MR AHMED SHAHIR, M. FURAHANI

EIA report for Reconstruction of berth at Thilafushi block 149C

January 2011

Land and Marine Environmental
Resources Group Pvt Ltd, Maldives

Declaration of the Consultant

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

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Date: 18 January 2011

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EXECUTIVE SUMMARY

1. This Environmental Impact Assessment (EIA) report is to fulfill the regulatory requirements under the Environmental Protection and Preservation Act of Maldives prior to the proposed restoration of alongside berth and harbor at Thilafushi block 149C.
2. Project proponent of the proposed project is Mr Ahmed Shahir, M Furahani who is the lease holder of Thilafushi block 149C.
3. The proposed project involves construction of alongside berth and reclamation of land at Block 149C, Thilafushi. The reclamation area is confined to existing harbor basin; while berth will be constructed at reef slope side and basin side. The berth at the reef slope side will be constructed using piles and tie beams thereby cantilevering to attain depths of -20m (used for berthing large vessels).
4. The location of project site is at Thilafushi block 149C, which is located at the eastern side of Thilafushi facing the channel between Thilafushi and Gulhi Falhu. The project site, reclamation area is a dredged harbor, while the berth area is damaged breakwater (which at present is submerged). A timber walk way or jetty is observed at the area which is at present used for loading and unloading material from larger vessels.
5. Pilling works will be done using modified excavator with hydraulic system. The piles will be driven using a Tommen Vibrohammer attached to the excavator. The circular 600mm piles for the berth area will be driven to 18m below ground level (outer most piles); while the inner piles and sheet piles will be driven to a depth of 9m below ground level. The sheet piles at the harbor basin area will also be driven using the vibrohammer to a depth of 9m. 15 round piles will be driven at the alongside berth area which will be used as the super structure for tie beams and quay wall. The distance between two piles will be 5m. The sheet pile line total length is 204m, the sheet pile sections will be anchored at 3m interval.
6. The reclamation works will be carried out using construction debris from resorts (construction debris generated from reconstruction of resorts) as core material and dredged spoil from basin area as top soil. The dredged spoil from dredging of basin area will be temporarily stored at existing reclaimed land at block 149C. Excavator on barge will be used for dredging the basin area. Filling works will be done after sheet pilling and piling works of berth area is completed. The existing entrance area will also undergo maintenance dredging. The dredged harbor basin and entrance will have a depth of -4MSL.
7. The length of alongside berth is 70m, the alongside berth will have fenders at 10m intervals. The berth quay area will be concrete slab caste on top of the tie beams. The design of the berth is made such the deep water access is made without the need of dredging the reef slope area. The quay wall will be cantilevered approximately to 3m, which would attain depths of 15-20m suitable for large vessels. Behind the berth, sheet pile section will run all along the periphery of the reclaimed area.

8. The reclamation works will be done after completion of excavation and pilling works, which would effectively bund the reclamation area. Construction debris from resorts will be used for fill the area as core material. Approximately 7360m^3 of construction debris will be used as core material. The top soil requirement will be met by dredged spoil generated during the deepening of basin and entrance area. Approximately 4100m^3 of dredged spoil will be generated during this work. This material will be stored on land temporarily until core material filling is finished. The finish level of reclamation area is 1.5MSL (which is the finish level of paving stone).
9. Status of marine environment at the project area and adjacent block area was done by visual assessment. Snorkeling survey was done at the reef flat and slope area recording the major benthic substrate cover. The reef slope at the area is very steep, with few over hangs. The reef flat area is observed with major anthropogenic impacts; these include construction waste and other debris (since these areas are reclaimed using constriction debris and similar waste). Live coral cover at the area was less than 1%, with only few encrusting forms. Reef slope area also had very few love coral (less 1%), with few laminar forms and massive colonies. Sedimentation was observed at the rock substrate possibly due to reclamation/excavation works done at other sites at Thilafushi.
10. The project involves modification of existing harbor facility at Thilafushi Block 149C. The coastline and reef area of Thilafushi has undergone major modifications over the years after establishing the island as an industrial island. At present a number of alongside berths and harbors are built at Thilafushi catering for different industrial and commercial uses. Therefore the project area is not a pristine environment. It has to be noted that major excavation/reclamation works are done at Thilafushi and adjacent reef (Gulhifalhu which has far greater environmental impacts).
11. Since the project site is already polluted by construction debris and other solid waste, it is thought that impact of mobilization and loading/unloading works will have minor impacts. Since existing basin will be used, additional impacts to reef or lagoon will be minor.
12. Thilafushi reef system especially at the inter atoll side is severely impacted due to reclamation, dredging and waste disposal works. In this regard reef area near block 149C is almost void of live coral, while the reef flat area is littered with construction debris (used for reclaiming land). Therefore it is not possible to assess and monitor changes to reef health in terms of development work at block 149C. The parameters that can be monitored are water quality (which will also need to be monitored during construction and operational stage, especially if fuel loading and unloading work will be carried out at the berth), vibration levels during piling works and visual assessment of piling area after driving each pile.
13. In conclusion, with due consideration environmental components the project is likely to effect the consultant concludes that the project components and designs are feasible and appropriate mitigation measures are given to correct and minimize unfavorable environmental consequences (considering environmental condition of project area).

1. INTRODUCTION

Thilafushi originally was as a lagoon called 'Thilafalhu' with a length of 7 km and a width of 200 metres at the shallowest regions. It came into existence following a series of discussions and efforts to resolve Malé's irrepressible garbage predicament during the early 1990s. The decision to reclaim Thilafalhu as a landfill was made on December 5, 1991 (Wikipedia.org).

During its early years of waste disposal operations, pits (also known as cells) with a volume of 37,500 ft^3 (1060 m^3) were dug, after which the sand obtained from the excavation was used to construct walled enclosures around the internal perimeter of the cells. Waste received from Malé was deposited into the midst of the pit, which was topped off with a layer of construction debris and then uniformly leveled with white sand. Initially there was no segregation of the waste since it had to be disposed immediately due to mass accumulation.

Today Thilafushi has a landmass of more than 4.6 million ft^2 (0.43 km^2). The speedy terrestrial growth of Thilafushi was observed by the Government, and in November 1997, it was decided that land was to be leased to entrepreneurs interested in acquiring land for industrial purposes. Initially there were just 22 lease holders. Within the past 10 years, this number has doubled to 54 resulting in more than 1.2 million square feet (0.11 km^2 or 27.5 acres) of land being used currently, which generates an excess of 14 million Rufiyaa (about USD1,000,000.00) per annum. Soon after, an area of 0.2 km^2 (known as Thilafushi-2) was reclaimed using white sand as the filling material to provide terra firma for the more heavy industries (Seventh National Development Plan 2006, website: isles.egov.mv). Currently Thilafushi has announced expansion of Thilafushi and has awarded reclamation works to a local dredging company.

The current (major) industrial activities in the island are boat manufacturing, cement packing, methane gas bottling and various large scale warehousing.

The proposed involves construction of a material loading unloading berth and reclamation of land at Block 149C, Thilafushi. At present the reclamation area is used as small harbor basin while the main quay wall area is a jetty pier accessing to deep water. The main purpose of the material loading unloading berth is to enable large vessels to berth and load/unload material. The project is funded and carried out by Mr Ahmed Shahir, M Furahani.

a) Purpose of the Report and Need for the EIA

This EIA covers the environmental reporting requirements in preparation for Coastal development project as stipulated by the environmental regulations of Maldives. Coastal developments such as construction of jetties/piers and reclamation that are likely to a have a significant impacts to the environment are required to submit an EIA or IEE report by

Environmental Act of Maldives. Article 5 (a) of the Environmental Protection and Preservation Act of Maldives (Law No. 4/93) provides for an impact assessment study to be submitted to the Ministry of Housing and Environment (MHE) before implementation of any activity that may have a significant impact on the environment. The Environmental Impact Assessment Regulation of Maldives (EIA Regulations, MEEW, 2007) provides a list of development proposals requiring environmental impact assessment reports which are outlined in Schedule D where EIAs are mandatory for such development projects.

Therefore, in accordance with the above requirements and procedures to follow under the EIA regulations, a scoping meeting to discuss the development project and determine the Terms of Reference (TOR) for the EIA report was held between the representative of Client (Design consultant, Mr Hussein Shiyam, MVK), LaMer Group Pvt Ltd as the EIA Consultant and representatives from Environment Protection Agency (EPA) as the Regulator on 4th November 2010. This report provides the results of the field work carried out on Thilafushi in December 2010 that followed based on the TOR approved by EPA.

b) Structure of the Report

The structure of this report follows the Terms of Reference (TOR) discussed in the presence of the developer, the EIA consultant and representatives of Environmental Protection Agency (EPA) as the EIA regulatory body. Upon submission of a draft TOR by the EIA consultant it was approved by the EPA on 21st December 2010, based on discussions between the consultant, the client and the other stakeholders. The approved Terms of Reference (TOR) for this report is attached in Appendix 1 of this document.

2. PROJECT SETTING

The project conforms to the requirements of the Environmental Protection and Preservation Act of the Maldives, Law no. 4/93. The EIA has been undertaken in accordance with the EIA Regulation (MEEW, 2007) of the Maldives by a registered consultant. Furthermore, the EIA adheres to the principles underlined in the regulations, action plans, programs and policies of the following Government Ministries.

- Ministry of Housing and Environment
- Thilafushi Corporation Limited

a) Environment Protection and Preservation Act of Maldives

The Articles of the Environmental Protection and Preservation Act (Law No. 4/93) addresses the following aspects of environmental management:

- Guidelines and advice on environmental protection shall be provided by the concerned government authorities.
- Formulating policies, rules and regulations for protection and conservation of the environment in areas that do not already have a designated government authority already carrying out such functions shall be carried out by MEEW (now known as MHE).
- Identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation.
- An EIA shall be submitted to MHE before implementing any developing project that may have a potential impact on the environment.
- Projects that have any undesirable impact on the environment can be terminated without compensation.
- Disposal of waste, oil, poisonous substances and other harmful substances within the territory of the Maldives is prohibited. Waste shall be disposed only in the areas designated for the purpose by the government.
- Hazardous / Toxic or Nuclear Wastes shall not be disposed anywhere within the territory of the country. Permission should be obtained for any trans-boundary movement of such wastes through the territory of Maldives.
- The Penalty for Breaking the Law and Damaging the Environment are specified.
- The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment.

The proposed development project at Thilafushi Block 149 will fully abide by the Environmental Preservation and Protection Act. Disposal of oil, chemicals and other hazardous materials will be strictly controlled and managed. Such materials will not be disposed at inappropriate locations in the local or the regional vicinity, but will be transported to designated waste disposal site at Thilafushi.

b) Second National Environmental Action Plan (NEAP II)

The aim of NEAP II (MHAHE, 1999) is to provide the necessary guidance for the protection and preservation of the environment of the Maldives and to sustainably manage its resources for the collective benefit and enjoyment of present and future generations.

The main strategies of NEAP II are:

- Continuous assessment of the state of the environment in the Maldives, including impacts of human activities on land, atmosphere, freshwater, lagoons, reefs and the ocean; and the effects of these activities on human well being;
- Development and implementation of management methods suitable for the natural and social environment of the Maldives, and maintain or enhance environmental quality and protect human health, while at the same time using resources on a sustainable basis;
- Consultation and collaboration with all relevant sectors of society to ensure stakeholder participation in the decision making process;
- Preparation and implementation of comprehensive national environmental legislation in order to provide for responsible and effective management of the environment;
- Adhering to international and regional environmental conventions and agreements and
- Implementation of commitments embodied in such conventions.

NEAP II specifies priority actions in the following areas:

- Climate change and sea level rise; coastal zone management;
- biological diversity conservation; integrated reef resources management;
- integrated water resources management;
- management of solid waste and sewerage;
- pollution control and management of hazardous waste;
- sustainable tourism development;

- land resources management and sustainable agriculture; and
- human settlement and urbanization.

NEAP II contains environmental policies and guidelines that should be adhered to in the implementation of the proposed project activities.

c) Protected Areas and Sensitive Areas

Under Article 4 of the Environment Protection and Preservation Act, the Ministry of Environment (now MHE) is vested with the responsibility of identifying and registering protected areas and natural reserves and drawing up of rules and regulations for their protection and preservation. At present there are no rules and regulations made available to the public on designation and protection of habitats and heritage areas.

Since the proposed project is at an industrial zone, therefore are no sensitive areas at proximity to the project area. Therefore only the project area will be affected.

3. PROJECT DESCRIPTION

a) Project Proponent

Project proponent of the proposed project is Mr Ahmed Shahir, M Furahani who is the lease holder of Thilafushi block 149C.

b) The Project

The proposed project involves construction of alongside berth and reclamation of land at Block 149C, Thilafushi. The reclamation area is confined to existing harbor basin; while berth will be constructed at reef slope side and basin side (see Appendix 2 for site plan). The berth at the reef slope side will be constructed using piles and tie beams thereby cantilevering to attain depths of -20m (used for berthing large vessels).

c) Need for the Project

The main purpose of the alongside berth is to facilitate berthing of larger vessels for loading and unloading. The reclamation area will be used for constructing storage facility and temporary storage area. At present a small jetty is constructed for the purpose of loading and unloading material from larger vessels, but at times during rough spells of NE, this jetty cannot be used. Therefore the client wishes to construct a berth that can be used in both seasons to allow loading unloading materials from larger vessels. The types of materials loaded or unloaded are fuel, construction material and large buoys.

d) Location and Extent of Site Boundaries

The location of project site is at Thilafushi block 149C, which is located at the eastern side of Thilafushi facing the channel between Thilafushi and Gulhi Falhu (see Figure 1). The project site, reclamation area is a dredged harbor, while the berth area is damaged breakwater (which at present is submerged). A timber walk way or jetty is observed at the area which is at present used for loading and unloading material from larger vessels.

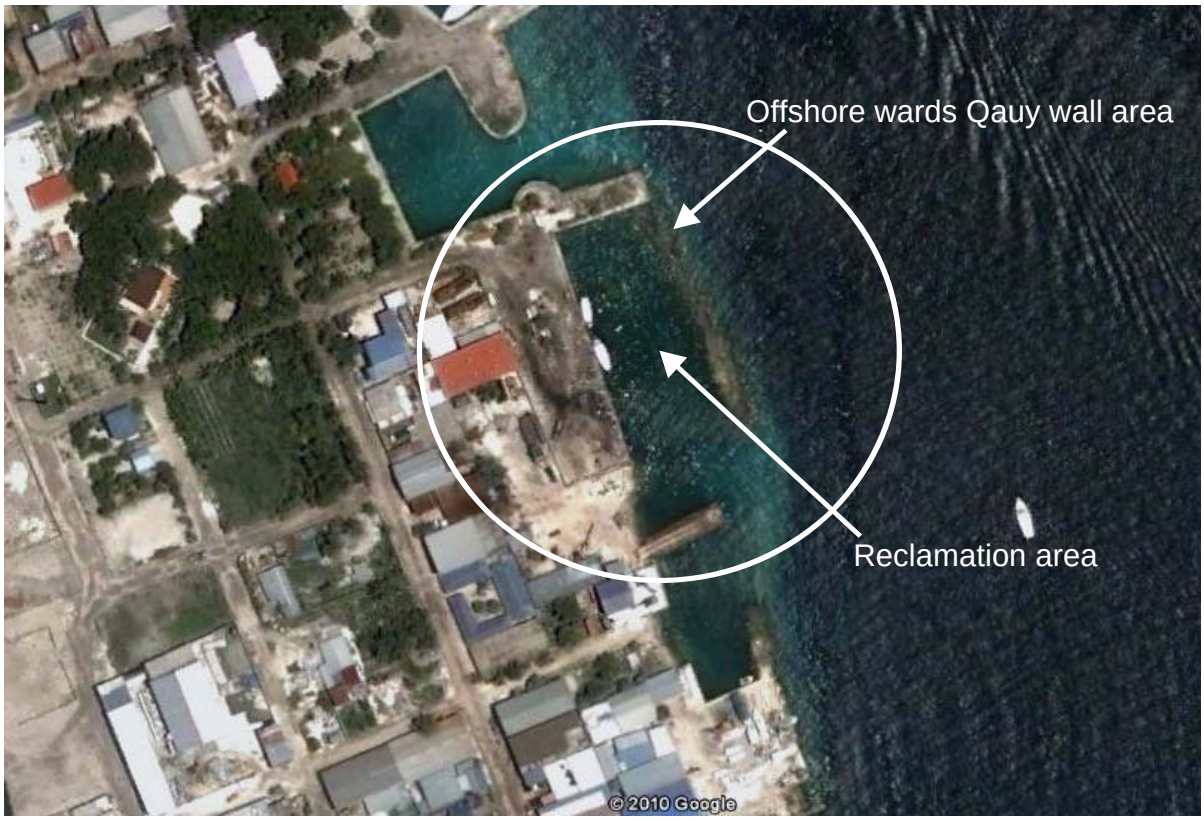

Figure 1 Block 149C showing proposed quay wall area and reclamation area

Figure 2 Existing alongside berth and harbor area at block 149C.

e) Construction Phase and Schedule for Implementation

The project construction will be carried out in two phases, in phase one the dredging to attain top soil and to deepen the basin area), sheet piles and pilling works will be carried out. While the phase two will involve reclamation (using construction debris from resorts used as core material), concrete works and final finishes (capping beams and paving).

Table 1 Construction schedule for Thilafushi block 149C

Phase	Description	months							
		1	2	3	4	5	6	7	8
Phase 1	Mobilization and material unloading								
	Setting out work								
	Dredging of basin area								
	Pilling works at berth area								
	Sheet piling works at basin and berth area								
Phase 2	Filling of reclamation area								
	Concrete works (sheet pile and berth area)								
	Final finishes works (fender installation and paving works)								

f) Major Inputs

i) Mobilization and material unloading

All material for the proposed project will be transported to the site on landing crafts and barges. Reclamation works will be done using construction debris from resort renovation works and similar. Construction debris will be transport to site on cargo dhonis. Almost all construction waste from resorts and other developments are disposed at Thilafushi. Small strip of land is already reclaimed at the area therefore this area can be used as temporary storage and setup.

ii) Workforce

The total workforce for the project is estimated at 30-35 workers, all workers will be housed at site, labor accommodation and toilet facility is already present at block 149C (constructed for accommodating laborers working at site).

iii) Heavy machinery and power generation

Machinery to be used for the proposed project is excavator (1 unit), cranes and wheel loader. Sheet piling works will be done using modified excavator with sheet pile rig. Power for the project site will be met by portable power generators. All fuel for the project will be stored in barrels (diesel for excavators, cranes and trucks).

g) Construction methods

i) Piling works

Pilling works will be done using modified excavator with hydraulic system. The piles will be driven using a Tommen Vibrohammer attached to the excavator. The circular 600mm piles for the berth area will be driven to 18m below ground level (outer most piles); while the inner piles and sheet piles will be driven to a depth of 9m below ground level. The sheet piles at the harbor basin area will also be driven using the vibrohammer to a depth of 9m. 15 round piles will be driven at the alongside berth area which will be used as the super structure for tie beams and quay wall. The distance between two piles will be 5m. The sheet pile line total length is 204m, the sheet pile sections will be anchored at 3m interval.

ii) Reclamation works

The reclamation works will be carried out using construction debris from resorts (construction debris generated from reconstruction of resorts) as core material and dredged spoil from basin area as top soil. The dredged spoil from dredging of basin area will be temporarily stored at existing reclaimed land at block 149C. Excavator on barge will be used for dredging the basin area. Filling works will be done after sheet pilling and piling works of berth area is completed. The existing entrance area will also undergo maintenance dredging. The dredged harbor basin and entrance will have a depth of -4MSL. Blasting will not be carried out under any component of the proposed project.

iii) Construction berth

The berth area will be constructed after sheet piling, piling at slope area and reclamation works are completed. The berth will have a concrete finish and paving behind the structure. Concrete slab segments will be in-situ caste at the area, fenders will be installed at the outer edge of berth for protection.

h) Major Outputs

i) Alongside berth

The length of alongside berth is 70m, the alongside berth will have fenders at 10m intervals. The berth quay area will be concrete slab caste on top of the tie beams. The design of the berth is made such the deep water access is made without the need of dredging the reef slope area. The quay wall will be cantilevered approximately to 3m, which would attain depths of 15-20m suitable for large vessels (see Appendix 3 for pile details). Behind the berth, sheet pile section will run all along the periphery of the reclaimed area.

ii) Harbor quay wall and basin

The harbor quay wall will be constructed using sheet pile and concrete capping beam. The length of basin side quay wall is 75m; the existing quay will remain at the western side (land side, which is also sheet piled). The southern side of the harbor will also be sheet piled and closed off from the neighboring blocks harbor. This section will have a length of 58m.

The harbor basin will have a finish depth of -4MSL. The harbor basin is designed for 35m vessels with 3m draft, while the alongside berth is designed for 4000tonnage vessels.

iii) Reclaimed land

The reclamation works will be done after completion of excavation and pilling works, which would effectively bund the reclamation area. Construction debris from resorts will be used for fill the area as core material. Approximately 7360m^3 of construction debris will be used as core material. The top soil requirement will be met by dredged spoil generated during the deepening of basin and entrance area. Approximately 4100m^3 of dredged spoil will be generated during this work. This material will be stored on land temporarily until core material filling is finished. The finish level of reclamation area is 1.5MSL (which is the finish level of paving stone).

i) Risks Associated with the Project

Thilafushi is developed as an industrial island at present, although in the past and present waste disposal is carried out. The waste disposal is done at large excavated pits which is filled with waste and topped with excavated sand, while open burning is also carried out. Many coastal structures have been developed at the shoreline area; these include fuel jetties, alongside berths and cement dispatching platforms...etc. Therefore Thilafushi reef is extensively dredged and reclaimed, which over the years has degraded the reef (based on finding of the reef survey done for the EIA). At present most of the alongside berths are constructed similar to the proposed project using piles driven at the slope, therefore additional impact to reef area is thought to be minor.

Reclamation impacts will be minor since reclamation works will be done after piling works are completed therefore spread of sediment plume will be minor. Excavation works at the basin area will cause sedimentation impacts, since live coral cover is very low at the area, this impact will be minor.

4. Methodology

The approach to data collection and compilation of this report includes;

- Consultation and discussion with the design consultants and engineers with regard to design and work methodology that would be used to implement the proposed activities
- Examination of proposed project activities,
- Examination of the existing environment to identify significant environmental components that would be affected,
- Evaluation of available and relevant literature on environmental impacts associated with similar projects.

Information on existing environment was collected during the field visit to the project site during December 2010. General information on the existing environment was based on available secondary data, such as climatic data for Kaafu atoll in general (National Meteorological Centre at Hulhule) because no site specific data was available. Due to the general uniformity of the climatic data along Maldives, climatic data from Hulhule were considered applicable to the site given the proximity of site to Hulhule. Oceanographic data and information used to determine the current pattern around the island was also based on monsoonal wind patterns, wind generated waves, tidal flushing, geographic setting, the topography of the lagoon and shape of the shoreline. Qualitative assessment was done at the project site (piling area, basin area and adjacent sides). Visual assessment was made at the reef area by doing snorkeling survey recording estimated cover of live coral and other benthic substrata. Water quality assessment was done at two sites, inside existing harbor and at reef slope area (Figure 3 shows the water sampling and reef survey locations along with GPS coordinates).

Figure 3 Location of water sampling and reef assessment area

5. Stakeholder Consultation

a) Institutional Arrangements

Thilafushi is at present operated by Thilafushi Corporation Limited, which is a state owned company. Development guidelines and limits are controlled by Thilafushi Corporation. Prior to any development at leased blocks, permit has to be attained by Thilafushi Corporation.

b) Consultation

Stake holder consultation was done with Thilafushi Corporation and adjacent block owners. As agreed during the scoping no objection letter from Thilafushi Corporation was attained by Mr Shahir in regard to the proposed development work. In the no objection letter dated 6th January 2011, Thilafushi Corporation limited requested that copy of approved EIA report to be submitted to them before commencement of work. Thilafushi Corporation also stated that they have no objection for preparatory works for the project (see Appendix 4 for letter from Thilafushi Corporation Limited).

Consultation with adjacent block owners was done along with Mr Shahir (block south of 149C, since block north of 149C is also leased to Mr Shahir no consultation was done for this area). The block south of 149C is leased to RKL Pvt Ltd; consultation was done with Mr Hussain Asir of RKL in regard to the development works. He informed that he has no issues regarding the development works at the block 149C, while he also clarified whether the harbor basin area will be closed off. The main reason is at present harbors of both blocks are not separated and at times causes difficulties. Mr Shahir informed that a sheet pile segment will separate both harbors.

6. Existing Environment

a) General Setting

The Maldives archipelago consists of a double chain of coral atolls, 80 – 120km wide stretching 860km from latitude 7° 6' 30" N to 0° 41' 48" S and longitude 72° 32' 30 E to 73° 45' 54" E (Ministry of Construction and Public Works, 1999). The double chain of the Maldivian atolls lies on the parallel submarine ridges in the central part of Indian Ocean known as Lacadive-Chagos ridge. The archipelago comprises 25 natural atolls (Naseer, 2004) grouped into 20 administrative units (see Figure 4). The atolls are separated by east-west running deeper channels. The atolls vary in shape from circular and oval to elliptical. The atolls contain 1190 islands, of which only 198 are inhabited. The total reef area of Maldives is 4,493.85km^2 while the total land area is 227.45km^2 (Naseer, 2004). Approximately 80% of Maldivian land area is less than 1m above mean sea level.

The characteristics of reefs and coral islands of the Maldives vary considerably from north to south. The atolls to the north are broad banks discontinuously fringed by reefs with small coral islands and with numerous patch reefs and faros (the word faros is derived from the Maldivian word "*faru*") in the lagoon. To the south the depth of atoll lagoon increases, faros and patch reefs are rare in the lagoon, the continuity of the atoll rim is greater and a large proportion of the perimeter of the atolls is occupied by islands (Woodroffe, 1992). The islands have shallow reef flats on their seaward side, some with shingle ramparts at the seaward limit of the reef flat. The islands and the shingle ramparts owe their origin to the deposition of shingle or coral debris during storms. A number of islands can be found on a single reef. These islands may be separated by shallow passages that run across the reef flat. The width of some of these passages could be less 100m while some passages are over a few hundred meters wide.

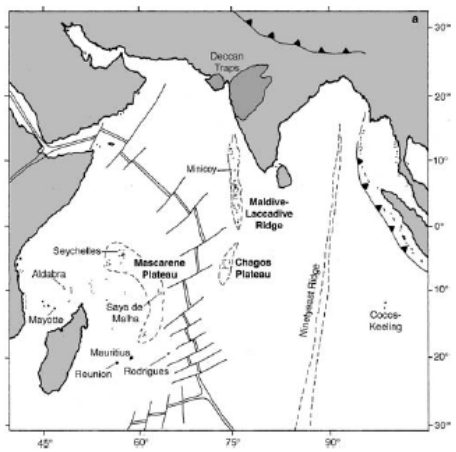

Figure 4 Geographic location of Maldives in Indian Ocean

b) Geographical location and general setting of Thilafushi

Thilafushi is located at 04° 10' 58" N and 73° 26' 47" E. Thilafushi is located west of Gulhifalhu and east of Giraavaru Resort. Orignally the island was used as a landfill but with the vision of possible industrial use the island was later on developed as an industrial island. The proposed project site is located at the eastern side of the island, facing the channel between Gulhifalhu and Thilafushi. The project works will be limited to block 149C and reef area leased along with the block (Figure 5 shows location of Thilafushi and project site).

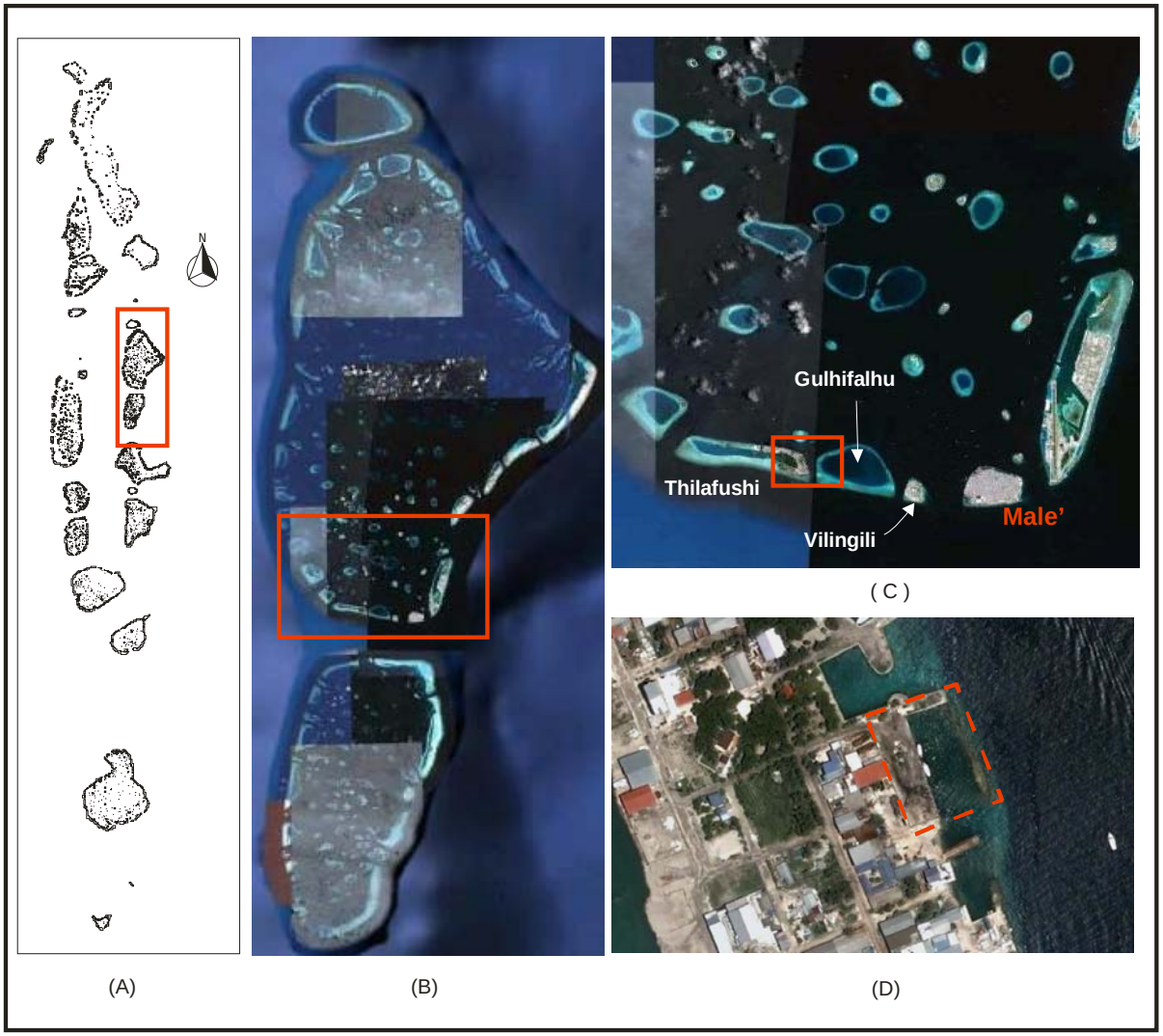

Figure 5 Geographic location of Thilafushi in North Male' Atoll and location of Block 149C.

c) Climate and Oceanography

i) Wind climate

Wind climate in the Maldives is dominated by the Indian monsoon climate South West (SW) monsoon and North East (NE) monsoon. The Indian monsoon system is one of the major climate systems of the world, impacting large portions of both Africa and Asia (Overpeck et, al., 1996). The monsoon climate is driven by the atmospheric pressure differences that arise as a result of rapid warming or cooling of the Tibetan Plateau relative to the Indian Ocean (Hastenrath 1991; Fein and Stephens 1987). During the summer of northern hemisphere the Tibetan Plateau warms rapidly relative to the Indian Ocean which results in an atmospheric pressure gradient (Low pressure over Asia and high pressure over the Indian Ocean) between the Asian landmass and the Indian ocean, which drives the prevailing wind from south to westerly directions. The period during which prevailing winds are from south to westerly direction is known as the SW monsoon. In the winter of northern hemisphere the continent cools relative to the ocean. This reverses the pressure gradient (low pressure over the Indian Ocean high pressure over the Asian landmass) and the prevailing winds become northeasterly. The period during which prevailing winds are from northeasterly directions is known as NE monsoon. The transitions from NE to SW monsoon and vice versa are distinctly different from SW or NE monsoon. During these transition periods the wind becomes more variable.

The SW monsoon lasts between May and September while the NE monsoon lasts between December and February. The period between March and 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 is known as Iruvai Halha. Iruvaihalha lasts from October to November (Table 2). The SW monsoon is generally rough and wetter than the NE monsoon. Storms and gales are infrequent in this part of the world and cyclones do not reach as far south as the Maldivian archipelago (Ministry of Construction and Public Works, 1999).

Table 2 The four seasons experienced in the Maldives

Season	Month
NE-Monsoon	December January February
Transition Period 1	March April
	May June

SW-Monsoon	July August September
Transition Period 2	October November

SW monsoon is characterized by strong Westerly winds and is considered to be the wetter period of the year. The seas are generally rough in this period. In contrary, NE Monsoon is characterized milder wind from NE quadrant. This period is in general much lighter and dryer than other seasons. Gale and storm winds in this region are infrequent and cyclones do not reach deep into the central region of Maldives.

An analysis of the wind climate was done using the daily averaged wind data for 2000 to 2009 from Hulhule meteorological station. In this analysis, wind rose diagrams based on wind speed and direction and the frequency of speeds and direction was produced. In addition, a spectral analysis (2002 to 2006 data) was done to decipher the cyclic nature of the wind.

Wind rose plots (Figure 6) shows that winds from WSW to WNW are dominant wind direction in the SW monsoon. And in NE monsoon, ENE and E is the prevailing wind direction. Rest of the winds throughout the year is roughly scattered (less than 30% of a year).These prevailing wind directions in both easterly and westerly winds are the directions in which the strongest wind blows. As suggested from the analysis the winds in Thilafushi are confined to WSW, W and WNW in SW monsoon and ENE during NE monsoon.

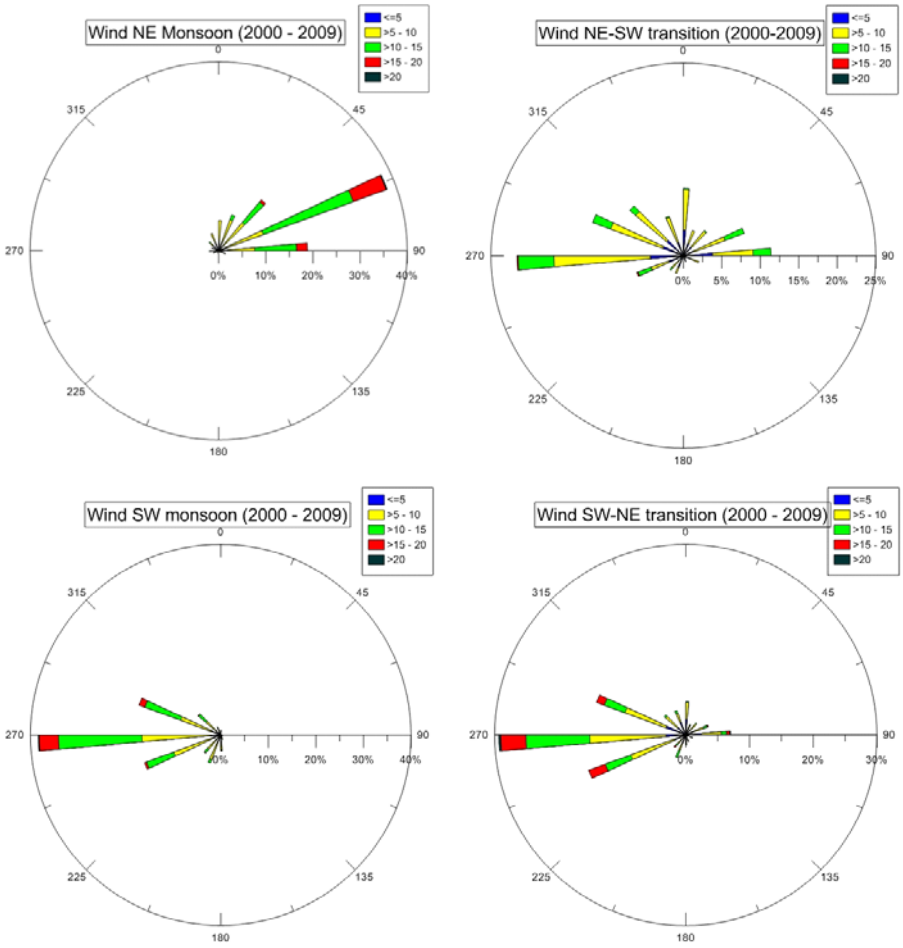

Figure 6 Seasonal wind rose at Hulhule (2000-2009)

The spectral analysis of wind speed data from 2002 to 2006 shows fairly regular cyclic variations of seasonal wind patterns. The strongest wind speed peaks in the power density spectral graph corresponds to 4 months, 6.1months, 2.4 months and 1.6 months respectively. The strongest of these is the 4months period which is 1.3 times stronger than 6month period.

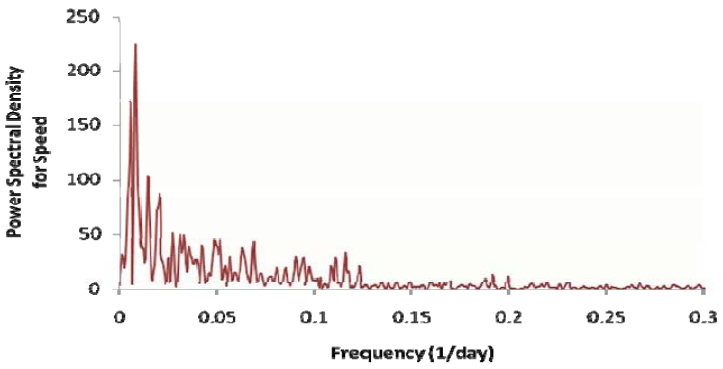

Figure 7 Power spectral density graph for the wind speed data from Male' International Airport for the period between the years 2002 to 2006

Upon examining the spectral analysis for the wind direction data, its shows that even though the wind speed is at 4months period, the wind direction change is exhibited mostly in 6 month periods. The magnitude of 6 month period is 1.7 times of the 4 month period. This shows that the change in wind direction is a biannual cycle rather than the traditionally believed 4months easterly and 8 month westerly wind.

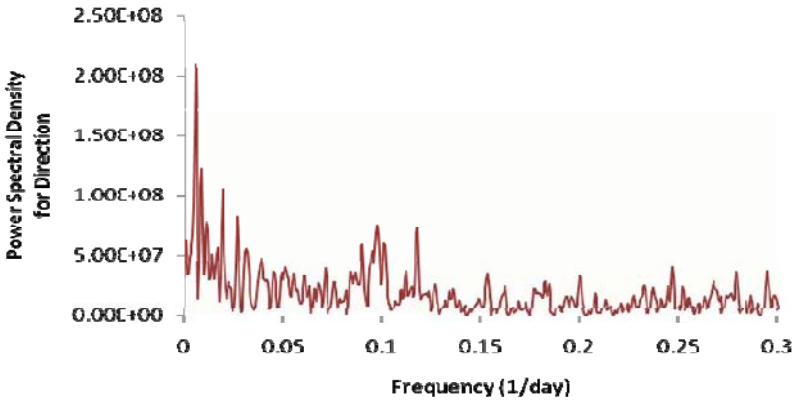

Figure 8 Power spectral density graph for the wind direction data Male International Airport for the period between the years 2002 to 2006.

ii) Wave and current

Information on the waves in the Maldives is limited, but local wind generated wave climate for the Maldives can be estimated from the long term wind data available from the Department of Metrology, Maldives. Wind generated waves for the years between 2002 and 2006 have been calculated (Figure 9 and Figure 10) using the wind wave formula [Hm0 = 5.112 x 10-4UAF1/2, Tm = 6.238 x 10-2(UAF) 1/3] (Shore Protection Manual, 1984). These estimates indicate that the local wind generated waves around Thilafushi have an averaged wave height of 0.3m and the wave height does not exceed 1.3m. The averaged wave period is 2.1sec and the maximum wave period is 4.8sec.

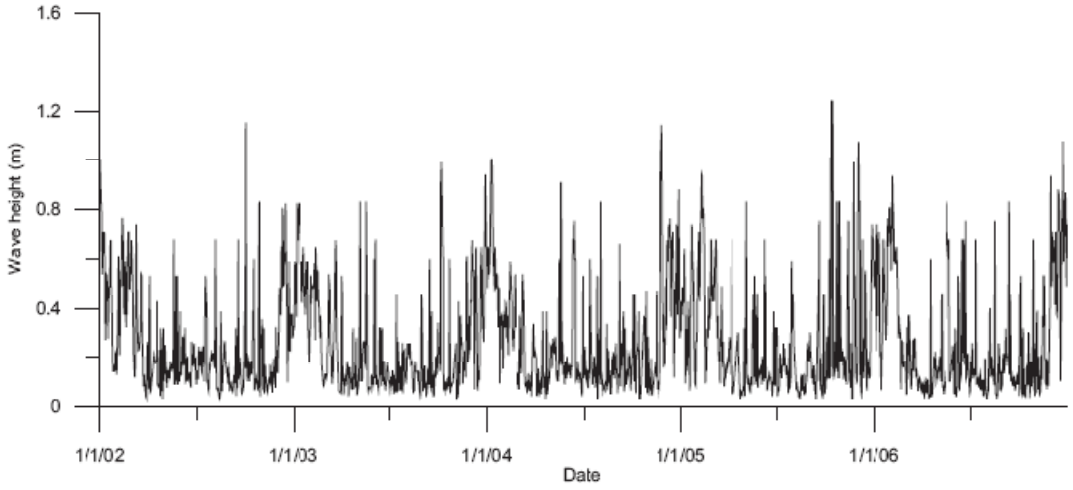

Figure 9 Time series plot of wind generated wave heights, estimated using local wind data

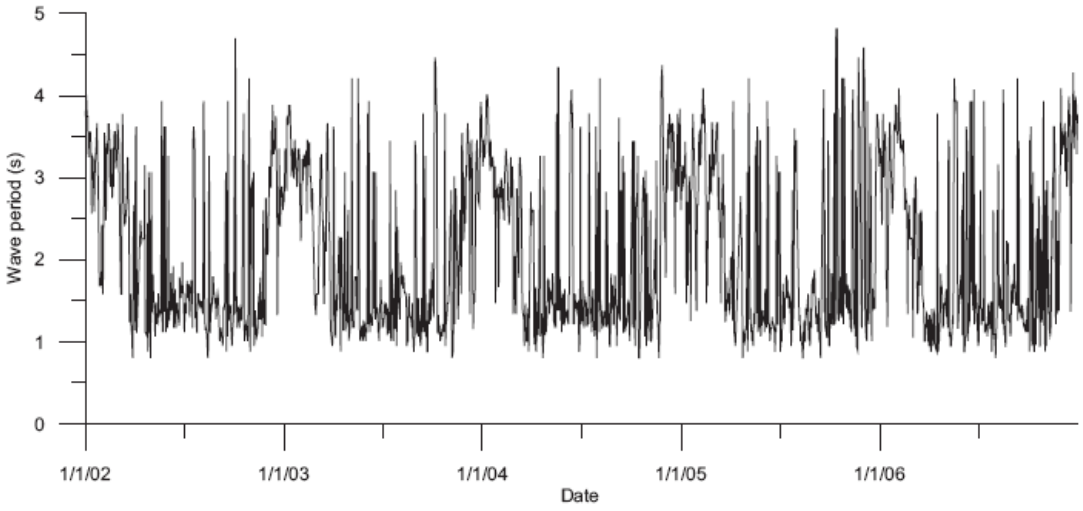

Figure 10 Time series plot of significant wave period for the estimated wind generated waves

Detail analysis of frequency of wave height distributions (Figure 11, 12 and 13) for the most prevailing wind directions indicate that during the 176days when winds prevail between WSW and WNW the wave heights higher than 0.5m exceeds for 10.1% of the time (17.6days a year). When the winds prevail from the directions between ENE and E (81days a year) the wave heights higher than 0.5m exceeds for 50.26% of the time (40.8days a year). For wave from all the directions the frequency of exceedance of waves of height greater than 0.5m is 17.29% of the time (63.1days a year).

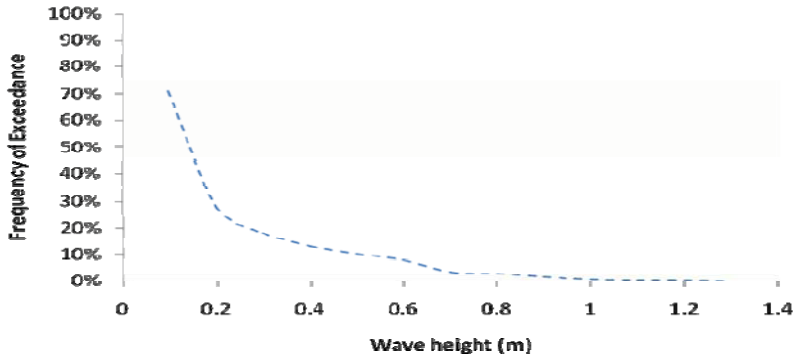

Figure 11 Frequency of exceedance of wave heights for waves from prevailing westerly directions

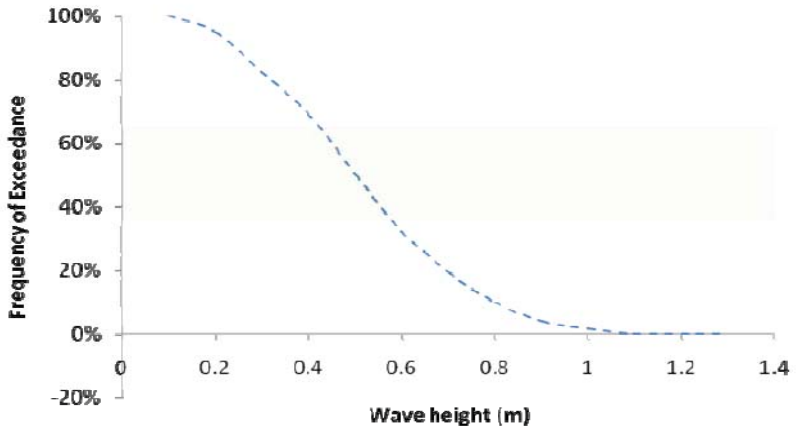

Figure 12 Frequency of exceedance of wave heights from prevailing easterly directions

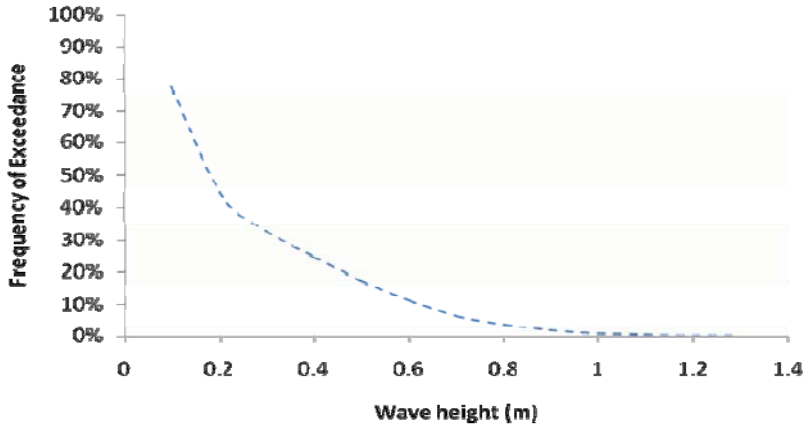

Figure 13 Frequency of exceedance for waves from all directions

Swell wave climate data for the Indian Ocean region surrounding the Maldives (Young, 1999) indicate that the dominant swell approaches from southerly quarters. On a seasonal basis, swell is

from the south-southwest from April to November with a peak significant wave height (Hs) of 1.8 m in July, and from the southeast from December to March with a minimum mean Hs of 0.75 m in March (Kench and Brander, 2006).

The Thilafushi reef system is submitted to three main oceanic climate factors, diffracted swell (which hits the south side of the reef system (channel between South and North Male' Atoll); the southwest monsoon wind waves, and the northeast monsoon wind waves. Figure 14 shows assumed wave climate of the reef system.

The dominant water current at the reef system (localized to Thilafushi area) is oceanic swell induced currents. The oceanic swells break at the reef from SE direction (refracted swell waves received from *Vaadhoo Kandu*, channel between North and South Male' Atoll). The swell waves beraking at the southern side creates a current north wards, while the refracted swell waves entering the channel between Gulhifalhu and Thilafalhu creates a current westwards. Wind generated currents are predominant west to east during SW monsoon, while east to west during NE monsoon. The project site is sheltered during SW monsoon, but during rough spells of NE monsoon, the area gets very turbid.

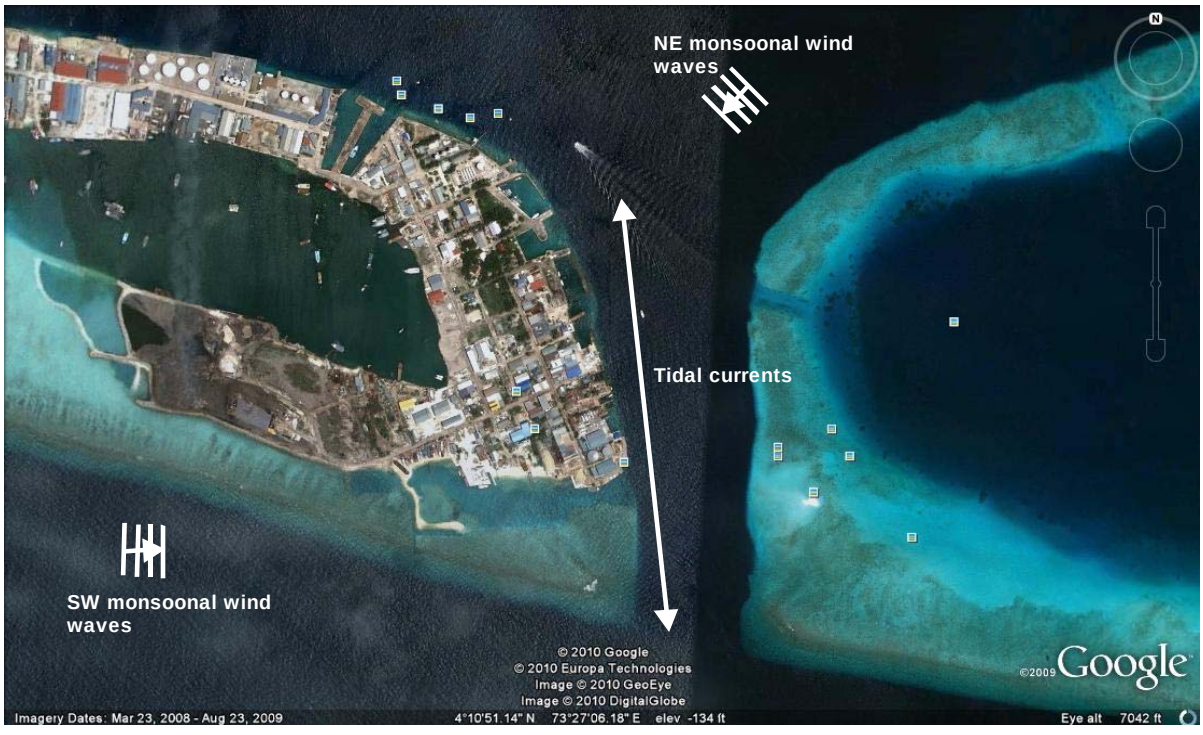

Figure 14 Monsoonal wind generated waves effecting Thilafushi reef system

iii) Tide

Long-term water-level records for Male International Airport are available from the web site of University of Hawaii. All coastal development projects require determination of the water level or water datum. Tide which consists of number of wave forms, termed tidal constituents generate many different water levels that are used as different datum. The most commonly used tidal datum in the Maldives is the Mean Sea Level (MSL). However, for designing the heights of the seawall, groynes and breakwaters the Highest High Water Level, Lowest Low Water Level Mean Higher High Water Level, Mean Lower Low Water Level, Mean Lower Low Water Level and Mean Higher Low Water Level are important tidal datum. The astronomical tide at Thilafushi has been assumed to be same as that at Male International Airport.

Spectral analysis of one years (year 2007) tidal records from Male International Airport (Figure 15) allowed establishment of the main tidal constituents M2 (Principal lunar semi-diurnal constituent), S2 (Principal solar semi-diurnal constituent), K1 (Luni-solar declinational diurnal constituent) and O1 (Lunar declinational diurnal constituent) (Table 3). Summation of M2, S2, K1 and O1 gave the approximate level of LLWL and approximate HHWL relative to MSL. Summation of M2 and S2 gave the approximate MHHWL and approximate MLLWL while the summation of K1 and O1 gave the approximate MLHWL and MHLWL relative to MSL (Table 4).

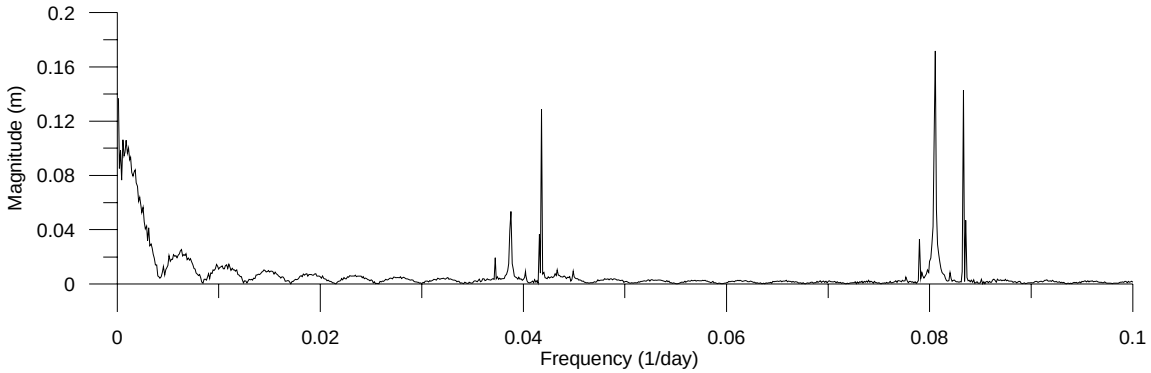

Figure 15 Spectral density for the tide (year 2007) from Male International Airport

Table 3 Magnitude of the dominant tidal constituents for the tide at Male International Airport

Tidal Constituent	Magnitude (m)
M2 (Principal lunar seim-diurnal constituent)	0.1716
S2 (Principal solar semi-diurnal constituent)	0.1427
K1 (Luni-solar declinational diurnal constituent)	0.1289
O1 (Lunar declinational diurnal constituent)	0.0535

Table 4 Water levels relative to MSL for Thilafushi

Tidal Datum	Height rel MSL (m)
Highest Astronomical Tide (HAT)	-0.50
Mean Higher High Water (MHHW)	-0.31
Mean Lower High Water (MLHW)	-0.18
Mean Sea Level (MSL)	0
Mean Higher Low Water (MHLW)	-0.18
Mean Lower Low Water (MLLW)	-0.31
Lowest Astronomical Tide (LAT)	-0.50

d) Marine Surveys

Status of marine environment at the project area and adjacent block area was done by visual assessment. Snorkeling survey was done at the reef flat and slope area recording the major benthic substrate cover.

The reef slope at the area is very steep, with few over hangs. The reef flat area is observed with major anthropogenic impacts; these include construction waste and other debris (since these areas are reclaimed using constriction debris and similar waste). Live coral cover at the area was less than 1%, with only few encrusting forms. Reef slope area also had very few love coral (less 1%), with few laminar forms and massive colonies. Sedimentation was observed at the rock substrate possibly due to reclamation/excavation works done at other sites at Thilafushi.

The reclamation area under the proposed project is an existing harbor basin, therefore no live coral was observed at the area. While the entrance area is also an existing entrance used by Block 149C and adjacent block at the southern side.

Figure 16 Entrance area condition at harbor of block 149C

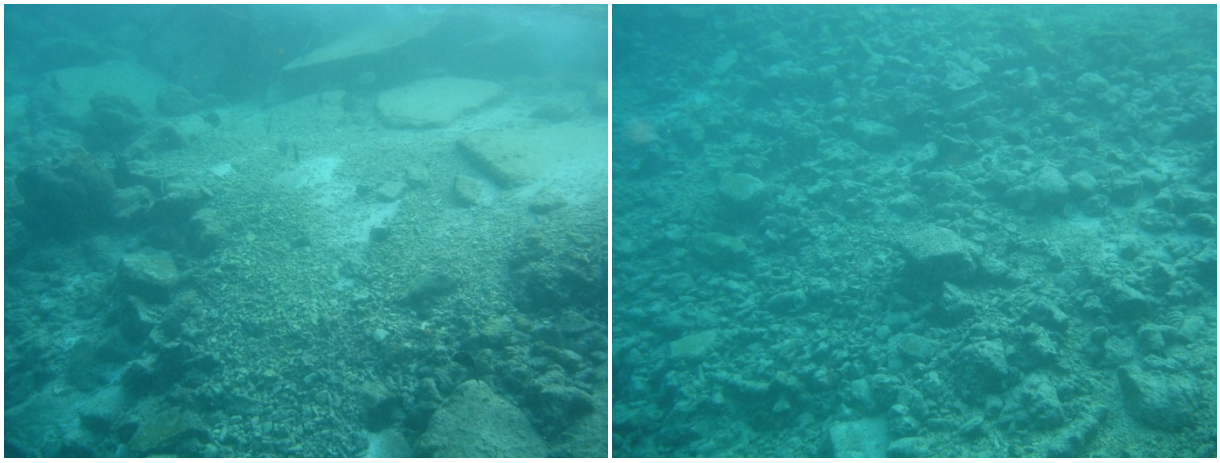

Figure 17 Construction debris at the reef flat area

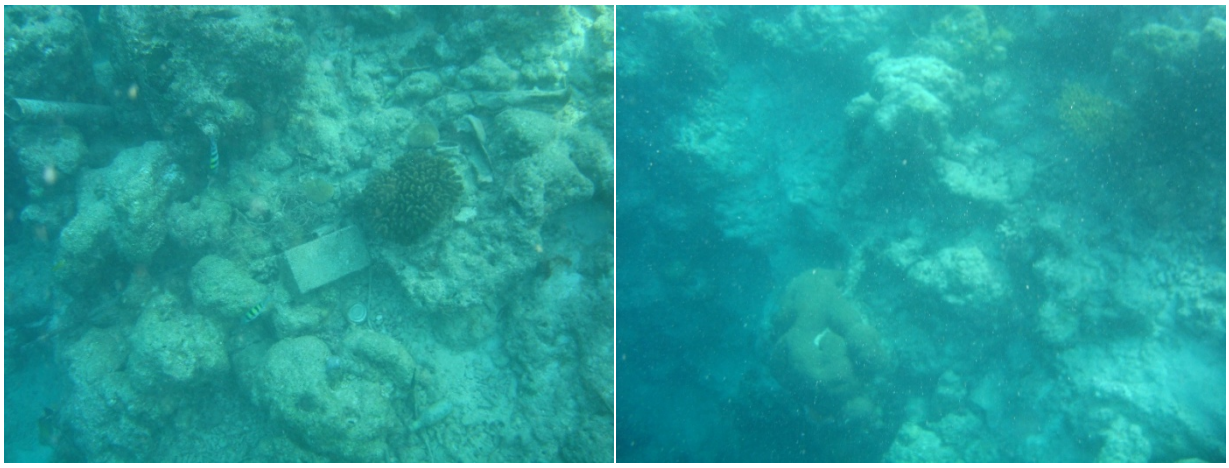

Figure 18 Solid waste observed at the reef flat area (left), few live coral colonies were observed during the reef survey these include laminar and massive forms (right)

iv) Seawater quality

The condition or quality of coastal water is important for ecological functioning of the organisms living in the habitat, for health and safety reasons and also for visual and aesthetic impacts. The water quality is generally determined by the level of nutrients. There are several sources that can lead to increased nutrients in coastal waters, e.g. sedimentation and terrestrial storm water runoff. Sediment stirrup can also lead to release of nutrients within the sediments especially when there is large scale excavation and dredging involved. Thilafushi reef area has almost sustained reclamation or dredging works past couple of years for harbor or other facilities development by different commercial companies. Also recently large scale reclamation works have been carried out at adjacent reef (Gulhifalhu), therefore seawater quality at the reef area is not pristine.

Seawater sampling location is provided in Figure 3. A list of parameters tested and their values are given in Table 5.

Table 5 Seawater quality parameter tested and their results at the sampling location at Thilafushi. Data analysis was carried out by the National Health Laboratory, Maldives Food and Drug Authority and using portable water test probe Hanna Multi-probe water test kit

Parameters	**W1**
Physical appearance	Clear with suspended particles
Temperature (°C)	27
Salinity (mg/l)	37200
pH	8.4
Turbidity (NTU)	0
Suspended solids (mg/l)	23
Nitrite (mg/l)	0
Nitrate (mg/l)*	-
Phosphate (mg/l)*	-
Dissolved oxygen (mg/l)	6.0
BOD (mg/l)	16

* Test that were available at NHL due lack of reagents

7. Environmental Impacts

Impacts on the environment from various activities of the project works have been identified through consultation with design engineers, field data collection and surveys and based on past experience in similar development projects. Possible impacts arising from the construction and operation works are categorized into reversible and permanent (irreversible) impacts. The impacts identified are also described according to their location, extent (magnitude) and characteristics. Reversible and irreversible impacts are further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken. Below are the impact categories (Table 6).

Table 6 Impact prediction categorized

Impact category	Description	Reversible/ irreversible	Cumulative impacts
Negligible	the impact has no significant risk to environment either short term or long term	Reversible	no
Minor	the impact is short term and cause very limited risk to the environment	Reversible	no
Moderate	Impacts give rise to some concern, may cause long term environmental problems but are likely short term and acceptable	Reversible	May or may not
Major-	impact is long term, large scale environmental risk	Reversible and Irreversible	Yes, mitigation measures has to be addressed

The project involves modification of existing harbor facility at Thilafushi Block 149C. The coastline and reef area of Thilafushi has undergone major modifications over the years after establishing the island as an industrial island. At present a number of alongside berths and harbors are built at Thilafushi catering for different industrial and commercial uses. Therefore the project area is not a pristine environment. It has to be noted that major excavation/reclamation works are done at Thilafushi and adjacent reef (Gulhifalhu which has far greater environmental impacts).

The severity of impacts is predicted by reviewing the design plans and construction methodologies and resources exposed to the impact. Mitigation measures are formulated in light of the information revealed by the project design engineers based on construction method, excavation method and equipment or machinery used.

a) Limitation and uncertainty of impact prediction

Most of the developments at Thilafushi have been done prior to EIA regulation enforcement or without EIAs, therefore baseline data is not available. Since Thilafushi reef system is already heavily dredged and impacted by other activities, it is not certain to monitor impacts in relation to proposed project. Water quality impacts are also uncertain even during and operational stage of the project since activities at other areas of Thilafushi may also cause water quality degradation.

b) Construction Impacts

Any development work involving excavation or dredging will have major impacts on reef and lagoon. The Impacts of excavation can range from smothering of live coral to kill of live coral. Since the project site is already heavy modified and impacted by other activities construction impacts is thought to be minor:

- Maintenance dredging works at the harbor basin and entrance channel
- Piling works at berth area and sheet piling works at basin

i) Schedule, logistics and loading and unloading construction materials

All construction materials will be transported to the site on cargo *dhonis* and barges and unloaded at the existing harbor basin. Material unloaded will be stored at the already bare area (already reclaimed land at block 149C). Initially heavy machinery for excavation works will be mobilized, once excavation works are completed, piling and sheet piling works will be carried out. After wards filling o reclamation area will be commenced. Impacts arising due to mobilization and unloading of materials include;

- Accidental spillage of construction materials (cement bags, rocks)
- Accidental oil spills (used for excavators and other heavy machinery)

Since the project site is already polluted by construction debris and other solid waste, it is thought that impact of mobilization and loading/unloading works will have minor impacts. Since existing basin will be used, additional impacts to reef or lagoon will be minor.

ii) Impacts due to construction methods

Since excavators will be used for the maintenance dredging works, sedimentation is inevitable and this is an impact that will be unavoidable. But it has to be noted that Thilafushi has undergone major coastal developments and some are ongoing, therefore these impacts are not limited to block 149C. Also it has to be noted that major reclamation work has been done at adjacent reef close to project area (Gulhifalhu reclamation works). Major environmental concerns associated with dredging and reclamation works are direct habitat loss, sedimentation and deterioration in water quality. High levels of sedimentation and silt from dredging activities is a major source of reef degradation. The consequences of excessive sedimentation on corals are well known and include:

- direct physical impacts like smothering of corals and other benthic reef organisms,
- reduces light penetration, which has a direct effect on zooxanthellae photosynthesis and thus the net productivity of corals. It also reduces coral growth, calcification rates and reproduction.
- dredged silt may form false bottoms, characterized by shifting unstable sediments
- silt suspension may increase nutrient release, leading to eutrophic blooms
- silt may act as sink or trap for many pollutants, which are absorbed onto the sediments

Sheet piling works will be done using vibro hammer, therefore vibration impacts will be experienced. Nearest building to project site is approximately 30m away while the distance between nearest building and piling area (alongside berth) is 85m. Since sheet piling area is inside basin, vibration impacts are envisaged to be minor to moderate. Piling works will be done also using vibro hammer (according to design engineer).

Impact on marine environment (physical impacts) due to the proposed project piling works will be minor since reef flat and slope area has very low coral cover. Heavy machinery for piling works will be operated on land side (reclaimed land).

iii) Impact on vegetation

No impact on vegetation is envisaged due to the proposed project.

iv) Dredged material disposal

Dredged material from maintenance dredging works will be temporally stored at the existing reclaimed land at block 149C, until sheet piling works are completed. Since the block is very close to harbor basin, impacts to groundwater due to salt water leaching from dredged spoil will be minor. Core material for reclamation work will be met construction debris from resorts, these will mainly include remains of masonry walls. Since reclamation works will be done after completion of sheet piling works, sedimentation impacts will be minor, since the sheet piles will act as a bund wall stopping the flow of sediment plume.

v) Social impacts, noise and air pollution

The proposed project will cause noise and air pollution primarily due to operation of heavy machinery. Since open burning of waste is carried out at Thilafushi any air quality impact cause by the proposed project would be minuscule in comparison to existing condition. During the field visit, due to wind direction smoke plume from the burning area was passing over Thilafushi southern and eastern side which lowered visibility at project area to less than 50ft.

Same condition is experienced for noise impacts; since Thilafushi is an industrial island, heavy vehicle traffic is high therefore noise pollution at project site will be minor addition to existing ambient noise level.

c) Operational Impacts

Since the project is a restoration project, additional impacts in terms of operation impacts are not envisaged. Although this may be the case, impacts are envisaged during operation of facility;

- degradation of sea water quality accidental spills

i) Degradation of water quality

Since fuel recharge and dispensing will be done at the berth area, possible spills will cause significant impact of the marine environment. Oil spill may be transported to nearby reef depending on current and wind direction causing indirection impact on live coral and fish life.

8. Mitigation Plan

There are a number of actions that can be taken to minimize the identified impacts. Those that are explored below emerged out of the discussions and consultations during this EIA and from the past experience of the consultant (Table 7). Mitigation measures are selected to reduce or eliminate the severity of any predicted adverse environmental effects and improve the overall environmental performance and acceptability of the project.

Table 7 Mitigation measures proposed development works at Thilafushi

Possible Impacts	Mitigation measures	Location	Time frame (Phase)	Impact intensity	Institutional responsibility	Cost (MRF)
Littering on terrestrial and marine environment	Littering, accidental disposal and spillage of any construction wastes should be avoided by pre-planning ways of their transportation and disposal. Careful planning of the work activities can also reduce the amount of waste generated.	Reef flat, lagoon and land	During construction (6 months)	Minor, short term impact	Client	N/A
	During construction of capping beams and pavements, all construction related waste collected stored at project site, and later disposed at Thilafushi waste disposal area	Lagoon, reef flat	During construction (6 months)	Minor	Client / contractor	N/A should be included in the project cost
Loss of habitat, damage or death of coral at the entrance area, berth area	Avoid excavation works beyond the boundary of entrances, set out stakes marking the area for deepening	Reef flat, lagoon	During construction phase (6 months)	Minor impact since already significant sedimentation is observed due various activities done at Thilafushi, also it has to be noted live coral cover is very low at immediate project area	Client / contractor	N / A
	Construction of berth done by excavators or cranes on landward side thereby avoiding possible impacts on reef area (considering operation of excavator on a barge					
	Completing the excavation works within the shortest time frame as possible	Reef flat/basin area	Construction phase (6 months)	Minor/short termed	Client/contractor	N/A
Accidental spills (oil or other material)	Avoid unloading works at berth area during extreme weather conditions	Marine environment	operation al stage	Unpredictable impact (timing)	Client	N/A

9. Alternatives

Since the location of project cannot be changed, alternatives are given for type of quay wall and reclamation works.

a) Quay wall type

The main reason for selecting sheet pile type quay wall is due to need for reduction of construction time. Considering alternatives, a concrete L section pile is an alternative. This type of quay wall will eliminate the use of vibro hammer since driving piles is not required. The disadvantage is additional time required for casting L section piles and space for pre-casting. Therefore due limited time and space available sheet pile method seems appropriate. It has to be noted Thilafushi reef area is already impacted by various development works therefore additional impacts will be minor.

b) Reclamation works

The proposed reclamation method is using construction debris from resorts as core material and dredge spoil from harbor basin maintenance dredging works as topsoil. Alternatives can be sourcing sand from a burrow area (nearby reef or Thilafalhu reef area), considering this alternative sourcing from a burrow area will cause additional impacts of reef which is unnecessary. Also cost of transportation of dredged material from burrow site will be costly. Considering positive aspect of use of construction debris, recycling is a positive impact. Also it is a cheaper option since only transport cost is required. Similar method of reclamation has been used at Thilafushi for reclamation. Therefore the proposed method is thought to be feasible.

c) The no project scenario

If considering the no project scenario, environmental impacts due to sedimentation and suspension of fine silt in the water column can be avoided. Although this maybe the case, reclamation or excavation works carried out at other areas of Thilafushi will still cause sedimentation impacts. Also it has to be noted that Thilafushi reef system is already severely impacted (channel side and inter atoll side around the developed area at Thilafushi) due to various development activities in the past and present.

If "no project scenario" is chosen, financial loss to client is a negative impact. At present lots of difficulties are faced during loading/unloading process at the existing berth area, and if "no project scenario" is selected the client may face not only financial loss but loss of customers. Therefore in terms of economic benefits and sustainability of Block 149C operations, "no project scenario" is not feasible.

10. Monitoring and Reporting

Thilafushi reef system especially at the inter atoll side is severely impacted due to reclamation, dredging and waste disposal works. In this regard reef area near block 149C is almost void of live coral, while the reef flat area is littered with construction debris (used for reclaiming land). Therefore it is not possible to assess and monitor changes to reef health in terms of development work at block 149C. The parameters that can be monitored are water quality (which will also need to be monitored during construction and operational stage, especially if fuel loading and unloading work will be carried out at the berth), vibration levels during piling works and visual assessment of piling area after driving each pile. Commitment letter for financing and carrying out mitigation and monitoring works stated in the EIA report is provided in Appendix 5.

Table 8 Monitoring program and cost

Parameter	Methodology	Sampling frequency	Estimated cost for monitoring
Seawater quality	Water samples sent to Food and drug authority for analysis. Following parameters are to be tested; temperature, turbidity, salinity, TDS, electrical conductivity, pH, Nitrate, Nitrite, Phosphate and Ammonia	Once every two during construction stage and every 3 months afterwards (sampling done at two sites, inside basin and at berth area	Rate per test set USD 100.00
Vibration levels	Using vibration meters which detects vibrations of 0.5-50mm/s. Vibration measurement should be done at the existing quay wall area. Vibration should be within 5mm-10mm/s (BS 5228-4:1992 section 8.4.2)	Data recorded at 10 minute interval per each pile. Log sheet should include pile number, date, time increments and vibration measurement. This log sheet should be sent to EPA along with the monitoring report	Rate USD 2000.00 (includes cost of instrument).
Vibration impacts during piling work	Visual assessment of reef slope area, recording substrate condition near pile using underwater camera (still image) after each pile is driven.	Assessment of pile footing area for each pile after driving works is completed	Rate USD 500.00

11. Conclusions

The proposed project involves construction of a along berth, reconstruction of harbor and reclamation works at block 149C. The alongside berth will be constructed on 600mm diameter piles driven in to seabed to 18m, while the tie beams will be cantilevered at the slope side to attain draft depths for larger vessels. Sheet pile quay wall will be constructed at the harbor area. Reclamation at block 149C will be done at part of existing basin area; while construction debris (core material for reclamation) and dredge spoil from maintenance dredging at basin area will be used for reclamation.

Considering possible impacts due to the proposed project, it has to be noted that Thilafushi is an industrial island which over the years has undergone a lot coastal developments including reclamation, excavation, construction of jetties, docking area, alongside berths, fuel dispensing plat forms…etc. Also the island is still used for waste management of Male' region and from resort (waste includes construction debris among other things).

In conclusion, with due consideration environmental components the project is likely to effect the consultant concludes that the project components and designs are feasible and appropriate mitigation measures are given to correct and minimize unfavorable environmental consequences (considering environmental condition of project area).

Appendices

Appendix 1 Terms of Reference (TOR)

بسم الله الرحمن الرحيم

Environmental Protection Agency

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Fax: 333 5953
E-mail: admin@erc.gov.mv
Website: www.erc.gov.mv

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بسم الله الرحمن الرحيم

Environmental Protection Agency

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EPA

Terms of Reference for Environmental Impact Assessment

The following TOR is based on the points discussed in the scoping meeting held on the 04th November 2010, for undertaking the Environmental Impact Assesment report for Reconstruction of Berth at 149C, Thilafushi.

1. Introduction - Identify the project and specific component s of the project in relation to the proposed reclamation, sheet piling and development. Describe the reclamation, sheet piling and 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– Provide a brief description of the proponent, full description of the relevant parts of the project, using clearly labeled maps, scaled site plan. This is to include: the project boundary, location and size of reclamation and burrow sites. Number of vessels and size of vessels that would be used at the berth, depth of the berth, area of sheet piling, sheet piling methods and extension of excavation. In addition to this project inputs and outputs shall be provided. Also include work method for dredging, reclamation and sheet piling, source and volume of sand needed for reclamation and a project schedule. The boundaries of the study area for the EIA shall be provided. The details of the operations of the project site should also be included,

Task 2. Description of the Environment Where baseline data is to be collected, careful consideration shall be given to the methodologies of sampling and surveying. Data collection shall focus on key issues needing to be examined for the EIA. Consideration of likely monitoring requirements shall be borne in mind during survey planning, so that the data collected can be used as a baseline to monitoring impacts.

Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area and shall include:

a) Physical environment:
- *Meteorology (rainfall, wind, wave and tides) in the context of the two monsoon seasons in Maldives.*
- *Bathymetric survey of the lagoon for the proposed reclamation area, burrow area and over water based facilities.*

b) Biological environment
- *Marine environmental condition of the reef around the area*
- *Assessment of the reef at the berth, reclamation area and burrow sites and vicinity*

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- *Marine water quality of the proposed area. The seawater quality parameters shall be; temperature, turbidity, salinity, total suspended solids, electrical conductivity, pH, Nitrate, nitrite, phosphate and ammonia.*

The extent and quality of the available data shall be characterized indicating significant information deficiencies and any uncertainties associated with the prediction of impacts. All available data from previous studies, if available shall be presented.

All survey locations shall be referenced with Geographic Positioning System (GPS). 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. Project Setting - Describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project.

Task 4. Determine the Potential Impacts of the Proposed Project- Identify impacts related to the work in relation to their size, scale and duration. Distinguish between significant impacts that are positive and negative, direct and indirect, and short and long term. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making. This should include impacts of reclamation, dredging (burrow sites and berth) and sheet piling.

Task 5. Analysis of Alternatives to the Proposed Alterations to the Project. – Describe the alternatives examined for the proposed alterations that would achieve the same objective including the "no action" alternative. Distinguish the most environmentally friendly alternatives.

Task 6. Mitigation and Management of Negative Impacts- Identify possible measures to prevent or reduce significant negative impacts from implementation of the proposed activities to achieve the project objectives. Cost of the mitigation measures, equipment and resources required to implement those measures also should be included.

Task 7- Stakeholder Consultation - Specific stakeholder and community consultations shall be made with Thilafushi Development Cooperation and neighboring establishments. The discussions held at the scoping meeting can also be used as a part of consultation.

Task 8. Development of a Monitoring Plan- Identify areas and issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan during and after completion of the proposed project. Details of monitoring programme including frequency, duration and Cost commitment to the mitigation measures must be included with equipment and resources required to implement those measures. Detailed reporting time table and ways and means of undertaking the monitoring programme must be provided.

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

……

21st December 2010

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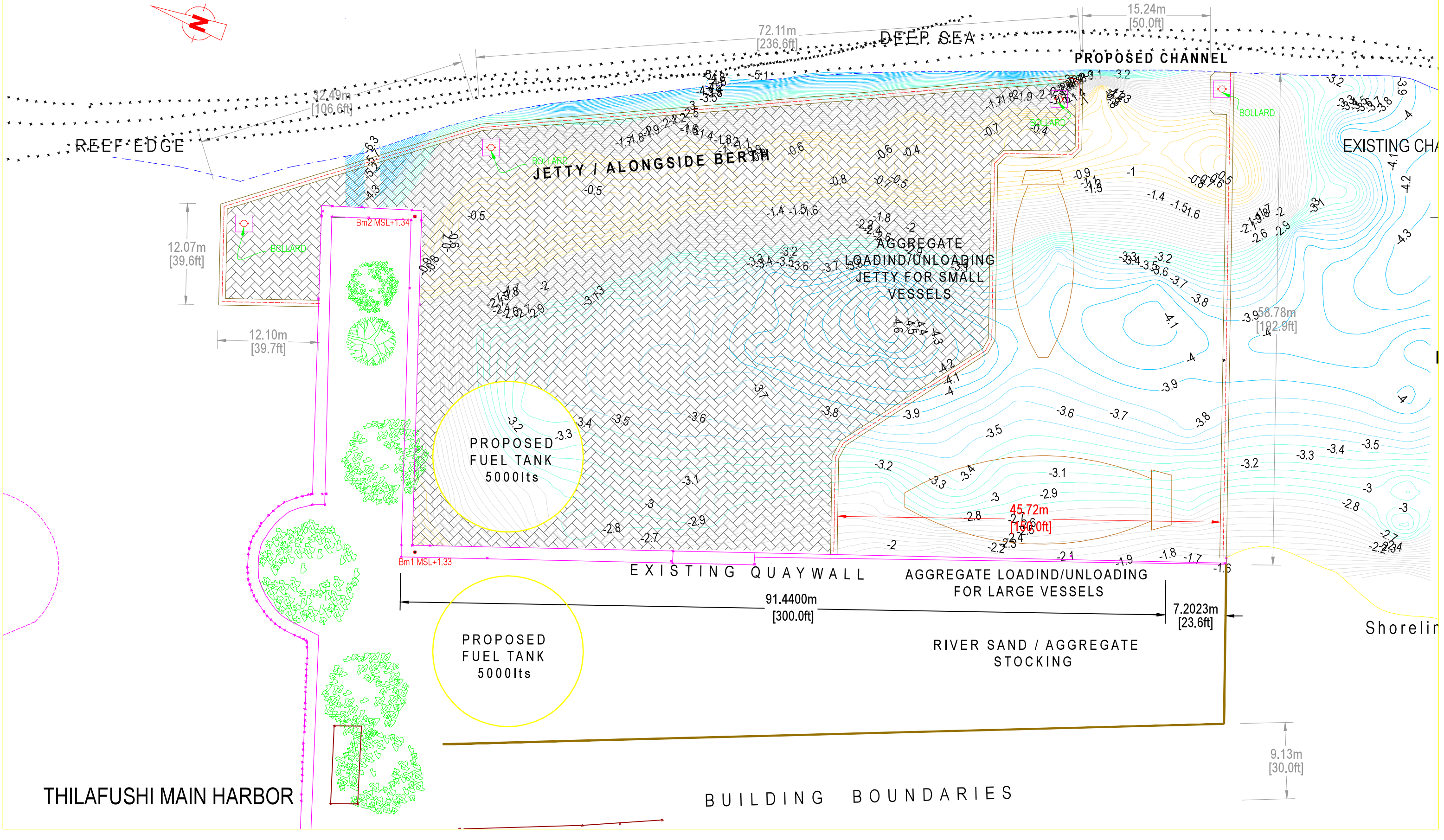
Appendix 2 Site Plan

PROPOSED JETTY CONCEPT

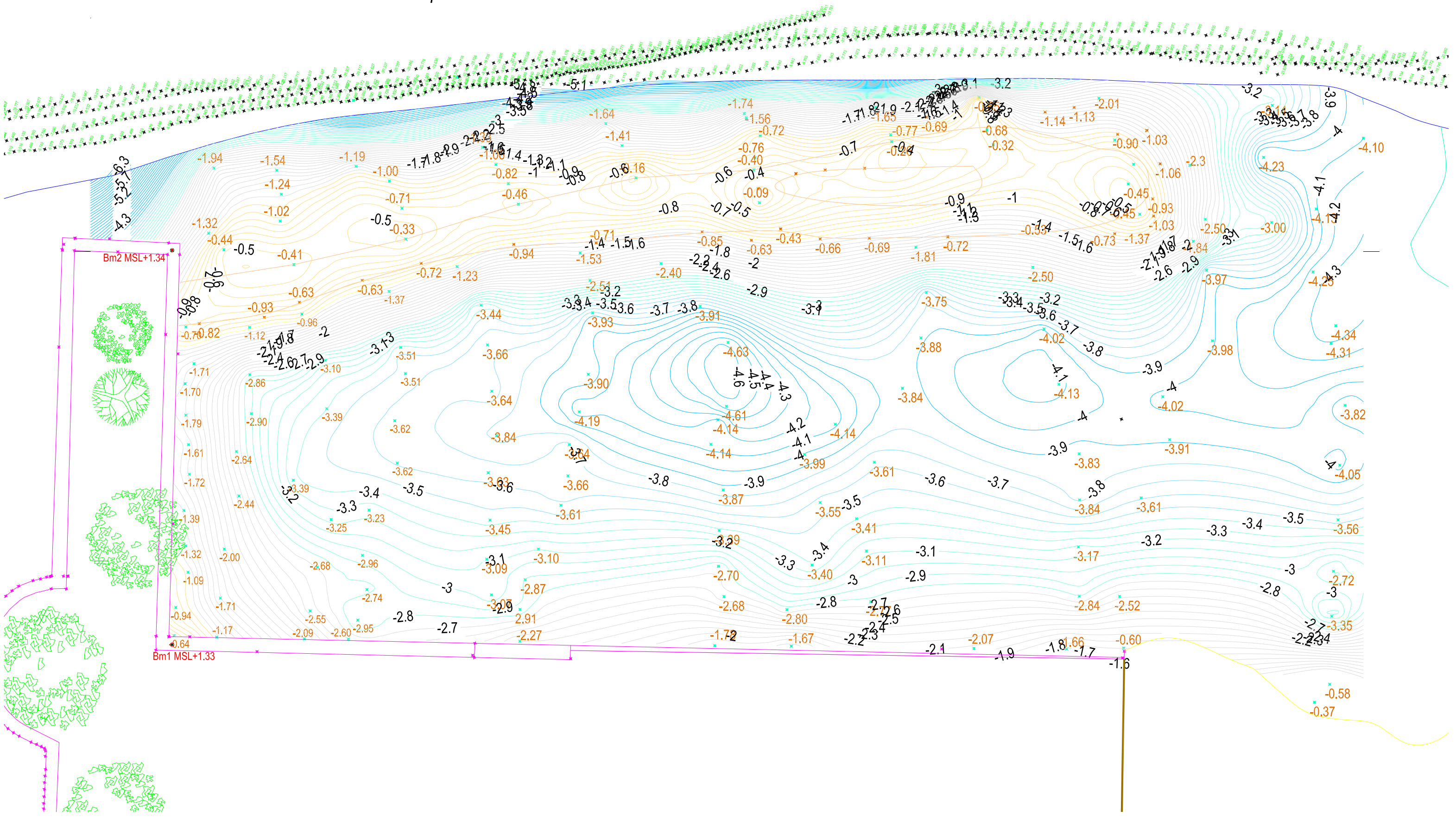
Resort Garbage Harbor - THILAFUSHI.



BATHYMETRIC SURVEY

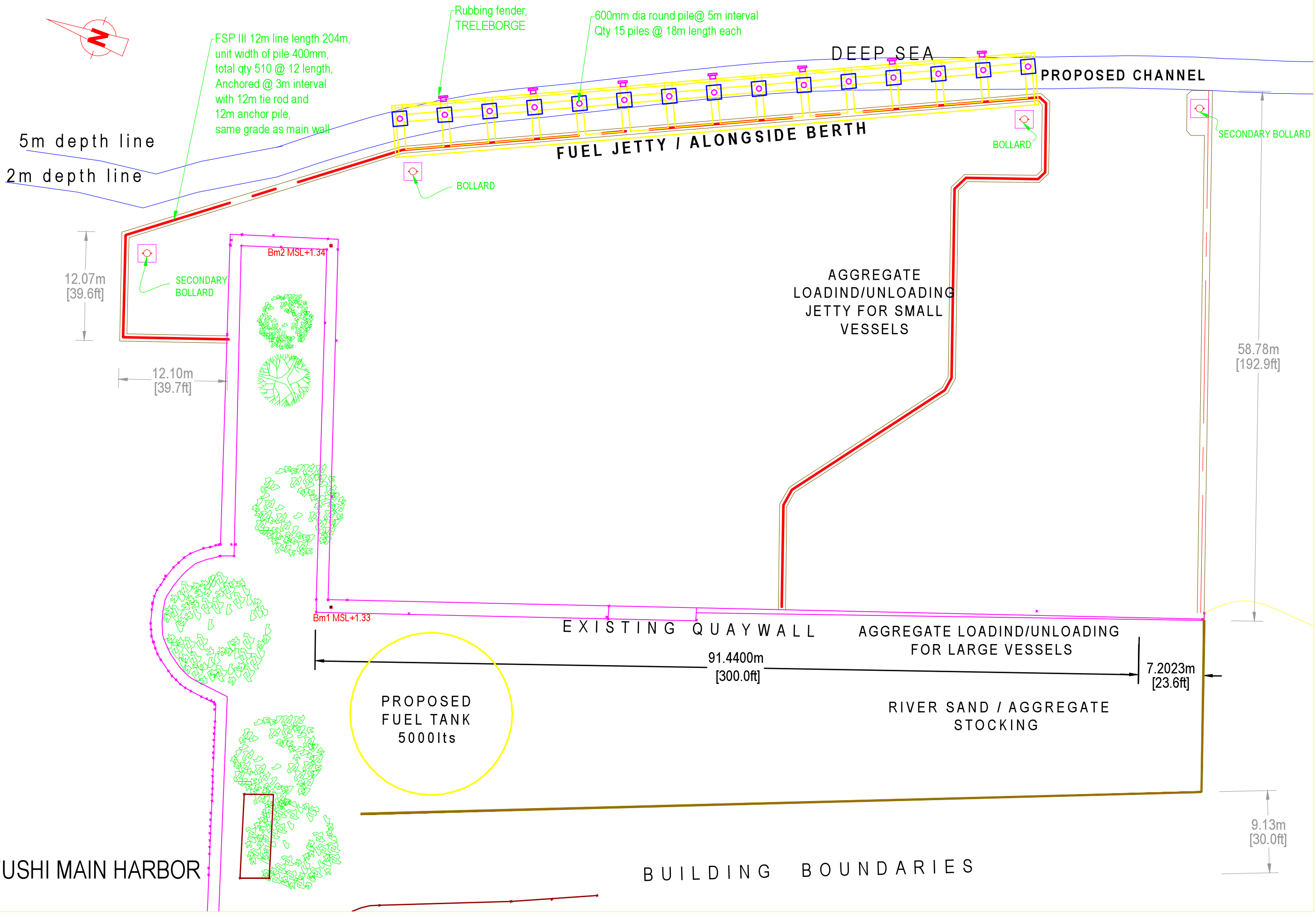
Resort Garbage Harbor - THILAFUSHI.

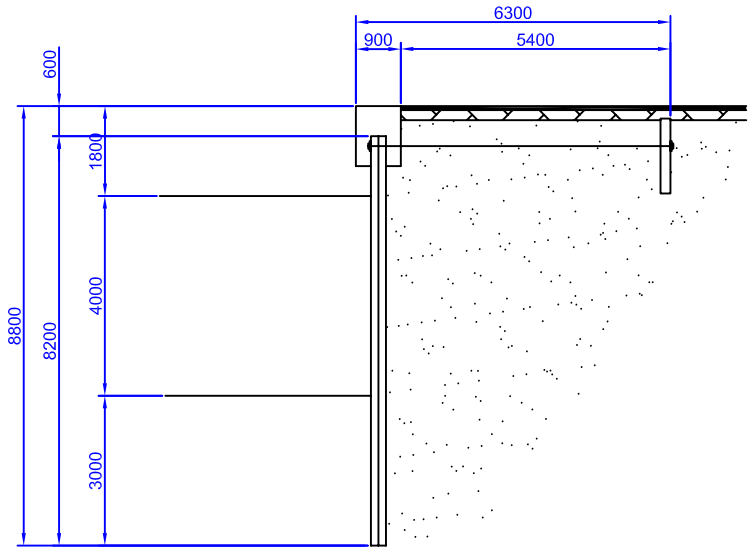
NOTE : All depths are related to Mean Sea Water Level in meters.



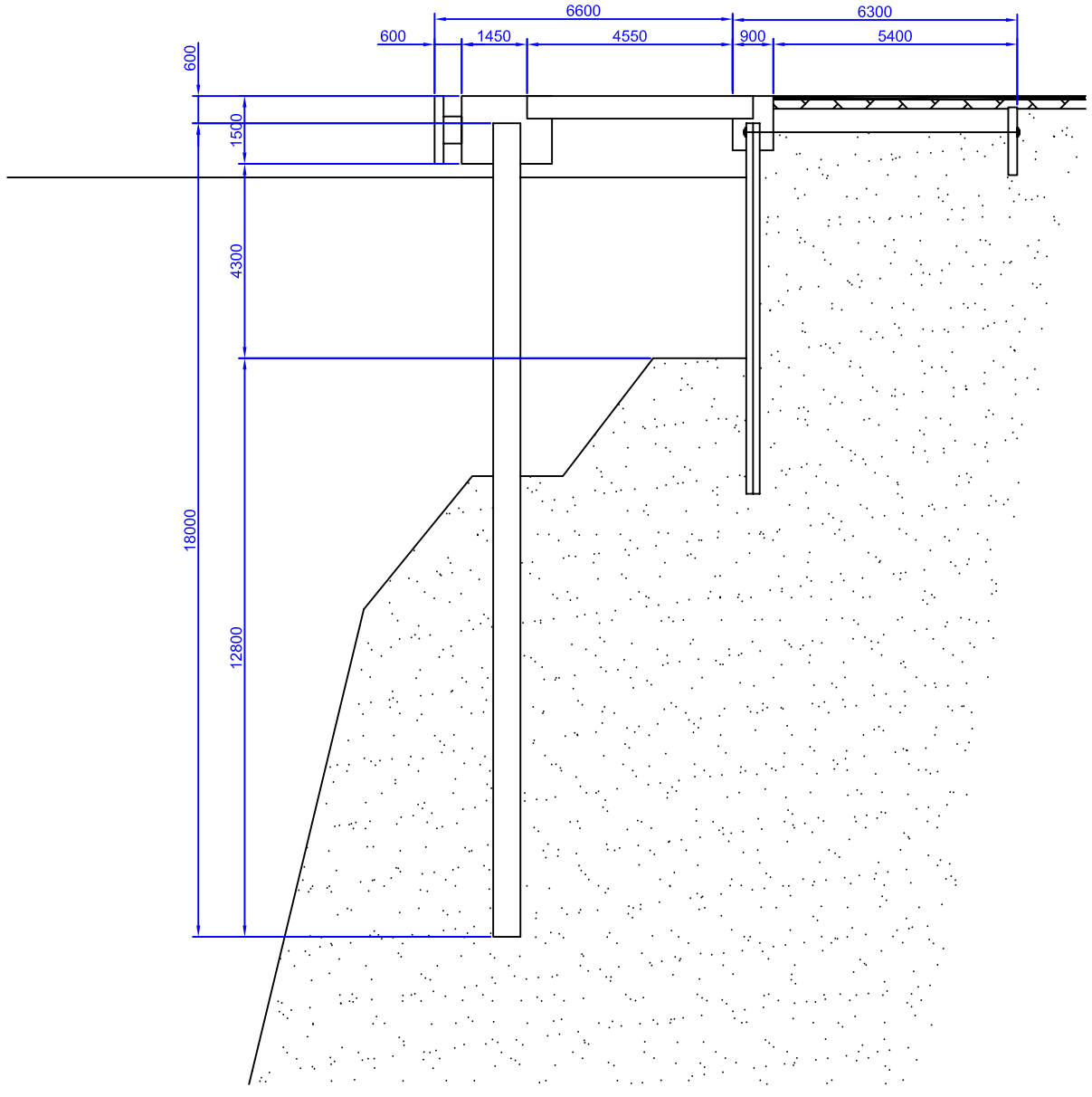
Appendix 3 Pile details

PROPOSED FUEL JETTY CONCEPT
THILAFUSHI.





Section at Unloading Jetty
for Small and Large Vessels



Outer Alongside Berth

Appendix 4 No objection letter from Thilafushi Corporation Limited

THILAFUSHI
CORPORATION

Ref: TCL/OPER/11/1004
Date: 9th January 2011

Mr. Ahmed Shahir
M. Furahani,
Male'.
Republic of Maldives

Dear Sir,

Referring to your letter dated 3rd January 2011; we have no objection of you carrying out the necessary preparatory works including the Environment Impact Assessment (EIA) to develop the land (land No. 149C) leased to you. You must present a copy of the approved EIA and obtain an approval from TCL before starting physical works.

Thanking you

Yours Sincerely,

Ahmed Sofwan
Manager, Operations

Appendix 5 Commitment letter

January, 03rd 2011

Mr. Mohamed Zuhair
Director General
Environmental Protection Agency
Male, Republic of Maldives

Dear Sir,

PROJECT: **BERTH AT 149C BLOCK, K. THILAFUSHI**
SUB: **MITIGATION MEASURES AS PER EIA REPORT**

I confirm to carry the mitigation measures and monitoring stated in the EIA with my own finance in relation to the development of 149C Block at K. Thilafushi.

With warm regards

Ahmed Shahir
M. Furahani
7771012

Appendix 6 References

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Naseer, A. and Bruce, G. H. (2004). Inventory of the Maldives coral reefs using morphometrics generated from Landsat ETM+ imagery. Coral Reefs.

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Appendix 7 CVs

بسم الله الرحمن الرحيم

CURRICULUM VITAE

1. POSITION: Environmental Specialist/EIA Consultant

2. NAME OF FIRM: LaMer Group

3. NAME: Hussain Zahir

4. DATE OF BIRTH: 10th February 1966

5. NATIONALITY: Maldives

6. EDUCATION:

Masters of Philosophy (MPhil) in Coral Reef Ecology
University of Newcastle upon Tyne. Newcastle Upon Tyne, United Kingdom
2006

Marine Biology B.Sc. (Hon)
University of Newcastle Upon Tyne.
Newcastle Upon Tyne,
United Kingdom
1993-1996

7. MEMBERSHIP OF PROFESSIONAL SOCIETIES:

8. OTHER TRAINING:

1988. Marine Science Institute, University of Philippines
Certificate of completion of training course on Scleractinian Coral Taxonomy

1989. Chulalongkorn University. Bangkok. Thailand
Certificate of Completion of training Course on Coral Taxonomy, Ecology and Management

1998 Okinawa International Centre, Okinawa, Japan
Certificate of participation on training course on Conservation and Sustainable Management of Coral Reefs

1999 Korean Research and Development Institute, Seoul, South Korea
Certificate of Completion of the Training Course on marine coastal zone conservation and management

1990. Department of Marine Sciences. Chulalongkorn University. Bangkok. Thailand
Workshop on Taxonomy of Soft Bottom Invertebrates (ASEAN-Australian Coastal Living Resources Project)

1991. Mc Master University, Hamilton, Ontario. Canada.
Training on Boring Sponges of Coral reefs in Maldives

1996 Turtle Specialist Group, Convention on the Conservation

of Migratory Species of Wild Animal (CMS) and government of India. Bhubaneshwar, India

Workshop and Strategic Planning Session for the Conservation of Sea Turtles of the Northern Indian Ocean

1999. United Nations Environment Program. Environment for South Asia and Pacific, organized by SACEP and Ministry of Home Affairs, Housing and Environment.

National Training for State of the Environment and Data Collection and Reporting

9. COUNTRIES OF WORK EXPERIENCE:

10. LANGUAGE AND DEGREE OF PROFICIENCY:

Dhivehi -Mother Tongue
English -Proficient

11. EMPLOYMENT RECORD:

Nov 2007- Present	Senior Reef Ecologist Marine Research centre, Ministry of Fisheries Agriculture and Marine Resources Male', Maldives.
Feb 2006- October 2007	Reef biologist Marine Research centre, Ministry of Fisheries Agriculture and Marine Resources Male', Maldives.
July 2001- January 2006	Senior Research Officer Marine Research centre, Ministry of Fisheries Agriculture and Marine Resources Male', Maldives.
June 2000 to Present	Marine Biologist/ Director (Part Time) Land and Marine Environmental Resource Group of Pte Ltd
July 1996 to July 2001	Research Officer Marine Research Centre , Ministry of Fisheries Agriculture and Marine Resources
1988 to 1992	Biological Aid Marine Research Centre , Ministry of Fisheries Agriculture and Marine Resources
1986 to 1988	Marine Research Centre , Ministry of Fisheries Agriculture and Marine Resources Trainee

12. DETAILED TASKS ASSIGNED:	WORK UNDERTAKEN THAT BEST ILLUSTRATES CAPABILITY TO HANDLE TASKS:
Marine Research Centre, Ministry of Agriculture and Marine Resources	**National coordinator of Global Coral Reef Monitoring Network** *Responsibilities:* Including Implementation and management of the programme activities in the country through the GCRMN Regional Node for south Asian Region in Srilanka. Current programme of activities include, establishing and monitoring of coral reefs to assess the recovery processes after the 1998 Bleaching and to monitor the temporal changes to the reef system. Responsibilities also include coordination and implementation of socioeconomic monitoring at designated pilot sites to asses the livelihood and their dependence on coral reef resources. Coordinating the establishment national reef database to share information at national, regional, and global level is also part of the program of activities. **Coral Reef Degradation in the Indian Ocean (CORDIO) Programme** *Responsibilities:* include implementation and management of the identified projects/ Studies funded by CORDIO. Currently involved biophysical studies designed to understand the reef recovery processes after a severe disturbance in coral reefs **Catalogue of Common Coral Reef of Maldives, 1996** *Year: 1996* *Location:* Maldives.
Task Undertaken Independent Consultant	**Initial Environmental Evaluation, Tsunami Emergency Assistance Project, Maldives** *Year: 2006* *Location:* Ha. Filladhoo, HDH. Nolhivaranfaru, Sh. Maroshi, N. Maafaru, DH. Meedhoo, M. Kolhufushi and Th. Madifushi, Maldives *Client: ADB* *Project features:* Rehabilitation of damaged infrastructures (electricity)due to the tsunami of December 2004 in the Maldives financed by ADB under Tsunami Emergency Assistance project *Positions held:* Domestic Environmental Specialist *Responsibilities:* Initial Environmental Evaluation for the Repair and Reconstruction of Diesel powered generator housed in the above 7 island communities. Environmental issues specific of diesel power generation in the local and national context were addressed following ADB environmental guidelines. I **Initial Environmental Evaluation, Tsunami Emergency Assistance Project, Maldives** *Year: 2005* *Location:* Ugoofaaru, Manadhoo , Dhidhdhoo, Maldives *Client: ADB* *Project features:* Rehabilitation of damaged infrastructures (harbours)due to the tsunami of December 2004 in the Maldives financed by ADB under Tsunami Emergency Assistance project *Positions held:* Domestic Environmental Specialist *Responsibilities:* Initial Environmental Evaluation of the project sites; Ugoofaaru, Manadhoo and Dhidhdhoo for the tsunami

emergency assistance project: TA-0001 (MLD). Specific Task include rapid environmental assessment of the project sites, prepare environmental evaluations based on filed data and community Consultants, predict environmental impacts and propose an environmental monitoring plan for the project activities.

Marine Biodiversity assessment, Faafu atoll, Maldives,
Year: 2003
Location: Faafu atoll, Maldives
Client: ADB
Project features: Identification of potential biodiversity hotspots (sites/species) as part of identifying priority areas for an MCPA planning project funded by ADB. Project involves assessment of socioeconomic and biophysical assessment of the short listed sites identified for the project.
Positions held: Biodiversity Environmental Specialist
Responsibilities: Marine Biodiversity assessment Faafu atoll Maldives. ADB regional technical assistance for coastal and Marine resource management and poverty reduction in south Asia. (ADB RETA 5974). A project implemented by Ministry of Fisheries, Agriculture and Marine Resources. Assignment involves detail preparation of marine biodiversity and Coastal management issues with special reference to grouper fishery and resource management.

Environmental Impact Assessment Report for the Development of Fish Processing Plant at Ha. Huvahandhoo, Maldives,
Year: 2002
Location: Maldives
Client: Jausa Fishery Links
Project features: Construction of a tuna processing plant
Positions held: Marine Biologist
Responsibilities: The EIA report involves collection and assessment of baseline and secondary environmental data both at the marine and terrestrial environment of the project site. It also involved a risk assessment and evaluation report. An environmental management plan was also developed as part of the EIA.

Task Undertaken as an employee o f Land and Marine Environmental Resource Group Pte Ltd

Replacement of wastewater collection, septic tanks and disposal systems in Ga.Villingili, Ga.Dhaandhoo, Gdh.Gahdhoo
Year: 2007-Ongoing
Location: Ga.Villingili, Ga.Dhaandhoo, Gdh.Gahdhoo
Client: American Red Cross
Project features: Design and construction of wastewater disposal systems in the specific islands
Positions held: EIA Specialist
Responsibilities: Environmental Impact Assessment research and analysis.
Preparation and submission of the Environmental Impact Assessment Report.

Environmental Impact Assessment for Reethi Rah Resort Redevelopment
Year: 2005
Location: Reethi Rah Resort
Client: Kersner International, Hotel Group
Resort development at Reethi Rah Resort
Positions held: Marine Biologist
Responsibilities: The EIA involves collection and assessment of baseline and secondary environmental data and marine and terrestrial environment of the project site. This is one of the largest reclamation project for resort development and assessment of impact of dredging and reclamation on the coastal marine habitats was a major component of this study

Environmental Impact Assessment Report for Villa Hakatha at Thilafushi, Male Atoll
Year: 2001
Location: Male Atoll
Client: Villa Hakatha,Maldives
Positions held: Project Biologist
Responsibilities: The EIA report involves collection and assessment of baseline and secondary environmental data both at the marine and terrestrial environment of the project site. It also involved a risk assessment evaluation report. An environmental management plan was also developed as part of this EIA.

Development at Baa. Landaagiraavaru, Maldives
Year: 2000
Location: Baa. Landaagiraavaru, Maldives
Client: Club mediterranee *Project features:*
Positions held: Project Biologist
Responsibilities: The EIA involved collection of Oceanographic data, Study of the beach environment, Vegetation, reef quality and reef water quality. The study examined the impacts of the island and mitigation measures where appropriate. The study also forms the baseline data for future monitoring of the environmental changes due to the resort development

Environmental state for the proposed channel dredging & associated Barrier Island at Sun Island Resort.
Year: 2000
Location: Sun Island Resort, Maldives
Client: Tekton Design Associates Pvt. Ltd
Positions held: Project Biologist
Responsibilities: The Study involved assessment of the potential environmental impact on the coastal shoreline of the island and on to the reef environment within close proximity of the proposed project site.

Tasks undertaken as an employee of Riyan Design and Management Pte Ltd

Environmental Statement for the Proposed Redevelopment of Reethi Rah Resort
Year: 2000
Location: Reethi Rah Resort
Client: Reethi Rah Resort
Positions held: Project Biologist
Responsibilities: This Study Involved assessment of the existing

status of the islands environment and identification of potential environmental impact areas related to the proposed redevelopment plans. Formulation of an environmental monitoring plan that would enable the client to record the environmental changes that may be related to anthropogenic activities or natural.

Environmental Statement for the Proposed Redevelopment of Reethi Rah Resort
Year: 2000
Location: Reethi Rah Resort
Client: Reethi Rah Resort
Positions held: Project Biologist
Responsibilities: This Study Involved assessment of the existing status of the islands environment and identification of potential environmental impact areas related to the proposed redevelopment plans. Formulation of an environmental monitoring plan that would enable the client to record the environmental changes that may be related to anthropogenic activities or natural.

Proposed Beach Nourishment at M. Medhufushi. An assessment of Environmental Design Parameters
Year: 2000
Location: M.Medhufushi
Client: Vaaly Brothers Pte.Ltd
Positions held: Project Biologist
Responsibilities: The study involved examination of the beach characteristic
Including the sediment properties, beach profiles. Identification of a borrow site by Comparing the borrow sediment characteristics of the borrow site and the native beach sand.

Environmental Evaluation of Small-bore Sewer System (SBS) in Lh. Hinnavaru and K. Gulhi
Year:1999
Location: Lh. Hinnavaru and K. Gulhi
Client: Maldives Water and Sanitation Authority
Project features: The Study Involved ground water/ Seawater analysis of sewage pollution; reef surveys hydro graphic /oceanographic surveys and survey of the slopes of the sewage lines.
Positions held: Project Environmental Analyst

Assessment of Oil Contamination in Male' Groundwater from Vehicle Garages and Petrol Stations.
Year:1999
Location: Male', Maldives
Client: Maldives Water and Sanitation Authority
Positions held: Project Environmental Analyst
Responsibilities: The study involved Ground water analysis of oil contamination and assessment of general working conditions and practices in the vehicle garages and petrol stations in male'.

Environmental Impact Statement for the Proposed Beach Protection Works at Nika Island Resort
Year:1999

Location: Male', Maldives
Client: Nika Island Resort
Positions held: Project Biologist
Responsibilities: The project involves assessment of physical environmental condition such as the wave, current sediment characteristics, bathymetry at the project site (Nika Island Resort). Assessment of the status of the reef at the project site and an evaluation of the possible impacts on the reef and the physical environment as a result of the proposed beach protection work.

Environmental Monitoring of F. Filitheyo Resort Development
Year:1999
Location: F.Filitheyo
Client: AAA Trading Company Pvt.Ltd
Positions held: Project Biologist

Environmental Monitoring of M. Medhufushi Resort Development
Year:1999
Location: M. Medhufushi, Maldives
Client: Vaally Brothers Pte Ltd
Position Held: Project biologist

Environmental Monitoring of Lh. Kanuhuraa, Maldives
Year:1999
Location: Lh. Kanuhuraa
Client: SIMDI Hotel Management Pte Ltd
Positions held: Project Biologist

Environmental Monitoring of R. Meedhupparu Resort Development
Year:1999
Location: R. Meedhupparu
Client: Cowrie Investment Pvt Ltd, Maldives
Positions held: Project Biologist
Responsibilities: The Monitoring programmes involved periodic measurements of the beach profiles around the islands, reef quality surveys, ground water/ seawater analysis and environmental auditing

Tasks Under Taken as a Freelance Consultant

Environmental impact Assessment for the F. Filitheyo Resort Development
Year:1998
Location: F.Filitheyo
Client: AAA & Trading Company, Maldives
Positions held: Project Biologist

Environmental Impact Assessment for Lh. Madhiriguraidhoo Resort Development
Year:1997
Location: Lh. Madhiriguraidhoo
Client: Guardian Agency Pte Ltd
Positions held: Marine Biologist

Environmental Impact Assessment for B. Fonimagoodhoo Resort Development
Year:1997
Location: B. Fonimagoodhoo, Maldives
Client: Thasmeen Ali, M. Sheeraazeege, Maldives
Positions held: Marine Biologist

Environmental Impact Assessment for M. Hakuraahuraa Resort Development
Year:1997
Location: M. Hakuraahuraa
Client: Fantasea Pte Ltd, Maldives
Project features:
Positions held: Marine Biologist
Responsibilities: The EIA studies Involved collection of oceanographic data studies of the beach environment, vegetation, reef quality and ground water / Seawater quality. These studies examined the impacts of the development on the island and mitigation measures where appropriate. The studies also form the baseline data for the future monitoring of the environmental changes due to the resort development

13. Certification:

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications, and my experience. I understand that any wilful misstatement described herein may lead to my disqualification or dismissal, if engaged.

_____ Date: 7 May 2008
[*Signature of staff member or authorized representative of the staff]* *Day/Month/Year*

Full name of staff member Hussain Zahir
Full name of authorized representative:

بسم الله الرحمن الرحيم

CURRICULUM VITAE

1.	**POSITION:**	Geotechnical specialist
2.	**FIRM:**	Riyan Pte. Ltd
3.	**NAME:**	Ismail Ibrahim
4.	**DATE OF BIRTH:**	31st March 1965
5.	**NATIONALITY:**	Maldivian
6.	**EDUCATION:**	PHD Program, Geotechnical Engineering/Construction Management, University of British Columbia, Vancouver Canada, Jan 2004 – Present Master of Engineering Science in Civil Engineering Majoring in Geotechnical Engineering, University of New South Wales, Australia, 1991-1992 Bachelor of Engineering (Distinction – Civil Engineering) Technical University of Nova Scotia, Canada, 1987- 1990 Bachelor of Engineering University of Prince Edward Isand, Canada, 1985-1987
7.	**OTHER TRAINING:**	2 Day Course on Risk Management National University of Singapore Singapore November 2000 Training Programme on Project Formulation and Appraisal, Ministry of Planning and National Development, Maldives October 1998 - December 1998 International Course on Dredging and Reclamation, Institute for Hydraulics, Environment and Infrastructure, Netherlands/ International Association of Dredging Companies March 1998 Concrete Repair Seminar World of Concrete Singapore February 1997 Seminar on the FIDIC family of Contracts, Male', Maldives

May 1996

8. LANGUAGE AND DEGREE OF PROFICIENCY:

Dhivehi – Fluent (Mother tongue)
English – Fluent
Japanese – JOLPT Level 3

9. MEMBERSHIP OF PROFESSIONAL SOCIETIES:

Member, American Society of Civil Engineers
Graduate Member, Institution of Civil Engineers UK

10. COUNTRIES OF WORK EXPERIENCE:

Maldives
Japan

11. EMPLOYMENT RECORD:

1997 - Present	Director/Civil Engineer, Riyan Design and Management Consultants Male' Maldives

- Responsible for engineering design and supervision and project management for residential development, resorts as well as engineering projects.

2000	Director Engineering, Ministry of Construction and Public Works Male' Maldives
1998 – 2000	Deputy Director, Engineering Ministry of Construction and Public Works Male' Maldives
1995 – 1998	Deputy Director, Projects, Ministry of Construction and Public Works Male' Maldives

- Overall responsibility for the Physical Planning Section of the Ministry of Construction and Public Works (Jan 2000 – Sept 2000)
- Overall responsibility for the Engineering Unit of the Physical Planning Section of the Ministry of Construction and Public Works.
- Responsible for organizational review/institutional strengthening of the Minsitry.
- Responsibility for the design review/assessment and project management for major public sector civil engineering and building projects
- Provision of technical advice on general civil engineering, geotechnical and coastal engineering and construction management to various organizations within the government

- Management of projects as per requirements of multilateral and bilateral funding agencies such as Asian Development Bank (ADB), World Bank, Islamic Development Bank (IDB), Japan International Co-operation Agency (JICA), Danish Development Agency (DANIDA). Mainly used FIDIC Family of Contracts.

- Liaison with counterpart professionals from consultancy firms and contractor organizations on these projects.

- Management and direction of quality control activities of public sector projects through field and laboratory testing

- Site supervision of building and civil engineering works

- Supervision of building approvals (structural stability and strength characteristics) of buildings over two storeys high – on behalf of Maldives Housing and Urban Development Board

- Co-ordination of the revision of the draft National Building Code.

1994 – 1995 Civil Engineer,
Overseas Technical Attachment/North Port
Office Miyazaki Prefectural Government,
Japan

- Site inspection for port expansion projects in Miyazaki Prefecture.
- Quality control of concrete structures.
- Inspection of pre-cast concrete works.
- Inspection of ground improvement works and site investigation works.

1993 – 1994 Civil Engineer (Grade III),
Ministry of Construction and Public Works
Male' Maldives

- Responsibility for the design review/assessment and project management of major public sector civil engineering and building projects.
- Provision of technical advice on geotechnical and coastal engineering issues to various organizations within the government.
- Site supervision for major building and civil engineering projects.
- Review of engineering designs for different projects.
- Development of a draft framework for contract administration of local building projects. -Appraisal of tender documents for various local and international

projects.
- Counterpart engineer for engineering and building projects executed under external funding.

1985 – 1991 Civil Engineer (Grade III)
Ministry of Construction and Public Works
Male' Maldives

- Site supervision for major building and civil engineering projects.
- Review of engineering designs for different projects.
- Counterpart engineer for engineering and building projects executed under external funding.

1984 – 1985 Civil Engineering Trainee,
Ministry of Public Works and Labour
Male' Maldives

- Survey Hand
- Drafting
- Assisting in data collection for various engineering projects

1983 Project Officer Trainee
Ministry of Trade and Industries
Male' Maldives

- Sorting/Assisting in the processing of applications of foreign investment and trade registration in the country

12. DETAILED TASKS ASSIGNED: **WORK UNDERTAKEN THAT BEST ILLUSTRATES CAPABILITY TO HANDLE TASKS:**

II-2, II-4, III-1, III-2, and III-3

Hulhumale' Development Project - Reclamation
Location: Maldives,
Year: 1997 - 2000
Time Spent: about 3 years
Position: Project Engineer and Manager

- *Duties:* Duties included project formulation, equipment procurement for construction (constructed by direct labour for about 3.5 years), counterpart technical support and management of environmental and technical study. Concurrently, as part of the duties as team member to develop a physical development plan for Hulhumale and as the team member responsible for the public utilities, I provided technical advice on some transportation aspects of the plan. The team deliberated on traffic flows and options for road surfaces (asphalt vs. interlocking block pavements).

- Duties also included overall supervision during project implementation (when carried out under direct labour). This included the rationalization and design of access

roads to optimise operations.
- Other duties included the preparation of tender documents and technical advice to contract out physical works of the project to international contractors.

Fuah Mulaku Harbor Project
Location: Maldives,
Year: 1991, 1995-2000
Time Spent: about three years intermittently
Position: Project Engineer and then Project Manager
Duties: Project formulation for pre-feasibility, feasibility, technical study and actual construction of a harbour in exposed conditions. Technical counterpart support for all study and consultancy phases, including model studies and layout studies at Danish Hydraulic Institute. Preparation of bid documents for construction and evaluation/negotiation with winning bidder. These also included pavement works for harbour areas. Duties included the technical and managerial review of all project components. Project identification and formulation of sub-project for road linking main settlement areas to the harbour on the southwest. This task was limited to identifying the need for the road as a project component and preliminary options for alignment and surfacing.

Second Malé Port Project (ADB)
Location: Maldives,
Year: 1993 – 1997
Time Spent: about two and half years intermittently
Position: Project Engineer and then Project Manager
Duties: The project involved the construction of an along-side berth and associated facilities such as approach ramp, mooring bollards etc, as well as the procurement of related equipment As project engineer, duties included the review/checking of design for the client, as well as providing counterpart technical support to the international consultant. Specific technical input was given on pile testing, and pavement design. Local experience on pavement performance from previous stages of port development was incorporated into design. Technical input also extended to assess traffic flows within port area in consultation with port authorities to design pavement profiles appropriate for various functions such as stacking etc, as well as for diverting traffic during construction to minimise disruption to port activities

Malé Seawall Construction Project (Phases I , II, III) (Japanese Bilateral Aid)
Location: Maldives,
Year: 1994- 1996; 1996- 1998 (scheduled)
Time Spent: about 2 years intermittently
Position: Project Engineer /Project Manager for Phase 2
Duties: Responsible for checking and assessing the design as well as for the local construction supervision and co-ordination of the project which involved the construction of seawalls along the west and east coasts of Male' island. Construction of pedestrian footpaths adjacent to the seawall proper was also a project component for which I undertook design review.

Malé Northern Harbour Dredging Project
Location: Maldives,
Year: 1998 - 1999
Time Spent: one year
Position: Project Manager/ Engineer
Duties: As the key professional representing the client, developed the full tender and project documents for bidding. These included technical requirements, and contract conditions. Also supervision of the project to ensure compliance to specifications was undertaken.

Development study for Solid Waste Management in Male' and Vicinity (Funded by Japan International Co-operation Agency)
Location: Maldives
*Year :*1997-1999
Position: Project Manager
Duties: Responsible for co-ordinating the multi-disciplinary aspects of this JICA-funded study. The study covered all operational aspects from collection to disposal as well as engineering issues related to landfill design and shore protection at the final disposal site. A detailed environmental impact assessment study was also conducted as part of the study.

Malé Port Development Project (ADB/UNCDF/OPEC)
Location: Maldives,
Year: 1990-1991
Time Spent: about 8 months
Position: Project Engineer
Duties: Responsible for reviewing design (for the client) for the project which involved the construction of temporary lighter age berths, heavy duty pavements and dredging works. As the local technical counterpart staff, input on the heavy duty interlocking pavements was given and appropriate mix-ratios for the cement-stabilized coral-sand base were developed together with the consultant.

Note: In the project listings above, the timing of projects has been such that more than one project has been handled at any one given time. Also some periods of inactivity had occurred in some projects. Hence the intermittent timing has been indicated

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[*Signature of staff member or authorized representative of the staff]* *Day/Month/Year*

Full name of staff member:
Full name of authorized representative: