ASIAN DEVELOPMENT BANK
TSUNAMI EMERGENCY ASSISTANCE PROJECT

☐ **IEE REPORT**

INITIAL ENVIRONMENTAL EXAMINATION FOR DH.MEEDHOO ELECTRICITY UPGRATION

POWER PROJECT

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Introduction

Tsunami of 26th December 2004 has caused significant damage of the infrastructure of Maldives including electricity in all the impacted islands. Upgrading of the replacement of electricity generating and supply systems in several islands is currently underway through government and international donor assistance. Dh. Meedhoo has been identified as one of the 7 islands for upgrading electrical supply systems funded by Asian Development Bank (ADB).

This Initial Environmental Evaluation (IEE) report thus fulfils the requirements specified in the terms of reference prepared for this project specific to the environmental specialist. In preparing the report consideration has been given to cover the environmental requirements by ADB for these kinds of projects as well as the environmental requirements by the government of Maldives.

This IEE was carried out between 18th and 19th February 2006 during the field visit made to the project site by the by the environmental consultant and other relevant consultants for the project.

Terms of reference

The 26 December 2004 tsunami inflicted widespread damage to the infrastructure and severely affected the living conditions of the people on the outer islands of the Maldives. The rehabilitation and reconstruction efforts on several areas are currently underway through assistance by several international organizations including Asian development Bank (ADB)

ADB's assistance as Tsunami Emergency Assistance Project (TEAP) is to provide the Government of the Maldives with the equipment, civil works, goods and other related services required for the rehabilitation and reconstruction of the tsunami-damaged infrastructure facilities. The Ministry of Environment, Energy, and Water (MEEW), in association with Maldives Electricity Bureau (MEB) has selected 7 islands for rehabilitation/reconstruction of the power stations under the Project. The designs for the 7 power stations have been completed under a separate contract awarded by MEB and financed by the Government and are currently in the process of preparation of tenders for submission to the Tender Evaluation Board (TEB). In order to thoroughly examine each of the 7 power stations, additional studies are necessary to be carried out that include: (i) an initial environmental evaluation (IEE) and if required an EIA, (ii) a socio-economic assessment, and (iii) an economic and financial analysis for each power station. In order to carry out the additional studies, consulting services are required to

assist the Government and ADB. During the study period, the consultant will be administered by ADB HQ and assisted, as required, by ADB's Extended Mission in the Maldives (EMM).

Detailed tasks and specific activities carried out by the environmental specialist specific activities to be carried out during the project include, but are not limited to:

1. Preparation of the initial environmental examination (IEE), and if required an EIA, for the 7 power stations; This will include a description and location of each station (maps, aerial photographs, satellite imagery), description of the environment, screening of potential environmental impacts and mitigation measures, institutional requirements, public consultation and information disclosure, findings and recommendations, and conclusions.

2. Preparation of the environmental monitoring and management plans for each power station;

3. Inclusion of clauses in the tender documents that are directly related to the environment and mitigation measures required of the contractor and to be followed explicitly by the contractor, or others, in order to monitor the environmental aspects during construction.

Project description

This project involves construction of a new powerhouse for the island community as a replacement of the existing powerhouse which provides electricity to the island which is managed by Island Development Committee (IDC).

As part of the new facility three diesel generator sets with total capacity of 280KW, a control room with automatic switching control panel, an office and billing area and an accommodation facility will be provide. In addition fuel and water storage tanks will also be constructed as part of the project (figure 1).

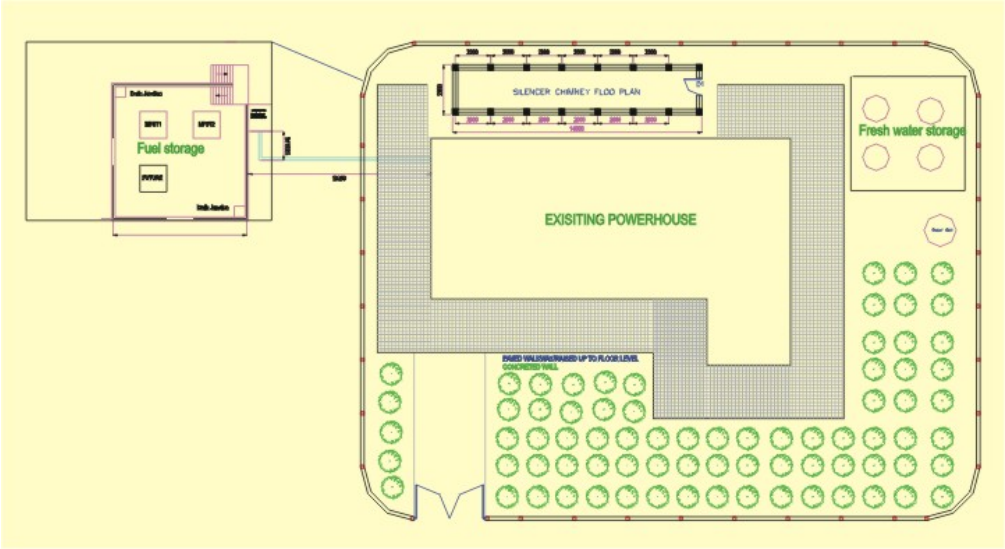

Figure 1 General layout of the powerhouse with the various facilities and components installed

Description of the environment

General setting: Project location

Geographically distinct, each community or village is physically separated from each other by sea where the islands are part of the atoll archipelago of Maldives in the north and central part of Indian Ocean. As such the island of Meedhoo is located on the north eastern corner of Dhaal atoll which is in the central part of Maldives (figure 2). The island is relatively small with high population density. The island is approximately 450 meters in length with an average width of 275 meters. The area of the island is approximately 9 hectares with a population density of 127 persons per hectare. The village occupies almost all the available land on the island with virtually no space for future development. There is a significantly large shallow reef flat on the eastern and southern side of the island which may be reclaimed for future development needs. The powerhouse is located on the southern tip of the island in the vicinity of the harbour.

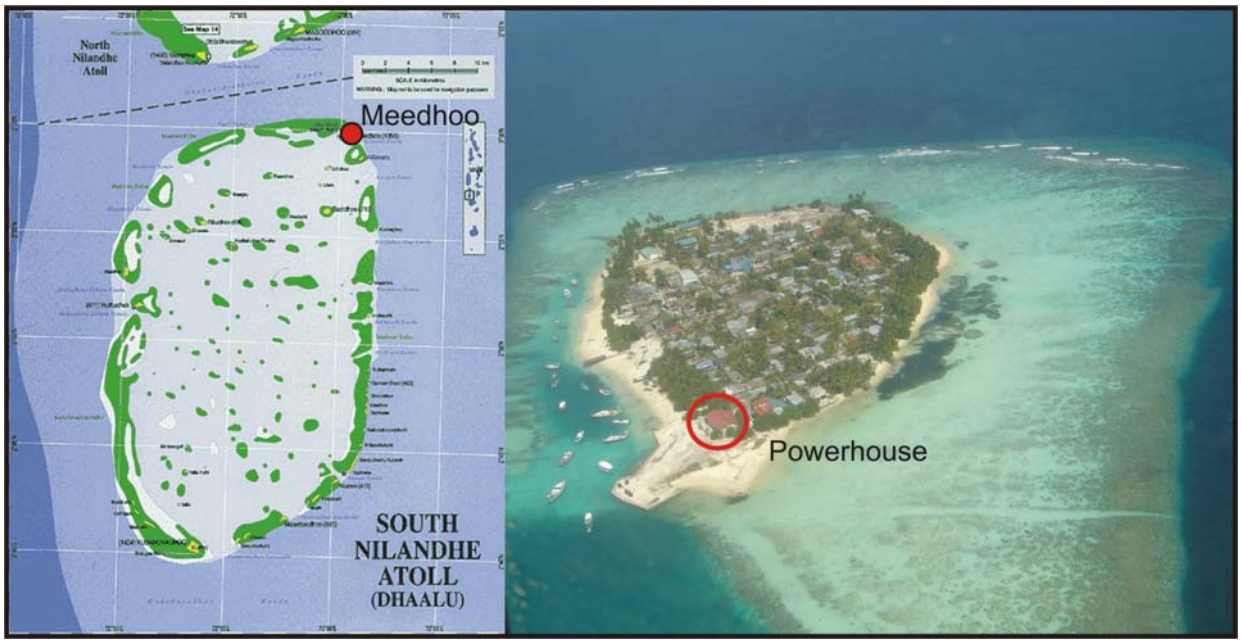

Figure 2 General location of Meedhoo and the project site location

Physical environment

Air quality

Air quality is generally good at the project site. There are few point source emissions or engine exhausts that would cause a significant impact to the environment. Among these include few mechanized fishing vessels, other sea transport vessels, a few motor cycles and the existing powerhouse, and the powerhouse is the main source which emits exhaust fumes continuously all year around. The tropical climate with monsoonal winds provides an environment with good flushing and mixing of air and leaves little or virtually negligible traces of foul air in the immediate environment from the current sources of exhaust emissions.

Although emissions from the motor vehicles are not a significant concern in outer islands such as Meedhoo it is already a significant issue and a concern in the capital Male. There are few regulatory measures to minimize the impacts on air quality. A road worthiness certification is imposed by the Ministry of Transport and Communication on motor vehicles every two years however, these routine checks are mostly on the physical aspects of the vehicle rather than the checks on regulating the exhaust fumes.

The powerhouse exhaust is currently not equipped with appropriate exhaust chimney. Chimneys are small bore pipes without a hood and emissions are directly discharged to the

open air. As a result soot and other particulate matter are accumulated on some of the plants in close vicinity of the chimneys. Carbon deposition on the wall of the powerhouse and some trees adjacent to the chimney has been witnessed by the consultant during the field visit which provided proof of some level of carbon deposition in the immediate vicinity if the powerhouse.

Noise

In general, noise pollution is not a significant human health issue in the Maldives as there are no large motorized industries. The most significant source of noise in the islands including the project site is from the electric power house which is powered by diesel generators (DEG). These generators are generally operated in compliance with the regulations imposed by the Maldives Electricity Bureau (MEB) of Maldives.

The existing powerhouse compound is in the vicinity of housing plots which is separated by narrow streets from two sides. None of the generators are sound proof and the building is not equipped with sound attenuators. As such sound levels from the powerhouse are in excess of 85 dB (A) in the immediate vicinity of the powerhouse (less than 20m radius). This is however, not in compliance with MEB regulation which specifies all diesel power generating systems should have a minimum distance of 60m from the residential areas (articles no. 8.4 of MEB regulation handbook, 1995).

Soil and groundwater

Soil in these small tropical islands are poor and highly alkaline in nature as result of the sediments been saturated by calcium carbonate (100% coral sand). Only the top thin layer of the soil contains humus which varies depending on the vegetation and canopy. As the soil is highly sandy the water retaining capacity of the soil is poor. Meedhoo soil can be categorized as fair to poor as majority of the islands in the Maldives. There main economic activity of the village is fishing and there is virtually no agricultural activity apart from some backyard gardening of few tropical vegetables and fruits.

Groundwater is generally poor and slightly saline, and the only source of water for cooking and sanitation purpose. Sewage disposal is generally through septic tank systems where the effluents are disposed to the ground which may eventually mix with the freshwater lens through drainage and precipitation. The community feels that the ground water is considerably contaminated from the sewage disposal through the septic tank system. As a result the community uses rainwater as the main source of drinking water. Many households have rainwater tanks to collect rainwater during the rainy season. There are also communal rainwater collecting facilities on the island with public finance.

Groundwater of all the islands inundated by the tsunami has been affected through contamination and saline intrusion. As a result the groundwaters in many islands are slightly

saline, however significantly improved over the 12 months since the tsunami. The community people reports that the groundwater has been affected by the saline intrusion during the tsunami. Groundwater was tested for salinity, electrical conductivity and total dissolved solids (TDS) from the water-well in the premises of the power house and a reference location about within 100 meter radius of the powerhouse. The primary intention of the tests for the water are to find out whether there is any trace of fuel in the groundwater as there is good indication of substantial spill of diesel in the area of fuel refueling. However, the Public Health Laboratory (PHL) in the Male does not have the reagents for testing trace levels of hydrocarbons at the time of the surveys. The salinity from both the powerhouse and the reference station was less than 4ppt (3ppt in the powerhouse well and 2ppt in the reference station). TDS and electrical conductivity (EC) was respectively lower in the reference station compared to the powerhouse water sample (1988 and 2900 mg/l respectively). The EC of both the powerhouse well-water and the reference station was between 4000 and 7000 µs/cm which is in excess WHO reference standards for drinking water (less than 1500 µs/cm). Therefore groundwater is not adequate for drinking.

Climate and oceanography

Maldives is affected by the Southwest monsoon (SW) (May – September) and the Northeast monsoon (NE) (December – 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 known as Iruvai Halha is from October to November. The SW monsoon is generally rough and wetter (locally known as the rainy season) than the NE monsoon. Storms and gales are infrequent in this part of the Indian Ocean and cyclones do not reach the Maldivian archipelago.

The average temperature of Maldives is around 28° C with little variation across the latitudes it spans close to the equator. The average daily temperature which can be applied to the project area is from Hanimaadhoo is between 31° and 25° C. Rainfall records for the area shows about 1780mm of rain annually. These conditions can be applied to the project site in general.

Tides

Tides experienced in Maldives are mixed semi-diurnal and diurnal with a strong diurnal inequality. There are few tidal record stations in Maldives. The nearest tide station to Meedhoo is at Hulhule International Airport in Male atoll. These tide measures can be applied to Meedhoo because of the insignificant tidal variations in tide levels throughout the Maldives. The tide station at Male International Airport has continuous records of tide for over the past 30 years. The maximum tidal range recorded at this tide station is 1.20m. The highest

astronomical tide level is +0.64m (MSL) and the lowest astronomical tide level is -0.56m (MSL) (Table 1). Tidal variation reported from National Meteorological Centre (NMC) reports about 0.15m north to south variation where the tidal range is slightly larger in the southern atolls of Maldives. Site specific records and calculations for the tide were not taken at the project site because these parameters are not directly relevant to the proposed project activities.

Table 1 Table summarizing tide levels at Hulhule International Airport, Male Atoll.

Tide level	Water level referred to Mean Sea Level (MSL) (m)
Highest Astronomical Tide (HAT)	+0.64
Mean Higher High Water (MHHW)	+0.34
Mean Lower High Water (MLHW)	+0.14
Mean Sea Level (MSL)	0.0
Mean Higher Low Water (MHLW)	-0.16
Mean Lower Low Water (MLLW)	-0.36
Lowest Astronomical Tide (LAT)	-0.56

Waves

The swell and wind waves experienced at Meedhoo are conditioned by the monsoons and the swells generated by the storms in the Indian Ocean. The waves approaching the shoreline of Meedhoo are conditioned by the two monsoons the NE and SW monsoon. Oceanic swells and the local wind generated waves that approach the shores of Meedhoo would loose most of their energy at the reef slope/crest and reef flat on the eastern side of the island. However the impacts of these waves on the shoreline would be less strong than the open ocean waves from the eastern side because of the central sea harbouring the double chain atoll area. The waves that reach the shoreline of the island would be waves that would have been regenerated on the reef flat after the original wave have broken on the reef slope/crest. The western side of the island is primarily subject to local wind waves generated within Dhaal Atoll. These waves become more significant on the shoreline of Meedhoo during the SW monsoon but with reduced intensity because of the atoll peripheral reef on this side. The eastern and southern side of the island has a wide reef flat with a shallow lagoon. The western side of the reef flat occupies a deep lagoon which is used as a natural harbour basin with berthing revetment wall on the shore side.

Currents

Generally oceanic current flow through the Maldives is driven by the monsoon winds. Westward flowing currents are dominated from January to March (NE monsoon) and eastwardly from May to November (SW monsoon). The change in current flow patterns occurs in April and December (roughly the beginning of monsoon change). In April the westward currents are weak and eastward currents flow will slowly take place. Similarly in December eastward currents are weak and westward currents will take over slowly. Near shore currents are slightly different from the oceanic currents and are largely influenced by the location, orientation and morphology of the reef s around the islands. Strong currents are not experienced in the near-shore environment of the island. Currents within the lagoon and near-shore are local wind driven and tidal currents which may sometimes create long shore currents. No specific wave data was collected at Meedhoo as this is unlikely to influence the project.

Ecological resources

Terrestrial environment

The vegetation structure of Meedhoo is dominated by coconut palms with the typical coastal vegetation types in tropical coral islands. These includes Kuredhi (*Pemphis acidula*), Magoo (*Scaevola taccada*) and Halaveli (*Suriana maritima*) dominating the near-shore andcoastal area. Timber size trees are rare on the island except coconut palms.

There are very few types of trees at the plot designated for the powerhouse. There are approximately 4 adult coconut palms, 11 Dhiggaa and 2 Hirundhu trees within the powerhouse compound. Few young coconut palms are also present within the compound. Since this is also the designated area for the powerhouse (only renovation and minor repairs) no trees would be remove as part of this project.

No major alteration to the soil or soil structure of the compound is anticipated because there is little building and construction works involved in the project. Most of the land area in the powerhouse compound is already cleared, as a result the soil or top soil is generally poor and dry.

Marine environment

Marine environment of Maldives is highly diverse in context of coral reef environment in which the whole Maldivian island ecology is dependent. The coastal marine environment is comprised of several coral reef related marine organisms many of which are ecologically

important in addition to the myriad species in the ecosystem. Currently there are over 1200 species of fish, 250 species of corals, 13 species of mangroves, several species of sea grasses, 25 species of whales and dolphins, five species of sea turtles among many other several animal groups from the coastal environment. Reef environment is highly important to the economy of Maldives both from a fishery and tourism perspective.

This project and its impacts are not directly related to the marine environment and its associated components. Therefore little effort is made to describe marine environment in detail.

Ecologically important habitats

The marine environment, the island environment and associated habitats are all ecologically important ecological entities in a national context. Some of the more significant habitats are reefs, sea-grass beds, mangroves and inter-tidal area which have more of an ecological value than economic value. There are no major habitats associated with the project site (island) except the coral reef surrounding the island which would have no or negligible impact from the proposed project activities. None of the other habitats are directly associated with the project.

Rare and endangered species

There are no rare or endangered species associated or would be directly impacted as a result of this project. Rare and endangered species in the Maldives are more confined to the marine environment. Not rare but endangered species that are of highly significant even at global level are all the 5 species of sea turtles found in Maldivian waters. In addition to sea turtles several other marine species are protected. There are several species with an export ban and few species with ban on exploitation.

Protected areas

Protected areas are few in the country which is mostly confined to marine protected dive sites. There are 25 protected dive sites in the Maldives but none in the vicinity of the project site. In addition to these protected dive sites a protected area has been recently declared in Addu atoll, known as Eidhegili kilhi area on of the first protected area that encompass both marine and terrestrial habitats. There are no protected areas associated with this project.

There is no cultural or historical site which may have some historical or archeological significance to the island.

Potential impacts and mitigation measures

The existing powerhouse at Meedhoo is located in vicinity but at the outer bounds of residential plots on the north-eastern side of the island. It has a boundary wall all around the powerhouse. The power house is equipped with 3 generator sets which are partially damaged but repaired after the tsunami and the condition of the generator sets are bad and the electricity provided is scanty and unreliable.

The existing building is not constructed to minimize the sound generated by the powerhouse apart from the lack of sound attenuators. The exhaust is open (without a chimney) so that all the particulate matter from the exhaust is widely dispersed to the vicinity. Accumulation of soot from some surfaces of the powerhouse compound and the water tank indicates deposition of these materials in the powerhouse vicinity. No attempts were made to quantify the amount of soot which may have been accumulating over the past several months.

Fuel storage at the existing powerhouse is not adequate with evidence of lot of spill around the pumping area. Fuel is stored in barrels, which are kept as they are transported from Male or Kulhudhuffushi. Waste oil is also stored in the powerhouse premises without proper environmental safety measures. No specific oil or waste oil containment area is designated among the powerhouse facilities.

The potential environmental impacts associated with the project activities and their likely magnitudes are described in table 2. These impacts were based on key environmental components and specific parameters within each component which is associated with the project. Considerations were also given taking to account the magnitude of the project and project activities in assessing these impacts.

Table 2 Potential areas of environmental impacts from the proposed project

KEY COMPONENTS		NO	YES		
			MINOR	MODERATE	MAJOR
Atmospheric	Air Quality		√		
Terrestrial	Vegetation Loss		√		
	Soil		√		
	Habitat		√		
	Waste management		√		
Water Resources	Groundwater	√			
	Freshwater Lens	√			
Coastal &	Damage to Reef	√			
	Damage to sea grass beds	√			

	Marine Pollution	√			
	Beach Erosion	√			
	Fisheries	√			
Socio-Economic	Noise		√		
	Public Safety	√			
	Public Health		√		
	Employment Opportunities		√		
	Land/Seascape Aesthetic		√		

As described in the table 2, many of the environmental components are identified to have a minor impact. These minor impacts are from activities either during the construction and operation phase of the project. As outlined earlier the magnitude of the proposed project and its components are not large, therefore the likely impacts associated with various activities are also not highly significant. The mitigation measures for the various impacts identified are given in table 3. In addition the magnitude and duration of the impacts, mitigation costs and responsible agencies are also identified.

Even though some of the impacts associated with the project are minor, the major components that may cause these impacts are outlined below. Description of these are based on the finding of field visit to the project site, consultations with the project engineer/manager, published information and reports and consultants own knowledge through several references in this field.

Table 3 Potential environmental impact mitigation measures

PHASE	POSSIBLE IMPACTS	MITIGATION MEASURES	LOCATION	TIME FRAME	MITIGATION COSTS	INSTITUTIONAL RESPONSIBILITY
CONSTRUCTION – temporary impacts	**Air quality** • Dust and construction related dust from site clearing and structural construction	Follow and adhere to code of conduct followed inn the local construction industry. Such practices may include; • Cover loose and dry material with canvas or other appropriate method. • Wet the construction area if it becomes dry to minimize potential dust issues.	Powerhouse plot and the vicinity	During the construction	Covered by the contractor	Contractor Project management consultant
	Noise and vibration • from construction works and machinery	Limit all work between 0600hrs and 1800 hrs Adherence of motor-vehicle noise standards	Powerhouse plot and the vicinity	During the construction	Covered by the contractor	Contractor Project management consultant

	Vegetation loss • site clearing at the powerhouse construction site • site clearing for construction material storage and workforce camp	Minimize land clearing to absolute necessary level by • avoid cutting trees where possible • transplant and relocate large trees where possible • planting and landscaping works carried out in the final stages of construction	Powerhouse plot and the vicinity	During the construction	Covered by the contractor	Contractor Project management consultant
	Pollution • waste generated from construction work force • construction waste • sewage disposal related to construction workforce	• Good code of conduct adhered by the workforce • Aggregate and segregate waste and dispose it according to the local waste management practice or to a higher standard (e.g. make arrangements to transport hazardous waste to municipal waste disposal site in Thilafushi, Male atoll. • Avoid if possible setting up construction workforce away from the community	Powerhouse plot and the vicinity Residential area	During the construction	Covered by the contractor	Contractor Project management consultant

OPERATION – permanent impacts	**Air quality** • Smoke from engine exhaust • Particulate matter in the exhaust fumes	• Good engine maintenance and adherence to repair and maintenance schedule specified by the manufacturers • Design and construction of silencers so that exhaust emissions dispose through the chimney	Powerhouse plot and atmosphere in the vicinity of the powerhouse	During the operation of the powerhouse	Covered by the contractor	PMU, project design engineer
	Noise and vibration • Engine operation (continuous sound)	• Powerhouse constructed to design specifications, away from residential area (minimum 200 feet radius from residential plots) • Install sound attenuators • Powerhouse operated to design specifications (proper use of double doors, door closers	Powerhouse plot and atmosphere in the vicinity of the powerhouse	During the operation of the powerhouse	Covered by the contractor	PMU, project design engineer
	Waste • Waste oil generated from the engines • Radiator waste • Waste rugs or cloths	• Good house keeping • Drain empty container before they are disposed burn waste clothes if they are in small quantities.	Powerhouse	During the operation of the power house but more during repair and maintenanc e	Powerhouse manager/ management unit	Powerhouse manager/ management unit

	Oil pollution • Oil and fuel is designed to be stored in the powerhouse premises. Accidental spill and leakages are likely during fuel transfer and transport	• Fuel storage tanks constructed by reinforced steel • Fuel storage area bunded to contain accidental leakages coated with impermeable material • Adhere to the code of conduct for engine repair and maintenance followed by MEB	Powerhouse and fuel storage area	Operation of the powerhouse ; during fuel transfer and refueling times.	Powerhouse manager/ management unit	Powerhouse manager/ management unit

New Powerhouse

Location and land clearing

The powerhouse is located well within the residential area close to the existing harbour (figure 3). An area of 40x30 meter plot and been allocated to demarcate the existing powerhouse to include the exiting fuel storage site within this compound. The site allocation and the decision to construct the powerhouse in this area have been approved by the IDC in the consultative process during the filed trip.

Figure 3 Location of the new powerhouse with respect to the residential and other significant infrastructure

There is no vegetation in the designated area for the new powerhouse. They are mainly bare except few coconut palms; some timber sized wood plants.

The damage to the terrestrial environment is anticipated to be minor as a result of the project. This is outlined in table 1. No trees have to be cut down to accommodate the powerhouse building.

Construction of powerhouse

The new powerhouse consists of DEG set room, control room, office/billing area, fuel room, fuel storage tanks and water storage facility (figure 1).

The construction works involve largely civil masonry works and commissioning and installment of new generator sets. Civil and masonry that may have impact if any would come from mainly sand and cement

Coral sand would be used for powerhouse building construction. Sand would be mined locally as it could be collected from approved designated areas within the atoll. Thus almost negligible impact is anticipated on the marine environment as a result of the project especially due to the small scale of the project. Cement for the project would be brought from Male in bulk quantities and stored in the construction site.

Dust from the cement has the potential to cause negative health impacts to the work force. However, with health conscious work practice followed by the construction workforce such as wearing simple masks in the immediate cement handling areas such negative impacts would be minimized.

In addition to the masonry works the project includes commissioning of three DEG sets, installment of associated equipment and partial repair and installment of underground power distribution cables.

All cables would be buried along the earthen (unpaved coral sand) streets. The trenches are narrow (0.3 meters) with an approximate depth of 1 meter (more or less above the groundwater lens). All cables would be covered with an inert polyvinyl chloride (PVC) sheath. The trenches will be open for only a short while and will be buried immediately after the cables are laid. Therefore disturbance to the soil structure is anticipated. Some level of discomfort to the community is anticipated as the cables would be buried in the existing streets. This is only for the duration of the cable distribution and is temporary.

Waste generation and waste management

The waste generated from the construction workforce is anticipated low given the scale and number of the workforce. Approximately 30 people are estimated to be involved during the construction of the project. The best option for accommodating the construction workforce is to find suitable accommodation within the community (temporary) so that a separate camp for

them is not needed. Additionally, unskilled and semi skilled worker can be recruited from the local community so that some economic return from the project is provided to the community even at the construction stage.

Construction related waste from the project can disposed following sound environmental practices followed in the country. It is proposed that organic and non hazardous waste is burned (common local practice as the land is scarce). Harmful waste has to be separately managed by the contractor and disposed to Thilafushi.

Noise and vibration

The new powerhouse located away from the residential areas would have improved noise control measures as compared to the old powerhouse. The building is designed to equip double doors into the generator room. There is no sound attenuators considered as part of the new design neither in the old design. However the double door concept together with the engine silencer emitting the exhaust through a chimney would minimize the noise level than at the old powerhouse where the chimney also has sound absorbing capacity. In addition the powerhouse compound would be planted with tress to further mitigate the noise levels outside the powerhouse

The generator sets are allocated for the powerhouse is all high speed light diesel engines and ground vibrations are not a significant issue. In addition anti-vibration mounts will be used when the DEG sets are installed, which comes with the DEG sets.

Emissions

Currently the exhaust fumes from the engines are dispersed without a chimney. However the new powerhouse would be equipped with residential class primary silencers emitting exhaust through a chimney. This action would reduce exhaust emission as compared to the old powerhouse which would have a positive impact on the air quality. The chimney in addition facilitate the sound reduction would also facilitate to reduce the particulate matter emitted through the exhaust. It is believed high level of carbon would be accumulated inside the chimney which has to be removed periodically by scraping the chimney floor. The carbon collected would be disposed to the local disposal site.

Diesel oil and other chemicals

The most significant environmental impact associated with the powerhouse would be related to the running and operation of the DEG sets. Three generator sets with a total capacity of 280 KW would be installed and operational at the powerhouse. Assuming 60% operation of the DEG sets (170 KW) the estimated annual fuel consumption is 455,000 liters. The total fuel storage capacity of the powerhouse is 18,000 liters, 3 tanks each with a capacity of 6000 liters. Diesel tanks would be constructed with steel with an outer bund-wall made from reinforced sand/cement structures. The purpose of this bund-wall is to contain accidental spill during fuel

transfer and also to accommodate leakages. The main fuel storage tanks would be connected to the fuel day tank which feeds fuel to the engines through a fuel line.

Waste oil generated from the DEG sets would produce a substantial amounting to over 1200 liters annually. Presently waste oil is stored in 200 liter polyethylene containers or metal drum in the powerhouse premises. Waste oil has some demand for treating timber and timber based small fishing vessels. Although this is commonly practiced care has to be taken in handling waste oil as it contains low levels of carcinogens which may cause skin irritations and it is important to notify the buyers of the waste oil the risk involved.

Reuse of waste oil mixed with diesel fuel has been considered as an option for optimal usage of the waste oil. Although such mixing methods are available it has not been widely practiced as the viscosity of the mixed fuel doe not meet the specifications required by for the smooth operation of the engines. Such options may not be favored as it may reduce the life of the engines.

The best practical method for disposal of the waste oil would be to transport it to a site designated by MEEW to dispose waste oil and other hazardous material. However, such a place does not exist within the atoll. The nearest waste disposal site is located in Kulhudhuffushi which had a regional waste management site. The other option is to transport the waste oil to Thilafushi, the main municipal and hazardous waste disposal site in the country.

Fire and other safety aspects

Work safety aspects required by MEB have been incorporated in the design of the powerhouse. Suitable fire extinguishers will be installed. Sound level in the generator room is anticipated to be higher than required by MEB, therefore employees would be provided with ear protection devices such as ear plugs or headphones. Safety shoes would also be provided to the employees.

Institutional requirements and environmental monitoring plan

The environmental impacts associated with this project are viewed in context of the fragile tropical environment of Maldives where some of the impacts can be regarded significant given the small size of the islands and sensitivity to adverse environmental impacts. The environmental impacts discussed will be systematically monitored and reported during construction and operation of the powerhouse in accordance with arrangements specified in the . The Project is designed to comply with the local construction standards, powerhouse/electricity operation and supply standards. With the design and operational specifications included in the contract document the project is expected to meet good

environmental standards. Table 3 summarizes the mitigating measures, the monitoring requirements (e.g., parameters monitored), frequency of monitoring, and the parties responsible for compliance and implementation.

Table 4 Environmental Monitoring and Management Plan.

ENVIRONMENTAL COMPONENT	PROJECT STAGE	PARAMETERS	LOCATION	FREQUENCY	STANDARDS	COSTS	RESPONSIBLITIES	
							IMPLEMENTATION	SUPERVISION
Terrestrial Vegetation loss	Construction phase	Felling of trees for constructing the powerhouse	Powerhouse plot	once	Identified in consultation with MEEW	Approx. USD 150.00	Contractor	Consultant in association with MEEW
Air quality	Operation phase	Exhaust particulate matter	In the vicinity of the powerhouse	Twice a year	Identified in consultation with MEEW	Approx. USD 200.00	environmental officer/consultant	Consultant in association with MEEW
Noise	Operation phase	Noise levels from the powerhouse	Vicinity of the powerhouse	Twice a year	Identified in consultation with MEEW and MEB	Approx. USD 200.00	environmental consultant	Consultant in association with MEEW
Oil spillage/pollution	Operation phase	General housekeeping audits, Oil in groundwater/ soil	Powerhouse, fuel storage area, workshop	Twice a year	Identified in consultation with MEEW	Included in operation and maintenance costs, USD 200.00	environmental consultant	IDC

MEB/MEEW pay close attention at all stages of the project, to monitor and control environmental performance and to consult regularly with the responsible authorities and the community (e.g. powerhouse manager or relevant representative in IDC). The plant operations organization will include a specific person responsible for environmental management and monitoring, and training. Programs will include appropriate environmental management activities for all operational staff.

The institutional arrangement for environmental management and monitoring of the powerhouse is shown in Figure 4.

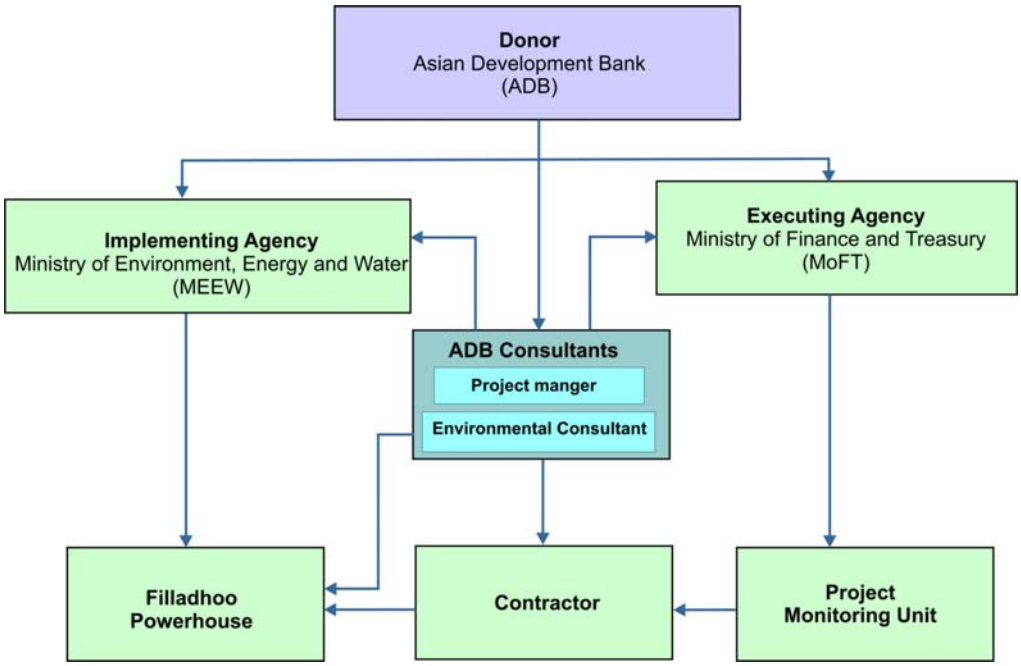

Figure 4 Institutional arrangements for the project implementation

Public consultation and information disclosure

The design for the powerhouse, equipment and services provided under the project has been consulted and approved by Maldives Electricity Bureau (MEB) and MEEW. Environmental consultations during for the IEE were carried out with the relevant stake holders including island communities and other relevant agencies. The main purpose of these consultations were to discuss the ADB requirement for IEE and its objectives of setting the baseline for the project sites and confirming which environmental category the project belongs to with respect to both the Governments and ADB regulations. The full list of those met and consulted is in Appendix 1.

The Island Development Committee (IDC) and key senior citizens including Women Development Committee representatives from the island has been briefed on the environmental consideration required by the project. Detailed description of the each component of the project was presented to the community to get their feedback and perception on the overall project. In addition, the group was asked their environmental concerns in general as well as any related to the project.

Among the issues which were raised in consultations, apart from the state of the electricity and the need for improved electric supply system, those that aroused the most concern were state of the groundwater and waste management. Although the groundwater has been generally good, it has been contaminated with seawater during the tsunami flooding. The flooding of the island is only partial and groundwater is slowly return to a better state with the precipitation. However the community feels the degraded water is a considerable problem and fears it not become normal. The source of drinking water for the islanders has always been mainly rainwater collected from the roofed areas which are stored in storage tanks either privately owned or communal. Annual precipitation is generally adequate and the current storage capacity is merely adequate. If the weather is dry and prolonged without rain then the community alternatively used groundwater for drinking.

Waste was highlighted by the IDC as the second serious problem. There is currently no waste management site designated to dispose the waste. As the island is relatively large the community disposes the waste into the woods away from the residential area. This is carried out differently in smaller islands where waste is used as landfill at the shoreline mostly in artificially enclosed areas. Sewage disposal is through septic tank systems where each household has a system. The effluents from the sewage system slowly drain to the groundwater. In small quantities the groundwater or the soil has the ability to purify the effluents from the contaminants. The extent of contaminants in the groundwater from the sewage disposal is unknown. Some of the key informants feel that groundwater is contaminated in some area. This cannot be verified at the time of the study and no effort was given to establish the extent of the contamination of the groundwater.

Harmful chemicals and waste collection and disposal system has been implanted in the island which is introduced by International Society for Red cross (ISR) an initiative to help to establish an appropriate waste management system in the island of Maldives especially in areas affected by the Tsunami of December 2004. Containers are specifically located to segregate various types of harmful waste which is aimed to collect such wastes from different islands and disposed at a central location in the Maldives preferably at Thilafushi.

When asked about the environmental issues related to the existing powerhouse. The noise level at the existing powerhouse has been identified as a significant nuisance as the powerhouse is located within the village. Smoke was not identified as a concern. The community was a consensus the environmental issues related to the powerhouse (especially noise) would be negligible with its relocation.

In addition population density and lack of land for future development has also been considered as a major problem even right now and is foreseen to worsen in the future. Powerhouse is located in a partly reclaimed area near the harbour.

These concerns and other points of view of the community and the environmental issues associated with the project and its components have formed the basis of this IEE, supplemented as necessary by the consultants' own observations and knowledge on the environmental issues in the Maldives.

Public consultation would be made as part of the public information and disclosure process as required by MEEW. As soon as the report is approved by the relevant authorities, ADB and MEEW, it would be available to the key stakeholders involved in the project for comments.

The report would be published in ADB website: www.adb.org
It would also be made available at MEEW website; www.environment.gov.mv
Also it would be provided, at least for perusal, to those who request it.

Findings and recommendations

This IEE report confirms that all the significant adverse environmental impacts associated with the new powerhouse with fuel storage facility and its operations in Meedhoo can be satisfactorily mitigated.

Then project will an overall positive impact on the environment as the efficiency of the diesel powered electricity supply would be improved through decommissioning of the old engines and installment of the 3 new DEG sets with renovation of the distribution network. This new improved power generating system with its efficiency would also reduce the fuel and other electricity related losses.

Noise levels would be reduced through the installment of the chimney in the new powerhouse. In addition to the noise, emissions would also be reduced and controlled by the settlement of carbon in the chimney walls and floor as the exhaust fumes pass though the chimneys.

Fuel storage and handling efficiency would be improved through the implementation of the project. Accidental fuel spill can be retained and safely handled through the installment of the fuel retainer wall around the fuel tanks.

In addition to these mitigation measures powerhouse staff would be trained to safely operate the engines and electric system according to the specifications of the systems and powerhouse operation procedures outlined by MEB. Moreover, the powerhouse manager and staff would be trained by the contractor/consultant to follow and monitor the environmental monitoring and mitigation measures discussed in the environmental monitoring plan.

Conclusions

The finding of this IEE, after the assessment of the existing environmental conditions at the project site, environmental impacts associated with the proposed activities confirms that the impacts identified can be controlled provided all the environmental measures and monitoring procedures are followed.

Appendices

Appendix 1 List of people met

1.	Mr.Zahid Jameel	Team Leader/ADB
2.	Mr.Hussain Zahir	Environmentalist/ADB
3.	Mr.Adhnan Ibrahim	Socio Economist/ADB
4.	Mr.Siddeeg Ali	IDC President
5.	Mr.Ibrahim Naseer	IDC Deputy President
6.	Mr.Abdul Sattar Hassan	Asst Island Chief
7.	Mr.Abdul Shukoor Ali	IDC Member
8.	Mr.Moosal Musthafa	IDC Member
9.	Mr.Mohamed Shahir	IDC Member
10.	Mr.Abdul Rasheed	IDC Member
11.	Mr.Ahmed Mujuthaba	IDC Member
12.	Mr.Ahmed Ali	IDC Member
13.	Mr.Khalid Ali	IDC Member
14.	Mrs.Shareefa Ali	WDC President
15.	Mr.Hassan Ibrahim	Leading Businessman
16.	Mr.Ahmed Mohamed	Leading Businessman
17.	Mr.Ibrahim Ali	Leading Businessman
18.	Mr.Moosa Manik	Leading Businessman
19.	Mrs.Hafeeza Ibrahim	Leading Businessman
20.	Mr.Ali Shafeeq	Leading Businessman
21.	Mr.Ahmed Adam	Leading Businessman
22.	Mr.Ibrahim Ali	Senior Figure of the island

23.	Mr.Abdulla Shareef	Senior Figure of the island
24.	Mr.Adam Naseer	Senior Figure of the island
25.	Mr.Saeed Ali	Senior Figure of the island
26.	Mr.Ibrahim Mohamed	Senior Figure of the island

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