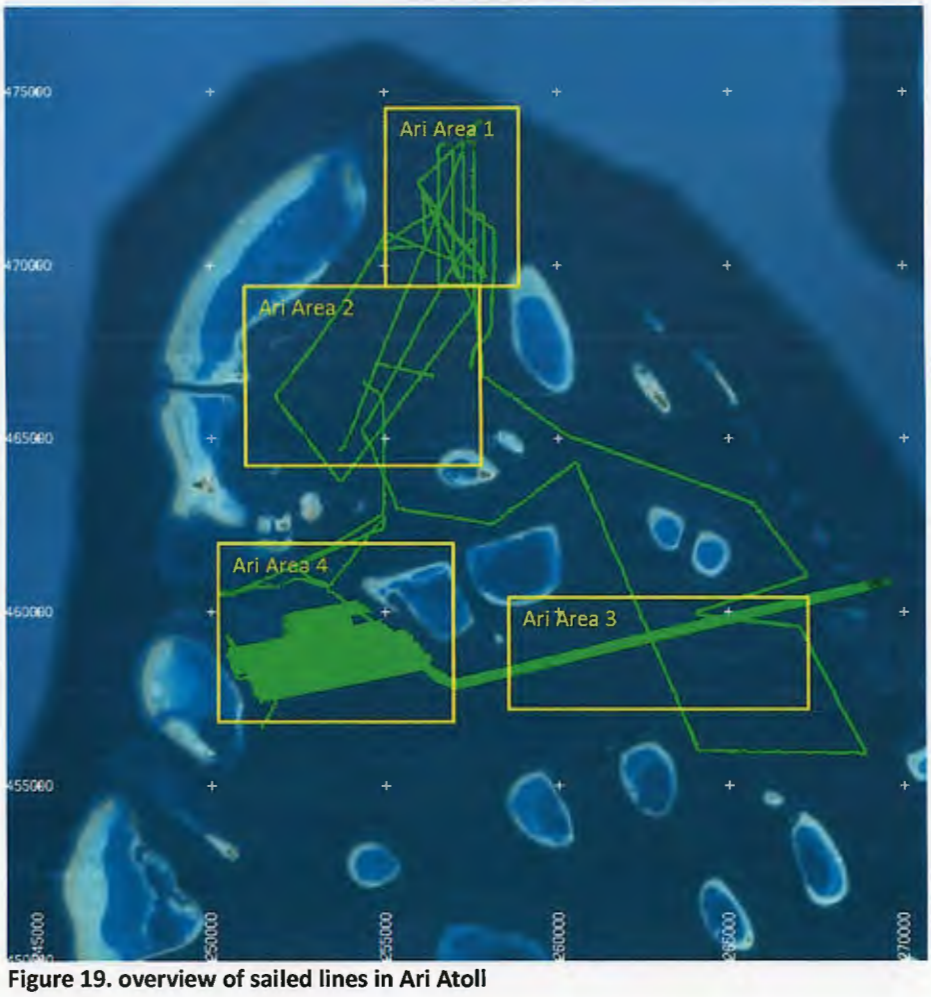

Figure 19. overview of sailed lines in Ari Atoll

3.2.1 Ari Area 1.

Area 1 is located in the north of the Ari Atoll. The multibeam survey in the area revealed large ripple structures on the seabed which are often indicative for sand waves. Vibrocores in the area did indeed confirm that the ripples consist of medium to coarse sand. Unfortunately the Pes Survey revealed that the sand waves are moving over a bedrock basement which results in a highly variable layer thickness. PES profiles show that the bedrock is exposed in-between succeeding waves. Due to absence of sand between the waves dredging in this area is highly unfavourable and should be avoided.

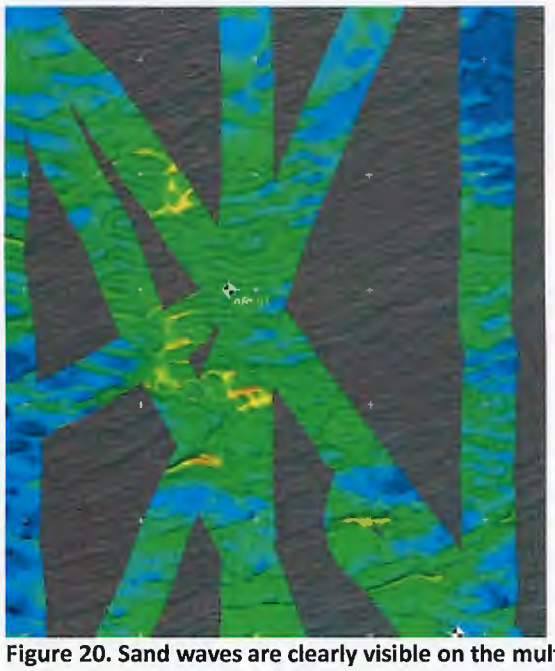

Figure 20. Sand waves are clearly visible on the multibeam survey lines.

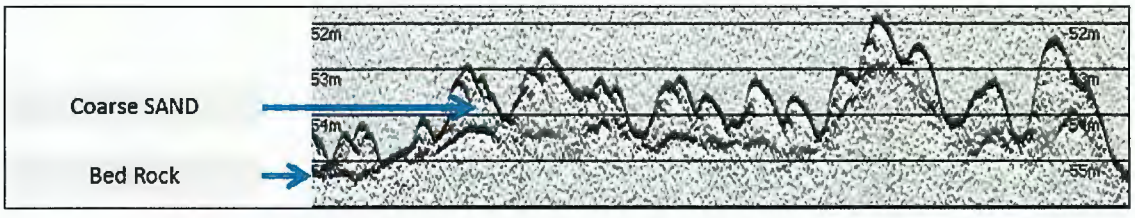

Figure 21. Pes profiles clearly show the sand waves on top of bedrock,

3.2.2 Ari Area 2 and 3.

Area two and three are located more inward of the Ari Atoll. The PES profiles in these areas revealed a thick sedimentary deposit up to 10 meters in thickness. Two vibrocores were deployed to determine the nature of the deposit and returned thick SILT layers. The areas were not further investigated.

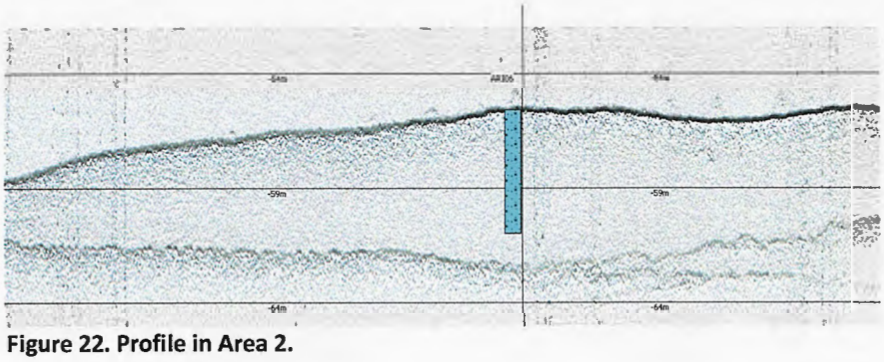

Figure 22. Profile in Area 2.

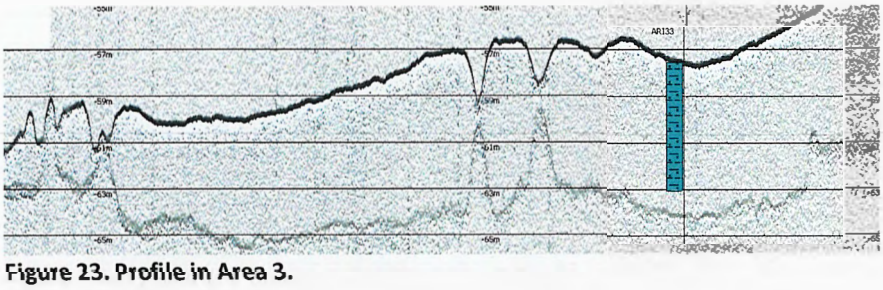

Figure 23. Profile in Area 3.

3.2.3 Ari Area 4.

Area 4 is located about 5.5.km south of Mathiveri. It is positioned just east of a large tidal channel which breaks through the barrier islands. Pes lines showed a sedimentary deposit between 1 and 2 meters in thickness.

Strong currents were experiences during sailing in the surroundings of area 4. As strong currents prevent fine material to settle coarser sedimentary deposits can be expected.

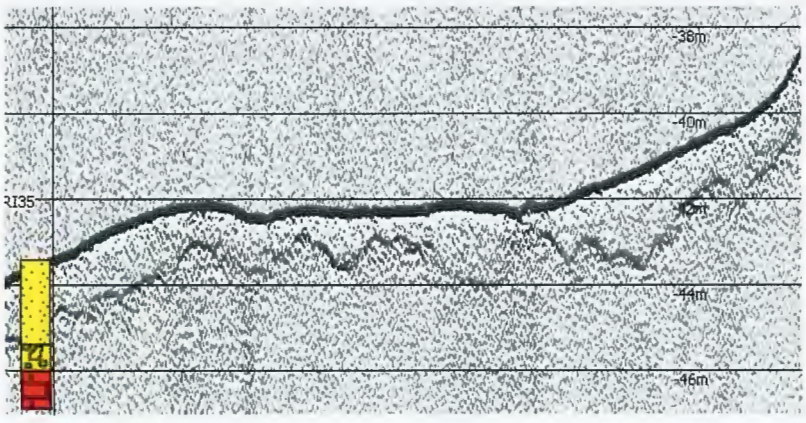

Figure 24. Sedimentary deposits in area 4 consisting of medium to coarse SAND.

The sedimentary deposit was mapped in detail with a PES survey and extensive Vibrocore Campaign.
Sailed lines and Vibrocore locations are displayed below. Vibrocores deployed in the area recovered yellowish white medium to coarse SAND.

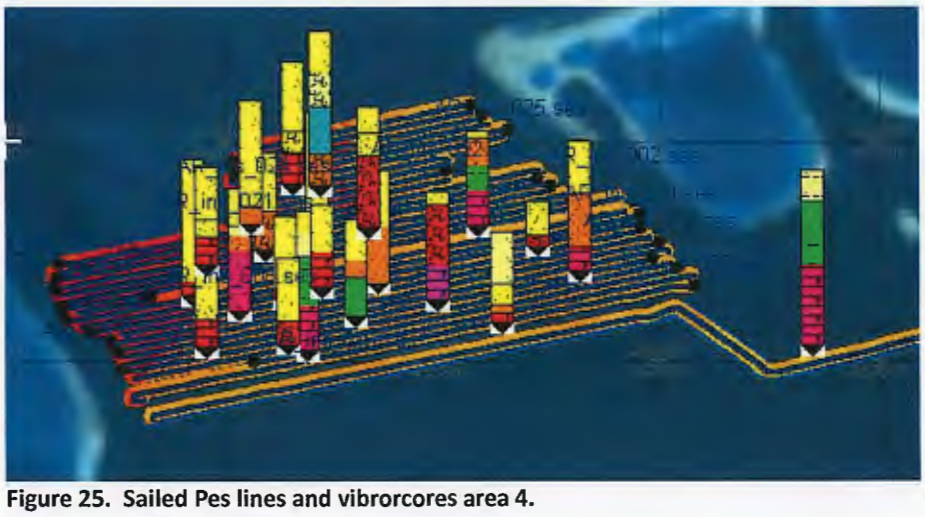

Figure 25. Sailed Pes lines and vibrorcores area 4.

Based on the PES, multibeam and vibrocore campaign a potential borrow area was identified and is shown below. The identified potential borrow area has a surface area of 2.4 km2.

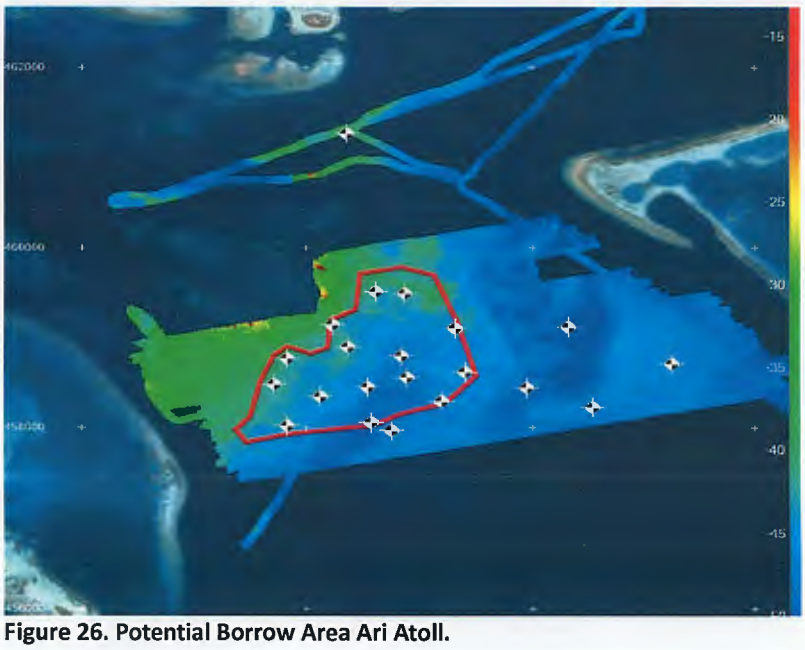

Figure 26. Potential Borrow Area Ari Atoll.

4 CONCLUSIONS

The site investigations in Male Atoll confirmed that the former dredge areas used for previous reclamation project are depleted or contain fine material very high in silt and clay and are hence unsuitable as potential borrow areas. Just east of the presidential island a small stretch of sand was encountered but is located across in the fairway and is considered too narrow for a large hopper dredger to dredge economically. In the western part of the male Atoll two small potential borrow areas were encountered. Small volume of sand could be sourced from these areas.

The site investigation in the Ari atoll resulted in one potential borrow area containing a sediment layer of about 1 to 2 meters in thickness. Although the encountered layers are relatively thin the surface area is significantly larger than the areas found in the Male Atoll. In addition to the material encountered in the Ari Atoll contains virtually no fines due to high currents in the area. This favors the Ari Borrow area above the Male areas.