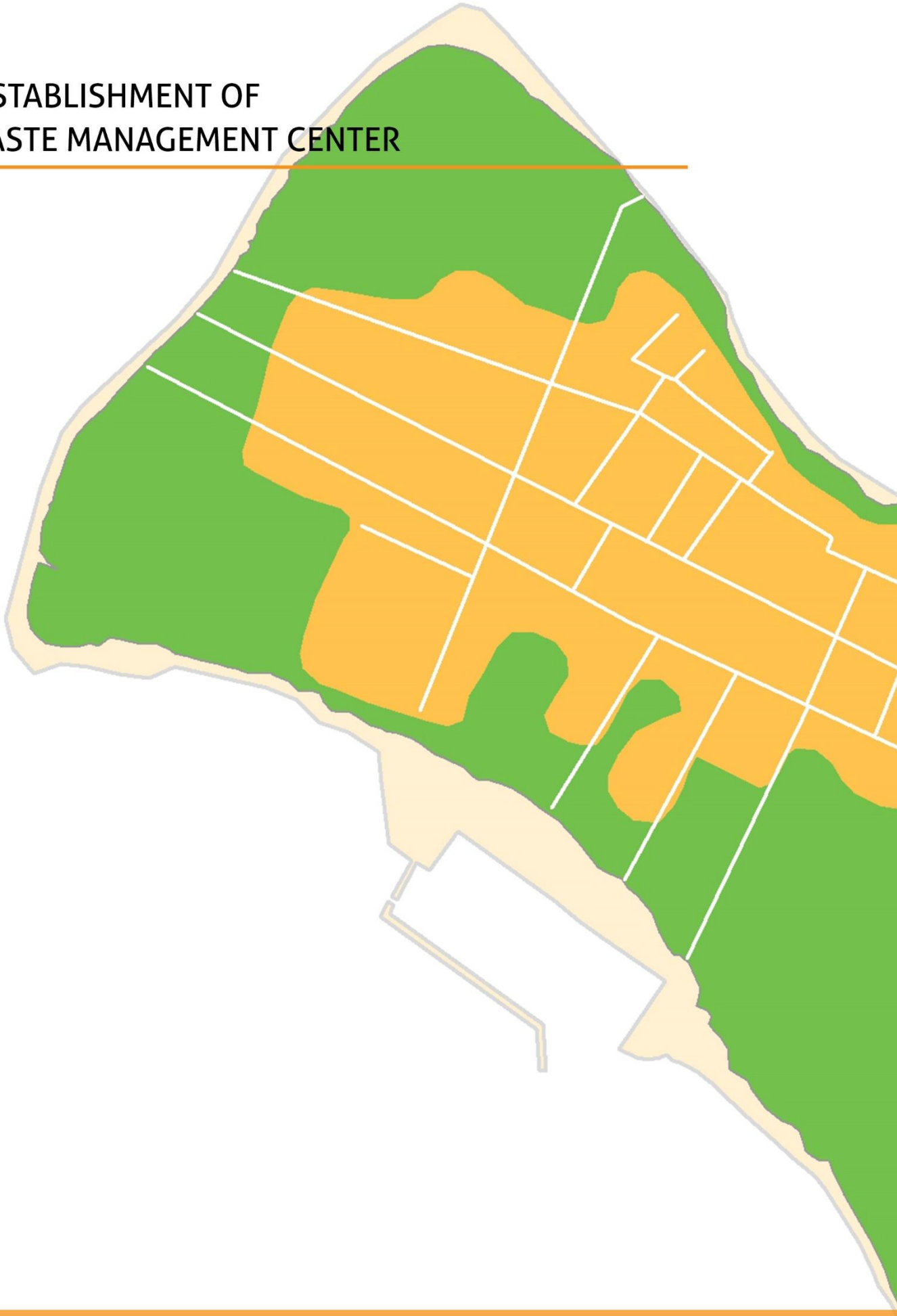
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

FOR THE ESTABLISHMENT OF ISLAND WASTE MANAGEMENT CENTER

JULY 2018



M. MULAH

PROPONENT: Ministry of Environment and Energy

MEECO
MALDIVES ENERGY AND ENVIRONMENTAL COMPANY

July 2018

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN
FOR
THE ESTABLISHMENT OF ISLAND WASTE MANAGEMENT CENTRE
IN
M. MULAH

PREPARED FOR
MINISTRY OF ENVIRONMENT AND ENERGY

PREPARED BY
AHMED SALEEM

JULY 2018

PROJECT SYNOPSIS

Name of the Project: Establishment of Island Waste Management Centre in M. Mulah
Project Proponent: Ministry of Environment and Energy
Project Value: -
Expected Duration: 12-24 weeks
Consultant: Ahmed Saleem
Date: July 2018

WEIGHTS AND MEASURES CONVERSIONS

1 metric tonne = 2,204 pounds (lbs.)
1 kilogramme (kg) = 2.2 pounds (lbs.)
1 metre (m) = 3.28 feet (ft.)
1 millimetre (mm) = 0.03937 inches (”)
1 kilometre (km) = 0.62 mile
1 hectare (ha) = 2.471 acres

LIST OF ABBREVIATIONS

CBD	Convention on Biological Diversity
CO_2-e	Carbon dioxide equivalent
DA	Decentralisation Act
DDRPM	Development of Disaster Risk Management Profile Maldives
DIRAM	Detailed Island Risk Assessment in Maldives
DNP	Department of National Planning
DO	Dissolved Oxygen
EIA	Environment Impact Assessment
ESMP	Environmental Monitoring Plan
EPA	Environmental Protection Agency
EPPA	Environmental Protection and Preservation Act
ES	Environmental Score
EPZ	Environmental Protection Zone
GHG	Green House Gas
GPP	Gross Primary Production
GoM	Government of Maldives
HIES	Household income and expenditure survey
HIA	Hanimaadhoo International Airport
Hs	Peak Height
IWM	Island Waste Management
IWMC	Island Waste Management Centre
IWMF	Island Waste Management Facility
MCA	Multi Criteria Analysis
MEE	Ministry of Environment and Energy
MHI	Ministry of Housing and Infrastructure
MMS	Maldives Meteorological Service
MOFA	Ministry of Fisheries and Agriculture
MPA	Marine Protected Area
MSL	Mean Sea Level
MoT	Ministry of Tourism
NBSAP	National Biodiversity Strategy and Action Plan
NBSAP	National Biodiversity Strategy and Action Plan
MNSSD	Maldives National Strategy for Sustainable Development
NAPA	National Adaptation Programme of Action
RWM	Regional Waste Management
RWMC	Regional Waste Management Centre
RWMS	Regional Waste Management System
WMP	Waste Management Plan
RWMP	Regional Waste Management Plan

IWMP Island Waste Management Plan

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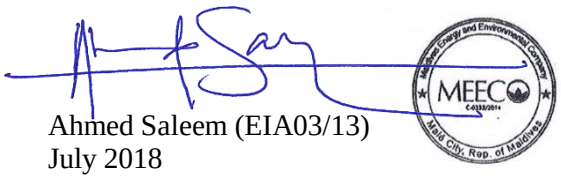
DECLARATION OF THE CONSULTANT AND PROPONENT

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



Ahmed Saleem (EIA03/13)
July 2018

Proponent

The proponent of this project Ministry of Environment and Energy, Maldives has provided the declaration and commitment letter which is attached in **Annex 1.**

AKNOWLEDGEMENT

The author of the report is Mr. Ahmed Saleem who is a registered EIA consultant with the Maldives EPA. In preparing the report the author was assisted by a multi-disciplinary team of experts and wish to acknowledge their invaluable input in preparing the report. The team members, their respective field of expertise and areas of contribution to the assessment is given in **Table 1**.

Table 1: The ESMP Team

Name	Qualification	Designation/Field of Expertise	Contributing Area
Mr. Ahmed Saleem	MSc. Ecology & Environment	Author, Lead EIA Consultant	• Overall administration of the ESMP preparation • Chapter reviews • Report compilation
Mr. Ali Hammadh	BSc. Environmental Management	Consultant	• Stakeholder consultations • Contributed to the various chapters of the report.
Mr. Maumoon Saleem	BSc. (Hons) Civil Engineering	Civil Engineer / EIA Consultant	• Data analysis • Data collection • Concept review • Stakeholder consultations • Field work • Contributed to the various chapters of the report.
Mr. Dinal Shalika		Surveying	• Preparation of maps and charts, filed work
Mr. Muslih Mujtaba		Surveying	• Surveys, field work

NON-TECHNICAL SUMMARY

1. Recognising that preventing and managing waste is at the heart of sustainable development in the islands of the Maldives, the Ministry of Environment and Energy as the Proponent has proposed a project to establish an Island Waste Management Centre (IWMC) in six (6) islands of Zone IV and V (islands within the atolls of Meemu (M), Faafu (F), Dhaalu (Dh), Thaa (Th) and Laamu (L)) in order to manage waste generated at island level. The project is funded by the World Bank under the "Saafu Raajje – Maldives Clean Environment Project for Zone IV and V". The proponent has requested consultancy services of the Consultant for the preparation of an Environmental and Social Management Plan (ESMP) for the proposed project. This ESMP includes 1 of the 6 islands, namely M. Mulah.

2. M. Mulah council pointed out that there are 2 areas at the island's beach used frequently for dumping and burning waste. Waste dumped in these areas can scatter into the lagoon due to wind and inundation. There is currently no waste management system in place in M. Mulah. Kitchen waste is disposed into the lagoon of the island along with plastic bags in some cases. M. Mulah had an approved Island Waste Management Plan (IWMP) at the time of field visit under the current project, as well as gazetted island level waste management regulations.

3. The proposed IWMC under the current project is located in the southern end of the island at 2°56'29.5"N, 73° 35'14.6"E. The site requires vegetation clearance and there is no cleared road giving access to the plot. Plot vegetation includes *Terminalia cattapa* (Midhili), *Psidium guajava* (Feyru), *cocos nucifera* (Dhivehi ruh), *Hibiscus tiliaceus* (Dhigga) and some undergrowth. It is estimated that 65 coconut palms and 5 other trees will require removal from the site for the establishment of the IWMC. As per the proposed arrangement, while site clearance works will be done by the contractor, the Island Council is required to clear the access road leading to the site. It is estimated that 107 coconut palms and 6 other trees will be required to be removed from the access road.

4. The main activities involving the construction of the IWMC include vegetation clearance, shallow excavation, substructure and superstructure works as well as masonry works. The proposed design of the IWMC requires a shallow foundation due to the structure being a single story structure. After the structural works are done, masonry, plastering, roofing works are completed prior to the addition of the services components such as electricity, fire-fighting and plumbing. The construction phase of the project is expected to be completed within 12-24 weeks.

5. The operational phase of the project would mainly include waste collection from households, institutions, and public spaces, sorting, volume reduction and stockpiling of re-usable, recyclables, composting of organics, and storage of hazardous waste.

6. Key activities anticipated to have a negative impact during construction phase are:

Table 2: Impacts envisaged during construction phase and proposed mitigations

Activity	Main Impacts	Major mitigations
Workers Influx and Settlement	Impacts on flora and fauna	Sensitive workers on intentional/unintentional damage to flora, sensitive sites, against catching birds and animals, damage to flora, workforce kept at minimum, littering prohibited.
	Impacts on resource use	Keeping workforce to minimum needed, creating awareness on avoiding wastage of resources, proper supervision and auditing of the resource use.
	Sociocultural impacts	Encourage choosing local workers, if foreign workers are brought ensure proper work permits, worker orientation to the island's social, religious and traditional values and customs.
Transportation of Materials	Marine and terrestrial pollution	Prevent littering, containing waste generated during construction phase, clear guidelines implemented by workers on managing various types of waste generated during construction phase.
	GHG Emissions	Obtain materials from closest source, buy materials in bulk, and reduce wastage, use of well serviced, efficient, and vehicles conforming to regulations during all stages of the project.
	Roads deterioration	Include in agreement with the contractor to repair any damages to roads after project, use the shortest route for transportation, only the required amount and size vehicles shall be used.
	Accidents & injuries	Licensed drivers, speed limits shall be strictly observed, avoid transportation at night, secure loads being transferred.
Site Demarcation and Fencing	Impacts on flora and fauna	Work site shall be clearly marked and area fenced. Avoid unnecessary land clearance by establishing the required boundary by qualified surveyors using accurate survey equipment's.
	Accidents & injuries	Workers safety guidelines shall be in place and properly explained before work begins, provide to the workers protective clothing, works done during daytime, site clearance shall take place under strict supervision.
Site clearing and earthworks	Loss of vegetation	Only those trees requiring absolute removal shall be uprooted. Hence marking of those vegetation for removal shall be done prior to site clearance works.
	Social impacts	Privately owned trees to be identified in consultation with island council and compensated prior to removal.
	Soil and groundwater impacts	Follow prescribed steps in the report to remove trees, fill bulb cavities with sand sourced by contractor, level and compact site after removal, fill the bulb cavity as soon as possible and no unfilled cavities shall be left.

	Untargeted species impacts	Prevent unnecessary removal of trees by clearly marking site clearance boundary, workers shall be clearly told not to damage vegetation outside the project boundary.
	Air pollution	Well serviced vehicles used, machines switched off when not in use and idling stop used.
	Economic impacts	Relocating trees within the island shall be given the priority, sale of coconuts or making it available for locals free instead of discarding those as waste, trunks of those trees needing cut could be sold for timber
	Aesthetic impacts	Careful surveying and planning to limit number of trees removed, replanting trees by relocation as much as possible.
	Accidents & injuries	Carry out work in fair weather, PPE provided, all machinery and equipment inspected and maintained, qualified and certified operators shall only be allowed to operate heavy equipments and machineries.
	Noise	Provide necessary personal protection equipment's (PPE) to workers, use well serviced plants and machineries, and reduce vehicle idling time.
Construction	Material storage	Equipment fenced off, no naked flames allowed in the storage area, National Fire Code followed for handling fuel, firefighting equipment's made available.
	Terrestrial pollution	Temporary waste storage area set onsite, cleaning of litter, hazardous waste shall be stored in closed containers and stored separately, transfer all project related waste to nearest approved waste management facility.
	Noise	Provide PPE equipment, use well serviced plant and machinery, and reduce vehicle idling time.
	Impacts on flora and fauna	Setting out survey, demarcate the plot, fence off site.
	Accidents & Injuries	Occupational safety plan, orientation, PPE provided.
Waste Generation	Marine and terrestrial pollution	No construction related waste shall be allowed to enter into marine environment through proper waste management during construction phase, littering of waste shall be prohibited by the workers, containment of waste at the project site and waste transported to nearest waste management facility after works are completed.
Resource Use	Water	Water conservation practices shall be followed by all workers as a work site rule, regular checking of leaks, practice water conservation.
	Electricity consumption	Electricity wastage at site shall be avoided through good practices and creation of awareness, work shall be planned to be conducted during daytimes as far as possible.

Out of the construction phase activities, vegetation clearance was identified to be a significant negative impact if not properly mitigated. The remaining impacts identified are expected to be minor to moderate negative impacts.

Key activities anticipated to have an environmental impact during operation phase were:

Table 3: Impacts envisaged during operational phase and proposed mitigations

Activity	Main Impacts	Major mitigations
Waste collection and transportation	Habitat degradation (land, reefs, beaches)	• Island level regulations on preventing waste littering, dumping of waste on undesignated areas through imposing fines and penalties. • Requirements for waste separation and containment for collection.
	Climate impacts Residual waste transport from the island to nearest waste management center would generate GHGs	• Minimise waste generated at source by regular waste awareness programs and introducing polluter pay principle to discourage waste generation • Regularly servicing of vehicles. • Restrict use of vehicles only certain times in WMP.
	Accidents and injuries Potential health risks to workers - collecting certain types of waste such as metals and glass people can get cuts and infections	• Adequate PPE shall be made available to those collecting wastes • Overloading of vehicles prevented. • Occupational safety plan, orientation, well trained personnel to use vehicles.
	Air quality Odour issues during transport	• Use well serviced vehicles, vehicle covered, spray water to suppress dust during dry periods if necessary. • Ensure battery operated vehicles are used for waste collection and transport where applicable.
Waste management activities (dumping, sorting, volume reduction and composting)	Impact on land The island has very limited land area, which limits allocation of large areas of land for waste management. Allocation of space for waste management would mean having to forgo alternative uses of the allocated land plot.	• Reduction of waste at its sources and the reduction of the total volume of waste requiring disposal. Waste reduction should include use of clean technologies, reuse and recycling. Regular public awareness campaign to promote reduction of waste at household and community levels is also fundamental. • Development and introduction of a regulatory framework, including proper guidelines for managing waste, are needed. Once these instruments are in place enforcement measures will need to be in place.
	Health impacts Waste collection site can become a breeding ground for pests and disease causing agents such as mosquitoes and rats. Odour issues. Waste can pollute groundwater through the leaching of toxic chemicals into the ground.	• Waste shall be dumped on paved areas. • Piling and overfilling of waste dumping area shall be prevented through volume reduction, transport to final site etc.. • Hazardous waste shall only be stored in closed and sealed containers, and kept on hard surface to prevent seepage into the groundwater lens. • Compaction and baling of waste needing transport to final waste management site.

	Groundwater pollution	• HDPE linings provided through design, leachate collection system. • waste not stockpiled on the ground.
	Amenity impacts	• Developing and enforcing island level waste management rules to prohibit littering within the premises and en-route to the site on the island. • Impose penalties for littering, regular cleaning and supervision of the IWMC, keep stockpiles of organics low, keep pest and vermin population controlled through various IWM practices described.
	Air quality impacts	• Preventing long-term accumulation of unmanaged waste at the site through proper IWM practices.
	Fire hazards	• Burning of waste as a waste management practice is not encouraged at the site. • Firefighting equipment's shall be made available at the waste management site. • Proper electrical wiring by a certified person. • Naked flames shall not be allowed at IWMC, placing awareness signs at the premises. • Place a signboard at the IWMC indicating that smoking is prohibited inside the premises. • Conduct fire drills and briefing sessions for waste management staff and emphasize on dangers of smoking inside IWMC.
	Accidents and injuries	• Formulate occupational safety plan. • Worker training on safety practices and providing PPE. • Use licensed drivers and operators. • Placing a first aid kit at IWMC.
Waste generation	Groundwater pollution Waste generation being the main cause of all related impacts most efforts need to be focused on reducing the waste generated at source.	• Regular targeted awareness programs to all members of the community on ways to minimise waste generated. • Measures at island level on the use of non-biodegradable wastes. • Placing awareness sign boards at appropriate locations of the island. • Introducing polluter pays principle through fee schemes after a proper willingness to pay study.
Resource consumption	Water	• Ensure compost windrow is shaded during dry periods. • Use a spray hose to decrease water consumption. • Arrangements to collect rainwater within the facility which can be used for cleaning and composting purposes.
	Electricity consumption	• Ensure the equipment are properly serviced and maintained • Equipments shall only be operated when under a given schedule and switched off as soon as operations are complete. • Use of solar panels and solar lights to minimize use of fossil fuel based electricity.

Introducing a proper waste management scheme to the island is expected to have significant positive impacts to the island. These include positive effects on the overall health and well-being of the island community and improved air qualities, prevention of polluting beaches and

marine environment, controlling of pests and disease causing animals. In islands poor waste management leads to overpopulation of crows and rats which can directly negatively impact cash crops in addition to them acting as agents for spreading certain diseases. Proper waste management would control their population explosion of pests and disease causing organisms and thereby positively impacting the population. In addition proper waste management would improve the overall aesthetic appeal of the island improving overall mental wellbeing of the residents and visitors to the island. The local economy is also envisaged to have such impacts due to the generation of jobs, business opportunities through transportation of waste, and income from selling of compost, and other recyclable materials such as metals, glass and plastics.

7. It is expected that approximately 70% of the waste generated within the island can be managed at the IWMC and 30% would need removal from the island as residuals. However in the absence of a regular arrangement to remove residuals from the island, these can quickly accumulate and the whole waste management system could collapse. Therefore, in order to avoid the IWMC reaching capacity for storage and composting, it is recommended to have in place a regular transport mechanism to transport unmanaged waste to the nearest waste management facility. In contingency for cases where transportation is delayed, it is recommended to provide wheelie bins within the premises to temporarily store the unmanaged organic waste, while alternative transportation options are arranged.

8. It should be noted that without the proper assistance, financially (in terms of regular budgetary allowances for operational and transport requirements) and technically (in terms of provision of trainings and equipment), the IWMC runs the risk of potentially turning into a dumpsite, exacerbating the possible negative impacts to the receptors. Provision of resources to the Island Council, in the form of budgetary allocations, proper training and waste management equipment is seen as a central cog in ensuring the proper management of waste in the island. The Proponent shall ensure the aforementioned assistance is provided.

9. Implementation of the island's Waste Management Plan, in addition to the enforcement of Waste Management Regulations and Guidelines is seen as crucial in achieving proper waste management within the island. The Island Council also shall ensure the proper operation of the IWMC and waste management within the island through enforcing penalties on non-conformances to gazetted waste management regulations and guidelines.

10. A reporting mechanism has been proposed with this ESMP, which includes the IWMC occupier, the Island Council, and the Proponent. Proper reporting of the IWMC operations within the mechanism can ensure the continued monitoring and evaluation of the operations, provision of required assistance, and provide crucial information for future planning and policy decisions for the Proponent.

11. The Proponent of the project, Ministry of Environment and Energy guarantees their commitment to undertake the necessary mitigation measures and monitoring during all stages of the project that has been proposed in the report.

12. In conclusion, the findings of the ESMP shows that the proposed activities for this project has major negative impacts due to land allocation, clearance, minor to moderate negative impacts during the construction works, and minor negative impacts as well as positive impacts during the operational phase. With the proposed measures, the envisaged negative impacts can be mitigated, and the positive impacts enhanced. Given that the Proponent has committed to the mitigation actions it is anticipated that the project can be implemented with almost all

significant impacts brought to an acceptable level, and ensure the positive impacts envisaged from this much-needed project.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

Ministry of Environment and Energy, Maldives (MEE) has proposed a project to establish an Island Waste Management Centre (IWMC) in six (6) islands of Zone IV and V (islands within the atolls of Meemu (M), Faafu (F), Dhaalu (Dh), Thaa (Th) and Laamu (L)) in order to manage solid waste generated at island level. The project is funded by the World Bank under the "*Saafu Raajje – Maldives Clean Environment Project for Zone IV and V*".

The completion of the proposed project will result in the establishment of an Island Waste Management Centre (IWMC) in these six islands (6), and the operation of the IWMC will be facilitated under the Waste Management Plan (WMP) formulated by the respective Island Councils and approved by EPA.

The project will be implemented under the *Saafu Rajje Policy* formulated by MEE to:

- Reduce the amount of waste produced and discarded;
- reuse, items discarded as waste;
- recycle waste to create value added products;
- use waste to generate energy; and
- dispose waste in an environmentally sound manner.

The main objectives of the policy are to:

- Ensure that all Maldivians understand the importance of waste management and create awareness with regard to the waste management policy;
- evolve and develop the society through awareness so that it strives to protect and manage the natural environment sustainably;
- ensure all aspects of civil life are hygienic;
- ensure that air pollution is controlled and prevented; and
- ensure that Maldives retains its natural coastal and marine environment free from pollution.

In order to achieve the objectives of *Saafu Raajje Policy*, a Regional Waste Management Center (RWMC) will be created in each zone/region as the final treatment and disposal facility for the waste collected at island level.

The scope of the proposed IWMC is to facilitate island level management of the waste generated within the island, which includes sorting of waste types, storage of hazardous wastes, volume reduction of inorganic waste, stockpiling and composting of the waste. The waste that is not manageable in the island level is to be transported to the proposed Regional Waste Management Center (RWMC). At the time of the report, MEE is currently in the process of selecting a consultant to undertake the feasibility study of the RWMC for the region.

The proposed IWMC will be financed by World Bank and constructed by contractors procured by MEE locally. Prior to construction of IWMC, preliminary studies such as site selection/approval, environmental and social management plans are to be completed. Therefore, proposed locations for IWMC was screened by EPA and Ministry of Housing and Infrastructure (MHI). The initial screening of the locations resulted in the following six (6) islands listed below was classified as requiring an Environmental and Social Management Plan (ESMP).

- M. Mulah

- Th. Buruni
- Th. Omadhoo
- Th. Madifushi
- Th. Kinbidhoo
- Th. Thimarafushi

This report includes one (1) of the aforementioned six (6) islands, namely M. Mulah.

1.1.1 The Project Island

Among the other Project islands, this report is focussed on M. Mulah which is one of the inhabited islands of Mulaku Atoll having a total population of 1799 people. Located 02°56′50″N and 73°35′05″E the island covers an area of approximately 68.2 ha. Mulah measures approximately 1.32 km in length and 0.49 in width. The island also has a harbour with an area of roughly 2.2 ha.

The island has 24-hour electricity service and a central sewerage system has been constructed. At the time of the visit the sewerage service had not started in the island. The island has a 24 hour health centre and education provided up to grade 10 and BTech grade 11.

Project Management and Overall Organisation

The proposed project is facilitated by MEE and financed by the World Bank under the "*Saafu Raajje – Maldives Clean Environment Project for Zone IV and V*". It is expected that upon completion of the project, the island will have a proper waste management facility in place. The operation of the IWMC will be in accordance with the Waste Management Plan devised by the Island Council and Approved by EPA.

The scope of the IWMC would include sorting, volume reduction and stockpiling of recyclables, composting of organics, and temporary storage of hazardous waste. The waste that is not manageable in the island level shall be transported to an approved waste management facility.

The Consultant prepared this document in accordance with the EIA Regulations 2012, (in addition to the Environmental and Social Assessment and Management Framework (ESAMF) of MCEP and the TOR provided by MEE) to obtain the required environmental clearance for the proposed construction of IWMC. This ESMP provides an assessment of the proposed IWMC in terms of existing environmental conditions and potential environmental impacts on the island. The findings of this report are based on information collected from a site visit, professional expertise and experiences from past projects of similar nature. For site investigations, a field visit was conducted during the month of June 2018.

1.2 INTERPRETATION OF SPECIFIC TERMINOLOGY USED IN THE REPORT

Certain terms used in this report shall be interpreted in the context of the current project taking into account legal and administrative requirements for preparing the ESMP in the Maldives. The term Environment has been used in a broad context to include, natural environment, human environment, heritage, recreation and amenity assets and livelihood, lifestyle and well-being of those affected by the Project.

Proponent in the document implies to the project owner MEE and Project Island shall be interpreted as M. Mulah. The term Project means 'Establishment of IWMC in Project Island' and the contractor shall be interpreted as the company undertaking development works of the Project. IWMC occupier shall be interpreted as the party undertaking the operational works of the IWMC.

Nearest waste management facility shall be interpreted as Thilafushi. If in the future, waste from zone IV and V is accepted by another approved Regional Waste Management Centre (during project construction and operational phase) which is closer than Thilafushi, then the facility which is closest to the source island shall be selected to reduce transportation impacts.

Site in the report is referred to the location of the IWMC and road means access pathway proposed for getting access to the site.

1.3 OBJECTIVE OF THE ESMP

The objective of the ESMP study is:

a) To provide the ways by which the proponent will manage and control the works associated with the construction and operation of the IWMC;
b) to provide an assessment of the potential environmental effects of the proposal and determine which of these, if any are likely to result in a significant effect on the environment and to propose ways and means of avoiding, mitigating, and or compensating the perceived negative effects of the project;
c) enhance Project benefits; and
d) to provide necessary information to EPA applicable to the proposed development in line with the EIA Regulations.

1.4 ESMP IMPLEMENTING PROCESS

In general the objective of an ESMP report is to address the environmental and social concerns of the developmental project. The ESMP report will also help to promote informed environmental and sound decision making during the development of the project.

The aim of the ESMP is to identify, describe and assess in an appropriate manner, proposed development, in accordance with the provisions of guidelines and regulations of the Government of Maldives, the direct, indirect and residual effects of the project on the physical and biological environment of project environment. The ESMP would also provide the ways by which the proponent will manage and control the works associated with the construction and operation of the IWMC.

This ESMP has been developed within the framework outlined in the EIA regulations 2012 (in addition to the Environmental and Social Assessment and Management Framework (ESAMF) of MCEP and the TOR provided by MEE). This ESMP establishes the environmental management controls to be followed by the contractor, its employees, subcontractors and sub consultants in carrying out the construction and operation of the IWMC.

Once the decision note is issued from EPA the proponent is obligated to implement the ESMP and matters highlighted in the decision note.

1.5 PROJECT SETTING

Mulah is one of the inhabited islands of Mulaku atoll located 02°56′50″N and 73°35′05″E the island covers an area of approximately 68.2 ha. Mulah measures approximately 1.32 km in length and 0.49 in width. The nearest inhabited island is Veyvah located northeast to Mulah. Maalhaveli being the nearest uninhabited island the nearest resort is Medhufushi Island Resort Hotel in the island of Medhufushi. There is no airport in Mulaku atoll hence the closest airport to Mulah is in Dhaalu atoll Kudahuvadhoo which is approximately 80 km from Mulah.

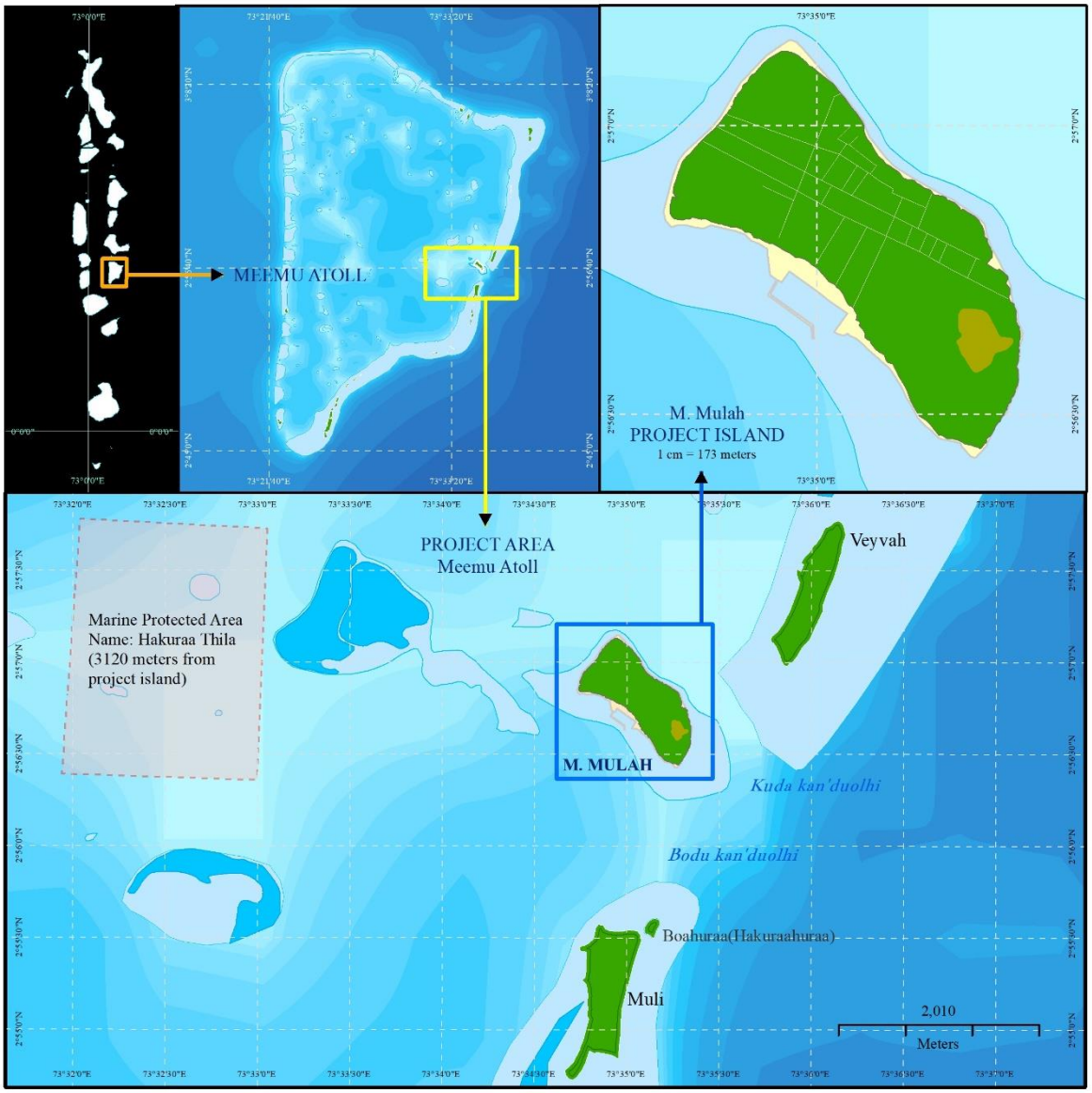

Figure 1: Project setting

1.5.1 Site Location

The proposed Island Waste Management Centre (IWMC) is located in the southern end of the island at 2°56'29.5"N, 73° 35'14.6"E. The site requires vegetation clearance and there is no cleared road giving access to the plot. Plot vegetation includes *Terminalia cattapa* (Midhili), *Psidium guajava* (feyru), *Cocos nucifera* (Dhivehi ruh), *Hibiscus tiliaceus* (Dhigga) and some undergrowth. It is estimated that 65 coconut palms and 5 other trees will require removal from the site.

Clearance of vegetation for the access road does not fall under the contractor's scope of works, therefore the Island Council is responsible for clearing the access road. There are 107 coconut palms and 6 other trees on the proposed access road.

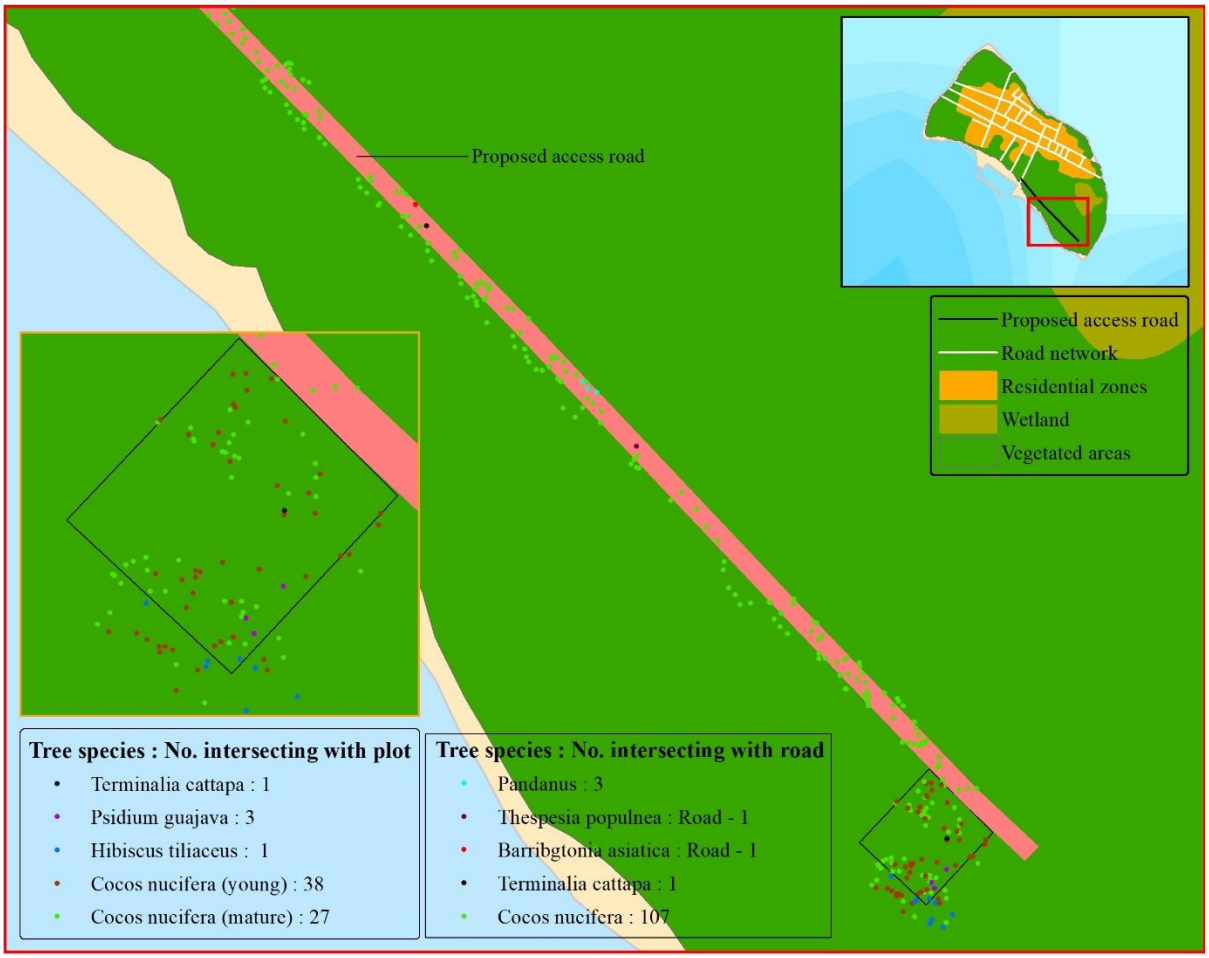

Figure 2: Proposed location for the waste management site on Mulah Island

1.6 CURRENT STATE OF WASTE GENERATION AND WASTE MANAGEMENT

1.6.1 Waste Generation in M. Mulah

The rate of solid waste production depends on the socio-economic situation, the level of industrialization, type and numbers of industries, climate, and land use and therefore can vary from island to island. However such variations are not expected to be significantly different from island to island and therefore in making estimates waste audits conducted for similar islands can be safely applied. Hence, past waste audits had been used to estimate waste composition and quantities for for Mulah Island.

According to the waste audit conducted in 2016 for Zone 1 (which includes HA, HDh, and Sh.) an average per capita waste generation was found to be 1.30 kg/person/day. The study also finds that, by far the most significant proportion of the waste is green and compostable (75%), plastics comprising of 6%, paper and cardboard making 5% of the waste, 1% metals, 6% hazardous waste, 1% glass and 6% attributed to all other types of waste.

In another waste audit study conducted by the Ministry of Environment and Energy in 2011 under the Maldives Environmental Management Project (MEMP) for five inhabited islands in the north central region of the Maldives (Hinnavaru, Naifaru, Eydhafushi, Maalhos, Lhohi), it was determined that 0.83 Kg of waste was generated/person/day. Similar to the above study it was revealed that organics was the largest component making 65% of the household waste stream, plastics comprising of 5%, paper and

cardboard making 5% of the waste, 1% metals, 8% hazardous waste, 2% glass and 8% attributed to all other types of waste.

The estimated percentage of organic waste as well as the sum of the plastics, glass and metals for both zones were found to be very similar hence the averages of the two studies were taken and considered to be the estimated percentages of various types of waste generated in Mulah Island as shown in **Figure 3**. Similarly per capita waste generation for the island had been determined by taking the average per capita in the two studies above which is **1.07 Kg/person/day**. This finding is expected, since the lifestyle and food habits are similar for most of the inhabited islands across Maldives with the exception of Male' and few other cities.

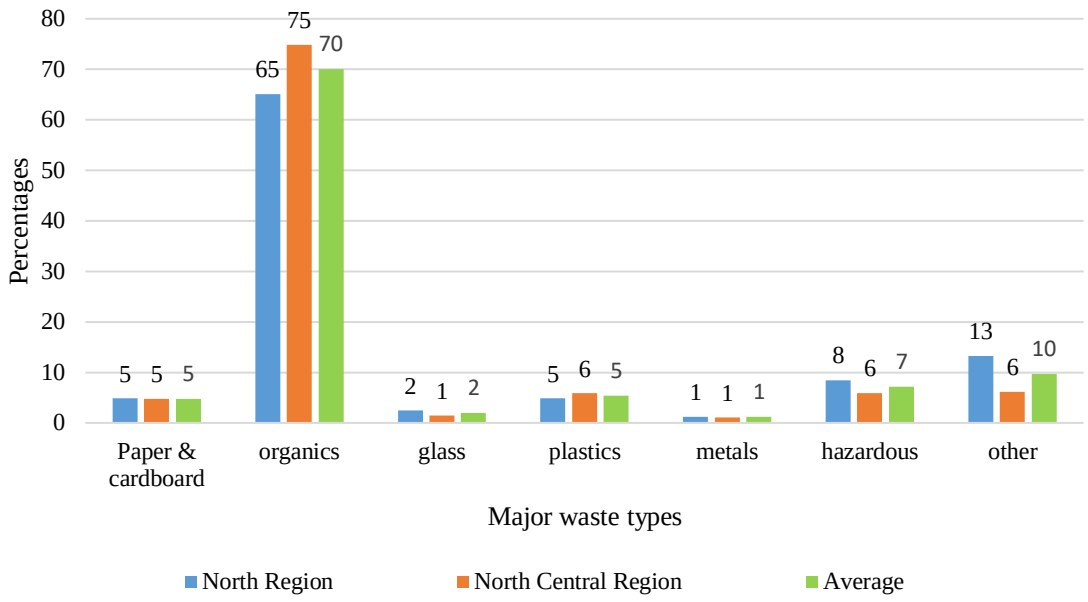

Figure 3: Waste composition comparison in two separate regions of the Maldives

Hence it is expected that the majority of the waste generated in the island to be organic wastes at 70%, which include kitchen and green wastes or compostable waste. Paper and cardboard wastes is estimated at 5% of the total waste generated. Recyclable materials such as plastic, metals, and glass make up 8% of the composition. Approximately 7% of the total waste generated is chemicals and hazardous waste and all other types are expected to be at 10%. Using these estimates and considering the current population of M. Mulah's, the daily waste generation was determined as shown in **Table 4**.

Table 4: Estimated waste generation quantities of M. Mulah households

Waste Type	Average (%)	Waste Generation (Kg/Person/Day)	Total (Kg/Day)
Organic (kitchen & green waste)	70	0.75	1347
Paper / cardboard	5	0.05	96
Glass	2	0.02	38
Plastic	5	0.05	96
Metals	1	0.01	19

Chemicals / Hazardous	7	0.07	135
Others	10	0.11	192
Total	**100**	**1.07**	**1925**

Hence it is estimated that a total of **1925 Kg** of solid waste will be generated daily at Mulah.

1.6.2 Current state of waste management in M. Mulah

The majority of waste sources in M. Mulah are households. Small scale boat building, production of dried fish, and operation of an ice plant were to be the notable commercial activities observed on the island. As far as institutions are concerned, typical institutions that are commonly found in an average island were found. These include, school, Health Centre, Secretariat of Island Council and magistrate court. Agriculture is not practiced at a large scale, although the council is now in the process of allocating additional land for agricultural purposes. Therefore in the future, increased waste input from agriculture may be expected.

The waste management at Mulah Island seemed to be in a very poor state. Construction work of an IWMC by Canadian Red Crescent started in 2006 but the project was found to be incomplete. Although the island has an approved IWMP, due to resource constraints and limited capacity, the plan was never implemented. The island's waste management regulations have also been formulated and gazetted. Regulatory enforcements required for safe and sound waste management seemed to be completely lacking. Waste generated on the island is dumped in the open at a sensitive location. Waste separation was not practiced to any extent and hence waste was dumped as mixed waste. Pollution of the beach in various parts of the island was apparent. Open burning and burying of waste in the ground was practiced as means to reducing the volume of waste accumulated (see **Figure 5**). As observed in many other islands in the Maldives, kitchen waste was dumped into the lagoon, in some cases along with their containers such as cans or plastic. Waste piles were observed on either side of the island's harbour. The harbour area seem to be the main location where the island's waste is mostly dumped (see **Figure 4**).

Figure 4: Areas where waste is currently disposed at M.Mulah

The current state of waste management on the island is summarised in **Table 5**

Table 5: Current waste management status of the island

Parameter	Yes	No	Number	Description
Harbor (accessibility)			-	• Determined to be accessible.
Waste transportation			-	• No waste collection systems or services provided in the island.
Vehicles for waste transportation			-	• No vehicles.
Waste management equipment			-	• No waste management equipment
Presence of dumpsites			2	• Two dumpsites are present
Dumpsites demarcated			-	
Dump site 1			-	• The site is not demarcated
Dump site 2			-	• The site is not demarcated
Separation of waste at dumpsite			-	-
Dump site 1			-	• Waste is not separated
Dump site 2			-	• Waste is not separated
Burning waste			-	-
Dump site 1			-	• Waste is burnt regularly
Dump site 2			-	• Waste is burnt regularly
Burying waste			-	-
Dump site 1			-	• Waste is buried to reduce volume
Dump site 2			-	• Waste is buried to reduce volume
Dumping waste into the beach/sea			-	• Kitchen waste is dumped into the lagoon in some cases along with their containers such as cans or plastic.
Presence of large waste piles			-	• Both dumpsites contain piles of waste mainly consisting of burnt residue, construction waste and mixed waste.
Pollution of inland/other areas			-	• Terrestrial pollution of inland areas is controlled
Clinical waste management			-	• Clinical waste is managed at the Health Centre
Public area waste collection			-	• Council contracts Women's Committee to clean and collect waste from public areas, sometime locals take the initiative and clean themselves.
Presence of waste bins			-	• No
Presence of workers			-	• No
Electric connection at the dumpsite			-	• No

Figure 5: Current state of waste disposal in the island. (A) and (B) Waste disposed at eastern side of the harbour, (C) and (D) Waste disposed at western side of the harbour, (E) and (F) Burning waste.

Table 6: Type of waste separated, burnt, buried and dumped at the island. (Highlighted cells show which waste type is managed in the stated way)

Types of waste separated	Types of waste burnt	Types of waste buried	Type of waste dumped into beach/sea
Plastics	Plastics	Plastics	Plastics
Metals	Metals	Metals	Metals
Construction	Construction	Construction	Construction
Yard/Organic	Yard/Organic	Yard/Organic	Yard/Organic
Kitchen	Kitchen	Kitchen	Kitchen
Hazardous	Hazardous	Hazardous	Hazardous
Diapers	Diapers	Diapers	Diapers
Paper/cardboard	Paper/cardboard	Paper/cardboard	Paper/cardboard
Partial separation of mixed Waste	Mixed Waste	Mixed Waste	Mixed Waste
All	All	All	All

1.7 ISLAND WASTE MANAGEMENT PLAN

M. Mulah has formulated an IWMP on December 2016 for the period of 2017 – 2021, which has been approved by the EPA. The plan includes main principles that need to be taken into account in establishing and implementing a suitable strategy for waste management; most notably, sustainable development, proximity and self-sufficiency, precautionary principle, polluter pays principle, waste hierarchy, best practicable environmental option (BPEO), and producer responsibility.

Outcome

Since formulation of the IWMP not much progress had been made in order to effectively implement it. There is currently no waste management system in place in the island and therefore the objectives of the IWMP are yet to be met.

Consultation

The plan was formulated with wide stakeholder consultation and engagement. In the process of formulating IWMP, institutions, women's committee, clubs and associations, schoolchildren and general public were consulted. Consultations were held with different groups separately. Hence community ownership of the IWMP is expected to be greatly felt which is believed to be a prerequisite for the successful implementation of the IWMP.

Current situation

Since the project to construct a waste management centre began in 2008 and was subsequently halted, there is no demarcated area to dump waste. Council has temporarily set two areas for this purpose where the population can easily access. As the waste accumulated in these areas cannot be managed, it has become a nuisance for the general population.

Waste Management Goals

1. Formulate waste management regulations and gazette;
2. Reduce the amount of waste produced;
3. Reusing and recycling waste;
4. Generating income from waste;
5. Conduct waste management in a sustainable manner;
6. Separation of waste category at household level;
7. Further separation of waste at IWMC;
8. Establish a way to transport unmanaged waste out of the island;
9. Transportation of waste daily from households using a vehicle;
10. Safe management of medical waste; and
11. Safe management of hazardous waste

Under this IWMP, Mulah Council plans to achieve sustainable waste management through the following means.

- Establish an IWMC;
- Obtaining a vehicle to transport waste to the IWMC;
- Employing permanent staff for IWMC operations;
- Obtaining machinery required for IWMC operations;
- Conducting awareness programs regarding sustainable waste management;
- Collecting a monthly fee from households, businesses and institutions;
- Separation of waste to five categories at household level;
- Daily collection of waste using vehicle;
- Making arrangements to manage clinical waste within the health center; and
- Transportation of waste that cannot be managed within the island to Thilafushi.

In order to sustainably conduct IWMC operations, Mulah Council states that 4 permanent staff will be utilized for waste management purposes. The Council plans to conduct composting for kitchen waste and garden waste produced within the island. Plastics, glass and metals will be separated, compacted or shredded and sold to markets.

Fee schedule

The fee schedule proposed within the IWMP is as below:

- Households – 100 MVR
- Businesses, restaurant/cafes and offices – 200 MVR
- Industrial works – 300 MVR

Waste management committee

Under the IWMP, a waste management committee is proposed with the following composition:

- 3 island councilors;
- 1 member from Atoll Family and Children Center;
- 1 member from School;
- 1 member from Health Center;
- 1 member from Police Station;
- 2 members from clubs and associations;
- 2 members from women's committee;
- 2 members from the general public; and
- 2 members from business community.

Waste management committee will play a role in monitoring waste management within the island, provide feedback and awareness programs aimed at the community.

2 DESCRIPTION OF THE PROJECT

2.1 THE PROPONENT

The Proponent of the project is Ministry of Environment and Energy (MEE) of the government of the Maldives. The proposed activity is part of a greater project titled "Saafu Raajje – Maldives Clean Environment Project for Zone IV and V" financed by the World Bank.

2.2 PROJECT DURATION AND SCHEDULE

The construction works of the proposed project is expected to be carried out in 12-24 weeks. A tentative schedule of the shortest work duration is found in **Table 7**.

Table 7: Tentative work plan for IWMC

		Weeks											
#	Activity	1	2	3	4	5	6	7	8	9	10	11	12
1	Mobilization												
2	Site clearing												
3	Excavation works												
4	Substructure and superstructure works												
5	Masonry works												
6	Plastering works												
7	Roofing works												
8	Structural steel works												
9	Electrical works												
10	Plumbing works												
11	Doors and windows												
12	Demobilization												

2.3 PROJECT DESCRIPTION

The proposed site plan is presented in **Figure 6.** Engineering details are provided in **Annex 2**.

The development of the IWMC consists initially of site selection, site approval, mobilization, site clearing followed by site construction. The works include shallow excavation, substructure and superstructure works as well as masonry works. The proposed design of the IWMC requires a shallow foundation due to the structure being a single storey structure. After the structural works are done, masonry, plastering, roofing works are completed prior to the addition of the services components such as electricity and plumbing.

The operational phase of the project will include the daily collection of waste from the households and institutions, in addition to waste management works in the IWMC, which include;

- Sorting of waste;
- Storing of hazardous waste;
- Volume reduction of plastics, glass and metals;
- Stockpiling of sorted waste; and
- Composting of organic waste.

The proposed IWMC is made up of an equipment room, and separate areas to store metal waste, paper and cardboard, plastic waste, glass waste, reusables as well as hazardous waste. Staff quarters as well as an office and a toilet is included in the IWMC. A compost pad as well as a compost storage area is also provided.

Figure 6: The site plan

2.3.1 Machinery

The following plants and equipment will be mobilized specifically for the project during site clearance and construction phase.

- hydraulic excavator for vegetation clearance;
- Truck for transportation of materials;
- Vibratory plate compactor;
- Concrete mixer;
- Concrete supply pump and piping; and
- Daily 4" pump.

2.3.2 Mobilisation

As the amount of input materials are relatively minor, the construction materials shall be stored inside the demarcated site throughout the construction period. The workers if sourced from outside the island can be accommodated in the existing houses with a small rent. This is expected to eliminate the need for putting up a labour quarter and can be cost effective.

2.3.3 Demarcation and Site Clearance

Prior to beginning construction works, a survey shall be done by the contractor to demarcate the limits of the site, determine exact number of trees intersecting with the plot. The site shall be fenced off and work shall be conducted within these limits.

The site in the project island requires removal of vegetation and palm trees. This Section highlights the site conditions of proposed location in the island. Results include actual survey data.

During the field visit it was observed that the proposed site for the construction of the IWMC has no access, hence requiring clearing an access path for the site. However, clearing of access road is not within the scope of works of the current project, making it a responsibility of the Island Council to do the clearing of access road. The proposed access road has a significant amount of vegetation including mature palm trees and therefore this activity shall follow **2.3.4.1**. However for the purpose of this ESMP both road clearance, construction and operation of the IWMC has been considered as a single project in order to facilitate the environmental clearance requirements.

Before the site clearance activities begin a professional surveyor will need to be engaged mark the boundaries using pegs. These control points will guide the construction crew during the entire process of site clearance. The survey will include a tree survey which will list all tree species within the footprint of the project, including the type, height, diameter and the estimated age. Following the set out survey all trees will be marked as per its final use using a letter code; ***RI (number) – relocation within the project island***, ***RO (number) – relocation outside the project island, T(number)*** – ***timber*** **and** ***W(number) – waste***. Hence trees needing removal can fall into any of these four categories. Abbreviation shall be used to code for the location and batch, as well which would make tracking and distribution easier. The final outcome of the set out survey will be a detailed inventory of all trees (not including shrubs, herbs and vines) requiring removal appropriately labelled.

At the time of the field survey; the proposed site contained *Terminalia cattapa* (Madhu), *Psidium guajava* (feyru), *cocos nucifera* (Dhivehi ruh), *Hibiscus tiliaceus* (Dhigga) and some undergrowth. It is estimated that 65 coconut palms and 5 other trees will require removal from the site.

Figure 7: Site condition

2.3.4 Uprooting Trees

All trees within the site will require removal using hydraulic excavators (20 tonnes or higher) by direct pulling. The excavator will have a lock-out mechanism fitted to the hydraulics so that the boom does not drop if a hose bursts. During the felling process, the excavator will be directly behind the tree. This is the position from which it can apply the most leverage. The excavator should contact the tree with either the bucket or live heel. Holding the tree with the grapple is not considered the best practice. The grapple can knock bark down on to the faller and even the smallest boom movement will alter the forces on the tree. Stump pullers may also be attached for removing dead stumps. In areas where undergrowth is found, the process of removing larger trees will begin by clearing undergrowth using machete or chainsaw which will be necessary for making tree access and creating work space also for enhancing visibility of the tree crown and removing obstructions in the landing zone. All the private trees that have been marked shall be compensated prior to removal.

Site clearance will be conducted responsibly aimed at removing only targeted trees that are pre-labelled and identified. Work will be done under strict supervision and clear record keeping by the site supervisor. Work can progress in multiple sections simultaneously depending on availability of workers, supervisors and equipment. Within a given section, trees removed for timber will be uprooted using excavator arm, the trees will be pushed from the mid-section until the root bulb detaches from the ground and falls down. The uprooted trees will be set aside until all the trees in the surveyed section has been removed.

i) <u>Trees for relocation</u>

Trees identified for re-location shall be removed with extreme care as palms are not very tolerant of extreme root disturbances. According to literature, for palms less than fifteen

feet in height, a root ball of shovel-width radius from the trunk is a common industry average for size of root ball that needs to be carefully extracted. This would provide for adequate root survival chance once the tree is replanted elsewhere (Broschat & Meerow, 1997).

Soils that cling to the root ball are the most amenable to mechanized harvest. Prior to digging, the soil around the root system will be thoroughly wetted to help keep the root ball together. Palms grown on sandy soils will usually need to have their root balls burlapped after digging, while palms grown on soils with greater structural integrity may not require burlapping. Excess sand shall be removed prior to burlapping. However, since trees will be stacked for some time before being transported to replanting site, it is recommended to burlap all palm trees removed for relocation. A supporting splint will be required to tie each trunk and this will extend up to the foliage to protect the bud.

The greatest loss of water in newly dug palms occurs from transpiration through the leaves. To minimize this, one half or more of the older leaves will be removed at the time of digging. The remaining leaves will be tied together in a bundle around the bud with a twine.

Once the palm tree is carefully extracted it will be transported and stacked at the harbour area, where it will be transported out of the island by concerned parties. The root ball cavity will be filled and levelled. Sand shall be used as a fill material for the root cavities before levelling. (See **Figure 8** for an illustration of uprooting method)

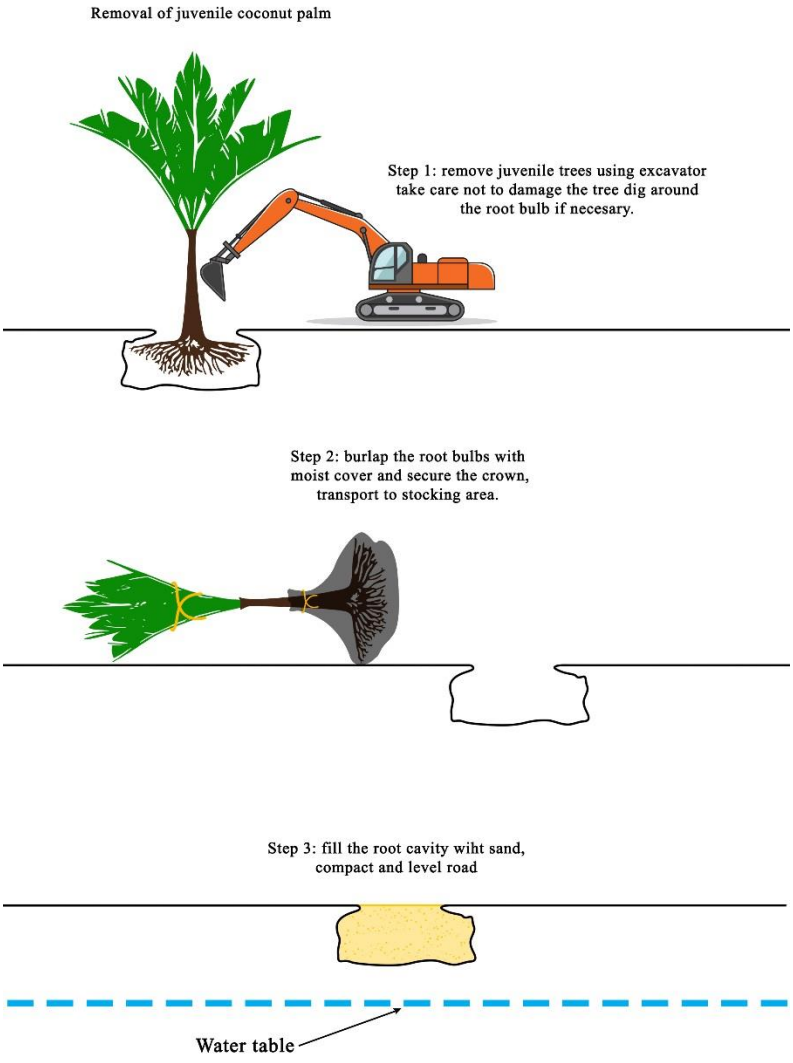

Figure 8: Illustration of uprooting palm trees for re-plantation

If the water table is reached during removal of trees, sand shall be used to cover up before adding organic material. Trees removed for relocation out of the island shall be stored at the designated areas illustrated in **Section 2.3.16**.

ii) Trees for timber

All fronds and root bulb and base of the trunk of the tree that is felled for timber or firewood shall be cut using a chainsaw and only trunk will be transported to the stockpiling area to be sold. Parts of the root bulb will be used for backfilling of the depression created (See **Figure 9** for illustration of removal method). The use of root bulbs for backfilling or grinding the stump of the root bulb will minimise waste generated during site clearance, maintain original soil conditions as well as minimise additional sand needed for filling. All fronds and nuts will be removed from the terminal bulb and piled up separately. Nuts will be sold and fronds will be left to dry and eventually burned. All residual waste shall be disposed of as described in **Section 2.3.16**.

Similarly, all the undergrowth and other trees will be removed and depending on the size of the tree, excavator or chainsaw shall be used. Branches of shrubs and other types of trees will be cut to manageable pieces to be stockpiled for firewood and smaller branches and leaves will be left for sun drying after which they will be burnt.

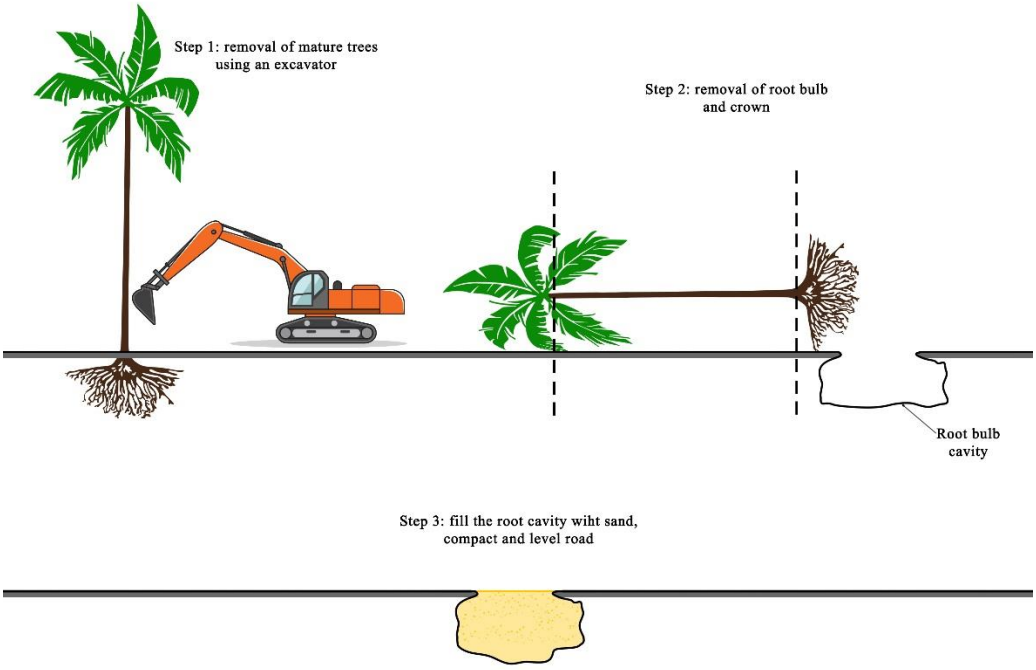

Figure 9: Illustration of removal of trees for timber

2.3.4.1 Alternative options for trees intersecting with access road

The access road will be cleared by the Island Council. Number of trees intersecting with the proposed and approved IWMC plot and access road based on the vegetation survey undertaken for the ESMP are summarized in **Table 8.**

Table 8: Summary of trees intersecting with proposed plot for IWMC and access road

Name of Island	No of trees intersecting with proposed plot	No of trees intersecting with proposed access road
M. Mulah	65 coconut palms + 5 other trees	107 coconut palms + 6 other trees

There are not many options available for the councils other than removal of trees using manual labor. This is due to the lack of resources and specialized contractors available in the island. Under the baseline scenario, most of the trees intersecting with the project area will be lost, Furthermore, due to the limited resources and financial capacity of the council there is a significant risk of the project being hindered under the baseline scenario.

The alternative options for trees intersecting with the access is proposed with the aim of conserving bio-diversity loss by saving as many trees as possible while avoiding delays and hindrance to the proposed project. The three main alternatives are:

1. **Option 1:** Procurement of parties that are willing to buy and replant the trees intersecting with the project area;
2. **Option 2:** Relocating trees within the source island; and
3. **Option 3:** Removal of trees to be used as timber/firewood and compensating for trees lost by replanting 2 trees elsewhere.

A. Option 1: Procurement of parties that are willing to buy and replant the trees intersecting with the access road

Since vegetation clearance of the access road is not within the scope of project works by MEE (only the vegetation clearance of plot is within the scope of works by MEE), it is identified as a progress limiting activity for the project. This is because, vegetation clearance is expensive and requires specialized equipment. And in order for the contractor to access the project site, a cleared access road will be a pre-requisite.

However, the island does not have specialized equipment or contractors equipped to undertake significant land clearance.

These constraints are further challenged by the fact that private trees will have to be compensated for before its removal as a measure to mitigate social impact and re-plantation of trees by translocating them are environmentally more preferred in order to mitigate negative environmental impacts (See **Section 5.3.1.1)**

In order to solve these limitations and challenges that could hinder project progress, it is highly recommended for the Island Council to identify parties through a transparent process who are willing to buy and relocate trees within or any other island. The approach will result in the following advantages.

- Number of trees cut down as an indirect impact of the project lowered;
- prevention of bio diversity and biomass loss;
- proper management of site during vegetation clearance;
- means of income to the island council; and
- clearance of vegetation by specialized equipment will be highly efficient will avoid damages to the untargeted vegetation and land clearance within a short period of time and avoiding delays.

When procuring potential buyers, the council shall reference the steps highlighted in the flowchart below (see **Figure 10).**

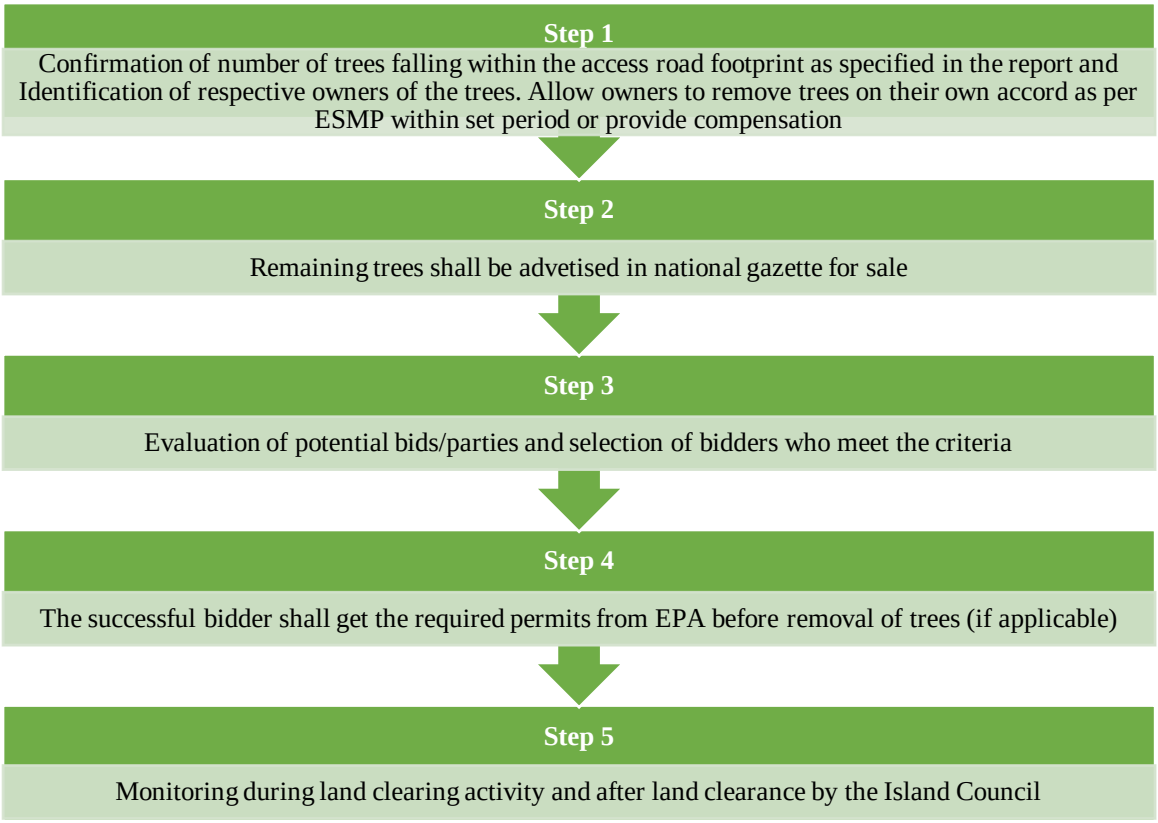

Figure 10: Steps involved in procuring vegetation buyers

Prior to selecting buyers, it is important to define the roles/responsibility of selected parties and the council (state) in terms of contract administration, contract terms /conditions, contract structure, main contract activities, termination/cancellation, records/inspection, financial provisions and project plan.

The Contract must in all respects be governed by, and construed according to, the substantive laws of the country.

In general, as a minimum the bidder shall provide the following details for effective evaluation of the proposals:

1. Proposed work schedule (work method shall follow that provided in this Section);
2. details of key members including project manager;
3. signed power of attorney letter to respective individual. Representatives of the bidder must have the authority to make binding commitments within the bounds set forth in the contract; and
4. financial provisions, which shall include bidding price for individual trees in accordance to the gazetted advertisement.

The successful bidder shall follow the guideline given below when removing trees and vegetation.

- All trees designated by the council in the gazetted advertisement as per vegetation survey shall be removed. Trees designated for removal shall be marked distinctly at breast height. A list of trees to be removed and their locations shall be supplied by the Island Council. Only those trees so marked and on the list shall be removed. The Island council reserves the right to increase or decrease the quantity of trees at any time based on the vegetation survey and approved ESMP;

- trees shall be removed for relocation, hence removal methodology described in **Section 2.3.4** of the report or any similar methodology evaluated to be acceptable shall be followed;
- all brush less than three (3) inches in diameter within a two-meter boundary of the major tree being removed shall be chipped immediately and removed from the work site within three (3) days of being cut as described in **Section 2.3.16**;
- all wood and brush disposed of during removal of tree must be in accordance to **Section 2.3.16** of the report;
- trees shall not be dropped or placed across road ways;
- for any plant or tree that had been cut during the removal process the successful bidder shall grind stumps and brace roots so that soil can be returned to the hole and levelled;
- for root bulbs cavities created after removal of trees for relocation the successful bidder shall cover it up using soil or mixture of soil and debris as described in **Section 2.3.16** These cavities shall not be filled with waste or left without levelling;
- tree trimming shall be performed on trees that have been designated by the island council; and
- the successful bidder shall remove all chips, grinding and trimming residue from the site and dispose it according to the waste management plant proposed.

By successful implementation of **Option 1** could theoretically save all the significant trees that intersect with the project area, which would have been lost otherwise. Loss of trees have been identified as a major negative impact due to its ecosystem services, economic and cultural value.

B. Option 2: Relocating trees within the source island

The second option for trees which need to be removed is relocating them within the source island. Relocating within the island is the ideal solution as far as environmental aspects are concerned, however it was deemed not feasible due to space constraints. There are no viable areas in the island that could be used to relocate trees. The process of successfully transplanting trees requires proper equipment and resources currently lacking to execute this operation by the Island Council. Unconventional removal of trees will likely result in the majority of plants getting damaged in the process.

C. Option 3: Removal of trees to be used as timber/firewood and compensating for trees lost by replanting 2 trees elsewhere

Removal of trees for timber or firewood is the least preferred option due to its numerous negative impacts which has been describe in **Section 5.3.1.1**. Those trees that cannot be replanted still needs removal, shall be checked for suitability for use as timbre or firewood and sold. Coconuts and dried branches shall be cut into manageable sizes and may be sold. Root bulbs shall be grinded and waste generated during vegetation clearing could be managed as explained in **Section 2.3.16** Undergrowth vegetation and other parts of the tree shall be cut into manageable sizes using chainsaw or wood chipper and allowed to dry and buried.

2.3.5 General construction works

All construction works will follow the **Annex 5** of the ESAMF Guidelines for IWMC Establishment.

2.3.6 Foundation

The foundation for the proposed IWMC consists of 300mm wide foundation beams. 300x300mm footings are proposed for the collection bay, in addition to the 450x450mm footings for the lamp post.

Excavation: Excavation will be undertaken to the required width, depths and dimensions of footings shown on the Drawings. Excavations will be done manually to receive the ground beams as per the drawings indicate. The foundation level will be defined as the level at the underside of the

concrete. The base of the excavation will be compacted and trimmed to ensure that at no point the level is more than 25mm above or below the foundation level.

Any over-excavation of earth below foundation level will be backfilled and re-compacted. Surplus excavated material will be used in the construction of embankments or spoiled as directed by the project officer. The excavation will be kept free of water.

The deepest excavation expected from foundation works include the 700 mm excavation to receive the light post foundation.

Concreting Materials: Cement used will be Ordinary Portland Cement. All cement will be transported in watertight containers and will be protected from moisture until used. Caked or lumpy cement will not be used.

2.3.7 Construction of Compost Slab

The compost slab has an area of 23.75 m by 10 m. The 100 mm thick reinforced concrete slabs are cast over ground beams B1, B2 and B3. The ground beams B1 and B2 have a depth of 0.3m while B3 has a depth of 0.4m from the top of the slab. B3 has a void on top of the beam centrally to receive a 100mm PVC pile cut in half sloping at 1% from the upper end to the lower end, connecting to the leachate tank at the end. Excavations will be done manually to receive the ground beams as per the drawings indicate. The maximum depth of excavation for the beams is 0.3m. The construction of the slab and ground beams include initially laying of HDPE membrane on the slab and beam footprint. Formwork will be added to the sides of the beams, and following that, the arrangement of the required reinforcing steel. Concrete will be poured for the ground beams, followed by the slabs. Concrete mixing will be done on site.

Control Movement Joints: Control movement joints will be built into slab where shown on the Drawings and at all points of potential cracking. The joint spacing will not be greater than 6 metres and shall be continuous across the full width of the base. Reinforcement mesh and bars will be clear of the control movement joints by the specified cover.

2.3.8 Construction of Leachate Tank

The leachate collection tank is located at the end of the compost slab. The leachate tank has an area of 2 m by 4 m and a depth of 1 m extending below ground. Excavation of the leachate tank area will be done to the required depth. Formwork is placed to the sides prior to placement of 10 mm reinforcing bars at 100 mm centre to centre distance, horizontally and vertically. The mixed concrete will be poured into the formwork and curing commences until the concrete reaches desired strength. The excavation can be done manually and the excavated material is stored on the side of plot.

2.3.9 Construction of Sorting Area

The sorting area is 4.85 m long by 4.0 m wide and 100 mm thick slab consisting of high tensile reinforcement placed at 200 mm centre to centre along the breadth and width. The slab rests on 300 mm thick concrete columns. The top of the sorting area is 750 mm above the floor finish level. Formwork is placed to the sides prior to placement of 10 mm reinforcing bars at 200 mm centre to centre distance, horizontally and vertically. The mixed concrete will be poured into the formwork and curing commences until the concrete reaches desired strength.

2.3.10 Construction of Perimeter Fence

The perimeter of the site is to be fenced except the gate area. The fencing includes a 150 mm thick masonry wall of 0.6 m height from ground level, followed by the PVC coated mesh fence of elevation 2.8 m from ground level. The mesh is held together by 50 mm diameter GI pipes vertically at equal centres which are welded to three evenly spaced 50 mm GI pipes horizontally. The strip foundation

below the masonry wall has a depth of 0.6 m with a 50 mm thick lean concrete placed below. The trenches required to receive the strip foundation and footings will be excavated manually.

2.3.11 Construction of Well

A well is proposed to be constructed at the eastern corner of the IWMC. This well is 1000 mm in diameter and the walls will be precast concrete while the base and top cover will be precast reinforced concrete. The pre-casting of the well will be done on site. Excavations will be done to a depth depending on the depth of the water table. After the excavation, the well base and body is fitted into the pit, and the top cover is laid on top of it.

2.3.12 Construction of Superstructure

The superstructure of the IWMC consists of the sorting area, storage area, staff quarters, office and the equipment room. The structure consists of a 4 m high wall for the office/equipment room building. The 150 mm masonry wall and roof beams are supported by reinforced concrete columns 150 x 150 mm size. The roofing is made of LYSAGHT roofing sheets. The roof truss is made of 50 mm GI pipe horizontal members and 25 mm GI pipe vertical members

2.3.13 Construction of Septic Tank

Construction of a septic tank is proposed to manage the sewage generated during the operational phase. The tank will be constructed to ensure water tightness. Waterproof paint will be used on the masonry wall.

The septic tank consists of a primary tank of 1.3 m by 1.3 m made of 150 mm brick wall, covered with 75 mm thick concrete with 6 mm reinforcing steel placed at 150 mm center to center. The primary tank is 2 m deep. The primary tank is connected by a 100 mm diameter PVC pipe to a secondary tank of the same dimensions filled with 1 m of coral stone and white sand filling. The bottom 1 m of this secondary tank is perforated with 25 mm equally distributed holes to allow for discharge of treated effluent.

2.3.14 Inspection of concrete works

Inspection of foundation, formwork and reinforcement will be made by the Proponent before concrete pouring is commenced.

2.3.15 Labour Requirements and Availability

A 10 person workforce would be involved in the construction. It is encouraged to choose workers from within the island, to reduce the impacts of influx of non-local workers. If no such arrangements are made, labour accommodation will be arranged for the 10 person workforce from existing houses.

2.3.16 Waste Management

Construction waste, which would mainly be excavated earth, nylon cement bags and general construction debris shall be collected and temporarily stockpiled in the project site. The small amounts of waste oil that may be generated from vehicles shall be contained in closed containers and shall not be allowed to leak into the ground.

A description of how various types of wastes generated from the project will be managed is given below.

A. Biodegradable waste

Wastes such as leaves, branches, paper, and materials collected from the general cleaning of the site areas will be stored as described in **Figure 11.** Only organic waste generated during site cleaning may be burnt to reduce its volume. If burning is opted it shall be carried out in such a way that fire is controlled and considering the wind direction such that smoke plume moves away from the residential area. Burning shall only take place during day time and schedule shall be discussed with the Island Council. Large wood stumps shall be cut into smaller pieces and sold to locals to be used for firewood or carpentry. If not sold they shall be stored in bins or sacks and transported to nearest waste

management facility. All residual biodegradable waste shall be kept within the site for removal from the island at the end of the project.

B. Non-biodegradable waste

Materials such as plastics and glass will have to be collected separately and transported to nearest waste management facility at the end of the project construction period. These will most likely be nylon cement bags, wrappings, steel/glass leftovers and other municipal waste generated at the construction site.

C. Kitchen waste

Food wastes and other biodegradable wastes generated in food preparation shall be buried in the ground. The pit dug to bury such wastes shall not reach the water table.

D. Waste from Site Clearance

Most of the waste is expected to be generated during the site the clearance process. However the volume of the waste generated would depend on the option adopted for managing trees that fall within the footprint. Relocation (Option 1) would significantly lower the volume of waste generated while cutting down of trees (Option 3) would generate greatest volume of waste. Waste produced by removal of coconut palms will consist of parts of palm tree which cannot be utilised for a meaningful purpose, such as the crown and root system of the palm that are bulky, heavy and occupies a large volume, which makes their management even more challenging.

For those trees that are not suitable for re-planting but may be useful as timber the crown and root bulb of the coconut palm will have to be removed and those residual parts generated will become waste elsewhere. This is mainly because the root section of the coconut palm trees comprises of soft pith that cannot be used as timber. This means the Project's negative impact will be extended, beyond Project Island. Transportation of these waste will not be viable hence; the following waste reduction strategy shall be applied.

1. The highest priority shall be given to reduce the number of trees removed during the site clearance. Careful surveying and strict supervision shall ensure that the trees removed are absolutely essential;
2. trees that are removed because they fall on the footprint of the IWMC shall be relocated as far as possible;
3. those trees which require removal but are not suitable for replanting shall be assessed for their suitability for use as timber or firewood;
4. only once these uses have been thoroughly exhausted can a tree be considered as "waste"; and
5. waste generated after relocation of trees shall be managed at the island level by burning them as described below. Those that cannot be managed at the island shall be transported to nearest operational waste management centre.

E. Burning of Site Clearance Waste

Since transportation of all the yard waste from the island will be prohibitive in terms of costs and other resources required, residual yard waste at the site, shall be left to dry and may be burned at a designated safe area away from residential areas. Burning shall be carried out in an open area that would not impact unintended vegetation. Wood ash that results from burning can be buried as it contain calcium, potassium, and a variety of trace minerals that can enrich the soil. They can also be stored in sacks and used for composting once the IWMC becomes operation.

During burning care should be taken to contain fire within the area of burning to prevent fire becoming uncontrolled. Plastics, metals, fabric and other inorganic wastes shall NOT be mixed with yard wastes while burning. In effect this means, majority of yard waste generated from land clearance can be

managed at the island level avoiding the costlier transportation of these waste to the nearest waste management facility.

Yard waste shall be burned only after attempting to reduce site clearance waste as described in the previous sub-section of report.

F. Hazardous waste

During construction phase, hazardous waste generated from machineries such as oils, solvents, batteries etc shall be sealed in labelled containers and shall be stored on paved hard surface before being transported to the nearest waste management facility. They shall be stored at the designated areas illustrated in **Figure 11**. It is essential to ensure that hazardous waste is fully contained and transported out of the island to nearest waste manage facility as quickly as possible. It is recommended to install signs in the designated temporary storage area.

Figure 11: Transportation route and storage area

2.3.17 Pollution and Control Measures

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

a) Machinery to be properly tuned and maintained to reduce emissions/spills/leaks;
b) fuel storage, paint, lubricants will be stored securely and bunded;

c) spill kits would be made available on site to control any liquid spills;
d) construction site will be wetted regularly to minimize impacts of dust; and
e) all vehicles used for the project must have up to date road worthiness license.

2.3.18 Health and Safety Measures

The project involves many activities that can put workers as well as the general public to risk of injuries and accidents. However, with careful precautionary measures and good practices during the works can eliminate or reduce many of these risks. Health and safety measures for the construction phase include and are not limited to:

a) Undertaking all relevant safety measure during the site clearance and construction works shall be part of the legal contract to undertake the works. The contractor shall be made to bear the responsibility to protect the workers as well as the general public from activities related to the project.;
b) Strict supervisor shall take place during, site clearance, construction and decommissioning phase of the project;
c) Only experienced and licensed operators will be allowed to operate heavy machines;
d) First aid kit should be made available at the work site;
e) PPE should be provided to all workers and the work force would be required to use safety gears as appropriate;
f) Fire extinguishing equipment would be available at the site;
g) Operation of any heavy machinery will need the assistance of a banksman as all times;
h) All heavy lifts must be supervised and slings inspected; and
i) Appropriate safety signs shall be placed at the work site.

2.3.19 Demobilization

The demobilization plan will commence in the last week of the contract. This would involve removing all items and personnel belonging to the contractor and handing over of the site to MEE. Prior to demobilisation and site handover site inspection by the officials of the MEE will take place to ensure that project has been completed to the full satisfaction of MEE and scope of work fully competed. The demobilisation shall also involve removal of all residual waste generated from the project and repairing of any public property damaged during the project. These will be the responsibility of the contractor.

2.4 OPERATIONAL PHASE

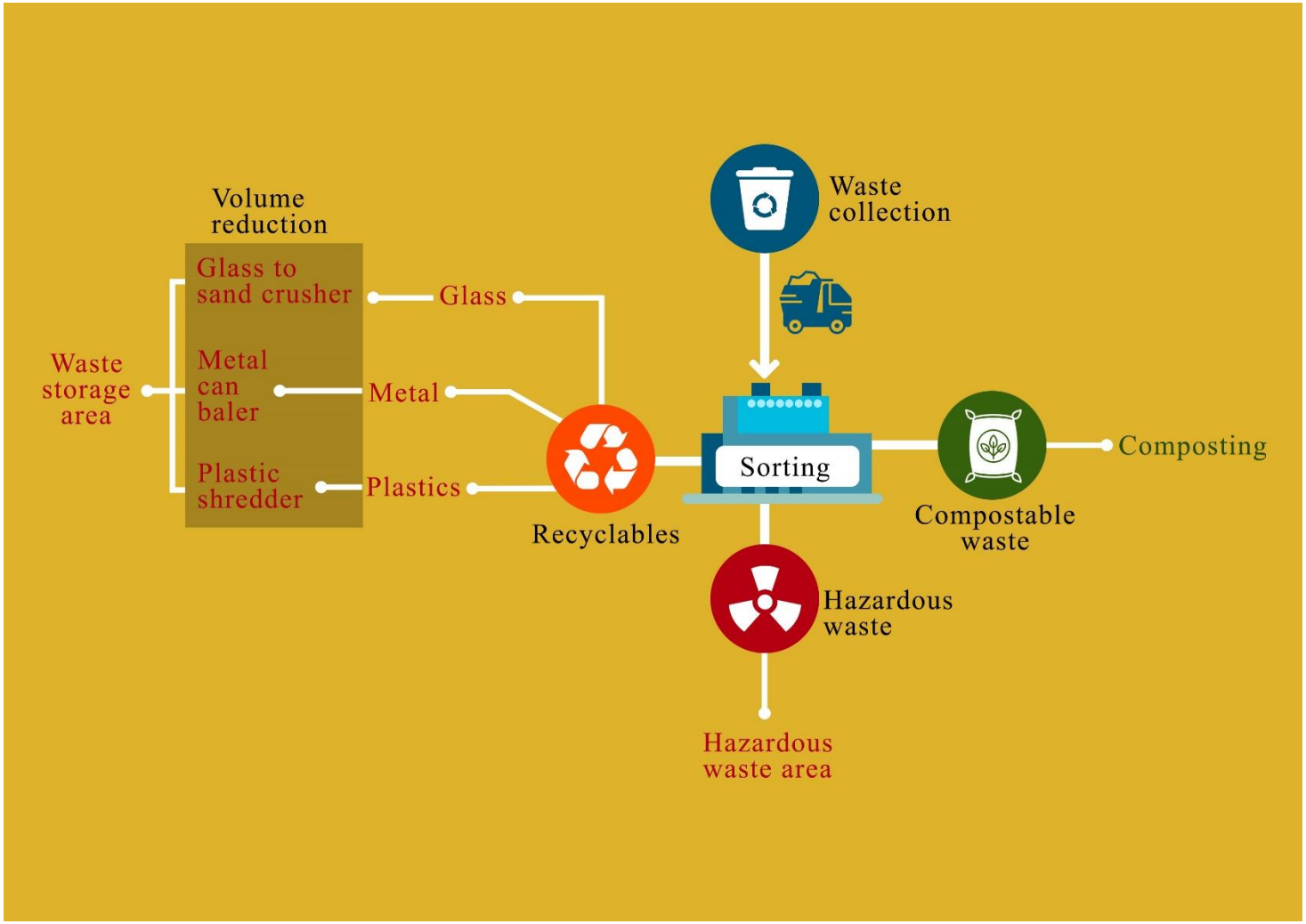

Figure 12: Operational phase flowchart of the IWMC of M Mulah

The following Section will briefly highlight the operational aspects of the IWMC. This includes the machinery and equipment proposed to be used in the IWMC, in addition to the main activities to be carried out at the IWMC and within the island. The IWMC activities begin from collecting waste generated at source and transporting it to the IWMC. This collected waste will be pre-sorted into categories such as compostable waste, recyclable waste and hazardous waste. Compostable waste is used in making compost while glass, plastics and metals undergo volume reduction processes before being stored in their respective compartments. The hazardous waste is stored in the hazardous waste compartment.

2.4.1 Machinery and equipment proposed

The IWMC will require general equipments and tools needed to handle the waste. These include wheelbarrows, garden hoes, shovels, buckets and cultivators. This equipment will be used during the IWMC operation for handling as well as composting operations. A manual rotary compost screen is also included for the screening stage of the composting process.

Other equipment required includes waste volume reduction equipment such as a plastic shredder, metal can baler, vegetation shredder, and glass to sand crusher. Typical equipment required is detailed below.

Table 9: Typocal equipment proposed for waste management works

Waste Management Equipment
Chainsaw
Wheelbarrow
Heavy Duty Gumboots
Heavy Duty Hand Safety Gloves
Long Handled Flathead Steel Rake
Long Handled Cultivator
Garden Hoe
Round Point Shovel
Square Point Shovel
20L Bucket
40L Bucket
Polypropylene Surgical Mask
Weighing Bench Scale
Wheelie Bins
Glass to Sand Crusher
Plastic Shredder
Metal Can Baler
Vegetation Shredder
Manual Rotary Compost Screen

2.4.2 Waste Collection

During the consultation meeting with the Mulah Council, it was learnt that the IWMC operational works will be conducted by the Council. The waste will be collected from source using a vehicle as per IWMP.

2.4.2.1 Sorting of Incoming Waste

Incoming waste is required to be sorted to separate biodegradable and non-biodegradable waste. The separation of kitchen waste, yard waste and other types of waste at household level can streamline this process. The IWMP of Mulah specifies that waste will be separated into 5 categories at household level.

Table 10: Domestic Waste Categories

Incoming Domestic Waste			
Biodegradable materials	**Hazardous materials**	**Others**	**Recyclables**
Organics • Food waste • Garden waste • Animal waste Paper & Cardboard • Printed paper • Cardboard	• Paints & Solvents • Batteries • Cleaners • Expired medicine • Medical waste • Pesticides • Special (Nappies, tampons)	• Textiles • Wood • Inert (Dust/Dirt/Ash/Rock) • Liquid container	• Metal • Plastic • Glass

As per the IWMC site layout plan, a slab is dedicated for the sorting area. Here, the collected waste will be kept, and further sorted into their respective categories. The IWMC is designed to have separate storage areas for reusable waste, metal, paper and cardboard, plastic, glass, and hazardous waste. After sorting, the waste is stored in the respective location.

2.4.3 Composting

One of the main operations that will be conducted in the IWMC is the composting of the organic waste such as kitchen waste and green waste. Composting uses the process of the slow decomposition of the organic matter by various microorganisms, in an optimised and controlled process. The process is controlled in terms of parameters such as input materials, temperature, moisture and pH. The finished product of composting can be sold as fertilizer, thus enabling the reuse of the waste collected within the island.

The main constituents of a compost heap include kitchen and garden waste, along with water and air in the pore spaces between the constituent.

2.4.3.1 The Composting Process

After the incoming waste is properly sorted into compostable wastes and other wastes, mixing of the compostable waste is done. This mixing is done to provide an optimum Carbon-Nitrogen ratio for the process to occur. Prior to mixing, if the waste contains branches, twigs and such, they are fed into a wood chipper to reduce their size. After the mixing is completed, composting process begins on the composting slab as an open windrow compost. After the compost matures, screening is done depending on the particle size of the compost required. This compost is bagged and stored. These steps will be elaborated below.

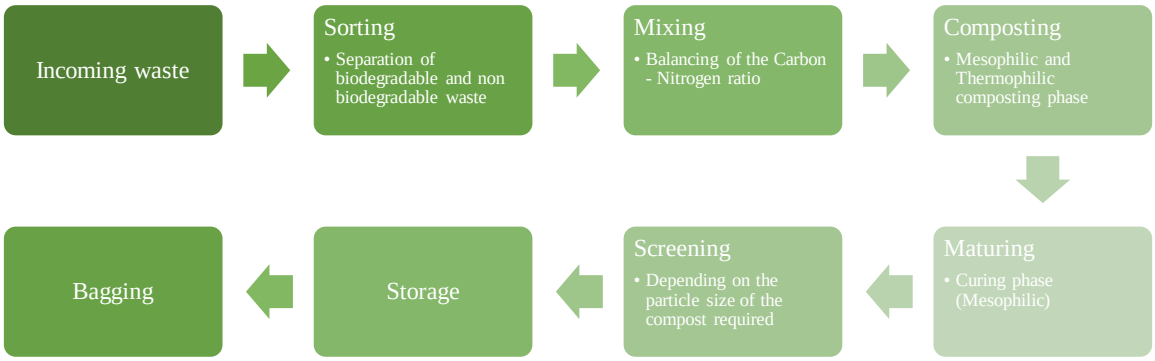

Figure 13: The composting process

2.4.3.2 Mixing (Carbon – Nitrogen Ratio)

One of the most important factors in the process of composting being successful is the Carbon – Nitrogen ratio. Carbon is used for energy by the microbes in order to continue with the decomposition, while Nitrogen is needed by the microbes to grow and multiply. The optimum Carbon – Nitrogen ratio is 25 - 30:1 (DEC NSW, 2004). If the ratio is less than 30:1, it would result in the loss of Nitrogen as ammonia gas which would result in undesirable odours. If the ratio is greater than 30:1, it results in the cooling of the compost and slow degradation of the pile.

Looking into the composition of compostable wastes from the Zone 1 Waste Audit, it is seen that the majority of compostable wastes constitute of garden (green) wastes. Garden wastes make up 64% of waste generated, while the second largest contributor to compostable wastes is kitchen wastes, at 28%. Printed paper and cardboard make up 5% of compostable waste while 2% of the category includes animal waste. This composition is important in determining the Carbon-Nitrogen ratio of the compost heap in order to provide optimum conditions for composting.

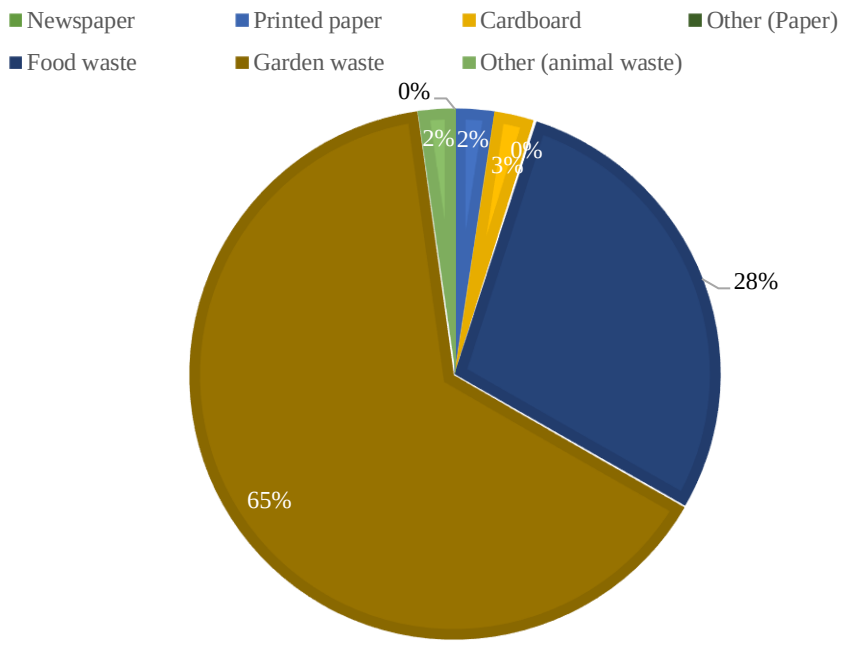

Figure 14: Composition of compostable waste for Zone 1

Table 11: Estimated compostable waste generation quantities of Zone 1

CATEGORY		Average Per Capita (kg/day)	Percentage
Primary	**Secondary**		
Paper & Cardboard	Newspaper	0.00	0.0%
	Printed paper	0.02	2.4%
	Liquid container	0.00	0.5%
	Cardboard	0.02	2.4%
	Other (Paper)	0.002	0.2%
Organics	Food waste	0.29	28.2%
	Garden waste	0.67	64.2%
	Other (animal waste)	0.02	2.2%
Total		1.04	100

Green wastes such as vegetable wastes (kitchen waste), and poultry manure have high Nitrogen values while brown wastes such as foliage, wood chips, bark and paper have high carbon values. From the waste audit, it is seen that 64.2% of the compostable waste produced is garden waste while 28.2% of the waste generated is food waste. Therefore, it can be said that the composition of compostable waste is in favour of providing a high Carbon content compared to Nitrogen.

2.4.3.3 Composting and Maturing

Thermophilic composting is the process of composting using thermophilic (heat-loving) bacteria. Thermophilic composting consists of three phases;

Table 12: The phases of composting

Stage	Temperature	Duration	Organisms
Mesophilic	Moderate, up to 40 °C	2 days	Initial decomposition is done by mesophilic organisms that thrive at moderate temperatures
Thermophilic	High, over 40 °C	Few days to several months	Mesophilic organisms become less competitive and replaced by thermophilic heat loving microbes. High temperatures break down proteins, fats, and complex carbs like cellulose and hemicellulose (major structural molecules in plants)
Mesophilic (curing or maturation phase)	Moderate, up to 40 °C	Several months	As the compounds decrease, compost temperature gradually decreases and mesophilic organisms take over again for the final curing of the remaining organic matter.

As seen from the **Table 12**, the composting process can prolong to several months.

2.4.3.4 Leachate Management

As the process of composting occurs, leachate will be produced from the organic waste within the compost pile. The composting will be done on the specially constructed compost slab. The bottom of the slab and ground beams in this area have an HDPE membrane between the reinforced concrete and the ground.

In addition to this, the expansion joints of the compost slabs are filled with silicone and polythene joint filler foam. This ensures that the leachate does not leak into the ground. The compost slab is also designed with a 1˚ slope from both sides, towards the centre, where the ground beam is fitted with a 100

mm PVC pipe cut in half with 1% slope towards the leachate collection tank. The leachate is then collected in the dedicated leachate collection tank at the end of the compost slab.

2.4.4 Volume Reduction

Prior to storage, volume reduction of the waste is conducted. This includes metal can baling using the metal can baler, plastic shredding using the plastic shredder, and glass bottle crushing using the glass to sand crusher. The resulting reduced volumes of the waste is then easily stored in their respective compartments.

2.4.5 Sewage management

The 'primary tank' facilitates 'primary treatment'. The separation of liquids and solids by gravity - to take place. Raw sewage flows into the tank and the heavy solids, 'sludge', sink to the bottom, lighter solids, grease and oils or 'scum' float to the surface. Some of the sludge is degraded by naturally occurring anaerobic (without oxygen) bacteria. The liquid effluent flows to the secondary tank which is filled up to 1 m with coral stone and white sand layer. This tank is perforated at the bottom 1 m to allow for discharge of liquid effluent into the land.

The most environmentally sound method for disposing the domestic sludge is allowing it for drying in a sludge drying bed. The dry sludge can be used following appropriate treatment, as part of compost. Sludge will be dried on a sludge drying bed.

2.4.6 Projected Capacity of the IWMC

The proposed IWMC is planned to manage a portion of the waste produced at the island level, with the unmanaged waste (approximately 30% of waste generated within the island to be transported to a central waste management facility). The projected capacity for 1 month's waste for the island of Mulah is shown below.

Table 13: Projected waste management capacity for the waste generated in M. Mulah in 1 month

Waste Type	Details	Amount	Unit
Organics	Composting capacity in IWMC. Assuming 1m height windrow with a width of 2m	97.5	m^3
	Organic waste generated per month	77.95	m^3
Paper waste	Storage capacity (4.3 by 4.15m compartment assuming height of pile 1.5m	26	m^3
	Waste generated bulk density after volume reduction 0.65 tons/m3	5.354	m^3
Glass	Storage capacity (4.3 by 4.15m compartment assuming height of pile 1.5m	26	m^3
	Waste generated bulk density after volume reduction 0.65 tons/m3	1.523	m^3
Plastics	Storage capacity (4.3 by 4.15m compartment assuming height of pile 1.5m	26	m^3
	Waste generated bulk density after volume reduction 0.65 tons/m3	6.923	m^3

Metals	Storage capacity (4.3 by 4.15m compartment assuming height of pile 1.5m	26	m^3
	Waste generated bulk density after volume reduction 0.65 tons/m3	1.385	m^3

Organic wastes make up the bulk of the waste stream in the island. The composting capacity of the proposed compost slabs (assuming a windrow of 1 m height and 2 m width at the bottom and 1m width on top) is approximated as 97.5 m^3. The calculated volume for the organic waste generated in a month in Mulah is 62 m^3 assuming waste is generated from the current population. Therefore; it is be expected that, less than 1.5 month's organic wastes produced in M Mulah would take up the composting capacity of the IWMC for the succeeding 4 – 6 months. There is no additional storage space for the organic wastes provided in the facility. Hence it is imperative waste from island is routinely transported to a regional facility.

2.5 PROJECT INPUTS AND OUTPUTS

The table below elaborates the approximate amount of resources that will be required for the project. These include workers, fuel, water, and construction materials.

Table 14: Project inputs

Stage	Input	Source / Type	Estimated Amount	Means of obtaining the resources
Construction	Workers	Local and foreign	10	Encourage the use of local / regional workers
	Fuel	Diesel		Local Suppliers
	Water	Groundwater for non-potable use	Average 150 l/p/d	Groundwater wells present in the island
	Materials	Concrete including reinforcement and formwork	78 m^3	Local Suppliers
		Masonry Works (150 mm bricks)	553 m^2	Local Suppliers
		Structural Steel		
		50mm GI Pipe for perimeter fence	57 m	Imported / purchased where available locally
		75mm GI pipe (structural columns)	10 Nos.	
		Truss	23.45 m	
		75mm GI pipe for flood light fixing poles	2 Nos	
		Paint		
		Emulsion paint coating	1105 m^2	Local suppliers

		Electrical Components		
		3 Phase power sockets	6 Nos.	Local suppliers
		20W LED lights	7 Nos.	
		18W LED lights	3 Nos.	
		Ceiling fan	3 Nos.	
		AC	1 Nos.	
		Exhaust fans	4 Nos.	
		Well water pump	1 Nos.	
		200W flood light	2 Nos.	
		Metal doors for		
		Equipment room	1 Nos.	Local suppliers
		Hazardous waste area	1 Nos.	
		Waste yard entrance	1 Nos.	
		Plumbing		
		Fresh water pipe network and plumbing fixtures		Local suppliers
		Roofing		
		Lysaght roofing sheets	286.6 m^2	Local suppliers
		Flashing sheets	86.4 m	
		Lysaght gutter		
		Timber beams 150x75mm	59.7 m	
		Timber beams 100x50mm	318.47 m	
		Timber beams 50x38mm	477.70 m	
		50x50 PVC coated mesh fence	138.93 m^2	Local suppliers
		HDPE membrane	238 m^2	Imported / purchased where available locally
		Timber top cover	3 nos.	Local suppliers
		PVC pipe for leachate tank drain	15 m	Local suppliers
		600 x 900 5mm plastic sheet signboard	1 Nos.	Local suppliers
		Firefighting equipment and fire alarm system	1 Nos	Local suppliers
		Septic tank	1 Nos	Materials from local suppliers
Operation	Equipment and Materials	IWMC tools	1	Imported / purchased where available locally
		Weighing Bench Scale	1	
		Glass to Sand Crusher	1	
		Plastic Shredder	1	
		Metal Can Baler	1	

		Vegetation Shredder	1	
		Manual Rotary Compost Screen	1	
	Waste	Waste generated within the island	Approximately 1.9 ton of waste per day	Waste collected by vehicle from the waste bins within the island
	Fuel	Diesel	5000-15000 L/month	Local suppliers
	Water	Freshwater	200-1000l/day	Groundwater

Table 15: Project outputs

Stage	Output	Source / Type	Amount	Means of managing
Construction	Road	Sand surfaced	3060 m^2	N/A
	Land plot for IWMC	Cleared land for construction of IWMC	825 m^2	N/A
	Removed Coconut palms		65 (for site) 107 (for road)	
	Removed mature trees (other than coconut)		5 (for site) 6 (for road)	
	Soil	Excavation for substructure	8.30 m^3	To be used back in the levelling and backfilling of site.
	Construction Waste	Construction works	Moderate amount of construction waste	Transfer all waste to nearest Waste management facility
	Yard waste from site clearance	Yard waste While a great Emphasis is placed on relocating, trees some trees and branches may have to be removed and preferably used as timber or discarded as yard waste.	Approximately 5-10 tons	See **Section 2.3.16** for details
	Hazardous waste	Construction and clearing of vegetation	Moderate amount of hazardous waste	See **Section 2.3.16** for details
	Municipal waste	Workers	346.5 kg	See **Section 2.3.16** for details
	Dust	Excavation	Moderate amount of dust	
		Cement mixing	Moderate amount of dust	
	Greenhouse gases	Machinery	Moderate amount of GHG from direct and indirect emissions	
		Concreting works	Moderate amount of GHG from direct and indirect emissions	
		Reinforcement	Moderate amount of GHG from	

			direct and indirect emissions	
		PVC Pipes	Moderate amount of GHG from direct and indirect emissions	
Operation (based on presumption the IWMC will be fully functional without major issue)	Compost	Open windrow composting	39 m^3 of compost per full batch	Sold as fertilizer
	Green waste	Residual		
	Crushed Glass	Glass crusher	1.14 ton per month	Crushed glass stockpiled in the IWMC compartment prior to sale. Unmanaged waste transferred to central waste management facility
	Compacted Metal	Metal baler	0.57 ton per month	Compacted metal stockpiled in the IWMC compartment prior to sale. Unmanaged waste transferred to central waste management facility
	Shredded plastic	Plastic shredder	2.9 ton per month	Shredded plastic stockpiled in the IWMC compartment prior to sale. Unmanaged waste transferred to central waste management facility
	GHG	Electricity usage		N/A
	Sewage	Workers	Approx 180 l/day/person	See **2.4.5**

3 EXISTING CONDITIONS

3.1 DESCRIPTION OF THE ENVIRONMENT

M. Mulah has a land area of 68.4 ha. The island's community of 1746 people has a settlement footprint of 23.2 ha. This is 34% of the island's total land area. There is a patch of wetland with an area of 2.46 ha located on the eastern side. Approximately 32.2 ha of the island is covered with natural vegetation

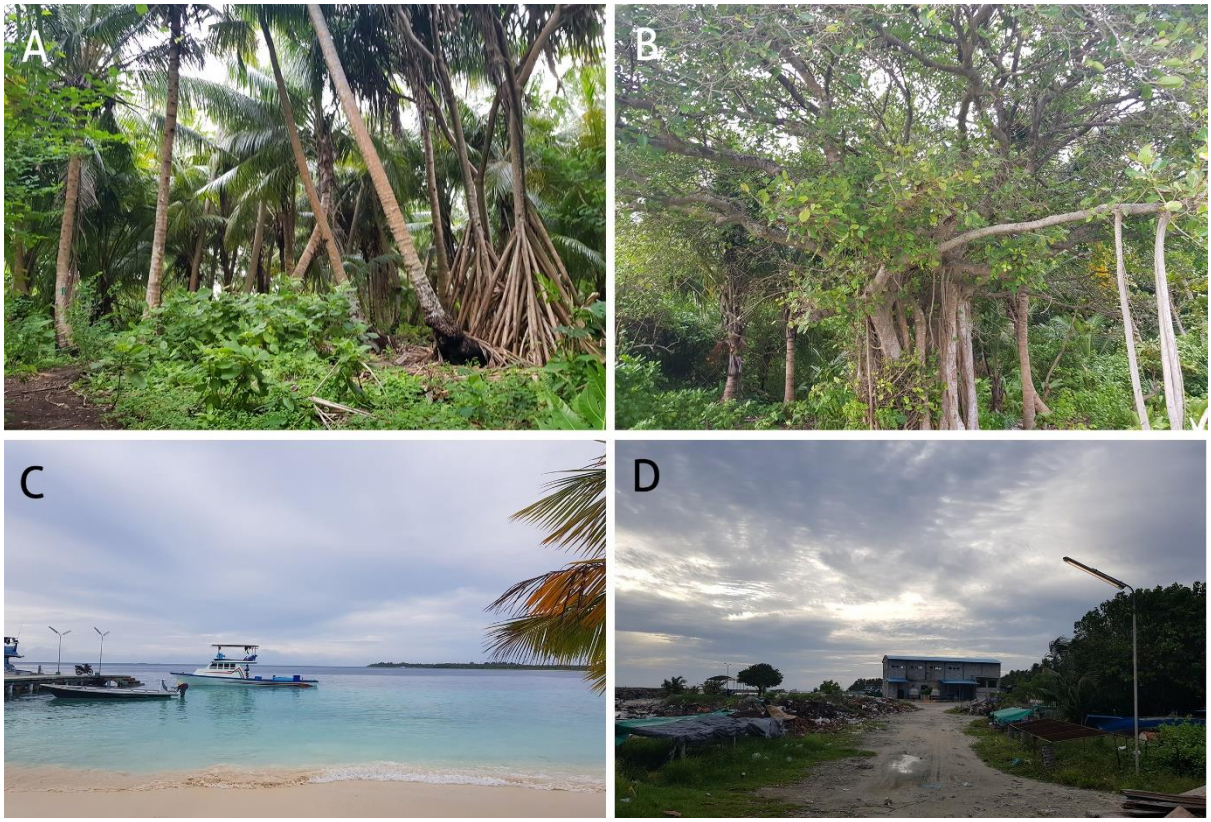

Figure 15: A and B: Terrestrial vegetation at M. Mulah C: Jetty on Northern side of the island D: Current waste dump east of the islands harbour

The coastal area close to the project site was observed to have a stable beach with a low gradient. Exposed beach rock outcrop was observed in high abundance in this area. A healthy coastal vegetation belt was present in the area.

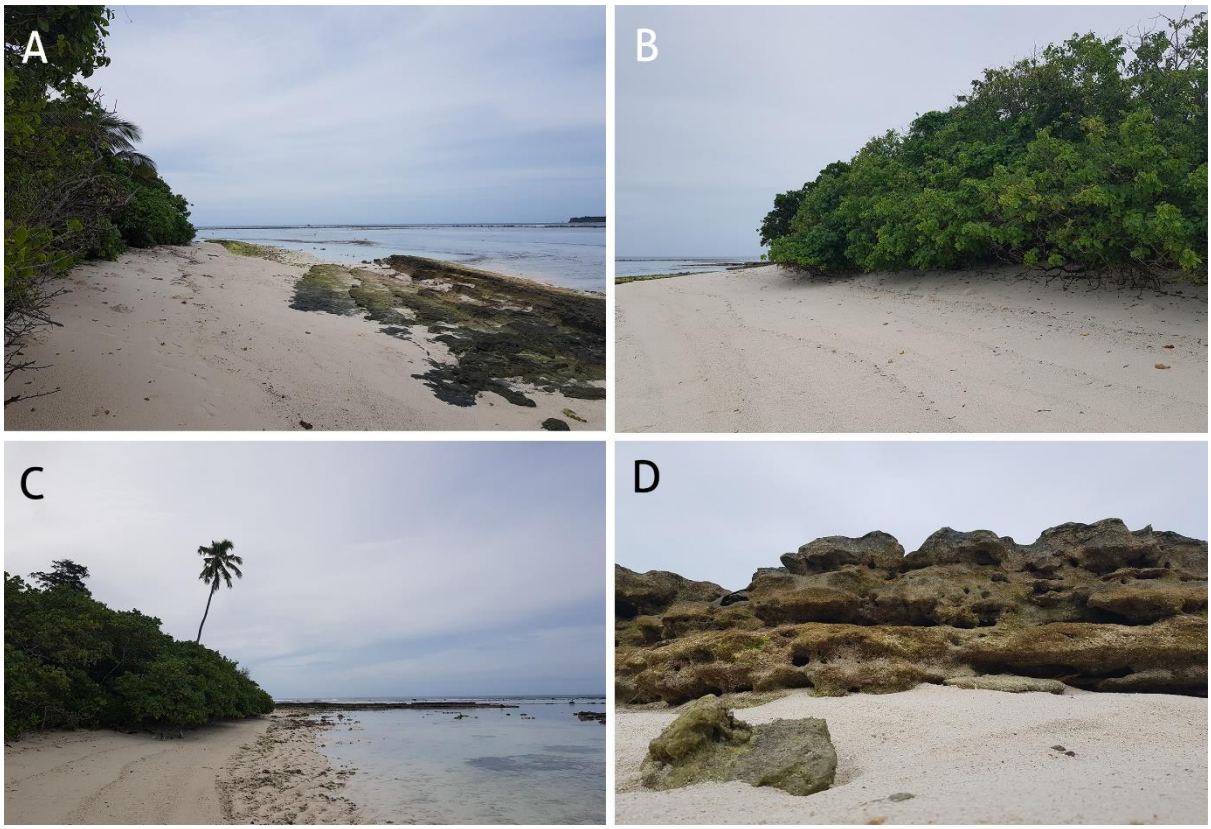

Figure 16: A,B,C and D: Coastal features close to the project site at M. Mulah

3.2 PROJECT SITE

The proposed site for Island Waste Management Centre (IWMC) is located at the southern side of the island. The project site was selected by a rigorous process involving the Maldives Land and Survey Authority of the MHI. EPA's "Environmental Guideline for Site Selection of Waste Management Centers (Sep 2017) is referred to during the site selection process.

The site measures an area of 825 m^2 which requires vegetation clearance. As described earlier in the report there is no cleared access route to the site, hence the island council has planned to develop a new access road which measures approximately 510 m in length and 6 m in width that connects to the islands existing road network. The development of this road had already been approved by the Ministry of Housing and Infrastructure according to the Island Council, and therefore is not expected to require additional planning permission.

The proposed road requires extensive vegetation clearance. Trees observed in the area include *Terminalia cattapa* (midhili), *Psidium guajava* (feyru), *cocos nucifera* (Dhivehi ruh), *Hibiscus tiliaceus* (Dhigga) and some undergrowth. It is estimated that 65 coconut palms and 5 other trees will require removal from the site, while 107 coconut palms and 6 other trees requires clearance to make way for the proposed road. Furthermore, some vegetation undergrowth require clearance. Hence in the worst case scenario a total of 183 mature trees will be eliminated from the island as direct and indirect effect of the project assuming no tree that falls within the footprint of the road and IWMC site is salvaged. The total percentage of the vegetated area cleared (road + site) would therefore be 1.2 % of the island's existing vegetated area. Hence, this amount is not considered to be significant considering the remaining vegetated area of the island even after the land clearance works. No rare, protected or endangered tree will require cutting or removal as a result of the project.

Figure 17: A, B, & C: Vegetation at the proposed site

3.3 WETLANDS

A wetland of approximately 2.46ha is located on the islands eastern side. This makes up approximately 7% of the islands natural vegetation. It should be noted that the exact boundaries of the island's wetlands have not been surveyed during the visit, and approximate areas have been determined with the use of satellite imagery and approximate boundaries provided by the Island Council. The wetlands at M.Mulah are densely vegetated. Common plants in the area include Coconut palms (*Cocos nucifera*), Red bead tree (*Adenanthera pavonina*), Screwpine (*pandanus*) and mangrove plants *Bruguiera cylindrica* and *Rhizophora mucronate*.

Figure 18: Wetlands of M. Mulah

3.3.1 Site zoning guidelines by EPA

The EPA has provided guidelines for the optimum zoning of the IWMC site. The distances include, the site being at least 20 to 30 m from the coastal vegetation belt, at least 30 m from the nearest freshwater well, at least 40 m from the nearest recreational area and at least 30 m from the wetlands area as well as the residential area. The field surveys done on the island recorded the locations of the aforementioned categories and the comparison table for the actual distances and EPA guidelines are provided below:

Table 16: Comparison between the proposed site location and EPA guidelines

Location	Distance from site (m)	EPA Recommended Distance (m)
Coastal vegetation	54.5	20 - 30
Freshwater well	374.3	30
Recreational area	40+	40
Wetlands	147.1	30
Residential area	374.3	30

As seen on
Table 16, the proposed plot is located 54.5 m from the shoreline and 374.3 m from the nearest residential areas. The site is 147.1 m away from the closest wetland area, therefore it fulfils the EPA and MLSA recommended buffers. The site meets all the recommendations of the EPA and MLSA.

3.4 STAKEHOLDER CONSULTATIONS

Stakeholder consultations were held for the project with Island Council of the project island. Highlights of the meetings which apply to the ESMP islands are presented below. Consultation attendances are provided in **Annex 3.**

3.4.1 Meeting with Island Council

- There is no proper waste management site at the island. Currently waste is dumped near the beach on either side of the harbour. Waste scattering into the islands lagoon is a pressing issue with the current waste management practice.
- The island is accessible via the islands harbour and also a small jetty located on the northern side of the island. The areas to east of the Jetty can be used as an access point for landing crafts.
- Separation of waste is not practiced.
- Previously unmanaged waste has been buried at the current waste dump areas.
- The island conducts industrial activities such as fibre boat building, production of dried fish. ice plant. Agriculture is done sparsely. Although council is currently in the process of allocating land for agricultural purpose.
- The council identified the large residential footprint as a challenge in managing waste and foresees this to be an issue after the IWMC comes into operation as well. With the council expecting 2 pickups to be required to be in operation simultaneously every day in order to collect waste from all of the islands households.
- The council also identified their own financial and technical capabilities as being below the required levels for sustainable operation of the IWMC. The council stated that their main concern is that the IWMC would not be operated under the existing financial capacity and it would turn into a waste dumpsite. Even with expected income from compost production, and monthly fees from households, the council states that budget support from the government may be required.
- The islands waste management plan has been completed and gazetted. GRM forms will be available at the council and a focal point has been selected by the council. The council is also working on launching its Facebook page, which will also make publish the grievance form.
- Road clearance permits for construction of the access road have been acquired by the council. The road was planned to be cleared as part of the sewerage project. However, construction of the road was postponed.
- There are privately owned palms falling on the IWMC site and access road the loss of which will be compensated by the Council.

4 ALTERNATIVES

This section explores alternatives for the proposed project. The proposed options are compared with alternatives in detail. When comparing the alternatives, environmental, economic and social considerations were taken into account.

4.1 NO DEVLOPMENT OPTION

In the case of no project option, all foreseeable negative impacts as a result of the site clearance, construction, and operation of the IWMC can be avoided. However, no project option would also mean continuation of the poor state of waste management in the island (See **Section 1.6**). The people would continue to engage in unsustainable waste management practices. The island would not have an approved demarcated waste management area, waste would continue to be dumped in open areas deteriorating, beaches, open spaces, lagoons and reefs. Allowing existing practices to continue would also mean no resource recovery and ultimately all resources getting lost in the "waste". Allowing open dumping waste with no management would also mean increasing risks to human health, lowering aesthetic qualities and lowered quality of life. The aspiration of the people to move in the path of sustainable development would also be compromised. The positive effects of proceeding with the project far outweighs negative impacts associated with the project which can be managed and kept at an acceptable level. Hence, no development option of the project is rejected. **Table 17** below shows comparison of no development option with the development option at M. Mulah.

Table 17: Comparison of the no development option with development option

Option	Environmental	Social	Economic
No Project Alternative	All negative impacts associated with project avoided, however, the island environment may continue to slowly deteriorate due to pollution as a result of poor waste disposal. Land area will be rendered unusable or will be polluted by the residual waste remaining after burning and burying waste. Seepage of leachate into groundwater film as a result of burying waste in excavated pits. Risk of waste piles sliding as a result of heavy rain or flooding events. Increased pollution of beaches, lowered aesthetic values, pollution of the lagoon and coral reef.	Benefit to the society by the project will be missed and chances of polluting the island is high which could lead to health implications as well as visual negative impacts. Risk of waste coming into direct contact with children. Without a proper waste management system there is a risk of the island turning into a slum as a result of population increase and economic developement.	No significant improvement to the local and regional economy. Jobs and income earning opportunities expected as a result of the project will not realize.
Project Alternative			
	The project will result in loss of large trees and coconut palms. Vegetation clearance will be required for the plot as well as for the road. The process of cutting down of trees and clearance of land will change the exiting environment of the affected area. Alteration of the existing vegetation will result in affecting the fauna associated with the vegetation. Cutting down of trees will also result in minor climatic impacts. However, changes to the vegetation is not considered significant as it would affect approximately 1% of the existing vegetated area of the island. No protected species or habitat will be lost. All impacts can be managed and maintained at acceptable level.	Increased direct and indirect employment opportunities for the locals during the construction phase in addition to when the IWMC and waste management system becomes operational. Knowledge transfer and development of technical capacity with regard to waste management and compost making. More resources and manpower to manage the island would become available as a result of the project. The aesthetic qualities of the island would improve and thereby promote healthy and more enjoyable life on the island.	Enhanced opportunity for locals to start and diversify tourism related services, since a safe and clean island would facilitate attracting visitors to island. Creation of job opportunities and development of skills. Development and expansion of agriculture in the island as more and more people are expected to take an interest in agriculture sector when quality compost becomes easily available. Price and profit from agricultural produce will become more competitive due to availability of compost.

	The project will control and prevent further pollution of the environment, and thereby promote sustainable development of the island.	During the operational phase of the project, smell, dust and particulate matter especially from composting activities may be emitted from the IWMC. However due to the isolated nature of the site to the populated area of the island such impacts are not expected to be significant.	Potential to get income by selling compost etc. which would develop the island's economy.

5 ASSESSING THE LIKELY IMPACTS AND MITIGATION MEASURES

5.1 IMPACT METHODOLOGY, NATURE AND IDENTIFICATION OF IMPACTS

The main objective of this report was to assess all negative and positive impacts of the Project on the project on the environment in a logical and systematic manner and to describe actions that will be taken to avoid or minimize the significant impacts to enhance the benefits of the Project. As the first step, for effectively to determine and evaluate the impacts right mix of expertise in relevant disciplines was chosen. This was followed by a number of critical steps such as, defining the spatial boundary of the study area, identifying specific areas for detailed study to understand the baseline environment. It also included, a number of specific stages in the preparation of the EIA namely screening, scoping, characterization of baseline environment, determining project sequence, activities and methodology, alternatives evaluation and review of relevant laws and policies.

5.2 IDENTIFYING IMPACTS AND ANALYSIS

Impact definition used in the report has been adapted from the United Nations Environment Program (UNEP, 2002). Accordingly, an impact or effect used in the current assessment implies the change in an environmental parameter, which results from a particular activity or intervention relating to the proposed Project. Thus the change or the impact is the difference between the environmental parameter with the Project compared without the Project (baseline) measured over a specified period and within the Project location (UNEP, 2002). In identifying and predicting impacts 'best estimates', past experiences, professional judgments, references, and information collected from stakeholder discussions were the main methods used.

As explained, understanding the baseline condition of the Project environment and determining the extent of an impact were critical initial steps in impacts. The overall methodology applied in studying the baseline conditions included collecting information from the field and review of available relevant literature including reports, other related studies and data source. In addition, information obtained from discussions with the stakeholders was also used to characterise specific aspects of the study area. Spatial extent of the affected area/study area was determined by relevant guidance obtained during the scoping meeting, discussions with the stakeholders and professional judgment of the consultant's team.

A modified Leopold matrix was applied in evaluating the impacts identified. The Leopold matrix, which is widely applicable in carrying out an EIA for different types of projects has been chosen as a suitable method for predicting impacts of the proposed project. A clear advantage of using the matrix 'as a checklist or reminder' of the large scope of actions and impacts on the environment that can relate to the proposed actions (Leopold et al., 1971). According to the Leopold matrix method, EIA should consist of three basic elements: a) a listing of the effects on the environment that the proposed development may induce, including the estimate of the magnitude of each of the effects; b) an evaluation of the importance of each of listed effects (e.g., regional vs. local); and c) a summary evaluation, which is a combination of magnitude and importance estimates.

In order to achieve higher efficiency of the matrix, a starting point is to check each significant action listed in a horizontal axis. The experience often proves that 'only about a dozen actions will be important' (Leopold et al; 1971). Each checked action is evaluated in terms of magnitude of effect on environmental factors that are listed in the vertical axis. In the matrix, across each box where significant interaction is expected, a slash (/) is placed diagonally from upper right to lower left angle of the block. In the text which accompanies the Leopold matrix, the evaluator has to indicate whether the assessment is for short-term or long-term impacts. Then, in the upper left-hand angle of each box with a slash, the evaluator should place a number from 1 to 10, which indicates the magnitude of the possible impact, where 10 represents the greatest magnitude of impact and 1 the least (no zeros should be assigned). The scale of importance (placed in the lower right-hand angle of each box with a slash) may also range from

1 to 10, with the same principle applied – the higher the value, the higher the importance. Assignment of numerical value for importance is based on subjective judgment of a multi-disciplinary team working in the EIA. In addition to assigning the numerical values to each marked box, plus (+) or minus (-) sign can be used to show whether an impact is beneficial or adverse.

In this regard, for the analysis of possible impacts of certain activities and procedures during the construction and operation of the island waste management centre, 11 possible activities on the realization of the proposed project, have been identified from a wider list of potential factors of impacts that can be expected for such type of interventions in the environment. Although it is possible to partially determine aggregate, i.e. average assessment of impact factors for each of these components, it is sufficiently appropriate and functional to present them as a whole. The fact is that some of them are synergistic ones, mutually reinforcing their effects, so that this matching of information should be maintained in the analysis. A synthetic presentation of endangering factors is given through mean values and not through aggregate assessment, which will be later scaled.

Furthermore, physical, biological and socio-cultural environmental characteristics of the subject location have been separated and, within them, 14 environmental components have been defined.

The significance of impacts is based on the calculated magnitude score for total impact area and impact activity. The significance is assigned based on the following total impact magnitude ranges. For ease of identification these ranges have been colour coded as shown in the (***Table 20***)**.**

The steps involved are briefly summarised below:

- All Project related actions identified;
- associated environmental characteristics for each action identified;
- the magnitude of the impact was then determined by applying a number from 1 to 10 (1 is the minimum and 10 the maximum). This number is placed in the upper left hand corner in the corresponding box of the matrix, representing the scale of the action and its theoretical extent. A plus (+) was used for positive impacts and a minus (-) was used for negative impacts; in the lower right hand corner of each cell a number from 1 (least) to 10 (most) to indicate the importance of the impact was placed. It then gives an evaluation of the extent of the environmental impact according to the judgement of the EIA team; and
- the significance was then determined by the joint consideration of its magnitude and the importance (or value).

These two factors have been applied as per the definitions given below.

Importance

In comparing relative importance of environmental impacts, the impacts have been characterised by considering the following;

- Duration over which the impact is likely to occur (temporary, short term, long term, permanent);
- timing or when the impact is likely to occur;
- spatial extent of the impact (such as on-site, local, regional, or national);
- frequency or how often the impact is predicted to occur;
- intensity (negligible, low, medium, high); and
- likelihood (certain, likely, unlikely, likely or very unlikely).

Magnitude

Magnitude of the impact was expressed in terms of relative severity, such as major, moderate or minor/negligible. In determining severity other aspects of impact magnitude, notably whether or not an impact is reversible and the likely rate of recovery are also considered. Hence, the following equation was used to determine the impact significance (UNEP, 2002).

$$Impact\ characteristics\ (magnitude)\ \times\ Importance\ (value) = Impact\ significance$$

The scores obtained for the magnitude of each of the impacts (both positive and negative) were categorised as given in **Table 18**.

Table 18: Categorization of the significance

Total magnitude score	Category
> 40	Major positive
20 to 39	Moderate positive
1 to 19	Minor positive
0	Negligible
-1 to - 19	Minor negative
-20 to - 39	Moderate negative
>- 40	Major negative

Significance categories given in **Table 18** is defined as explained in **Table 19**.

Table 19: Impact characterization matrix

Significance	Characteristics	
Major	An impact of major significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. A goal of the EIA process is to get to a position where the Project does not have any major residual impacts that would endure into the long term or extend over a large area.	Requiring appropriate mitigation measures
Moderate	An impact of moderate significance is one within accepted limits or standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable.	
Minor	An impact of minor significance is one where an effect will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value.	

Different colour codes have been used in the impact matrix to distinguish between positive and negative impacts as depicted in **Table 20**.

Table 20: Colour codes used for distinguishing positive and negative impacts

Significance categories	Colour code
Major positive	
Major negative	
Moderately positive	
Moderately negative	
Minor positive	
Minor negative	
Negligible	

Cumulative Impacts

Cumulative impacts which may be defined as impacts that result from incremental changes caused by other past, present or reasonably foreseeable activities together with the project are generally considered in the impact assessment studies. The environment where the proposed IWMC will be situated is relatively undeveloped area and no projects have been planned for the immediate future. Hence the proposed approach for assessing cumulative impacts was to consider those that had already been completed. In this regard, the only foreseeable cumulative impact of the project had been identified to be in relation to the electricity consumption. Power needed for the IWMC will be sourced from the island's existing power network. Considering the equipments that will require electricity at the IWMC, it is envisaged that it would not have a significant impact on the island's power system. Long term additional power usage will have a cumulative impact on the greenhouse gas emissions which can contribute to climate change. However such cumulative impacts on climate system are believed to be insignificant.

Impact Mitigation

EIA regulation requires practical and appropriate mitigation measures for significant impacts identified to be proposed in the ESMP. The Proponent is required to submit a letter of commitment in the ESMP report stating that all the mitigation measures proposed in the report will be implemented during all phases of the Project. Hence full implementation of the mitigation measures is considered an important condition for issuing the ESMP decision statement to proceed with the project. For each identified significant negative impact in proposing mitigation measures the priority was given to avoidance of a predicted impact by taking measures such as bringing changes to the design and/or work methodology. In cases where avoidance of an impact was not possible practical and cost effective measures have been proposed to reduce the impacts and enhancing positive impacts. Practical experience and lessons learnt by the ESMP team from projects of similar nature played a key role in proposing mitigation measures.

In addition to predicting impact of the project on the environment, impacts of the environment on the project components for ensuring sustainability of the project was also considered.

Gaps in Baseline Information

Accurate impact assessment demands accurate baseline information collected over a reasonable period of time. However, even with the best effort to collect all relevant primary data required, inherent challenges make it almost impossible to have all such information collected within a relatively short period of time available to complete the assessment within the contract period to complete the study. Hence in certain cases it becomes necessary to make assumptions when limited or no information is available.

Understanding of the baseline conditions in studying existing environment was limited to a short period of time. Collecting all necessary environmental information is rarely possible due to time and cost constraints and therefore, the data captured is representative of the conditions at the time of the surveys.

In the case of the present study, the data gaps have been adequately filled by experiences and lessons learnt from similar projects carried out in the Maldives.

Gaps in Understanding Impacts

Impact identification, characterization as well as significance analysis also involved uncertainties as ideally such an exercise should take place against a framework of criteria and measures established for the purpose in the relevant legislation which is not the case in the Maldives at present. Specified criteria necessary for impact evaluation such as environmental standards and thresholds are yet to develop in order to strengthen the EIA process in the country. In order to address these gaps, where impact magnitude cannot be predicted with certainty professional experience and scientific literature was used and adapting criteria and measures from elsewhere that are relevant to local circumstances was used. In cases where a greater degree of uncertainty is believed to exist precautionary approach had been adopted in which likely maximum impact was considered.

Lack of compressive baseline information on all aspects of the Project environment was a critical setback in predicting impacts. However, developing and operating island level waste management centers is not uncommon in the Maldives and a lot of experiences have been gained in terms of actual impacts associated. Hence, in the case of present project uncertainties associated with the most significant impacts could be considered relatively small.

5.3 POTENTIAL IMPACTS AND MITIGATION MEASURE FOR KEY IMPACTS

For every minor to moderate to major impact identified, a mitigation measure has been proposed and discussed below. The mitigation measures proposed would be strictly adhered to eliminate environmental impacts arising from the project, even before it occurs. The impacts and mitigation measures are detailed in the two stages, construction and operational stages as explained below.
The possible mitigation measures include:

a) Changes in work practices and increasing awareness;
b) Provision of environmental protection and health safety equipment; and
c) Environmental monitoring during construction phase and operational.

Mitigation measures suggested in the report will focus on the existing environmental conditions as well as impacts that may rise during operation of the IWMC.

Table 21: Impact Matrix for Construction Phase									
	Envisaged impact factors	C1 Worker Influx and Settlement	C2 Transportation of materials	C3 Site Demarcation & Fencing	C4 Site Clearance and Earthworks	C5 Construction	C6 Waste Generation	C7 Resource Consumption (Water, Electricity)	Total (Impact Area)
Physical Components	Seawater	-2	-2				-3		-7
		1	3				4		8
	Ground water	-2			-6	-4	-4	-5	-21
		1			3	4	4	5	17
	Air	-3	-3	-2	-6	-3	-5	-3	-25
		2	3	2	4	3	4	3	21
	Noise	-2		-1	-3	-3	-2		-11
		1		2	3	3	2		11
	Coastal Zone							-1	-1
								1	1
Biological Components	Flora	-2	-1		-6	-2	-4	-3	-18
		2	3		4	2	5	2	18
	Endangered species/protected areas		-2		-3				-5
			2		5				7
	Coral Reef						-1		-1
							1		1
	Fauna		-2		-6	-4	-3		-15
			2		4	3	3		12
Socio-Cultural Component	Aesthetics	-2	-3		-4	-5			-14
		2	3		3	5			13
	Accidents	-1	-7	-2	-6	-6	-2	-1	-25
		1	5	1	7	4	2	1	21
	Landscape				-5	-7		-6	-12
					6	7		4	13
	Health/Well being	-1	-5	-1	-4	-5	-5		-21
		1	5	2	3	3	6		20
	Local economy	4	4	1	4	7		-2	18
		1	4	2	6	5		2	20
Total (Construction Activity/Risk)		-11	-21	-5	-45	-32	-29	-21	
		12	30	9	48	39	31	18	

Summary of the multi-criteria analysis is given in **Table 22**

Table 22: Summary of multi-criteria analysis for construction phase

Activity	Impact Score	Overall Impact
C4 Site clearance & earthworks	**-45**	**Major negative**
C5 Construction	**-32**	**Moderately negative**
C6 Waste generation	**-29**	**Moderately negative**
C7 Resource consumption	**-21**	**Moderately negative**
C2 Transportation of materials	**-21**	**Moderately negative**
C1 Worker influx & settlement	**-11**	**Minor negative**
C3 Site demarcation & fencing	**-5**	**Minor negative**

5.3.1 Impacts and Mitigation from Construction Phase

5.3.1.1 C4 Site Clearing and Earthworks

During the construction phase among all activities expected to take place, vegetation clearance, by far, is expected to have the most negative effect on the environment. It is estimated that 172 mature palm trees and 11 other types of mature trees will be removed from the island in order to clear the IWMC plot and access road under the scenario where no actions are taken to mitigate or salvage trees falling onto the direct footprint area of IWMC plot and access road.

Overall, the multi-criteria impact magnitude for this activity was -45, which meant that it will have a major negative impact. Trees will be removed for creating space for the waste management centre and to create access road (See **Section 2.3.4** for details of tree removal method). Approximately 0.39 ha of vegetation is expected to be lost as result of the project activities which accounts for 1.2 % of the existing vegetated area. Although in relation to the island the percentage is considered small, the impact has been considered to be significant due to the absolute number of commercially important coconut trees that need to be felled. In addition removal of vegetation will inexorably change the natural façade of the island and adversely affect its natural ambience in relative proportion. Consequently, reduction of habitats available for nesting and roosting birds and endemic bat is expected. Cutting down of trees will destroy any nests on trees and will directly affect invertebrates and microorganism that live on the trees. Clearance of undergrowth will affect microorganisms and micro-climate of the area. These impacts however, will not result in the loss of any significant animal species, and birds and bats may get adjusted to the changing environment and may avoid areas of heavy disturbance and occupy less disturbed areas of the island or move to another island nearby. Earthworks such as trenching and digging will alter the habitat impacting the structure of soil and organisms that occupy the affected area. Land clearance will also involve removal of undergrowth which will be stockpiled and burned. Trees that require removal shall be labeled and identified during the site demarcation.

The environmental impacts to the island resulting from the removal of trees can include, damage and death of trees. Loss of trees can directly affect the nests and nesting birds on such trees and destroy habitats for invertebrates that live on trees. Tree removal can alter the visual landscape of the island. Trees provide numerous eco-system services. They help reduce, storm water runoff, wind penetration and air pollution. Trees, prevent and reduce soil erosion which is one of the major issues currently faced by Maldivian islands. Trees maintain groundwater quality, and keeps the land fertile. Removal of trees, could increase surface salinity of groundwater. They are a habitat for animals and act as a food source. They enrich soil nutrient, facilitating growth of different types of trees. Maldivian soils are generally weak in nutrient. The typical concentration of total nitrogen in soil samples tested in Maldivian islands

hovered at 1140 mg/kg (ALS Scandanavia AB, 2015)[1]. Nitrogen content decreased rapidly, at the bottom soil layer where, concentration hovered at 209 mg/kg. Hence removal of trees would reduce the thickness of organic topsoil. Addition of fill material which usually consists of coralline sand and rubble to cover root bulb cavities and use of fill material to level the road would further deplete the organic top soil and interfere with the natural bioturbation of the soil. Since the root systems of coconut palm trees are embedded deep into the ground, removal of the root system may expose the groundwater below, which will be sensitive to pollution (Meerow & Broschat, 2003).

Forests and tree plantation crops are particularly important as carbon reservoirs because trees hold much more carbon per unit area than other types of vegetation (Lasco et al., 2002; Lamade & Bouillet, 2005). Coconut, being a perennial tree crop with 50-60 years of economic lifespan, has a potential to act as a carbon sink (Jayasekara & Jayasekara, 1995); (Ranasinghe & Silva, Photosynthetic assimilation, carbohydrates in vegetative organs and carbon removal in nut-producing and sap-producing coconut palms, 2007) and their potential to sequester carbon and the net carbon exchange rates were found to be in the range of 0.4 –1.9 Mg C ha^{-1} $month^{-1}$ (Ranasinghe & Thimothias, Estimation of carbon sequestration potential in coconut plantations under different agro-ecological regions and land suitability classes, 2012). In this regard, removing mature trees imply reducing the potential of the island's vegetation to act as a carbon sink.

Palm trees hold cultural and economic value. Coconut palm tree is a national symbol which is integrated to the national identity. All parts of the coconut palm tree are utilised in the Maldives. They provide wood for construction, leaves for shelter and fruits as food and fibre for rope making.

The method proposed to remove trees has inherent risks which may result in accidents. If trees are not removed with precaution they may potentially damage adjacent plants/equipment/people. Secondary impacts of the activity include air pollution and propensity for accidents as a large excavator will be used to remove trees. Health implication are also prominent as there is a risk of falling trees/coconuts and accidents due to electric saws which will be used to separate the crown and root.

The project will however not result in a loss of protected species or have an effect on threatened or rare plant species.

Although removal of trees and associated activities are considered to have the highest degree of negative impacts of all the activities that are planned under the proposed project, most of these can be reduced to an acceptable level through appropriate mitigation measures proposed in the report. Since the most significant impact of the project is expected from the removal of trees, all necessary measures shall be in place to minimise the number of trees that are removed and to salvage as many trees as possible by making arrangements to relocate them.

Mitigation Measures to Reduce Number of Trees Targeted for Removal

- During the initial set out survey, mark the limits of the plot as accurately as possible to avoid damaging or removing trees not intersecting with the plot.
- In site clearance works the priority shall be given to minimise the trees removed or felled by minor adjustments that could be brought in marking the final boundaries of the plot as well as the road.
- In the case of those trees that require absolute removal priority shall be given for relocation.
- For those trees that cannot be relocated for various reasons shall be checked for their suitability as timber or firewood;
- For each tree that is felled, two new trees of the same type shall be planted; and

[1] Source: Soil chemical analysis for R.Vandhoo, Lab report: T1633252

- Considering a tree as waste shall be considered when all the above options have been exhausted.
- A thorough tree survey shall be carried out to ensure only those trees that are absolutely required for uprooting is removed from the island;
- each tree falling on the footprint shall be labelled as per the code given in **Section 2.3.3** and recorded;
- once the trees have been identified and marked as requiring removal, all trees suitable for re-location shall be identified. Relocation of trees shall be prioritised as illustrated in **Figure 19.**

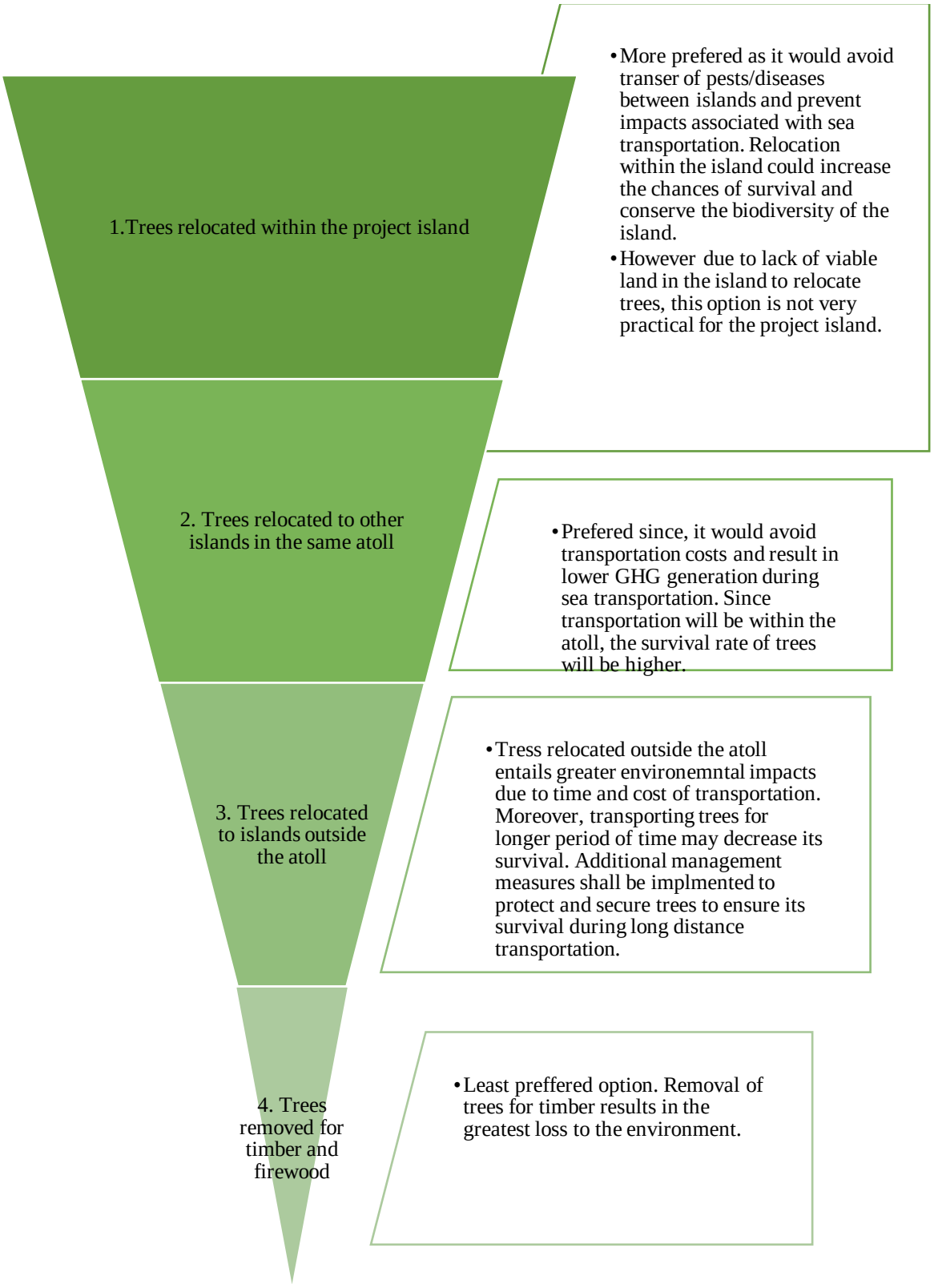

Figure 19: Preferred steps of relocation and removal of trees

- Since relocation of trees for the access road is expensive and costly, the report recommends Council to procure potential buyers who will undertake removal of trees by themselves as described in this report (See **Section 2.3.4.1)** All measures proposed in **Section 2.3.4.1** shall be followed by the buyers and council to mitigate and prevent impacts associated with land

clearance and most importantly to successfully complete land clearance. MEE shall provide assistance and support to the island councils as described in the report.

- Trees within the plot will be removed by the contractor, and therefore for these trees the report recommends to follow the steps as given in **Figure 22** in the removal of the trees falling within the plot;
- minimise the transfer time and enhance tree survival;
- strict supervision shall be in place during the tree removal works to ensure only the intended trees are removed;
- method prescribed for removing the tree in **Section 2.3.4** shall be followed;
- method prescribed for replanting trees in **Figure 8** shall be followed; and
- all records of trees removed and their end use shall be kept and monitored.

Mitigation Measures to Minimise Social Impacts

- Social impacts shall be mitigated by following the steps illustrated in **Figure 20.**

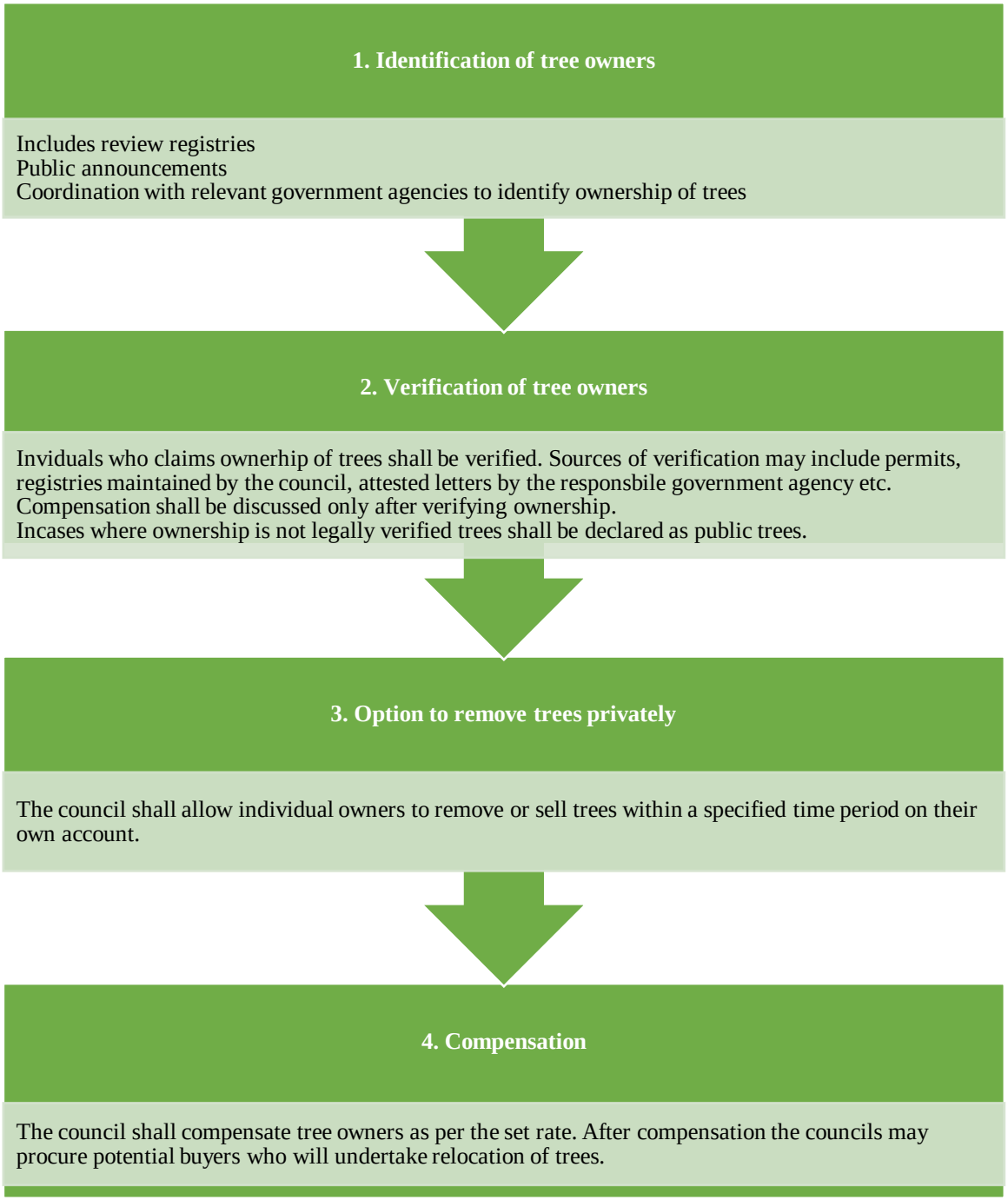

Figure 20: Social impact mitigation measures

Mitigation Measures to Minimise Impacts to the Soil and Groundwater

- Fill the root bulb cavities as soon as possible to prevent spills and contamination of groundwater and prevent accidents and injuries (As described in **Section 2.3.4**);
- plastics, non-biodegradable wastes shall not be used in backfilling of the hole created by uprooting of trees;
- when removing trees it is important to follow steps described in **Section 2.3.4** to minimise impacts on soil and groundwater;

- in backfilling the root bulb cavities sand shall be obtained from those who mine sand from approved areas and shall not be mined from the lagoon or the island beaches; and
- for those trees requiring felling, the tree shall be cut from the ground level and removing root bulb shall be avoided. After removal of trees the ground shall be levelled and compacted.

Mitigation Minimising Impacts to Untargeted Species

- In cases where bird nests are strongly believed to have existed on a tree that is targeted for removal, efforts shall be made to remove the nests carefully and relocate them to safer tree before the tree is knocked down.

Mitigation Minimising Impacts of Vehicular Emission during Site Clearance

- Vehicles should be serviced and maintained regularly to avoid delays and emission of harmful gases;
- machines should be switched off when not in use; and
- idle time shall be decreased; fuel minimization should be practiced by reducing use of electricity during day time.

Mitigation Measures to Minimise Accidents and Injuries to Workers

- Work shall be carried out only during fair weather. Work shall be terminated and employees moved to a place of safety when environmental conditions such as but not limited to high winds, heavy rain, and darkness that may endanger employees in the performance of their jobs;
- hard hats, eye protection, hearing protection, and foot protection shall be used by the workers during work times. Equipment operators should wear seat belts. Wear high visibility clothing as well;
- overhead hazards can cause injuries and therefore all workers should practice "heads up" to avoid possible hazards;
- inspect all machineries and equipment before use. Establish a regular, preventative maintenance program on all equipment;
- public shall not be allowed at work site; and
- all safety measures given **Section 5.3.1** shall be applied during construction phase.

Mitigation Measures to Minimise Aesthetic Impacts

- Limiting the number of trees removed to bare minimum by carefully surveying the project area.
- re-planting as many trees as possible by relocation as recommended in the report.

Mitigation Measures to Minimise Impacts of Carbon Balance

By designing the project as described in **Section 2.3.4** almost all of the coconut trees removed can be relocated, which could potentially neutralise the net loss of carbon balance. Hence the most logical mitigation strategy would be to compensate for trees removed and relocate trees. For each tree that cannot not be re-planted it is recommended to plant 2 new trees in the island. MEE shall commission and facilitate planting coconut palm trees as stated in the report.

5.3.1.2 C5 Construction

There are a number sub-activities that can affect the environment related to construction of the IWMC. Overall, the multi-criteria impact magnitude for this activity was -32, which meant that it will have a moderately negative impact.

Material Storage

At the initial stage all resources required for the construction of the site will have to be procured and stored. These include construction materials, vehicles, machineries, fuels, and tools required for the land clearance and IWMC construction. Due to the nature of the project, even though a large volume of construction materials are not required care must be taking in storing materials to avoid any potential damages to the environment. The improper siting of stockpiles and storage of sand, gravel, cement, fuel, etc., at the construction sites could lead to fine materials being lost, damaged during heavy rainfall events. This would not only represent a waste of resources but could also be a cause of project delays. Hazardous and flammable materials (e.g. fuel, paints, thinner, solvents, etc.) improperly stored and handled on the site are potential health hazards for construction workers and spilled chemicals would have the potential to contaminate soil and inhibit plant growth in localized areas.

Mitigation for material storage impacts

- Safe storage area should be identified and retaining structures put in place prior to the arrival and placement of material;
- the stockpiling of construction materials should be done in a such a way that the materials are not exposed to weather conditions and are properly controlled and managed by the site supervisors; and
- hazardous chemicals (e.g. fuels) should be properly stored in appropriate containers and these should be safely locked away. Conspicuous warning signs (e.g. 'No Smoking') should also be posted around hazardous waste storage and handling facilities.
- equipment shall be stored in fenced areas and maintained appropriately during the course of the project and no new such facilities shall be developed for the purpose of the project;
- National Fire Code (NFC) shall be strictly followed while handling, transporting and storing fuel. Inflammable goods such as fuel drums, portable fuel containers and cleaning solvents and chemicals will be closed off from public access.
- portable extinguishers placed to be readily available when someone finds a fire;
- fuel should be stored in well contained barrels and place over a concrete. This is to contain oil spills during storage and to prevent infiltration of oil into soil; and
- tool shed shall be locked and all the equipment, vehicles and tools must be accounted for.

Noise and vibration

It is important to identify the sources of noise and vibrations and the intensity of such impacts on the project island. The noise and vibration impacts are expected to be minor as the nearest residential area to the project site is more than 300 m away.

The main source of noise from the construction phase of the project will be from the engines used in the machinery and vehicles. No high impact works such as pile driving or demolishing structures are part of the proposed construction, therefore the impact noise is not a major source of noise pollution for this project. Typical noise level of construction equipment are detailed below:

Table 23: Typical construction equipment and their noise levels 50ft from the source

Equipment	Typical Noise Level (dBA) 50ft from source
Concrete mixer	85
Concrete pump	82
Concrete vibrator	76
Pump	76
Saw	76
Shovel	82

Tie Cutter	84
Truck	88

Assuming the highest noise produced during construction is at 85 dBA, a noise decay calculation was done using initial assumptions without factoring for dampening effects due to obstacles and vegetation. From the initial calculations, the noise levels are projected to decrease down to less than 59 dBA at the nearest residential area. This is expected to further decrease taking into consideration the high growth of vegetation surrounding the proposed site.

Noise during construction is determined to be a short term negative impact. Due to the distance of the project site and the surrounding vegetation, it is identified that noise impacts will be minimal to the residential zones, while the construction workers will be most affected by the noise impacts.

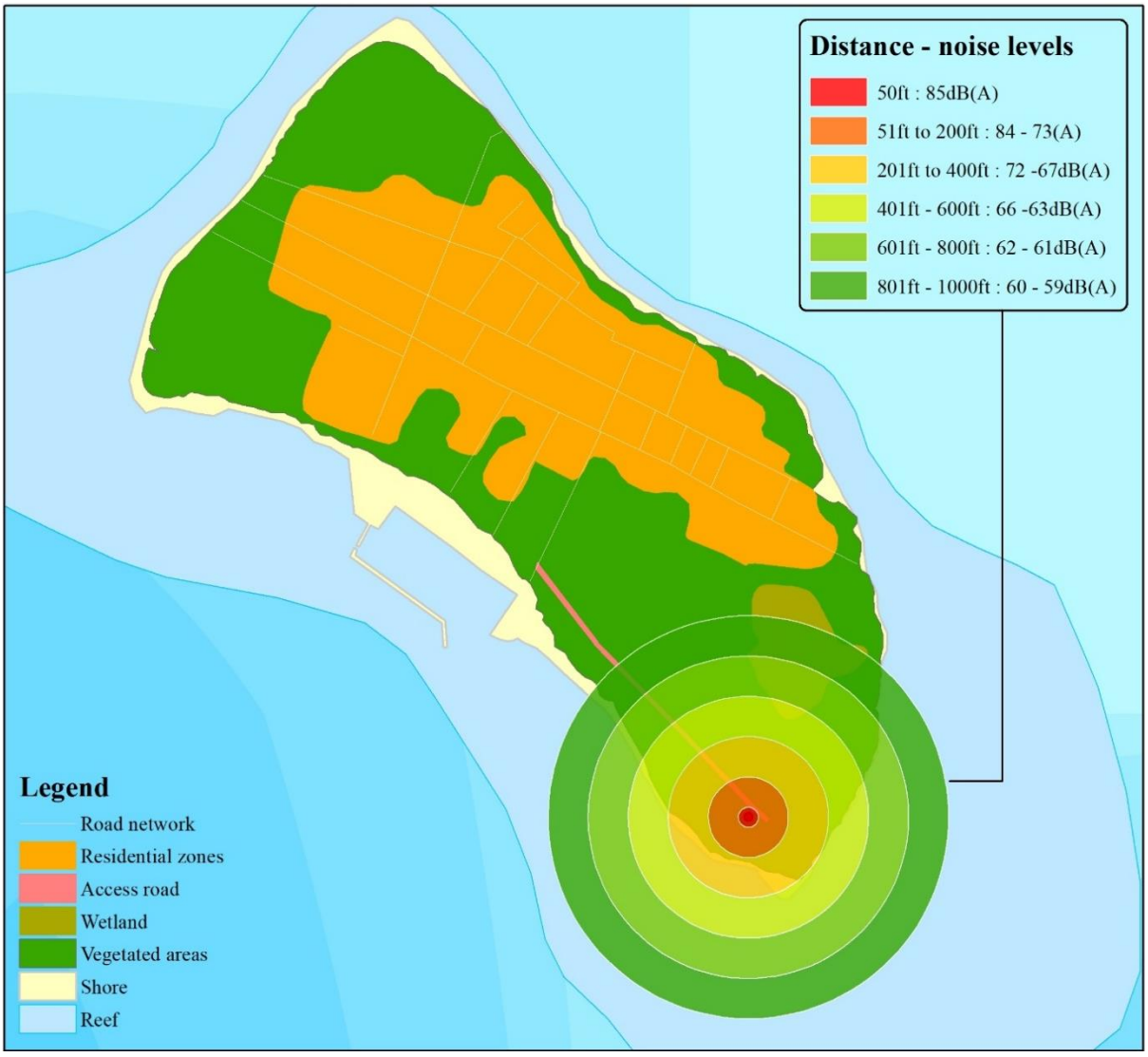

Figure 21: Noise range map for M Mulah

Impact on vegetation

The impact and measures on vegetation have been discussed in **Section 5.3.1.1.** No other structures, temporary, or permanent are proposed to be built for this project (such as workers' camp). Careless

workmanship may result in damages to the vegetation during movement of materials and other project related activities during the construction phase.

Mitigation Measures

- Workers shall be informed to avoid damaging trees and disturbance to animals and to generally avoid engaging in destructive activities to the environment intentional or unintentional.

Accidents and injuries

For a construction project of this nature there can be a number of causes that can result in accidents and injuries to workers. Hence it is imperative to identify and put in measures to avoid accidents and injuries to workers during construction phase. Some of the likely causes include:

- inhalation of cement during the site cast and pre-casting of concrete: inhaling high levels of cement dust during construction can be irritating to the nose and throat. Prolonged exposure to cement dust can result in silicosis (CSAO, 2001);
- contact with concrete mix: concrete has caustic, abrasive and drying properties and prolonged contact with concrete allows the alkaline compounds such as calcium oxide to burn the skin;
- wet concrete trapped against the skin can cause first, second, or third degree burns;
- falling of heavy objects: constructions sites are prone to falling of heavy objects which can be fatal to workers;
- falls: workers may be under the risk of falling into open pits, trenches and seriously injuring themselves;
- Bodily injuries due to manual lifting of heavy items; and
- being struck by moving equipment and vehicles.

Mitigation measures

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

- Appropriate PPE will be worn at all times. This will typically include hard hats, eye protection,
- protective trousers, gloves and reflective clothing, hearing protection, masks and wet weather clothing as appropriate;
- first aid kit will be on site at all times;
- all plant will be operated by competent certified operators. Plant to be inspected regularly and
- have the appropriate certification;
- manual lifting operations will be kept to minimum by the use of mechanical means;
- site visitors should not be generally allowed to work site except when its essential in such cases shall be accompanied at all times and required PPE shall be provided;
- provide first aid services in the site;
- proper signage and fencing should be provided around the site;
- carry out works during good weather;
- well trained personnel to use machinery and vehicles;
- avoid transportation during night; and
- aecuring any loads on vehicles during transportation.

5.3.1.3 C6 Waste Generation during Construction

Solid waste generated during land clearance and IWMC construction work would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite. Overall, the multi-criteria impact magnitude for waste generation was -29, implying that it will have a

moderately negative impact.Waste burned onsite would generate smoke, possibly impacting negatively on ambient air quality and human health. On the other hand, if all site clearance waste is to be transported this would also result in requiring burning fossil fuels and would require significant finance. Solid waste, if allowed to accumulate, could cause localised conditions conducive to the breeding of nuisance and health-threatening pests such as mosquitoes. Poor construction waste management constitutes a short-term, possibly long-term, negative impact.

Vehicle, equipments and tools maintenance works will likely be the primary source of chemical wastes during the construction period. The majority of chemical waste produced is therefore expected to consist of waste oils, solvents and used batteries. Typical wastes may include the following:

- Solid wastes (Empty fuel/lubricant drums, used oil/air filters, scrap batteries, vehicle parts);
- and
- Liquid wastes (waste oils/grease, spent solvents/detergents and possibly spent acid/alkali from batteries maintenance).

However, the amount of chemical and hazardous waste produced will not be significant. Other construction waste includes, packaging, concrete, wood and steel in minor quantities.

Municipal wastes are also expected to be generated during the construction phase by the workers comprising of food wastes, packaging wastes and waste paper.

The amount of human waste generated per person is approximately 125 g/day, which means 1.9 kg will be produced daily if approximately 15 workers were active which equates to discharge of approximately 2,550 l/day of waste water. Sewage will be managed through existing septic tank systems that have been installed in the island.

Since there is no existing waste management system in the atoll and since there is no waste management practice in the island to accommodate the construction waste generated, the environmental receptors will have a significant burden from construction waste. Some of the hazardous oils if not disposed properly may cause health implications to the people and vegetation.

Mitigation Measures

- Ensure to manage waste as described in **Section 2.3.16** of the report;
- avoiding cooking and eating at work site to eliminate food waste and kitchen waste. Hence food for workers can be arranged with existing services on the island;
- reusable inorganic waste (e.g. excavated sand) should be stockpiled away from drainage features and used for in filling where necessary;
- regular sweeping of the of the worksite to collect litter, empty cans etc which could become breeding ground for mosquitoes and other pests;
- open defecation whether it's on land or on the beach shall be prohibited;
- appropriate general site cleanliness related signboards could be placed on the worksite to give workers reminders on good waste management practices;
- ensure to reduce waste by following the 3R steps; and
- waste collected shall be transported to nearest waste management facility after the construction works have ended.

5.3.1.4 C7 Resource Consumption

As shown in the BoQ for the project various types of construction related resources are required for the project. Consumption of goods impacts the environment in many different ways. For instance materials

used for the project would contribute, directly or indirectly through the product lifecycle, to climate change, pollution, and biodiversity loss and resource depletion locally or elsewhere in the world. The most important resource as far as the current project is concerned would be the allocation of land for the site. For the purpose of developing the waste management centre at least 825 m^2 of land would be required which represent 0.1% of the existing area. Allotting a plot of land for waste management with permanent concrete structures developed would essentially result in a loss of the options for alternative land use and thus represents an irreversible commitment of land resources. The loss of optional uses for the allocated land although is inevitable is considered a negative impact. Other resources required would include sand, water, power and construction materials required for the IWMC development. Since the resource utilization is considered to be relatively small, and that it is not expected to significantly contribute to deplete the natural resources and would be a major source of GHG emission, the multi-criteria impact magnitude for this activity was -21, which meant that it will have a moderately negative impact.

Since it would be very difficult to precisely determine by how much exactly the current project would contribute to the depletion of each type of various natural resources required for the project at local and global levels and by how much it would have contributed to global climate change, general impacts that are normally associated with natural resource use can be applied in relative terms for the project.

Mitigation

- Resource conservation shall be given a high priority in all stages of project development through bulk purchasing, putting in place measures to avoid wastage, encouraging reuse and recycling;
- initiate rainwater collection and storage as early as possible into the project construction;
- careful store management and record keeping on use of materials;
- reduce idle time for vehicles and equipments and switching off after use;
- use well maintained, energy efficient equipment and lights;
- sand shall not be mined from beaches and lagoons of the island for construction purposes, if coral sand is used it should be obtained from a government approved location;
- materials that are locally available shall be obtained as such instead of opting to bring those after a long haulage;
- materials shall be procured in bulk as much as possible;
- utilize day time hours for the construction when plenty of light is available; and
- FENAKA power supply will be used for electricity generating purposes.

5.3.1.5 C2 Transportation of Materials

Transportation of construction materials from the source to the project island is identified as an activity with climate impacts, through the transportation of sea vessels, as well the transportation of the materials on land. The use of vessels and vehicles would require burning of fossil fuels which result in the release of greenhouse gases (GHG) into the atmosphere. The fuel usage of a supply barge is estimated at 1.3 kWh /t. As a general rule the longer distance would mean more fuel burnt and more GHGs produced. As the resource sourcing hierarchy in **Figure 22** shows, the greatest importance shall be placed on sourcing any available materials from within the island, with the next option being from within the atoll or region, from islands such as Th. Thimarafushi, M. Muli, Dh. Kudahuvadhoo and F. Nilandhoo. Next in the hierarchy is Male' and the industrial areas in the zone, from where majority of the remaining materials can be sourced. Lastly, in cases where a proposed material cannot be obtained from within the country, only shall the contractor procure the material from a neighbouring country which is not likely due to relatively small volume of material requirement and commonly available nature of those. The multi-criteria impact magnitude for this activity was -21, which meant that it will have a moderately negative impact.

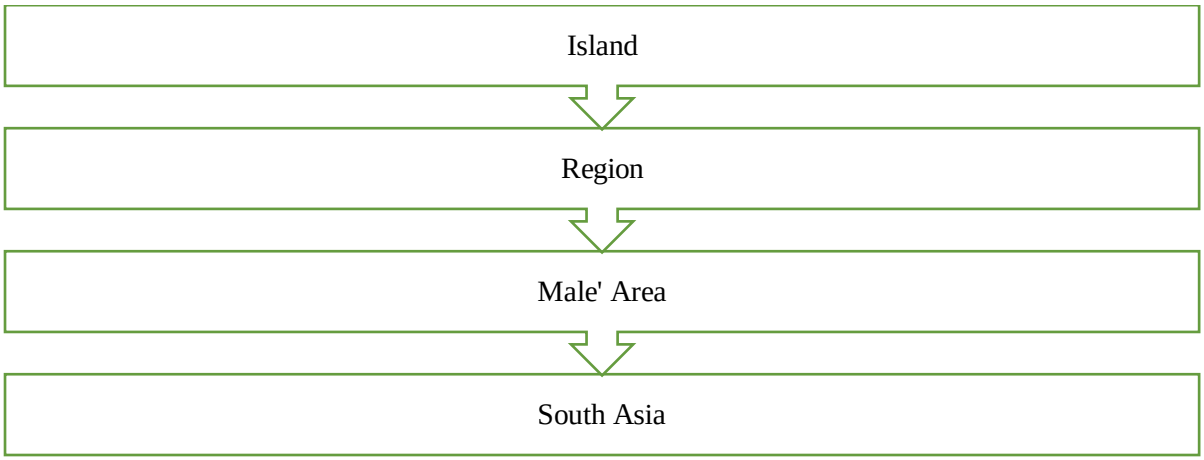

Figure 22: Material sourcing hierarchy proposed for the project

Along with the reduction in travel distances by choosing a close source, the number of trips to be made can magnify the distances travelled. The Proponent has produced the Bill of Quantities (BoQ) for the project works, which enables the contractor to purchase the required amount of materials in bulk, reducing the number of trips and wastage of materials. While the sea transport is expected to have the greatest impact of released GHG, the transport on land is expected to be minor, due to the short inland travel distances within the island.

The inputs of the project elaborated in the **Section 2.5** show the estimated amount of resources that will be used for the project. The use of resources for the project can have indirect impacts of GHG emissions from the production process. The main materials used in this project include concrete, reinforcing steel, structural steel, in addition to PVC pipes. Defra / DECC (2012) states that for every tonne of concrete casted, 135 kg of indirect CO_2 emissions result. The greatest indirect CO_2 emissions are estimated from the usage of reinforcing steel. Due to the small scale of the construction, the estimated indirect CO_2 emissions from material usage are minimal for this project.

The use of heavy vehicles on unpaved roads can cause compaction of the soil by the force applied by the tires of the vehicles. This can lead to the destruction of the soil structure, reduction of porosity, and thus reducing the water and air infiltration into the soil. The resulting soil is dense with few large pores and poor internal drainage (Wolkowski & Lowery, nd.). Roads impacted with the traffic from heavy vehicles can thus result in undulations and puddling.

Figure 23: Impact on roads from heavy vehicle transport in an island in Maldives

For the purpose of construction, no heavy vehicles are proposed. Although this is the case, a pickup truck will be used to transport the construction materials to the site, in addition to yard waste and construction waste from the site. The vehicle is not expected to cause major impacts on the road, force applied by the pickup truck is expected to be lower than heavy vehicles and plant. The number of trips required are also reduced in the case of the proposed project, due to the small scale of construction.

Although, for the purpose of land clearance and uprooting of trees, a hydraulic excavator may be required (in cases where trees can be removed for replanting). The movement of the excavator through the roads of the island can incur damage to the roads as stated above. It should be noted that the movement of the excavator will not occur frequently through the public roads, as the site access is to be created by a cleared road.

Other impacts on roads due to transportation include the generation of dust during transportation, which can lead to impacts on the local air quality especially during dry weather. In addition to this, littering of construction materials from uncovered transportation vehicles can cause terrestrial pollution and amenity impacts.

Mitigation for climate impacts

- Sourcing of materials shall be done according to the hierarchy presented in **Figure 22**. Materials shall be obtained from the closest source;
- The materials shall be bought in bulk and transported to the island within a single trip where possible;
- Detailed BOQ has been produced by the Proponent, which shall be followed by the contractor when purchasing materials in order to reduce wastage of materials as well as the number of trips;
- The materials shall be stored on the project site to eliminate transportation of vehicles within the island throughout the construction phase;
- Idle time of the vehicles shall be avoided in order to reduce emissions;
- contractor shall use serviced vehicles and plant equipment for the project;
- contractor shall only use the needed amount of vehicles and plant for project; and

- vehicle used for the purpose should comply with the roadworthiness requirements of the Transport Authority and display the compliance stickers.

Mitigation for impacts on roads

- The contractor shall only bring in the necessary number of vehicles and plant to the island for the project;
- it shall be stated in the contract that any damages to the roads from transportation of construction materials and machinery shall be assessed after the civil works are completed, and the damages shall be repaired by the contractor;
- use the closest route from the harbor area to the site;
- cover the materials being transported to and from the site; and
- spray water on the road surface during dry periods to suppress dust.

Mitigation for accidents and injuries

- Vehicle drivers shall be licensed and competent;
- loads being transferred shall be fully secured; and
- transportation shall be done during day time as far as possible; and
- speed limits shall be observed when operating vehicles especially in residential areas.

Mitigation for marine and terrestrial pollution

- contractor shall clean any littering on the terrestrial or marine environment caused during transportation; and
- contractor shall enforce strict policy against littering and appropriate penalties; and

5.3.1.6 C1 Worker Influx and Settlement

A large number of work force is not expected for the project. An estimated 10-15 workers will be required for this project. Since resource consumption, waste generation and behavior related impacts on the environment are likely to have an incremental increase with additional people to the island. However, even though minor workers related negative impacts can range from damage to flora and fauna of the island, impacts associated with resource utilization, waste generation and potentially negative social impacts. On the other hand, even though small, more people to the island could have a positive effect on the local economy. Multi-criteria impact analysis shows that this activity will have a overall minor negative impact with a score of -11.

For the duration of the project, the workers related waste output is detailed in **Section 2.3.16**. For this project, worker related impacts can be reduced through the following mitigation measures.

Mitigation for impacts on flora and fauna

- The contractor is required to keep the workforce as minimum as possible, and to not bring in any surplus workers for the project;
- the project island currently has vacant properties as well as rooms to let in houses, which can easily house the influx of 10-15 workers. Therefore no new facilities will be made for the accommodation of the workers in order to avoid clearing of land or spending resources unnecessarily for making worker quarters;
- all construction workers and persons on site must be given specific instructions not to catch or harm birds and animals allow them to retreat into undisturbed areas and prohibit damaging vegetation that are not;

- rules shall be formulated by the contractor and workers shall be oriented on the rules and conduct during the project works;
- workers shall be given instructions on the sensitive and protected areas of the island;
- enclosed containers shall be provided to dispose of waste oil and other hazardous waste;
- workers shall be given instruction not to catch or harm any birds or animals present on the island, and not to damage any vegetation that is not already sanctioned for removal within the demarcated site bounds;
- littering shall be prohibited; and
- waste bins shall be placed within the site.

Mitigation for impacts on resource use

- Reducing, reusing and recycling of resources shall be encouraged through proper monitoring of worker activities and awareness; and
- Keep workforce to the minimum required.

Mitigation for sociocultural impacts

- hire local workers where possible;
- orient foreign workers on communication, personal hygiene and sanitation and infectious diseases; and
- ensure all foreign workers have their legal permits.

5.3.1.7 C3 Site Demarcation & Fencing

Site demarcation and preparation involves, surveying all the trees within the footprint of the plot and identifying trees that needs to be removed or relocated as described in **Section 2.3.3**. Vegetation surveys shall be done in detail (**Section 2.3.3)**. This activity is considered to have minor environmental impacts with multi-criteria impact analysis score of – 5 as it is largely noninvasive.

However, improper or inaccurate demarcation and labelling could result in removal of untargeted trees which could result in having to remove more number of trees than that are required. Incorrect labelling of the trees may lead to increased waste generation and reduced number of trees that can be salvaged. In areas with thick undergrowth may cause bodily harm if proper protective clothing is not used. Trimming undergrowth to access vegetated areas and use of spray paint during demarcation could have a slight negative impact on the biological environment and health of workers.

With proper planning, engaging qualified people and use of proper equipment, and with proper protective measures these impacts can be avoided. This activity is expected to have a minor impact overall.

Mitigation measures

- Ensure that the surveyors and helpers engaged in site demarcation properly understand the scope of works and recommendations of this report;
- qualified surveyors shall be engaged in site demarcation and labelling of trees;
- accurate and reliable equipment shall be used to minimize errors;
- ensuring proper labelling according to how they will be used following uprooting. Example labelling method proposed is described in **Section 2.3.4.1;**
- hazardous waste used during site demarcation and fencing such as empty spray paint containers shall not be discarded haphazardly. These will have to be managed as per the **Section 2.3.16**.

- wearing, clothes/helmets to protect against thorns and freefalling coconuts and wearing protective clothing; and
- carrying out the works during the day time.

Table 24: Impact identification matrix for operational phase

Envisaged impact factors		O1 Waste collection and transportation	O2 Waste sorting, separating and composting	O3 Waste generation	O4 Resource consumption (water/electricity)	Total (Impact Area)
Physical Components	Seawater	9				9
		9				9
	Ground water	8	-2	-1	-3	0
		5	2	5	2	14
	Air	-3	-2	-2	-3	-10
		5	3	2	4	14
	Noise	-3	-1			-4
		4	2			6
	Coastal Zone					0
						0
Biological Components	Flora	6	7	-1	-3	9
		2	6	1	3	12
	Fauna	5	5	-1	-3	6
		5	5	1	3	14
Socio-Cultural Component	Aesthetics	9	8			17
		9	6			15
	Accidents	-4	-4		-4	-12
		4	4		5	13
	Landscape	9	6	-1		12
		6	5	2		13
	Health/Well being	9	-5	-2	-4	-5
		6	5	2	7	20
	Cultural heritage					0
						0
	Local economy	-3	8	-2	-1	2
		9	5	4	1	19
Total (operational Phase Activity/Risk)		**42**	20	-10	-21	
		64	43	17	25	

5.3.2 Impacts and Mitigation from Operational Phase

Since the overall objective of the project is to establish economic viability and environmental sustainability of the proposed waste collection, transfer and disposal systems to prevent impacts on human health and environment through approaches that are sustainable and locally appropriate, the operational phase of the project is expected to yield overall positive outcomes. In this regard, the proper management of waste sorting, collection, transport and disposal in the new system will reduce potential environmental and health impacts from waste. Furthermore, a safer and better environment will promote business, especially tourism, in the area and create better livelihood conditions. However, as summarised in **Table 25**, the operation of the waste management system itself will result in certain negative environmental impacts which will have to be managed properly through appropriate mitigation measures to ensure that those negative impacts are kept at an acceptable level. The paragraphs below briefly discusses the likely impacts and proposed mitigation measures.

Table 25: Summary of multi-criteria analysis for operational phase

Activity	Impact Score	Overall Impact
O1 Waste Collection & Transport	**42**	**Major positive**
O2 Waste sorting, separation, and composting	**20**	**Moderately positive**
O4 Resource consumption	**-21**	**Moderately negative**
O3 Waste generation	**-10**	**Minor negative**

5.3.2.1 O1 Waste Collection and Transportation

As stated in this report, currently M. Mulah has two areas that are used for dumping and burning waste regularly. Both of these areas are at the beach of the island where waste can be easily scattered into the lagoon resulting in negative impacts to the marine biodiversity. Although two areas have been used for dumping of waste, the Island Council states that some residents still dump waste in other areas as well. In addition to lowering of the aesthetic appeal of the island, open waste dumping on various parts of the island could become source of various diseases. The practice of open burning of waste also takes place resulting to potential respiratory issues from the inhalation of smoke. Uncontrolled littering of waste at the island is believed to be directly linked to the uncontrolled mosquitos, flies, mice populations. Hence a reliable, affordable and locally appropriate transport system is critical to collecting waste from houses, businesses and institutions. Equally important is an arrangement for marine transport to remove residual waste from the island in order to make the system complete and effective. The successful implementation of the IWMC together with land and marine transfer arrangement are two important aspects to implement Waste Management Plan to make the island cleaner and healthier for the people to put a stop to littering and burning of waste in the island. This will lead to the improved health and psychological well-being of the residents and visitors of Mulah. It has been identified as a long term positive impact on the residents and visitors of Mulah.

Mulah council states that two vehicles will be obtained for the purpose of collecting and transporting the waste within the island daily, at a set schedule. At the moment there is no specific arrangement for marine transfer of residual waste from the island although by the time IWMC is complete it is expected

to have this arrangement in place. The multi-criteria analysis shows waste transport arrangement will have a major positive impact with an overall score of 42.

While both land transport and marine transfer of waste are expected to have significant positive impacts, unregulated transport arrangements can result to environmental issues. If not properly managed likely environmental impacts include, noise, hardening of road surface, creation of puddles during wet season, and littering on the roads, bad odour during transport, and health issues to workers, vehicular emission, dust generation as a result. In the case of marine transport, there can be chances of dumping of waste intentional or unintentional en-route to the final disposal site in addition to engine emissions. However, these impacts can be effectively managed and negative impacts can be kept at an acceptable level.

Measures to ensure and enhance the positive impacts

- Proponent and Island Council shall follow the management plan provided with the ESMP in order to monitor the operations of the IWMC, and bring about any necessary changes to the operations and policies, in addition to providing any needed technical assistance for the island;
- proponent shall review the waste management operations within the island regularly and update the National Waste Database;
- Island Council shall conduct awareness programs to the residents of the island regarding the best practices in waste management, as well as conduct programs to familiarize the residents with the gazetted regulations and guidelines to manage the waste within the island;
- regular awareness programs conducted to minimise waste generation and Polluter pays principle established in order to reduce the waste generation within the island;
- proponent shall provide resources in terms of required equipment, machinery and technical expertise to ensure the operation of the IWMC; and
- Proponent shall assist in creating markets / avenues where the IWMC's can generate income through selling compost and recycled metals, plastics and glass.

Mitigation for terrestrial pollution

- Implement rules within the IWMC workers to impose penalties for any littering within the island due to improper handling of the waste and improper transport practices;
- the status of the vehicles used shall conform to the Waste Management Regulations 2013/R-58 and provide cover to the waste being transported in order to avoid littering;
- during waste collection instead of stopping the vehicle at every house, the residential area can be divided into blocks and vehicle stops can be pre-determined and from where waste containers can be hand carried by the workers from respective houses to be loaded to the vehicle.

Mitigation for accidents and injuries

- Waste collecting workers shall wear appropriate clothing and PPE to avoid injuries in handling waste;
- vehicles should be driven by licensed drivers;
- records of the vehicle trips shall be properly maintained;
- speed limits shall be observed; and
- a strict schedule shall be stated in the IWMP and followed in order to reduce the transportation frequency thus reducing the probability of accidents.

Mitigation for air quality impacts

- Vehicle speed shall be kept appropriately to suppress dust;

- vehicles used shall be regularly washed and kept clean; and
- The waste being transported shall be covered to minimise the impact of odour on the public.

Mitigation for climate impacts

- Regular servicing of vehicles used to transport waste;
- ensuring the vehicle has roadworthiness certification from the Transport Authority;
- restricting the use of the vehicle only for the stated time in the IWMP;

Measures to prevent marine pollution

- Wastes destined to nearest waste management facility will require to keep logs of waste being loaded from the island and unloaded at nearest waste management facility. The records to be signed by the vessel captain and a copy returned to the waste management supervisor;
- vessels used shall have a certified captain and vessel should have valid seaworthiness certificate;
- vessels shall not be overloaded and waste containers shall be kept closed and shall not be allowed to flyaway due to wind and sea conditions; and
- Waste shall not be transferred during extreme weather conditions.

5.3.2.2 O2 Waste Management Activities

Assuming that operations of the IWMC will be properly resourced and functioning properly, the waste sorting, separating storing and composting will have an overall positive impact as shown by the multi-criteria impact assessment with a score of 20. On top of reducing the volume of waste, these activities, will make resource recovery and ultimately a significant proportion of the waste becoming a valuable resource. These activities will be carried out in the IWMC where employees will be trained to undertake these activities.

In general, the operational phase of the project will greatly improve the existing waste management condition of the island preventing pollution and spread of diseases. These activities would prevent pollution of groundwater, coastal areas and forested areas which would prevent impacts to biodiversity, health and wellbeing of the public.

However, if these activities are not properly implemented there is a risk of IWMC being deteriorated into a dump site where mixed waste are disposed, burned and buried. This means without proper mitigation measures and regular transportation of waste out of the island to a central facility, there is a greater risk of IWMC being overfilled. This entails a loss of investment and a greater impact to environmental receptors as some sites are moderately close to public areas. Moreover, impacts associated with composting sorting and storing waste has inherent impacts which will have to be properly managed, identified and mitigated to enhance and ensure the positive impacts of the proposed IWM. Propensity of these impacts are greater for the following environmental receptors:

- Groundwater;
- Climate/air; and
- Health and wellbeing: noise, odour and accidents/injuries

The following Sections describes the factors influencing these impacts and proposes measures to mitigate negative impacts and to ensure the overall positive impact of the IWMC during operational phase.

Impacts on health

While overall positive impacts on public health are identified from this project, the negative impacts of running a waste management centre (especially one where composting is to be done) shall be highlighted. Composting can be a source of particulate matter in the atmosphere. The highest concentration of particulate matter in the air occur during the pre-treatment phase where the fresh organics are shredded and mixed. Particles also become airborne during the turning of the biodegrading compost heap to regulate the temperature.

Certain pathogens may also be transmitted via air during the composting process. These include *Legionella longbeachae*, *Aspergillus fumigatus*, *Mycobacterium tuberculosis* and *Hantavirus* (DEC NSW, 2004). Harrison (2007) has done a comprehensive literature review on the health effects of composting operations, which show increased concentrations of bio-aerosols within the vicinity of the composting facilities and related health effects to workers as well as affected public. Bunger et. al (2006) states that exposure to organic dust at composting workplaces is associated with acute and chronic respiratory health effects. Muller et. al (2006) and Wouters et. al (2006) agree with these findings, stating that changes were found in white blood cell counts, increase in neutrophils, decrease in oesinophils were measured in healthy subjects.

As for the association between the health symptoms and the distance from the site, Herr et. al (2004) showed that total bioaerosols were found at > 10^5 CFU / m^3 close to the composting site and dropped to background levels within 550 m from the site. Herr et. al (2004) also showed from another study where higher than background concentrations were found within 200 m from an outdoor composting site (> 10^5 CFU / m^3), and dropped to background concentrations at 300 m.

Wheeler et al (2001) stated that composting activities do not emit bio aerosols at levels that can be of a hazard to the public. Wheeler et al suggests a buffer zone of 250 m. The conservative values for the concentrations given by Wheeler at al includes:

Table 26: Background concentrations of bio aerosols (Source: Wheeler et al (2001))

Bio aerosol	Concentration
Total Bacteria	1000CFU/m3
Total Fungi	1000 CFU/m3
Gram-negative bacteria	300 CFU/m3
Inhalable dust	250 µg /m3

Wheeler et. Al; (2001) states the concentrations of bio aerosols exceed this limit where 10^5 – 10^6 of bacteria and 10^3 and 10^4 of fungi have been measured, the concentrations drop to background levels at 250m distance from site. Although it should be noted that the expected composting operations in the IWMC are not as large scale as the studies cited above. Therefore, the health impacts of the bio aerosols can be minimised by following the mitigation measures provided.

Other potential health effects can arise from the introduction of vermin or pests, putrescible wastes attracting flies, puddles allowing the breeding of mosquitoes. Impacts that may arise from the IWMC becoming a makeshift waste dumpsite for organics are also addressed in the subsequent Sections of the report.

Impacts on groundwater

When organic waste is stockpiled for composting, there is potential for leachate production from the waste. This is especially prevalent in cases where the waste includes food, meat, fish and fatty sludges. This leachate can infiltrate into the ground and mix with the freshwater lens of the island, thus polluting the lens with high amounts of nutrients, which can introduce bacteria and other microbes. If the conditions are anaerobic, the resulting leachate can be acidic and cause the corrosion of metals and

introduction of metallic compounds in the groundwater. If the conditions are aerobic, alkaline leachates will result with a low carbon – high nitrogen ratio. The main parameter in leachate that is considered to have a negative environmental impact is nitrogen that results from biodegradable waste.

Leachate production can increase during the rainy season, with the additional water from rain causing leachate from garden materials, wood and fibrous materials. Rain can also cause the stockpile to become anaerobic, thus resulting of undesirable odours.

The operation of the IWMC is identified to have an overall positive impact of the groundwater of the island. While the aforementioned infiltration of leachate would still be an issue (if improperly managed at the IWMC), it should be noted that the same waste has been dumped throughout the island without any measures, enabling the pollution of the groundwater with the leachate. Therefore, the proper operation of the IWMC and the proper management of the collected waste will result in the reduction of the pollution of the groundwater from waste sources, thus improving the status of the groundwater in the island.

GHG emissions

The waste management activities will require power consumption for operation of the machines, lighting and pumping. Since the island's power system is fossil fuel based incremental increase in electrical energy consumption at the IWMC will result in GHG emissions. However, the power consumption at IWMC is expected to be small and therefore is not considered a significant issue. In addition, CO_2 which a GHG will be the main gas produced during the composting process in aerobic conditions while in anaerobic conditions, methane is released into the atmosphere, which has even a higher greenhouse warming potential compared than CO_2. In open systems, methane is not released in large quantities as long as the aerobic environment is maintained. (USEPA 2002). If the composting is well managed and kept in aerobic conditions, the methane production is reduced, which contributes to the reduction in global warming, as such waste would otherwise produce methane in a normal oxygen poor landfill or dump. It has been debated that, the CO_2 produced from the degradation of the compost pile would have been produced anyway, in the longer term if kept in a landfill or dump.

Amenity impacts

The IWMC operations can cause various negative amenity impacts from inappropriate management. This issue is especially exacerbated through improper handling of raw organics as well compost windrows. The potential negative impacts include:

- Odour pollution;
- Particulate matter;
- Vermin and pests;
- Litter;
- Fire; and
- Noise

Biodegrading organics as well as compost heaps can attract birds such as crows which can lead to noise problems, and the littering of organic waste scraps within the site as well as away from the site. The unprocessed organic wastes as well as the compost heaps can be an attraction to pests and vermin. These pests can be environmental as well as health hazards. Airborne dust from a poorly managed site can have a visual impact as well as public health impacts including respiratory issues.

Wind can blow the materials off the compost heaps as well as the other stockpiled waste types out of the IWMC, which can degrade the local amenity. This impact is mitigated through the design of the IWMC perimeter walls which include a perimeter fence made of 50 × 50 PVC coated mesh.

Littering inside the IWMC can cause amenity issues such as tracking of litter on the wheels of the waste transport vehicles leaving the IWMC. The litter can be deposited out on the roads of the island, which leads to issues such as visual impacts, odour, and possible contamination of groundwater from leachate.

Air quality impacts

Odour

Composting odours can originate from sulphur compounds, nitrogen compounds and volatile organic compounds. Ammonia is also commonly associated with unpleasant odour resulting from composting. If the composting is done under aerobic conditions, the main gaseous product is carbon dioxide. Gas compounds contributing to the odours of composting organics containing bio solids include dimethyl sulphide, dimethyl disulphide, dimethyl trisulphide, carbon disulphide and benzothiazole. These chemicals, while potentially toxic, are not present in high concentrations in open air composts. The gas methane is generated when the microbes do not get enough oxygen, and anaerobic biodegrading occurs. Methane gas has a strong and foul odour. The generation of ammonia, volatile amines, hydrogen sulphide and volatile organic compounds cause these odours.

Table 27: Odours generated from the composting process (Source: Goldstein (2002)

Compound	Description of smell	Detection limit for a particular odour panel (µg/m^3)
Sulphur compounds		
Dimethyl disulphide	Rotten cabbage	0.1
Dimethyl sulphide	Rotten cabbage	2.5
Carbon disulphide	Rotten pumpkin	24
Hydrogen sulphide	Rotten egg	0.7
Methane thiol	Pungent sulphur	0.04
Nitrogen compounds		
Ammonia gas	Medicinal	27
Trimethyl amine	Fishy	0.11
Volatile fatty acids		
Acetic acid	Sour (vinegar)	1019
Propionic acid	Rancid	28
Butyric acid	Putrid	0.3

This site is 374 m away from the nearest residential area, therefore the impact of odour on the residential areas are deemed minimal.

Fire hazards

There is a possibility of fire hazards at the IWMC coming from biogas emissions and human activities. Fires can pose a risk to the workers through explosions and suffocation from smoke, in addition to damage to equipment.
Possible fire hazards are caused by the following (DCE NSW, 2004)

- Spontaneous combustion;
- Sparks from welding;
- Lightning strikes;
- Cigarettes; and
- Arson

The most common causes of fire during composting activities are reported to be cigarettes, welding activities and spontaneous combustion (Rynk 2000). The cause of spontaneous combustion is when the decomposing organics self-heat to ignitable temperatures (DCE NSW, 2004). Although Rynk (2000) states that spontaneous combustion is more prevalent within large undisturbed piles containing raw

organics, curing compost or finished compost rather than active composting. Therefore it is important to limit the storage of organics (meant for transport to a central waste management facility) on the IWMC.

Noise and vibration impacts

The main sources of noise from the operation of waste management centres come from the material recovery machineries used and the operation of vehicles. According to the Health and Safety Executive UK, most material recovery facilities have noise levels exceeding 80 dBA and 85 dBA. Assuming a maximum noise level of 85 dBA, the noise decay map in **Figure 21** can be used for this purpose too. From the initial calculations, the noise levels are projected to decrease down to less than 59 dBA at the nearest residential area. This calculation does not take into account the dampening effects of the surrounding vegetation. Therefore, the long term negative impacts of noise would be borne by the employees of the IWMC, and the effects of noise to the residential areas are minimal

Workplace safety and accidents

The group of people most likely to be impacted by the IWMC operations are the workers at the site. The various operations such as transportation, collection, handling, sorting and storing of the wastes, in addition to the composting and volume reduction operations all pose different risks to the worker onsite. The impacts discussed above and their proposed mitigation measures can provide a level of safety to the workers. Even with these mitigation measures put in place, a proper workplace safety guidelines shall be formulated by the contractor for all workers onsite to follow.

In addition to the impacts discussed above, other work related safety issues include falling stock or during lifting activities, moving vehicles and falls from height. The accidents can result in injuries of varying nature.

Mitigation for health impacts

- A distance of 374 m is available between the IWMC and the nearest residential area, which is greater than the buffer zone proposed by Herr et al (2004) and Wheeler et al (2001), it is expected that bio aerosol concentrations will reduce to background level at the stated distance;
- site is located in such a way that winds from both monsoons blows the airborne particles from the IWMC away from the residential zone;
- handling of compost will be minimized;
- compost turning will be done based on temperatures and not on schedules;
- compost turning will be done using windrow turning equipment;
- adding moisture to the compost to minimize dust;
- placing a geo-fabric cover over the compost windrow to minimize release of bio aerosols; and
- workers will wear appropriate safety clothing, follow the workplace safety mechanisms and guidelines set by the contractor and practice safety and personal hygiene when handling the compost.

Mitigation for impacts on groundwater

- The composting area has a dedicated composting slab made of reinforced concrete, along with an HDPE lining between the soffit of the slab and the ground. Concrete is an inert and highly impermeable material, and with the combination of HPDE lining, the possibility of leachate leaking directly from the compost slab is low;
- The composting slab is designed to have a slope towards the centre from both sides, which will propagate any leachate produced towards the 100 mm PVC pipe, which in turn drains into the leachate collection tank;

- Regular turning of the compost pile can help minimise the quantity of leachate produced; and
- The leachate collected shall be reused to provide moisture to the compost heaps.

Mitigation for rainfall related leachate production

The current design of the IWMC consists of a composting slab is an open windrow composting system. The compost windrow is kept on the compost slab which is sloped in such a way that the leachate from the compost will collect at the pipe in the centre, which will propagate the leachate into the leachate collection tank. While this scenario is ideal during fair weather, heavy rainfall and strong winds should also be considered. There is a possibility of heavy rainfall increasing the produced leachate, as well as the water collected over the composting slab propagating to the leachate collection tank. This can cause an overflow of the leachate collection tank, releasing its contents into the ground and subsequently the groundwater aquifer.

The rainfall can also cause the scattering of the compost materials, the increased water content in the compost windrow can cause another issue: the saturation of the windrow can decrease the available oxygen within the compost windrow, leading to anaerobic conditions.

- A valve is placed at the inlet pipe which can be closed in instances where the leachate tank may overflow from heavy rainfall onto the compost slab;
- compost slab is raised through design, to avoid any ingress of water which may otherwise be possible from puddles and possible inundating due to heavy rain; and
- windrow cover shall be used to mitigate the impacts from rainfall. The cover shall be made of geofabric and allow for the air circulation while protecting the compost. The advantages of the cover include moisture control, which reduces leaching and nutrient loss, as well as reducing water loss from the sun and wind. In order to keep the cover in place during strong winds, weights attached to ropes shall be placed on top of the cover at regular intervals.

Figure 24: Windrow cover being utilised in an open composting system (source: Midwestbiosystems.com)

Keeping stockpiles of raw organics low

Stockpiles of raw organics (waiting to be processed or transported) can cause impacts such as foul odour from the biodegrading organics, leachate reaching and contaminating groundwater, issue of vermin and pests, and visual impacts from the stockpiles.

As per the design of the IWMC, there are compartments for the storage of all major waste types other than organic wastes. A dedicated slab is provided for the composting of the organic waste materials. As per the calculations in **Section 2.4.6** it is seen that the composting slab has the capacity for composting less than 1.5 month's organic waste produced in the island. As the composting process may take between 4 – 6 months (Halliburton, 2002), the remaining months' organic wastes can accumulate unmanaged and without any means of storage.

The consultant proposes the following mitigation measures:

- Arrangements to regularly transport the unmanaged waste to a central waste management facility; and
- in cases where the waste cannot be transported due to delays and unforeseen circumstances, it is not recommended to stockpile the unmanaged waste on the ground in the open. Covered bins shall be provided to store unmanaged organic wastes. It is also recommended to separate the putrescible waste from the green waste while storing in the wheelie bins. While this mitigation is not the most ideal, it is seen as the option with the least impact, pertaining to the resources available to the island and the difficulty in transportation. Alternative transfer arrangements shall be made within this duration.

Keeping pest and vermin populations low

- An area where waste (especially raw organics) is concentrated will naturally be an attraction to pests and vermin. In order to reduce the possible health hazards from such pests, their population shall be kept low with the following mitigation measures;
- unprocessed waste (including those waiting to be processed and unmanaged waste awaiting transportation) shall not be kept uncovered. 660 L wheelie bins are provided to store such organic wastes. The bins are lidded, which controls both the possibility of odours emanating and the means of access to pests. The bins are also watertight in order to avoid the infiltration of water both into and out of the bin. The bins shall be designed to resist the action of organic acids and facilitate washing;
- covering the compost heap;
- ensure that the IWMC surfaces are adequately drained to prevent the occurrence of ponds; and
- establish deterrence and eradication measures to control the outbreaks of pests or vermin.

Control of wind-blown litter

Wind-blown litter control is incorporated in the design of the IWMC, with the provision of PVC coated mesh fence. Even with this mitigation measure in place, there is a possibility of wind-blown littering occurring. Such litter shall be cleaned by the occupier of the IWMC. It is recommended to implement procedures to clean up the wind-blown litter after strong winds; and
clear all litter within the premises daily and any litter that has been blown out of the IWMC.

Mitigation for odour impacts

- Covering of rapidly biodegradable organics. Rapidly biodegradable organics include grass clippings, food and animal organics and organic sludges. The exposure of such organics to the atmosphere should be kept at a minimum. In open air composting such as the proposed technique for the IWMC, piles of compost can be covered by a 15 cm thick layer of fresh

compost in the curing stage. The microbes present in this layer of compost help reduce the odour of the compost pile underneath;
- keep the moisture levels of the compost pile optimum, which promotes free airspace and results in aerobic respiration;
- avoid uncontrolled emissions of biogas from the compost pile by keeping the pile well aerated;
- keep the carbon – nitrogen ratio at an optimum level (this is achieved at the mixing stage) to decrease the amount of ammonia produced; and
- keep records of complaints about odours, and correlate with weather conditions and categories of organics used.

Mitigation for fire hazards

- A fire management plan shall be developed by the IWMC occupier;
- Adequate firefighting equipment shall be provided at the IWMC, and placed at locations easy to access. The current design of the IWMC includes a fire alarm system as well as firefighting equipments;
- the IWMC occupier shall be able to show that firefighting capacity of the IWMC is sufficient to suppress and minimize the incidence and impact of fires;
- training and awareness raising on firefighting shall be conducted on a regular basis for the workers; and
- signs shall be kept on the premises stating that open flames are not permitted on site.

Mitigation for noise impacts

- Obtain noise data from supplier prior to purchase of machinery;
- enclose the noisy machinery with sound insulating enclosure;
- reduce duration of exposure by implementing job rotation; and
- provide employees with hearing protection if required.

Mitigation for workplace accidents

- The IWMC occupier shall be required to develop occupational safety management plan, and safety guidelines shall be displayed in the work site at all times;
- provide clear instructions to the workers on:
    - The possible risks
    - Measures in place to control risks
    - Follow emergency procedures;
- provide proper training including manufacturer's safety instructions to employees on how to operate machinery;
- conduct proper and regular maintenance of machinery used;
- prior to maintenance, make sure the equipment is made safe and prevent access to dangerous parts. Make sure others are aware that maintenance is being carried out;
- machinery and vehicles should only be handled by employees with the proper credentials and training; and
- proper PPE should be provided at work. PPE should be used after all possible risks have been eliminated as much as possible and to manage any remaining risks.

Figure 25: Recommended protective clothing for waste management employees. Adapted From: Ministry of Health, Thailand. Bangkok, 1995. *noise cancelling headphones and safety glasses during use of machinery

Table 28: Operational phase hazards and suitable PPE

Hazard	Suitable PPE
Stock movement and falling items	• Safety shoes • Hard hats
Moving vehicles	• High-visibility jackets
Slips	• Safety shoes with slip resistant soles
Sharp edges	• Gloves • Forearm protection • Aprons • Hand pads • Thumb guards • Head protection
Noise	• Noise cancellation headphones

5.3.2.3 O3 Waste Generation

Not considering the waste collected from the island, waste generated as a direct result of operations at IWMC during the operational phase of the IWMC will be relatively low. These will include waste oil/batteries for waste management equipment, yard cleaning waste, used spare parts, used clothes, etc. Since eating and cooking inside the IWMC will be prohibited, no mixed municipal waste will be generated during the operational phase of the project. Hence overall impact for this activity would have a minor negative impact on environmental receptors. The multi-criteria impact analysis shows it would have a minor negative impact with an overall score of -10.

Mitigation Measures

- All wastes generated as a direct result of the waste management activities shall enter the waste management stream and managed as prescribed for different waste types; and
- prohibit eating/cooking in the IWMC.

5.3.2.4 O4 Resource Consumption

Electricity, fuel and water will be directly required for the operation of the IWMC. Water will be mainly sourced from the ground while electricity will be obtained from the island's mains.

Water will be mostly required for cleaning purposes and moistening compost piles and volume of water required for these will be relatively small. As most of the moisture required for the compost pile will be sourced from the leachate collected from the leachate tank the volume of water required will be significantly less. It is estimated that approximately 200 -300 l/day of ground water will be required during the operational phase of the project. Since the volume of water required is relatively low, it is not expected to have a significant impact on groundwater.

A compactor and shredder/crusher can be used to reduce the volume of waste streams. The waste weight will remain the same so there will be no savings from the total amount of waste produced. However, savings will occur because waste volume will be reduced by approximately 80% which will decrease the number of times the storage area is required to be emptied, therefore resulting in lower transportation costs.

Depending on the type of equipment's used such as chainsaws will require small volumes of fuel for operations. Most of these equipment's, however, are run very infrequently when enough waste has been separated and stored and are relatively efficient when run, meaning the amount of energy consumed by the compactor will be low. The running wattage mid-range compactors and shredders may range from 700 – 2000 watts, which means approximately 30-60 kW will be required to power all equipment simultaneously. However, this will not be the case since many of these equipment don't need to be switched on daily and at the same time. There may be periods where the only electricity required will be for switching on the lights at the IWMC. Therefore. Electricity consumption of the IWMC during the operational phase will be relatively low. The activity would have a moderate negative impact on environmental receptors.

However, the following mitigation measures shall be implemented to reduce water and electricity consumption.

Mitigation Measures

- It is strongly encouraged to install solar panels on the IWMC roof to generate required power for the IWMC;
- use solar lights in the premises;
- work shall be planned to be carried out during day times;
- ensure that the compost pile is shaded during dry periods to avoid rapid loss of moisture content;
- use a spray hose so that the surface area of water droplets is increased which would reduce the amount of water consumed;
- ensure that all equipment is serviced and kept clean daily, to reduce the amount of water required for cleaning;
- prepare a plan to switch on the compactors and shredders depending on the incoming waste stream to conserve electricity and
- make sure all equipment are properly serviced and maintained.

Table 29: Impacts and proposed mitigation measures for the construction and operational phase of the project

No	Potential Risk/Impact Description	Receptor Description	Nature	Reversibility	Significance Major positive Major negative Moderately positive Moderately negative Minor positive Minor negative Negligible	Mitigation	Cost USD
CONSTRUCTION PHASE (C)							
C1	Impacts from worker influx and settlement (flora and fauna, resource use and sociocultural impacts)	People of Mulah, and terrestrial and marine environment	negative	Reversible	**Minor**	• **See Section 5.3.1.6**	Included in the construction costs.
C2	Impacts from transportation of materials. (climate impacts, and impacts on roads)	Residents of Mulah, terrestrial and marine environment, global environment	negative	Reversible	**Moderate**	• **See Section 5.3.1.5**	Included in the construction costs.
C3	Impacts from site demarcation and fencing (Impacts on flora and fauna)	Local flora and fauna	Negative	Reversible	**Minor**	• **See Section 05.3.1.7**	Included in the construction costs.
C4	Impacts from site clearing and earthworks (terrestrial pollution, vegetation removal)	Vegetation of the site and surrounding areas	Negative	Reversible	**Major**	• **See Section 5.3.1.1**	Included in the construction costs.

C5	Impacts from construction works (vegetation impacts, noise and vibration, accidents and injuries, pollution from material storage)	Workers and residents of Mulah	Negative	Reversible	**Moderate**	• **See Section 05.3.1.2**	Included in the construction costs
C6	Terrestrial pollution from construction waste generation	Residents of Mulah, ecosystem	Negative	Reversible	**Moderate**	• **See Section 5.3.1.3**	Included in the construction costs
C7	Impacts from resource use	Residents of Mulah, ecosystem	Negative	Reversible	**Moderate**	• **See Section 5.3.1.4**	Included in the construction costs
OPERATIONAL PHASE							
O1	Waste collection and transportation (Climate impacts, air quality, amenity impacts)	Residents and visitors to Mulah	Positive	Reversible	**Major**	• **See Section 05.3.2.1**	Cost borne by IWMC occupier
O2	Waste management activities (Public health, noise, groundwater, fire, accidents, odour impacts)	Mostly IWMC workers, residents and visitors to Mulah	Positive	Reversible	**Moderate**	• **See Section 5.3.2.2**	Cost borne by IWMC occupier
O3	Waste generation (terrestrial pollution, groundwater contamination)	Residents and visitors to Mulah	Negative	Reversible	**Minor**	• **See Section 5.3.2.3**	Cost borne by IWMC occupier
O4	Resource consumption (water and electricity)	Residents and visitors to Mulah	Negative	Reversible	**Moderate**	• **See Section 5.3.2.4**	Cost borne by IWMC occupier

6 IMPLEMENTING THE ENVIRONMENTAL MANAGEMENT PLAN

6.1 SCOPE

This chapter would present in detail the management measures put in place by the Proponent and the contractor to mitigate the environmental impacts that would arise from the project activities. The assessment of impacts and mitigation measures that would be put in place had been discussed in detail in the previous chapter. The main scope or objectives of the Environmental and Social Management Plan are to:

a) Produce a framework for anticipated impacts, including practicable and achievable performance requirements and systems for monitoring, reporting and implementing corrective actions during pre-construction, construction and operational phase; and
b) provide evidence of conformity to laws and regulations and requirements of enforcement agencies.

6.2 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 under EIA Regulation 2012, and ESAMF of MCEP.

a) Environmental Management Planning and establishment of key performance indicators: The ESMP specifies environmental management measures and required performance standards;
b) IWMC construction and operations: The aspects of the construction and operation will be established and operated according with the ESMP;
c) Monitoring and corrective action: The implementation of ESMP measures will be monitored during operational stage and will be reported. Any inconsistencies between the ESMP and its on-site implementation will be identified and addressed through corrective actions; and
d) Auditing, reviews and enhancement: The ESMP will be reviewed. Improvements to the ESMP will be made as necessary to achieve desired environmental outcomes.

6.3 ENVIRONMENTAL MANAGEMENT STRUCTURE

This Sections detail the various parties involved in the implementation of the environmental plan and their responsibilities.

6.3.1 The Proponent, Ministry of Environment and Energy

MEE will be responsible for the execution of the project activities within the required timeframe. MEE is also responsible of policy level decisions and provision of support regarding the waste management works undergone in the island as well as the regional level. MEE will also be responsible for leading the discussions with the Island Council and other relevant organisations on capacity development, training and facilitating resource acquisition for the sustainable management of the IWMC. In addition, MEE will be responsible for the following:

- Environmental monitoring according to the proposed framework; and
- Management of grievances received at tier 2 (those that are not resolved at tier 1 by the Island Council). See **Table 35** for details.

6.3.2 Island Council

During the construction phase, the Island Council is responsible for land clearance works for the access road. In addition, the Island Council will be primarily responsible for the following:

- Facilitating all activities related to the Project at island level;
- implementation of the Waste Management Plan (WMP) for a period of 5 years.

- implementation waste Management Regulations for the island;
- implementation of Waste Management Guidelines for the island; and
- overseeing the operations of the IWMC.
- The Island Council is responsible to ensure the progress of the Waste Management Plan and achievement of the set goals through implementing the plan. The island council is also responsible for the compilation of the IWMC reports submitted by the occupier as well as producing an IWMC monitoring report as well as reporting of public grievances. These reports shall be submitted to the MEE bi-annually for review. This also includes management of grievances at tier 1. See **Table 35** for details.

6.3.3 The Contractor

The contractor will undertake the project in accordance with the ESMP and will report to the Proponent and environment consultant about any unexpected environmental impact or health and hazard issues. During the construction stages, the contractor will follow all mitigation and management measures proposed in the report, mainly waste management, pollution control, accident prevention and work methodology proposed.

6.3.4 Environmental Consultant

The environmental consultant would prepare the ESMP based on field visits and surveys and based on past project experiences in similar settings. If there are any modifications to be made to the ESMP during any stages of the project, the consultant would do the modification.

6.3.5 Environmental Protection Agency

The Environmental Protection Agency would review the monitoring reports submitted by the Proponent and would continue with regulatory monitoring visits to the project site upon their needs.

6.3.6 IWMC Occupier

The IWMC occupier will be responsible in running the operations in accordance with the guidelines set by this ESMP and the approved IWMP of Mulah Council. The responsibilities of the IWMC occupier include producing the IWMC operations reports and submitting the reports to the Island Council at the proposed regularities.

6.4 REPORTING

Reporting will be carried out on a timely manner to implement the Environmental and Social Management Plan and will cover details of site conditions, and operations. A detailed reporting mechanism for the IWMC operational works is provided in **Section 6.10**. Monitoring reporting shall be carried out during the stated time frames and frequencies in **Section 6.6**.

6.5 ENVIRONMENTAL MANAGEMENT PLAN

A practical plan taking into consideration available resources is proposed to meet the aims and objectives of the ESMP. One of the major risks to the investment and operation of the IWMC and island level waste management is the centre itself which can be converted back into a dumpsite due to mismanagement as often seen in island level waste management endeavours all across the Maldives. This is partly due to the fact that a lot of linkages connecting island level waste management with regional level waste management are absent or unknown until it is much too late. As described in **Section 5.3.2.2**, one of the main risks facing the current project is rapid accumulation of organic waste at the IWMC. Hence the proposed IWMC management plan aims to control and mitigate such risks without severe negative impacts.

Table 30:Details of Environmental and Management Plan proposed for the IWMC

Activity	Phase	Measures	Time frame	Responsible person
Training of workers and contractors	Pre-construction, Pre-operation	Contractor and project workers are provided with detailed information on the project, impact mitigation measures, compliance with environmental permits and the ESMP. Workers are also provided with the information on sensitive areas of the island and other environmental issues. Training of staff involved in the monitoring of the construction phase Training shall be provided to the workers of the IWMC on the waste management practices and mitigation measures in order to ensure the operations are run efficiently and effectively.	Prior to construction works Prior to operational phase	Proponent Environmental Consultant Island Council
Documenting non-conformances and corrective actions	Construction Operation	Non-conformances to the environmental regulations, permits and the ESMP is monitored and documented. Corrective measures are taken and follow ups are done. MCEP has established a Grievance Redress Mechanism. See **Table 35** for details.	Construction and Operation phase	Proponent Environmental Consultant Island Council
Supervision of activities	Construction Operation	The project activities are to be supervised by the Proponent throughout the construction and operational phase to ensure the activities are carried out accordingly and the impacts are minimised. The Proponent shall review the IWMC operations reports from the island councils, and provide the required support, bring about any necessary policy updates	Construction and Operation phase	Proponent Environmental Consultant Island Council

6.6 ENVIRONMENTAL MONITORING PLAN

The Environmental Monitoring Plan has the following objectives;

- To ensure that the environmental and social mitigation and enhancement schemes, are well understood and communicated to all involved parties.
- To evaluate the effectiveness of environmental and social remedial measures and procedures.
- To evaluate if the intended benefit of the project is realised

The intended positive impacts of the project can only be accurately determined by the post-project monitoring scheme. In order to ensure effectiveness of the proposed project it is essential to monitor, collect information, evaluate the information collected and information disseminated.

Table 31: Monitoring plan for the construction and operation phase of the project

Objective	Activity	Parameters to be monitored	Location	Method	Frequency	Responsible Agency	Verifiable indicator	Cost (MVR)	Phase[2]
Minimize vegetation removal	Tree survey & set out survey	Vegetation falling within the footprint of plot. Set out survey shall be carried out as described in **Section 2.3.4.1**	**At project site (land)**	Vegetation and set out survey.	Once	Contractor	Survey report. The report shall contain the exact number of trees identified to be relocated and removed as timber should be identified. The survey report shall provide a justification for removal of a tree as timber.	45,000	**C&O**

[2] C = construction phase, O = Operational phase

Ensuring that the project activities does not affect the quality of the groundwater	Groundwater quality observation	Visual observation, smell.	**Project site**	Physical observation and surveying IWMC workers and nearby households	Twice during construction phase and 1 year after operation commences	Proponent ESS Officer	Water quality observation report	12,000 per monitoring trip	
Ensure waste generated at work site is audited and managed responsibly	Management of waste generated as described in **Section 2.3.16** of the report	Estimation of waste generated at project site and recording these data routinely. This includes quantifying and recording the amount of yard waste, hazardous waste and general waste stacked and stored for transportation.	**Work site & IWMC**	Keep records in a log book, or data sheet	Every two months	IWMC occupier Construction Contractor	Record sheets, photographs and quantity of waste processed at nearest waste management facility and IWMC. If there are no significant discrepancies between the quantity of waste generated on site and processed at nearest waste management facility, it can be safely assumed that impacts of waste on the environment was reduced.	Included in the project costs	**C&O**

Ensuring survival of relocated and re-planted trees.	It is important to ensure the survival of relocated trees after investing heavily in its relocation.	The parameters for monitoring include: 1. Nitrogen Deficiency 2. Phosphorous Deficiency 3. Boron Deficiency 4. Manganese Deficiency 5. Water Deficiency 6. Pests and Diseases	**Re-planted and relocated island**	Based on visual assessments and chemical tests	Monitoring shall be undertaken one year after replantation	Proponent ESS Officer	Monitoring reports which shall include diagnosis, remedial measures and observations after remediation.	Approximately MVR 100,000.00	O

Monitoring Health and safety of workers and the public	Accidents during construction of IWMC, land clearance, operation of IWMC and maintenance of IWMC. Fire hazards and natural disaster events. Noise and smell complaints during operation and construction phase. Compost condition, output and quality	Type of accident/complaint Cause of accident/complaint Date and time. Physical inspection of compost. Determination of input feed and output product. Rate of compost production	**IWMC**	Keep records in a log book, or data sheet	Biannually	IWMC occupier Construction (phase) land clearance contractor Island council MEE See **Section 6.3** for responsibility of each stakeholder.	Measures to adapt and prevent accident and risks. Health assessment reports published or available from the local health centre. Policy changes and upgrades. Compost quantity and quality. Income from selling compost.	Included in project cost.	**C&O**
Grievance redress	Addressing public grievances regarding proposed project activities	N/A		Log of records of number of complaints received and actions taken	Throughout the construction phase and once when the project is completed and one year after project completion during operational phase	Council MEE	Grievance Redress Report	Included in project cost.	**C&O**

Spillage assessment	Monitoring spillage during the operational phase	Waste collection arrangements, littering around the island, spillage during transfer to IWMC, spillage within the IWMC, proper use of IWMC, spillage during transfer to regional waste facility.		Spillage assessment records	Once when the project is completed and one year after project completion	MEE	Spillage Assessment Report	Included in project cost	O

6.7 RESOURCE REQUIREMENT FOR MONITORING

For the monitoring program to be successful, it is important that adequate financial and human resources are available and strong coordination among the key stakeholders is maintained.

The primary function of implementing the mitigation and monitoring plan will lie with the Proponent and environmental consultant. Since the project at developmental and operational stage will be engaged by the Proponent it will be the responsibility of the Proponent to take care of the environmental safeguards at all stages of the project during implementation and at operational phase. The Proponent should prepare an Environmental Action Plan, which states all measures for mitigation and enhancement and monitoring as described here in the ESMP with their responsible organisation and person, planning, methodology, timing and other relevant aspects.

Environmental and Social Safeguards (ESS) Officer of MCEP will undertake and audit the monitoring program prescribed in this report. Following each monitoring visit the ESS Officer will prepare a report with clear recommendations and corrective measure if necessary. The report will have to be submitted to EPA for their review and actions.

6.8 MONITORING SCHEDULE

Table 31 highlights the monitoring plan in which responsibilities of main stakeholders has been assigned. In order to track and compile the findings of these measures, ESS Officer shall be tasked to audit the projects ESMP. This is to

- identify gaps in monitoring and mitigating impacts arising from the project;
- determine the challenges and resource inadequacies to implement the proposed ESMP; and
- determine the current environmental condition and propose modification/upgrades to the initial ESMP.

Monitoring frequency for various individual components **Table 31** shall be followed by all responsible parties. **Table 32** gives indicative timeline for the monitoring visits by ESS Officer.

Table 32: Monitoring visit schedule

Visit	Indicative timeline	Indicative parameters to monitor	Reporting	Cost (MVR)/per report/island.
Visit 1	During land clearance	Setting out survey, work method, waste management monitoring and monitor health and safety of workers. Review reports by contractors and Proponent.	Submit monitoring summary report 1 to Proponent within 2 weeks	10,000.00
Visit 2	During construction of IWMC	Monitor work method, waste management, monitor health and safety of workers. Monitor impacts to nearby vegetation and ensure vegetation removal is as per set	Submit monitoring summary report 2 to Proponent (MEE) within 2 weeks. Proponent will compile and submit monitoring reports to EPA after completion of construction phase.	10,000.00

		out survey. Review reports prepared by contractors.		
Visit 3	One year after relocation/replantation of trees.	Monitor relocated and replanted trees according to **Table 31**	Submit summary report 3 (1-4.) Proponent within 2 weeks	30,000.00
Visit 4	Two months into operation of the IWMC. One year after start of operations	Monitor water quality through observations and noise. Monitor IWMC. This includes review of reports dated in **Table 34** or determine condition of IWMC. Monitor compost condition as described in **Table 34**and **Table 31.**	Submit summary report 4 (1-4.) Proponent within 2 weeks	25,000.00

As indicated, during the course of the Project implementation summary reports following each trip is expected to be submitted by the ESS Officer. These environmental audits will provide a basis for assessing at least the shorter-term efficacy of the environmental measures and thereby provide lessons to be learned for future monitoring sessions and other projects with similar impacts. The ESS Officer will prepare and submit the reports to Proponent. Based on the findings of the report, the management approach may be adapted and its efficacy will be determined in the consecutive monitoring trip.

6.9 MONITORING REPORT

Reporting will be carried out by the ESS Officer assigned for the purpose by the Proponent.
The report will include among other information;

- Details of what was being monitored;
- Methodology of data collection and data analysis;
- Major findings;
- Effectiveness of the mitigation measures in place and
- Recommendations and conclusions.

A detailed environmental monitoring and management report is required to be compiled and submitted to the EPA. In addition to this, regular site monitoring would be carried out by the Proponent that requires maintaining logs of events as explained in this report. Enforcement officers from EPA may also visit the site for inspection from time to time.

6.9.1 Monitoring Report Format

The environmental monitoring report outlined in **Table 33** below will be used in reporting environmental monitoring to be carried out as given in the monitoring plan.

Table 33: Monitoring report format

Project Title:
Name of the Island:
Monitoring Date:
Period Covered:
Prepared by:
Contributions:

A. Introduction
Give a brief introduction about the project and the monitoring carried out
B. Methodology
Brief detail of the methodology applied for undertaking the monitoring assessment
C. Environmental Monitoring
a. Groundwater quality
Parameters given in the monitoring plan need to be assessed
b. Management of trees removed
These include monitoring trees removed, its fate and validation of number of trees removed.
c. Survival of relocated plants
These include monitoring for pests and diseases as described.
d. Waste generation and management at IWMC
These include monitoring for pests and diseases as described.
D. Risks and Mitigations
Please indicate any critical unresolved risks that affect the course of the system operation, analyse the cause, assessing the potential impacts on the environment providing the proposed mitigation strategy
E. Problems Encountered
Indicate any problem areas encountered and any corrective measures that will have to be taken.
F. Recommendations and Adaptations as Solution
If specific recommendation is noted during the monitoring phase, specify it in the report
G. Conclusions
Reference
Appendix

6.10 IWMC OPERATIONS REPORTING MECHANISM

Table 34:Details of the reporting mechanism proposed for the IWMC

IWMC (Occupier)

Reporting	Details	Frequency
General report	Logs of the incoming waste	Monthly
	Classified by type and weight	
	Vehicle maintenance details	
	Machinery maintenance details	
	Machinery fuel usage details	
	Workplace injuries	
IWMC capacity	Details of the utilized and remaining capacity of IWMC	Every two months
	Leachate tank maintenance and capacity	
IWMC inventory status report	Details of the status of IWMC equipment	Bi-Annually
	Details of the status of emergency kits and firefighting equipment	
	Details of amount of input waste materials	Bi-Annually

Island Council (Municipal Unit, Waste Management Committee)

Components	Details	Frequency
Public grievances	Grievance Redress Mechanism developed by MCEP. See **Table 35** Public grievance records and actions taken shall be compiled into a report submitted to MEE bi-annually	
IWMC monitoring	Monitoring report of the IWMC operations	Bi-Annually
Compilation of IWMC reports from IWMC occupier		Bi-Annually
Income report	Summary of IWMC operations income	Bi-Annually

MEE

Components	Frequency
Review of IWMC Reports from Council	Bi-Annually
Update National Waste Database	
Policy updates from findings	
Provision of support to IWMC	
Overview of the waste management system on island level and regional level	
Public grievances	Grievance Redress Mechanism developed by MCEP. See **Table 35**

Compost output report	Details of compost output in weight	
Noise and odor complaints	Log of noise and odor complaints	Every two months
	Complaints to be provided along with weather conditions and incoming waste details coinciding with the dates of complaints	

6.11 GRIEVANCE REDRESS MECHANISM

Based on the ESAMF, MCEP has formulated a Grievance Redress Mechanism (GRM). GRM is established to receive and facilitate grievances of the affected persons during the implementation of the project.

Island Councils were consulted on the progress regarding setting of focal points and availability of the GRM forms at the Council. M. Mulah Council stated that the Council would make the forms available physically at its office as well as publicly displayed. The Council has nominated a waste management focal point for this purpose (Hussain Shareef 7845088). Mulah Council does not have a website, although work is underway on creating a Facebook page, in which a link to the GRM forms will also be provided.

Following are the details of the GRM developed by the MCEP. GRM at tier 2 will be managed by the ESS Officer of MCEP. Tier 2 GRM forms will be made accessible from the respective council office and MEE front office and is published in MEE website. Below are the links.

English page:
http://www.environment.gov.mv/v2/en/download/7189

Dhivehi page:
http://www.environment.gov.mv/v2/dv/download/7191

Table 35:Details of the Grievance Redress Mechanism developed by the MCEP

Tier of Grievance Mechanism	Nodal Person for Contact	Contact Communication and other facilitation by the project	Timeframe to address grievance
First Tier: Island Council	Island Council will be the first point of contact for any grievances. The staff designated as the waste management focal point by the island council will manage grievances on behalf of the council.	GRM should be publicly displayed in the construction site as well as the council office. GRM should also be outlined in official website and/or social media pages of Council, MEE (and/or the project), including contact details of the nodal person in each tier. Grievances can be addressed informally by contacting the council through email / telephone / in person. If the grievance cannot be resolved informally, an aggrieved party must submit a complaint on the Tier I Complaint Form. A copy of the form (with the council seal) should be provided to the aggrieved party as evidence of receipt. Electronic version of the complaint form should be available from the websites and/or social media pages of MEE and the council. Physical copies of the form should be	15 working days

		available from the council front office. Council will provide assistance to fill the form for those who cannot write. The council should keep separate registries for informal and formal complaints and maintain records of all complaints received. The council will discuss the matter with the Women's Development Committee and other relevant stakeholders (Farmers, Fishermen, School, Health Center etc.), where deemed necessary and attain views of them. If such meetings are arranged, the date, time, location or venue, list of participants (with contact details) and a summary of the main outcome of the consultation must be annexed to the written decision issued by the council. If the complaint is resolved within 15 working days, the council must communicate the decision to the aggrieved party in writing. The aggrieved party must acknowledge the receipt of decision and submit their agreement or disagreement with the decision within 10 working days. If no acknowledgement is submitted from the aggrieved party within this period, then the decision will be considered as accepted. If a complaint requires more time to address, this requirement must be communicated to the aggrieved party in writing and the aggrieved party must consent and sign-off the request for the extension to take effect. An extension can be made to an additional 15 working days. The staff designated as the waste management focal point by the island council will manage and provide feedback	

		for grievances submitted to the council.	
Second Tier: Ministry of Environment and Energy (MEE)	Environmental and Social Safeguards officer at the Project Management Unit (PMU) will be the focal point.	If the grievance cannot be resolved through Tier 1 to the satisfaction of the aggrieved party or if the issue is outside the jurisdiction of the council (issues related to RWMF), an aggrieved party may submit a complaint on the Tier 2 Complaint Form. A copy of the form (with MEE seal) should be provided to the aggrieved party as evidence of receipt. Electronic version of the complaint form should be available from the websites and/or social media pages of MEE and the council. Physical copies of the form should be available from the council and MEE front office. A copy of the Tier 1 Complaint Form should be submitted with the Tier 2 Complaint Form. MEE will forward the grievance to PMU. PMU screens the grievance and determine if its related to MCEP. If it is unrelated, the aggrieved party must be notified in writing and the way forward must be outlined to them including the necessary government institutions to follow up. Environment and Social Safeguards Officer at the PMU will be the contact person in processing a grievance through the Second Tier. PMU will discuss the matter with EPA and other relevant institutions, where deemed necessary and attains views of them. PMU will also arrange site visits and hold onsite discussions and meetings if necessary. The PMU will be responsible to ensure that there is no cost imposed on the aggrieved person, due to the grievance mechanism at the second tier. If the complaint is resolved within 15 working days, the PMU must communicate the	15 working days

		decision to the aggrieved party in writing. The aggrieved party must acknowledge the receipt of decision and submit their agreement or disagreement with the decision within 10 working days. If no acknowledgement is submitted from the aggrieved party, then the decision will be considered as accepted. If a complaint requires more time to address, this requirement must be communicated to the aggrieved party in writing and the aggrieved party must consent and sign-off the request for the extension to take effect. An extension can be made to an additional 15 working days. If the grievance is not resolved to the satisfaction of the aggrieved party within 15 working days of submission of the grievance to tier 2 then the aggrieved party may notify the MEE, in writing, of the intention to move to tier 3.	
Third Tier: Judiciary Power / Assistance to Vulnerable Persons beyond the Project's Grievance Redress Mechanism	Judiciary system is an option for an aggrieved person and/or community in case that the other tiers have not been effective	The legal system is accessible to all aggrieved persons. Assistance from the PMU of MCEP is available only for vulnerable person(s)* as per this grievance mechanism. In cases where vulnerable person(s) are unable to access the legal system, the Attorney General´s office will provide legal support to the vulnerable person(s). The PMU must assist the vulnerable person(s) in getting this support from Attorney General´s Office. PMU must also ensure that there is no cost imposed on the aggrieved person if the person belongs to the vulnerable groups. The list of vulnerable groups is as defined in the footnote but may be further defined by MEE. The verdict of the Courts will be final.	As per established Judicial Procedure

*Vulnerable person(s): A vulnerable person(s) for the purpose of this project is a person who is poor, physically or mentally disabled/handicapped, destitute, and disadvantaged for ethnic or social reasons, an orphan, a widow, a person above sixty years of age, or a woman heading a household.

7 RECOMMENDATIONS AND CONCLUSION

The construction and development of the IWMC at M. Mulah is a much needed project to provide waste management services to the island. The IWMC will be an improvement to the current waste disposal practices conducted in the island, while reducing the environmental pollution and providing health and economic benefits to the island.

Although the project is perceived to yield significant environmental and human health benefits and contribute towards achieving sustainable development goals, it should be understood that these benefits as outcomes would depend on smooth operations of the waste management system as a whole. In order for the system to function sustainably adequate resources in particular financial resources shall be made available. Part of the required funding could be obtained through introducing a fee structure for the service and sale of metals and compost. However these revenue sources are not likely to be adequate enough for the entire operation. Hence, support from the government will be critical to maintain the system functional. Unavailability of the funds could mean breakdown of the transport system which could ultimately collapse the waste management service. Regular removal of residual waste from the island will have to be ensured as a key aspect of the project implementation. A RWMF and a regional collection and transport system in Zone 4&5 will be established under MCEP. Regional collection and sea transport will be through WAMCO in agreement with the Council once the regional system is established. Location and technology used for RWMF will be determined through the Feasibility Study and BPEO Study.

Based on past experiences gained from projects of similar nature, it is also important to undertake a one off clean up activity of the island that includes removal of existing stockpile of waste. Failing to undertake this could lead to overloading of the waste management centre resulting failure to carry out the operational activities in the planned manner.

The construction and operational impacts that might arise from the project should be managed, mitigated and monitored on a continuous basis and should adhere to the EIA regulation all throughout the construction and operation of the project. Strict considerations are to be given to the pollution control as well as health and safety measures

The consultant's recommendations for the project include:

- Plan a one off clean up activity prior to the official opening of the waste management centre;
- plan and have in place a sea transfer arrangement to remove residual waste from the site on a regular basis;
- carryout necessary training for the waste management personnel in particular in the area of composting;
- adequate awareness raising of the general public on the operation and functioning of the new waste management centre and sensitising the public on the rules and procedures that would come into effect with regards to the new waste management system;
- implementing fee for service system;
- strengthening enforcement capacity of the local authorities;
- provision of adequate financial and technical support at least for the initial 3 years into the project implementation to the island council;
- determine an operational plan for the centre that takes into account details of all aspects of operating, managing and sustaining the service;
- conduct supervision and monitoring of the project works by the Proponent;
- enforcement agency to make an effort to make at least one visit to the project site during the construction phase to ensure environmental compliance of the project activities; and
- proponent appoints a focal point to coordinate activities relating to monitoring and reporting.

This ESMP has looked into the key factors that need to be considered during construction and operational stage and identified all likely environmental impacts. Among other temporary and highly localised minor negative environmental impacts, the study has identified the following unavoidable moderately negative terrestrial impacts due to proposed development works:

- Almost an irreversible change the overall terrestrial environment as a result of the placement of the IWMC footprint;
- loss of mature 65 mature coconut palms and 5 other types of mature trees as a direct result of placing the footprint of the IWMC and loss of 107 coconut trees and 6 other types of types indirectly as a result of clearing of access road vegetation from the project site (assuming no mitigation); and
- generation of yard waste as a result of site clearing (assuming no mitigation).

The study also found that through the implementation of the proposed practical and cost effective mitigation measures almost all identified impacts can be brought to an acceptable level. The study found no evidence of the project resulting loss of endangered or protected species or habitat.

Thus based on the findings, it is concluded that the benefits on the environment and human health greatly outweighs the negative effects resulting from the implementation of the project.

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ANNEX 1: DECLARATION & COMMITMENT OF PROPONENT

ANNEX 2: APPROVED CONCEPT PLAN

ANNEX 3: STAKEHOLDER ATTENDANCE

ANNEX 4: A3 SITE LOCATION

ANNEX 5: WASTE MANAGEMENT PLAN

ANNEX 6: IWMC SITE SELECTION FORMS AND EPA DS