Environmental Impact Assessment

For the proposed renovation, refurbishment and addition of overwater villas and spa complex at Laguna Island Resort, South Malè Atoll

Proponent:
Universal Enterprises Pvt. Ltd

Prepared by:
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August 2008

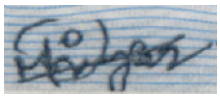
List of Acronyms

MoTCA	Ministry of Tourism and Civil Aviation
EPAA	Environmental Protection and Preservation Act
ERC	Environmental Research Centre
EIA	Environmental Impact Assessment
MoEEW	Ministry of Environment, Energy and Water
MoFAMR	Ministry of Fisheries, Agriculture and Marine Resources
NHL	National Health Laboratory (of Maldives Food & Drug Authority)
MFDA	Maldives Food and Drug Authority
MoH	Ministry of Health
UN	United Nations
UNCLOS	United National Convention of Law of the Sea
NCPE	National Commission for the Protection of the Environment
ToR	Terms of Reference
GPS	Global Positioning System

Declaration of the Consultant

I certify that the statements made in this Environmental Impact Assessment study are true complete and correct.

Mahmood Riyaz



25 August 2008

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Non-Technical Executive Summery

This is the Environmental Impact Assessment (EIA) report on the proposed renovation and refurbishment and addition of overwater villas to the Laguna Island located on the south Male atoll, under the management of the Universal Enterprises Pvt. Ltd. The proposed redevelopment includes complete demolition of existing two storey buildings (11 building) beach bungalows (11 single rooms), swimming pool, grill and some of the staff accommodation buildings and other facilities. The main new development will be the additional 20 over-water bungalows, 30 beach bungalows, 5 pool over-water bungalows, one over-water presidential suite and an over-water spa with 6 treatment rooms on the south western shallow reef flat. Presently there are only 17 over-water bungalow units on the northern side and 50 beach bungalows in the island. The development has been identified as necessary step to keep up the island with the current tourism development trends, targeted to the upper market, and to cater for new demands and to come to the level of present tourism reputation of the Maldives.

The total cost of the proposed redevelopment project is approximately 10 million US$. The renovation period is scheduled to take approximately 8 months. Resort operations after the redevelopment of the island is expected to significantly increase revenue generation from the is expected to double the present level of income from the island and to create approximately 320 permanent direct employment opportunities at the island. Several indirect employment opportunities related to the resort operations are also expected to be created.

This report has been prepared in accordance with the Environmental Impact assessment Regulations published by the Ministry of Environment Energy and Water in May 2007 and covers both negative and positive environmental and socio-economic impact arising from the proposed redevelopment works of the Laguna Island. Major findings of this report are based on as much information as possible that could be gathered during two field visits made to the island in April 2007 and August 2008. Possible effects of the project activities were determined through the field observations and extensive literature review and experiences gained from similar projects elsewhere in the Maldives.

The proposed redevelopment work will take place in Laguna island which is located on the closed end of the V-shape reef on the northern side of South Male Atoll. Laguna being located on the NW rim of the atoll it is exposed to high energy oceanic swells during the southwest monsoon and refracted, reflected and regenerated indirect fetch waves during the northeasterly monsoon. Due to the exposure of Laguna reef to the direct oceanic waves during southwest monsoon the lagoonal island is formed at the narrow end of the V-shape reef, which is supposed to be the most stable and less energy area within in Laguna Falhu. During the NE monsoon Laguna Falhu is very much sheltered and only exposed to refracted, reflected and regenerated indirect oceanic swells, and the period of exposure is shorter than the western monsoon. However the island shoreline is exposed to regenerated waves from the deep lagoon on the eastern side of the island during the NE monsoon. Laguna reef is in excellent state. Where there were corals along the transect, live coral cover was estimated to be over 90%. Clear demarcation of reef zones were observed in Laguna reef. The high energy zone of reef crest is predominantly composed of robust-branching and tabular Acropora framework and/or encrusting algal ridges. The coral cover decreased rapidly on the reef flat. Most of the area is covered by sand and rubble and patches of the massive corals

Results of the vegetation mapping show that large areas were covered by typical plants belonging to coastal community. The diversity was relatively low. Overall, a total of 20 large plant species were encountered of which the coconut tree and coastal trees are dominant. There are a small numbers of exotic ornamental plants grown on the island. Some alien plant species were also encountered during the survey. The overall quality of soil in Laguna is poor. Island soil consists of three layers. The top layer consists of material comprising of decayed leaf matter with sand followed by a less humus layer and the bottom layer consisting of medium to fine sand creamy white consists of coral and shall fragments. The depth of the water table was 0.9 m form the surface, ground water is not used for any purpose in the island. Fresh water is through RO desalination supplemented by the rainwater catchments.

Impact matrix, which is a standard EIA tool for identifying the possible impacts of project activities, was created for proposed Laguna development project. The activities carried out during the demolition, construction and operational phases are arrayed against a selection of environmental factors that may be affected directly or indirectly as a result of project activities.

Anticipated environmental impacts during the demolition include creation of large volumes of demolition waste, which consists to a large extent of building materials and small amounts of hazardous substances. Increased noise and dust is expected as well as additional demolition debris to be retrograded.

The report has identified and described in detail possible change that would occur to the existing condition of the environment caused during the construction phase and have suggested appropriate mitigation measures for each and every impact identified in the report. Sedimentation and increase in suspended sediment level in the water, has been identified as the most significant negative coastal and marine environmental impact that could be associated with the construction of overwater villa offshore shallow lagoon. Although these are temporary impact they could be mitigated if the activities are undertaken in calmer weather condition and preferably at low tides, during NE monsoon period because it is expected to transport the bulk of sediments suspended in the water by the currents into the deep waters of the atoll lagoon and disperse faster, this will contribute for significant reduction in impacts associated with sedimentation. Liquid, solid and other forms of wastes and particularly hazardous waste generated during the construction has also been identified as significant impact associated with the construction phase and appropriate mitigation measures are suggested for each and every waste related impact identified in the study. Since all the land constructions will be on the footprints of the existing buildings in Laguna vegetation clearance will not take place. Also the fact that Laguna being an isolated island noise, air pollution (dust) and vibration generated during the construction has been identified as local impact that might cause some effect for the workers on the site. Therefore the report has suggested providing safety helmets and appropriate noise reducing headphones, nose covering etc to the workers on the site as a mitigation measure from the impact.

The study has evaluated two alternative options for the project and has suggested that the path proposed in this EIA report is the best option as it is moderate and the level of environmental modification is minimal with significant socioeconomic benefit. The report has come-up with an extensive monitoring programme that will keep on monitoring the environmental changes associated with the development and make necessary adjustment to the activities of the project based on the findings of various measured environmental parameters suggested in the monitoring and environmental management plan.

On the basis this environmental impact assessment study and the impact mitigation measures proposed in the report will be duly implemented and recommendations are given due consideration, it is concluded that the benefits of the planned redevelopment in Laguna Island will substantially outweigh its imposition on the environment.

I. Introduction

1.1 Background

The tourism industry in the Maldives primarily targets for niche markets, and hence, the standard of the Maldives tourism product is continuously improving. Resorts that were developed in the 1980s are now being redeveloped and upgraded to higher standards continuously. Almost of all the resort are targeted to high end clients and as such they aim for five-star plus standard.

Laguna (Velessaru) island resort is one of the first resorts developed in the Maldives and has been upgraded in early eighties. The resort is owned by Universal Enterprises pvt. Ltd. is a private company that owns and operates 5 resorts in the Maldives. The built environment on the island is now an old and design and layout is out of style. Some of the guest rooms are two storey units are old and its design is not acceptable for current standards. This design has intended to optimize space, not exceeding the 20% built area rule. The building is old and ad-hoc repairs and refurbishments do not help to bring the look and feel of a modern tourist resort

The developer is proposing to demolish some of the existing built units and rebuild single story luxurious guest rooms instead and addition of more over-water guest rooms. The main feature of the project would be the addition of over-water bungalows and other facilities for the island. At present there are 128 rooms in Laguna, after demolition, renovations and addition of new water units the number of rooms will remain same.

The environmental impact assessment (EIA) report has been prepared in order to meet the requirements of the clause 5 of the Environmental Protection and Preservation Act of the Maldives. The EIA would to assess the impacts of the proposed reconstruction works. The report will identify the potential impacts, both positive and negative, of the proposed entire reconstruction works of the project. The report will consider the justification for undertaking the proposed project components. Alternatives to the proposed development activities in terms of location, design, and environmental considerations would be suggested. A mitigation plan and monitoring activities following the project development will be proposed.

There are no environmental reports to the Laguna Island. The findings of this report are based on data collected from field visits and discussions held with the manager and the owner of the resort.

The total investment of the proposed development is estimated to be 10 million US$. The project will create large number of direct and indirect employment opportunities throughout the country. Therefore the project will significantly contribute to the economic growth and other relevant socio economic activities. Table one gives an estimated of breakdown of costs is US$:

Table 1. Breakdown of estimated renovation cost of Laguna Island.

Construction of New rooms, over water villas	4 million US$
New beach villas	2.7 million US$
Renovation and others	3.3 million US$

1.2 Aim and Scope of the Environmental Impact Assessment

This EIA covers the environmental impact assessment arising from the proposed demolition and reconstruction of two storey guest accommodation units and development of overwater villas on the eastern part of Laguna Island at South Kaafu Atoll under the management of the Universal Enterprises Pvt. Ltd. This involves:

1. Demolition, clearing, transport and disposal of the some of the existing building built structure and development of overwater Villas on the eastern lagoon of Laguna Island and works associated with this.

2. Site preparation for the reconstruction works.

3. Impacts arising from the proposed construction work on the island including the construction of the proposed over-water bungalows on eastern reef flat.

1.3 Environmental Impact Assessment Process

The process followed in the preparation of the this EIA report consists of following steps
Scoping consultation
Development of Terms of Reference
Literature review
Field Survey
EIA methodologies
Stakeholder consultation
Presentation of the outputs

1.3.1 Scoping consultation

Consultations were held in the initial stages to determine the scope of the EIA. The scoping consultations were undertaken as per the EIA regulations of 2007, issued by the Ministry of Environment Energy and Water (MEEW). The formal scoping consultation among the key stakeholders was held at the Environment Research Centre on 12th April 2008

1.3.2 Terms of reference

Terms of Reference for the EIA was decided by the ERC following the scoping consultation. A copy of ToR is provided to the developer on 3rd June 2008, is given in the Annex 1 of this report.

1.3.3 Literature Review

A literature review was conducted to get background information on the site and its environment as well as to identify environmental impacts of the project. In this context the consultant relied on similar studies undertaken in various resort development projects in the Maldives.

1.3.4 Field surveys

This EIA is based on field surveys and measurement both quantitative and qualitative, of the existing environmental conditions of the project site Laguna Island, south Male Atoll. Conditions of existing environment were analysed using appropriate scientific methods. Field surveys were undertaken in 2007 April and August 2008. Mobilisation of some of the construction material to the site was observed during the second field survey period.

1.3.5 EIA Methodologies

The methodologies available to undertake and EIA process are numerous. They are subject of several text books and vast amount literature is available. The EIA process in the Maldives was initiated more than 10 years ago, with the proclamation of the Environmental Protection and Preservation Act, and development of Environmental Impact Assessment Regulations in 2007 the process is developing in the right path and has become more transparent. Comparing with the Field work and public consultation are minimal, still in most of the cases expert judgments of consultants from their previous works are drawn for impact prediction and analysis. This EIA is based on three important sources of information:

1. Surveys and qualitative information gathered during the field visit made in 2007 and 2008.
2. Maps aerial photographs.
3. Discussions held with the and the present lease of the island
4. Expert judgment of the consultants

Baseline conditions of the existing environment were assessments made using standard scientific methods. Where possible quantitative data has been obtained and variability of the estimates provided. The initial development of the island started prior to the requirement of the EIA reports.

1.3.6 Stakeholder consultation

Major national level stakeholders identified are:
Ministry of Tourism and Civil aviation
Ministry of Environment Energy and Water
Ministry of Fisheries Agriculture and Marine Resources

1.3.7 Structure of the EIA report

The main output of the EIA process is this EIA report, the structure of the report is as follows:
Chapter I Introduction, background on the project and EIA process
Chapter II Project description
Chapter III Legal and Administrative framework
Chapter IV Existing Environment
Chapter V Environmental impacts and mitigation measures
Chapter VI Project Alternatives
Chapter VII Environmental management and monitoring Plan
Chapter VIII Bibliography

II. Project Description

2.1 The Proponent

The project is proposed by the Universal Enterprises Pvt. Ltd – a fully Maldivian own company who has been managing the Laguna Resort since 1989. The company got the resort through open bidding process in 1988.

2.2 Project Location

The Laguna Island Resort and Spa is located north western end of the South Malé Atoll at 4°07' 15.80"N; 73°26'12.34"E. Laguna is located approximately 10 miles from the Malé International Airport, requiring only 12-15 minutes by speed launch. The present area of the island is just 81507 m2 .The island is set on an irregular reef (Falhu) on the northwestern rim of South Male Atoll (Figure1.).

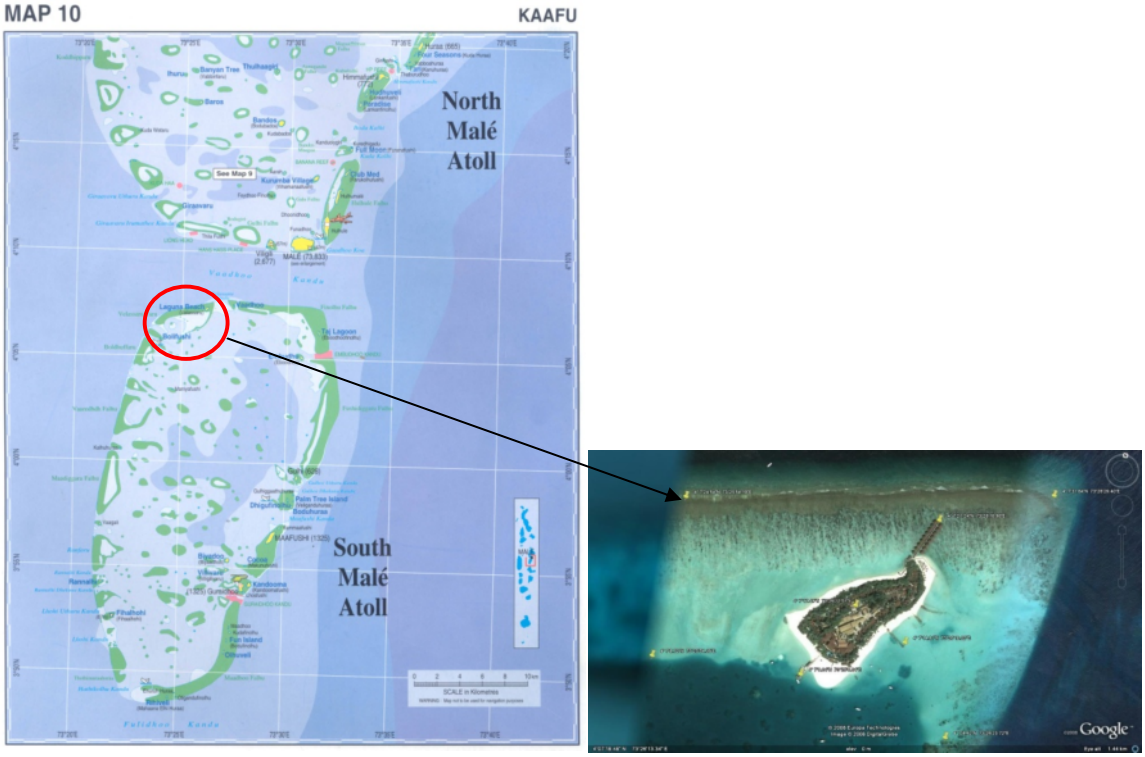

Figure 1. Map showing the location of lagoon in South Male Atoll.

2.3 Project justification

2.3.1 Problem Analysis and Need of the Project

The Laguna Island lies close to Malé and the Hulhule International Airport. The island is one of the first resort operations started mid 1970s and is well established as a tourist resort in the Maldives Therefore, it has huge tourism potential. Resort operations started at Vellessaru Island in mid 70s by Naseema Mohamed Kaleyfaanu and later the resort was operated by Mr. GT Manik. The resort was put for public bidding in 1988 and the Universal Enterprises Pvt. Ltd won the bid and started operations early 1989. The built-environment on Laguna has been renovated several times and the last was 18 years ago. The island also consists of number of two storey guest accommodation blocks. The center of the island houses the staff accommodation, power house, desalination plant, laundry, general stores and workshop. The dive shop and water sports building is on the main jetty, while the restaurant in north eastern side. Existing facilities and structures in Laguna Island are shown in (Figure 2).

2.3.2 Old and out-of-date built environment

The two storey guest accommodation bock is old and the existing swimming pool bars grills are not acceptable for current standards. This design has intended to optimize space, not exceeding the 20% built area rule. The building is old and ad-hoc repairs and refurbishments do not help to bring the look and feel of a modern tourist resort. Additions of the water bungalows are restricted by the size of the island. Additional accommodation units and service buildings are badly needed for any service improvement on the resort. Therefore in order to keep up with the current tourism development trends, targeted to the upper market, Laguna needs to be redeveloped to cater for new demands and to come to the level of present tourism reputation of the Maldives.

Higher standard would also mean a higher staff to guest ratio. Many of the five-star resorts have guest to staff ration of 1: 1.5. Most of the guest visit to Maldives for pure relaxation and so restaurants, bars, grill, swimming pool, spa complex are an important feature of modern resorts. Thus a partial redevelopment work is necessary to bring the resort to current standards in the Maldives.

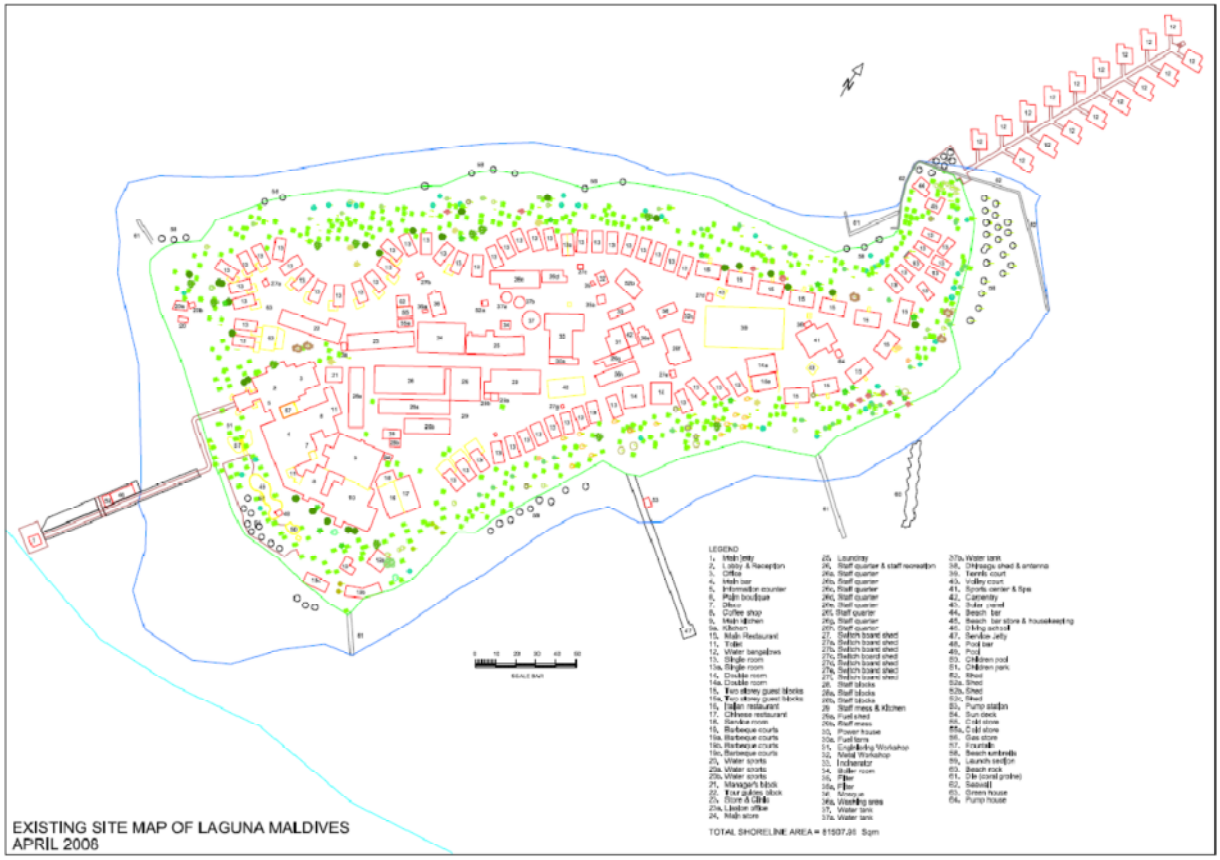

Figure 2. Map showing the existing facilities and built environment in Laguna

2.3.3 Pressure to Improve the Standard of the Resort

Maldives is geared toward moving to niche market. All the new developments are being made in the Maldives. The recent change in policy has allowed further development of tourism in the outer atolls in the extreme north and south and so far all most all of the developments have been geared to high market tourism product.

2.4 Renovation Plan

Presently Laguna is a Four star standard catering for medium range market mainly from Italy, Germany and Switzerland and Japan. The main attractive feature of the resort is the diving and the water sports, but relaxation tourism is also getting popular. The average room rates at present is 300 US$ half board. Estimated present annual earning from the resort is approximately 11520000 US$.

The renovation plan is to completely dismantle the two storey guest rooms (11 buildings), beach bungalow (11 single rooms) swimming pool, grills and staff accommodation blocks and other facilities used for the operational purposes of the resort. Gray coloured boxes in (figure 3) shows the areas that will be demolished completely.

The main new development will be the additional 20 over-water bungalows, 30 beach bungalows, 5 pool over-water bungalows, one over-water presidential suite and an over-water spa with 6 treatment rooms on the south western shallow reef flat. Presently there are only 17 over-water bungalow units on the northern side and 50 beach bungalows in the island. Under the new development a total of 128 deluxe rooms will be available (Figure 4.). Revenue generation from the island is expected to double the present level of income generate from the island (the assumed average room rate is 750/room/day)

To provide a complete range of services, restaurant, bars, coffee shop will be renovated. There will be new staff quarters with more space for entertainment / sports activities. Workshop and general store area will also be increased

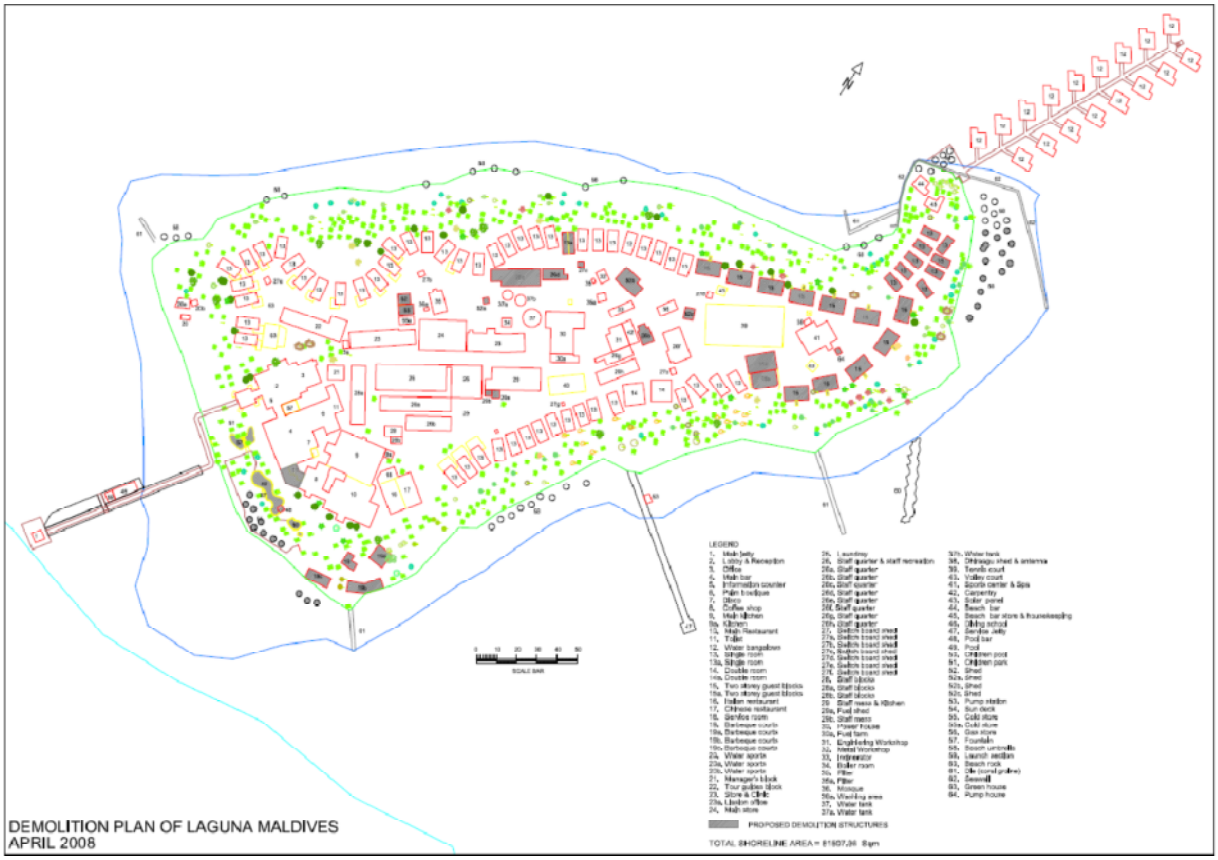

Figure 3. Map showing the location of demolition areas, Gray coloured boxes show the location of buildings that will be demolished.

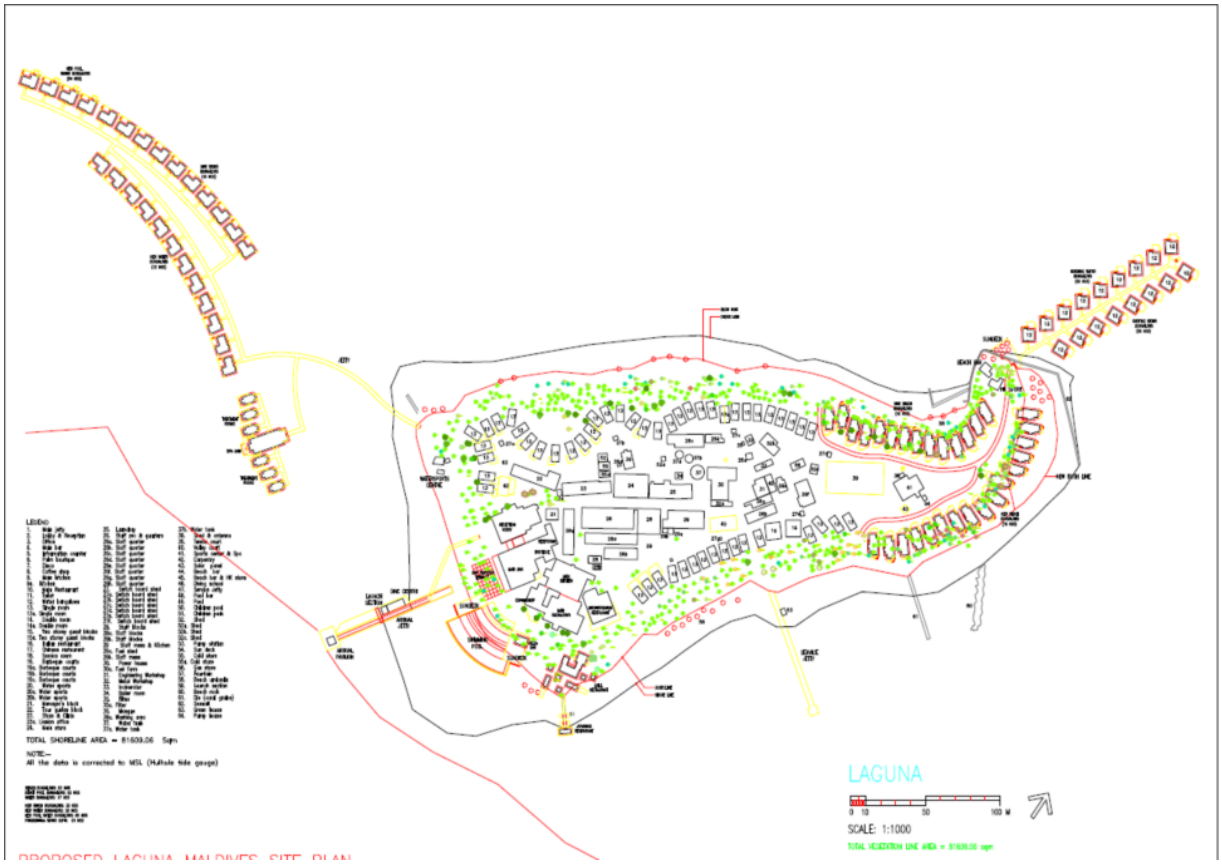

Figure 4. Proposed redevelopment plan showing the location of new over water Villas

2.5 Project Activities – Development phase

2.5.1 Site Clearance and Preparation

Most of the new buildings on the land has been planned to be constructed on the footprints of the old buildings to accommodate the infrastructures under the re-development some degree of site clearance will be required. Where required the site clearance will be done in a manner that will allow protection of trees not contained within the footprints of buildings. All shrubs and small flowering trees that require removal will be stored at a site to be designated for replanting later during site landscaping. Cut vegetation will be sent to the *Thilafushi* disposal site for disposal. Burning vegetation and organic material on the site will not be allowed.

2.5.2 Landscaping and terrestrial habitat

The detailed design for natural landscaping has not yet been prepared. Exotic plants and potentially invasive species will not be imported for that purpose. Every attempt will be made to utilize native and local plant species in a manner to create a habitat that will support an even more

diverse fauna than existed at the outset. The challenge will be to creatively use landscaping as a market differentiator in a competitive industry.

2.5.3 Excavations & Foundations

Most likely modes of failure for shallow foundation placed on island environment are load induced shear failure and/or failure related to vertical or lateral deformation. Therefore, a foundation type that reduced or mitigated the effects of these possibilities is likely to be most appropriate for this site. The developers have also decided not to use an option that would first require excavation, de-watering and removal of soil and thereby avoid creating environmental issues.

2.6 Construction system

2.6.1 Beach Bungalows

The buildings will be constructed of traditional block and steel placed on concrete platforms supported by piles. Consideration is being given to having a small concrete batching plant located on the site to produce the volume of concrete that will be required during construction. Appendix 2 gives design details of beach bungalows.

2.6.2 Overwater structure

All water bungalows, spa and their corresponding walkway will be constructed on radiate concrete poles with pads. This method involves constructing the precast concrete poles with pads. The pads will then be placed on their fixed locations and connected by the supporting horizontal trusses. Once these horizontal trusses are in place, then construction of the bungalow wall structure will be placed. After the construction of the walls, plumbing, electrical and fire networking lines will be laid. Appendix 3 gives design details of over water villa and spa complex footing plan and details.

2.7 Project Schedule

The actual construction work of the project is estimated to be 8 months. During the construction period the resort operations will be closed. Table 2 shows the renovation work and construction schedule.

Activity	2007			2008											2009			
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Project concept and initial surveys																		
Architectual design																		
Concept approval from MoT																		
EIA preperation and submition																		
EIA Approval																		
Project Mobilisation																		
Building works																		
Demolition work																		
Earthwork and foundations																		
Constrution of new swming pools																		
Construction of Water villa and spa path ways																		
Construction of beach Villas																		
Presidentail suit																		
Services (Electrical)																		
Fix 1. Laying of electrical condutes and wiring																		
Fix 2. Supply and istallation for electrical fixtures including light																		
Services (Hydraulic and driniage)																		
Fix1. pipe laying and pressure testing																		
Fix 2. Supply and installtion of sanitary fixtures & accessories																		
Installation of sewage pipe lines																		
Installation and connection to the RO system																		
Isntallation and upgrading of generator sets																		

Table 2. Renovation work schedule.

2.8 Project Inputs and Outputs

The input / output analysis of a project helps us to define and understand the potential environmental impacts of the project in systematic ways and help to address the environmental issues more effectively. Linking inputs to processes and activities leads us to outputs and consequently to impacts. The inputs and outputs relating to the construction and operation fresh fish processing facility maybe primarily derived from the project description, including the main activities of the development namely the construction of beach and water villas swimming pools and spa complex.

It should be noted that Laguna Island has been has been operational for long period of time and some the equipment required for the construction works. Following may be required for the project works.

2.8.1 Project Inputs

1. Construction workers and labourers: A large proportion of construction workers are expected to be expatriate labourers imported from countries within the region. Various socio economic impacts result from the import and management of such labourers. It is important to note that Universal Enterprises pvt. Ltd. is well established and number of similar projects already have implemented. Therefore it is likely that the construction work will be subcontracted to local groups and they will be responsible for the labourers for this work.

2. Construction materials: Multitudes of materials are required for the construction harbour and the fresh fish packing facility. Imported river sand and aggregate, concrete, timber and timber products, metal and aluminium products, plastics of sorts, gypsum boards and plywood, fibreglass materials, paints, varnish, thinners and hydrocarbons, ceramic tiles, electrical wires and many types of industrial cables, glass and plastic sheets. Procurement will take place early in the project and it is likely that they may be temporarily stored in the ware houses on Malé.

3. Construction tools and machinery: small vehicles and construction machinery, excavators, lorries, concrete machines, and tools.

4. Power generation: existing four Diesel generators will be used during the construction period. Details of power generator sets are given in Table 3.

Table 3. Details of existing generator sets in Laguna Island.

Details	Generator 1	Generator 2	Generator 3	Generator 4
Generator set				
Make	Magnamax	Magnamax	Magnamax	Magnamax
Model				
DOM	na	na	na	na
Engine				
Make	Cummins	Cummins	Cummins	Cummins
Model	KTA 19G5	KTA 19G5	KTA 19G5	KTA 19G5
DOM	na	na	na	na
Alternator				
Make	Marathon Electric	Marathon Electric	Marathon Electric	Marathon Electric
Model	572 RSL 4024	572 RSL 2037	572 RSL 2037A	572 RSL 2028A
Serial No.	WA510370-0797	XE 3804241-03	WB 3647711-12	VM3644953-02
Rating kW/KVA/A/V/Hz/pf	360/450/650/400/ 50/0.8	360/450/684/380/ 50/0.8	400/500/760/380/ 50/0.8	320/400/556/415/ 50/0.8
Speed rpm	1500	1500	1500	1500
DOM	na	na	na	na

5. Water production: Existing 180 ton RO desalination plant will be used during the construction period

6. Diesel and other heavy oils and lubricants for power generation and operation of all types construction and other machinery

7. Office equipments and furniture: Televisions, Computers, fax and copying machines, telephones and accessories, air conditioning equipment.

8. Existing resort kitchen appliances and tools, refrigerators, ovens, microwaves and cooling equipment will be used during the construction period.

9. Transport: Speed boats and power motors use highly inflammable fuels such as petrol and kerosene. Slow boats such as dhonis use diesel and other fuels.

10. Chemicals: laundry detergents, cleaning products for kitchens and bathrooms, household chemicals such as floor cleaners, window cleaners, fire fighting and prevention equipment

11. Household paper materials including all types of cleaning tissues.

2.8.2 Project outputs

The Outputs of the development can be summarised as below:

1. Excavated and scoured coral sand and aggregate from the earth and foundation work which will have be temporarily stored on the island.

2. Construction wastes including leftover concrete, pieces of wood, binding wire, deformed iron rods, empty bags etc.

3. Waste from the assembly of machinery and equipment: pacing material, rubber, polythene, compressed ammonia, copper pipes, pieces of sheet, plastic sheeting, etc.

4. Organic wastes: Fish offal, meat, blood water mixed with disinfectants and other chemicals, plant materials resulting from land clearings, kitchen waste (potatoes peelings, etc),

5. Burnt fuel emissions and left over oil wastes and bilges from transport vessels.

6. Plastic and glass bottles and containers

7. Noise from construction equipment and vehicle and building operations, limited to the island only

8. Dust emission from the construction work such as cement mixing, and other processes. Localised to the island environment only.

III. Policy and Legal Framework

3.1 2008 Constitution

The President of the Maldives assented the newly amended constitution of the Maldives, enacted on the 7th of August 2008. Clause 22 of the 2008 constitution states "The State has a fundamental duty to protect and preserve the natural environment, biodiversity, resources and beauty of the country for the benefit of present and future generations. The State shall undertake and promote desirable economic and social goals through ecologically balanced sustainable development and shall take measures necessary to foster conservation, prevent pollution, the extinction of any species and ecological degradation from any such goals."

According the clause 269 of the 2008 constitution laws in force at the time 2008 constitution comes into force, which are not inconsistent with the new Constitution shall continue to remain in force. Similarly Acts done pursuant to or in accordance with any law which is not inconsistence with the new Constitution, remain valid, as long as it does not affect any right or obligation of a person. Also regulations derive their authority from laws passed by the People's Majlis are enforceable pursuant to such lawful authority. According to the clause 271 of the 2008 constitution any regulations requiring compliance by citizens must only be enacted pursuant to authority granted by a law enacted by the People's Majlis. Therefore laws and regulations related to environment and tourism which were made pursuant to laws enacted by the People's Majlis still remain valid and enforceable.

3.2 Environmental protection and preservation act

The guiding legal instrument on environmental management in the Maldives is the Environmental Protection and Preservation Act (EPPA, Law no. 4/93). This was enacted by the People's Majlis during 1993 and forms the basis of environmental management in the Maldives. By virtue of the powers conferred in the Article 5 of the EPPA, responsible Government authorities can make regulations. With regards to EIA the Environmental Impact Assessment Regulation 2007 that came in to force during May 2007 follows on the specific case of the environmental impact assessments. According to EIA regulations issued by MEEW on 1st May 2007 all major tourism developments require an EIA study prior to development.

3.3 Maldives Tourism act

The guiding legal instrument on tourism in the Maldives (Act no. 15/79) was passed by the Citizen's Majlis in November 1979, outlining the basic regulations for the resorts on registration and operation, and tax policies. The original law had seven clauses in it and amendments were made to the original law through law no: 11/80, 14/80, 4/82, 6/83 and 2/87. The present law (2/99) came into force on the first of November 1999.

Based on tourism act a number of regulations, standards and controls have been specified by the Ministry of Tourism and Civil Aviation for operations within the tourism sector. The book of tourism regulations comprises of important regulatory measures including the Building Standards, Sanitation Standards, Disposal of Garbage, Carrying Capacity, Electricity Code and Tourist Behaviour. A tourism planning permission has to be obtained from the Ministry of

Tourism and Civil Aviation before undertaking any tourism related project. Such permission often requires a study of the environment and the likely impacts.

The Tourism Act empowers the MoTCA to impose strict regulations and guidelines for resort construction and operation. In the development of tourist infrastructure, MoTCA is particularly concerned not to exceed the 'carrying capacity of the islands. The measures taken to limit the number of people in a resort below this level include:

- limiting the maximum built-up area to 20% of the total registered land area of the island;
- the maximum height of the building has been limited to two storeys, provided that there is vegetation on the island to conceal these buildings;
- in the construction of tourist accommodation, all rooms should face the beach and five linear meters of beach line has to be allocated to each guest in front of their rooms.
- Only 68% of the beach length can be allocated to guest rooms, as 20% has to be allocated to public use and 12% left as open space; and
- Construction on reef flats and lagoons are discouraged.
- Over-water bungalows are permitted to be constructed provided equal open space is left on the land for each building developed on the lagoon.
- Solid waste disposal is also regulated in that bottle crushers and incinerators has to be in place before the permit for resort operation is given.

3.4 Other relevant regulations

- Regulations for tourist resort development and operation in 2006 by the Ministry of Tourism and Civil Aviation
- Regulations on cutting down and uprooting of trees issued by the Ministry of Environment, Energy and Water 2006. Under this regulation the developer is required to plant two coconut trees for each coconut tree felled and plant two trees for each tree felled in the island. This regulations prohibits removal of any vegetation within 15 meters from beach
- EIA regulations issued by the Ministry of Environment, Energy and Water on the 1st of May 2007.
- Desalination System regulation which requires the registration of desalination systems that will be operated for use by a population exceeding 200 or for large-scale agricultural or tourism activities or for the purpose of implementing project(s) that involves economic or industrial operations.
- Regulations on Wastewater disposal in tourist resorts are covered in Tourism regulations.

3.5 International Context and Extrinsic Legislation

The Maldives is signatory to many international conventions relating to environmental issues. These include

- United Nations Framework Convention on Climate Change
- Kyoto Protocol

- Vienna Convention (1985)
- Montreal Protocol on Substances that Deplete the Ozone layer (including ratification of the 1989 London, Copenhagen and Beijing amendments)
- Basel Convention on Trans-boundary Movement of Hazardous Wastes
- Civil Liability for Oil Pollution
- Convention on Biological Diversity (1992)
- UN Convention on the Law of the Sea (UNCLOS) and associated international agreements

IV. Existing environment

This chapter of the report describes the baseline conditions of the redevelopment site at Laguna Island. Qualitative assessments were made on the geological and hydrological setting of the island, coastal dynamics marine and terrestrial environment. Quantitative measurements on currents water quality, island vegetation and beach dynamics. The assessments focused on marine and coastal environment as the most important component of the redevelopment is the over-water bungalows that is being constructed on the shallow lagoon on the reef flat on southwestern side of the island.

4.1 Geography

Laguna Falhu is a V-shape reef with a deep lagoon on the open end on the south, one arm of the V represents the outer atoll rim of South Male Atoll, and the second arm is on the atoll lagoon. Laguna island is located on the close end of the V-shape reef on the northern side (figure 1.). Laguna Falhu is located between two atoll openings (Kandu olhi); narrow channel between Laguna and Bolifushi on the south, Velessaru Kandu on the north between Vaadhoo and Laguna. The nearest resorts to Laguna are Bolifushi 4km to the south, Vaadhoo, 4 km to north and Emboodhoo, 9.8km to the east. The capital island Malé is 8km to the NE of Laguna. The total length of rim arm of the V is 5km while the inner atoll arm is 3kkm. Laguna Island is approximately 450m long and 200m wide, and has an area of 81507 m^2. Considering the size large size of the Laguna Falhu the island occupies a very small proportion of the total reef area.

4.2 Geological Setting

South Malé Atoll is at the central region of Maldives and it is located on the eastern side of the double chain of atolls of Maldives. Laguna being located on the NW corner of the atoll rim it is exposed to high energy oceanic swells during the southwest monsoon and refracted, reflected and regenerated indirect fetch waves during the northeasterly monsoon. Due to the exposure of Laguna reef to the direct oceanic waves during southwest monsoon the lagoonal island is formed at the narrow end of the V-shape reef, which is supposed to be the most stable and less energy area within in Laguna Falhu. During the NE monsoon Laguna Falhu is very much sheltered and only exposed to refracted, reflected and regenerated indirect oceanic swells, and the period of exposure is shorter than the western monsoon. However the island shoreline is exposed to regenerated waves from the deep lagoon on the eastern side of the island during the NE monsoon. This might be the main reason for the formation and development of the island, at the most sheltered narrow end of the V-shape reef, where much of the wave energy is reduced as it enters the shallow area of the lagoon.

Comparison of aerial photos of 1969 with more recent Google Earth ® images indicates that the vegetated area of Laguna has decreased (**Error! Reference source not found.**). A large part from the western side of the island has decreases. The comparison also shows that the sand spits (thundi) as it is now used to form on the northern and southern end of the island. It seems that the 90m long solid jetty is preventing sand movement from east to west. Sand accumulation is seen on the east of the Jetty while sand starvation is on the opposite side. Existing coastal structures in Laguna Island and its impact will be discussed elsewhere in this report.

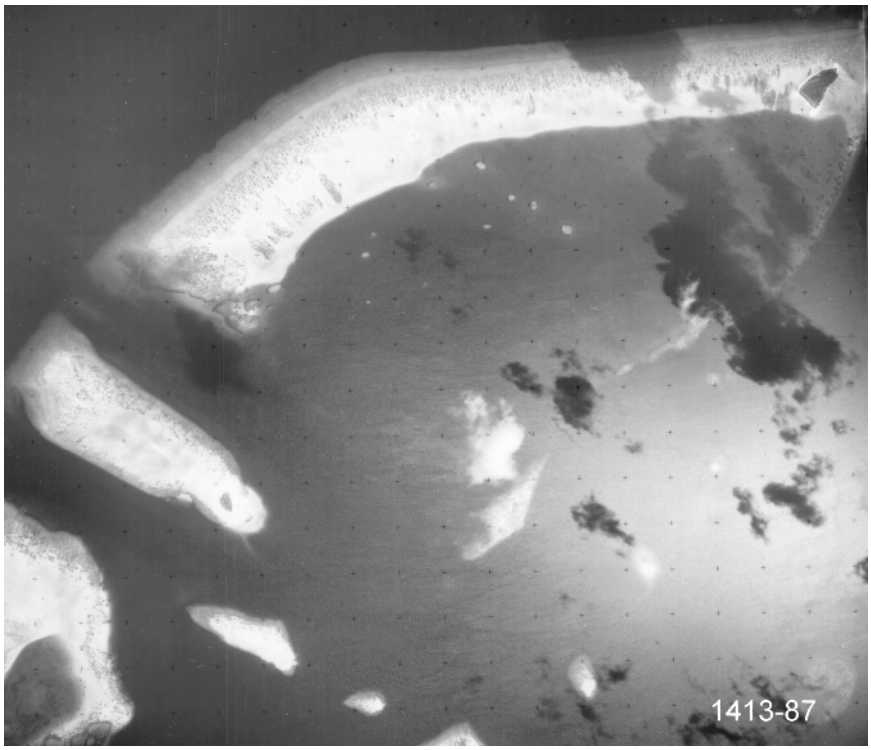

Figure 5. Aerial photograph of Laguna (Velessaru) taken in 1969, showing the changes taken place to the island in 39 years, the size of the island has decreased and part of the westerns shoreline has eroded significantly.

5.3 Data Collection and Assessment Methodologies

Various surveys undertaken for this assessment were taken in two time periods, one April 2005 and another in August 2008. During the April 2007 survey current measurements were taken by deploying a S4 current in the proposed location for the overwater development. Bathymetry surveys were also conducted in April 2007. All the other surveys mentioned in this report were carried out in August 2008. At the time of August 2008 survey construction material for the island already has been mobilized.

a) Reef Survey: Laguna reef is relatively large and the island sits on the north eastern corner of the reef area. The proposed redevelopment takes place on the southwestern side of the island on the shallow lagoon.

b) Fish Census: At each transect fish visual assessment of fish fauna were done. Each species seen is noted and recorded their abundance (or later revising) it. Abundance was recorded as Abundant, very common, common, and rare

c) Island vegetation: Standard survey methods were used to each and every large tree in the island. Abundance and diversity of tree types are recorded. Bushes and low level vegetations were not mapped.

d) Bathymetry: A handheld echo sounder was used to measure the depth around the area proposed for the construction of over-water-bungalows.

e) Current measurements: S4 current meter was deployed in two occasions in April 2007. The first deployment was from 4-13 and the second was from 14-31 of April 2007. S4 current meter measured both the velocity and direction of the current within the reef flat.

f) Beach profiles: Beach profiles were taken by using a semi-automatic (optical) level for survey. Height data are based on the apparent sea levels with tide level corrections. Heights measured were related to the Mean sea level obtained from Hulhule.

g) Water Quality : Sea and ground water samples were taken from the lagoon and the island, and tested at the Public Health Laboratory.

4.4 Hydro geological Setting

In small coral islands, coral sand, coral limestone are the main water bearing formations. The small size of the island and soft coral sand indicates that water retention of the island will be very low. The mean monthly rainfall is roughly 170mm and occurs mostly during March to December. Normally there is high rate of percolation through very permeable coral sands, the net storage of fresh groundwater is minimal on such small islands.

The height of the water table above the sea-level will have a significant bearing on the movement of saline water into the freshwater zone. While in large and mature islands the fresh water lens sits significantly higher than the sea-level.

The ground water table in Laguna island is about 0.9m below. A water samples was tested from the island and the results are presented in Table 5. Generally the ground water in Laguna is acceptable for human consumption for washing or gardening but the salinity is high saline and not usable for drinking. Ground water of the island not used for purposed and fresh water for the island is obtained through RO desalination supplemented by the rainwater catchments.

Figure shows an idealized cross-section through a typical limestone or coral island, showing the main features of a freshwater lens. In most cases, the thickest part of the freshwater lens is not in the centre as shown, but is displaced towards the lagoon side. This is due to the lower permeability sediments on the lagoon side slowing down the mixing of the freshwater and sea-water, thus enabling a thicker freshwater zone to develop.

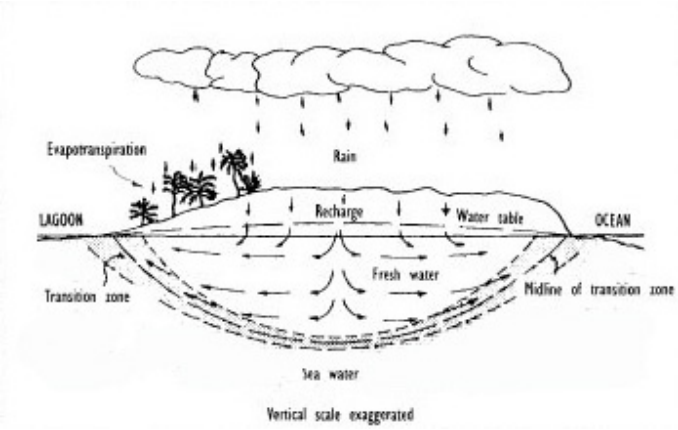

Figure 6: An idealized cross section of a coral island showing the relationship of the ground water lens and the sea-level.

4.5 Climate

The climate of Maldives is dominated by the monsoons; the North East (NE) monsoon from December to February and the South West (SW) monsoon from May to September. The period between, March-April is the transition period from the NE monsoon to SW monsoon known locally as the Hulhangu Halha, while the transition period from SW monsoon to NE monsoon known as Iruvai Halha is from October to November. The SW monsoon is generally rough and wetter than the NE monsoon.

Analysis of weather records from 1986-2002 at Hulhule meteorological station indicates that the predominant wind direction during the SW monsoon is from W-WNW, while the predominant wind direction during the NE monsoon is a NE northeast to east north east (ENE) direction and strongest wind is during May-July reaching to a wind speed of more than 8m/s (Figure).

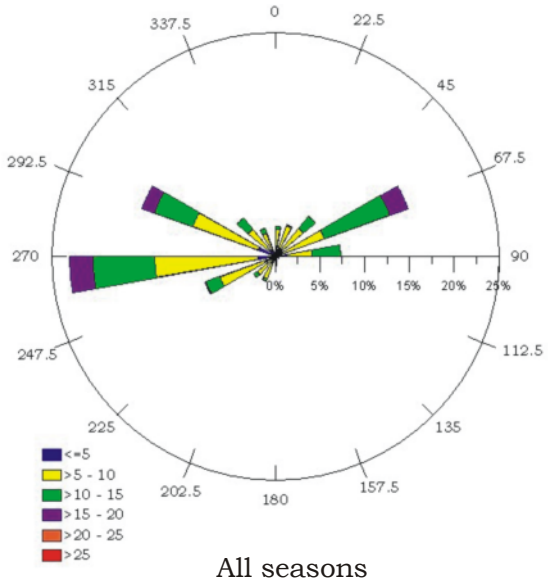

Figure 7: Typical wind rose plot for Hulhule Malé data (2002-2003), closest meteorological station to Laguna (extracted from LaMER EIA reports).

Generally precipitation is lower in the north of Maldives than the south. Average of the total monthly rainfall during NE monsoon is 140 mm/month and during SW is 200 mm/month and average annual rainfall at Hulhule ranges between 1900-2200mm (Figure).

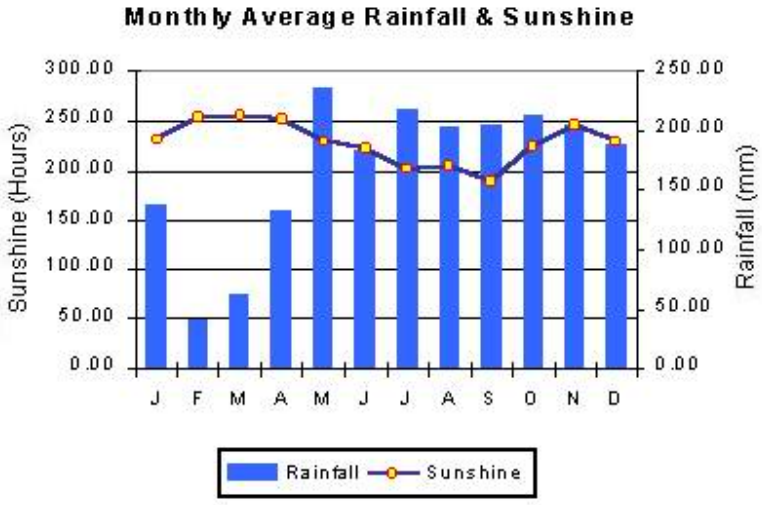

Figure 8. Monthly average rainfall over the Maldives, Dept. of Meteorology, Source: http://www.meteorology.gov.mv

4.6 Lagoon

The lagoon in Laguna Falhu could be divided into physiographically distinct zones, the shallow lagoon and the deeper blue lagoon. The average depth of the shallow lagoon ranges between 1-2.5 m and deep lagoon ranges between 3-25 meters. The shallow lagoon is mostly on the northern part the narrow end of the V-shape reef, and the deep area is on the wide opening of the V-shape reef, which also gradually increases depth towards the inner atoll lagoon. There is a very distinct margin between deep and shallow lagoon with a fairly gentle slope. Slope between the shallow and deep lagoon consists of loose medium grained sand material. In the deeper lagoon there are few patch reefs and random coral colonies.

4.7 Beach Composition and morphology

Beach material of Laguna Island like elsewhere in the Maldives comprise of bioclastics derived from the breakdown of biological organisms living in the lagoon and the reef. The sediment source is exclusively local, whereby the material is provided as a result of physical and biological processes that take place around the island and direct productions by organisms living in the lagoon and the reef. Hence here beaches depend on suitable environmental conditions for growth, development and eventually the supply of material from the bounding reef. The major sediment providers are Scleretarian and soft corals, coralline algae, mollusks and foraminifera. In addition, the skeletal remains of other organisms such as crustaceans, echinoids and bryozoa also contribute to supplies of sediment. *Halimeda* is considered to be one of the major contributors of carbonate sediments in the tropical reef areas

Beach material around Laguna Island is fairly uniform and consists of medium to fine grained coral sand. Fairly wide sandy beach exists around the island except the northern part near the existing water villas where a seawall in constructed to protect the island from erosion. The widest sandy beach is on the eastern side of the main jetty where large amount of sand has accumulated and filled more than half of the length of the jetty from this side. Sand starvation was observed the eastern and western side of the jetty which acts as a groyne.

Beach slope is fairly gentle on the northern part but relatively steep on the southwestern part of the island. Four beach profiles were taken from the island, their location and beach profiles are shown (Figure 9).

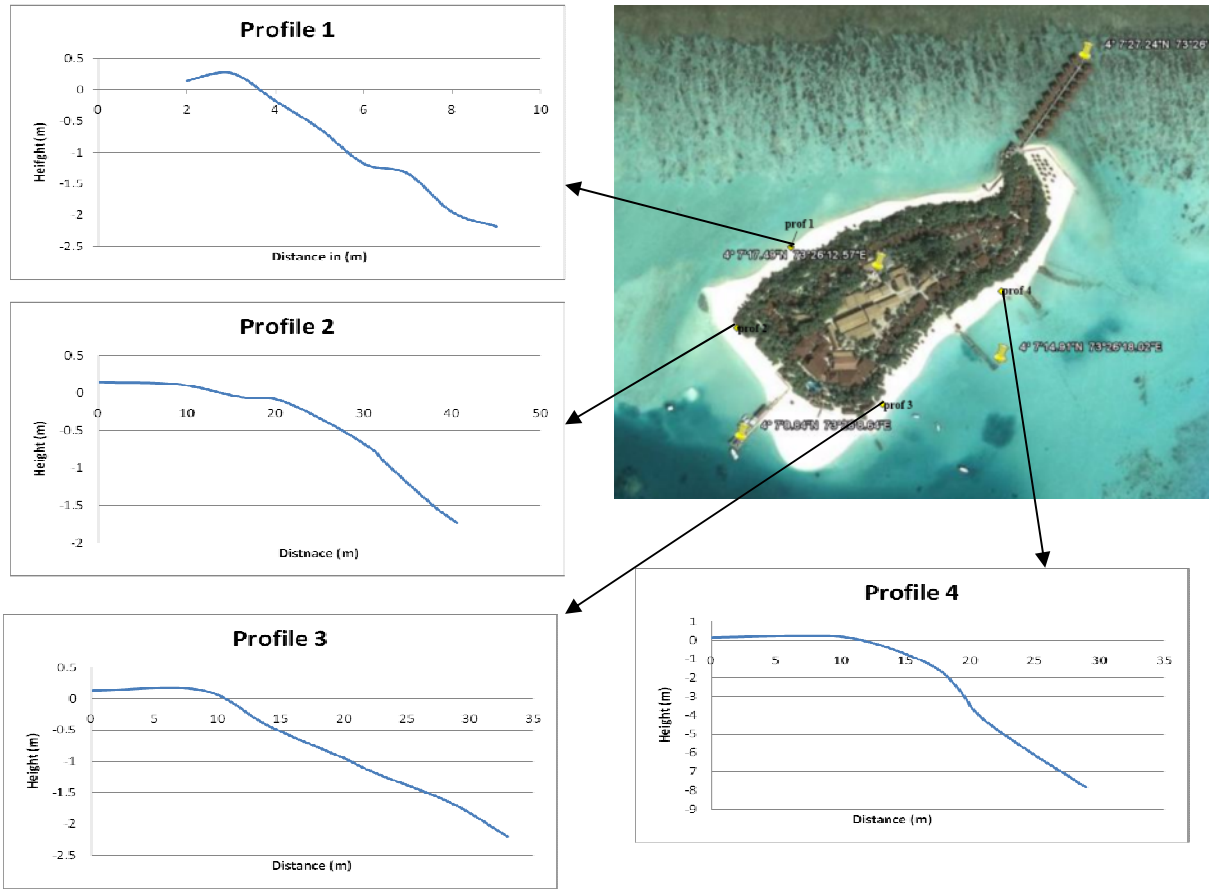

Figure 9. Location of beach profiles taken from the island, related to sea level showing the elevation of the beach.

4.8 Hydrographic & Hydrodynamics at Laguna

4.8.1 Bathymetry

A bathymetry survey of the lagoon area proposed for the overwater villa development has been surveyed in 2007. A bathymetric contour map of the area is shown in (Figure 10).

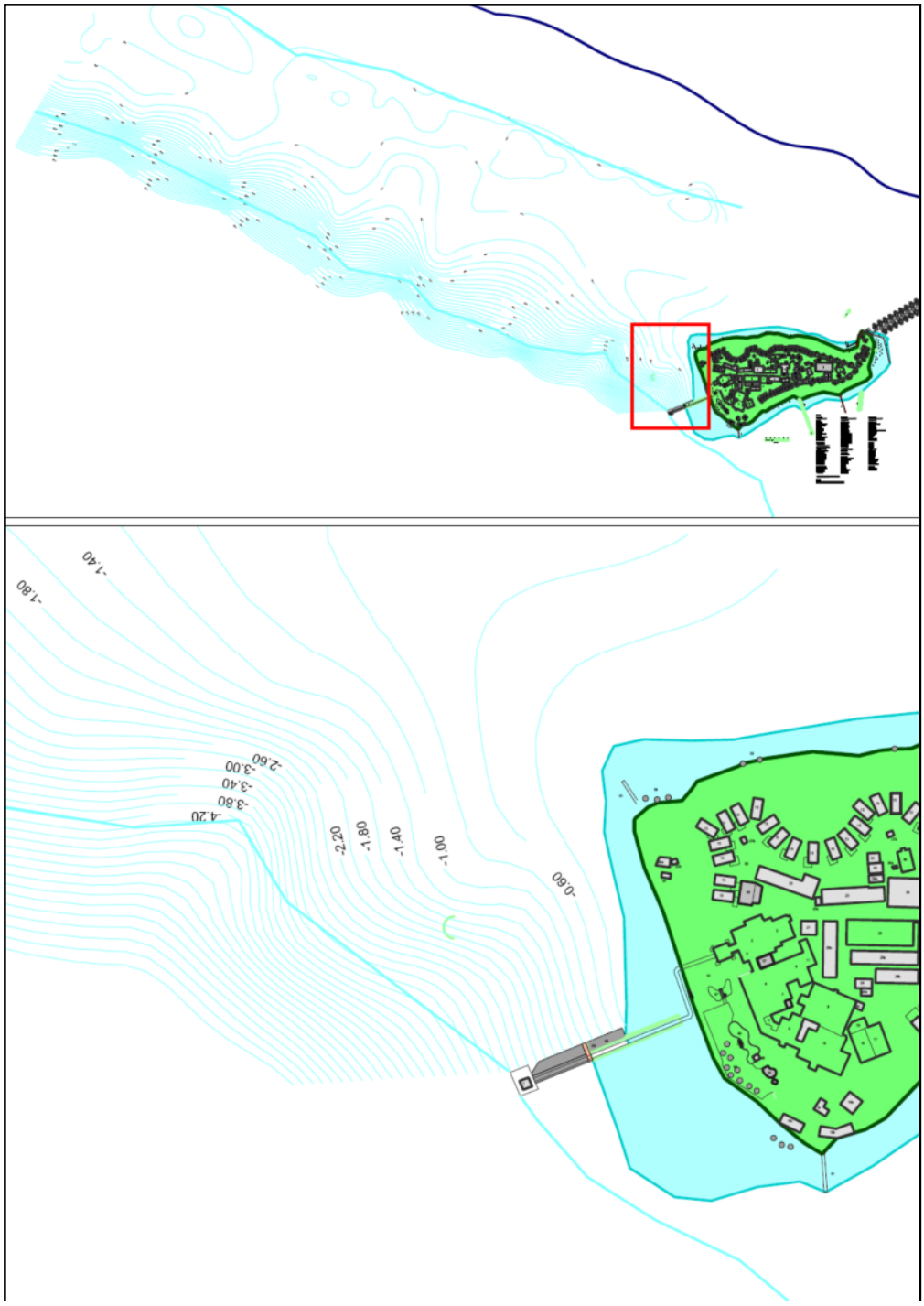

Figure 10. Bathymetry map of Laguna Island, showing the surveyed area on top and the shallow lagoon area proposed for overwater villa and spa complex development magnified at the bottom.

4.8.2 Tides

Tides in the Maldives are diurnal-semidiurnal type, and can be further divided into spring and neap tide periods. The tidal range is about a meter. The highest and lowest tide levels are based on the hourly observed extreme tide level data recorded by the Sea Level Center between 1989-2001 (13 years) for Hulhulé, and 1987-2001. The highest and lowest tide levels are 255.7 cm (67.9 cm above MSL) and 111.3 cm (76.5 cm below MSL) at Hulhulé, (Kan et al 2007).

Analysis of tide prediction data for Hulhule tidal station, obtained from the University of Hawaii Sea Level Centre from 2000-2005 indicated that the lowest predicted tide level in five years is equal to the chart datum (CD). The lowest predicted level for Hulhule is 22.1cm equal to LLWL +0.0CD (LLWL). Tide station at Hulhule is the closest station to Laguna, approximately 10km NE. It has been assumed because of the close proximity to Hulhule that the Laguna tidal variations are the closest standard tidal station. Tidal ranges recorded for Hulhulé area is given in Table 4.

Table 4. Tidal ranges recorded for Hulhule` nearest meteorological station to Laguna Isalnd.

Highest Astronomical Tide (HAT)	+0.64m
Mean Higher High water (MHHW)	+0.34m
Mean Low High Water (MLHW)	+0.14m
Mean Sea Level (MSL)	0m
Mean Higher Low Water (MHLW)	-0.16m
Mean Lower Low Water (MLLW)	-0.36m
Lowest Astronomical Tide	-0.56m
Tidal range	1.2m

4.8.2 Waves

Laguna being located at the NW rim corner of the South Malé Atoll it is exposed to direct oceanic swells from the western side during the SW monsoon. Being located at the corner of the atoll two it is exposed to wedge waves that passes through the channel between Laguna and Vaadhoo. These waves are very much limited in their height and energy by the depth of water over which they travel before reaching the shoreline of the island. Surf waves breaking into the reef flat were observed on the western side of the island and this type of waves will continue to break into reef flat during the SW monsoon. However due to the large distance between the reef edge and the island shoreline the wave energy is significantly reduced by the time it reaches to Laguna shoreline (Riyaz et al 2008). Calculated maximum wave height, based on water depth, for the proposed overwater villa development area is shown in (Figure 11). The observed wave height on the south and western side of the island is between 0.3-0.7m with a period of 5-12seconds.

Figure 11. Shows the calculated maximum wave height in (m) that will be expected in the area proposed for overwater villa and spa complex development. The black dot marks the location of S4 current meter was deployed for current measurements.

4.8.3 Currents

During the design period of over water villas, current measurements were obtained from the lagoon of the proposed overwater villa development area. S4 current meter was deployed in two occasions in April 2007. The first deployment was from 4-13 and the second was from 14-31 of April 2007. Current measurements both the velocity and direction was obtained by using S4 current meter. Figure 12 shows the velocity and direction of lagoon current in Laguna Island. The maximum velocity obtained during the period was 150cm/s. During the first deployment period the dominant direction was SW but the strongest were northerly with a speed of 120cm/s and southeasterly with a velocity of 100cm/s. During the second deployment 14-31 April 2007 the velocity was more or less north and north easterly. And the strongest current speed was observed on the easterly direction with a speed of 150cm/s.

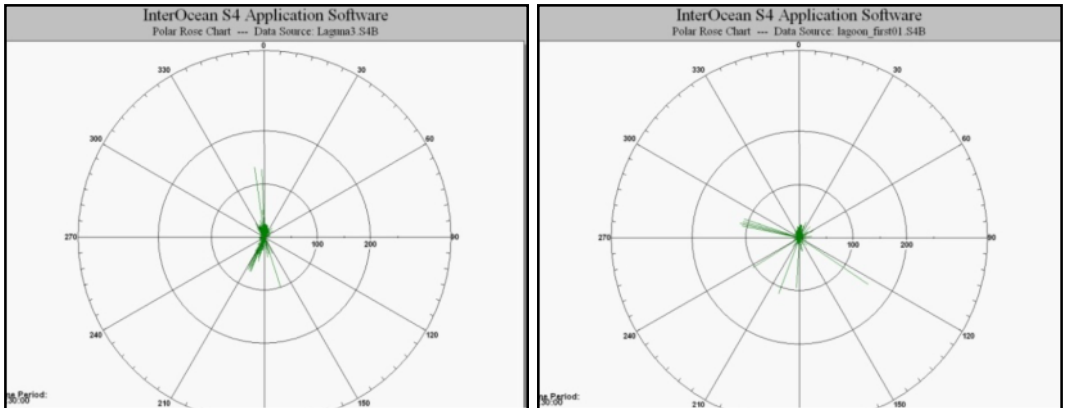

Figure 12. Polar Rose Chart current measurements obtained from S4 current meter deployments. The chart on the left is the results of measurements obtained from 3-13 April and the left is obtained from 14-31 April 2007.

4.9 Existing Coastal Structures and its Impacts

Number of groynes (shoreline perpendicular coastal structures) is constructed around the island to maintain the white sandy beach. A seawall (shore parallel adjacent coastal structures) is constructed on the northern tip of the island adjacent to the existing overwater villas (Figure 13). From a coastal engineering point of view these coastal development are haphazard and has been developed without much thought on the coastal and hydro dynamics of the island. Particularly, the extremely long, solid jetty (the main jetty on the southern side), which acts as a terminating groyne. This jetty has been constructed at the initial stages of resort operations in Laguna Island. Initially it was a continuous solid jetty but later the management made an opening at the center of jetty to pass sand through it. This solid jetty prevents sand movement from North to south, a large amount of sand is accumulated on the northern side and sand starvation is on the western side of the jetty. Pile of sediments accumulated on the northern side is making the lagoon shallower also blocks the opening at the center of the jetty. According to locals in the island last couple of years a very large amount of sand has accumulated and kept on piling up on the northern side of the jetty. Large amount of sand brought by the tsunami of 2004 accumulated never returned back causing sand starvation in various parts of the island. Apart from this long solid jetty, there are 4 groynes on the north eastern side of the island. Existence of these structures function to trap sand in between but as usual sand accumulation on one side and sand starvation on opposite side of all groynes were observed. Some of these structures are not properly aligned and therefore ineffective in achieving the desired objective. They are also esthetically unattractive.

Construction of overwater villas on the northern tip of the island contributed to severe erosion of the northern side. Existing seawall on the northern side serves to protect island shoreline from erosion. The seawall structure is also causing erosion on the northwestern tip of the island. It seems the erosion problems on the northern side initiated with the development of overwater villas on the northern tip of the island. Because northern tip of the island used to be most dynamic part of the island where a seasonal sand spit is formed. Naturally the sand spit serves to supply

sand around the island but its functions were interrupted by human intervention and construction of overwater villas.

Interaction of various existing coastal structures contributed to the unbalanced sediment distribution around the island. Due to the extreme length of some of the main jetty back-and-forth movements of sand has been blocked and the natural sediment balance was prevented.

Figure 13. showing some of the coastal structures found around Laguna Island, the top two pictures shows typical impact of groynes, (erosion on one side and accretion on the opposite side). (Bottom left) is disoriented coastal structure where the groyne on the left could be eliminated. (Bottom right) picture shows the seawall constructed on the northern tip of the island to prevent erosion and protect the island.

4.10 Water Quality

4.10.1 Sampling of groundwater

Certain physico-chemical parameters that would enable predictions on the quality of groundwater in the Island were conducted .A ground water sample was obtained from the Island Laboratory analysis was done at Public Health Laboratory of the Ministry of Health. Analytical results of the water sample and its GPS location is given in table 5.

Table 5: Analytical results of ground water collected from Laguna Island at GPS location 4°7' 16.62"N, 73° 26' 15.05"E.

Parameters tested	Results	Test method
Physical appearance	Pale Gray	Manufacturer (Hach, USA)
pH	7.2	Manufacturer (Hach, USA)

Total dissolved Solids	1211 mg/L	Manufacturer (Hach, USA)
Electric Conductivity	2460µs/cm	Manufacturer (Hach, USA)
Salinity	55mg/L	Manufacturer (Hach, USA)
Nitrate	26.56 mg/L	Manufacturer (Hach, USA)

4.10.2 Seawater

Two seawater samples from *the lagoon* were collected at high tide and analysed at the Public Health Laboratory in Malé. Results of lagoon water test and their GPS locations are given in table 6.

Table 6. Analytical results of seawater samples collected from Laguna Island.

Location / Parameters tested	4°7' 13.48"N, 73° 25' 32.81"E	4°7' 10.91"N, 73° 26' 06.86"E	Test method
Physical appearance	Clear	Clear	Manufacturer (Hach, USA)
Temperature	19.7°C	19.5°C	Manufacturer (Hach, USA)
pH	8.2	8.2	Manufacturer (Hach, USA)
Total dissolved Solids	26800mg/L	26700mg/L	Manufacturer (Hach, USA)
Salinity	35300mg/L	35200mg/L	Manufacturer (Hach, USA)
Chemical Oxygen Demand	1230mg/L	123mg/L	Manufacturer (Hach, USA)
Suspended Solids	6mg/L	8mg/L	Manufacturer (Hach, USA)
Turbidity	3NTU	4NTU	Manufacturer (Hach, USA)

4.11 Marine Environment

Laguna reef is located on the north western side of the South Malé Atoll. The island is located on the north eastern corner of the reef and is minute relative to the size of the reef. The reef extends well over 6 km west of the island. A dominant feature of the reef is the relatively large lagoon which merges with the atoll lagoon in the south. Several shallow features are seen in the lagoon (Figure 14). While the reef formation is prolific on the northern margin it is not so in the south. Clear distinction of reef slope, reef crest, reef flat and the lagoon are visible from on the northern margin from the satellite images (Figure 15). The environmental factors responsible for these differences are wave action, current direction and intensity, light intensity and light spectra, etc.

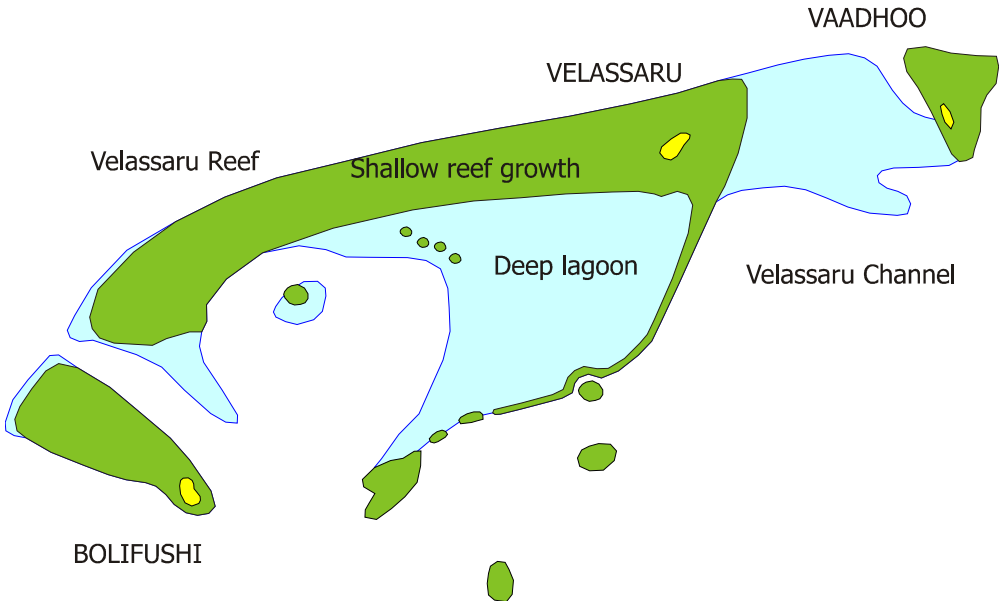

Figure 14: (Laguna Resort) and the adjacent areas – Bolifushi and Vaadhoo

Figure 15: Google Earth image of the section of the Laguna to show the clear zonation of the reef on the northern margin of the Laguna reef.

This section of the report describes baseline conditions of the marine environment at Laguna reef particularly the proposed location for the development of overwater villas on the shallow lagoon on the southwestern side. The assessments focused on marine environment as the most important component of the redevelopment is the over-water bungalows that is being constructed on the shallow reef flat and on the western side of the island.

4.11.1 Survey Methods

The surveys were restricted on the section of the reef immediately opposite the main development site (Figure 16). Where possible the data gathering methods followed established scientific methods procedures.

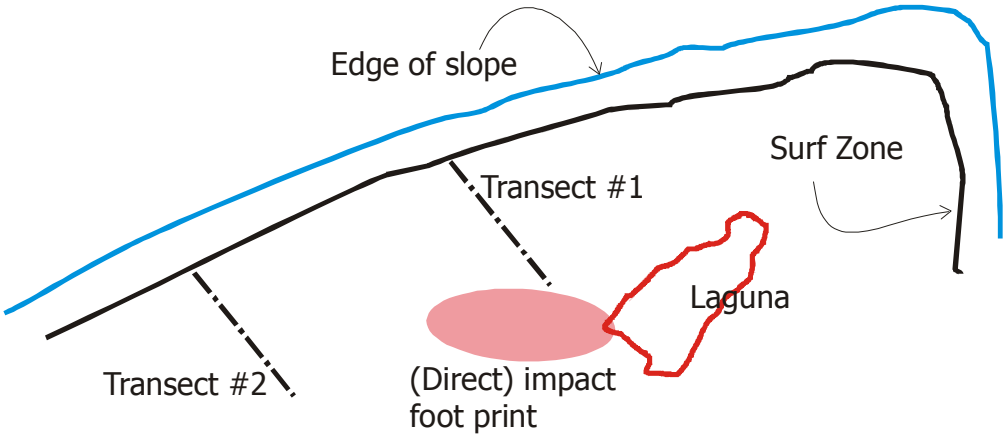

Figure 16: Reef assessment study area of the Laguna. The two transects and the main impact footprint is shown

Marine surveys undertaken for this assessment were:

a) Reef Survey: Laguna reef is relatively large and the island sits on the north eastern corner of the reef area. The proposed redevelopment takes place on the western side of the island on the shallow lagoon. In order to assess the status of the reef, a sequence of photo images of transects were taken from two section of the reef flat. Two such transects were chosen (Figure 6). The starting point of each transect was at the surf zone on the inner reef. While swimming across the reef flat roughly perpendicular to the reef line a series of photo images were taken at every two-fin kicks Roughly 100 m distance was covered. The camera was kept at horizontal plan just below the water. Magnification of the image was kept constant in all the shots. The sequence of images provide a good 'feel' of the coral cover on the transect.

b) Fish Census: At each transect fish visual assessment of fish fauna were done. Each species seen is noted and recorded their abundance (or later revising) it. Abundance was recorded as Abundant, very common, common, and rare

4.11.2 Coral Cover

Maldivian reefs were severely impacted during the anomalous warming event of 1998. The coral were severely bleached. It has been said that over 90% of the shallow water corals died

following the event (Zahir et al. 2006). Coral reef monitoring, since then, has shown that reef have been recovering slowly. While some reefs have shown remarkable recovery most have not.

There are no records of the status of the Laguna reef following the 1998 bleaching event. Staff who has been working on the island tells us there outbreaks of crown-of-thorn star fish (*Acantahster plancii*) in the recent past. The dive school and management have been vigilant on these outbreaks and have physically removed animals during such periods. We saw a single star fish on transect one (Figure). No other crown-of-thorn star fish or dead coral were seen. In general the Laguna reef is in excellent state. Where there were corals along the transect, live coral cover was estimated to be over 90%.

As have been mentioned earlier clear demarcation of zones were seen on the transect line. The high energy zone of reef crest is predominantly composed of robust-branching and tabular Acropora framework and/or encrusting algal ridges.

The coral cover decreased rapidly on the reef flat. Most of the area is covered by sand and rubble and patches of the massive corals (Figure and Figure). The organisms living here must be able to withstand intense ultra violet radiation, desiccation, high salinities and elevated water temperature. At low-tide levels, parts of the reef flat may be very shallow. The lagoon area is also well defined. Few small 'islands' of sclerantinian corals are present

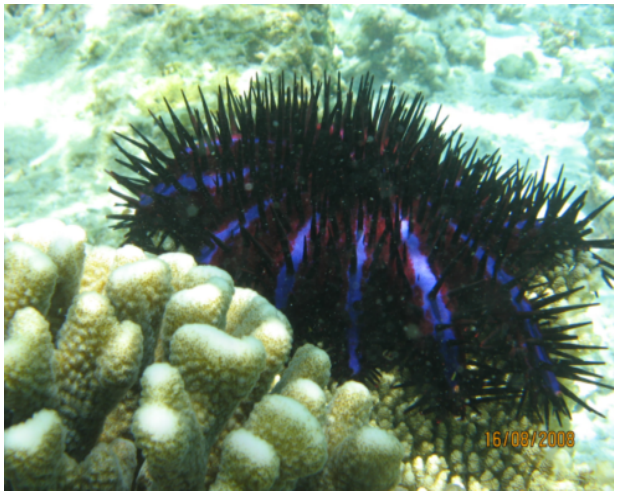

Figure 17: Crown of thorn starfish (Acanthaster plancii) a single individual was seen devouring on Acropora coral, Transect #1, on reef flat.

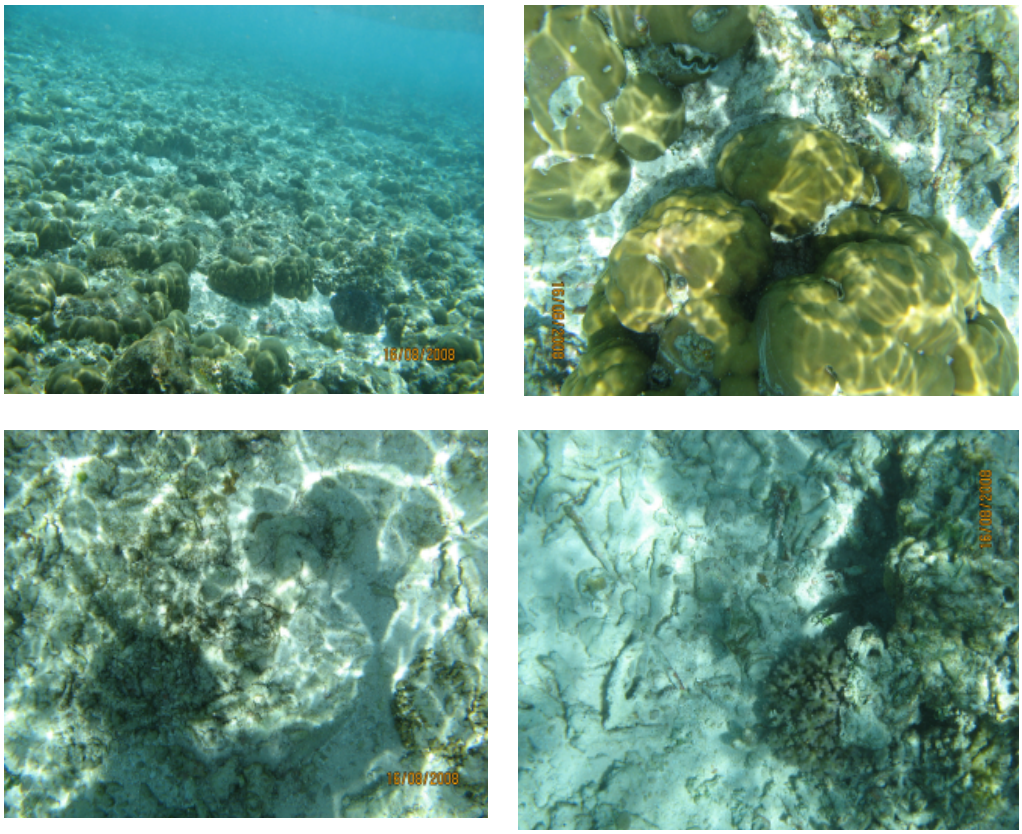

Figure 18: A selection of images from Transect # 1. The one on top right hand corner is the broad view of the area of the surf zone.

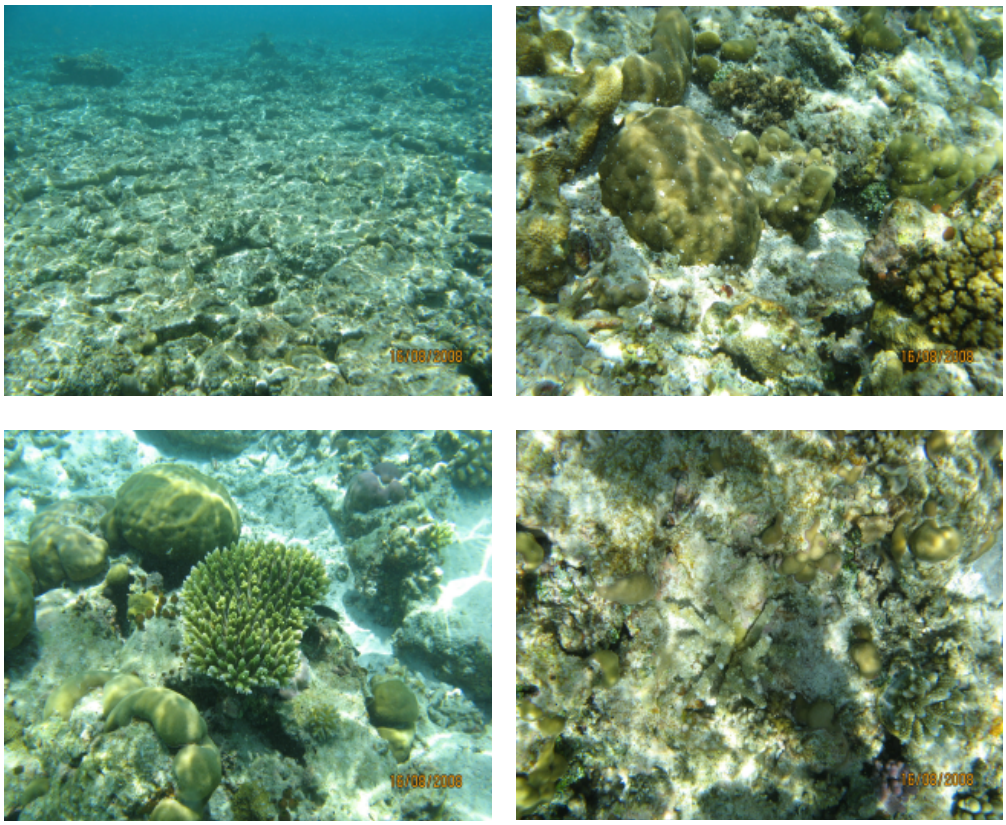

Figure 19: Selection of images on Transect #2. The one top right hand corner is surf zone area. Nearly 90% of the coral was live and the area perfect for snorkelling.

4.11.3 Fish Census

The abundance and species diversity of fish may be considered average. As expected not much herbivores (Acanthurids) were found. These are fish that graze on algae which were not seen. The families, Chaetodontidae, Labridae, Pomacentridae are well represented. Large school of the juvenile snappers (*Lutjanus gibbus*) were seen on the reef flat area.

Table 7: Summary of fish fauna abundance observed on the Laguna reef.

Species	Occ	Species	Occ.
Stethojulis albivittata	C	Scarus frenatus	R
Chrysiptera biocellata	C	Scarus pissttacus	R
Chaetodon klenni	C	Lutjanus gibbus (juv)	C
Chaetodon xanthocephalus	R	Scolopsis bilineata	R
Chaetodon citrenellus	C	Centropyge multispnis	C
Thalassom hardwicke	C	Pygoplites diacanthus	R
Acanthurus triostegus	C	Chaetodon auriga	R
Dascyllus aruanus	C	Chaetodon trifasciatus	R
Chelinus fasciatus	R	Chaetodon trifascialis	R
Chelinus oxycephalus	R	Chromis viridis	A
Chelinus cholrorus	R	Chrysiptera brownriggi	C
Halichoeres hortulans	C	Pomacentrus indicus	C
Rhinecanthus aculeatus	R	Halichoeres scapularis	C
Parupenus macronema	C	Hemigymnus fasciatus	R
Chaetodon falcula	C	Lizard fish	R
Parupenus bifasciatus	R	Zanculus cornutis	R
Chlorus sordidus	C		

4.12Terrestrial Environment

4.12.1 Survey Methodology

Vegetation: during the land survey large trees in the island were mapped by using a total station. List of all the plant species occurring at the island were determined. The map shows the level of dominance/importance of each plant species, locations of the large trees, (shrubs not included) are shown in (Figure 20). The level of dominance/importance of each plant species in the form of a DAFOR (Dominant, Abundant, Frequent, Occasional & Rare) ranking. The species list is given at Table 7. The field survey was carried out over two weeks in April 2007.

Bird survey: Due to the rarity of occurrence of birds at the study site, bird survey was undertaken by visual observations and interviews with the resort staff.

Soil: The soils were assessed from analyses of 1x1m pit made at centre of the island

4.12.2 Flora

The results of the vegetation mapping show that large areas were by typical plants belonging to coastal community (**Error! Reference source not found.**). The diversity was relatively low. Overall, a total of 20 plant species were encountered of which the coconut tree and coastal trees are dominant. There are a small numbers of exotic ornamental plants grown on the island and in pots this includes Boaganvilla Boalha kinkirima, Kaneeru Gulsampa etc (Figure 20). Some imported alien species were also found in the island, such as X-mas tress Malay coconut tree (Figure 21). The island possesses a continuous coastal vegetation belt but the coastal vegetation line was broken with small intact patches to give path for beach access.

Figure 20. Some of the ornamental plants found in the Island

Figure 21. Alien plant species found in the island

Coconut trees were the most significant type of tree found on the island. Other important species included the salt-bush, pandanus (*Pandanus lerum*), (*Scaevola taccada*) pemphis (*Pemphis acidula*), beach hibiscus (*Hibiscus tiliaceus*), milo, (*Thespesia populnea*), cordia (*Cordia subcordata*). Few trees of and ficus (*Ficus benghalensis*) were also recorded. Morning-glory (*Ipomoea pes-caprae*), Tholhi and other vine found in some areas of the island. Ferns were also abundantly found in some areas of the island, most probably those ferns were planted in the

island. There were no endemic or ecologically rare plant species encountered during the field survey.

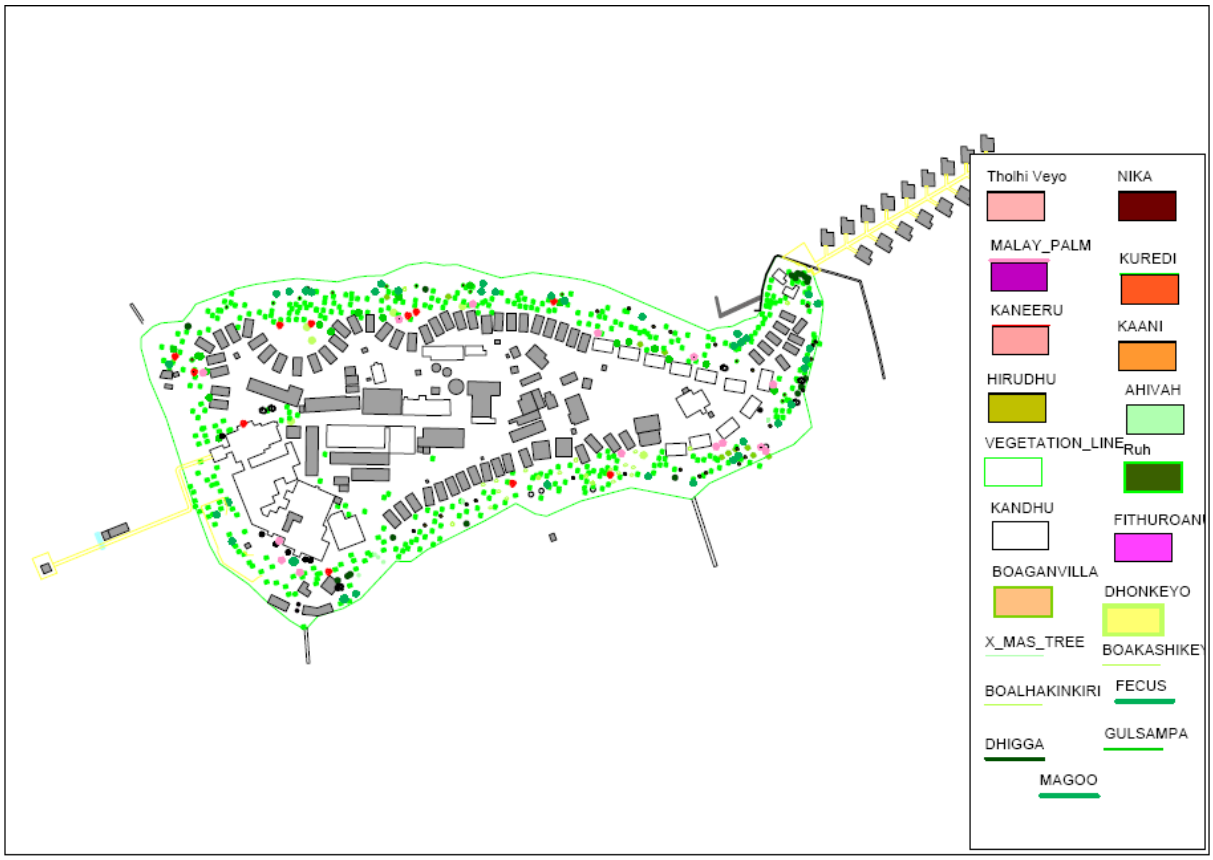

Figure 22. Vegetation map of Laguna island showing distribution of different species of plants.

A complete list of the plant species encountered and their relative dominance are provided in

Table below.

Table 8: List of flora observed during DAFOR survey

Local Name	Occurrence DAFOR ranking
Ahivah	R
Dhon keyo	R
Boganvilla	F
Boakashikeyo	A
Boalha kiniri	R
Dhigga	A
Fecus	R

Fithiroanu	R
Gulsampa	F
Hirundhu	A
Kaani	F
Kandhu	O
Kaneeru	O
Kuredhi	A
Kandhu	F
Magoo	D
Malay Palm	
Nika	A
Dhivehi ruh	D
X-mas tree	R
Fern	F
Kandholhu	F

The proposed redevelopment will not require removal of any of the trees as all the construction will be on the footprints of previous buildings.

4.12.3 Soil

Soil profiles obtained from the island indicate poor development of soil on the island. Three main distinct zones were observed. The top layer consisted of humus layer material comprising of decayed leaf matter with fine gray sand. The second layer is creamy to gray medium to fine sand layer. The third layer is a medium to coarse creamy to white coloured coral sand with coral and shell fragments. Tree roots particularly coconut roots are abundant along the soil profile. The depth of the water table was 0.9 m form the surface. The physical characteristics of the island's soil are given in (Table 9). A photographic representation of the soil profile is provided in (Figure 23)

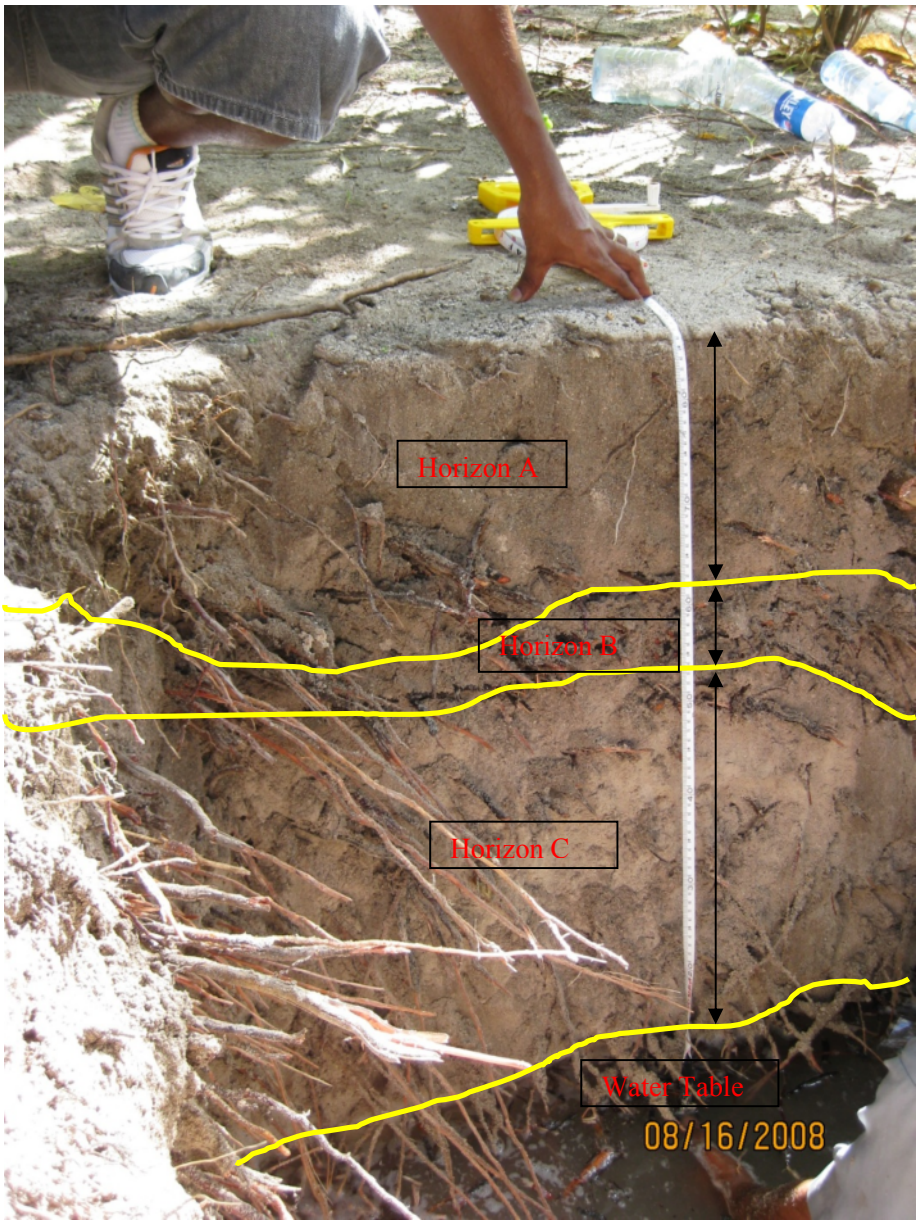

Figure 23. Soil profile of Laguna Island showing three distinct layers of soil with dense coconut roots.

Table 9: Physical characteristics f Laguna Island's soil

Diagnostic feature	Characteristics
Porosity	High
Structure	Laminated and sorted
Color A horizon	Gray- brown
Texture	sandy
Color B Horizon	Creamy to gray
Color C Horizon	Creamy to white

4.12.4 Fauna

The fact that the site has been significantly disturbed through the development of infrastructures and operation of the resort, terrestrial fauna encountered were very few and was restricted to few insects snails, birds, cats, common garden lizard (*Calotes versicolor*), common house gecko (*Lapidodactylus lugubris*) and black rats. Most of which are believed to be introduced by humans, either intentionally or accidentally.

Some seabirds as well as shorebirds are known to visit the island from time to time. During the field visit only three species of birds were observed. They were eastern common heron (*Ardea cinerea rectirostris*), cattle egret (*Bubulcus ibis*), and Maldivian water-hen (*Anous tenuirostris)*; of these the latter has the protected status in the Maldives.

V. Assessment of Impacts and Mitigation Measures

Assessments and prediction of environmental impacts involves certain degree of uncertainty as natural and anthropogenic impacts can vary from place to place due to differences in ecological, environmental or socio-economic conditions in a particular place. Although the proposed development is common an many of the resort in the Maldives there is no long term data that can be used to model and predict the environmental impacts over time. Impacts can be minimized if monitored properly and appropriate measures are taken promptly during and after the developmental period. A summary of the impacts during the construction phase is given in Table 10.

5.1 Definition & Classification of Environmental Impacts

5.1.1 Impact Significance

An environmental impact is any change to the existing condition of the environment caused by human activity or an external influence. Impacts may be positive (beneficial) or negative (adverse). They may also be direct or indirect, long-term or short-term in duration, and wide-spread or local in the extent of their effect. Impacts are termed cumulative when they add incrementally to existing impacts. In the case of Laguna development project, potential environmental impacts would arise during the construction and the operations phases of the project and at both stages positive and negative impacts would occur.

The purpose of an EIA is, *inter alia*, to identify the significant impacts related to the project or activity under consideration and then to determine the appropriate means to avoid or mitigate those which are negative. Significant impacts are defined, not necessarily in order of importance, as being those which:

1. Are subject to legislative control;
2. Relate to protected areas or to historically and culturally important areas;
3. Are of public concern and importance;
4. Are determined as such by technically competent specialists;
5. Trigger subsequent secondary impacts;
6. Elevate the risk to life threatening circumstances; and
7. Affect sensitive environmental factors and parameters.

5.1.2 Impact Matrix

An impact matrix is a simple but effective tool for identifying the possible impacts of project activities on the environment and this has been done for the proposed development project in Laguna (Table 10). Here, the activities carried out during the, construction and operational phases are arrayed against a selection of environmental factors that are deemed relevant to the site, or which may be affected indirectly as a result of project activities. The construction phase activities have been sub-divided into the three key areas of activity; a) building works, b) overwater Villa Development, and c) construction activities. The impact matrix should not be misinterpreted to mean that all the identified impacts would occur during implementation of the project. However, the matrix does serve to identify the potential impacts and significant concerns and this leads to the next step of the EIA process, mitigation, which considers the appropriate measures to remove or ameliorate the adverse impacts that have been identified. At this stage measures to enhance the positive aspects of the development can also be devised.

Table 10. Environmental Impact Matrix for the proposed development at Laguna. ***"Major Negative Impact"*** *cannot be completely avoided even if mitigation measures are taken, it is considered as a key factor in decision making process.* ***"Moderately Negative Impacts"*** *cannot be completely avoided even mitigation measures are taken but can be minimized to an accepted level. These are not considered as key issues in decision making process.* ***"Minor Negative Impacts"*** *Have no significance with regard to decision making process*

			Demolition and Construction Phase																	Operational phase								
			Actions																									
		Key: Minor Negetive Impact; Moderate Negetive Impact; Major Negetive impact; Potential Positive Impact; Negligable or no impact	Building foundation	Building sourcing and building Material	Building material stockpilling and storage	Concret mixer operation	Concrete waste storage and disposal	Dusting, air quality degredation	Construction work noise	Heavy vehicle operation, noise, air quality dust	Sewage and litter management	installation and upgrading of utilities	Construction work water demand	Replanting and land scaping	Employment	Visual intrusion on seascape	Coastal ex cavation and construction work	Sourcing gravel and placement of columns	material stock pilling	Employment	Fuel and chemical storage	solid waste management	Equipment vehicle maintanace	Staff trainign	water demand	Electricity demand	Sewage collection and disposal	solid waste management and disposal
I- Physical and Chemical Chracteristics	1.Land	a.Soil	❄	❄	❄	❄	💣	☒	☒	❄	✞	✞	✞	✞	☒	☒	✞	☒	☒	☒	✞	✞	✞	✞	☒	☒	✞	✞
		b. landscape	❄	❄	❄	❄	❄	☒	☒	❄	❄	❄	❄	✤	❄	❄	❄	☒	☒	✤	❄	✞	✞	✤	✞	☒	❄	✞
		c. soil erosion	❄	❄	❄	❄	❄	☒	☒	✞	☒	✞	☒	✤	☒	☒	✞	☒	☒	☒	☒	☒	☒	✤	☒	☒	☒	✞
	2. Water	a. Ground water																										
		water table contamination	❄	✞	✞	✞	💣	❄	☒	☒	❄	❄	✞	✤	☒	☒	❄	❄	❄	✞	❄	✞	✞	✤	💣	☒	✞	✞
		interaction with surface driniage	❄	✤	✞	✞	✞	✞	☒	☒	❄	❄	✞	☒	☒	☒	❄	❄	❄	✞	❄	✞	✞	☒	✞	☒	✞	✞
		change in water quality	❄	☒	❄	❄	✞	✞	☒	☒	❄	❄	✞	✤	✞	☒	☒	☒	✞	✞	❄	✞	✞	☒	💣	☒	✞	✞
		b. surface water																										
		runoff characersitics	❄	❄	❄	❄	💣	☒	☒	☒	✞	✞	✞	✤	☒	☒	💣	💣	✞	☒	❄	✞	☒	✞	☒	☒	✞	✞
	3. Amosphare	a. air quality (gases, aerosol)	☒	❄	❄	❄	✞	✞	☒	💣	✞	✞	☒	❄	❄	☒	✞	✞	✞	☒	❄	☒	✞	☒	✞	☒	✞	✞
		b. Climate	☒	☒	☒	❄	☒	✞	☒	💣	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	✞	☒	☒	✞	✞	✞
II-Biological Conditions	1. Coastal and Marine Resources	a.current sediment dynamics	✞	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	💣	💣	💣	☒	☒	☒	☒	☒	✤	☒	☒	☒	☒
		b.lagoon water quality (turbidity)	✞	☒	☒	❄	✞	✞	☒	❄	✞	☒	☒	✤	☒	✞	💣	✞	💣	✞	☒	✞	☒	❄	☒	☒	✞	✞
		c. coral	✞	☒	☒	❄	✞	❄	☒	❄	✞	❄	☒	☒	☒	✞	💣	💣	❄	✞	☒	✞	☒	❄	☒	☒	✞	✞
		d.sandy bottom creatures	💣	☒	☒	☒	✞	☒	☒	☒	❄	❄	☒	✤	☒	✞	💣	💣	☒	☒	☒	✞	✤	☒	☒	✞	✞	✞
		e. beaches	✞	✤	☒	☒	✞	✞	☒	❄	💣	☒	☒	☒	☒	💣	💣	💣	💣	☒	❄	✞	✞	✤	☒	☒	✞	✞
		f. fish and fisheries	☒	☒	☒	❄	✞	✞	☒	☒	✞	☒	☒	☒	☒	✞	💣	✞	☒	☒	✞	✞	❄	✤	☒	☒	✞	✞
		g. Endangered species	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	✤	☒	☒	☒	☒
	2. Flora	a.trees, shrubs, grass	✞	❄	✞	✞	✞	❄	❄	✞	✞	✞	✞	✞	❄	☒	☒	☒	✞	☒	✞	✞	✞	✤	❄	☒	☒	✞
		b. endangered species	✞	☒	☒	☒	❄	❄	☒	✞	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	✤	☒	☒	☒	☒
	3.Fauna	a. birds land animals, reptiles	❄	✤	✞	✞	✞	✞	💣	💣	✞	✞	❄	✞	☒	✞	✞	✞	❄	✞	☒	✞	✞	✤	☒	☒	✞	✞
		b. insects	✞	✞	✞	✞	✞	✞	💣	💣	✞	✞	✞	✞	✞	✞	✞	✞	✞	✞	✞	✞	✞	✤	☒	☒	✞	✞
		c. Endangered species	✞	✞	☒	☒	☒	☒	💣	💣	✞	✞	☒	✞	☒	☒	✞	✞	✞	☒	☒	☒	☒	✤	☒	☒	✞	✞
III- Aesthtics, Cultural & socio-economic Condition	1. Aesthetics and Human	a.Scenic view and vistas	💣	✞	💣	💣	💣	💣	✞	✞	✞	✞	☒	✤	☒	💣	💣	💣	💣	✞	💣	💣	💣	✤	☒	☒	💣	💣
		b.noise/vibration	💣	☒	💣	💣	☒	☒	💣	💣	✞	💣	☒	☒	☒	☒	💣	💣	✞	✞	❄	✞	💣	✤	✞	✞	✞	✞
		c.litter/debris/dust	💣	✞	✞	💣	💣	💣	☒	💣	💣	💣	☒	☒	✞	☒	💣	✞	💣	✞	💣	💣	💣	✤	☒	☒	💣	💣
		d.ordour	❄	✞	✞	✞	💣	✞	☒	✞	💣	✞	☒	☒	☒	☒	✞	☒	✞	☒	💣	💣	✤	☒	☒	💣	💣	
		e.Wildness qualities	❄	❄	❄	❄	❄	❄	❄	❄	❄	❄	✞	☒	☒	❄	✞	❄	❄	☒	☒	❄	✤	☒	☒	✞	✞	
		f.Open space qualities	❄	✞	✞	✞	✞	✞	✞	❄	❄	☒	☒	☒	❄	✞	❄	❄	✞	✞	✞	✞	✤	☒	☒	❄	❄	
		g.landscape desing	❄	☒	☒	☒	❄	☒	☒	✞	❄	❄	✞	☒	☒	☒	✞	☒	✞	✤	☒	✞	✞	✤	✞	☒	❄	❄
		h.unique physical features	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	❄	☒	☒	☒	☒	✤	☒	☒	☒	☒
		i.rare and unique species	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	✤	☒	☒	☒	☒
	2. Cultural Status	a. cultural patterns lifestyles	☒	❄	☒	☒	☒	☒	❄	✞	✞	✤	✞	✤	✤	☒	☒	☒	☒	✤	❄	✤	✞	✤	✞	❄	❄	❄
		b. health and safety	✞	✞	✞	💣	✞	💣	✞	✞	💣	✤	❄	✤	✤	☒	✞	❄	❄	✞	💣	✤	💣	✤	❄	✞	✤	✤
		c. Employment	✤	✤	✤	✤	✤	💣	💣	💣	✞	✤	❄	☒	✤	☒	✤	✤	✤	✤	✤	✤	✤	✤	✞	✞	✤	✤
	3. Socio-economic	bussiness oppertunities	✤	✤	✤	✤	✤	☒	❄	✤	☒	✤	☒	☒	✤	☒	✤	✤	✤	✤	✤	✤	✤	✤	✤	✤	✤	✤

5.2 Impact Description & Mitigation

5.2.1 Demolition Phase Impacts

5.2.1.1 Site clearance – creation of demolition waste, dust and noise

Impact: existing two story buildings and other areas shown in (Figure 3) buildings will be demolished with roofs dismantled the shallow foundation underneath the building demolished, and the resulting debris and other materials removed. In areas where new building works are not necessary the demolished site will then be backfilled, and the fill compacted and leveled. Impacts would include creation of large volumes of demolition waste. In general, demolition waste is heterogeneous and consists to a large extent of building materials but includes even small amounts of dangerous and hazardous substances. Other impacts would include increased noise and dust and additional demolition debris to be retrograded.

Mitigation: The re-use of waste building materials in their existing state without down-grading and reprocessing is the most environmental sound option for supplying construction works (apart from not building at all). It is expected that a significant amount of materials from demolition works could be salvaged with potential for using wherever possible. It is anticipated that the resort management will take necessary steps to achieve this through 'deconstruction' of the buildings.

Noise and dust would be mitigated by manually disassembling the major portions of the structure. Demolition requiring the use of heavy equipment would be accomplished while wetting down the structure with water to reduce dust propagation.

All demolition debris would be handled to avoid material being blown by the wind from the area to the surrounding environment.

5.2.2 Construction Phase Impacts – Building Works

5.2.2.1 Offshore overwater Villa construction

Impacts: Increased rates of sedimentation as a result digging and placement of prefabricated columns adversely affect the structure of coral communities in three ways: physically, chemically or phtosynthetically which in turn influences negatively on calcification growth and net accretion rates. Direct impacts associated with excessive sedimentation includes; physical smothering of corals and other benthic reef organisms, reduces light penetration thus decreasing the rate of photosynthesis and net productivity of corals, reduces coral growth and reproduction, reduces fish diversity and abundance in the vicinity of dredged area.

Long term and irreversible loss of immobile marine biota, in particular, habitat loss for benthic organisms living on the lagoon due to loss of space and digging is inevitable. However, some of the adverse impacts associated with overwater villa construction could be mitigated if appropriate measures are taken in a timely manner.

Long term impact on coastal dynamics of the island would be accretion of sediment and change in the near shore bottom contours due to sediment accretion. This may cause erosion on some parts of the island due to sediment starvation and alteration of sediment balance.

Sedimentation will be the main impact of dredging works. Sedimentation causes in the reduction of water quality in the lagoon, which affects benthic organism and fish. If the sedimentation persists for prolonged periods 'suffocation' and smothering of coral may occur. However during the construction work in Laguna not much of sedimentation problem is anticipated to persist for long periods. As this involves only the placement of precasted concrete piles columns embedded in concrete pads. A summary of the activities, affected environment and affected components are diagrammatically shown in (Figure).

Mitigation: One way to mitigate effects of sedimentation would be to time the construction in accordance with the tide. If the placement of precast concrete piles offshore is conducted at low tide the sediments would be carried out of the reef and dispersed quickly at high tide. Dispersion pattern of dredged material in the Maldives has shown that as soon as the material reaches the deep water, the rate of dispersion is fast and the sediment plume disappears faster due to the strong current and wave actions. Therefore in the case of Laguna it is recommended to conduct off shore activities during the NE monsoon when the current flow and wave direction is from NE. Timing of NE monsoon period it is expected to carry the sediment plume into the deep waters and disperse faster, this will contribute for significant reduction in impacts associated with sedimentation.

Changes in the bottom near shore bottom contours should be continuously monitored and island dynamics should be measured by appropriate methods. Based on the monitoring appropriate coastal mitigation measures should be implemented.

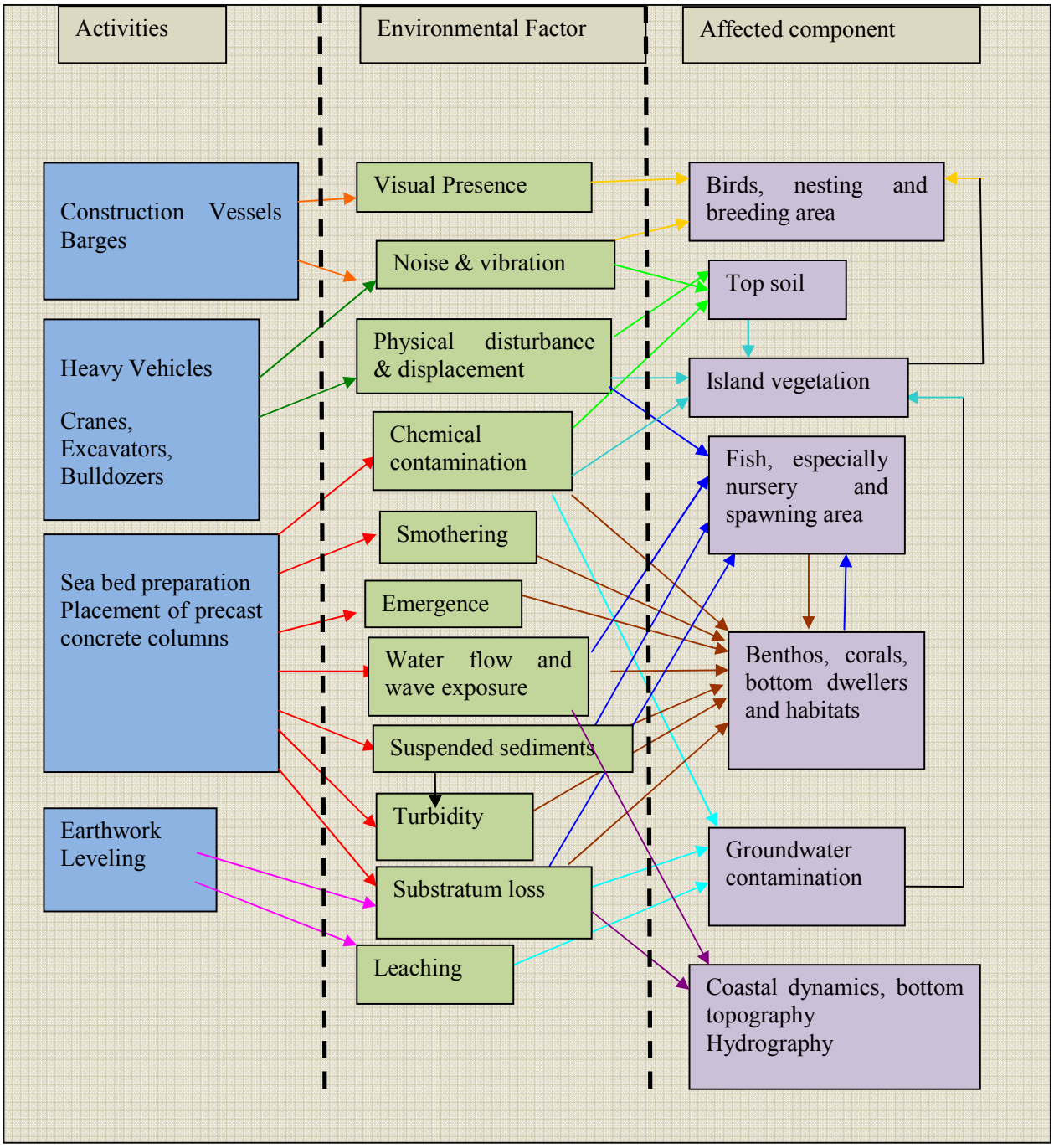

Figure 24. Summary of the environmental Impacts during the construction phase of offshore overwater Villas.

5.2.2.2Vegetation clearance – loss of terrestrial habitat & biodiversity

Impact: The proposed development does not involve vegetation clearance as all the land construction will be made on the footprints of the previously existing buildings. Thereofore no major vegetation clearance is involves with the project. However minor clearance such removal of bushes and small tress may be involved during the construction either to ease obtain to space for construction work or any other related purpose. Such works will result in the loss of some of the existing vegetation and a consequent reduction in habitat. . Noise, vibrations, and intrusive activities related to construction works may scare away any animals remaining on the site after vegetation clearance. These are some of the environmental trade-offs for resort development and expansion of the tourism industry. It is anticipated that some of the fauna will return after the construction works, especially after the remaining vegetation grows back or after landscaping and replanting of the site.

Mitigation: Restore as much of the original vegetation, including trees, as is practical on the island. This would be achieved by protecting the existing trees as much as possible and by a replanting and landscaping programme that focused on recreating habitat favorable to fauna. All the buildings will be constructed on the footprint of previously existing buildings structures, the proposed construction methodology, and the nature of construction works, it would require concerted effort to successfully retain and protect the existing trees and shrubbery.

Those trees that can be protected in situ should be marked, clearly identified on the site construction plan, and properly protected prior to the commencement of construction.

The building contractor should be made subject to punitive penalties for any breaches of the tree protection plan and for damage to protected plants. These penalties should be an integral part of the works contract and specifications.

The landscape plan should seek to utilize low-maintenance native species tolerant of typical coastal conditions which are attractive to birds. It must not include imported and invasive species.

Based on the landscape plan, an inventory and collection of selected plants and ecologically valuable trees on the site should be made. These plants should be correctly removed, stored and maintained at a properly appointed plant nursery until they can be transplanted back on the site as stipulated by the landscape plan.

5.2.2.3 Vegetation clearance – soil erosion

Impact: Site preparation, vegetation clearance, demolition, and building works would expose soils in the affected areas and leave them vulnerable to erosion by heavy rainfall and surface run-off. The latter would threaten adjacent coastal waters and inshore and coral habitats with high turbidity and sediment deposition, a negative consequence. However, the flat topography of the site would tend to militate against erosive surface flows under such circumstances and the threat of turbidity should exist only during the early stages of construction before subsequent landscaping and drainage works reduce the susceptibility to soil erosion.

Mitigation:

- Stage site clearance works so as to minimize the area of exposed soil at any given time. Re-cover exposed soils with vegetation as soon as possible.
- Temporarily bund exposed soil and redirect flows from heavy runoff areas that threaten to erode or result in substantial turbid surface runoff to adjacent marine waters.
- Monitor areas of exposed soil during periods of heavy rainfall throughout the construction phase of the project to ensure that any incidents of erosion are quickly controlled.

5.2.2.4 Building foundations – noise & vibration

Impact: construction work will result in repeated machinery operation sounds which will be audible to the workers living on the island. These sounds will at most be of nuisance value, will occur during the construction period. There may also be minor vibrations associated with machine operations and construction work this is not considered to be of significant concern as these will be largely absorbed by the coarse soil type found on the site.

Mitigation: Workers operating equipment that generate noise should be equipped with noise protection gear. Workers operating equipment generating noise levels greater than 80 dBA continuously for 8 hours or more should use earmuffs. Workers experiencing prolonged noise levels of 70 – 80 dBA should wear earplugs.

5.2.2.5 Earth materials sourcing – illegal sand mining

Impacts: Earth materials needed for construction (e.g. sand, aggregate) will mostly be purchased from abroad. Imported river sand might have some alien organism that may bring invasive alien species to the country. Locally mined sand may also be required for construction activities. Conscious or unwitting purchase of these materials from unlicensed operations indirectly supports, encourages and promotes environmental degradation at the illegal mining sites and causes medium to long-term negative impacts at source.

Mitigation: Earth materials must be obtained from officially licensed and approved sites. Imported river sand and aggregate should be screened for potential invasive alien species that may exist in the sand.

5.2.2.6 Construction solid waste - inappropriate storage & disposal

Impact: Considerable volumes of solid waste will be generated during site preparation and construction works, which would include vegetation and typical construction waste such as wasted concrete, steel, wooden, plastics, rubber and forms, bags, waste earth materials, etc. This waste will negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite. Waste burned on the site would generate smoke, possibly impacting negatively on ambient air quality and human health. Vegetation and solid waste, if allowed to accumulate on the ground, could cause localised pooling and flooding. Pooling of water, in turn, would create conditions conducive to the breeding of nuisance and health-threatening pests such as mosquitoes. Poor construction waste management constitutes a short term negative impact.

Mitigation:

- A site waste management plan should be prepared by the contractor prior to commencement of building. This should include designation of appropriate waste storage areas, collection and removal schedule, identification of approved disposal site, and a system for supervision and monitoring. Preparation and implementation of the plan must be made the responsibility of the building contractor with the system being monitored independently.
- Special attention should be given to minimizing and reducing the quantities of solid waste produced during site preparation and construction. To reduce organic waste, softer vegetation may be composted onsite and used for soil amendment during landscaping.
- Vegetation and combustible waste must not be burned on the site.
- Reusable inorganic waste (e.g. excavated sand) should be stockpiled away from drainage features and used for in filling where necessary and/or possible.
- Unusable construction waste, such as damaged pipes, formwork and other construction material, must be disposed of at an approved dumpsite.

5.2.2.7 Sewage & litter management

Impact: Improper disposal of food cartons and other domestic forms of construction camp garbage (including styrofoam) could lead to littering of the site and pollution of adjacent coastal waters. Imapct of sewage would not be anticipated during the construction period because the existing toilets in the island will be used by the workers during the construction period.

Mitigation:

- Provide solid waste receptacles and storage containers to prevent littering of the site.
- Special areas should be designated for cooking and eating of meals where adequate garbage containers are available and controls can be imposed on littering.
- Make arrangements for the daily collection of litter from the site and its disposal at the approved areas.
- Avoid excessive packaging of construction materials and buy in bulk

5.2.2.8 Equipment & vehicle maintenance

Impacts: All sorts of motorized equipment, from generators to trucks, requiring fuel, lubrication and maintenance will be used on the construction site. Many will be fitted with lead batteries. Therefore the potential will exist on the site for spillage and contamination of the soil and the sea by hydrocarbons as well as the careless disposal of batteries.

Mitigation:

- Confine vehicle maintenance to specially prepared areas with impermeable pads.
- Ensure changed engine oil is collected in drip pans and stored in covered drums until it can be properly removed from the site for appropriate disposal
- Ensure used batteries are properly stored and kept under cover.

5.2.3 Resort Operation Impacts

5.2.3.1Employment & staff training

Impact: During the previous operation period there were 290 staffs in the Laguna. On completion of the project, the resort will be up-graded to five star standards. Hence with additional services and facilities additional job opportunities will be created and the number of staff is expected to be 320 in the island. This would represent a positive long-term socio-economic benefit arising from the project. This benefit would be enhanced by in-house training of staff.

5.2.3.2 Water and electricity

Impact: The existing RO plant is capable of producing 180 tons / day. The existing capacity is sufficient to meet the demands of the resort re-development. Since no water will be abstracted from the island's aquifer no negative impact on the groundwater resource is anticipated.

At present seawater is used in flush tanks and after renovation fresh water will be used and a sewerage treatment plant will be installed in the island.

Water consumption is anticipated to net increase due to better services and increased number of up-market visitors to the island will mean an increase in the demand for water resources. The resort should put the following water conservation devices or technologies in place.

Mitigation: Provide adequate water storage facilities to ensure adequate supplies for the resort.

- Install aerators/flow restrictors on all taps.
- Install low flush toilets.
- Install gutters and collect rainwater from building roofs and store for grounds irrigation.

Impact: existing five generator set will be sufficient to supply electricity for the island. The incremental demand due to upgradation is expected to be within the capacity of the existing system. However, this increased demand will commensurately increase the utility's use of fossil fuel to generate that electricity, and thus the project will indirectly incur negative impacts associated with greenhouse emissions.

Mitigation:

- Mitigation measures relate to incorporating and improving energy management and conservation practices.
- Sub-meters and real-time energy monitoring equipment, timers, photoelectric cells, thermostats, etc. should be installed in the room blocks and other facilities.
- Install translucent shades and fluorescent lighting.
- Pipe insulation, tank lagging (not asbestos!) and heat recovery systems should be installed wherever it is practical to do so.

5.2.3.3 Solid waste management & disposal

Impact: The resort will generate significant quantity of solid waste per day, comprised mainly of organic food waste. Poor waste management at the resort would lead to unsanitary conditions including vermin and fly infestation, odours and unsightly conditions. However, garbage management and good housekeeping will be practiced at the resort and potential issues related to improper solid waste storage will therefore be avoided. A dedicated waste dhoni will be engaged to collect and dispose of waste from the resort on a regular basis to Thilafushi.

Mitigation:

- Ensure all waste management equipments required by the Ministry of Tourism are put in place and maintained in working order and dedicated waste management staff be employed by the resort management.
- Awareness raising among guests are conducted on ways to reduce and avoid solid waste
- Composting be encouraged on the island
- Ensure residual waste is disposed of at the Thilafushi and waste dhoni to maintain a regular log of waste.

5.3 Socioeconomic aspects

Impacts: The redevelopment of the Laguna resort would have positive socio-economic impacts in that increased scale of operation would mean increased employment opportunities. The developer has plans to attract locals to increase proportion of the local employees in the resort. The way to achieving this would be to provide training, but equally making the work environment more attractive.

The overall impact of the redevelopment would be positive that will bring direct and indirect socio-economic benefits from resort supplies from Malé, possibility of making use of local travel agents, fishermen, transport sector, all will benefit directly and indirectly from the project.

VI. Summary Evaluation of the project Alternatives

The proposed redevelopment and upgrading project of Laguna Island resort involves to bringing moderate changes to the existing facilities and guest rooms and addition of new overwater villas and spa complex offshore. This development will bring some degree of changes to the environment. The description of those activities and how it will be done has been given in detail in this document. In the previous chapter environmental impacts and ways to mitigate them were also given.

This section will briefly look at alternatives to undertaking the proposed redevelopment works on the resort island. There are two options

1. No renovations and only make some ad-hoc refurbishments and continue operating the resort.
2. Develop the resort to the 5 star standards and take the path that is proposed in here for the redevelopment works.

If the redevelopment works as proposed were to be implemented it is necessary to take economic, ecological, and social aspects of the project into considerations and weigh the long terms implications for the environment and society at large. Neither the economic benefits nor social and ecological concerns can be avoided. The two options are discussed below.

Option 1**:** The resort will continue to operate at the present level (rating of 4 stars). The issues of the built-environment discussed in the project rationale will be neglected.

The problem with this option is that some of the buildings are out of date and require major over-hauling, which means complete demolition and reconstruction. This option is also the not appropriate due to the increased competitiveness of the resorts and standards that are required by the luxurious niche market targeted by the Maldivian tourism industry. Design of some of the buildings and utility services simply does not meet the required standards and would require complete over-hauling of the services. Therefore improvements in standards is inevitable if Laguna wants to survive in the fast growing luxurious tourism industries Maldives is famous for, to make the resort operation competitive and make profit in the long term.

Option 2: Assuming that the resort will be renovated and upgraded to five–star standard this option turns out to be economically viable. However removal of existing two storey buildings and addition of overwater villas would impact the environment to some extent but most of those impacts can be mitigated. The level of environmental modification is kept minimal for the proposed redevelopment works. Given that Laguna reef is separate and located on the reef edge the recovery would be rapid and re-establishing the new ecological equilibrium. Therefore weighing environmental, economical and social aspects of the project against the overall benefit of the project indicates that implementation of path proposed in this project substantially outweigh its imposition on the environment.

VII. Environmental Management Plan

Environmental monitoring program for this project should be implemented to address all activities that have been identified to have potentially significant impacts on the environment during construction and operation phase. Environmental monitoring activities should be based on direct or indirect indicators of coastal erosion, reef degradation, effluent discharges, and resource use. Monitoring frequency shall be sufficient to provide representative data for the parameter being monitored.

Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with normal operating standards so that any necessary corrective actions can be taken.

7.1 Coral reef Monitoring

The major components of the monitoring of the marine environment are reef quality and also of sea-water quality. Understanding the changes to these two components is important to minimize the impacts if they are linked to the activities originating from the island.

The main purpose of monitoring seawater quality in the reef system is to assess the changes and trends in the reef environment. Changes in the level of nutrients in the water column have the potential to affect the benthic assemblages and hence the reef community as whole. Therefore, assessment of water quality especially chemical parameters would be helpful in relating the cause to the effects.

Important physical and chemical parameters should be analysed using standard laboratory techniques. These should include; salinity, pH, electrical conductivity, total dissolved solids, nitrite, nitrate, dissolved organic nitrogen, dissolved in organic phosphorus, dissolved organic phosphorus.

Plot sampling or quadrats would be used to assess the sessile benthic communities of the reef. Quadrat sampling is a reliable and efficient sampling method for obtaining quantitative percent cover, abundance and diversity of benthic communities especially target species. It can also provide detailed information on spatial patterns of the reef communities. If quadrat sampling is repeated through time with sufficient replication it can also provide information on temporal changes.

Reef fish communities would be assessed by visual census of the fish at each site. The main purpose of this would be to assess the differences in the assemblages of reef fish at different sites. It would also provide information on the different types of fish on the reef and would also be useful in studying the changes to community structure.

7.2 Terrestrial Vegetation and Ground Water Quality

It is understood that the management have no plans to use groundwater for any purpose. However, it is important to periodically monitor groundwater in order to assess its quality and identify potential sources of contamination.

Vegetation cover and changes in the diversity of vegetation is also important to monitor, mapping and species identification and random quadrat sampling of vegetation could be used for monitoring.

7.3 Coastal Shoreline monitoring

Most of the anticipated environmental impact from the proposed development is to be on the coastal processes of the island particularly with the overwater villas and spa complex to be developed offshore Laguna island. Monitoring the coastal processes around the island can be used to evaluate the environmental impacts of the development on the island over a long period of time. Information gathered from such monitoring can result in significant cost reduction for future coastal works and planning environmental mitigation measures. The proposed coastal monitoring activities for the coastal environment at Laguna are as following:

1. Shoreline and nearshore response and changes to the morphology of the island
2. Onshore/offshore sediment movement around the island,
3. Waves and current patterns around island,
4. Seasonal beach dynamic (erosion and accretion),

The above monitoring activities shall be continued for over a period of 2 – 3 years and the results of the monitoring activities shall be reported to the person heading the technical department and to relevant government authorities as required. It is also proposed that modification of existing groynes be adjusted, if necessary, based on the findings of these monitoring works.

An overall monitoring schedule based on the components discussed above is provided in Table 2***:*** . This monitoring should be the responsibility of the client. It is expected that standard and consisted monitoring methodologies are followed and data recorded accordingly.

Table 2: Summary schedule of Environmental monitoring at Laguna Island.

	Coastal changes	**Coral reef habitats**	**Terrestrial habitats**
Beach line survey of the island	2 times/year		
Beach vegetation line	once/year		
Beach profiles	2 times/year		
Wave data and currents	2 times/year		
Coral and benthic cover		quarterly	
Water quality		quarterly	yearly

The developer is fully committed to undertake impact monitoring according to the above environmental monitoring schedule (Table 11). The cost of monitoring is estimated to be US$ 3,000 per annum.

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Appendixes

Appendix 1 Terms of Reference

Environment Research Centre
Ministry of Environment, Energy & Water
Male', Republic of Maldives

Terms of Reference for Environmental Impact Assessment

The following is the TOR based on the scoping meeting held on 14th May 2008 for undertaking the EIA for the **proposed water villa development at Laguna Island(velassaru), South Male' Atoll, Maldives.**

1. Introduction - Identify the development project to be assessed and explain the executing arrangements for the environmental assessment.

2. Study Area - Specify the boundaries of the study area for the assessment as well as any adjacent areas that should be considered with respect to the project.

3. Scope of Work - The following tasks will be performed:

Task 1. Description of the Proposed Project –Following things shall be provided in the project description.

- *a) brief description of the proponent and proposed project components. A full description of how the project activities will be undertaken including work method for constructing structures, project concept, duration of the project, and the relevant parts of the project.*
- *b) clearly labeled site plan, using maps at appropriate scales where necessary. This is to include: facilities to be developed, sketches of foundation pads and columns of over-water structures.*
- *c) waste management plan (a solid waste management plan), sewage system with particular emphasis on wastewater disposal location, water supply, power generation and fuel management with particular emphasis on waste oil management*
- *d) inputs and outputs related to the proposed activities, project costs, their need and justification and a detailed project schedule; and life span.*

Task 2. Description of the Environment - Where baseline data is to be collected, careful consideration must be given to the design of the survey and sampling programme. Data collection must focus on key issues needing to be examined for the EIA. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that the data collected is suitable for use as a baseline to monitoring impacts.

Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area (and disposal sites), including the following:

a) Physical environment: geomorphology, meteorology (rainfall, wind, waves and tides) and sea currents, surface hydrology, deep lagoon, shallow lagoon and marine water quality(The seawater quality parameters shall specifically include; COD, BOD dissolved oxygen, salinity, suspended solids, pH, temperature and turbidity, phosphates and nitrates among other chemical parameters). Ground water in terms of electrical conductivity or total suspended solids, pH and nitrates and phosphates should be tested and provided.

b) Biological environment: terrestrial and marine vegetation and fauna, rare or endangered species, other sensitive habitats, species of commercial importance, species with the potential to become nuisances or vectors and coral reef status (status of the coral community, fish community) at reference location to establish baseline data on significant environment.

c) Socio-economic environment: Aesthetics, boat transportation navigation conditions, employment and community perception of the development.

All survey locations shall be referenced with Geographic Positioning System (GPS) including sampling points, reef transects, vegetatation transects, manta tows and soil sampling sites. All water samples shall be taken at a depth of 1m from the mean sea level or mid water depth for shallow areas. The report should outline the detailed methodology of data collection utilized to describe the existing environment

Task 3. Legislative and Regulatory Considerations - Describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project. Reference shall be made to Montreal Protocol on substances that deplete the ozone layer when relating to establishment of cooling and refrigeration systems and use of fire extinguishers.

Task 4. Determine the Potential Impacts of the Proposed Project – The EIA report should identify all the impacts and shall determine and analyze all the significant impacts for the proposed development. Particular attention shall be given to impacts associated with the following:

a) Sewage and waste water generation-giving details of intake and outfall locations
b) Water supply and demand
c) Use of generators and fuel
d) coastal development especially those in the beach line and beyond, areas of housereef that are likely to be impacted should be indicated and significance of these impacts defined
e) Solid waste management

It should also describe the methods used identify the significance of the impacts outlined. In particular, the impacts should be described for both during the construction stage and also during the operational stage. The report should outline the uncertainties in impact prediction and also outline all the positive and negative: short and long-term impacts. Identify impacts that are cumulative and unavoidable.

Task 5. Analysis of Alternatives to the Proposed Project. – Describe the

a) Alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". This includes alternative technologies, material, designs, locations of beach and water villas etc, and mitigation options should be specified for each component of the proposed project.

b)Atleast three alternatives should be discussed including no development option. Determine the best practical environmental options. And mitigation measures must be described for the alternative.

Task 6. Mitigation and Management of Negative Impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to sedimentation control and future changes in beach morphology. This include impacts that may arise due to dredging(if any), dredge spoil disposal and disposal/sedimentation containment and turbidity control. Mitigation measures must also be identified for both construction and operation phase. Cost the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

Task 7. Environment Management Plan and Monitoring – Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for coastal modification, beach morphology, sediment movement around the island. Detail of the monitoring programme including the physical and biological parameters for monitoring, reasonable time period and schedule should be outlined for environment monitoring in both construction and operational phase and cost commitment from

responsible person to conduct monitoring in the form of a commitment letter, detailed reporting time table and ways and means of undertaking the monitoring programme must be provided.

Task 8. Stakeholder Consultation – Major stakeholder consultation to include Ministry of Tourism and Civil Aviation, Ministry of Environment, Energy and Water and any other relevant stakeholder including the management of the resort. EIA report should include a list of people/groups consulted and the methodology of consultation.

Presentation - The Environmental Impact Assessment Report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Report, 2007.

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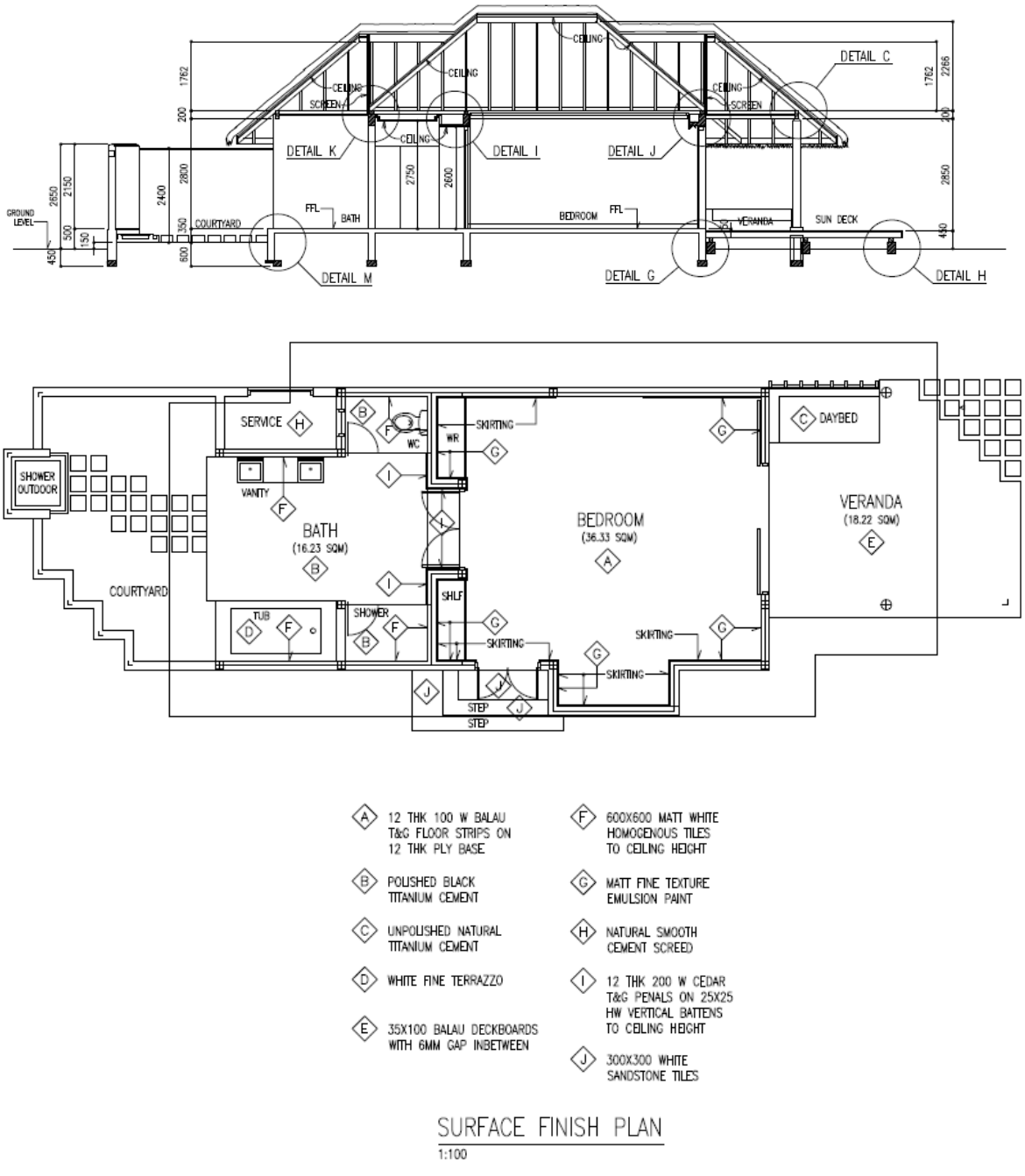
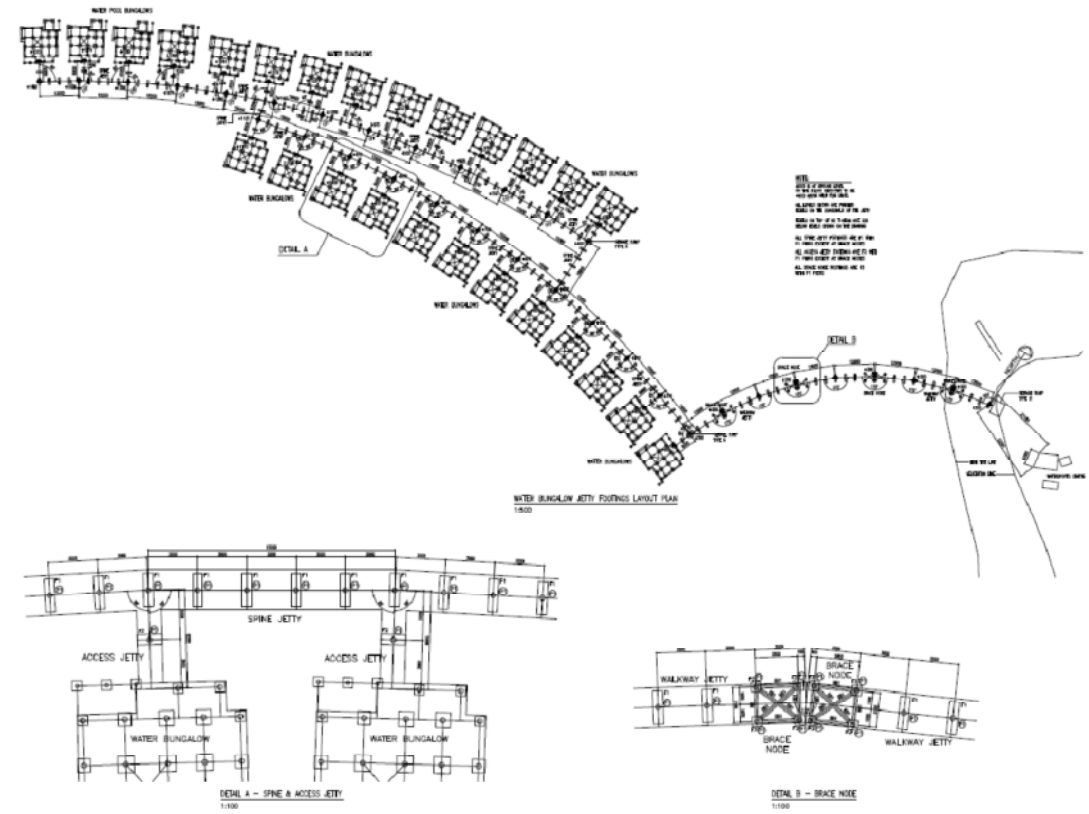
27th May 2008

Appendix 2. Beach Villa design details

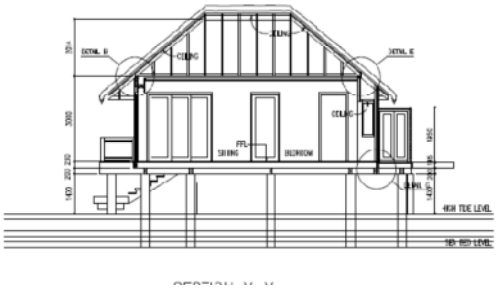


Beach Villas view from outside and surface finish plan

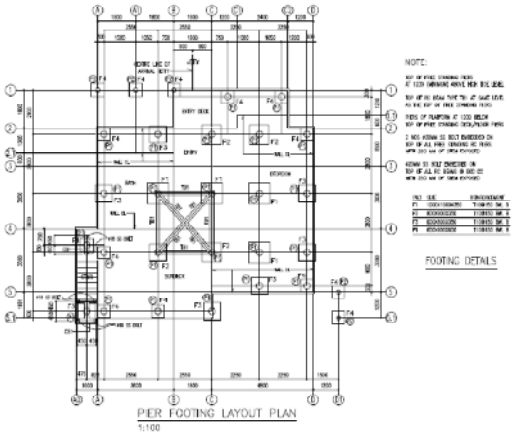
Appendix 3. Over water Bungalows design details



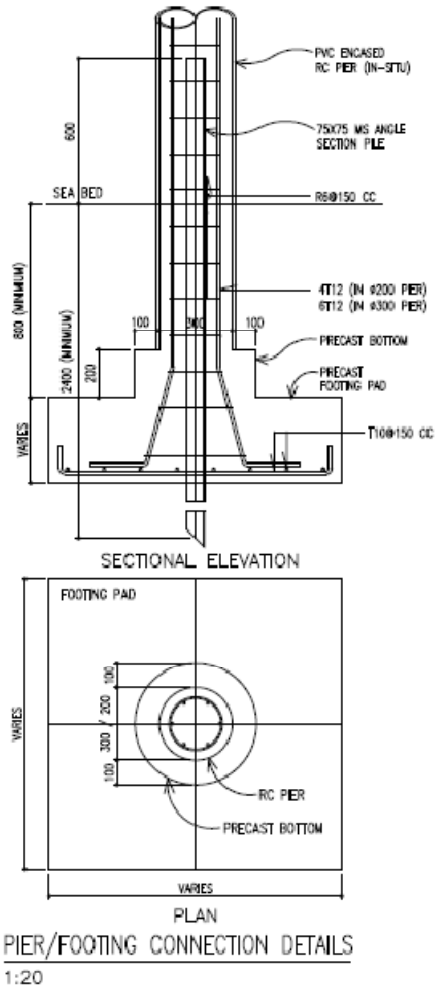
WATER BUNGALOW JETTY FOOTINGS LAYOUT PLAN & DETAILS



Overwater Villa design



Overwater Footing layout plan.



Footing details

Appendix 4. Curriculum Vitae of Consultant

Curriculum Vitae

Mahmood Riyaz

Date and place of birth 16th November 1968,
Lh. Naifaru Karankaage, Maldives
Permanent Address Lh. Naifaru Karankaage
Current address: Asian Institute of Technology,
P.O. Box 4, Klong Luang, Pathumthani 12120,
Thailand
Tel, +66 02 5247460
maheyriyaz@yahoo.co.uk
mahmood.Riyaz@ait.ac.th

Education

Post Graduate Diploma	Remote Sensing and Geographic Information System, Centre for Space Science and Technology Education In Asia and Pacific (CSSTEAP) Affiliated to the United Nations, Indian Institute of Remote Sensing (IIRS) 2003-2004
Master of Science M.Sc.	Tropical Coastal Management University of Newcastle Upon Tyne, UK (1998- 1999)
B.Sc. Hon.	Geology Al Azhar University Cairo Egypt (1991-1995)
Secondary Education	Institute of Cairo, Cairo, Egypt (1988-1991)

Training Courses

Hydrographic Department Oceanography and data Processing Course Japan Coast Guard (21 Nov. 2001- 8th March 2002)

GCRMN Coral reef Monitoring IOC-UNESCO/ UNEP/IUCN GCRMN South Asia, Coral Reef Survey Methods Training Workshop, Bandos, Maldives, 3-14th May 1998 IOI/ UWICED,

Deep sea-bed Mining Training Workshop, KingstonJamaica, 4-29 August 1997

Employment

Deputy Director Coastal Management

Ministry Environment Energy and Water (2004 July) Environment Research Centre Jamaaludheen Building, Male` 20-05, Maldives.

Email Address: Maheyriyaz@yahoo.co.uk

Telephone (960) 3335952 Fax: (960) 3335953

Languages

Languages : Dhivehi mother tongue,

Fluent English and Arabic,

Good reading, writing and speaking ability in Indonesian language. Basic Japanese communication skills.

Research Activities

I. Conference papers

M. Riyaz, K.-H. Park (2008) Reef slope failure in the northeastern corner of Malé, Maldives, 11th International Coral Reef Symposium, Fort Lauderdale, Florida, USA, 7-11 July 2008.

Riyaz M., Park K.H., Ali M., Kan H. (2008) Combined effect of Island Topography and Reef Morphology in Dissipating Tsunami Wave Energy in Maldives, proceeding of Conference on Marine Problems and Specific Solutions (COMPASS 2008), June 15-18 Bandos, Maldives

M. Riyaz, K.-H. Park (2008) 'Safer Island Concept' developed after the 2004 Indian Ocean Tsunami: A case study of Maldives, International Symposium on the Restoration Program from Giant Earthquakes and Tsunamis January 22-24, Phuket, Thailand

Kan. H, Ali M, Riyaz M. (2005). The 2004 Indian Ocean Tsunami in Maldives: Waves and Disaster Affected by Shape of Coral Reefs and Islands, *EOS Trans*. *AGU, 86(52)* Fall meeting., Abstract U11A-0814.

Kan. H, Ali M, Riyaz M. (2005) Topography of Coral Reefs/Islands, and Tsunami Disaster in Maldives, Japan Geographic Association, in press

Riyaz M., Ali M., (2004) Environmental Impacts of dredging Reclamation and coastal modifications, A case study from Maldives, Proceedings of 2nd International Conference on Scours and Erosion (ICSE 2004), Vol. 2. P 390-399

II. Other relevant works

Riyaz M (2004) Classification of near shore substrate types of South Andaman, Using Optical Remote Sensing Data, unpublished Post Graduate Diploma project report, submitted to Centre for Space Science and Technology Education in Asia and Pacific (CSSTEAP) and Indian Institute of Remote Sensing (IIRS).

Riyaz M. (1999) Implications of sea level rise on Sand Cay Sediment Budget;

Maddoohulhudhoo Island and Nelivaru Sand cay, Baa Atoll, Maldives. MSc. Dissertation, University of Newcastle Upon Tyne.

Elder D., Riyaz M. Shareef M. (1998) Coral Bleaching Event: Republic of Maldives, May 1998. Report to the Ministry of Planning Human Resources and Environment

Recreational

PADI certified open water, advanced open water and PADI Research diver.