ENVIRONMENT IMPACT ASSESSMENT

FOR THE

ESTABLISHMENT OF A Floating Fish Processing Facility at Hulhumale’

March 2013

Prepared for
Ocean Seafood Pvt Ltd.
Maldives

Consultant
CDE Consulting, Maldives
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List of Abbreviations

COADS  Comprehensive Ocean-Atmosphere Data Set
DO    Dissolved Oxygen
EIA    Environmental Impact Assessment
EPA    Environmental Protection Agency
GPS    Global Positioning System
IPCC   Intergovernmental Panel on Climate Change
IPPC   International Plant Protection Convention
MEE    Ministry of Environment and Energy
MHI    Ministry of Housing and Infrastructure
MoTAC  Ministry of Tourism, Arts and Culture
MoTCA  Ministry of Tourism and Civil Aviation
MSL    Mean Sea Level
MWSC   Maldives Water and Sewerage Company
NAPA   National Adaptation Programme of Action
NE     North East
NEAP II National Environmental Action Plan II
NW     North West
SAP    Strategic Action Plan
SE     South East
SW     South West
TSS    Total Suspended Solids
ToR    Term of Reference
UNFCCC United Nations Framework Convention on Climate Change and the Kyoto Protocol
Acknowledgement

Team Leader for this Assessment is Dr. Ahmed Shaig.

Additional assessments were undertaken by the following team members.

Mr Zameer Zubair (baseline assessment, impact assessment and report writing)

Mr Mohamed Ali (Marine environment specialist)

The curriculum vitae’s of the EIA consultants are attached in Appendix G of this report.
Lead Consultant’s Declaration

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

Dr. Ahmed Shaig
Proponents declaration

As the proponent of the proposed project, I guarantee that I have read the report thoroughly and that to the best of my knowledge all information provided here is accurate and complete.

Yours faithfully,

Umar Jamaal
Managing Director
Executive Summary

The purpose of this document is to fulfil the requirements to get necessary environmental clearance from the Environmental Protection Agency (EPA) to maintain the existing fish processing facility anchored in Hulhumale harbour area. The proponent of this project is Ocean Seafood Pvt Ltd. The project is solely designed, implemented and financed by the proponent.

The existing facility has all necessary facilities for fish processing. Including ice plants, desalination plants, generator sets etc.. The processing is divided into fish filleting, storing, packing and transporting to Male’ International Airport for airfreight.

All project activities will be in conformance to the laws and regulations of the Maldives, and relevant international conventions that Maldives is party to. The key laws and regulations applicable to this project are Environmental Protection and Preservation Act and Environmental Impact Assessment Regulation 2012.

The project site is Hulhumale’ harbour area designated for such vessels and many safari and tourist vessels are moored in this area.

There environmental impacts from the project are to marine water quality and to subsequent marine life. The impacts are rather cumulative as sewage and waste water are expelled to lagoon by all the vessels in the area. However, measures have been put forward to minimise moderate impacts and any unpredicted impacts and accidents. This project will generate new jobs in Male’ Region, which is a significant positive impact.

The main alternatives assessed for the project are alternate sewage and waste water disposal methods, alternate site and island. “No project” option has also been considered and given the economic and environmental factors the best option would be to proceed with the project.

Housing Development Cooperation (HDC), the main regulating authority in Hulhumale’.

Monitoring plan is designed to assess any changes marine water of the site and waste generation from the facility. The management plan for this project is designed to produce a framework for anticipated impacts, including practicable and achievable performance requirements and systems for monitoring, reporting and implementing corrective actions. In addition provide evidence of compliance to legislation, policies, guidelines and requirements of relevant authorities.
EIA for the establishment of a Fish Processing Facility at Hulhumale Island harbour, Kaafu Atoll
1 Introduction

1.1 Purpose of the EIA

This Environment Impact Assessment (EIA) report is an evaluation of the potential environmental, socio-economic and natural impacts of the proposed establishment of a fish processing facility at the harbour of Hulhumale’. A floating vessel has been purpose built to be used as a factory for fish processing and packaging. The project is proposed by Ocean Seafood Pvt Ltd. The EIA consultant is CDE Consulting.

This document has been developed based on the Terms of Reference (Appendix A) issued by the Environmental Protection Agency (EPA) on 18th February 2013. This document is submitted to EPA by the proponent to fulfil the requirements of Environmental Protection and Preservation Act (EPPA) of the Maldives (4/93), more specifically the clause 5 of the Act which states that a report should be submitted before implementation of any project that may have a potential impact on the environment.

1.2 Project Scope

The main components of the project are:

1. Supply of fish
2. Fish processing
3. Storage and refrigeration
4. Packaging
5. Transportation to airport

The fish processing facility has been purpose built and has extensive on-board facilities which can cater all the needs along the chain of fish processing facility.

1.3 Project Rationale

Ocean seafood Pvt Ltd is a company specialised in exporting Tuna since 2001. During the year 2002 fish processing barge named “Ocean Glory” is anchored in Hulhumale’ harbour which cuts the fins and head of tuna before being packed with ice to be transported to Airport for exportation.

The barge has been operated under an authorisation letter issued by then Hulhumale’ development unit during the year 2002.
Again during the year 2009 the Ocean glory barge has been registered as a factory vessel anchored in the same location as the location falls under free zone, which was identified under the advertisement number HDC.161-M IU/2009/34 issued by Hulhumale’ Development Corporation.

The Ministry of Fisheries and Agriculture in coordination with EPA has issued a letter to Ocean seafood to obtain Environmental Clearance via an Environmental Assessment Report within 03 month period. The above mentioned letters has been presented in Appendix I.

1.4 Aim and Objectives

The aim of this project is to provide the following services and facilities:

1. Process the Skipjack tuna up to international standards
2. Accessibility of Ice to fisherman near Male’ as most catch is sold to exporters in Male’ and processing facilities near Male’ (eg. Himmafushi fish processing plant).
3. Buy fish from fisherman from a location close to Male’ as a convenience
4. Close vicinity to airport adds quality of fish as transportation time is reduced.

1.5 Consultants, Contractors and Government Institutions

All the EIA related work is undertaken by consultants from CDE Consulting. Design criteria and technical specifications have been developed by the proponent.

The project is financed and executed by Ocean seafood Pvt Ltd (the proponent).

The Ministry of Environment & Energy (MEE), The Ministry of Fisheries & Agriculture (MFA), Environmental Protection Agency (EPA) and Housing Development Corporation (HDC) are the Government agencies as stakeholders of the project.

1.6 Scope and Terms of Reference of EIA

The scope of this EIA is broadly based on the Environmental Impact Assessment Regulations 2012. The assessment more specifically adheres to the Terms of Reference (ToR) issued by the Environmental Protection Agency on 18th February 2013. The ToR is based on scoping meetings held between the stakeholders on 28th January 2013. A copy of the ToR is attached in Appendix A.

The EIA report contains the following main aspects.
A description of the project including the need for the project, how the project will be undertaken, full description of the relevant parts of the project, implementation schedules, site plans and summary of project inputs and outputs (Chapter 1&2).

A description of the pertinent national and international legislation, regulations and policies that are relevant and applicable to the project and a demonstration of how the project conforms to these aspects (Chapter 3)

Information on the baseline environmental condition of the project site; this includes information on terrestrial environment near the project site (Chapter 4).

An assessment of the potential impacts during both construction and operational stages of the project and identification and cost of the potential mitigation measures to prevent or reduce significant negative impacts during both construction and operation stages of the project (Chapter 5 & 6).

Assessment of alternatives for the proposed project (Chapter 7).

Details of the environmental management and monitoring plan (Chapter 8 & 9).

Stake Holder Consultations (Chapter 10)

Potential gaps in information (Chapter 11)

Main conclusions (Chapter 12)

1.7 Summary of Assessment Methodology

The process followed in the preparation of this EIA report consists of five parts. These are: scoping consultations; literature review; field surveys; analysis of results; and compilation of the assessment in the form of a report.

The first step of the process covered consultations with client and government agencies to determine the scope of the impact assessment. During this stage the client clearly outlined their development needs and assessment was geared to match the development plan and environmental assessment needs. The environmental assessment needs was determined based on the EIA Regulations 2012 and the issues brought forward by the Environmental Protection Agency in the scoping meeting.

During the second stage, a literature review was conducted to acquire background information on the site and its environment as well as to identify possible environmental impacts of similar developments in island settings. In this context, the EIA Regulations 2012, best practices from
similar development activities, scientific studies undertaken in similar settings around Maldives and previous documents/historical publications was considered.

The third stage involved field assessment on the island and areas covered by the EIA scope. Conditions of the existing environment were analysed using established scientific methods. The fourth stage involved in house analysis using scientific analysis methods to identify, predict and assess the impacts and alternatives. These methods will be explained in detail in later sections.

The final stage involved compilation of individual consultants’ findings.

The methods used in field assessments and impact prediction are summarised in their respective chapters.

1.8 Study Team Members

The team members of this EIA are:

- Dr. Ahmed Shaig (Team Leader)
- Mr. Zameer Zubair (Report compilation and Environmental assessment)
- Mr. Mohamed Ali (Marine Environmental Specialist)

The curriculum vitae’s of the EIA consultants are attached in Appendix G of this report.
2 PROJECT DESCRIPTION

2.1 Project Location

The project location is Hulhumale, a reclaimed island located on the south eastern rim of North Male’ Atoll at approximately 73°54’02.31”E and 4°21’32.09”N (see Figure 2.1).

Hulhumale’ is a large island with a length of 2100 m and a width of 950 m at its widest point. The total surface area of the island is 192.7 Ha (1.9 km²). The reef of Hulhumale’ Island is large with a surface area of 1183 Ha (22.80 km²) stretching to 11.8 km. The reef system holds the resort island Club Faru, Ibrahim Nasir International Airport (Hulhule Island) and Hulhumale’.

Hulhule’(Ibrahim Nasir International Airport) and Hulhumale’ are connected via a causeway.

Reclamation works of Hulhumalé commenced in 1997 and was completed in 2002. Primary developments in terms of the required physical and social infrastructure and residential developments were completed in 2004 and the very first settlement of Hulhumalé began in the middle of 2004 with a resident population of just over 1000 people.

The Floating fish processing facility is located at the harbor of the island where safari’s boats and other vessels are located. From 2002 the Ocean glory barge has been anchored in the designated area under the advertisement number HDC.161-M IU/2009/34 issued by Hulhumalé’ Development Corporation.

The facility has been located in Hulhumale’ as the harbour is safe during SE and SW monsoons for the facility and the fishing vessels coming to sell the catch and load with ice. In addition the close vicinity to the Airport makes it ideal when the quality of fish is considered as the quality is enhanced when transportation time is reduced.

The Yellow fin tuna fisheries boats normally go out into the open ocean for several weeks. For the trips they come to male to get the necessary stocks of ice, food and fishing equipment’s. The Fish processing facility being close to male’ is an advantage to the fishing vessels coming to stocks for the trips as ice could be bought from the same vessel to which they sell their catch and in close proximity to male’.

2.2 Project Outline and major components

The project involves all major components necessary for a fish processing including ice plants, desalination plants, generator sets and fish processing area.

The main components of the project are:
1. Supply of fish
2. Fish processing
3. Storage and refrigeration
4. Packaging
5. Transportation to airport

The next section provides the details of the project components.
EIA for the establishment of a Fish Processing Facility at Hulhumale Island harbour, Kaafu Atoll

Figure 2-1: Location map of Hulhumale' Island
EIA for the establishment of a Fish Processing Facility at Hulhumale Island harbour, Kaafu Atoll

Figure 2-2 Locality map and environmentally sensitive zones in the vicinity
Figure 2.3 Project site
2.3 Detailed Project Outline and Work Methodology

The floating facility has been anchored at the given location in figure 2.3 since 2002; hence the facility has been operational by providing cold storage, fish processing facilities and other labour requirements of staffs working on the facility.

Components of the fish processing process include the following:

1. Supply of fish
2. Fish processing
3. Storage and refrigeration
4. Packaging
5. Transportation to airport

2.3.1 Facility design

The floating facility is a 110 ft × 40 ft fully fibre glass vessel manufactured in Maldives by local and foreign crafts men. The facility is 3 decked with full-fledged cold storage facilities, fish processing area, pumps, desalination plants, ice plants, generators and accommodation and living quarters for the staffs on board.

2.3.1.1 Anchoring method

Four large anchors are placed at the lagoon bottom and connected together with steel chains. This connection is then attached to the front of the vessel such that the vessel could manoeuvre itself according to the currents. About 6 points at the bow of the vessel are connected to the common connection at about 5m from the sea surface.

The metal anchors are connected together using iron chains.

2.3.1.2 Refrigeration

Refrigeration is composed of two categories, one where small bags of ice is prepared which is used in packaging. The other is large fiberglass tanklike boxes each with a capacity of 2.5 tonnes.

A total of 8 refrigerators of capacity 6ft × 3ft are used to freeze the small bags used in the packaging process.
The large ice boxes used for storing processed fish is kept at a clean laboratory conditions as shown in the following figures. The ice required is made from the two ice plants on-board the vessel. The processed fish is stored for not more than 10 hours as they will be packed and sent to airport to be air freighted to the international buyers.

2.3.2 Fish Processing

Yellow fin tuna is gutted and cleaned by fishermen when brought to the Processing facility. Fish head and fins are removed at the clean environment of the processing facility and stored in the large ice boxes till they are packed as shown in figure 2.4.

2.3.2.1 Quality assessment

The fish brought to the facility are assessed for quality and freshness using a grading stick. A cylindrical fish sample is extracted and the colour and texture of the sample is used to determine the quality. If the quality is low the fish is rejected and is not taken up to the facility.

To maintain the cleanliness of the fish processing area certain protocols are followed as follows:
• Fish processing area is always kept clean and doors closed at all times
• Feet and hands have to be disinfected by thorough washing before and after entering the processing area.
• Lab coats, gloves and head caps are worn by all the employees inside the area
• The fish have to be cleaned heads and fins removed and stored immediately (the fish goes into freezing temperature below zero degrees within a maximum of 10 minutes).

Figure 2-5 the fish processing area

2.3.3 Packaging

The processed fish is encapsulated in polythene bags and packed in cardboard boxes with small ice packs. Ice packs are used to maintain the cold temperatures during transportation.

The cardboard boxes and ice packing bags are imported. Faulty cardboard boxes are not thrown but used in packaging to fill up the boxes.

Figure 2-6 Polythene bags used in packing the fish

The following figures show the small ice packs and cardboard boxes used for packaging.
2.3.4 Transportation of the packed fish to airport

Special purpose built fiberglass boats owned by the Ocean seafood Pvt Ltd, are used to transport the packed fish to the airport. The route takes approximately 5mins to reach the harbor of the airport.

Approximately 02 tons of fish was transported for exportation per day in 2012. (Company records of 2012.)

The boats range from 65-75 ft in length and are fully covered so that the cardboard boxed could be housed. The area designated for fish stocking is not used for any other purpose and kept clean at all times.
2.3.5 Waste disposal

2.3.5.1 Waste from fish processing and packaging

The removed heads and fins are normally given to the Rihaakuru makers of Hulhumale’ or given to recreation fishermen to be used as bait. Even if large quantities are brought the removed parts are sent to Rihaakuru makers.

The processing area is rinsed before and after fish processing using the highly saline brine from the desalination plants. The waste water is then collected to a 24m³ collecting tanks.

The cardboard boxes and ice packing bags are imported. Faulty cardboard boxes are not thrown but used in packaging to fill up the boxes.

2.3.5.2 Heated water from engine cooling

Water used for engine cooling is extracted from the intake pipes attached at the bow of the vessel. The heated water from the engine gets collected in a common tank where sewage water and other waste water from vessel is collected. This is then expelled at midnight hours after its been cooled down.

2.3.5.3 Sewage water

Sewage waste is collected into tanks throughout the day. The tanks are fitted with grinders where the collected waste water from sewerage systems and vessel washings are collected. The waste is grinded to fine sediment level and expelled from an opening found at the stern of the ship.

2.3.6 Utility services

The facility is self-sustained with its own power generators, Desalination plant, ice plants and pumps.

2.3.6.1 Power generation

Two gensets of 250KW and one with 24KW is in service on board. In normal conditions the 24KW genset is used. The two 250KW genset is used during the operation of ice plant and 24 KW gen set is kept as a backup generator.

The gensets are water cooled and the water is obtained from the sea from same pipelines as to desalination plants. The heated water is collected to 24m³ collecting tanks which is common for all waste water.
2.3.6.2 Desalination facility

A desalination plant with 16tonn capacity is placed on board the vessel. Water intake is located at the bow of the vessel. The brine water produced from the desalination facility is used to wash the fish processing area as the highly saline water makes helps in keeping the site sterile.

The filter size of the plant filtration is 0.5-10 microns.

![Figure 2-8: Water intake pipeline (left) and outlet pipe at the base of the vessel](image)

2.3.6.3 Pumps

For water pumping two 3KW diesel pumps are used. These pumps are used for water intake for desalination plants and water distribution for onboard water distribution network.

2.4 Project Schedule and Life Span

The factory vessel has been operated at the site since 2002 and located at the current location since then.

As this project has been initiated and ongoing this EIA is carried out under the instruction of the Ministry of Fisheries and Agriculture. (Refer to letter no 30-D/PRIV/2012/1077 Appendix I)

2.5 Labour Requirements and Availability

A total of 15 staffs are on board the vessel including a supervisor and an engineer. The staffs are multitasked depending on the quantity of fish brought to the vessel.

All the staffs are from the Proponent Ocean seafood Pvt Ltd.
2.6 Pollution and Emission Control Measures

The following measures will be taken to ensure minimal pollution during construction stage.

- Machinery will be properly tuned and maintained to reduce emissions and minimize risk of spills/leaks.
- All paints, lubricants, and other chemicals used on site will be stored in secure and bunded location to minimize risk of spill.

2.7 Health and Safety Measures

- The contractor would ensure that Health and Safety procedures are complied with at all times.
- Construction activities would be carried out under the supervision of a suitably experienced person.
- All reasonable precautions will be taken for the safety of employees, and equipment will be operated by competent persons.
- Warning signs, barricades or warning devices will be provided and used. Necessary safety gear will be worn at all times.
- Fire extinguishing equipment would be readily available and employees will be trained in its use. In general, water-based fire extinguishers would be used.

2.8 Summary of Project Inputs and Outputs

The types of materials that will go into the fish processing facility and given in Table 2.4 and the type of outputs (products and waste streams) and what is expected to happen to the outputs are given in Table 2.5

Table 2-1 Major Project Inputs

<table>
<thead>
<tr>
<th>Input resource(s)</th>
<th>Source/Type</th>
<th>How to obtain resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory workers</td>
<td>Local and foreign</td>
<td>Contractor’s employees</td>
</tr>
<tr>
<td>workers workers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polythene and</td>
<td>Ocean seafood pvt ltd</td>
<td>Import</td>
</tr>
<tr>
<td>cardboard used for</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Input resource(s) | Source/Type | How to obtain resources
--- | --- | ---
Packaging | | 
Engineers and Site supervisors | Local and foreign | Employed by Ocean seafood Pvt ltd
Water supply | Existing desalination plants on board | 
Maintenance material | Maintenance parts and fluids required for the machinery and piping. | Import or purchase locally where available
Food and Accommodation | Existing accommodation facilities onboard | Onboard
Fire fighting equipment | Fire Extinguishers...etc. | Contractor’s equipment
Fuel | Light Diesel, Petrol, Lubricants | Local suppliers
Telecommunication | Mobile phones, fax machines and internet facilities | Proponents equipment
Food and beverage | PET bottles, glass bottles, packaging waste, plastic bags and various frozen, packaged and fresh food. | Purchased locally

### Table 2-2 Major Project Outputs

<table>
<thead>
<tr>
<th>Products and waste materials</th>
<th>Anticipated quantities</th>
<th>Method of disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic waste</td>
<td>small quantity</td>
<td>Disposed in designated waste management site on Hulhumale’</td>
</tr>
<tr>
<td>Waste oil</td>
<td>Small quantities</td>
<td>Barreled and sent to Thilafushi site during demobilisation.</td>
</tr>
<tr>
<td>Hazardous waste (diesel)</td>
<td>Small quantities</td>
<td>Barreled and sent to Thilafushi site during demobilisation.</td>
</tr>
<tr>
<td>Plastic and packaging wastes</td>
<td>Small quantities</td>
<td>Sent to Waste management site at Hulhumale’</td>
</tr>
</tbody>
</table>
3 POLICY AND LEGAL FRAMEWORK

These legal and policy provisions have to be fully respected in carrying out the proposed development. All contractors and sub-contractors will be informed of these requirements. This project conforms to all relevant laws and regulations of the Maldives.

3.1 Relevant Environment Legislation

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

- Environment Protection and Preservation Act of Maldives (4/93) is the framework law on environmental management in the Maldives. Articles 2, 4, 5, 6, 7, and 8 of the law are relevant to this project.

- Article 2 states that the concerned government authorities shall provide the necessary guidelines and advise on environmental protection in accordance with the prevailing conditions and needs of the country. All concerned parties shall take due considerations of the guidelines provided by the government authorities. The project proponent shall abide by any guidelines or advice given by the concerned Government authorities for the project. The concerned Government authorities are identified in this Chapter.

- Article 4 states that the Ministry of Housing, Transport and Environment shall be responsible for identifying protected areas and natural reserves and for drawing up the necessary rules and regulations for their protections and preservation. The proponent shall ensure that there is no negative impact from the proposed project on any protected areas.

- According to Article 5 (a) of the Act, an Environmental Impact Assessment study shall be submitted to the Ministry of Housing and Environment (MHE) before implementing any activity that may have an impact on the environment. This EIA report is prepared and submitted by the project proponent to fulfil the legal requirement stipulated in Act (4/93) Article 5.

- According to Article 6, the Ministry of Housing, Transport and Environment has the authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation. The project proponent is aware of this provision and will take all practical measures to ensure there is no irreversible and significant negative impact of the project.
– Article 7 of the Environment Protection Act (4/93) prohibits the disposal of wastes, oil and gases in a manner that will damage the environment. Wastes, oil and gases has to be disposed off in areas designated by the Government. Hence, the project proponent shall use the Environmental Management Plan for this project which specifies how the wastes, oil and gases generated by the project will be disposed.

– Article 8 of the Environment Protection Act (4/93) prohibits the disposal of hazardous wastes. Any hazardous wastes that may be generated from the project shall be transferred to the designated waste site in Thilafushi for disposal according to Government regulations and standards.

3.2 Relevant Regulations and Guidelines

– Environmental Impact Assessment regulations were issued by Environment Ministry on 8th May 2012. The first step in environmental assessment process involves screening of the project to be classified as one that requires an EIA or not. Based on this decision, the Ministry then decides the scope of the EIA which is discussed with the proponent and the EIA consultants in a “scoping meeting”. The consultants then undertake the EIA starting with baseline studies, impact prediction and finally reporting the findings with impact mitigation and monitoring programme. This report follows the principles and procedures for EIA outlined in the EIA regulations.

– The EIA report is reviewed by MEE following which an EIA Decision Note is given to the proponent who will have to implement the Decision Note accordingly. As a condition of approval, appropriate environmental monitoring may be required and the proponent shall have to report monitoring data at required intervals to the Ministry. The project proponent is committed to implement all impact mitigation measures that are specified in this EIA report. Furthermore, the proponent is committed to environmental monitoring and shall fulfil environmental monitoring requirements that may be specified in the EIA decision note as a condition for project approval.

– Coral mining from house reef and atoll rim has been banned through a directive from President’s Office dated 26 September 1990. Coral would not be mined and used in any stage or activity of this project.
3.2.1 Guidelines of Public Health Laboratory for controlling the quality of yellow fin tuna fisheries and processing vessels

This guideline is used to standardise the vessels and processing areas used for Yellow fin tuna fisheries and processing. The following guidelines are used to assess the vessel before the issuance of health certificate;

- Engine oil and fuel should be stored and used away from the area where fish is handled
- There should be no rodents and roaches
- All areas of the vessel should be clean with special care to the areas where fish is handled
- Filleting should be carried out in clean environment and filleting waste should be separated from the fish at all times
- Tools and equipment’s used for fish processing need to be clean and in good condition
- The storage containers must have outlets for easy drainage of ice and waste water
- The toilets should be separated and doors should not open to the area where fish handling and processing is carried out.
- Physical observation to check the quality
- Temperature checks
- Histamine levels of fish must be below 100.
- Microbiological test needs to be carried out if required

The vessel “Ocean glory” has attained approval from The Maldives food drug authority on December 2009. The approval letter is presented in Appendix F.

3.3 Environmental Permits Required for the Project

3.3.1 Environmental Impact Assessment (EIA) Decision Note

The most important environmental permit to initiate project work would be a decision regarding this EIA. The EIA Decision Note, as it is referred to, shall govern the manner in which the
project activities must be undertaken. This EIA report assists decision makers in understanding the existing environment and potential impacts of the project. Therefore, the Decision Note may only be given to the Proponent after a review of this document following which the Ministry may request for further information or provide a decision if further information is not required. In some cases, where there are no major environmental impacts associated with the project, the Ministry may provide the Decision Note while at the same time requesting for further information.

3.4 Responsible Institutions

The main government institutions that have roles and responsibilities relevant to this project are summarised below.

3.4.1 Ministry of Environment & Energy

The Ministry of Environment and Energy (formed in 2012) formerly the Ministry of Housing and Environment is mandated for the effective implementation of the Environmental Protection Act of the country and has the statutory power over issues related to the environment. It has the central control over the environment protection, management, conservation and environmental emergencies. The Ministry operates mainly at a policy level and the more regulatory and technical assessment activities are mandated to the Environmental Protection Agency (EPA). In this respect EPA has now been mandated to manage all issues relating to Environmental Impact Assessment of individual projects.

The Ministry of Environment also seeks the advice of National Commission for the Protection of Environment (NCPE) on all significant environmental matters. The commission is appointed by the president and is mandated to advice the Minister of Environment on environmental matters such as environment assessment, planning and management, and political decisions with regard to the protection of environment.

3.4.2 Ministry of Fisheries & Agriculture

The Ministry of Fisheries and Agriculture is mandated to oversee the Agriculture and Fisheries sector and issues Fish processing licenses to Firms under Law no 31/79. Ocean seafood has attained the license from The Ministry of Fisheries & Agriculture on 30\textsuperscript{th} March 2013. The License document is presented in Appendix E.

3.4.3 Housing Development Corporation (HDC)

The Housing development Corporation formerly known as Hulhumale’ development corporation is responsible for managing Hulhumale’ including its reclamation and development projects.
HDC manages and monitors the harbour area and thus consultations were carried out with the relevant departments of HDC as presented in chapter 10.

3.5 Guiding Policies and Documents

3.5.1 National Environmental Action Plan III (NEAP III)

The Third National Environment Action Plan (NEAP III) of the Government of Maldives sets out the agenda for environmental protection and management for the period 2009 till 2013. NEAP III provides the basis for environmental planning, budgeting, performance measurement and accountability. The key target of NEAP III is to achieve measurable environmental results that matter to the people of the Maldives.

NEAP III provides the following principles to be adhered to in environment protection and environmental management.

1. Environmental protection is the responsibility of every individual. Protection of the natural environment and practicing environment friendly lifestyles is a responsibility of every Maldivian.

2. Achieve results. The actions, activities, regulations, supervision, reporting, incentives, information and advice for environmental management shall be directed and well-coordinated to achieve the results the citizens want.

3. Promote and practice sustainable development. In environmental management the principle of sustainable development shall be followed. Conditions shall be created to give equal distribution of environmental goods and services both geographically and between generations including future generations. Special attention shall be given to address the concerns of the most vulnerable groups in the population.

4. Ensure local democracy. In environmental management the actions and decisions shall be taken and authority exercised at the most appropriate level.

5. Inter-sectorial co-ordination and co-operation. Co-ordination and co-operation is essential from all sectors. For environmental management all should work informatively and cooperatively toward the goal of integrating environmental aspects into the goals and actions of all sectors.

6. Informed decision making. Actions for environmental management should be based on documented facts to as great extent as possible and not to pursue self-interest or short term gains.
7. Precaution first. Where there is threat of irreversible damage and when the factual basis is inadequate or uncertain, the precautionary principle shall apply.

8. Continuous learning and improvement. Favorable conditions shall be created for continuous learning and improvement in the work with environment management at the national, regional and local level.

9. Right to information and participation. The citizens have a right to information about status of the environment as well as the right to participate in decisions affecting their environment. They also have the right to actively participate in protecting the environment.

10. Environmental protection complements development. Environmental protection efforts shall not be portrayed as competing with the development needs and aspirations of the present people. Healthy debate about values as they relate to ecological and social sustainability shall be encouraged.

More importantly, NEAP III consists of the following six strategic results that shall be attained during the period 2009-2013:

- Resilient Islands,
- Rich Ecosystems,
- Healthy Communities,
- Safe Water,
- Environmental Stewardship, and
- Carbon Neutral Nation

The proponent is aware of NEAP III and is committed to work with the 10 guiding policies and towards achieving the strategic results of NEAP III.

3.5.2 Waste Management Policy

The aim of the waste management policy is to formulate and implement guidelines and means for solid waste management in order to maintain a healthy environment. Accordingly, the key elements of the policy include:

- Ensure safe disposal of solid waste and encourage recycling and reduction of waste generated;
- Develop guidelines on waste management and disposal and advocate to enforce such guidelines through inter-sectoral collaboration;
- Ensure safe disposal of chemical, hazardous and industrial waste.
3.6 “Aneh Dhivehi Raaje” The Strategic Action Plan 2009 – 2013

The Strategic Action Plan 2009 - 2013 (SAP) of the Government of Maldives sets out the agenda for environmental protection and management as one of the key area. SAP provides the basis for environmental planning, budgeting, performance measurement and accountability. The new policy focus is to ensure sustainable adaptation measures and is developed on the view that ability to adapt to environmental degradation is fundamentally linked to good governance and careful planning.

Strategic Action Plan provides the following policies to be addressed for the attainment of proper environmental management.

1. Strengthen EIA process with an emphasis on EIA Monitoring
2. Conserve and sustainably use biological diversity and ensure maximum ecosystem benefits.
3. Develop resilient communities addressing impacts of climate change, disaster mitigation and coastal protection
4. Strengthen adaptation and mitigation responses for beach erosion and develop a system to assist communities where livelihood and property are affected by beach erosion
5. Ensure management of solid waste to prevent impact on human health and environment through approaches that are economically viable and locally appropriate.
6. Ensure protection of people and the environment from hazardous waste and chemicals
7. Improve air quality to safeguard human health.
8. Enable a fully functional decentralized environmental governance system.
9. Develop a low carbon economy to achieve carbon neutrality by 2020
10. Inculcate environmental values in the society and enable environment friendly life style.

More importantly, Strategic Action Plan highlights and indicates other directive documents that were adopted by the government. Key documents that were highlighted are;

- National Solid Waste Management Policy
- Third National Environment Action Plan (NEAP III)
- Maldives National Strategy for Sustainable Development
- Environment Impact Assessment Regulations
First National Communication to the United Nations Framework Convention on Climate Change

The proponent is aware of Strategic Action Plan 2009 – 2013 and is committed to work with the 10 guiding policies and towards achieving the strategic results of Strategic Action Plan.

3.7 International Conventions

3.7.1 Convention on Biological Diversity

The Maldives is a party to the United Nations Convention on Biological Diversity. The objective of the convention is “the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding”. The proposed development activities outlined in this project does not fall on any area recognised for its ecological value. Therefore it is unlikely there will be a major loss of biodiversity. The loss is not going to be significant at atoll or national level. Yet, it is recommended that the developer ensures that silt screens are used during dredging works, construction of the jetty and breakwaters to minimise any impact on the marine biodiversity.

3.7.2 International Plant Protection Convention

The Maldives has become a party to the International Plant Protection Convention (IPPC) as a step to protecting native plant species in the Maldives from the risk of diseases introduced by imported plant varieties. The Maldives adhered to the IPPC on 3 October 2006 and the Convention requires that certificates of phytosanitary condition and origin of consignments of plants and plant products be used for import and export of plants and plant materials. Contracting parties have the full authority to regulate entry of plants and plant products and may prescribe restrictions on imports or prohibit importation of particular plants or plant products. Thus it is advisable that the proponent be aware of the requirements of IPPC and obtains the necessary phytosanitary certificates if any plants are to be imported to stabilise the beach or for landscaping.

3.7.3 UNFCCC and Kyoto Protocol

The Maldives is a party to the United Nations Framework Convention on Climate Change and the Kyoto Protocol to the UNFCCC. The objective of the Convention is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic
interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The IPCC defines mitigation “as an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.” The greenhouse gas inventory of the Maldives forms an integral part of the First National Communication of the Maldives to the UNFCCC. In March 2009, the President of the Maldives has announced the target to make Maldives carbon neutral by 2020. Hence, in the implementation of the project, careful attention needs to be given to ensure energy efficiency and reduce transport related fuel consumption. Furthermore, planting of beach vegetation would help in mitigation of greenhouse gas emissions from the project.

The IPCC defines adaptation “as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects.” Various type of adaptation include anticipatory and reactive adaptation; private and public adaptation; and autonomous and planned adaptation. The adaptation policies and strategies of the Maldives are given in the Maldives National Adaptation Programme of Action (NAPA).
4 EXISTING ENVIRONMENT

4.1 Study Methodologies

Baseline environment of the study area were analysed by using standard scientific methods. Particular attention was placed in detailed surveys on the marine environment life, as this component is likely to involve the most significant environmental impacts. The different methods used in assessing and presenting the conditions of the existing environment of the island are given in the following subsections.

4.1.1 Study Area and Survey Locations

Details of the study areas area and survey locations, including map coordinates, are presented in Appendix B. A reduced map is presented in Figure 4.1.

4.1.2 Marine Water Quality

One of the main environmental components that would be affected by implementing the project would be marine water quality. Water quality was assessed from MWSC laboratory. Water quality was assessed at three different locations. Parameters measured include temperature, pH, salinity, turbidity, sedimentation rate, phosphate, nitrate, ammonia, and sulphate, Biological oxygen demand (BOD) and chemical oxygen demand (COD). Samples were collected in clean 1.5L PET bottles and 750ml glass bottles after washing them with the water to be sampled. Water samples were collected at mid depth.

4.1.3 Marine Assessments

4.1.3.1 Manta tow survey

Manta tow survey was conducted to determine the general benthic cover and reef condition along the study area. A snorkeler (observer) was towed behind a slow moving boat, along the reef edge for a series of set periods of 2 minutes. At each stop the observer noted down the estimated percentage cover of Live Corals, Dead Corals, Dead Corals, Sand/Silt and Rubble along the tow area. The GPS coordinates were recorded at the start and end of each new tow.

4.1.3.2 Photo quadrat survey

A quadrat of 0.5m$^2$ was placed at points on every 05 meters along a 50 m transect on a random basis. The quadrats were photographed and analysed using Coral Point Cover software which is a Microsoft excel based program used to determine coral species and percentage of coral cover.
4.1.3.3 **Timed swim**

Timed swim carried out at two locations, to qualitatively determine the benthic substrate composition at these locations. Swims were timed at 5 minutes, during which two observers swam across the site noting down the main benthic substrates, seagrass and coral species observed. Three replicate swims were made at each site.

4.1.3.4 **Fish census**

Fish census was carried at each line transect survey location. All fishes observed along 50 m belt transect at each site was recorded and their abundance recorded as follows: Single (1), Few (2-10), Many (11-100) and Abundant (>100).
Figure 4-1: Survey locations Map
4.2 Physical Environment

4.2.1 Meteorology

4.2.1.1 Climate

The climate in Maldives is warm and humid, typical of the tropics. The average temperature ranges between 25°C to 30°C and relative humidity varies from 73 percent to 85 percent. The annual average rainfall is approximately 1,948mm. As Maldives lies on the equator, Maldives receives plenty of sunshine throughout the year. Significant variation is observed in the climate between the northern and the southern atolls. The annual average rainfall in the southern atolls is higher than the northern atolls. In addition, greater extremes of temperature are also recorded in the southern atolls. On average southern atolls receive 2704 hours of sunshine each year. Table 4.1 provides a summary of key meteorological findings for Maldives. The nearest meteorological station is National Meteorological Centre on Hulhule’ Island. This study uses National Metrological Centre due to more comprehensive data.

Table 4.1 Key Meteorological Information of the Maldives

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Rainfall</td>
<td>9.1mm/day in May, November; 1.1mm/day in February</td>
</tr>
<tr>
<td>Maximum Rainfall</td>
<td>184.5 mm/day in October 1994</td>
</tr>
<tr>
<td>Average air temperature</td>
<td>30.0 C in November 1973; 31.7 C in April</td>
</tr>
<tr>
<td>Extreme Air Temperature</td>
<td>34.1 C in April 1973; 17.2 C in April 1978</td>
</tr>
<tr>
<td>Average wind speed</td>
<td>3.7 m/s in March; 5.7 m/s in January, June</td>
</tr>
<tr>
<td>Maximum wind speed</td>
<td>W 31.9 m/s in November 1978</td>
</tr>
<tr>
<td>Average air pressure</td>
<td>1012 mb in December; 1010 mb in April</td>
</tr>
</tbody>
</table>

4.2.1.2 Monsoons

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

The winds that occur across Maldives are mostly determined by the monsoon seasons. The two monsoons are considered mild given that Maldives is located close to the equator. As a result, strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to July. During stormy conditions gusts of up to 60 knots have been recorded at Male’.

Wind has been uniform in speed and direction over the past twenty-plus monsoon seasons in the Maldives (Naseer, 2003). Wind speed is usually higher in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms\(^{-1}\) for the period 1975 to 2001. Mean wind speed as highest during the months May and October in the central region. Wind analysis indicates that the monsoon is considerably stronger in central and northern region of Maldives compared to the south (Naseer, 2003).

Besides the annual monsoonal wind variations there are occasional tropical climatic disturbances (tropical storms or low intensity tropical cyclones) in the central region which increases wind speeds up to 110 km/h, precipitation to 30 to 40 cm over a 24 hour period and storm surges up to 3 m in open ocean (UNDP, 2006).

Table 4.2 summarises the wind conditions in central Maldives throughout a year. Medium term meteorological data from Hulhule Meteorological Centre (see Figure 4.2, Figure 4.3 and Figure 4.4) and findings from long-term Comprehensive Ocean-Atmosphere Data Set (COADS) are used in this analysis.

<table>
<thead>
<tr>
<th>Season</th>
<th>Month</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE - Monsoon</td>
<td>December</td>
<td>Predominantly from NW-NE.</td>
</tr>
<tr>
<td></td>
<td>January</td>
<td>High Speeds from W</td>
</tr>
<tr>
<td></td>
<td>February</td>
<td></td>
</tr>
<tr>
<td>Transition Period 1</td>
<td>March</td>
<td>From all directions. Mainly W; High Speeds from W.</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td></td>
</tr>
<tr>
<td>SW - Monsoon</td>
<td>May</td>
<td>Mainly from W.</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>High Speeds from W</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td></td>
</tr>
<tr>
<td></td>
<td>August</td>
<td></td>
</tr>
<tr>
<td></td>
<td>September</td>
<td></td>
</tr>
<tr>
<td>Transition Period 2</td>
<td>October</td>
<td>Mainly from W.</td>
</tr>
<tr>
<td></td>
<td>November</td>
<td>High Speeds from W</td>
</tr>
</tbody>
</table>
Figure 4-2 Monthly Frequencies of Wind Direction in Central Maldives based on National Meteorological Center 10 year Data (adapted from Naseer, 2003).

Figure 4-3.24 Year Wind Frequency Recorded at National Meteorological Center.
The Disaster Risk Profile of Maldives (UNDP, 2006) reports 11 cyclonic events over the Maldives in the last 128 years and only one event over the central Maldives. All of these events were of category 1 cyclones. There have been no cyclonic events since 1993.

### 4.2.1.4 Rainfall

The average annual rainfall for the archipelago is 2,124mm. There are regional variations in average annual rainfall: southern atolls receive approximately 2,280 mm and northern atolls receive approximately 1,790 mm annually (MEC, 2004). Mean monthly rainfall also varies substantially throughout the year with the dry season getting considerably less rainfall. This pattern is less prominent in the southern half, however. The proportions of flood and drought years are relatively small throughout the archipelago, and the southern half is less prone to drought (UNDP, 2006).

The mean annual rainfall in Hulhule’ is 1991.5 mm with a Standard Deviation of 316.4 mm and the mean monthly rainfall is 191.6 mm. Rainfall varies throughout the year with mean highest rainfall during October, December and May and lowest between February and April (See Figure 4.5).
Analysis of daily maximum annual rainfall data shows high variability; including extremes (see Figure 4.6 below). However, no significant long term trends are evident in the Hulhule data.
The probable maximum precipitations predicted for Hulhule’ by UNDP (2006) are shown in Table 4.3.

<table>
<thead>
<tr>
<th>Station</th>
<th>Return Period</th>
<th>50 year</th>
<th>100 year</th>
<th>200 year</th>
<th>500 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hulhule’</td>
<td>50 year</td>
<td>187.4</td>
<td>203.6</td>
<td>219.8</td>
<td>241.1</td>
</tr>
</tbody>
</table>

Source (UNDP, 2006)

### 4.2.1.5 Temperature

Daily temperatures of Maldives vary little throughout the year with a mean annual temperature of 28°C. The annual mean maximum temperature recorded for Male’ during the period 1967-1995 was 30.4°C and the annual mean minimum temperature for the same period was 25.7°C. The highest recorded temperature for Male’ was 34.1°C on 16th and 28th of April 1973. The hottest month recorded was April 1975 with a maximum monthly average temperature of 32.7°C, the next highest being 32.6°C in April 1998. The lowest minimum average temperature of 23.7°C was recorded in July 1992.

There is considerable inter annual variability in extreme temperatures for Hulhule as shown in Figure 4.7. A maximum temperature of at least 33.5°C is rare at Hulhule and has a return period of 20 years (Hay, 2006).

![Maximum Temperature by year in Hulhule’](image-url)
4.2.2 Hydrology

4.2.2.1 Waves

There are two major types of waves observed along the islands of Maldives. The first type is wave generated by local monsoon wind with a period of 3-8 seconds and the second type is swells generated by distance storms with a period of 14-20 seconds [Kench et. al (2006), DHI(1999), Binnie Black & Veatch (2000), Lanka Hydraulics (1988a & 1998b)]. The local monsoon predominantly generates wind waves which are typically strongest during April-July in the south-west monsoon period. Wave data for Male and Hulhulé’ between June 1988 and January 1990 (Lanka Hydraulics 1988a & 1998b) shows that the maximum significant wave height (Hs) recorded for June was 1.23 m with a mean period (Tm) of 7.53s. The maximum recorded Hs for July was 1.51 m with a Tm of 7.74s. The mean wave periods were 5.0 – 9.0s and the peak wave periods were within 8.0 – 13.0s.

Maldives experiences occasional flooding caused by long distance swell waves that are generated by South Indian Ocean storms (Goda 1988). The swell waves of height 3 meters that flooded Male’ and Hulhulé’ in 1987 are said to have originated from a low pressure system off west coast of Australia (refer the next section for more detail). In addition, Maldives have recently been subject to earthquake generated tsunami reaching heights of 4.0m on land (UNEP, 2005). Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than 1 occasion, most notable has been the 1883 tsunami resulting from the volcanic explosion of Karakatoa (Choi et al., 2003).

Being located on the eastern rim of the eastern line of atolls in Maldives, the eastern side to the Hulhumale’Island reef system is exposed to NE monsoon wind waves. The eastern side of the reef system is generally protected from wind generated waves during SW monsoon but can be exposed to NE monsoon wind waves when the wind blows directly from N to NE.

4.2.2.2 Swell Waves and Storm Surges

Waves studies around Maldives have identified the presence of swell waves approaching predominantly from a southwest to a southerly direction Kenchet. al (2006), Young (1999), DHI(1999), Binnie Black & Veatch (2000) and Naseer (2003).

As noted before, being located on the eastern rim of Male ‘Atoll, Hulhumale’ Reef system is exposed to long distance swell waves from the SE. The timing of the long distance swell waves are associated with the South Indian Ocean storm activity Young (1999). Waves generated from abnormal events could also travel against the predominant swell propagation patterns (Goda, 1998), causing flooding on the eastern and southern islands of Maldives (UNDP, 2009).
4.2.2.3 Tidal Pattern

Water levels at the site vary mainly in response to tides, storm surge or tsunamis. Tides in the Maldives are mixed and semi-diurnal/diurnal. Tidal variations are referred to the standard station in at Hulhulé Island. Typical spring and neap tidal ranges are approximately 1.0m and 0.3m, respectively (MEC, 2004). Maximum spring tidal range in Hulhulé is approximately 1.1m. There is also a 0.2m seasonal fluctuation in regional mean sea level, with an increase of about 0.1m during February to April and a decrease of 0.1m during September to November. Table 4.4 summarizes the tidal elevations reported at Hulhulé, which is representative of tidal conditions at the project site.

<table>
<thead>
<tr>
<th>Tide Level</th>
<th>Referred to Mean Sea level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Astronomical Tide (HAT)</td>
<td>+0.64</td>
</tr>
<tr>
<td>Mean Higher High Water (MHHW)</td>
<td>+0.34</td>
</tr>
<tr>
<td>Mean Lower High Water (MLHW)</td>
<td>+0.14</td>
</tr>
<tr>
<td>Mean Sea Level (MSL)</td>
<td>0.00</td>
</tr>
<tr>
<td>Mean Higher Low Water (MHLW)</td>
<td>-0.16</td>
</tr>
<tr>
<td>Mean Lower Low Water (MHLW)</td>
<td>-0.36</td>
</tr>
<tr>
<td>Lowest Astronomical Tide (LAT)</td>
<td>-0.56</td>
</tr>
</tbody>
</table>

The predicted tide curve for the period for the month of February and March at Hulhule Tide Gauge is presented in Figure 4.8 and 4.9 below. The data corresponds to the main survey period of the project. The largest measured tide during the short monitoring period had a range of about 1.05 m.

Figure 4-8 Predicted tides for February 2012, based on data from Department of Meteorology, Maldives
4.2.2.4 Currents

Currents that affect the reef system of Hulhumale Island be caused by tidal currents, wind-induced currents and wave-induced currents. It is presumed that generally current flow through the country is defined by the two-monsoon season winds. Westward flowing currents are dominant from January to March with the change in current flow pattern taking place in April and December (Kench et. al, 2006). In April the westward currents become weak while the eastward currents start to take over. In December the eastward currents are weak with the westward currents becoming more prominent. Hence, currents within the site are very likely to be heavily influenced by the monsoons.

Current measurements were undertaken on the island during field visits (28\textsuperscript{Th} February) during day time high tide.

<table>
<thead>
<tr>
<th>Site</th>
<th>Currents m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1 (C1)</td>
<td>0.1</td>
</tr>
<tr>
<td>Site 2 (C2)</td>
<td>0.15</td>
</tr>
<tr>
<td>Site 3 (C3)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Localised measurements during the survey showed a westerly flow during the NE monsoon. Details of the findings are summarised in table 4.5. The corresponding locations of the current sites are given in figure 4.1. In general, the survey period witnessed slow moving currents.
between 0.15 m/s to 0.3 m/s. The strongest currents were observed on the close to the channel. This was the result of wave setup towards the rim. The SW monsoon currents could not be measured due to time limits for the EIA. However, it is estimated that there would generally be a westerly flow for 8 months of SW monsoon.

Generally, long term studies are required to establish the prevailing site specific current patterns. However, due to time limitations of the present study a snapshot assessment was undertaken using drogue technique.

**4.2.2.5 Marine water quality**

The main objective of the marine water sampling and testing was to determine baseline water quality conditions. The data is used to establish "action levels" for determination of whether the proposed development may have an adverse effect on marine water quality of the site.

Tests were conducted to determine the quantity of following parameters present in the samples; physical appearance, pH, temperature, salinity, turbidity, nitrate, nitrogen ammonia, phosphate, sulphate Chemical Oxygen Demand and Biological Oxygen Demand.

**Table 4-6: Results of water quality results**

<table>
<thead>
<tr>
<th>Parameter Tested</th>
<th>Optimal Range (EPA)</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Site 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Appearance</td>
<td>-</td>
<td>Clear</td>
<td>Clear</td>
<td>Clear</td>
<td>Clear</td>
<td>clear</td>
</tr>
<tr>
<td>pH</td>
<td>8.0 – 8.3</td>
<td>8.20</td>
<td>8.24</td>
<td>8.22</td>
<td>8.27</td>
<td>8.28</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>18 - 32</td>
<td>24.9</td>
<td>25.0</td>
<td>25.5</td>
<td>25.2</td>
<td>25.6</td>
</tr>
<tr>
<td>Salinity (‰)</td>
<td>3.2% – 4.2%</td>
<td>34.66</td>
<td>35.22</td>
<td>34.70</td>
<td>35.19</td>
<td>34.43</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>3 - 5</td>
<td>0.167</td>
<td>0.108</td>
<td>0.179</td>
<td>0.12</td>
<td>0.124</td>
</tr>
<tr>
<td>Nitrate (mg/l)</td>
<td>&lt; 5</td>
<td>3.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Nitrogen Ammonia (mg/l)</td>
<td>Max 2 - 3</td>
<td>0.10</td>
<td>0.1</td>
<td>0.06</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>Phosphate (mg/l)</td>
<td>0.005 – 0.020</td>
<td>0.05</td>
<td>0.04</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Sulphate (mg/l)</td>
<td>2 and 80</td>
<td>2600</td>
<td>2600</td>
<td>2800</td>
<td>2800</td>
<td>2700</td>
</tr>
<tr>
<td>Biological Oxygen Demand (mg/l)</td>
<td>&lt; 2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (mg/l)</td>
<td>&lt; 20</td>
<td>74.5</td>
<td>71.9</td>
<td>76.3</td>
<td>71.9</td>
<td>70.9</td>
</tr>
</tbody>
</table>

pH level is within the recommended optimal range by EPA. pH ranges between 8.20 – 8.32. The average Sulphate level ranges between 2000 mg/L – 2500 mg/L which is within the normal seawater sulphate content of seawater. Biological Oxygen Demand of all the water samples is 1 which is an acceptable level given the EPA ranges.(< 2 mg/L). The COD level is way higher than the optimal range and this denotes the level of organic nutrients in the water as COD is the amount of oxygen required for oxidation of organic nutrients to inorganic forms.
4.3 Biological Environment

4.3.1 Introduction

The aim of this assessment is to establish the baseline condition at proposed project location of Hulhumale’ Island. Assessments were carried out on 28th February 2013. The weather during the assessments was sunny with calm seas.

Main objective of this survey was to determine the benthic substrate composition and fish fauna present at the project location.

4.3.2 Manta Tow Survey

Manta tow survey was conducted to determine the general benthic cover and reef condition of the study area. Weather during the survey was cloudy and the sea was rough. Tow was conducted along the reef edge; depth varied between 2 – 3 m, the reef slope appears generally steep.

Table 4.7 summarizes the results of manta tow survey; the numerical values in the table for each substrate category refer to percentage estimate benthic cover: 1 = 0-10%, 2 = 11-30%, 3 = 31-50%, 4 = 51-75% and 5 = 76-100%.

Table 4-7: Summary of Manta tow survey (10th February 2013)

<table>
<thead>
<tr>
<th>Tow number</th>
<th>Live corals</th>
<th>Dead Corals</th>
<th>Rocky basement</th>
<th>Sand/Slit</th>
<th>Rubble</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>Gentle slope, highly turbid with garbage</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>Gentle slope, High sedimentation</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Gentle slope, High sedimentation</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>Gradual slope, COT observed</td>
</tr>
</tbody>
</table>

Benthic composition is very similar across all the tows. Along the reef edge benthic substrate is dominated by rocky basement (40 – 60%); dominant coral family observed was Acroporidae. Dead coral cover is approximately between 25-50% and sand made up approximately 10-20% of the area. High turbidity and sedimentation was observed along the reef. Reef condition is poor due to the prolonged reclamation activities during Hulhumale’ reclamation.
Figure 4-10: Photos showing benthic cover at each tow
4.3.3 Photo quadrat

4.3.3.1 Site 1

The mean water depth along the line transects deployed at this site was 3 m. Dominant benthic substrate recorded at this site was rocky basement (upto 85%), live coral (1%) and rubble (5%). Main coral families observed were; Acroporidae (Acroproa sp Poritidae (Porites sp) and Pocilloporidae). Mean Sand/Rock/Rubble cover was approximately 94%. Algae cover very high (25%). Figure 4.13 summarizes the mean benthic substrate composition at site 1.

![Photos showing the benthic cover at site 1](image)

*Figure 4-11: Photos showing the benthic cover at site 1*
4.3.3.2 Site 2

The mean water depth along the line transects deployed at this site was 3-4 m. Dominant benthic substrate recorded at this site was rocky basement (upto 76%). live coral (1%) and rubble (8%). Mean live coral coverage along the two transect surveys done at this site was approximately 30%. Main coral families observed belong to Pocilloporidae. Mean Sand/Rock/Rubble cover was approximately 94%. The following figure summarizes the mean benthic substrate composition at site 2.
4.3.4 Fish census

4.3.4.1 Site 1

7 fish families were recorded at site 1, highest number of fishes were observed from family Acanthuridae (5 species) and Pomacentrida (4 species). In addition few pin-cushion sea stars were observed at the site. Table 4.8 presents the results of the fish census.

The following table shows the list of Fish species identified along the transect site.

Table 4.8: Results of fish census - Site 1

<table>
<thead>
<tr>
<th>Family</th>
<th>Scientific name</th>
<th>Common Name</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOLOCENTRIDAE</td>
<td>Sargocentron caudimaculatum</td>
<td>White-tail Squirrelfish</td>
<td>F</td>
</tr>
<tr>
<td>CHAETODONTIDAE</td>
<td>Chaetodon trisfasciatus</td>
<td>Pinstriped Butterflyfish</td>
<td>F</td>
</tr>
</tbody>
</table>
### 4.3.4.2 Site 2

Six fish families were recorded at site 2, highest number of species was recorded from the Acanthuridae family (3 species) and Pomacentridae (3 species). Table 4.9 summarizes fish census done at site 2. Fish life was poor at the site as live coral cover is significantly low.

The following table shows the list of Fish species identified along the transect site.

*Abundance codes: S = Single, F = Few, M = Moderate, A = Abundant

**IUCN Red List Status codes: LC = Least Concern, NT = Near Threatened, NE = Not Evaluated, DD = Data Deficient

<table>
<thead>
<tr>
<th>Family</th>
<th>Scientific name</th>
<th>Common Name</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chaetodontidae</td>
<td>Chaetodon trsifasciatus</td>
<td>Pinstriped Butterflyfish</td>
<td>F</td>
</tr>
<tr>
<td>Chaetodontidae</td>
<td>Chaetodon fulca</td>
<td>Double saddle butterfly fish</td>
<td>F</td>
</tr>
<tr>
<td>Pomacanthidae</td>
<td>Apolomichthys trimaculatus</td>
<td>Three-spot Angelfish</td>
<td>F</td>
</tr>
<tr>
<td>Pomacentridae</td>
<td>Chromis viridis</td>
<td>Green Puller</td>
<td>M</td>
</tr>
<tr>
<td>Pomacentridae</td>
<td>Abudefduf vaigiensis</td>
<td>Seargent major</td>
<td>F</td>
</tr>
<tr>
<td>Pomacentridae</td>
<td>Plectroglyphidodon lacrymatus</td>
<td>Jewel Damsel</td>
<td>F</td>
</tr>
<tr>
<td>Scaridae</td>
<td>Scarus sordidus</td>
<td>Shabby Parrotfish</td>
<td>F</td>
</tr>
<tr>
<td>Pomacanthidae</td>
<td>Apolomichthys trimaculatus</td>
<td>Three-spot Angelfish</td>
<td>F</td>
</tr>
<tr>
<td>Pomacentridae</td>
<td>Chromis viridis</td>
<td>Green Puller</td>
<td>M</td>
</tr>
<tr>
<td>Pomacentridae</td>
<td>Abudefduf vaigiensis</td>
<td>Seargent major</td>
<td>F</td>
</tr>
<tr>
<td>Pomacentridae</td>
<td>Plectroglyphidodon lacrymatus</td>
<td>Jewel Damsel</td>
<td>F</td>
</tr>
<tr>
<td>Scaridae</td>
<td>Scarus sordidus</td>
<td>Shabby Parrotfish</td>
<td>F</td>
</tr>
<tr>
<td>Scaridae</td>
<td>Cetoscarus bicolor</td>
<td>Two-colour Parrotfish</td>
<td>F</td>
</tr>
<tr>
<td>Scaridae</td>
<td>Ctenchaetus striatus</td>
<td>Fine-lined Bristletooth</td>
<td>F</td>
</tr>
<tr>
<td>Acanthuridae</td>
<td>Ctenchaetus truncatus</td>
<td>Gold ring Bristletooth</td>
<td>F</td>
</tr>
<tr>
<td>Acanthuridae</td>
<td>Acanthurus leucosternin</td>
<td>Powder blue surgeon fish</td>
<td>F</td>
</tr>
<tr>
<td>Acanthuridae</td>
<td>Acanthus pectoralis</td>
<td>Fine-lined Bristletooth</td>
<td>F</td>
</tr>
<tr>
<td>Acanthuridae</td>
<td>Acanthus leucosternin</td>
<td>Powder-blue Surgeonfish</td>
<td>F</td>
</tr>
<tr>
<td>Acanthuridae</td>
<td>Ctenchaetus striatus</td>
<td>Fine-lined Bristletooth</td>
<td>F</td>
</tr>
<tr>
<td>Acanthuridae</td>
<td>Zebrazosoma scopas</td>
<td>Brown Tang</td>
<td>F</td>
</tr>
<tr>
<td>Balistidae</td>
<td>Balistapus undulatus</td>
<td>Spotted hawkfish</td>
<td>F</td>
</tr>
<tr>
<td>Balistidae</td>
<td>Balistapus undulatus</td>
<td>Spotted hawkfish</td>
<td>F</td>
</tr>
</tbody>
</table>
4.3.4.3 Timed swim

Time swim at the inner reef edge towards lagoon shows high level of sedimentation and algal growth as shown in the following pictures. There were no live corals at the site. However rubble and rocky basement dominates the area.

![Figure 4-15: Benthic setting at the reef edge towards lagoon](image)

At the project site the Benthic cover of this site is dominated by fine white sand as shown in the following photographs. There were no live corals. Small amount of rubble was found. The site shows high sedimentation and the bottom was soft muddy texture

![Figure 4-16: Benthic setting at the project site (lagoon 11-12m depth)](image)

4.3.5 Marine protected areas and sensitive sites

There are ten marine protected areas in Kaafu atoll. They are:

- Boduhithi Thila
- Madivaru

*Abundance codes: S = Single, F = Few, M = Moderate, A = Abundant

**IUCN Red List Status codes: LC = Least Concern, NT = Near Threatened, NE = Not Evaluated*
- Kudakodhipparu Finolhu
- Maagiri Reef
- Okobe Thila
- Huraagandu
- Lhoifushi Beyrukandu
- Thulusdhoobeyrukandu
- Nerukonunufagandu
- Meeru corner
- Gaavimas Faru
- Kuda Thila
- Vellassaru corner
- Vaadhoo channel
- Emboodhoo Canyon
5 IMPACTS IDENTIFICATION

5.1 Introduction

Potential adverse and beneficial impacts of operation stage of the fish processing facility are identified and evaluated in this section. Significant impacts are identified and evaluated in two stages. The first stage identifies the environmental and socio-economic components that may be impacted from key project activities. The second stage determines the significance of impacts on each component. The following sections provide details of the evaluation of impacts.

5.2 Nature of potential impacts on key components

Nature of potential impacts is defined here as no impact, adverse impact or beneficial impact. Table 5.1 below provides the nature of potential impacts from the proposed project on environmental and socio-economic components by the project. Where impacts are not applicable to different components, this is indicated as ‘na’. Some components may be affected both adversely and beneficially from the project.

5.3 Identification of significant impacts

Environmental and socio-economic components that may be impacted by the project as identified in Table 5.1 are further evaluated to identify significant impacts. Assessments of the impacts are conducted using the four criteria of magnitude, reversibility, duration and distribution as described below. Evaluation of key impacts is provided in Table 5.2.

1. **Magnitude**: Refers to the quantum of change that will be experienced as a consequence of the impact.

2. **Reversibility**: Refers to the degree of reversibility of an impact (i.e. ease of reversing the conditions).

3. **Duration**: Refers to the temporal scale (i.e. duration, frequency) of the impact. It does not take into account the duration of the impact’s effects.

4. **Distribution**: Refers to the spatial scale of the area impacted (e.g. a small portion of a reef or an entire lagoon)

Estimates for negative impacts represent a ‘worst case scenario’ based on the assumption that the project will undergo full scale development with no consideration for its environmental and social consequences, i.e. significance is assessed prior to implementation of mitigation measures. Values are attributed by the EIA team on the basis of direct observation of surveyed sites, professional judgment and pre-existing experience in development projects of similar nature.
### Table 5-1 Impact Identification Matrix

<table>
<thead>
<tr>
<th>Activity</th>
<th>Noise Level</th>
<th>Air Quality</th>
<th>GHG emissions</th>
<th>Marine environment</th>
<th>Marine Flora</th>
<th>Marine fauna</th>
<th>Protected species</th>
<th>Natural hazard risk &amp; safety</th>
<th>Health and safety</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation Stage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation of the Ice plant</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>+</td>
</tr>
<tr>
<td>Operation of desalination plant (brine)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>+</td>
</tr>
<tr>
<td>Refrigeration and other utility services</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>+</td>
</tr>
<tr>
<td>Fish processing (filleting and storing)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>+</td>
</tr>
<tr>
<td>Packaging</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>+</td>
</tr>
<tr>
<td>Transportation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>+</td>
</tr>
<tr>
<td>Staff accommodation and food</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>+</td>
</tr>
</tbody>
</table>

X (no impact), - (negative impact) + (positive impact)
### Table 5-2 Evaluation of key impacts on the natural environment during construction and operation stage

<table>
<thead>
<tr>
<th>Impact area</th>
<th>Potential impacts</th>
<th>Nature/Distribution/Duration/Magnitude</th>
<th>Reversibility</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction stage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient noise level</td>
<td><strong>Noise pollution:</strong> Operation of plants and machineries required for fish processing. However these will not be operated continuously for a long period of time.</td>
<td>Direct/negative; 200 m radius; Project site; Shore term; Minor negative change</td>
<td>Easily reversible</td>
<td>Insignificant - Limited hours of operation.</td>
</tr>
<tr>
<td>Ambient air quality</td>
<td><strong>Air quality degradation:</strong> low level of air pollution with emissions during the operation of machinery.</td>
<td>Direct/negative; 200 m radius; Short term; No change;</td>
<td>Easily reversible, negligible effects</td>
<td>Insignificant - Negligible level of emissions over a short time period.</td>
</tr>
<tr>
<td>GHG emissions</td>
<td><strong>Increase in GHG gas in atmosphere:</strong> due to operation plants and gen sets</td>
<td>Direct/negative; Island level; Short term; No change;</td>
<td>Easily reversible</td>
<td>Insignificant - low levels of GHGs is anticipated to be released.</td>
</tr>
</tbody>
</table>
**EIA for the establishment of a Fish Processing Facility at Hulhumale Island harbour, Kaafu Atoll**

<table>
<thead>
<tr>
<th>Impact area</th>
<th>Potential impacts</th>
<th>Nature/Distribution/Duration/Magnitude</th>
<th>Reversibility</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employment</strong></td>
<td>Increase in employment opportunities; 15 workers will be employed for the construction work.</td>
<td>Direct/positive; Island level; Short term; Moderate positive change</td>
<td>NA</td>
<td>Minor - Long term employment opportunity</td>
</tr>
<tr>
<td><strong>Waste Management</strong></td>
<td>Increase in domestic waste and sewerage waste</td>
<td>Direct/positive; National level; Short term; Moderate</td>
<td>Reversible</td>
<td>Insignificant as waste generated by the facility is not much and the waste management facility has the capacity.</td>
</tr>
<tr>
<td><strong>Marine Environment</strong></td>
<td>Increase in brine outfall: Brine outfall is expected to increase with more production. Increase in sewage outfall: increased sewage and waste water may lead to eutrophication.</td>
<td>Direct/indirect/negative; 100 m radius around brine outfall and 300m sewage outfall</td>
<td>Reversible once production stops</td>
<td>Highly Significant</td>
</tr>
<tr>
<td>Impact area</td>
<td>Potential impacts</td>
<td>Nature/Distribution/Duration/Magnitude</td>
<td>Reversibility</td>
<td>Significance</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------</td>
<td>----------------------------------------</td>
<td>---------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>Significant negative change.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*EIA for the establishment of a Fish Processing Facility at Hulhumale Island harbour, Kaafu Atoll*
6 SIGNIFICANT IMPACTS AND MITIGATION MEASURES

6.1 Impact on Marine environment

The most significant impact on the marine environment is caused by the release of brine, sewage and waste water to the lagoon environment. Currently the sewage water and other waste water is collected in a common tank, grinded and then released to the lagoon environment during night hours.

Increase in organic matter in the lagoon leads to eutrophication leading to algal bloom and oxygen deficiency to marine life including corals. However the 12m depth of the lagoon and high currents reduces the accumulation of organic matter. The water test results from the area show high Chemical Oxygen demand denoting the high organic matter in the water.

The harbour area at any given time is used by more than 20 safari boats for maintenance or docked for tourist off season. Given that the safari boats also have the same sewage and waste water mechanism the high organic matter in the harbour is a cumulative impact from all these vessels.

It would be desirable if the HDC provides proper sewage and waste water disposal mechanism at the harbour for a fee. This could significantly improve the environmental conditions of the site.

Mitigation Measures

The following mitigation measures will help minimize the impacts:

- The sewage and waste water could be expelled at high tide during night hours
- Instead of daily disposal it could be collected and disposed in high tides with strong current condition

6.2 Impact on Aesthetic quality of the area

As many vessels are docked at the harbour the sewage and waste water disposal is carried out in a significant quantity leading to pollution. However the deep lagoon and high currents help mitigate the pollution by preventing the accumulation of organic wastes. To minimise these impacts in the long term the HDC needs to provide safe disposal facilities at the harbour.
6.3 Impact on Socioeconomic environment

The removal of sewage and waste water is done during night hours by all the vessels in the area. Due to high depth and high currents dispersal is relatively fast in Hulhumale’ harbour. Currently the ammonia levels in the area are very low with 0.06-0.1 mg/l denoting fast flow of water and dispersal. Therefore odour is not a concern at this site. However in the long-term with the addition on more safaris this might be an issue.

The HDC currently do not provide any utility services to the vessels in the harbour. It is maintained by the on-board facilities on the vessels. Therefore this project does not strain the existing facilities and resources of Hulhumale’. If docking space is considered currently there is huge area untouched and could be used. In addition with the proposed reclamation of phase 2 of Hulhumale’ the size will be increase double or three folds.
7 ALTERNATIVES

This chapter considers possible alternatives for relevant components of the project including the no project option.

7.1 ‘No Project’ Alternative

The option of a no project alternative has been considered for the establishment of the fish processing facility. The advantages and disadvantages of the No Project option are presented in Table 8.1.

Table 7-1 Pros and cons of ‘no project’ option

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Reduced organic waste disposal to marine environment</td>
<td>– Economic losses associated with less industrial activities</td>
</tr>
<tr>
<td>– Convenient for fisherman as they get ice from the same vessel fish catch is sold.</td>
<td>– High opportunity cost</td>
</tr>
<tr>
<td></td>
<td>– Growth of major economic industries hampered</td>
</tr>
</tbody>
</table>

7.2 Alternative sewage and waste water disposal methods

The vessel has separate outlets on the sides which could be used to transfer the sewage and waste water to another vessel that could be transported and disposed deep sea.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposal to the lagoon</td>
<td>– Reduced cost</td>
</tr>
<tr>
<td>Deep sea disposal away from islands</td>
<td>– No impact on marine environment of the docked harbour or lagoon</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Given the implications and cost of building a custom made vessel with sealed tanks and pump systems for deep sea disposal of waste water the current method of disposal is preferred. However the lagoon water needs to be monitored regularly and the deep sea disposal option need to be considered in case of severe degradation of marine water quality.

### 7.3 Alternative Site

As identified in the chapter 1 the site is chosen based on the ease of mooring with calm weathers and ease of unloading fish and loading ice for fisherman. Since 2002 the Ocean glory barge has been officially registered as a factory vessel but was anchored in the designated area since 2002.
8 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) is an important component of the EIA process, needed to determine the accuracy of impact prediction, the adequacy of mitigation measures, and level of compliance with commitments regarding implementation of mitigation measures and monitoring of relevant environmental aspects.

The main objectives of the environmental management plan are to:

- Produce a framework for managing anticipated impacts, including practicable and achievable performance requirements and systems for monitoring, reporting and implementing corrective actions.
- Provide evidence of compliance to legislation, policies, guidelines and requirements of relevant authorities.

8.1 Environmental management system

The environmental management framework for the proposed project is based on the standards and policies set out by the Environmental Protection Agency of the Maldives.

- Environmental Management Planning and establishment of key performance indicators: The EMP specifies environmental management measures and required performance standards
- Monitoring and corrective action: The implementation of EMP measures will be monitored. Any inconsistencies between the EMP and its on-site implementation will be identified and addressed through corrective actions
- Auditing, reviews and improvement: The EMP will be reviewed. Improvements to the EMP will be made as necessary to achieve desired environmental outcomes.

The environmental management strategy is demonstrated in the following figure.
8.2 Management structure and responsibilities

The following parties are involved in the EMP of this project:

- Project proponent
- Environmental consultant
- Environmental Protection Agency (EPA)

The roles and responsibilities of the parties involved are as follows.

8.2.1 Project proponent

- Execution of all project activities
- Preparation of EMP
Monitoring of the project activities
 Submission of annual environmental monitoring reports as required by the EPA

8.2.2 Environmental Consultant

 Preparation of EMP
 Monitoring of performance of project activities according to the EMP
 Auditing the EMP to ensure desired outcomes are achieved
 Making amendments to the EMP according to the results of the audits
 Preparation of environmental monitoring report as required by the EPA (detailed in Chapter 9 of this report)

8.2.3 Environmental Protection Agency

 Review environmental monitoring report
 Intervention in the event of a breach in environmental permit conditions

8.3 Reporting requirements

Reporting shall be undertaken to provide evidence of the ongoing implementation of the EMP and will cover any training activities, site conditions and operations, monitoring data, details of non-conformances, incidents, complaints and follow up action, results of audits and reviews. Reporting shall be undertaken by the project proponent and the Environmental Consultant.

The environmental reporting process is summarized in the figure below. All non-compliances and complaints during the execution of the project are to be reported to the EPA. The environmental management plan for execution of the project is provided below.
Environmental Management Plan for construction and operation phase

- Environmental Protection Agency
  - Issues raised from periodic review of project
  - Recording of complaints

- Project proponent
  - Training of personnel
  - Environmental monitoring
  - Recording of incidents
  - Recording of complaints and follow up actions
  - Review of EMP

- Environmental consultant
  - Training of personnel
  - Environmental monitoring audits
  - Review of EMP

- Preparation of draft environmental report
  - Submission of report

- Annual environmental monitoring report finalized

Prepared by: CDE Consulting
Table 8-1 Environmental Management Plan for construction and operation phase

<table>
<thead>
<tr>
<th>Activity</th>
<th>Management measures</th>
<th>Responsible party</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training of staff and contractors</td>
<td>All construction workers and project management staff will be provided information on general environmental issues, compliance with environmental permits and EMP. All staff involved with environmental monitoring will be provided training in environmental monitoring procedures.</td>
<td>Project proponent &amp; Environmental Consultant</td>
<td>Before commencement of construction activities</td>
</tr>
<tr>
<td>Documenting non-conformances and corrective actions</td>
<td>All non-conformances to the environmental permit conditions, observed during monitoring will be documented. Necessary corrective actions and preventative actions will be identified Corrective actions will be implemented, with systematic follow ups to ensure effectiveness of these measures</td>
<td>Project proponent &amp; Environmental consultant</td>
<td>Continuous during construction phase</td>
</tr>
<tr>
<td>Control of water contamination</td>
<td>Oil, solid waste and hazardous waste handled carefully and transported in sealed containers. All paints, lubricants, and other chemicals used on site stored in a secure and bunded location. General refuse stockpiled in one area. Construction activities carried out under the supervision of an experienced person.</td>
<td>Project proponent</td>
<td>Continuous during operational phase</td>
</tr>
<tr>
<td>Waste management</td>
<td>All waste segregated, stored temporarily and transferred to the existing waste management site. Agreements shall be made with</td>
<td>Project proponent</td>
<td>Continuous, throughout the</td>
</tr>
</tbody>
</table>
## Activity | Management measures | Responsible party | Timing
--- | --- | --- | ---
 | the waste management operators to handle commercial waste being generated from the facility. Otherwise a mechanism to transfer waste directly to Thilafushi must be identified. |  | project

Supervision of project activities | Assign suitably experienced and qualified personnel to supervise the entire project and ensure that all activities are carried out with minimal adverse impact on the environment | Project proponent | Throughout the project
9 ENVIRONMENTAL MONITORING PLAN

9.1 Introduction

While the negative environmental impacts of the project can be significantly minimised if proper mitigation measures are taken, as identified in Chapter 6, the potential for unforeseen impacts still exists. Furthermore, some of the predicted impacts may turn out to have greater significance than predicted, making the suggested mitigation measures ineffective. Therefore, frequent and regular monitoring of the relevant environmental aspects is a vital component of environment management. This chapter outlines the environmental monitoring plan for the proposed project.

9.2 Objectives of the Monitoring Plan

The main objectives of the monitoring plan are:

- To identify whether the predicted impacts are accurate and mitigation measures taken are effective
- To identify any unforeseen impacts so that appropriate mitigation measures can be taken at the earliest
- To identify and resolve any issues of social unrest at the earliest
- To eliminate or reduce environmental costs
9.3 Aspects of the Monitoring Plan

Table 9-1 below summarizes the key aspects of the monitoring plan. The Table indicates the methodology, frequency and estimated cost for each monitoring attribute that will be required for the proposed project.

Table 9-1 Aspects of the Monitoring Plan

<table>
<thead>
<tr>
<th>Monitoring Attribute</th>
<th>Indicator</th>
<th>Methodology</th>
<th>Frequency</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste monitoring</td>
<td>Waste generation levels</td>
<td>Waste census</td>
<td>Monthly; continuous</td>
<td>US$150 per survey</td>
</tr>
<tr>
<td></td>
<td>Oil leakage from machinery or vessels</td>
<td>Maintenance and tuning of all machinery &amp; vessels chemical analysis</td>
<td>Annually during operational phase. Monthly logs to be maintained Annually throughout the project duration</td>
<td>US$250 per survey</td>
</tr>
<tr>
<td></td>
<td>Total hydrocarbon content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phosphate, nitrate, nitrite,</td>
<td>Chemical analysis</td>
<td>Every six months throughout the project duration</td>
<td>US$450 per survey</td>
</tr>
<tr>
<td></td>
<td>nitrogen ammonia, biological oxygen demand and chemical oxygen demand</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9.4 Monitoring Report

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

The proponent is fully committed to undertake the monitoring program outlined in this Chapter (refer Appendix H of this report).
10 Stakeholder consultations

HDC is the responsible party for regulating the development aspects of Hulhumale’. The islands land use plan and other related aspects are monitored and regulated by them.

Formerly known as Hulhumale’ Development corporation now the Housing Development corporation oversees all activities in Hulhumale’ and its harbour.

The following members of Housing Development Cooperation were consulted;

Ms Khadheeja Mohamed – Assistant Director

Mr Adhuham Niyaz- Assistant Director (Planning & Projects department)

Mr Ibrahim Ihsan – Assistant Planning Officer (Planning & Projects department)

The abovementioned officials from HDC, project proponent and CDE Consulting met at HDC office at Hulhumale on 27th March 2013. The following were the main discussion points.

The HDC formulated a guideline for vessels anchored in the harbour area during 2008, however due to continuous changes in laws and regulations with the advent of decentralisation act and other laws and regulations the mentioned regulation is no more applicable.

The HDC is reviewing the situation of harbour and formulating a new regulation to be implemented soon.

As the Proponent has obtained a letter authorising the maintenance of the vessel (Appendix C) at the site without legal basis it could not be asked to be moved. However the HDC has decided not allow new applicants to anchor before the new guidelines.

The project could be preceded with the approval of the EIA as it has been anchored with due clearance. In future the HDC will consider environmental factors and pollution prevention measures.

The ministry of Fisheries & Agriculture Mr Hussain Shinaz (Director) has informed the proponent that the EIA is a requirement to issue “Fish Processing License” (refer to Appendix E). Thus in future the license will be renewed with reference to the outcome of the EIA by the Environmental Protection Agency.
11 Potential Data Gaps and Assessment Limitations

11.1 Gaps in Information

The environment of Maldives is generally poorly understood. This may be due to the lack of detailed studies in the Maldives. Much of the literatures on coral islands are derived from studies done in the Pacific which unfortunately has very different climatic and geologic settings.

Detailed environmental analysis for an EIA is often required to be undertaken in a relatively short period of time. Give the seasonal climatic variations in Maldives and the differences in local geomorphologic and climate settings in individual islands such a short time frame is often too little to assess selected aspects of the environment. This problem is compounded by the absence of long-term studies in other parts of Maldives. Hence, most EIA’s end up being based on an environmental snapshot of specific point in time. However, experienced EIA specialists can deliver a close match to reality based on a number of similar assessments. In this regard, the following gaps could be identified in information.

- Absence of long-term site specific or even regional data (at least 2 years). Most critical data include current, wave and terrestrial modification history.
- Absence of historical and long-term records on reef and lagoon environment.
- Lack of detailed data on geology and soil due to time limitation in EIA submission.

These gaps are seriously considered in the assessment and care has been taken to address the issue in designing mitigation measures and the monitoring programme.

11.2 Uncertainties in Impact Prediction

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. As note earlier, there is also no long term data and information regarding the particular site under consideration, which makes it difficult to predict impacts. It is important to consider that there will be uncertainties and voluntary monitoring of natural processes as described in the monitoring programme is absolutely essential.
12 Conclusions:

The major conclusions derived from the project are;

- The proposed developments are in conformance to the laws and regulations of the Maldives.
- The project is an ongoing project where fish processing has been going on since its registration and docking at Hulhumale’ harbour from 2002.
- The marine environment at the adjacent reef is poor with very low live coral cover (upto5% or less). Algae covered basement is the dominant benthic substrate. This may have resulted from extended periods of reclamation during Hulhumale’ reclamation project and the subsequent effects of algal growth from added organic matter by safari’s and other vessels anchored in the harbour.
- The significant impact from this project is marine water contamination from the release sewage and waste water albeit it’s in relatively small quantities. In addition contamination from oil and other chemical leak to the marine environment.
- The alternatives evaluated for the project are waste water disposal methods and site location or Alternative Island. In addition no project option has also been evaluated.
- The monitoring plan has been designed with a focus to analyse the impacts over time, particularly the effect on marine water quality and waste generation
- A management framework has been proposed and it is essential that this framework be used in the construction stage of the project.

The projects have cumulative adverse environmental impacts which need to be monitored for its significance and adversity. Given the existing site conditions and opportunity cost the project has to be carried out. The projects have to be carried out to provide the mentioned benefits to fisherman and its contribution to fisheries sector with the given setting.
REFERENCES

BINNIE BLACK & VEATCH 2000. Environmental / Technical study for dredging / reclamation


APPENDIX A – Terms of Reference
APPENDIX B – Survey Locations
APPENDIX C– Authorisation letter issued by HDC
APPENDIX D – Water Quality Results
APPENDIX E – Fish processing license from Ministry of Fisheries and Agriculture
APPENDIX F – Approval of Vessel from Maldives Food & Drug Authority
APPENDIX G – CV’s of Consultants
APPENDIX H – Commitment Letter
APPENDIX I– Letter from Ministry of Fisheries & Agriculture directing to carryout EIA