Environmental Impact Assessment

Document Stage: Updated
Number: 51077-003
August 2023

Maldives: Greater Malé Waste-to-Energy Project – Waste to Energy Plant (Part F)

Appendices

Prepared by the Ministry of Environment, Climate Change and Technology for the Ministry of Finance and the Asian Development Bank. This is an updated version of the draft originally posted in July 2020 available on https://www.adb.org/projects/documents/mld-51077-003-eia-2.

C

Ministry of Environment
Male', Republic of Maldives.

ފަރުވާއަދި ދަތުރުދާއިރާ ގުޅުންހުރި ވަޒާރާ
ދިވެހިރާއްޖެ

Minutes of the Meeting

Meeting Title: Public Consultation for Environmental Impact Assessment (EIA) of Regional Waste Management Facility
Date: 28th October 2019
Location: MNU Auditorium

Participants:

- Ministry of Environment (ME) -
  - Ibrahim Zameel — Project Manager
  - Mohamed Asif — Social and Environmental Safeguard Specialist
  - Sham'aan Shakir — Information Education and Communication Specialist
  - Hana Farook — Assistant Project Coordinator

- Waster Solution- EIA Consultant
  - Ahmed Jameel — EIA Consultant

- *Other* Participants
  - Fathimath Rishana
  - Abdullah Adam
  - Ahmed Mohamed
  - Adam Isham
  - Humaida Abdul Gafoor
  - Ahmed Afrah Ismail
  - Mariyam Mohamed
  - Juma Ahmed
  - Aleef Naseem
  - Hoodh Ahmed
  - Mohamed Rasheed (Bari)
  - Abdul Aleem

C

Ministry of Environment

Male', Republic of Maldives.

މިނިސްޓްރީ އޮފް އެންވަޔަރަންމަންޓް

މާލެ، ދިވެހިރާއްޖެ.

Points presented:

- Overview of the Project
- Results of the Environmental Impact Assessment of the Regional Waste Management Facility

Issues raised *and response:*

Timing and venue of the public consultation

- Some of the participants raised concern that the timing of the public consultation was not ideal as it falls within the official working hours. A participant also suggested that the University Auditorium was not ideal and that the closed space would discourage people from attending the public consultation. It was suggested that future public consultations should be held after the official working hours in the evening and at a public space such as the "Jumhooree park" to encourage more people to attend.
    - *ME informed that the points mentioned would be taken into consideration for future public consultations*

High-level Technology fund

- A participant inquired what was meant by the high-level technology fund
    - *ME informed they would clarify and inform later. Towards the end of the discussion it was informed that a High-Level Technology Fund is a multi-donor trust fund that provides grant financing to encourage more widespread adoption of high-level technology (HLT) to address development challenges in ADB's developing member countries*

Capacity building

- A participant inquired since there is capacity building in phase 1, what was already being done to acquire information
    - *ME informed that a firm would be hired for capacity building activity and that that the firm would be working throughout the project to build the capacity of the community.*

Involvement of Women.

- A participant inquired why involvement of women was specified in awareness raising.
    - *ME noted that the project aims to increase the involvement of women throughout the different activities planned in the project and as such even the committee under the Grievance Redress Mechanism also specifies that the president of the island's women's committee be included. Women had been involved in all stages of the project development.*

Reduction of Waste

- A participant inquired the plans to reduce waste. Another participant added that instead of incinerating, the solution would be to reduce wast, and decrease the import of items that would create waste.
    - *ME informed that under the project there were plans to increase community awareness with regard to waste reduction. The EIA consultant added that there would be a focus on 3R under the community awareness and behaviour change strategies.*

- A participant raised concern that incineration was being used as the solution to reduce waste and stressed that incineration and re-using the 'gunk' from the incineration plant was not the solution.

- *In the management of waste, even after carrying out successful waste reduction strategies, there will be residual waste that need to be treated and disposed. Incineration has been recommended as an optimum technology for the Maldives. ME informed that the bottom ash could be utilised for road development and that currently a feasibility study was being undertaken.*

- A participant inquired if the government's pledge to reduce waste to 3 percent would have an impact on the operation of the plant.
    - *The proposed waste management strategy had taken account to waste reduction strategies. The proposed system would have no impact with current change of policy to ban the use of single use plastic by 2024.*

Public involvement for the whole project

- A participant raised concern that the public consultation was only for the regional waste management facility and not for the whole project.
- Moreover, it was added that public involvement should have been at an earlier stage, before incineration was chosen as the way forward to manage waste, as it is similar to the World Bank waste management project in Vandhoo which had failed.
    - *ME noted that the waste management project for Zone III has been formulated based on the lesson learnt from the Vandhoo Project. Vandhoo project was s a Design and Build project, and the project had failed because the operator of the facility was different and the Government took a while to handover the facility to WAMCO to run the facility. The current project for the Zone III is a DBO, Design, Built and Operate, building on the lessons from Vandhoo case..*
- A participant added that they were not aware of the level of consultations which had taken place with regard to the project. And that since all government infrastructure development projects (such as the Gulhifalhu Reclamation, development of resorts on shallow, development of harbours in the islands) are related, it needs to be considered, and Mministries and other big companies needs to consulted before undertaking such a project.
    - *ME informed that stakeholder consultations had taken place at all the stages of project formulation from feasibility to EIA. During the feasibility stage, stakeholders were consulted and stakeholder meetings were held. During the designing stage of the project, stakeholders were consulted. Various stakeholders and communities meeting were held for the EIA for this project in the past 24 months. During these meetings, relevant ministries, resorts and companies had also been invited to participate in the stakeholder meetings and workshops.*
- Many participants suggested that a multi sectoral discussion should be held for the consultation to be more meaningful. It was also noted that the outcome of the stakeholder meetings was not known to the public.
- A participant inquired how much the comments received from the public would be incorporated. Another participant also inquired if the minutes of the meeting would be available.
    - *ME informed that the project formulation has been guided by the inputs from stakeholders in different stages of the project. The minutes of the consultations will be included in the EIA*

Sustainability of the project

- A participant inquired how the project aligns to the SDG goals 1,2,3. He also added that the project had no engagement of the community. He also stressed that civil society should be part of the project instead of creating mega-companies. He also questioned if such a project would be financially sustainable and the dollar value of the cost to the community. He also inquired how the project would affect the human capital and enhance human development. He also drew

examples of the Male' Sewerage Project which in his opinion had failed and did not work as designed, because there was no proper oversight from the regulator of the company.. He also highlighted that a gap between the design, installation and operation of a project could affect the sustainability of the project, thus a systematic approach would be needed. Another participant also questioned if the approach was sustainable.
  - *ME noted that the various stakeholders including NGOs and Civil Society groups has been engaged in the project development. The project aims to build the overall institutional capacity in the country. And as such, improving the institutional capacity of EPA is a priority. Moreover, since it's a DBO (Design Build Operate) project, the operational issues would be minimized and local capacity would be developed before the operation is handed over to the Ministry/WAMCO at the end of the DBO period.*
- A participant inquired if ME could assure that project would be sustainable and the sustainability plans of the project. Similarly, another participant also questioned the sustainability of the project and inquired if all these aspects had been considered.
  - *ME informed that lessons from similar projects were being considered, and feasibility studies were undertaken to ensure the project was viable.*

No solution for bottom ash

- A participant raised concern that there was no solution for the bottom ash produced from the WTE facility. And stressed that before the project starts there should a proper way for it to be utilised as currently its only a study which is being undertaken.
  - *EIA consultant briefed that currently there is work going to study the alternative uses for the bottom ash. Presently the study is being focused to use the bottom ask on the production of paving blocks and other similar kind of use in the construction industry. It was also noted that a key objective of the project is to address the waste issue in Thilafushi.*

Producer responsibility and consideration of other government projects

- A participant inquired about the details of the grant and loans and suggested that producers should take responsibility of the waste they generate, and if not, it would be a misusing state funds. As such, she highlighted that resorts are one of the biggest generators of waste and that currently waste from all resorts are being taken to Thilafushi. Thus, the participant questioned how thoroughly the project had considered all these issues, and stated that the project seems like a reactionary project and a band-aid solution. She also inquired if the increasing number of resorts and other infrastructure projects had been considered. Another participant also inquired if the population growth in the Greater Male' region had been considered.
  - *EIA consultant briefed the waste to energy facility for the zone III is being financed by ADB through a grant/concessional loan. Resorts bring the waste to Thilafushi because current regulations requires the waste from the resorts to be brought to Thilafushi for disposal. The feasibility considered that waste generated from the resorts in the zone III would be brought to Thilafuishi for treatment and disposal. WAMCO will be collecting the waste from the resort and the resorts will pay collection fee to WAMCO which includes the cost of treatment/disposal. The feasibility study considered the populations in the zone III, including the planned increase of resort beds in the region.*

EIA

- A participant also informed that they had been requesting for the EIA and was yet to receive it. Another participant also questioned the results of the EIA, as the participant stated that Thilafushi was dead in terms of bio-diversity thus the results were questionable.
  - *ME informed that the EIA would be shared once the EIA is finalised. It was mentioned that the EIA and annexes including the studies that is part of the EIA would be made available at the ADB website soon for comments. It would be made available on the*

website for a period of 3 months. EPA would also publish it on their website, once the ME submits the final EIA to EPA.

Inefficiency and ineffectiveness of ME and EPA

- Participants raised concern over the ineffectiveness of Ministry of Environment and the Environmental Protection Agency. It was noted that they do not hear back from the organisations in a timely manner for other matters that they have contacted to those institutions. It was also noted that EPA should have the capacity monitor air emission levels from the project.
  - *PM noted that the project would response on any queries regarding this waste project. ME noted that part of the project is to build the capacity of EPA and strengthen institutional capacity to monitor the air pollution emissions. Air pollution emission stations are recommended to be established at Thilafushi to monitor the impacts of stack emission on Thilhafushi.*

Other waste

- A participant inquired how hazardous waste, medical waste, construction and demolition waste, and end of life vessels would be handled at Thilafushi when this project is completed.
  - *ME noted that all the hospitals and health care facilities are required to have autoclaves to treat the medical waste before it is send to Thilhafushi for treatment and disposal. The proposed facility can manage the hazardous waste in the household. The facility would store any other hazardous waste received. The facility can receive end of life vehicles. ME noted that the facility at Thilhafushi is a municipal solid waste incinerator facility. Government is developing another facility to treat hazardous waste.*

Terms of Reference

Greater Male Waste-to-Energy Project

Project Management, Design and Construction Supervision (PMDCS) Consultant

A Background

1. The Greater Malé capital region and its outer islands (classified as Zone 3 in the national solid waste management policy) suffer from severe environmental pollution and deteriorating livability because of inadequate collection and haphazard disposal of solid waste. Zone 3 covers 35 inhabited islands, 73 tourist resorts, 14 city hotels, and 177 guest houses, in the North Ari Atoll (Alifu Alifu Atoll), South Atoll (Alifu Dhaalu Atoll), Malé' Atoll (Kaafu Atoll) and Vaavu Atoll, including the capital city of Malé, with a total population of 216,000 (51% of Maldives). Lack of a sustainable system to manage the 774 tons per day (tpd) of solid waste generated in Zone 3 (results in waste spillage into the ocean, and open dumping and burning of garbage at the 30-year old 10-hectare dumpsite on Thilafushi Island which has no pollution control measures creating a public health and an environmental hazard.[1] Plumes of smoke visible from the capital Malé, the international airport and nearby resorts compromise air quality and pose nuisance to residents and tourists, while leachate and plastics contaminate the surrounding marine environment.

2. The Government of Maldives is committed to improve the environmental conditions and to strengthen the solid waste management (SWM) system in the country. For Zone 3, the government plans to develop a sustainable regional waste management facility on a newly reclaimed 15 ha land on Thilafushi island adjacent to the current dumpsite. The facility will include a 500 tons per day waste to energy treatment plant (WTE) including a bottom ash processing plant, a landfill for air pollution control (APC) residues and bottom ash including leachate treatment plant. The facility will be developed through a Design-Build-Operate (DBO) Contract (the "Contract") pursuant to the FIDIC Gold Book, with design and build period proposed to be financed by the Asian Development Bank (ADB), Asian Infrastructure Investment Bank, ADB's Japan Fund for Joint Crediting Mechanism, and the government under the Greater Male Waste to Energy Project (the project). The government will cover the cost for the 20 years operation period. The project will mitigate greenhouse emissions and will be registered as joint crediting mechanism.

3. A shortlist of pre-qualified firms was finalized in fourth quarter 2019 and invitations for bids for the DBO contract is expected by December 2019. The DBO Contractor (the "Contractor") will be awarded in the fourth quarter of 2020, with the facility to be commissioned within 3.5 years after the notice to proceed. Included in the scope of the Contractor is design, build and operation of the facility, and also preparation of the permitting application for the construction and operation of the WtE plant. The volume of the design-build (DB) component of the DBO Contract is expected to be around $120 million.

4. The WTE facility will receive waste that is collected in Zone 3 and transferred to Thilafushi Island. Collection and transfer of solid waste is not part of the Contractor's scope. Besides this waste, a stockpile of baled waste that is generated in the transition phase after closing the dumpsite and the commissioning of the WTE will also be incinerated.

[1] The population is expected to grow to 300,000 within the next five years. In 2022 the expected generation of municipal solid waste (MSW) of residents, commercial and industrial entities and institutional bodies is approximately 115,000 tonnes which is complemented by another 70,000 to 100,000 tonnes of construction and demolition waste. Breakdown of solid waste by type: construction and demolition = 530 tpd (68%), household = 149 tpd (19%), resort = 48 tpd (6%), commercial = 27 tpd (3%), airport = 9.3 tpd (1.2%), industrial = 6 tpd (0.8%), market = 2.5 tpd (0.3%), hazardous = 1.5 (0.2%), and end-of-life vehicles = 0.65 tpd (0.1%). Source: Government of Maldives, Ministry of Environment and Energy. 2018. Feasibility Study for an Integrated Solid Waste Management System for Zone III (including Greater Malé) and Preparation of Engineering Design of the Regional Waste Management Facility at Thilafushi. Malé

5. The Ministry of Finance (MOF) is the executing agency while Ministry of the Environment (MOE) is the implementing agency. MOE will own and be in charge of the WTE facility operations. The state-owned Waste Management Company Ltd. (WAMCO) or other contractors will be the supplier of waste to the WTE facility. The Environmental Protection Agency (EPA) is responsible for regulatory activities for waste management and pollution prevention. The State Electricity Company Ltd. (STELCO), Greater Malé Industrial Zone Limited (GMIZL), Ministry of Planning and Infrastructure and Malé City Council are relevant stakeholders.

6. With respect to the FIDIC terminology, MOE will be the Employer.

Further information

7. The Greater Male Waste to Energy Project will complement the ongoing Greater Male Environmental Improvement and Waste Management Project (GWEIWMP), assisted by ADB $33 million grant. GWEIWMP supports (i) solutions for immediate control of nuisances from Thilafushi Island dumpsite and interim measures to manage the incoming waste until a new treatment facility is commissioned (e.g. baling of municipal solid waste); (ii) development a construction and demolition (C&D) waste treatment plant; (iii) island waste management centers in outer islands; and (iv) installing an appropriate collection and transfer system in Malé and other islands/resorts in Zone 3, including transfer stations in Malé and Villimale, (v) construct a disassembling plant for end-of-live vehicles, (vi) institutional capacity building and public awareness in sustainable SWM and reduce, reuse and recycling.

8. The state-owned Waste Management Company Ltd. (WAMCO) operates the waste collection in Malé, Hulhumale and Villimale and dumps waste on a dumpsite on the island of Thilafushi. On inhabited islands, the islands councils are in charge of collection and basic disposal. WAMCO took over the operational responsibility for waste management in December 2015.

9. The government also plans to i) rehabilitate the existing dumpsite in Thilafushi and ii) develop a transfer station in Hulhumale. The dumpsite rehabilitation invitation for bids is expected in the fourth quarter of 2020 or first quarter 2021. These two components are proposed to be financed on a parallel basis by the Islamic Development Bank.

B Objectives of the Assignment

10. To successfully implement the Greater Male Waste to Energy Project through high quality management, design and construction supervision, the government (executing agency and implementing agency also referred as the Client) will require the support of a professional engineering and management consulting firm (“the Consultant”). The firm will assist in the delivery of the different project components, which include the design, construction and initial operations (including capacity building of EPA and Employer in monitoring operations) of WTE facility and associated landfill of air pollution control residuals and non-marketable incineration bottom ash.

11. The Consultant will act as Employer’s Representative (ER, FIDIC Gold Book) during the design and build period and the first two years after the successful commissioning of the WTE plant (operation period).

C Scope

12. The Consultant's scope evolves from the roles and responsibilities stipulated in the relevant general conditions of the FIDIC Gold Book.

13. The Consultant is expected to provide inputs relating to the conceptual and detailed engineering and design reviews, construction supervision and contract administration, project management and monitoring, cost control, ensure compliance with social, environmental, occupational health and safety aspects, amongst others, provide capacity building support but not limited to the following:

    i. Ensure that the facilities and the equipment are designed according to the Employer's Requirements that are part of the DBO Contract;
    ii. Supervise, monitor and control the progress of design and construction of the WtE facility and the ancillary components in sufficient detail by, for example but not limited to, design reviews, inspection of manufacturing and construction sites, site meetings etc., as necessary and stipulated in the relevant contracts;
    iii. Monitor and manage any occurring interface during the construction activities of the Contractor and the contractor carrying out the dumpsite rehabilitation and minimize their impact on the timeline of the Project;
    iv. Supervise the construction of the new landfill and validate the bottom liner system construction Quality Assurance/Quality Management;
    v. Monitor and control the construction activities to minimize their environmental impact;
    vi. Monitor and control the commissioning and trial run operations including the tests on completion of the design-build period of the WtE plant including all ancillary facilities;
    vii. Support the Employer during processing of claims and invoices submitted by the contractors;
    viii. Assure that the contractor complies with relevant ADB safeguard standards;
    ix. Instruct and train the Employer's and EPA's staff in performance analyses and monitoring related to statutory compliance and to the performance guarantees of the WtE plant and its ancillary facilities;
    x. Draft a Joint Crediting Mechanism (JCM) methodology and support the Employer in registering the WtE facility for the GHG emission reductions;
    xi. Support the Employer during the first two years after of operation after issuing the commissioning certificate to monitor and review the performance of the DBO facilities.

D Responsibilities and Deliverables

14. The overall responsibility to deliver the outputs will rest with the consulting firm through the Team Leader/Project Manager. The Consultant will ensure timely delivery of the documents, establish coordination among all stakeholders and within the team members of the Consultant, scheduling mobilization/demobilization of team members and to interact with the Client on regular basis and as needed.

D.1 Project Management

15. Project management, control and monitoring responsibilities and tasks the Consultant will assume are as follows:

    i. Plan and manage the project, and assist the Employer on the project management, including risk management, cost control, scheduling, monitoring, auditing, reporting, and compliance monitoring for the project required under both the government and ADB rules

and guidelines;

ii. Review, comment and, if required, approve the Contractor's programs that are to be submitted including all pertinent activities and work packages, analyze critical paths, responsibilities and functions assigned and flag any time and cost over-run if required;
iii. Prepare a work programme for each of the Consultant's team members in line with the Contractor's schedule;
iv. Establish, coordinate and manage the information exchange between the Consultant, Contractor and the Employer and, as the case may be, other Project stakeholders;
v. Attend meetings necessary to manage the Project, prepare minutes and control the outcomes decisions taken;
vi. Establish a document control and proper filing system for project offices, including official correspondence, drawings, site instructions, variation orders and site records;
vii. Monitor open topics, claims of the Employer towards the Contractor, defects to be rectified, potential malfunctions of equipment etc. and track solutions to be implemented;
viii. Review and recommend on the Contractor's claims for progress payments;
ix. Review and examine the Contractor's requests for variation orders, extra items, new rates, claims for time extension and extra payment, filed by the contractor etc. and submit recommendations for approval, if appropriate;
x. Develop and implement procedures for timely payments to the Contractor and monitor for compliance;
xi. Assist constructively and submit recommendations in resolving any potential difficulty or dispute that may arise between the Contractor and the Employer;
xii. Prepare essential reports and documents including quick report on progress, quality, disbursement or any other relevant matter as may be required by the Client, Employer or the ADB and other funding institutions;
xiii. Assist the Employer in conducting regular meetings with all stakeholders, Contractor, and other government entities, etc., to discuss progress and issues related to implementation, and prepare minutes for recording and circulation;
xiv. Establish all necessary records and the procedures of maintaining/updating such records for each package and component of the Project;
xv. Assist on liaison with local authorities and government agencies, liaison with ADB and other funding institutions. Assist the Client/Employer in reporting to these institutions;
xvi. Review all proposed sub-contractors and verify their insurance, performance bond and collateral warranty or hereto relating parent company guarantees;
xvii. Assist the Client in ensuring compliance with all loan covenants during Project implementation and assist in reporting towards the funders.

16. Besides the responsibilities above, the Consultant will work closely with the Employer's project management unit by sharing relevant and requested information.

D.2 Review of the Design of the DBO Contract Components

17. The Consultant's responsibilities with respect to the design stages will include the review and approval of the proposed designs (submitted by the Contractor) including concept, detailed and works designs.

18. As per DBO Contract, the detailed design will be provided in packages to facilitate an appropriate design progress to develop the WtE facility and the residual waste landfill including permit application within 3.5 years. The Contractor may apply Building Information Modelling (BIM) to facilitate a smooth design and construction.

19. The Consultant's scope will include, but is not limited to, the following:

i. Review the design program of the Contractor with respect to feasibility, critical paths, achievement of milestones etc.
ii. Agree with the Contractor on the format and content to be delivered during the design stages, such as concept, detailed and works design, to achieve a timely delivery of the works included in the contract package;
iii. Assist the Employer in facilitating the Contractor to obtain the permit upon due consultation with the EPA, Ministry of Planning and Infrastructure, and key authorities or stakeholders;
iv. Agree with the Contractor on a defined conceptual design status in line with the milestones as per contract to limit variations during later design and construction stages;
v. Review, examine and, if required, approve during the different design stages (concept, detailed, works), drawings, design reports, calculations, technical specifications of equipment and materials etc., in due course as per phasing requirements that are stipulated in the DBO Contract;
vi. Check the design towards the functional and design criteria and specifications, H&S and environmental aspects, operability matters, flood and storm resilience, product quality and the supply chain to be established;
vii. Arrange and manage design review meetings in Malé to expedite and to facilitate a smooth design review;
viii. Monitor the design progress and inform the Employer about any deviations and potential delays;
ix. Suggest design changes if necessary and advise the Employer on these changes and potential cost and schedule implications by furnishing appropriate reports. In the event costs have to be borne by the Contractor, advise the Employer accordingly;
x. Review and, if needed, approve the contractor's method statements, site organization arrangements, utilities, shipment plans etc.;
xi. In the event procurement/manufacturing is carried out during the design stage, inspect or coordinate the inspection of manufacturing of critical components of the WtE plant as per contractual provisions incl. the review of certificates, technical specifications and workmanship;
xii. Check the hazard and operability (HazOp) analyses and hazard area classification drawings;
xiii. Review, comment and, as the case may be, approve the plans and documents the Contractor has to submit during the design-build phase, such as, but not limited to, operations and maintenance plan, the Contractor's environmental management plan (CEMP), quality management and assurance plan, the H&S plan, residual waste and landfilling plan, the programme on tests on completion of design-build, etc.; and
xiv. Ensure disaster- and climate-resilient features are incorporated in the final designs.

D.3 Construction Supervision

20. The Consultant will:

i. Review method statements, work drawings and construction methodology for their correctness and adequacy prior to the start of works, report findings and propose/recommend modifications or corrections to any defect or omissions and issue for execution; monitor impact and report on physical progress of the works and financial disbursements;

ii. Maintain sufficient site-based staff, with clear allocation of duties, to monitor, inspect and closely follow up the day-to-day construction activities in line with the timely requirements of the construction works;
iii. Maintain daily records of execution progress in an appropriate format to be shared with the Employer;
iv. Co-ordinate with all stakeholders to achieve timely completion of contractual obligations on the part of Contractor and the Employer;
v. Review any upcoming design changes in the course of the construction and advise the Employer on potential cost and design/construction schedule implications;
vi. Monitor the Contractors' performances against the stipulated milestones and the agreed project progress, furnish an updated list of open topics and advise the Employer about any expected or unexpected delay and potential cost implications;
vii. Check the adequacy and quality of the Contractor's input in terms of material, equipment & machinery, personnel and safety arrangements prior to commencement of the works and periodically during the construction activity;
viii. Inspect and control the executed works and the supplies of equipment to be in compliance with the approved work drawings (design for construction) and with the Employer's Requirements;
ix. Review, inspect and/or coordinate the review and inspection of manufacturers of major and critical components and their manufacturing sites pursuant to the Contract provisions with respect, but not limited, to certificates evidencing skills and experiences of workers, documented and certified materials used, technical specification of (sub)components embedded, the general workmanship and the final product quality;
x. Monitor the assembly of components and its progress towards expected milestones;
xi. Agree with the Contractor on the test programme prior to completion of the design-build, attend the tests, review the test reports and endorse test certificates;
xii. Review and approve the as-built-documentation and, as the case may be, request changes prior to acceptance;
xiii. Record and follow up on defects identified during the design-build period and ensure that all defects are remedied within the time stipulated;
xiv. Scrutinize the quality assurance system and quality control plan of the Contractor, prepare quality compliance and progress reports;
xv. Support and assist the Employer in Contract administration and compliance with contractual conditions and ADB's Project Administration Manual;
xvi. Support the Employer during the processing of payment and claims providing any necessary input (such as measurement of works progress, judgement and information concerning milestone achievements, acceptance of variation orders, deduction of retention money);
xvii. Assist the Employer in forecasting the progress of works and finalization of periodic targets for the expenditure and disbursement.

D.4 Commissioning Supervision

21. Responsibilities of the Consultant related to commissioning of the DBO contract components will include:

i. Maintain a sufficiently staffed and skilled team to keep up with the responsibilities assigned during the commissioning period including the demonstration of performance guarantees that were defined in the Contract;
ii. Support the Contractor, as far as required, to obtain the necessary permits to conduct

the commissioning activities;

iii. Assist the Employer in making available the required amount of waste prior to the tests on completion of the design-build;
iv. Review and approve the Contractor's test programme on the completion of the design-build and agree with the Contractor on a final programme;
v. Request to commission parts and sections of the works if need be;
vi. Attend and monitor the commissioning tests (incl. pre-commissioning) and trial operations including the tests on completion of design build to demonstrate the performance requirements, standards and guarantees;
vii. Furnish commissioning attendance protocols and highlight issues that might affect the scheduled tests on completion of design build;
viii. Review the test reports on completion of design-build and make necessary comments and adjustments, and, in the event of failure of the tests, request the Contractor to conduct a retest;
ix. Support the Employer during any claims related to the commissioning period;
x. After due consultation with the Employer, issue the commissioning *c*ertificate upon successful completion of the test on design build;
xi. Summarize the performance of the facilities being tested and give necessary instructions to the Employer and the EPA relating the performance monitoring and the compliance measurements.

D.5 Environmental and H&S Components

22. Responsibilities related to environmental, occupational health and safety are:

i. assist PMU in meeting requirements of ADB SPS and government on environment, occupational health and safety, and labor standards.
ii. assist PMU in obtaining all necessary permissions and complying with statutory requirements;
iii. ensure Contractor submits requirements per EMP and government clearances/permits,
iv. provide support to Contractor in preparing the Contractor's EMP (CEMP) to ensure ADB SPS and conditions in government clearances are incorporated accordingly;
v. assist PMU in updating the EIA for any change in scope, design, location, or unanticipated impacts that are not reported in the EIA;
vi. review any changes in the Contractor's design and support PMU in ensuring environmental assessment, impacts avoidance and mitigation measures are reflected in the CEMP and updated EIA
vii. assist the Contractor and the PMU in all EPA related clearances, and ADB's no-objection, and monitor and control construction and assembly compliance against the updated EIA, ADB's safeguards policy statement (2009), and CEMP;
viii. monitor the contractors' compliance with all safety requirements as stated in DBO contract and CEMP, during and prior to any construction activity.
ix. assist in preparation of accident report and keeping accident records on-site as required;
x. monitor the implementation of the CEMP during construction and pre/post construction phases;
xi. assist PMU in continuing stakeholders engagement, consultantations, information disclosure and addressing complaints/grievances;
xii. develop public awareness program and materials to support wider understanding of

the project, potential impacts and measures to ensure impacts are avoided, mitigated and affected people, if any, are compensated;

xiii. assist PMU in preparation of environmental monitoring reports
xiv. coordinate with external environmental experts on results of independent monitoring and support PMU to prepare corrective actions, if required
xv. provide and organize trainings/workshops/seminars on environmental safeguards, occupational health and safety, and labor standards
xvi. assist PMU in review of contractor's health and safety program and in monitoring its implementation
xvii. support PMU during ADB review missions
xviii. support PMU in developing data management system on environmental safeguards; and
xix. other tasks related to environmental safeguards, occupational health and safety, and labor standards

D.6 Capacity Building of EPA and the Employer's Personnel

23. Given the limited capacity of both the Employer's and EPA's staff to monitor the facility, the Consultant will provide training for the eligible MOE and EPA staff. The timing of the training activities will be aligned with the construction progress and the visits during the Operation Service Period to provide a firm understanding of the built facilities. The waste supplier's personnel will be included as far as necessary.

24. The Consultant's scope will cover the following aspects:

i. Prepare a training program for the Employer's and EPA's staff on monitoring the WtE plant and its ancillary facilities with respect to environmental compliance and best operational performance;
ii. Conduct induction training for the Employer and EPA amongst others on the following subjects relating the design:
    a) Technical design and construction characteristics of the WtE plant built and its ancillaries, particularly the furnace, boiler, turbine and APC system, landfill and leachate treatment;
    b) Continuous emission monitoring systems, its functionality and calibration;
    c) Access to the Plant Information Management System PIMS);
iii. Instruct the EPA and the Employer's staff on relevant H&S aspects, such as
    a) Fire hazards, safety, fighting and alarm system;
    b) Operating highly pressurized vessels;
    c) Handling chemicals, dust and toxic substances;
iv. Detail the operations and maintenance of a WtE plant, amongst others:
    a) Input control and fueling according to stoker capacity diagram and the hereto relating bottle necks (boiler, turbine, bottom ash quality etc.)
    b) Bunker management and mixing of waste for a steady state operations;
    c) Function and malfunction of the CEMS and how to detect those;
    d) Use of the SCADA (or DCS archives) and the interfaces to SCADA via the PIMS for a constant access of data;
    e) Necessary down times for inspection, revision or overhaul and typical annual maintenance schedule (incl. expenses) and its consequences towards the waste delivery;

v. Monitoring the facility is regarded as a primary task of both EPA and the Employer which makes it necessary to enhance the capacity in the following subjects:
   a) Reporting requirements towards the contractor;
   b) Scrutinizing regular reports, e.g. by assessing throughput, steam generation and flue gas volume vs. backwards calculated calorific value;
   c) How to utilize the access to archived SCADA data and to online data via the PIMS;
   d) Calibration records of essential components (weighbridge, crane scales, CEMS);
   e) Operational meetings on the facilities performance;
   f) Solving any potential conflicts prior to arbitration and what to tolerate and where to intervene.

vi. Contract management, such as performance guarantees and damages mechanisms, asset replacement fund utilization, milestones, timeframes for payments, dispute resolution etc.;

25. The training will be complemented by appropriate visits of the construction site and the operating plant to facilitate a better understanding of the characteristics of relevant components that are of a particular importance for EPA and the Employer (such as the continuous emission monitoring system, the APC system, the residue handling etc.).

D.7 Operation Service Period

26. The Consultant will be responsible within the first two years after issuing the commissioning certificate of the WTE facilities and components to assist the Employer to monitor and control the Contractor's performance amongst others in the following areas:

i. Follow up on a timely remediation of defects after issuing of the commissioning certificate and scrutinize the Contractor's final claim for reimbursement of the retention money as per DBO contract provisions;

ii. Assist the Employer in inspecting the facilities and reviewing their performance using the relevant data as per SCADA records or any other records to be made available by the Contractor with respect to
   a) the waste delivery (quality and quantity) and performance of WAMCO's C&D waste processing unit,
   b) the compliance to statutory requirements,
   c) the performance parameters and guarantees as per DBO contract,
   d) the production and quality of bottom ash and prospects of the bottom ash marketing;
   e) the production and contract compliant landfilling of APC residues;
   f) the consumption of supplies;
   g) scheduled down-times of the facility;
   h) the envisaged and applied maintenance;

iii. Suggest appropriate measures (e.g. within the DBO contract) in the event the Contractor fails to meet performance standards/guarantees;

iv. Advise the Employer of any issues identified during visits and suggest rectifications;

v. Prepare reports on each inspection visit;

vi. Upon reasonable request by the Employer, assist in solving occurring contractual issues arising out of the operations.

27. The responsibility of the Consultant will include two visits per year of appropriate staff of a duration of at least two weeks each to accommodate both the inspection and the training needs as per section D.6.

D.8 JFJCM Related Project Components

28. To apply for the Joint Crediting Mechanism (JCM), MoE will define the JCM methodology and prepare a project design document, and monitoring methodology that will be submitted for final approval and registration with the JCM. The Consultant will collaborate closely with MoE and take into consideration the requirements as defined in Annex 1. To obtain the approval, the Consultant will:

i. Draft JCM methodology for the proposed WtE and assist the project management unit (PMU) to have the methodology approved;
ii. Draft a project design document for the proposed JCM project, assist PMU to have the project design document validated, and have the project registered;
iii. Conduct a local stakeholder consultation (LSC) as required for the JCM process.
iv. Conduct a capacity building of the PMU to meet the requirement for the JFJCM including monitoring of GHG emission reductions, drafting a monitoring report, having the monitoring report verified, and requesting issuance of JCM credits;
v. Assist PMU to conduct monitoring and draft monitoring report, have the monitoring report verified, and request issuance of JCM credits;
vi. Train PMU staff in carrying out the JCM monitoring, reporting and verification process.

E Qualification Requirements for the Key Experts & Team Composition

29. **Expected qualification requirements and tasks assigned to the Key Experts:** The Consultant will provide experts to cover all aspects of the facilities as per the contractual agreements either being concluded already or to be tendered (e.g. fire engineering expertise). Because of the nature of a WtE facility, several experts may be required for the one or other field of expertise. It will be within the Consultant's discretion to name as many experts as deemed necessary to cover all elements of the WtE plant and its ancillaries that are subject of this DBO contract. The team composition and minimum requirements are as follow.

30. **Team Composition with estimated Input**: The Consultant team will comprise of International Key-experts (87 person-months), National Key-experts (76 person-months), and non-key experts (33 person-months) excluding those required for Consultant's administrative, clerical and support staff. The Consulting firm will be engaged for 5 years to cover 3.5 years for the DBO design-build and the first two years of the operation service period. The expert's positions with their estimated inputs are provided in Table 2 below.

Table 2: Team Composition

I	International Key Experts	Person Months
1	Team Leader cum WtE Expert	22
2	Financial/Commercial Expert	1.5
3	Site Engineer(s)	32
4	Civil Engineering Experts (infrastructure/structural)	6
5	Process/Mechanical Engineering Experts	7
6	Electrical Engineering Expert	3
7	Instrumentation and Control Engineering Expert	3
8	Environmental Safeguard Expert	6
9	JCM Expert	6
	International Key Experts Sub-Total	**87**
II	**National Key Experts**	
1	Deputy Team Leader/Construction Management Expert	34
2	Financial/Commercial Expert	6
3	Contract Management Expert	6
4	Civil/Structural Engineering Experts	10
5	Mechanical Engineering Experts	7
6	Electrical Engineering Expert	7
7	Environmental Expert	6
	National Key Experts Sub-Total	**76**
III	**Non-Key Experts**	
1	Assistant site engineers (international)	12
2	Other international experts (fire/building service engineers etc.)	6
3	Assistant site engineers (national)	15
	Non Key Experts Subtotal	**33**
	Overall total	**196**

31. **Team Leader cum Waste-to-Energy Expert (International):** The Team Leader cum WtE Expert will be responsible for overall project management and administration, construction supervision, quality control and monitoring, contract management, establishment of construction management and project performance monitoring and reporting system, assist in resolving contractual issues, preparation of progress and other reports as required. Jointly with the team, the Team Leader will fulfill the role of Employer's Representative. The Team Leader cum WtE Expert (International) will preferably i) be graduate mechanical/civil/environmental engineer and post graduate in project management or contract management with a certificate like or similar to PMP®, ii) have at least 15 years of working experience in WtE works of similar complexity and volume (400 tpd or higher, USD 50 million or higher), iii) experience and sound knowledge of FIDIC contract conditions and DBO contract management, and iv) knowledge and experiences in the application of building information modelling (BIM), and experience with international financial institutions (IFI) funded projects will have added advantage.

32. **Financial Expert (International):** The Financial Expert will support the Employer in financial management issues. He/she will work closely and supervise with the Employer in all matters related to the subject. Financial Expert (International) will preferably i) be a post graduate in economics or finance, ii) have at least 15 years of experience in carrying out economic and financial analysis of large (preferably similar) projects, and iii) good knowledge of ADB or other IFIs procedures/policies, and experience in WtE projects will have added advantage.

33. **Site Engineer(s) (International):** The Site Engineer(s) will be the point of contact towards the Contractor and the Employer for all construction related aspects and issues. He/she will

manage all day-to-day activities with the support of the national Deputy Team Leader and specialist construction and assembly supervisors (non-key assistant site engineers, both international and national) as required. He/she will be i) either a technician or a graduate engineer in mechanics/civil engineering with a post-graduate in construction management, ii) have at least 15 years of experience in similar projects and will be familiar with supervising and monitoring a WtE plant's construction site, iii) preferably will have knowledge of FIDIC Gold Book or similar DBO contract packages.

34. **Civil Engineering Experts (International):** Civil Engineering Experts will be responsible for the review and approval of civil engineering designs/drawings/details submitted by the Contractor. They will assist in monitoring and ensure quality assurance and control. Civil Engineering Experts (International) will preferably i) be graduates in civil engineering, and, as required per, expertise with post graduates in structural engineering, geotechnics, landfill engineering etc. ii) have 10 years of experience in the relevant design and design review in similar work environments, iii) be versed in the application of relevant CAD tools, iv) construction supervision, design and implementation related to similar works in low-lying land, knowledge of BIM and related tools will have added advantage.

35. **Process or Mechanical Engineering Experts (International):** Process or Mechanical Engineering Experts will be responsible for review of design, drawings and data, technical specifications and PI&Ds prepared by the Contractor, ensure quality assurance and quality control. They will assist in resolving technical and contractual issues. Process or Mechanical Engineering Experts (International) will preferably be i) post graduates in process/mechanical engineering, ii) have 10 years of experience in process or mechanical engineering related to WTE facilities such as, but not limited to, cranes, furnace, boiler, turbine and water steam system, APC system etc., iii) be familiar with the application of relevant process engineering and CAD applications, and iv) construction supervision and implementation of works related to WtE facilities and knowledge of BIM will be regarded as advantage.

36. **Electrical Engineering Expert (International):** Electrical Engineering Expert will be responsible for review and approval of designs, drawings, specifications and data, ensure quality assurance and quality control, assist in resolving technical and contractual issues. Electrical Engineering Expert (International) will preferably i) post-graduate in electrical engineering, ii) have 10 years of experience in electrical engineering designs of similar projects, 5 years thereof in the WtE field, and iii) construction supervision and implementation of works related to WtE plants will have added advantage.

37. **Instrumentation and Control Engineering Expert (International):** Instrumentation and Control Engineering Expert will be responsible for review and approval of lay-out, design, drawings, data related to SCADA/DCS, ensure quality assurance and quality control of SCADA/DCS design and implementation, assist in resolving technical and contractual issues. Instrumentation and Control Engineering Expert (International) will preferably i) hold a post-graduate in instrumentation & control engineering, ii) have 10 years of experience in instrumentation and control engineering design and implementation, 5 years thereof in the field of WtE facilities, iii) be versed in the application of relevant process engineering and CAD applications, and iv) experience in construction supervision in the WtE field will be regarded as advantage.

38. **Environmental Safeguard Expert (International):** Environmental Expert will be responsible for management and supervision of environmental safeguard requirements in line with the

Contract, EIA including ADB SPS (2009) and the Government of Maldives. Among the responsibilities will be the preparation and implementation of environmental safeguard action plan, review of the (updated) EIA report, monitor the implementation of the CEMP. Environmental Safeguard Expert (International) will preferably i) be graduate in civil engineering, environmental science, structural engineering, environmental management or related field. Post graduate degree related to the field will be an advantage; ii) have 10 years of experience in preparing, and/or carrying out EIA/IEE/EMP, 5 thereof in WtE facilities-related projects, and iii) good knowledge of ADB or other IFI safeguards policies, design and construction with respect to implementation of environmental safeguards will have added advantage.

39. **JCM Expert (international):** The expert will have experience in carbon offset mechanisms and knowledgeable in rules on the Joint Crediting Mechanism (JCM). The expert will have a bachelor's degree in science, environment, or engineering; with 10 years of post-qualifying experience; have worked in at least two JCM or similar activities, to develop documents, prepare trial calculations and measurement systems, to establish the emission reductions accrued. The consultant will have experience in developing methodologies that have been approved under the JCM scheme preferably. Knowledge and experience of waste to energy system are assets. The qualification will be verified by JFJCM Secretariat of the ADB.

40. **Deputy Team Leader Cum Construction Management Expert (National):** Deputy Team leader cum Construction Management Expert will assist the international team leader, will support in overall project management and administration, construction supervision (jointly with the international site engineer(s)), quality control and monitoring, contract management, establishment of construction management and project performance monitoring and reporting system, assist in resolving contractual issue, preparation of progress and other reports as required. Deputy Team Leader cum Construction Management Expert (National) will preferably i) be graduate mechanical or civil engineer and post graduate in engineering or management, ii) have 10 years of working experience in leading and managing construction and/or turn-key projects and iii) sound knowledge of FIDIC contract conditions and contract management will be preferred. Experience in externally funded projects will have added advantage.

41. **Contract Management Expert (National):** Contract Management Expert will support the management and administration of the Project effected by the Team Leader and Deputy Team Leader. He/she will assist in establishment of the contract management and reporting system. He/she will elaborate an adequate documentation on contract administration, time & cost control, variations and change orders, billing & payments to the contractors. He/she will be responsible for documentation to ensure adequate progress of works, control the project and minimize the cost over-run and time over-run, timely review and disposal of contractor's claims. Will assist in resolving contractual issue and dispute resolutions during implementation. Contract Management Expert (National) will preferably i) be graduate in process, mechanical, or civil engineering and post graduated in contract management, ii) have 10 years of experience in contract administration related to procurement of Works and Goods for urban infrastructure projects, and iii) sound knowledge of FIDIC contract conditions and experience with IFIs will be regarded as advantage.

42. **Civil/Structural Engineering Experts (National):** Civil/Structural Engineering Experts (National) will assist the international Civil Engineering Experts in the review of the design of all civil/structural engineering elements as required and as submitted by the Contractor. Civil/Structural Engineering Experts (National) will preferably i) be graduate civil engineers,

and will be post-graduated in structural, geotechnical, building services engineering, ii) have 7 years of experience in civil/structural, geotechnical and building services engineering , iii) be versed in the application of relevant CAD tools, and iv) construction supervision, design and implementation related to similar works. Experience in externally funded projects will have added advantage.

43. **Mechanical Engineering Expert (National):** Mechanical Engineering Expert will assist the international Process/Mechanical Engineering Experts in the review of the design of all process and balance of plant related documents and drawings and P&ID as required and submitted by the Contractor. Mechanical Engineering Expert (National) will preferably i) be post graduated mechanical engineer, ii) have 10 years of experience in mechanical designs and implementation of goods and plants in multi-lot projects, iii) be versed in the application of relevant CAD tools, and iv) construction supervision of similar works will be preferred. Experience in externally funded projects will have added advantage.

44. **Electrical Engineering Expert (National):** Electrical Engineering Expert will be responsible for review and approval of designs/drawings/details as submitted by the Contractor, for the quality assurance and quality control and resolving contractual issued related to his/her field of expertise. The Electrical Engineering Expert (national) will assist the international expert in reviewing the electrical engineering design and the documentation, drawings and specifications submitted by the Contractor. Electrical Engineering Expert (National) will preferably i) be a graduate electrical engineer, preferably post graduate in control engineering, ii) have 10 years of experience in electrical design and implementation in multi-lot projects, iii) be versed in the application of relevant CAD tools, and iv) construction supervision of similar works will be preferred.

45. **Environmental Safeguard Expert (National):** The national Environmental Safeguard Expert will support the PMU and the international Environmental Safeguard Expert in the overall management and implementation of environmental safeguard policies of ADB and the Government of Maldives. Environmental Safeguard Expert (National) will preferably i) be graduate in civil engineering, structural engineering, environmental engineering, environmental management, environmental science or related field. ii) have minimum of 5 years work experience on monitoring/supervision capacity, and iii) sound knowledge of ADB procedures and policies, design and construction supervision, design and implementation of similar works will be preferred.

46. **Non-key experts and supporting staff:** The Consultant is expected to deploy non-key experts having qualifications and experience as necessary to deliver the project, such as, but not limited to:

    i. International engineers to support the design review, to attend the factory acceptance testing, the commissioning procedures etc. of the DBO contract's scope;
    ii. National and international site engineers;
    iii. CAD operators and office support staff.

F Reporting Requirements and Time Schedule for Deliverables

47. **Reporting Requirements:** During the performance of the services, the Consultant will prepare required reports for submission to the Employer/Client in electronic form and/or hard copies as per Employer's instructions and in English language. The report format will be consistent with the requirements of ADB and Government of Maldives and will be proposed by the

Consultant in its inception report. The reporting formats will be subject to amended time-to-time in consultation with the Client. As a minimum the Consultant will submit following reports at periods stated in Table 3 hereunder.

Table 3: Reporting Requirements

Reports	Number of Copies	Time Schedule
Inception Report	Electronic copy only	Within a period of 30 days from the date of issuance of Notice to Proceed.
Monthly Progress Reports	Electronic copy only	Every month within 5 days of the commencement of next calendar month.
Quarterly Progress Reports	Electronic copy only	Every quarter within 10 days of commencement of next quarter.
Annual Progress Report	Electronic copy and 3 hard copies	Every year within 15 days of commencement of next year. For the purpose of Annual Progress Report the year will mean and refer either to Calendar year or other suitable period as the Client may decide in consultation with the Consultant.
Draft Completion Report	Electronic copy and 3 hard copies	Within 30 days of completion of Consulting Services Assignment.
Final Completion Report	Electronic copy and 3 hard copies	Within 30 days of issuance of Client's comments on Draft Completion Report.
Training programme for the capacity building	Electronic copy	At least 30 days prior to the commencement of the first training session
Any other reports	As required	As and when required by the Client.

G Employer's Input and Counterpart Personnel

48. Services, facilities and property will be provided by the Employer: Office accommodation with power and water supply for office establishment on site and in Malé.

49. Professional and support counterpart personnel will provided by the Employer.

H Inputs, Project Data and Reports to Facilitate Preparation of the Proposals

50. The Consultant will have access to the following inputs, project data and reports available with Client to facilitate preparation of the Proposals:

    a) Data, reports, maps etc. as available with the Employer;

    b) Feasibility reports, design reports and drawings as available with the Employer.

51. Any other input the Consultant deems necessary and the Employer is able to share will be provided upon request by the Consultant.

I Commencement of the Assignment

52. It is envisaged that the assignment will start three months prior to awarding the DBO contract (pls. refer to clause **Error! Reference source not found.**) to allow the Consultant to familiarize with the Contract.

ANNEX 1: REQUIREMENTS FOR EXECUTING AND IMPLEMENTING AGENCIES OF THE JAPAN FUND FOR THE JOINT CREDITING MECHANISM (JFJCM) GRANTS

1. The Ministry of Environment (MOE) will be responsible for developing a Waste to Energy plant project in Thilafushi under Greater Male Waste to Energy Project in the Maldives as a joint crediting mechanism (JCM) projects, and for fulfilling requirements as the project participant of the JCM project.

2. MOE will develop the JCM methodology and submit it to the JCM Joint Committee (JC) for approval. In case the methodology is not approved, MOE will revise the methodology and make best efforts to have it approved by the JC. Methodology approval is to be achieved before JCM project registration.

3. Upon methodology approval, MOE will prepare a project design document (PDD), hire an accredited third-party entity (TPE) to validate the project, and submit the project for registration to the JC. In case the project is not registered, the MOE will make necessary revisions to the PDD considering comments received and make best efforts to have the project registered. Project registration is to be achieved before commissioning of the project supported under the JFJCM.

4. MOE will monitor the project in line with the PDD and prepare a monitoring report at least once a year, based on the recorded monitoring data. The monitoring report will be reported to ADB. MOE will monitor the JCM project from commissioning until the end of the project operation or the expiry of the JCM bilateral document between the Maldives and Japan, whichever is earlier.

8. The Waste to Energy project supported under the JFJCM cannot apply for any other international carbon market mechanisms.

[redacted]

Appendix 20

GREATER MALÉ ENVIRONMENTAL IMPROVEMENT AND WASTE MANAGEMENT PROJECT
PHASE TWO: WASTE TO ENERGY (WTE) PLANT

Draft Terms of Reference for an Independent Environmental Monitor (IEM) (Subject to Finalization)

I. BACKGROUND

1. The Government of the Maldives is commissioning a design, build and operate (DBO) Contract for a Waste-to-Energy (WTE) Facility Project for the Greater Malé region to help in managing solid waste. The WTE Facility Project will be set up on the island of Thilafushi, Kaafu Atoll in the Greater Malé area. The project will be funded by the Asian Development Bank (ADB) and Asian Infrastructure Investment Bank (AIIB).

2. A concept design for the WTE Facility Project has been prepared by an engineering firm commissioned by the Maldives Ministry of Environment (ME). According to the concept design, the initial capacity of the facility shall be 167,000 Mg/y (two trains 250 tons per day or 10.5 tons per hour each), which then can be extended by a third train. Baled waste will be used as buffer to accommodate any waste volume fluctuations.

3. In relation to environmental management, the project is classified as Category A project per ADB Safeguard Policy Statement (SPS). The Category A classification derives from the project's likely significant adverse environmental impacts to air and marine environment that are irreversible, diverse, or unprecedented. Such classification requires the need of an independent external monitor or IEM.

4. The IEM shall be retained as an international expert under the WTE Facility Project with non-objection from ADB, and will report directly to ADB. The IEM shall not be involved in the day-to-day project implementation or supervision of the project. The IEM will closely coordinate his/her site visits and work with the project management unit (PMU).

II. PURPOSE.

5. An environmental impact assessment (EIA) report has been prepared for the project. The EIA contains an environmental management plan (EMP) developed to address the potential impacts and risks identified by the environmental assessment. The EMP includes the proposed mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators. This will be updated by the DBO Contractor based on the final detailed design, including the construction methods and materials to be used. The IEM will monitor compliance of the project in implementing the EMP.

III. DURATION

6. The engagement of the IEM shall commence on the Commencement Date of the DBO contract and end at the conclusion of the defects notification period following Commissioning of the plant. This duration is expected to be sixty (60) months. The engagement of the IEM may be

extended and should this be the case, notification of such an extension will be provided at least six (6) months before the expected date of the Commissioning Certificate.

7. The work will involve an initial visit of two months prior to or during the DBO Contractor mobilization, and every six months visits thereafter. Home office time will be allocated to report preparation and handling comments and questions from reviewers.

IV. QUALIFICATIONS

8. The IEM shall have the following qualifications:

(i) Degree in engineering, chemistry, environmental management or a related field. Masters or doctorate degree will be preferable.
(ii) Has extensive experience with day-to-day management and/or monitoring of incineration plants of municipal solid wastes, or other facilities involving incineration, and reporting of regular monitoring against the relevant emissions standards.
(iii) Prior experience on monitoring ADB-funded projects is preferable.

V. DUTIES

9. The IEM shall have the following duties:

(i) Become familiar with the project, including the EIA report and implementation arrangements for the project.
(ii) Contribute to the review of the updated EMP following the final detailed design, and provide comments and recommendations as necessary relating to (i) the adequacy of monitoring arrangements, (ii) the construction work method statements and (iii) the proposed mitigation measures to address newly identified negative environmental impacts and risks.
(iii) Review monthly environmental monitoring reports submitted by the Contractor to the project management unit (PMU) and quarterly environmental monitoring reports of PMU to ADB.
(iv) Inspect the project construction works and following construction, plant operations (depending on final arrangements in the future) every six months, assess the environmental impacts of the project based on the EMP and any other critical issues that may arise, and prepare a report on the findings.
(v) Recommend improvements to effectively implement the EMP and provide professional opinion on the degree of impacts, if any.
(vi) When on site, comply with all health, safety and welfare requirements, and participate in project meetings as required.
(vii) Submit all findings and reports directly to ADB.

VI. INDICATIVE COST

Cost Item	Description	Unit Cost (US$)	Total (US$)
A. Remuneration	Retention of international consultant for 77 equivalent days[1]	1,000.00	77,000.00
B. International Travel	11 international travels[2]	5,000.00	55,000.00
C. Per diem	Field work in Maldives for total of 55 days[3]	288.00.	15,840.00

Cost Item	Description	Unit Cost (US$)	Total (US$)
D. Miscellaneous Travel Expenses	Lump sum per international travel[4]	150.00	1,650.00
E. Contingency	5% of total cost		7,474.50
Grand Total			**156,964.50**

[1] (5 field working days + 2 home office days) for each monitoring activity
[2] 1 international travel prior to DBO Contractor mobilization plus 10 international travels for the next 5 years
[3] average of 5 field working days per monitoring activity
[4] lump sum of $150 per international travel

SAMPLE Quarterly Environmental Monitoring Report Template

1. INTRODUCTION

- Overall project description and objectives
- Environmental category as per ADB Safeguard Policy Statement, 2009
- Environmental category per national laws and regulations
- Project Safeguards Team

Name	Designation/Office	Email Address	Contact Number	Roles
1. PMU				
2. Consultants				

- Overall project progress and status
- Description and status of implementation (preliminary, detailed design, on-going construction, completed, and/or O&M stage)

Components/List of Works	Contract Status (specify if under bidding or contract awarded)	Status of Implementation (Preliminary Design/Detailed Design/On-going Construction/Completed/O&M)[1]	If On-going Construction	
			%Physical Progress	Expected Completion Date

[1] If on-going construction, include %physical progress and expected date of completion

2. COMPLIANCE STATUS WITH NATIONAL/STATE/LOCAL STATUTORY ENVIRONMENTAL REQUIREMENTS[2]

Statutory Environmental Requirements[3]	Status of Compliance[4]	Validity if obtained	Action Required	Specific Conditions that will require environmental monitoring as per Environment Clearance, Consent/Permit to Establish[5]

3. COMPLIANCE STATUS WITH ENVIRONMENTAL LOAN COVENANTS

No. (List schedule and paragraph number of Loan Agreement)	Covenant	Status of Compliance	Action Required

4. COMPLIANCE STATUS WITH THE ENVIRONMENTAL MANAGEMENT PLAN (REFER TO EMP TABLES IN APPROVED EIA REPORT)

- Confirm submission of Contractor's EMP (CEMP) by DBO Contractor.

EIA Documentation Status

DBO Contract Number	Final EIA Report based on Detailed Design				CEMP approved by Project Director? (Yes/No)	Remarks
	Not yet due (detailed design not yet completed)	Submitted to ADB (Provide Date of Submission)	Disclosed on project website (Provide Link)	Final EIA report provided to DBO Contractor (Yes/No)		

- For the DBO Contractor, provide name/s and contact details of contractor's EHS Manager and trained engineers on EHS, EMP and CEMP implementation.

[2] All statutory clearance/s, no-objection certificates, permit/s, etc. should be obtained prior to award of contract/s. Attach as appendix all clearance obtained during the reporting period. If already reported, specify in the "remarks" column.
[3] Specify (environmental clearance? Permit/consent to establish? Etc.)
[4] Specify if obtained, submitted and awaiting approval, application not yet submitted
[5] Example: Environmental Clearance requires ambient air quality monitoring, etc.

DBO Contractor's Focal Persons for Environmental Safeguards

DBO Contract Number and Project Name	DBO Contractor	Focal Persons (EHS Manager / Trained Engineers)	Email Address	Contact Number

- With reference to approved EMP/CEMP, complete the table below

Summary of Environmental Monitoring Activities (for the Reporting Period)[6]

Impacts (List from EIA Report)	Mitigation Measures (List from EIA Report)	Parameters Monitored (As a minimum those identified in the EIA Report should be monitored)	Method of Monitoring	Location of Monitoring	Date of Monitoring Conducted	Name of Person Who Conducted the Monitoring
Design Phase						
Pre-Construction Phase						
Construction Phase						
Operational Phase						

[6] Attach Laboratory Results and Sampling Map/Locations

Overall Compliance with EMP/ CEMP

No.	DBO Contract Number and Project Name	EMP/ CEMP Part of Contract Documents (Y/N)	CEMP/ EMP Being Implemented (Y/N)	Status of Implementation (Excellent/ Satisfactory/ Partially Satisfactory/ Below Satisfactory)	Action Proposed and Additional Measures Required

5. APPROACH AND METHODOLOGY FOR ENVIRONMENTAL MONITORING OF THE PROJECT

- Briefly describe the approach and methodology used for environmental monitoring of the project.

6. MONITORING OF ENVIRONMENTAL IMPACTS ON PROJECT SURROUNDINGS (AMBIENT AIR, WATER QUALITY AND NOISE LEVELS)

- Discuss the general condition of surroundings at the project site, with consideration of the following, whichever are applicable:
    - Confirm if any dust was noted to escape the site boundaries and identify dust suppression techniques followed for site/s.
    - Identify if muddy water is escaping site boundaries or if muddy tracks are seen on adjacent roads.
    - Identify type of erosion and sediment control measures installed on site/s, condition of erosion and sediment control measures including if these are intact following heavy rain;
    - Identify designated areas for concrete works, chemical storage, construction materials, and refueling. Attach photographs of each area in the Appendix.
    - Confirm spill kits on site and site procedure for handling emergencies.
    - Identify any chemical stored on site and provide information on storage condition. Attach photograph.
    - Describe management of stockpiles (construction materials, excavated soils, spoils, etc.). Provide photographs.
    - Describe management of solid and liquid wastes on-site (quantity generated, transport, storage and disposal). Provide photographs.
    - Provide information on barricades, signages, and on-site boards. Provide photographs in the Appendix.
    - Indicate if there are any activities being undertaken out of working hours and how that is being managed.

- Briefly discuss the basis for environmental parameters monitoring.
- Indicate type of environmental parameters to be monitored and identify the location.
- Indicate the method of monitoring and equipment used.
- Provide monitoring results and an analysis of results in relation to baseline data and statutory requirements.

As a minimum the results should be presented as per the tables below. Complete parameters should follow the recommendations in the EIA report.

Air Quality Results

Site No.	Date of Testing	Site Location	Parameters (Recommendations of the EIA)				
			PM10 µg/m3	PM2.5 µg/m3	SO2 µg/m3	NO2 µg/m3	Hg µg/m3

Marine Water Quality Results

Site No.	Date of Sampling	Site Location	Parameters (Recommendations of the EIA)					
			pH	Conductivity µS/cm	BOD mg/L	TSS mg/L	TN mg/L	TP mg/L

Noise Quality Results

Site No.	Date of Testing	Site Location	LA_{eq} (dBA) (WHO Standards)	
			Day Time	Night Time

7. GRIEVANCE REDRESS MECHANISM

- Provide information on establishment of grievance redress mechanism and capacity of grievance redress committee to address project-related issues/complaints. Include as appendix Notification of the GRM.

8. COMPLAINTS RECEIVED DURING THE REPORTING PERIOD

- Provide information on number, nature, and resolution of complaints received during reporting period. Attach records as per GRM in the approved EIA report. Identify safeguards team member/s involved in the GRM process. Attach minutes of meetings (ensure English translation is provided).

9. SUMMARY OF KEY ISSUES AND REMEDIAL ACTIONS

- Summary of follow up time-bound actions to be taken within a set timeframe.

10. APPENDIXES

- Photos
- Summary of consultations
- Copies of environmental clearances and permits
- Sample of environmental site inspection report
- all supporting documents including **signed** monthly environmental site inspection reports prepared by consultants and/or contractors
- Others

SAMPLE ENVIRONMENTAL SITE INSPECTION REPORT

Project Name
Contract Number

NAME: _____ DATE: _____
TITLE: _____
LOCATION: _____

WEATHER CONDITION:
_____

INITIAL SITE CONDITION: _____

CONCLUDING SITE CONDITION:

Satisfactory _____ Unsatisfactory _____ Incident _____Resolved _____ Unresolved _____

INCIDENT:
Nature of incident:
_____

Intervention Steps:
_____

Incident Issues

Resolution

Project Activity Stage	Survey	
	Design	
	Implementation	
	Pre-Commissioning	
	Guarantee Period	

Inspection

Emissions	Waste Minimization
Air Quality	Reuse and Recycling
Noise pollution	Dust and Litter Control
Hazardous Substances	Trees and Vegetation

Site Restored to Original Condition Yes ☐ No ☐

Signature
_____

Sign off

_____ _____

Name **Name**
Position **Position**

Appendix 22

[redacted]

PEMPHIS .48

Environmental Newsletter
Ministry of Environment and Energy

INVASIVE ALIEN SPECIES

Editor's Note

In this edition, Pemphis undertakes to highlight the obscure but important issue of Invasive Alien Species (IAS). We have always been concerned about our heritage, tradition and culture by our ancestors; but have we pondered about the identities and traits of our ecosystem?

The set of species inhabited in Maldives living in harmony and equilibrium over the generations are now challenged with **Invasive Alien Species**, since some species introduced to the Maldives have the ability to survive, reproduce and compete with native species.

The impacts does not confine to detriments to the ecosystem alone but is associated with illegal issues of trafficking of wildlife, drugs, and business fraud as well.

Pemphis greatly acknowledges the time and contribution provided by Maldives Customs Service for this edition. Senior Superintendent of Customs, Hussein Hameed shared some valuable insights and concerns regarding the issue of Invasive Alien Species and its associated problems.

Hope you all would find out more on " Invasive Alien Species" and its associated concerns from this month's issue.

Wish you all a safe and blessed days ahead.

Feedbacks, comments, articles, photos, etc .
environment@environment.gov.mv

"Invasive species are a major threat to biodiversity. Given the way they quickly become established and spread, measures taken by one Member State can have no eff ect if neighbouring countries fail to take action or respond in an uncoordinated manner. The ecological, economic and social consequences of the spread of invasive species for the EU countries are serious and need a harmonised response." EU Environment Commissioner Stavros Dimas

Ministry of Environment and Energy organized a stakeholder consultation meeting on invasive alien species on the 8th of this month. Participants which include government ministries and enforcement agencies expressed their concern over the issue. To conclude the meeting Director General of Environment Ministry Mr. Mohamed Zahir remarked upon the importance of putting a cooperative effort in addressing the issue.

Invasive Alien Species

"Invasive alien species (IAS) are species whose introduction and/or spread outside their natural past or present distribution threatens biological diversity." Convention on Biological Diversity

Basic Rule: Arrive, Survive & Thrive

For an alien species to become invasive, its introduced habitat should complement its survivability and reproducibility. However, it must also out-compete the native organisms and spread through and increase its population in its new environment. The local ecosystem can be subjected to negative impacts since this causes disruptions and alterations in the food chain and other associated biological features.

Common Characteristics of IAS

Rapid reproduction and growth
High dispersal ability
Phenotypic Plasticity *(Phenotypic Plasticity: ability to adapt physiologically to new conditions)*
Ability to survive on various food types and environmental conditions.

The Giant African snail, *Achatina fulica*, or locally referred to as "Finihaka" is said to make its mark in the Maldives in the 1960s. Upon the introduction, its population is known to increase dramatically. It is considered as a garden pest but with it can reproduce to such numbers to cause public nuisance. The Giant African snail can alter the habitat properties by feeding on the native plants. Furthermore it is known to out-compete the native snail population as well. It can also act as a vector of human pathogens and parasites.

Coconut Hispid Beetle, *(Brontispa longissima)* distresses seedlings, mature coconut trees and other palms, specifically palms up to five years old are at the greatest risk of infestation.

The beetle is known to attack the closed young fronds of the palm. As the spear unfurls the beetle moves on to other palms or the next emerging spear. Coconut hispid beetle invasion can kill the underlying tissue and reduce the leaf photosynthesis of the leaflets. Infestations may result in the complete defoliation of the palm and in worst cases palms can die.

The beetle was introduced to the Maldives in the late 1990s from ornamental palms imported from Malaysia and Indonesia. It is believed that these originated from adult or immature stages of the pest that were concealed in these palms. Even with the fragmented and isolated geography of the nation the beetle had spread to several islands in a year's period. A severely affected resort of Maldives has reported to have incurred direct economic loss of over US$ 200,000 within a period of 3 years.

Impacts of Invasive Alien Species

Predicting the progress and consequences of a biological invasion is a difficult endeavour packed with complex variables and uncertainties.

IUCN describes the impacts of alien invasive species as **"immense, insidious and usually irreversible".**

American botanist Warren Wagner of Michigan University explains the difficulty of predicting the effects of invasive alien species before it's arrival and invasion
"Nothing is more difficult than to predict what will happen to an exotic"

Impacts: Ecological and Environmental

Alien Invasive Species can impact the environment at all levels of organization including gene, species, habitat and ecosystem.

Gene Pool

Same as humans, it is important to recognize that each organism is genetically unique with respect to the habitat and nature of the ecosystem.

"If introduced or spread into habitats with closely related species, alien invasive species could interbreed with native species resulting in changes to the genetic makeup of either species (Secretariat of the Convention on Biological Diversity, 2003)."

Possible negative consequences of alterations in gene pool:

- Reduction in the survival of either species
- Creation of a more successful invader
- Creation of hybrids that could be more susceptible to certain pests and pathogens
- Loss of gene pools

Ecosystems

The impacts of alien invasive species at the ecosystem level include changes to trophic structures, changes in the availability of resources such as water and nutrients, and changes in the disturbance regimes (McNeely et al., 2001; Secretariat of the Convention on Biological Diversity, 2003a).

Species

Invasive alien species can influence species diversity, richness, composition and abundance. At the species level, direct effects of alien invasive species occur through processes such as the predation of, competition with, and pathogen and parasite transmission to individual organisms, eventually leading to population declines and species extinctions (Loehle, 2003; Secretariat of the Convention on Biological Diversity).

Habitats

Through their impacts on species and ecosystem processes, alien invasive species can result in the fragmentation, destruction, alteration or complete replacement of habitats which in turn, has cascading effects on even more species and ecosystem processes (McNeely et al., 2001; Secretariat of the Convention on Biological Diversity, 2003a).

Ecosystems

Changes subjected to the ecosystem can include changes to trophic structures, changes in the availability of resources, etc.

Economy

Economic impacts can be either direct or indirect. Direct costs are of those related to mechanisms adopted in controlling the spread of invasive species, while the degradation of ecosystem services can be accounted as the indirect.

Social & Health

These species often triggers skin complications, while they act as vectors for dangerous pathogens and diseases. Loss of food sources and decrease of land value are often associated with the introduction of invasive species.

Asian Tiger Mosquito, *(Ades albopictus)* native to South East known to carry over 20 highly dangerous human pathogens such as dengue, yellow fever and chikunguya was introduced to Europe in the form of eggs on used tyres or heavy duty equipment. Regular mosquito outbreaks have been reported across western and southern Europe, where it poses a major health risk.

Since the 17th Century invasive alien species is accountable to nearly 40% of all animal extinctions for which the cause is known

-UNEP-

Through direct impacts on species or through alterations of habitats, invasive alien species are responsible for placing 762 forest species at risk (IUCN, 2005). The loss of such species is leading to a more homogenous world which is perhaps the biggest threat to global biological diversity, behind habitat loss

(Perrings, Williamson and Dalmazzone, 2000; McNeely et al., 2001; Richardson and Rejmánek, 2004).

Miconia
Miconia calvescens

-Shades out native plants and completely takes over forests

-Shallow root systems encourage erosion -Decreases the amount of rainwater into the watershed

-The seeds spread easily through animals and even through dirt/mud stuck in vehicles, shoes, clothing, etc.

Has overtaken two-thirds of Tahiti's Forests, since its introduction in 1937 and is directly responsible for threatening 25% of their native forest species with extinction.

Invasive alien species are often associated with many emerging infectious diseases such as **Lyme disease, Ebola, Marburg hemorrhagic fevers, malaria, yellow fever, leishmaniasis, trypanosomiasis** and **Kyasanur forest disease**

(Morse, 1995; Sanchez et al., 1995; Wilson, 1995; Daszak, Cunningham and Hyatt, 2000; Chivian, 2001; Chivian, 2002; Cinco et al., 2004).

Giant Hogweed Plant
Heracleum mantegazzianum

Has been introduced to countries as an ornament. The plant has the potential to readily disperse and can grow along roadsides, ditches and streams. It contains high toxins which can cause severe dermatitis and burns when exposed to sunlight. If in contact with the eyes it can cause blindness to the eyes. Each year in Germany alone, 6 to 21 million Euros are spent for eradication and medical treatment. With its dense impenetrable strands, it can also reduce the biological diversity of the native plant species.

80% of the threatened species in the Fynbos biome of South Africa are endangered due to invasions by alien species

North American Red Swamp Crayfish,
Procambarus clarkii

The North American red swamp crayfish, *(Procambarus clarkii)*, was originally introduced into Europe for use in aquaculture. Having escaped into freshwater streams, this aggressive species has since spread across several EU countries, actively colonizing new territories at the expense of rarer native crayfish, such as ***Austropotamobius pallipes*** which is listed in the Habitats Directive. Apart from causing local extinctions, the red swamp crayfish is also a carrier of a fungus-like organism that is wiping out entire populations of European crayfish. The disease alone is estimated to have an economic cost of over €53 million/year.

Annual environmental losses caused by introduced pests in the US, UK, Australia, South Africa, India, Brazil have been calculated at over **US$100 billion**

-CBD-

It is estimated that US spends around 80 Billion to combat biological invaders.

Islands & Invasive Alien Species

As an island nation with dispersed and isolated geographical characters, Maldives limits immigration of new species, allowing established species to evolve with few strong competitors and predators. However, through human activity invasive alien species can be introduced causing dramatic changes to the island ecosystems. Island ecosystems are more prone to invasion by alien species with the lack of natural competitors and predators.

Being a small island developing state the issue threatens the fragile ecosystem, livelihood, economy and the wellbeing of its citizens.

Common pathways for the arrival of IAS

Ship ballast water, hull fouling, cargo containers and packaging materials, unprocessed commodities such as timber/agricultural goods, imported food species such as fish, horticultural/plant imports, waste material, military activities, and biological agents to combat pests.

Island Birds & IAS

Invasive alien species are stated among the most common threat to the avifauna of islands. Introduced rats, cats and diseases are accounted for half of the global bird extinctions over the past 500 years.

Invasive alien plants and trees have decreased water supplies for nearby communities and increased fire hazards in South Africa (McNeely et al., 2001; van Wilgen et al., 2001; Petit et al., 2004)

Australian Acacia species, such as *A. cyclops* and *A. saligna*, have radically altered nutrient cycling regimes in nutrient poor ecosystems due to their ability to fix atmospheric nitrogen (van Wilgen et al., 2001).

Island birds & IAS

Invasive species are among the most common threat to global avifauna and islands in particular. Invasive alien species, mostly from introduced rats, cats and diseases are responsible for half of the global bird extinctions over the 500 years.

Bird Life International

ScrewPine. *Pandanas*

Screwpine or locally referred to as Kashikeyo have been one of the core ingredients in many delicacies in Maldives. With the absence of common staple foods in the World War II, it is known that Maldivian communities relied on Screwpine to fill the void.

The native species of the screwpine are now threatened with the introduction of alien specimens. It is believed that these specimens were first introduced from a Caribbean country and distributed throughout the Maldives. Since the introduced screwpines had preferable features over the natives, farmers tend to promote the introduced foreign species of screwpine. At present the local vegetable and fruit market is occupied by these alien specimens, side-lining the natives.

Countering the issue of Invasive Alien Species

Each invasive alien present deserves individual management plans with respect to the habitat and environmental conditions.

Counter actions can be categorized into prevention, mechanical, chemical, biological, indirect and integrated.

Prevention

As a rule of thumb, prevention is the most cost-effective method against the issue of alien invasive species. Throughout the world, governments have imposed stringent laws and regulations to minimize the entry of invasive species. Common practices under prevention can be custom checks, shipment inspections and quarantine. Awareness of the general public is important for successful implementation of preventive measures.

Mechanical

These methods include use of machines, hand picking, soil tillage, trapping, shooting, etc.

Biological Methods

Biological control includes various methods which is associated around the use of a living organism as a predator with the aim of controlling a particular target alien invasive species.

Control strategies of biological means include:

Introduction (classical biological control) of a herbivore or parasite from the 'pest's' area of origin;
Inoculation - repeated releases (of sterile males, for example) so as to prevent pest build-up;
Inundation - where large numbers of natural enemies are cultured and released during critical periods in the life cycle of the crop or other alien species;
Conservation - where measures are taken to conserve and enhance the numbers of natural enemies already present in an area thus decreasing the mortality of the affected species; and
Augmentation - where natural enemies of a pest are at too low a level and the numbers are augmented by artificial rearing and release.

Chemical Methods

Herbicides/Pesticides: The most widely used method in eradicating unwanted animals and plants.

Anti-Coagulant poisons: Used to eradicate rodents by effectively blocking the vitamin K cycle, inhibiting the ability to produce essential blood-clotting factors.

Immunization: Animals are given immunization doses to combat from potential invasive species. In Ontario, raccoons and skunks are immunized to prevent the rabies virus.

Impeding reproductive ability: The method utilizes hormones to lower the reproductive potential of the species.

Pheromones: uses traps based on chemicals produced by the target species to attract members of the same species.

Pimentel, Zuniga and Morrison (2005) estimates that the 50 000 alien species in the United States cost almost US$120 billion in environmental damages and losses yearly. Pimentel et al. (2000) gave an estimate of US$137 billion per year.

Pimentel et al. (2001) looked at over 120 000 alien species of plants, animal and microbes that have invaded Australia, Brazil, India, South Africa, the United Kingdom and the United States causing significant economic losses in the agriculture and forest sectors and negatively affecting ecosystems. They estimated that the total cost in the six countries was US$314 billion in damages per year - Australia ($13 billion), Brazil ($50 billion), India ($116 billion), South Africa ($7 billion), the United Kingdom ($12 billion) and the United States ($116 billion).

OTA (1993) concluded that about 4 500 exotic species occur in the United States and that about 20 percent of them have caused serious economic and environmental harm. The cumulative loss caused by 79 of these species was estimated at almost US$97 billion for the period 1906 to 1991.

Pemphis Talk

Pemphis meets Senior Superintendent of Maldives Customs Service.

Hussain Hameed

Procedure followed by Customs when dealing with imported species

Since Customs is an enforcement agency, we follow laws and regulations set by policy making institutes. As per norm, Customs will ensure the species to be imported have been granted permissions from the relevant institutes.

If the species is found to be illegal, Customs will confiscate the species and handover to the relevant authorities; in required cases, extermination of the species will be carried out in presence of the relevant authorities.

Experience sharing of Customs with other countries:

Illegal doings along the border are shared with Regional Intelligence Liaison Office, World Customs Organization and countries of interests as well.

Trend in the imports of Alien Species:

A study is required to derive the actual statistics but with regard to the cases we can assume that the **trend is definitely not decreasing.**

Most Common Cases:

Snakes and Birds

Highest priority of Customs:

Narcotics comes first, followed by others

Advice to the general public on this matter:

The importers should know legal status of the subject to be imported. People should find out information about legal and illegal species before trying to import it. **Individuals should bare their responsibility towards the wellbeing of the nation before their own personal amusements**. Don't get involved in any illegal activity even if it's related to a friend of a family member. The general public is not aware. **People should share the information with customs or police about alien species; (if it's being smuggled into the country or if anyone is in possession of such a species)**. There is a mechanism in which information could be shared without disclosing who you are.

Health and Safety concerns of Customs officers when dealing with these species

Since Customs is an authority working at the frontlines the threat of such an event is there. As per health and safety Customs may always not be prepared in terms of work health and safety since such events would be isolated and dispersed.

Mechanism in identifying alien species:

At present there is no such mechanism formulated, but we are in need of one. Customs do have some difficulties therefore we need more training to be informed of the species.

Emergency plan, such as a virus infected shipment:

At the moment we lack a plan; but we are formulating such a plan which covers the required procedures.

Customs perspective on the relation between illegal imports of species and narcotics:

These species have been confiscated from Police operations regarding narcotics, so therefore it is known that there is a link between these two. With respect to the available information, drug dealers have these exotics as their pets.

Challenges faced by Customs in dealing with Alien Species:

Customs are required to check a lot of areas; it is fairly easy to check the airport passenger terminal area while Customs face difficulties in the air-cargo area. With the dispersion of sea vessels and the marine routes poses the greatest challenge for customs.

Another challenge is that the lack of coordination between the institutes working at the border. **To have a dedicated law and regulation to tackle the issue would be one of the solutions while implementing a documented rigid coordinating system to manage the ports among the relevant authorities and stakeholders.**

Public awareness and awareness campaigns regarding the issue is inadequate. **It is important to step up these campaigns as it is not just Customs officers who should be aware of this.**

Reason for the demand in smuggling Alien Species:

As per Customs perspective the demand is dependent upon two factors; import duty and legality of the subject. If the import duty is high or if the subject is banned or illegal; smuggling and demand does increase along with the associated profit of the sale.

Meet this month's Writers & Contributers

Mohamed Zahir
Miruza Mohamed
Ilham Atho Mohamed
Fazeela Ahmed Shaheem
Mohamed Simah
Aishath Aileen Niyaz
Hassan Nidham
Midhath Abdul Rasheed
Aishath Huma
Aminath Maiha Hameed
Mauman Abdul Rasheed
Ahmed Anwar
Mohamed Furaz
Ismail Ajmal
Mohamed Aflah

Layout & Design by:
Mohamed Aflah
Ismail Ajmal

Published by:
Environment Department,
Ministry of Environment and Energy,
Green Building, Handhuvaree Hingun Maafannu,
Male', Republic of Maldives.

You too can contribute to Pemphis newsletter.
Send pictures and articles to environment@environment.gov.mv
We welcome all comments on the articles.

@EnvGovMv
facebook.com/environment.gov.mv

APPENDIX 23

Environmental Monitoring Reports

October to December 2022, January to March 2023 and baseline monitoring reports

MDV-AAK-CEMPX-XX-RP-XXX-0004-000

Environmental Monitoring Report - March 2023

REPUBLIC OF MALDIVES

MINISTRY of ENVIRONMENT, CLIMATE CHANGE and TECHNOLOGY

DBO CONTRACTOR:

urbaser

RAMBOLL

EMPLOYER REPRESENTATIVE

FICHTNER

Review & Approval:

EPC CONTRACTOR:

alke ALKATAŞ

ALKE-ALKATAŞ JV

Project Title:	Design, Build and Operate of a Waste to Energy Facility at Thilafushi Contract No: (AGR)438-WPMC/PRIV/2021/71			
Document Name:	**ENVIRONMENTAL MONITORING REPORT** **WTE FACILITY AT THILAFUSHI, MARCH 2023**			
Status:	Project Management Deliverables			
Design:	Company:	Name:	Date:	Document No:
Prepared by:	AAJV	Ta Hoa BINH	31.03.2023	
Checked by:	AAJV	Şenol KIRCAALİ	03.04.2023	MDV-AAK-CEMPX-XX-RP- XXX-0004-000
	URB/RAM			
Released by:				

TABLE OF CONTENTS

List of Tables

List of Figures

1. INTRODUCTION

This is the environmental monitoring report of Ambient air quality, noise level and water for construction and Camp results were conducted in March 2023 as part of the pre-construction & construction stage monitoring of the Thilafushi Waste to Energy (WtE) facility project of Maldives. Environmental monitoring report is a contractual requirement of the DBO in the Environmental Impact Assessment report prepared for the project and as a part the requirements of the EIA monitoring and the Project Environmental Management Plan. This report presents results of the environmental monitoring of several environmental aspects during the monitoring reporting period, such as ambient noise, air quality and water for construction and Camp assessments conducted. Also, the report is being developed to meet the anticipated environment impacts, health and safety, as well as to ensure the environmental protection and sustainable of the Project activities.

2. RESUILT OF AMBIENT AIR QUALITY MONITRING

During the reporting period, the ambient air quality was conducted from 20th to 21th in March 2023 at seven locations, it includes: 6 locations at Thilafushi (AQ1, AQ2, and AQ3, ASR 2, ASR3 and ASR5) and one location (AQ4) at Villingili island. The location of air monitoring stations is showed in **Hata! Başvuru kaynağı bulunamadı.** The air parameter are: PM10, PM2.5, SO2, NO2 and O3 will be monitored to access the quality of air due to project activities and other pollutant impacts by using air quality monitoring stations based on sensor technology. Total suspended solid in (TSP) in air was measured by dust sampling devices conforming to the international HSE-MDHS 14/3. As recommended in the EIA report air quality were measured 24 hours at each station.

Figure 1 Sampling Locations for Ambient Air Quality monitoring stations

- **Results of air monitoring**

Table 1 Measurement Results for Air monitoring Location 1

Location	Sampling Date	Air Quality Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP	Humidity (%)	T (^{0}C)
AQ1	2023-3-21 12:00:00	18.54	12.77	0	0	61.52	70.2	29.5
	2023-3-21 13:00:00	8.18	4.88	0	0	58.80	69.0	29.7
	2023-3-21 14:00:00	7.99	4.90	0	0	56.36	68.4	29.9
	2023-3-21 15:00:00	7.86	4.77	0.89	0	55.74	70.8	29.2
	2023-3-21 16:00:00	12.04	8.10	0.59	0	57.26	73.0	28.6
	2023-3-21 17:00:00	8.31	5.32	3.32	0	60.16	73.3	28.3
	2023-3-21 18:00:00	8.26	5.61	3.05	0.36	63.55	74.7	27.8
	2023-3-21 19:00:00	8.44	5.80	0.35	2.14	64.69	78.5	26.6
	2023-3-21 20:00:00	8.35	5.84	5.31	0	65.15	81.2	25.9
	2023-3-21 21:00:00	8.26	5.85	4.94	0	64.87	83.0	25.6
	2023-3-21 22:00:00	7.75	5.55	0.58	6.36	62.07	83.4	25.5
	2023-3-21 23:00:00	7.36	5.07	0.21	0	57.63	84.6	25.4
	2023-3-22 00:00:00	7.38	5.07	0.16	0	58.74	84.9	25.3
	2023-3-22 01:00:00	7.45	5.05	0	0	59.46	85.3	25.5
	2023-3-22 02:00:00	7.30	5.11	0	0	59.89	82.0	26.3
	2023-3-22 03:00:00	7.98	5.94	0	0	67.78	80.4	26.7
	2023-3-22 04:00:00	7.71	5.59	0	0	65.30	81.4	26.4
	2023-3-22 05:00:00	11.36	4.87	0	0	61.20	80.3	26.6
	2023-3-22 06:00:00	17.59	8.47	0	0	63.92	78.1	27.3
	2023-3-22 07:00:00	21.91	12.98	0	0	64.20	77.8	27.3
	2023-3-22 08:00:00	11.09	5.77	0	0	63.81	77.4	27.4
	2023-3-22 09:00:00	18.60	7.43	0	0	61.60	70.7	29.1
	2023-3-22 10:00:00	33.48	20.26	0	0.66	71.62	65.0	30.7
	2023-3-22 11:00:00	17.60	12.57	0.47	0.34	47.82	72.14	29.8

Location	Sampling Date	Air Quality Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP	Humidity (%)	T (^{0}C)
Hourly Limit Values	TA Luft	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
24 h Average		11.70	7.23	0.83	0.41	61.38	76.90	27.52
Daily Limit Values	TA Luft	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

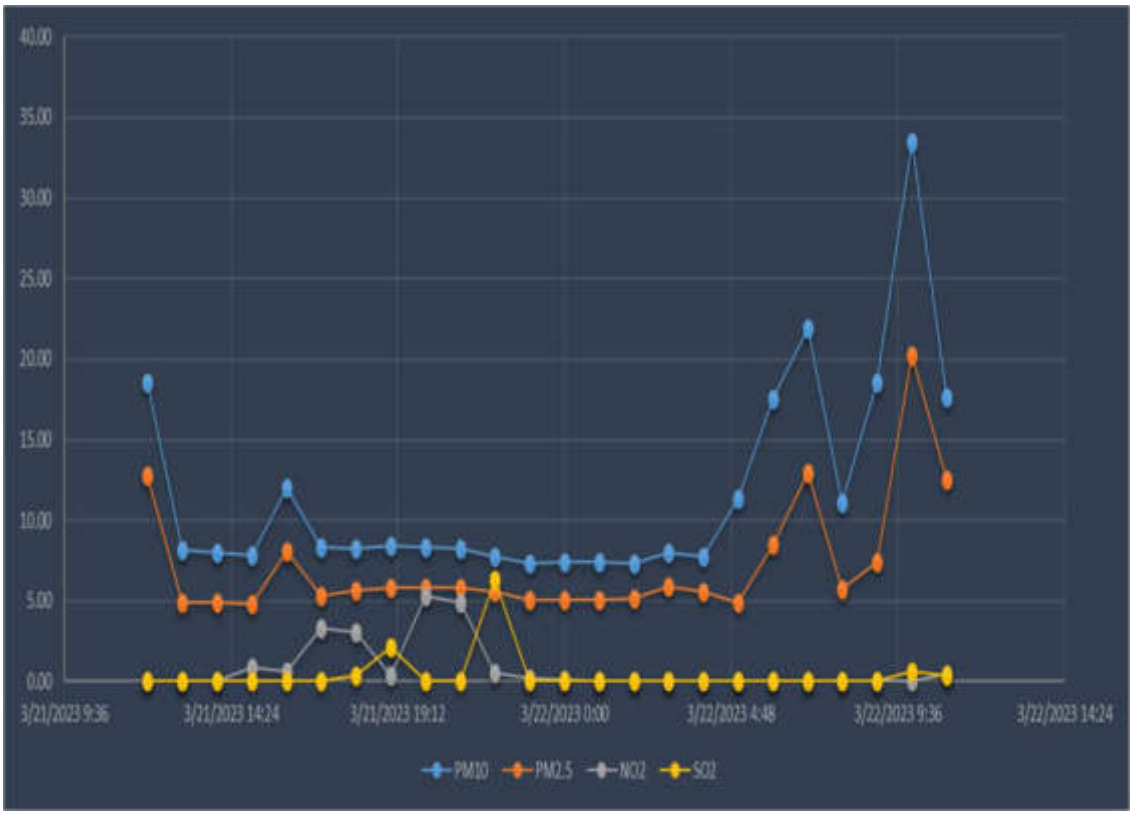


Figure 2 Measurement Graphs for Air monitoring Location AQ1

Table 2 Measurement Results for Air monitoring Location 2

Location	Sampling Date	Results (µg/m³)					Ambient conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24hrs. Average)	Humidity (%)	T(⁰C)
AQ2	2023-3-19 12:00:00	12.81	9.25	0	0	36.27	62.24	30.52
	2023-3-19 13:00:00	13.40	9.74	0	0	37.24	62.83	30.47
	2023-3-19 14:00:00	11.93	8.75	0	0	33.50	54.56	29.43
	2023-3-19 15:00:00	11.44	8.42	0	0	32.15	51.30	29.01
	2023-3-19 16:00:00	11.67	8.61	0	0	32.53	51.16	29.09
	2023-3-19 17:00:00	11.37	8.43	0.85	0	31.74	51.90	28.70
	2023-3-19 18:00:00	10.88	8.11	5.28	0.7	30.40	53.64	28.23
	2023-3-19 19:00:00	10.53	7.88	0.89	2.18	29.36	55.69	27.45
	2023-3-19 20:00:00	10.68	7.98	0	0.22	29.76	62.98	27.20
	2023-3-19 21:00:00	10.99	8.20	0	0.18	30.65	67.77	27.94
	2023-3-19 22:00:00	11.18	8.36	0	0	31.30	69.61	27.53
	2023-3-19 23:00:00	11.51	8.60	0	0	32.27	69.96	26.36
	2023-3-20 00:00:00	11.52	8.61	0	0	32.43	70.86	26.22
	2023-3-20 01:00:00	11.44	8.55	0	0	32.34	71.42	26.13
	2023-3-20 02:00:00	9.94	7.47	0	0	28.16	84.97	26.26
	2023-3-20 03:00:00	8.12	6.12	0	0	22.65	83.79	26.15
	2023-3-20 04:00:00	8.35	6.26	0	0	23.27	84.64	25.94
	2023-3-20 05:00:00	8.72	6.54	0	0	24.40	85.52	25.83
	2023-3-20 06:00:00	9.01	6.81	0	0	25.49	84.75	25.74
	2023-3-20 07:00:00	9.16	6.79	0	0.41	26.13	85.33	26.65
	2023-3-20 08:00:00	9.08	6.76	8.4	0.86	25.85	85.24	27.66
	2023-3-20 09:00:00	8.77	6.55	1.36	0.14	24.69	83.59	27.20
	2023-3-20 10:00:00	9.99	7.41	0	0	27.99	72.35	28.23
	2023-3-20 11:00:00	10.30	7.63	0	0	29.19	64.32	29.74

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 hrs Average)	Humidity (%)	T(^{0}C)
Hourly Limit Values	TA Luft	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		**10.53**	**7.83**	**0.70**	**0.20**	**29.57**	**69.60**	**27.65**
Daily Limit Values	TA Luft	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

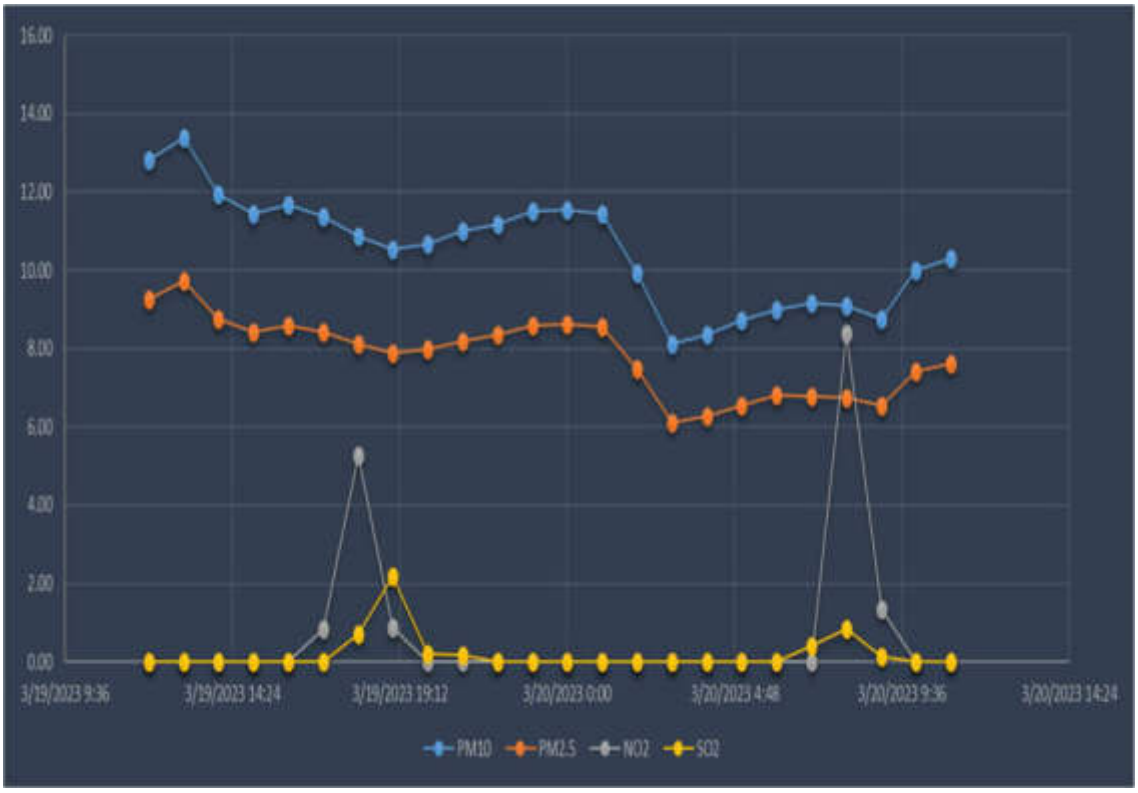


Figure 3 Measurement Graphs for Air monitoring Location AQ2

Table 3 Measurement Results for Air monitoring Location 3

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 Hrs. Averg.)	Humidity (%)	T(^{0}C)
AQ3	2023-3-21 12:00:00	10.48	7.75	0	0	33.07	69.7	30.0
	2023-3-21 13:00:00	16.43	13.86	0	0	32.87	74.7	28.2
	2023-3-21 14:00:00	11.38	9.87	0	0	33.71	79.6	27.1
	2023-3-21 15:00:00	13.93	10.93	0	0	33.57	80.7	26.9
	2023-3-21 16:00:00	13.46	11.34	2.63	0	33.62	81.6	26.7
	2023-3-21 17:00:00	13.11	11.51	0	0	33.71	82.4	26.6
	2023-3-21 18:00:00	12.94	11.98	0	0	33.92	83.8	26.4
	2023-3-21 19:00:00	13.38	12.43	0	0	33.54	85.3	26.1
	2023-3-21 20:00:00	14.11	12.95	0	0	33.60	82.9	26.0
	2023-3-21 21:00:00	13.35	11.35	0	0	34.85	84.2	25.8
	2023-3-21 22:00:00	13.30	10.97	0	0	35.91	84.1	25.8
	2023-3-21 23:00:00	13.33	10.66	0	0	36.85	84.0	25.7
	2023-3-22 00:00:00	13.47	11.93	0	0	37.75	84.3	25.6
	2023-3-22 01:00:00	13.44	12.39	0	0	38.07	83.7	25.6
	2023-3-22 02:00:00	14.69	13.78	0	0	35.03	82.0	26.4
	2023-3-22 03:00:00	15.56	13.72	0	0	28.39	67.8	30.2
	2023-3-22 04:00:00	15.01	13.88	0	0	26.80	62.5	31.8
	2023-3-22 05:00:00	14.97	13.89	0	0	27.96	61.0	32.3
	2023-3-22 06:00:00	15.03	13.57	0	0	32.59	63.5	31.5
	2023-3-22 07:00:00	15.26	13.50	0	0	29.07	63.7	31.7
	2023-3-22 08:00:00	14.94	13.30	0	0	29.63	61.5	32.1
	2023-3-22 09:00:00	14.41	12.74	0	0	29.15	61.0	32.5
	2023-3-22 10:00:00	14.20	11.97	0	0	29.92	60.1	32.6
	2023-3-22 11:00:00	14.22	11.56	0	0	31.78	61.4	32.3

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 hrs. Averg.)	Humidity (%)	T(^{0}C)
Hourly Limit Values	TA Luft	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		**13.93**	**12.16**	**0.11**	**0.00**	**32.72**	**74.40**	**28.58**
Daily Limit Values	TA Luft	50	-	-	-	-	-	-
	EU	50	-	-	-	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	-	-	-	-

Figure 4 Measurement Graphs for Air monitoring Location AQ3

Table 4 Measurement Results for Air monitoring Location 4

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 hrs. Averg.)	Humidity (%)	T(^{0}C)
ASR2	2023-3-19 12:00:00	14.18	9.85	0	0	37.69	67.53	29.98
	2023-3-19 13:00:00	15.12	11.80	0	0	40.74	70.19	29.21
	2023-3-19 14:00:00	15.13	12.04	0	0	40.07	68.61	28.03
	2023-3-19 15:00:00	15.66	12.40	0	1.24	41.14	67.70	27.97
	2023-3-19 16:00:00	15.67	11.56	6.41	11.18	41.53	68.40	27.83
	2023-3-19 17:00:00	16.65	12.58	0	4.32	43.74	68.89	27.59
	2023-3-19 18:00:00	19.53	14.74	1.96	0	50.40	69.81	27.24
	2023-3-19 19:00:00	16.94	12.79	0	0	44.22	71.62	26.81
	2023-3-19 20:00:00	16.13	12.19	0	2.61	42.38	75.94	25.55
	2023-3-19 21:00:00	17.38	13.11	0	0	45.40	78.59	24.73
	2023-3-19 22:00:00	19.21	14.46	0	0	49.70	80.50	24.41
	2023-3-19 23:00:00	20.64	15.55	0	0	53.18	80.50	24.30
	2023-3-20 00:00:00	20.43	15.40	0	0	52.62	81.69	24.20
	2023-3-20 01:00:00	19.88	14.98	0	0	51.19	82.06	24.15
	2023-3-20 02:00:00	18.96	14.29	0	0	48.49	84.71	25.46
	2023-3-20 03:00:00	18.23	13.73	0	0	46.39	81.07	26.38
	2023-3-20 04:00:00	18.10	13.65	0	0	46.14	79.21	26.82
	2023-3-20 05:00:00	17.44	13.18	0	0	44.69	80.64	26.49
	2023-3-20 06:00:00	18.59	14.05	0	0	47.39	79.67	26.67
	2023-3-20 07:00:00	18.47	13.94	0	0	46.82	76.78	27.61
	2023-3-20 08:00:00	16.80	12.71	4.08	0	42.93	76.54	27.58
	2023-3-20 09:00:00	15.82	11.97	0	0	40.75	76.33	27.60
	2023-3-20 10:00:00	16.45	12.47	0	0	42.71	71.23	28.92
	2023-3-20 11:00:00	16.26	12.32	0	0	42.10	65.23	30.49

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 hrs. Averg.)	Humidity (%)	T(^{0}C)
Hourly Limit Values	TA Luft	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		**17.40**	**13.16**	**0.52**	**0.81**	**45.10**	**75.14**	**26.92**
Daily Limit Values	TA Luft	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

Figure 5 Measurement Graphs for Air monitoring Location ASR2

Table 5 Measurement Results for Air monitoring Location 5

Location	Sampling Date	Results (µg/m^3)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 hrs. Average)	Humidity (%)	T (^{0}C)
ASR3	2023-3-22 12:00:00	15.05	14.98	0	0	28.42	60.58	30.95
	2023-3-22 13:00:00	13.59	13.52	0	0	28.55	61.19	30.76
	2023-3-22 14:00:00	13.05	12.98	0	0	27.33	55.96	30.15
	2023-3-22 15:00:00	12.77	12.73	0	0	26.77	54.67	29.55
	2023-3-22 16:00:00	13.90	13.83	0	0	26.29	54.74	29.49
	2023-3-22 17:00:00	12.49	12.45	0	0	26.60	55.55	29.15
	2023-3-22 18:00:00	12.70	12.65	0	0	26.59	58.08	28.32
	2023-3-22 19:00:00	13.00	12.94	0	0	26.63	61.28	27.22
	2023-3-22 20:00:00	13.41	13.35	0	0	27.43	66.63	27.59
	2023-3-22 21:00:00	11.78	11.71	0	0	27.83	70.25	27.58
	2023-3-22 22:00:00	14.99	14.93	0	0	28.40	71.92	26.24
	2023-3-22 23:00:00	15.02	14.96	0	0	28.47	72.49	26.12
	2023-3-23 00:00:00	15.37	15.30	0	0	29.10	74.32	26.95
	2023-3-23 01:00:00	10.93	10.89	0	0	29.75	74.53	26.82
	2023-3-23 02:00:00	10.28	10.25	0	0	27.73	84.84	26.16
	2023-3-23 03:00:00	9.33	9.28	0	0	24.13	84.21	26.07
	2023-3-23 04:00:00	9.30	9.28	0	0	24.04	84.35	25.92
	2023-3-23 05:00:00	9.62	9.59	0	0	24.95	84.98	25.82
	2023-3-23 06:00:00	9.88	9.86	0	0	26.27	84.33	25.78
	2023-3-23 07:00:00	11.23	11.20	0	0	26.19	84.39	25.72
	2023-3-23 08:00:00	11.08	11.05	0	0	26.05	81.89	25.71
	2023-3-23 09:00:00	9.14	9.10	0	0	24.25	78.24	26.20
	2023-3-23 10:00:00	8.93	8.92	0	0	24.20	73.08	29.00
	2023-3-23 11:00:00	9.08	9.06	0	0	25.15	65.21	30.48

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 hrs. Average)	Humidity (%)	T (^{0}C)
Hourly Limit Values	TA Luft	-	-	200	200	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		11.91	11.87	0.00	0.00	26.71	70.74	27.65
Daily Limit Values	TA Luft	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

Figure 6 Measurement Graphs for Air monitoring Location ASR3

Table 6 Measurement Results for Air monitoring Location 6

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24hrs. Average)	Humidity (%)	T (^{0}C)
ASR5	2023-3-22 12:00:00	14.89	11.72	0	0	36.73	65.42	30.67
	2023-3-22 13:00:00	14.75	11.66	0	0	36.37	68.47	30.76
	2023-3-22 14:00:00	14.91	11.84	19.73	0	35.70	68.93	30.71
	2023-3-22 15:00:00	15.25	11.94	8.44	2.21	35.64	68.77	30.73
	2023-3-22 16:00:00	14.62	11.72	1.25	6.14	34.87	68.71	30.87
	2023-3-22 17:00:00	15.08	12.47	5.67	1.38	36.31	68.72	30.68
	2023-3-22 18:00:00	17.08	14.76	9.04	0.96	40.25	69.86	30.34
	2023-3-22 19:00:00	15.00	12.70	2.91	0	36.67	72.72	29.49
	2023-3-22 20:00:00	14.54	12.13	2.87	1.06	36.36	77.39	28.06
	2023-3-22 21:00:00	15.08	13.27	3.28	0	38.01	80.54	26.99
	2023-3-22 22:00:00	16.50	14.55	0	0	40.73	82.57	26.62
	2023-3-22 23:00:00	17.67	15.53	0	0.38	42.68	82.44	26.50
	2023-3-23 00:00:00	17.62	15.54	0	0	42.93	83.67	26.36
	2023-3-23 01:00:00	17.56	15.21	0	0	42.47	84.26	26.27
	2023-3-23 02:00:00	17.07	14.50	0	0	41.05	83.91	26.45
	2023-3-23 03:00:00	16.56	13.69	0	0	38.44	80.71	27.20
	2023-3-23 04:00:00	16.32	13.69	0	0	38.91	79.56	27.52
	2023-3-23 05:00:00	15.84	13.25	0	0	38.40	80.91	27.22
	2023-3-23 06:00:00	16.81	14.02	0	0	39.88	79.70	27.38
	2023-3-23 07:00:00	17.34	14.54	0	0	41.71	77.49	28.13
	2023-3-23 08:00:00	15.89	13.09	0.53	0	38.80	77.36	28.09
	2023-3-23 09:00:00	14.72	12.01	0	0	35.14	76.52	28.23
	2023-3-23 10:00:00	15.25	12.37	0	0	35.37	69.61	30.19
	2023-3-23 11:00:00	15.39	12.39	0	0	36.06	62.90	30.21
Hourly Limit	TA Luft	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24hrs. Average)	Humidity (%)	T (^{0}C)
Values	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		15.91	13.27	2.24	0.51	38.31	75.46	28.57
Daily Limit Values	TA Luft	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

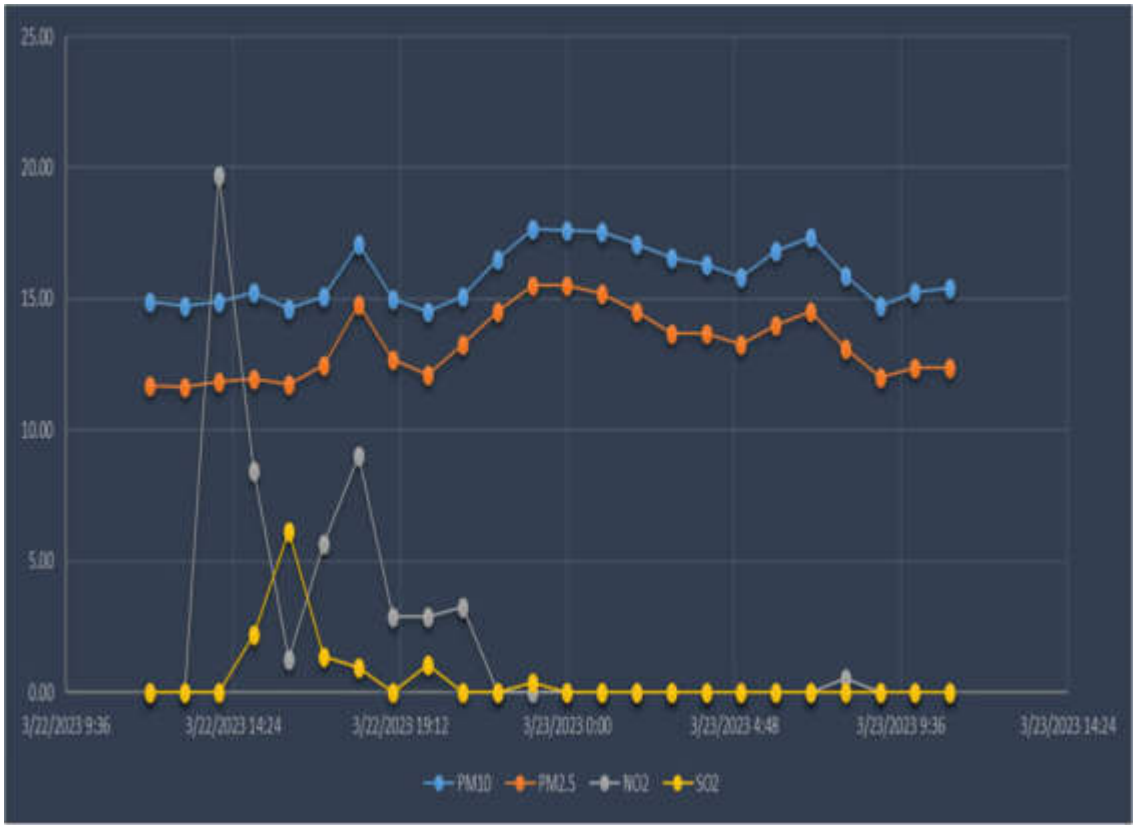


Figure 7 Measurement Graphs for Air monitoring Location ASR5

Table 7 Measurement Results for Air monitoring Location 7

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 hrs. Average)	Humidity (%)	T (^{0}C)
AQ4	2023-3-22 12:00:00	22.16	14.93	0	0	44.42	73.82	30.80
	2023-3-22 13:00:00	22.14	14.92	0	0	44.38	75.92	30.03
	2023-3-22 14:00:00	25.36	16.85	6.74	72.31	50.69	76.77	30.33
	2023-3-22 15:00:00	27.24	17.98	0.98	0	54.37	77.78	29.97
	2023-3-22 16:00:00	28.32	18.63	5.16	0	56.49	79.19	29.62
	2023-3-22 17:00:00	31.14	20.32	5.06	0	62.02	79.74	29.39
	2023-3-22 18:00:00	30.66	20.03	5.95	0	61.08	81.10	29.00
	2023-3-22 19:00:00	34.25	22.19	2.47	0	68.11	83.70	28.28
	2023-3-22 20:00:00	29.08	19.08	0.09	0	57.98	85.43	27.53
	2023-3-22 21:00:00	31.67	20.64	0.57	0	63.05	87.47	27.09
	2023-3-22 22:00:00	28.67	18.84	0.53	0	57.17	88.20	26.93
	2023-3-22 23:00:00	29.02	19.05	0.09	0	57.86	88.70	26.82
	2023-3-23 00:00:00	29.01	19.04	0.44	0	57.83	89.29	26.74
	2023-3-23 01:00:00	28.99	19.03	0	0	57.80	89.39	26.81
	2023-3-23 02:00:00	28.84	18.94	0.23	0	57.51	88.35	27.80
	2023-3-23 03:00:00	28.14	18.52	0	0	56.14	81.80	29.53
	2023-3-23 04:00:00	26.67	17.64	0	0	53.25	79.79	29.10
	2023-3-23 05:00:00	28.47	18.72	0	0	56.78	79.34	29.22
	2023-3-23 06:00:00	25.24	16.78	0	0	50.45	78.94	29.30
	2023-3-23 07:00:00	23.14	15.52	0	0	46.34	77.92	30.70
	2023-3-23 08:00:00	27.25	17.99	0	0	54.39	76.96	30.84
	2023-3-23 09:00:00	21.39	14.47	0	0	42.91	74.07	31.67

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 hrs. Average)	Humidity (%)	T (^{0}C)
	2023-3-23 10:00:00	18.36	12.65	0	0	36.97	69.78	31.79
	2023-3-23 11:00:00	21.96	14.81	0	0	44.02	71.08	31.84
Hourly Limit Values	TA Luft	-	-	200	350		-	-
	EU	-	-	200	350		-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-		-	-
Average		**26.97**	**17.81**	**1.18**	**3.01**	**53.83**	**80.61**	**29.21**
Daily Limit Values	TA Luft	50	-	-	125		-	-
	EU	50	-	-	125		-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40		-	-

Figure 8 Measurement Graphs for Air monitoring Location AQ4

3. RESULT OF AMBIENT NOISE MONITORING

As part of the monitoring of Thilafushi Waste to Energy facility, ambient noise levels measurements were repeated at the same five locations used in the EIA report. Ambient noise level measurement was done using a handheld sound level meter (ET-958 Professional Sound Level Meter) Measurements are recorded in NQ1, and NQ2 NQ3, NQ4 and NQ5 from 25th to 26th March 2023, continuously for 24 four hours. Table 8 summarizes the explanation on the selection of baseline monitoring stations given in the EIA report.

Table 8 Locations selected for Ambient Noise Level Measurements

Station name	Geographic Coordinates	Reason for selection
NQ1	4°10'26.4 N, 73°28'59.9 E	Included in the original EIA
NQ2	4°10'56.6 N, 73°26'53.3 E	Included in the original EIA
NQ3	4°10'58.3 N, 73°26'09.6 E	Included in the original EIA
NQ4	4°10'57.3 N,73°25'59.4 E	Included in the original EIA
NQ5	4°10'57.3 N, 73°26'14.4 E	Included in the original EIA

At each station hourly 7-8 readings are recorded for a duration of 30-50seconds at each location. Average of ambient noise level in dB(A) was recorded and the average noise of each location is calculated Table 9.

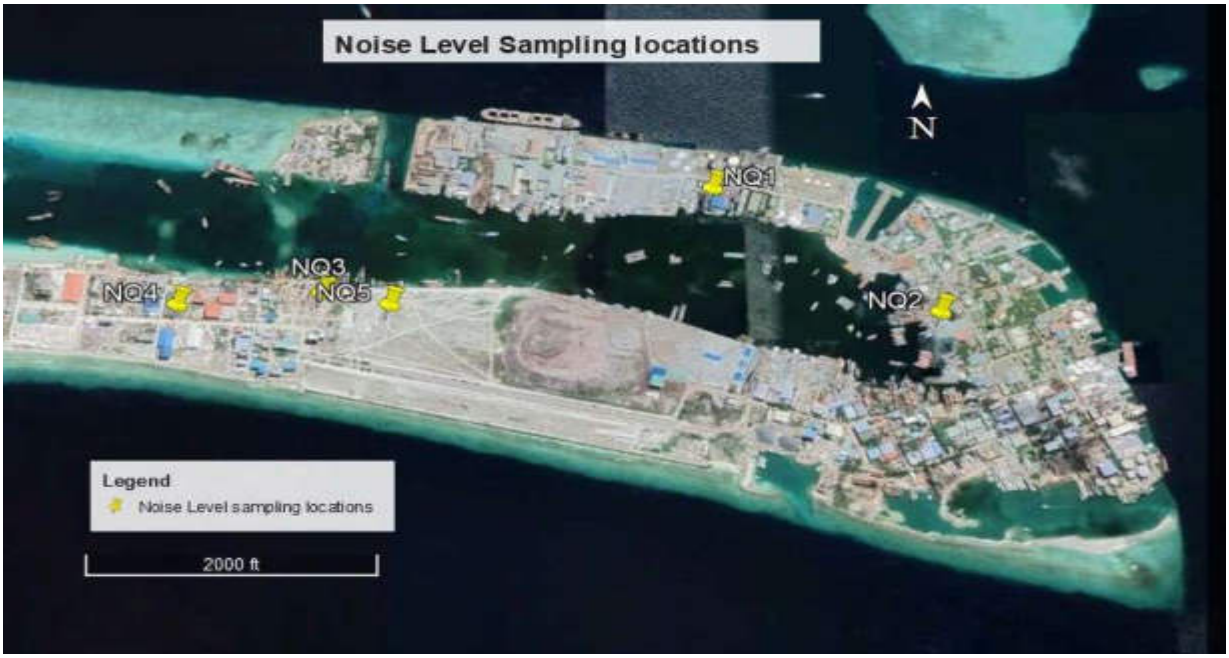


Figure 9 Ambient noise level sampling locations

Results

Table 9 Noise measurement records in (dBA), 25-26 March 2023

NQ1		NQ2		NQ3		NQ4		NQ5	
Date and time)	dB(A)	Date/time	dB(A)	Date/time	dB(A)	Date/time	dB(A)	Date/time	dB(A)
3/25/2023 22:15	47	3/25/2023 23:23	49.5	3/25/2023 10:42	46	3/25/2023 23:40	46.3	3/25/2023 22:35	49.8
3/25/2023 23:17	47	3/26/2023 0:22	50	3/25/2023 23:41	49	3/26/2023 0:40	42.5	3/25/2023 23:34	44.5
3/26/2023 0:17	48.9	3/26/2023 1:32	43.2	3/26/2023 0:41	40.4	3/26/2023 1:30	50.2	3/26/2023 0:34	43.2
3/26/2023 1:16	54.3	3/26/2023 2:22	45	3/26/2023 1:40	43.5	3/26/2023 2:39	51.2	3/26/2023 1:34	40.1
3/26/2023 2:16	53.2	3/26/2023 3:21	43.2	3/26/2023 2:40	40.2	3/26/2023 3:39	50.4	3/26/2023 2:33	45.3
3/26/2023 3:15	52.1	3/26/2023 4:21	43	3/26/2023 3:40	40.5	3/26/2023 4:39	48.1	3/26/2023 3:33	43.2
3/26/2023 4:15	52	3/26/2023 5:20	47	3/26/2023 4:49	48.3	3/26/2023 5:38	50.3	3/26/2023 4:32	43
3/26/2023 5:15	50.1	3/26/2023 6:20	49	3/26/2023 5:49	43.9	3/26/2023 6:38	46.3	3/26/2023 5:32	45.7
3/26/2023 6:14	63	3/26/2023 7:20	50	3/26/2023 6:48	55.2	3/26/2023 7:37	55.7	3/26/2023 6:32	49.3
3/26/2023 7:14	58.1	3/26/2023 8:39	51.2	3/26/2023 7:48	54.7	3/26/2023 8:37	52.7	3/26/2023 7:31	55.8
3/26/2023 8:13	61	3/26/2023 9:39	59.3	3/26/2023 8:48	54.4	3/26/2023 9:37	53	3/26/2023 8:31	55.3
3/26/2023 9:13	62	3/26/2023 10:28	55	3/26/2023 9:47	53.1	3/26/2023 10:06	55.1	3/26/2023 9:31	65.4
3/26/2023 10:13	58	3/26/2023 11:28	52.2	3/26/2023 10:47	54.5	3/26/2023 11:16	65.3	3/26/2023 10:30	58.8
3/26/2023 11:12	62	3/27/2023 12:27	57.8	A/26/2023 11:47	60.7	3/26/2023 12:15	55	3/26/2023 11:30	59.4
3/26/2023 12:12	59	3/27/2023 13:27	60.3	3/27/2023 12:46	51.5	3/26/2023 13:15	49.3	3/26/2023 12:29	60.4

2/16/2023 2:53	55.8	2/16/2023 2:51	57.1	2/16/2023 2:45	54.0	2/16/2023 2:51	48.4	2/16/2023 2:48	52.7
2/16/2023 3:52	55.9	2/16/2023 3:50	49.3	2/16/2023 3:45	57.2	2/16/2023 3:50	52.2	2/16/2023 3:47	50.0
2/16/2023 4:52	55.9	2/16/2023 4:50	51.9	2/16/2023 4:45	53.2	2/16/2023 4:50	47.1	2/16/2023 4:47	50.5
2/16/2023 5:51	56.3	2/16/2023 5:49	53.3	2/16/2023 5:44	50.2	2/16/2023 5:49	53.7	2/16/2023 5:46	49.8
2/16/2023 6:51	54.3	2/16/2023 6:49	48.5	2/16/2023 6:44	53.0	2/16/2023 6:49	50.5	2/16/2023 6:46	50.9
2/16/2023 7:51	57.8	2/16/2023 7:49	53.2	2/16/2023 7:43	47.1	2/16/2023 7:49	60.8	2/16/2023 7:46	52.4
2/16/2023 8:50	59.0	2/16/2023 8:48	53.7	2/16/2023 8:43	56.0	2/16/2023 8:48	57.8	2/16/2023 8:45	55.9
2/16/2023 9:50	59.8	2/16/2023 9:48	60.8	2/16/2023 9:43	55.6	2/16/2023 9:48	64.2	2/16/2023 9:45	57.8
2/16/2023 10:49	63.7	2/16/2023 10:47	65.4	2/16/2023 10:22	53.7	2/16/2023 10:47	52.6	2/16/2023 10:24	57.3
Average dB(A)	58.1		54.8		54.1		53.7		52.1
Daytime	**59.4**		**57.3**		**55.0**		**55.2**		**53.9**
Night time	**56.2**		**51.3**		**52.7**		**51.7**		**49.6**
WHO guideline for ambient noise level	**70**								

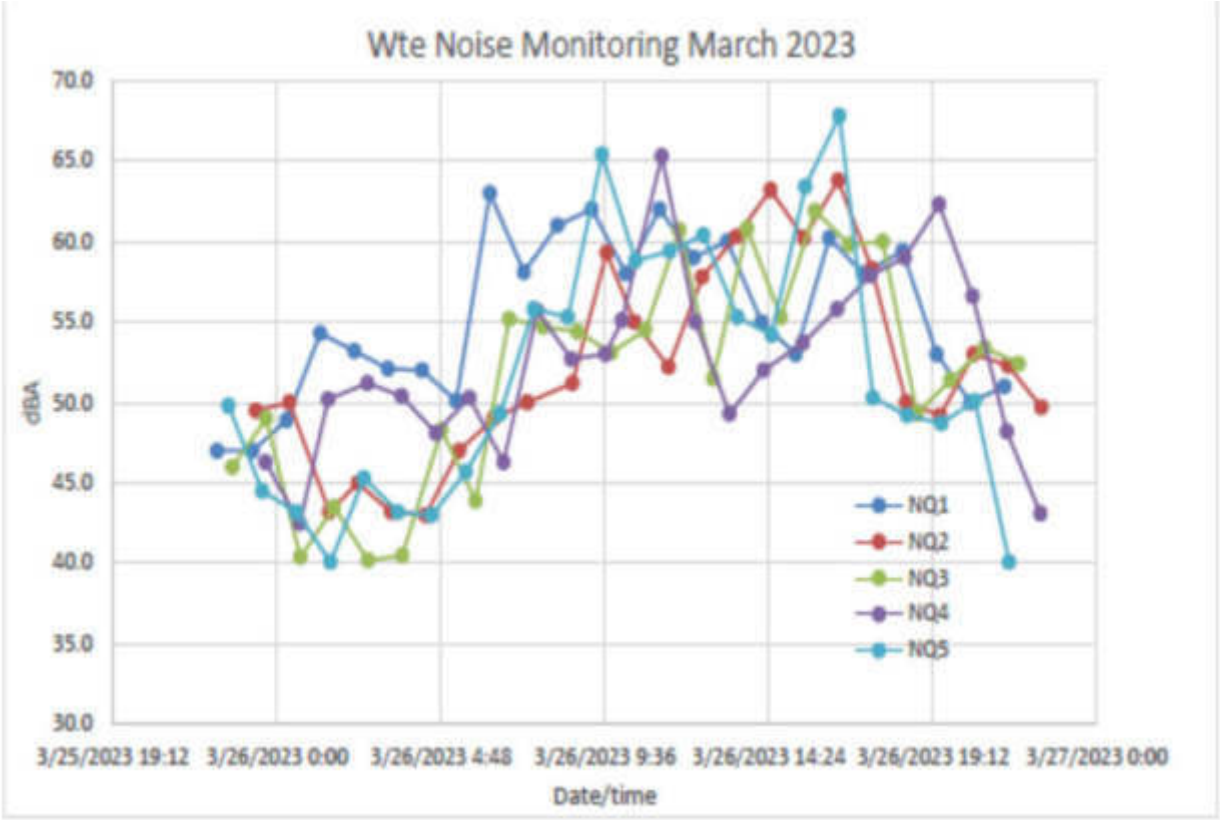


Figure 10. Graph showing the Ambient noise level recorded

There are no designated national standards for ambient noise level in outdoor industrial area in the Maldives. Compared to WHO and ADB specified noise level standards for outdoors industrialand commercial area the noise level in Thilafushi island and the subproject area is below the noise level standards. The results show that in all the stations ambient noise level are below threshold levels specified by the WHO standards.

4. RESULT OF WATER FOR CONSTRUCTION AND CAMP MONITORING

Water for construction and Camp was conducted on 13th March, 2023, there is one sample was collected at the site and sent to Care Lab, a branch laboratory of Bureau Veritas in Siri Lanka the result shows in table 10 below:

Table 10 Water for construction and Camp analysis result

Test Parameter	Unit	Results	Acceptable Limits*	Satisfactory / Unsatisfactory
Iron as Fe	mg/L	ND	Max 0.3	Satisfactory
Manganese as Mn	mg/L	< 0.001	Max 0.1	Satisfactory
Nitrate (as NO3-)*	mg/L	1.8	Max 45	Satisfactory
Arsenic as As	mg/L	< 0.001	Max 0.001	Satisfactory
Cadmium as Cd	mg/L	< 0.001	Max 0.003	Satisfactory
Lead as Pb	mg/L	< 0.001	Max 0.01	Satisfactory
Chloride (as Cl-)	mg/L	68.2	Max 200	Satisfactory
Mercury as Hg	mg/L	< 0.001	Max 0.001	Satisfactory
pH	--	7.0	6.5-8.5	Satisfactory
Turbidity	NTU	0.1	< 1.0	Satisfactory
Electrical Conductivity	µs/cm	1280	Max 1000	Unsatisfactory
Total Phosphates	mg/L	ND	--	--
Total Suspended Solids	mg/L	45	100	Satisfactory
Aerobic Plate Count	Cfu/ml	1.7×10^1	1×10^2	Satisfactory
Total coliform	Mpn/100ml	<2/ Absent	Absent/100ml	Satisfactory
Fecal coliform	Mpn/100ml	<2/ Absent	Absent/100ml	Satisfactory

MDV-AAK-CEMPX-XX-RP-XXX-0003-000

Environmental Monitoring Report - February 2023

REPUBLIC OF MALDIVES

MINISTRY of ENVIRONMENT, CLIMATE CHANGE and TECHNOLOGY

DBO CONTRACTOR:

urbaser

RAMBOLL

EMPLOYER REPRESANTATIVE	FICHTNER	Review & Approval:

EPC CONTRACTOR:

alke

ALKATAŞ

ALKE-ALKATAŞ JV

Project Title:	Design, Build and Operate of a Waste to Energy Facility at Thilafushi Contract No: (AGR)438-WPMC/PRIV/2021/71			
Document Name:	**ENVIRONMENTAL MONTHLY REPORT** **FEBRUARY 2023**			
Status:	Project Management Deliverables			
Design:	Company:	Name:	Date:	Document No:
Prepared by:	AAJV	Binh, T.H	28.02.2023	
Checked by:	AAJV	CIVAN KALAFAT	28.02.2023	MDV-AAK-CEMPX-XX-RP-XXX-0003-000
	URB/RAM	JMA/RLEE		
Released by:				

CONTENT

1. ENVIRONMENTAL REPORTING

This report provides an overview of the monthly environmental monitoring program conducted at the waste-to-energy construction project site on Thilafushi Island. The focus of the monitoring program is to assess the impact of the construction activities on the surrounding environment, particularly with regards to air, noise and water quality.

The monitoring program is carried out in accordance with relevant environmental regulations and guidelines to ensure the protection of the environment and the health and well-being of the local community. The results of the monitoring program are used to identify any potential environmental impacts and to implement appropriate corrective actions to minimize or mitigate these impacts.

This report provides detailed information on the monitoring results, including data on key environmental parameters, such as air and water quality parameters, and noise levels. The report also includes a summary of any significant findings and any corrective actions that have been taken.
We hope that this report will provide a useful source of information for stakeholders, including local residents, regulatory authorities, and other interested parties.

1.1 Activities on site

The environmental monitoring program was conducted at the waste-to-energy construction site during the reporting period. The monitoring activities focused on air, noise, and water quality and were performed by a combination of employed staff and subcontractors.

No environmental incidents or near misses were reported during the monitoring period, and all equipment was in good working condition and properly maintained. The monitoring data were collected and analyzed using established procedures, and the results provide a comprehensive assessment of the site's environmental conditions. The monitoring program is an important aspect of our commitment to protecting the environment and ensuring the health and well-being of the surrounding community.

Table 1: Activities at Site

Activity on site	Units	2022						2023	
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Staff - employed	Nos	44	48	52	48	46	46	46	90
Staff - subcontractors	Nos	08	08	08	06	10	10	10	0
Excavator	Nos	01	01	01	00	00	01	01	01
Jcb	Nos	01	01	01	01	01	01	01	01
Car Mix	Nos	01	01	01	01	01	00	00	00
Diesel generators	Nos	03	03	03	03	03	03	03	03
Small mobile generators	Nos	02	02	02	02	01	02	02	02
Lightweight Equipment (i.e tower lights, vibrators etc.)	Nos	01 each	01 each	01 each	01 each	01 each	4 each	6 each	6 each
Pick up	Nos	02	02	02	02	02	00	00	00
Forklift	Nos	02	02	02	02	02	02	02	02
Environmental Incidents/Near Miss:	No of incidents	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL

1.2 `Construction Material

A wide range of construction materials are supplied to the waste-to-energy construction site to support the ongoing construction activities. These materials include stone of all types, sand of all types, concrete, steel, macadam, cement, pipe, wood, plastic, glass, electric wire, machine oil, gasoline, soils from weathered excavation, filling earth, and disposal waste.

The materials are stored and managed on-site in accordance with established procedures and regulations, to minimize the risk of any potential environmental impacts. The storage and handling of the materials is closely monitored, and appropriate measures are taken to prevent any spillage or leakage that could impact the surrounding environment.

It is important to note that all materials supplied to the site are sourced from reputable suppliers and are subject to rigorous quality control procedures to ensure that they meet the required standards for use in construction. These materials are also closely monitored to ensure that they are used in an environmentally responsible manner, and any waste materials generated during the construction activities are properly managed and disposed of in accordance with established procedures.

Table 2: Construction Materials

Construction materials	Unit	Quantity
Stone of all types	m^3	1000
Sand of all types	m^3	570000
Concrete	m^3	30000
Steel	ton	3600
Cement	ton	12000
Pipe	pieces	
Wood	m^3	300
Machine oil	Litter	1000
Fuel (gasoline)	Litter	3000
Soils weathered excavation	m^3	30000
Filling earth	m^3	30000
Disposal waste	m^3	-

2. WASTE MANAGEMENT

The domestic and construction waste generated from the daily activities at the waste-to-energy construction site will be managed according to the Waste Management Procedure and Plan document, which is currently being reviewed.

As per the agreement between AAJV and WAMCO of Maldives dated January 29, 2023, the company will be responsible for the collection and classification of waste at the Thilafushi WTE project site in the Maldives, as outlined in Appendix 1. The location of disposal sites and sewage lines can be found in Appendices 3 and 4, respectively.

3. DOCUMENTATION

To ensure the responsible and sustainable management of the waste-to-energy construction project in the Maldives, a comprehensive suite of environmental management documents have been developed and approved in line with the requirements set forth by the Asian Development Bank (ADB). These documents are

key to ensuring that the project is managed in an environmentally responsible manner and that its impacts on the surrounding environment are minimized.

The environmental management documents include:

- The Waste Management System Plan outlines the procedures for managing and disposing of waste generated at the construction site.
- The Stakeholder Engagement Plan details the measures that will be taken to engage with and involve local stakeholders in the project.
- The Environmental Social Management Plan (ESMP) sets out the strategies and procedures for mitigating and managing the social and environmental impacts of the project.
- The Environmental Social Action Plan (ESAP) outlines the specific actions that will be taken to address any identified social and environmental issues.
- The Spill Control & Containment Plan outlines the measures that will be taken to prevent and respond to spills of hazardous materials at the construction site.
- The Chemicals & Hazardous Material Management Plan sets out the procedures for managing and disposing of chemicals and hazardous materials used at the construction site.
- The Public Health, Safety, and Security Plan, outlines the measures that will be taken to ensure the health, safety, and security of workers and the public.
- The Traffic Management Plan sets out the procedures for managing traffic and ensuring the safety of workers and the public during project construction.
- The Security Management Plan outlines the measures that will be taken to secure the construction site and protect workers and the public.
- The Standard Operating Procedures for GRM, outline the procedures for managing the day-to-day operations of the construction site.
- The Emergency Response Plan outlines the procedures for responding to and managing emergencies at the construction site.
- The ERP and Site Procedure Manual provides a comprehensive guide to the procedures and processes used at the construction site.
- The HIRA outlines the hazards and risks associated with the construction of the project and the measures that will be taken to manage them.
- The Marine and Beach Area Plan sets out the procedures for protecting and preserving the marine and beach areas in the vicinity of the construction site.

These environmental management documents form the foundation of the environmental management system for the waste-to-energy construction project and will be used to ensure that the project is managed in a responsible and sustainable manner, minimizing its impact on the environment and the surrounding community.

The following documents have been prepared, submitted reviewed and finalized:

Table 3: Status of Documents

No.	Document name	Accepted date	Rejected date	Date of Re-submitted	Deadline of re-submission
1	Marine and Beach Area Plan- MDV-AAK-HSEXX-XX-PL-MGT-0014-000	7-Feb-23			
2	Public Health Safety and Security Plan-MDV-AAK-HSEXX-XX-PL-MGT-0017-001		7-Feb-23	10-Feb-2023	
3	Traffic Management Plan- MDV-AAK-HSEXX-XX-PL-MGT-0016-000		7-Feb-23	11-Feb-2023	
4	ERP and Site Procedure Manual= MDV-AAK-HSEXX-XX-PL-MGT-0015-001		7-Feb-23	10-Feb-2023	
5	Chemical and Hazardous Material Management plan- MDV-AAK-HSEXX-XX-PL-MGT-0012-000	7-Feb-23			14-Feb-2023
6	Stakeholder Engagement Plan- MDV-AAK-HSEXX-XX-PL-MGT-0011-000	7-Feb-23			14-Feb-2023
7	Security Management Plan-MDV-AAK-HSEXX-XX-PL-MGT-0013-000	7-Feb-23			
8	Spill Control and Containment Plan-MDV-AAK-HSEXX-XX-PL-MGT-0010-000		3-Feb-23	11-Feb-2023	
9	Waste management procedure and plan- MDV-AAK-HSEXX-XX-PL-MGT-0009-000	30-Jan-23		11-Feb-2023	
10	Environmental Social Action Plan (ESAP)= MDV-AAK-CEMPX-XX-PL-MGT-0008-000	30-Jan-23			
11	Hazard identification risk assessment-MDV-AAK-CEMPX-XX-PL-MGT-0007-000	4-Feb23			
12	SOP for Grievances Redness Mechanism-MDV-AAK-CEMPX-XX-PL-MGT-0006-001		22-Jan-23	11-Feb-2023	
13	Environmental Social Management Plan (ESMP)-MDV-AAK-CEMPX-XX-PL-MGT-0005-001		15-Jan-23	10-Feb-2023	
14	Obligations register - environment impact & aspect register- MDV-AAK-CEMPX-XX-PL-MGT-0004-000	12.01.2023			
15	Environmental Management & Impact Mitigation Plan- MDV-AAK-CEMPX-XX-PL-MGT-0009-000			10-Feb-2023 (new uploaded)	
16	Emergency Response Plan for environment				14-Feb-2023 (new uploaded)

4. TRAINING COURSES ON ENVIRONMENTAL SAFEGUARDS

The following internal training courses and training material documents related to environmental protection and safety have been developed for the project

The training course on Driving Safety Awareness focuses on educating participants on the importance of safe driving practices in the construction site of the Thilafushi WTE project in the Maldives. The course covers a range of topics, including identifying unsafe driving decisions, appropriate responses to unexpected driving circumstances, and methods to avoid risk and accidents. The aim is to provide participants with a thorough understanding of the steps they can take to ensure the safe operation of vehicles on the construction site. Additionally, the course covers vehicle maintenance and upkeep to ensure that vehicles are in good condition and ready to operate safely.

The Spillage Response course is designed to create awareness among workers and staff on the construction site about the Maldives Government and EPA regulations, Environmental Impact Assessment (EIA), and Construction Environmental Management Plan (CEMP) related to spillage response and the impact of hazardous chemicals and materials on their health. The course covers the responsibilities and strategies for preventing spills, assessing the hazards presented by spills, reporting spills when necessary, and cleaning up spills when appropriate. This training aims to ensure that participants are well-informed about the measures they can take to prevent and respond to spills in a safe and effective manner.

The Awareness of Noise and Record course aims to provide participants with an appreciation of the nature of noise hazards in the workplace and their impact on human health and well-being. The course covers the understanding of conducting noise assessments in the workplace and general environment to determine the need for compliance with relevant standards. Participants will learn about the consequences of excessive noise exposure and the need for control measures, including personal protective equipment. The course also covers the measurement (including dosimetry) of noise in relation to current standards and the means of controlling noise levels in the workplace.

The AAJV environmental management responses to the training.

Three training courses have been done in January 2023, are as follows

Table 2. Training courses program in January 2023

	Training program	Location	Day	Time	Participant	Status
1	Spill Response, Clean-Up, and Emergency Response	At Thilafushi office	Jan 7, 2023	9.00-10.0 AM	All worker and staffs, officers	Done
2	Awareness training for noise/records	At Thilafushi office	Jan 10, 2023	9.00-10.0 AM	All worker and staffs, officers	Done
3	Driving safety in construction areas training course	At Thilafushi office	Jan 12, 2023	9.00-10.0 AM	All Drivers in site	Done

Training Plan for the Next Reporting Period

To ensure that new employees are equipped with the necessary knowledge and skills to work safely and responsibly, several training courses will be held in March 2023. These courses, including Spill Response, Clean-Up, Emergency Response, and Awareness of Noise/Records, will take place at the Thilafushi construction site of the Thilafushi WTE project in the Maldives.

The Spill Response training will aim to raise awareness among workers and staff about the regulations of the Maldives Government & EPA, EIA, and CEMP related to spill response, as well as the impacts of hazardous chemicals and materials on their health. This course will also provide information on the responsibilities and strategies for preventing spills, assessing hazards presented by spills, reporting spills when necessary, and cleaning up spills when appropriate

The Clean-Up training will focus on the proper procedures for cleaning up spills and managing hazardous materials. Participants will learn how to properly contain spills, dispose of contaminated materials, and minimize the environmental impact of spills.

The Emergency Response training will cover procedures for responding to emergencies on the construction site, including fires, spills, and other hazardous events. Participants will learn how to quickly and effectively respond to emergency situations to minimize harm to people and the environment.

The Awareness for Noise/Records training aims to provide participants with an understanding of the nature of noise hazards in the workplace and their effects on people. The course will also cover conducting noise assessments in the workplace and the general environment, determining compliance requirements, and controlling noise exposure, including the use of personal protective equipment.

Overall, the training sessions are an essential part of the project's environmental management, ensuring that new employees and workers are well-equipped to work safely and responsibly at the construction site. The Awareness for Noise/Records training will take place on March 16, 2023, while Spill Response, Clean-Up, and Emergency Response training will be conducted on March 17, 2023

5. ENVIRONMENTAL ACTIVITIES SUMMARY

5.1 Monitoring in the Pre-Construction Phase

In order to ensure the environmental impact of the waste-to-energy (WtE) facility at Thilafushi, Maldives is well-monitored, a monitoring schedule was proposed and followed. As per the schedule, the first round of environmental monitoring was carried out in February 2023. This report is a part of the pre-construction and construction stage monitoring, which is a contractual requirement outlined in the Environmental Impact Assessment report for the project. The purpose of the monitoring is to assess the environmental impact of the WtE facility on the surroundings.

The environmental monitoring conducted in February was focused on three main aspects: Ambient air quality, noise level, marine water, ground water. The ambient air monitoring was conducted from 5th -8th February 2023 at various approved locations, using AirQoon Sensor equipment. Similarly, the noise level monitoring was conducted on from 16th to 17th February 2023 at five locations, using T-958 Professional Sound Level Meter device. Marine water and ground water was conducted on 15th February 2023 by Bureau Veritas Consumer Products Services Lanka (Pvt) Ltd. The results of these environmental monitoring activities will help ensure that the WtE facility operates within the acceptable environmental standards and regulations set by the Maldives Government and Environmental Protection Agency (EPA).

5.2 Weather Conditions in Measuring Day

When conducting noise level and ambient air quality monitoring, several key considerations need to be taken into account to ensure accurate and reliable results.

For noise level monitoring, it is essential to consider the time of day when monitoring is conducted, as noise levels can vary significantly depending on the level of activity in the surrounding area. The type of environment being monitored, such as a busy construction site or a residential area, should also be considered, as this can impact the type of equipment used for monitoring and the locations of the monitoring points. The type of equipment used for noise level monitoring is also critical, as different types of meters can produce different results. In this case, the T-958 Professional Sound Level Meter was used, which is a reliable and accurate tool for monitoring noise levels.

When conducting ambient air quality monitoring, it is also important to consider the time of day and the weather conditions on the day of monitoring. Changes in wind speed, humidity, and other weather conditions can affect air quality, and the locations of the monitoring points should also be considered, as different locations can produce different results due to factors such as local traffic patterns and the presence of nearby industrial sources. In this case, the monitoring was conducted over a period of three days, with the AirQoon Sensor being used to monitor air quality at eight approved locations.

By taking these key considerations into account, the results of the noise level and ambient air quality monitoring conducted in January 2023 can be relied upon to provide an accurate and meaningful representation of the environmental conditions in the area surrounding the project.

Table 4: Weather Conditions During the monitoring days

Date	Time	Atmospheric temperature in °C	Atmospheric pressure in Hg	Wind speed Km/h	Wind direction	Air Humid %
5th Feb 2023	Night	28°C	29.8	20	East	81
	Morning	28°C	29.8	22	East	76
	Day	31°C	29.8	22	East North East	73
	Evening	28°C	29.8	16	East North East	68
6th Feb 2023	Night	28°C	29.8	16	East North East	83
	Morning	28°C	29.8	20	East North East	74
	Day	31°C	29.8	19	East	70
	Evening	28°C	29.8	17	East North East	76
7th Feb 2023	Night	28°C	29.8	14	East West	84
	Morning	30°C	29.8	12	East North East	79
	Day	31°C	29.8	13	North-North East	77
	Evening	28°C	29.8	14	North	82
8th Feb 2023	Night	28°C	29.8	11	North-North East	82
	Morning	31°C	29.8	12	North	73
	Day	32°C	29.7	15	North	68
	Evening	29°C	29.8	10	North	79
15th Feb 2023	Night	28°C	29.8	23	East North East	80
	Morning	31°C	29.9	21	East North East	70
	Day	31°C	29.9	25	East North East	63
	Evening	29°C	29.9	24	East North East	69

16th Feb 2023	Night	27°C	29.8	23	East North East	75
	Morning	31°C	29.9	24	East North East	66
	Day	32°C	29.9	26	East North East	58
	Evening	29°C	29.9	24	East North East	72

5.3 The summary weather conditions of the Maldives over the year

The Maldives are a group of tropical islands located in the Indian Ocean to the southwest of India. Known for their hot and humid climate, the Maldives experience two monsoons throughout the year that influence their weather conditions. The southwest monsoon, from April to September, is stronger in the northern islands and is accompanied by rough sea conditions, high humidity, and frequent cloudiness. The northeast monsoon, from October to December, brings showers and thunderstorms, especially in the southern atolls.

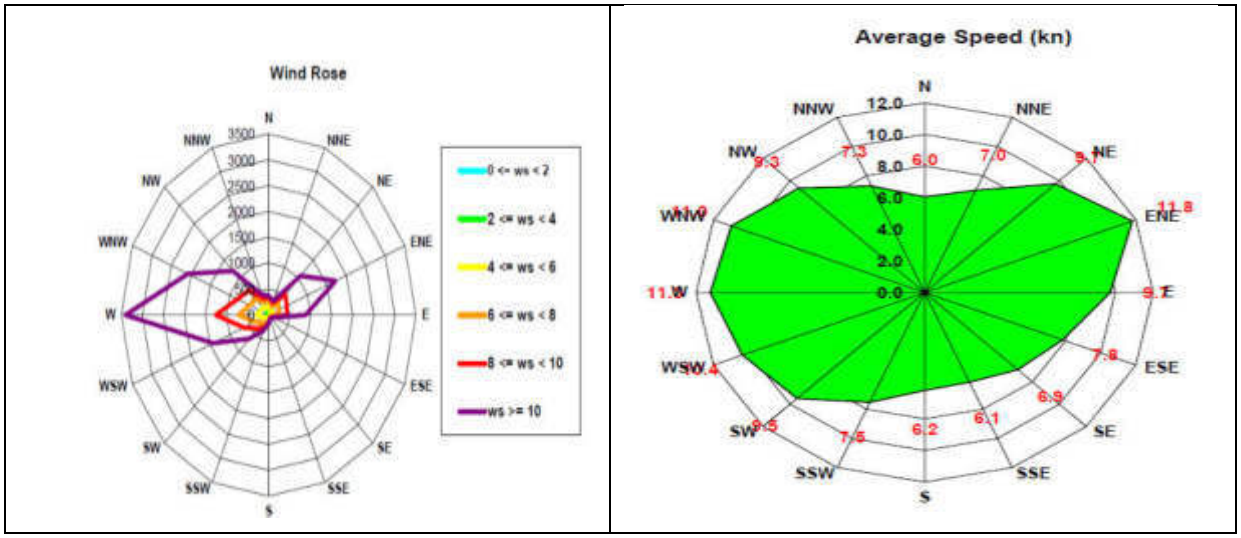
Between the monsoons, the driest period occurs from January to April, particularly in the northern atolls. The temperatures are consistent year-round, with a relative humidity of 80%. During the period of March to May, there is a slight increase in temperature, especially in the northern atolls, with maximum temperatures reaching 32-33 °C (90-91 °F) and minimum temperatures of 26-27 °C (79-81 °F).

In tropical areas like the Maldives, rainfall typically occurs in short, intense downpours or thunderstorms. The southern atolls experience slightly more rainfall, with an annual average of 2,200-2,300 millimeters (87-91 inches), while the north experiences an average of 1,700-1,800 millimeters (67-71 inches) per year due to a relatively dry season from January to mid-April. This dry season is more pronounced in the northernmost atolls.

- **Wind**: The prevailing wind over the Maldives follows the typical Asian monsoonal characteristics, with seasonal reversals of wind direction by more than 120° between January and July. Throughout the year, westerly winds are predominant in the country, varying between west-southwest and west-northwest.

The southwest monsoon, which lasts from May to October, brings winds predominantly between SW and NW. From May to June, winds are mainly from WSW to WNW, and from July to October, winds between W and NW predominate. On the other hand, the northeast monsoon, which lasts from December to February, brings winds predominantly from NE to E. Winds are variable in March and April.

November is a transitional month, with winds primarily from the west, becoming variable and occasionally exceeding 30 knots from the NE sector. However, yearly wind speeds during the northeast and southwest monsoons are observed to be between 9-13 knots.



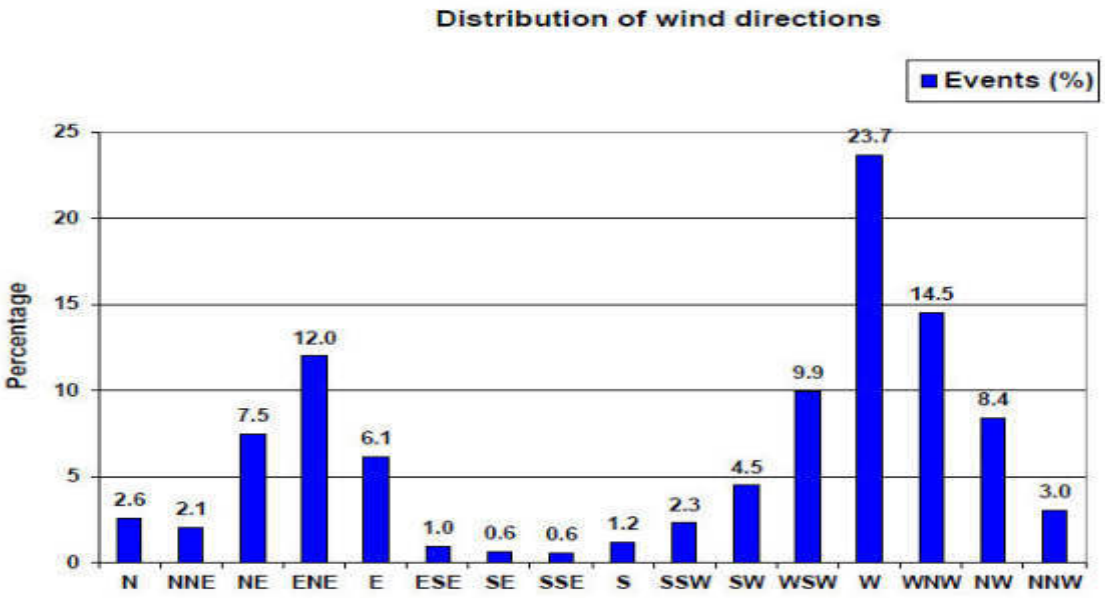


Figure 1: Spatial distribution of wind speed and directions (Source: MEE)

With respect to maximum wind speeds, visual inspection of the wind rose plot coincides with that of the mean wind speeds. Approximately 3% of the time, wind speeds had gone as high as > 40 knots in this region. The highest recorded maximum wind speed for the region during the data collection period was 62 knots. The most common maximum wind speed is between 10-20 knots. Wind rose plots for both maximum and mean wind speeds show that winds from the West are dominant (21.3% of the time).

6. Key Monitoring Findings from the Reporting Period

6.1 Ambient/Air Monitoring Results

The preconstruction environmental monitoring of the ambient air quality was conducted in from 5th -8th February 2023 at seven different locations, six of which were located at Thilafushi and one at Villingili. During the monitoring period, various air quality parameters were monitored using air quality monitoring stations that were equipped with sensor technology. The parameters that were monitored included PM10, PM2.5, SO_2, NO_2, and O_3. In order to measure the Total Suspended Particles (TSPs), dust sampling devices conforming to international HSE-MDHS 14/3 were used. As per the recommendations of the Environmental Impact Assessment (EIA) report, air quality was measured 24 hours at each station to ensure a thorough evaluation

of the air quality in the area. The locations for air quality monitoring were selected based on the findings of the EIA and the ASR 2, ASR3, and ASR5 recommended for monitoring in the EIA report.

Table 5: Sampling Locations Pre-construction Ambient Air Quality Monitoring

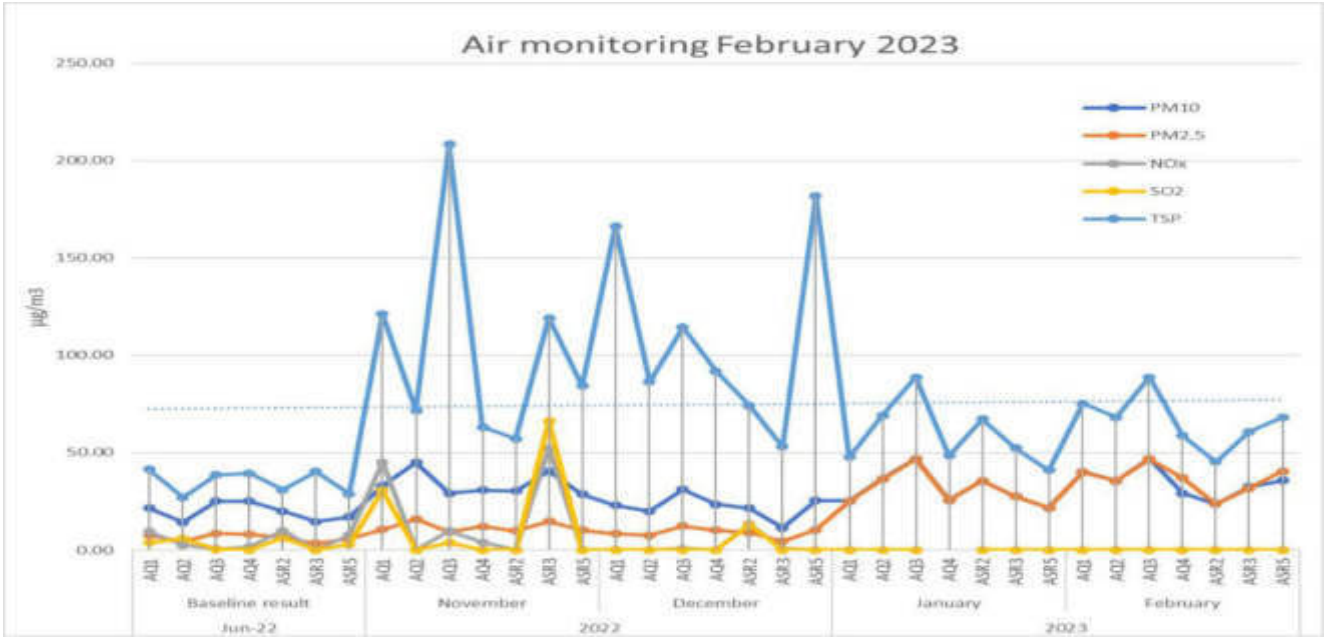
The approved Environmental Impact Assessment (EIA) document has identified and described the air quality monitoring locations. There are 7 designated air monitoring stations. These locations are further presented in the table below.

Table 6: Brief Description of Air Quality Monitoring Stations

AQ1	Represents a dense industrial area. The distance from the project area to the stations is 650m, and the location is located directly to the working area of Ship and vessel repair and maintenance
AQ2	Represents dense industrial area. The distance from the project area to the stations is 1000m and the location is located directly to the working area of Ship and vessel repair and maintenance
AQ3	Represents dense industrial area, the distance from the project area to the stations is 500m, and the location is located directly to the working area of Ship and vessel repair and maintenance
AQ4	Represents dense housing and population area, the distance from the project area to the stations is 4500m
ARS2	Represents a dense industrial area, the distance from the project area to the stations is 700m, the location is located directly to the working area of Ship and vessel repair and maintenance
ARS3	Represents dense industrial area, the distance from the project area to the stations is 500m the location is located directly to the working area of Ship, vehicle and vessel repair and maintenance
ARS5	Represents dense industrial area, , the distance from the project area to the stations is 1000m, the location is located directly to the working area of Ship, vehicle and vessel repair and maintenance

Table 7: Air Quality Monitoring Result in February 2023

	Jun-22							2022														2023													Standard value (WHO
	Baseline result							November							December							January							February							
	AQ1	AQ2	AQ3	AQ4	ASR2	ASR3	ASR5	AQ1	AQ2	AQ3	AQ4	ASR2	ASR3	ASR5	AQ1	AQ2	AQ3	AQ4	ASR2	ASR3	ASR5	AQ1	AQ2	AQ3	AQ4	ASR2	ASR3	ASR5	AQ1	AQ2	AQ3	AQ4	ASR2	ASR3	ASR5	
PM_{10}	21.46	14.20	25.14	25.03	19.9	14.6	16.88	33.06	44.87	29.23	30.67	30.45	40.55	28.59	22.87	20.00	31.06	23.47	21.55	11.41	25.47	25.28	36.6	46.84	25.59	35.54	27.61	21.68	40.11	35.54	46.84	29.1	23.63	32.44	35.62	50 µg/m^3
$PM_{2.5}$	7.69	4.37	8.67	8.09	6.6	3.4	5.78	10.52	15.85	9.25	12.06	9.83	14.84	10.19	8.41	7.55	12.28	10.10	8.95	4.44	10.42	25.13	36.45	46.64	25.56	35.46	27.57	21.66	39.97	35.45	46.64	37.13	23.6	31.7	40.58	25 µg/m^3
NO_x	9.42	2.57	0.69	1.60	9.9	0.0	7.66	45.18	0	9.85	4.03	0	52.53	0	0	0	0.86	0	13.35	0.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200 µg/m3
SO_2	3.83	5.96	0.50	0.07	6.18	0	2.93	30.78	0	3.81	0.08	0	66.25	0	0	0	0	0	12.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20 µg/m3
TSP	41.40	27.10	38.60	39.40	30.9	40.3	28.8	121.14	71.75	208.34	63.2	57.08	119.13	84.21	166.41	86.40	114.36	91.96	74.10	53.16	181.96	47.82	69.28	88.65	48.49	67.31	52.31	41.08	75.21	68.2	88.65	58.81	45.28	60.61	68.17	-



As the result shown in Table 5 and the graphic, the ambient air quality results obtained from the preconstruction monitoring in February 2023 indicate that the background air quality values comply with air quality standards.

Deviations from the baseline could be explained through a combination of the following factors, which are not necessarily related to the project activities:

- **Industrial and commercial activitie**s: The main activities on Thilafushi are not limited to dumping waste; the island also houses various industries, including gas and goods transportation, ship building and maintenance, and hot works such as welding and cutting. Currently, there are over 250 parties engaged in industrial activities on the island, with several factories established for ship, vessel, and vehicle maintenance and recycling. Additionally, Thilafushi serves as a storage site for gas and cement that are to be transported to Male. However, the commercial activities, coupled with indiscriminate dumping, have led to an abundance of toxic materials in the lagoon, including broken oil drums, asbestos, lead, and other harmful metals mixed with daily household garbage items, creating a noxious sludge. Unfortunately, very little on the island remains unpolluted, as harmful substances seep into the water and smoke from burning waste pollutes the air. Industrial and commercial activities, transportation, and population growth are more likely to be dependent on the monitoring location as they are directly influenced by human activities and the level of development of a particular area. Weather conditions and natural sources can affect air quality in a specific location, but their impact may not be as directly linked to the monitoring location as the other three factors.
- **Transportation**: The emission of pollutants from vehicles (for transportation and industry activities mentioned above), such as cars, trucks, and buses, can also contribute to poor air quality.
- **Weather conditions**: Weather conditions like temperature inversions, which trap pollutants close to the ground, can contribute to poor air quality.
- **Population growth**: As populations growth, the emission of pollutants such as toxic gas, high concentration of particles (PM10, PM2.5), etc., and human activities increases, leading to poor air quality

For this reason, it is also important to look at differences between the monitoring locations, to ascertain whether the deviations are because of the monitoring regime, affected by the project activities and/or factors outside of the project area.

Comparing air quality monitoring data over time provides several key benefits:

- **Identifying Trends**: Monitoring air quality over a period of time can reveal trends and patterns that may not be noticeable in isolated data points. This information can help to identify sources of pollution and prioritize mitigation efforts.
- **Evaluating the Effectiveness of Mitigation Efforts**: Comparing air quality data over time can show the impact of mitigation efforts, such as reducing emissions from industrial sources or implementing a clean-air policy.
- **Identifying Seasonal Variations**: Some air pollutants can vary seasonally, and comparing air quality data over time can reveal these patterns and help to understand the impact of weather on air quality.
- **Compliance Monitoring**: Comparing air quality data over time can help determine if a location is meeting air quality standards and regulations.

- **Supporting Research**: Comparing air quality data over time can support scientific research and provide important information for understanding the long-term effects of air pollution on human health and the environment.

Overall, comparing air quality monitoring data over time is an important tool for understanding and addressing air pollution and ensuring that communities have safe and healthy air to breathe.

Single data points from air quality monitoring are just snapshots of air quality conditions at a specific moment in time, and it is not possible to determine the cause of any changes in air quality based on just one data point. To determine the cause and effect of changes in air quality, it is necessary to examine the data over a longer period of time and consider multiple data sources. By analyzing data over time and considering multiple data sources, it is possible to identify the causes and effects of changes in air quality and develop strategies for improving air quality.

6.2 Noise Monitoring Findings

The purpose of conducting repeated ambient noise level measurements at five locations during the pre-construction phase of the Thilafushi Waste to Energy facility is to evaluate the noise impact of the facility on its surrounding environment. The ET-958 Professional Sound Level Meter is used to ensure accurate and consistent results. Although the methodology for conducting these noise level measurements is still under review, the objective is to establish a comprehensive and consistent approach for all future noise monitoring efforts at the facility.

To capture both daytime and nighttime noise levels, the measurements for this reporting period were conducted over a 24-hour period on February 16th to 17th, 2023. This was done to account for any differences in noise levels that may occur due to changes in human activities and other sources of noise during different times of the day. The results of these measurements were recorded and analyzed to determine the baseline noise levels in the surrounding environment and assess the waste-to-energy facility's potential impact on the community.

Table 8: Locations Selected for Ambient Noise Level Measurements

Station name	Geographic Coordinates	Reason for selection
NQ1	4°10’26.4 N, 73°28’59.9 E	Included in the original EIA
NQ2	4°10’56.6 N, 73°26’53.3 E	Included in the original EIA
NQ3	4°10’58.3 N, 73°26’09.6 E	Included in the original EIA
NQ4	4°10’57.3 N,73°25’59.4 E	Included in the original EIA
NQ5	4°10’57.3 N, 73°26’14.4 E	Included in the original EIA

Table 9: Brief Description of Noise Monitoring Locations

NQ1	The station was selected as it represents a major industrial location of the island and is also located close to the harbor. The location lies north of the proposed facility on the opposite side of the lagoon.
NQ2	The station was selected as it represents a major industrial location of the island. The location lies east of the proposed facility on the opposite side of the lagoon. The location has various industrial activities in its proximity

NQ3	This station was selected as it is located near the boundary of the proposed WTE facility.
NQ4	This station was selected as it is located west of proposed WTE facility. The area has less development and less activity during the day time.
NQ5	This station was selected as it is located at the proposed WTE facility.

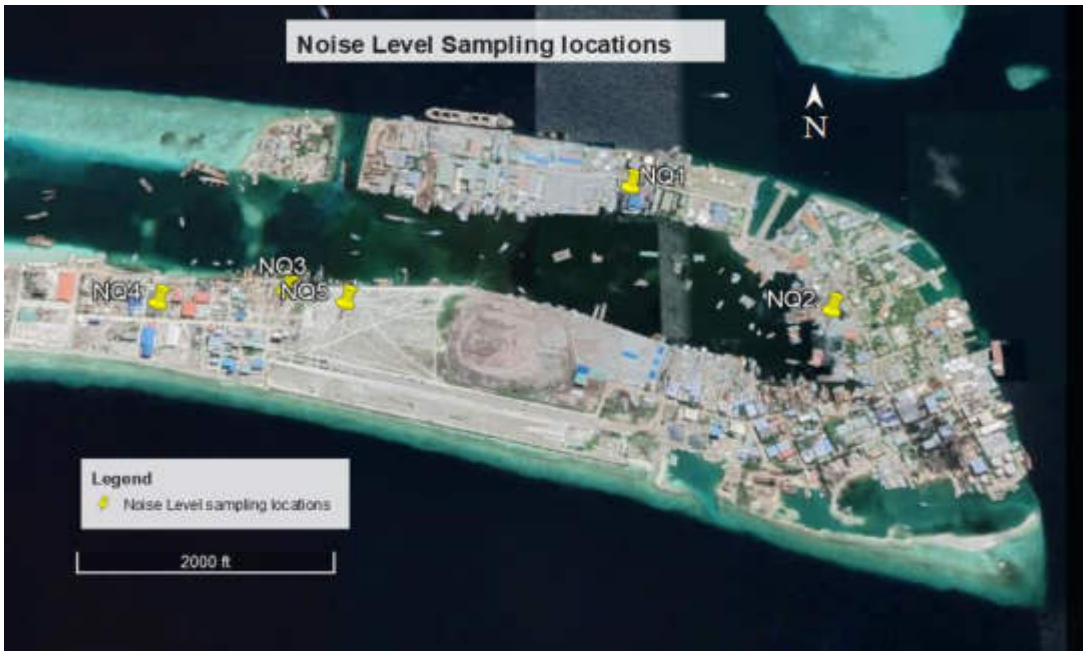


Figure 2: Ambient Noise Level Sampling Locations

Table 8. Noise monitoring result in February 2023

dBa	Baseline result 2022					Jan 2023					February 2023					Std. value
	NQ1	NQ2	NQ3	NQ4	NQ5	NQ1	NQ2	NQ3	NQ4	NQ5	NQ1	NQ2	NQ3	NQ4	NQ5	
Day time (dBA)	65.1	64.2	56.3	56.0	54.6	61.9	55.2	52.4	53.8	51.4	59.4	57.3	55	55.2	53.9	**70**
Night time (dBA)	58.7	51.8	50.0	48.9	49.0	55.6	50.5	54	56.1	44.3	56.2	51.3	52.7	51.7	49.6	

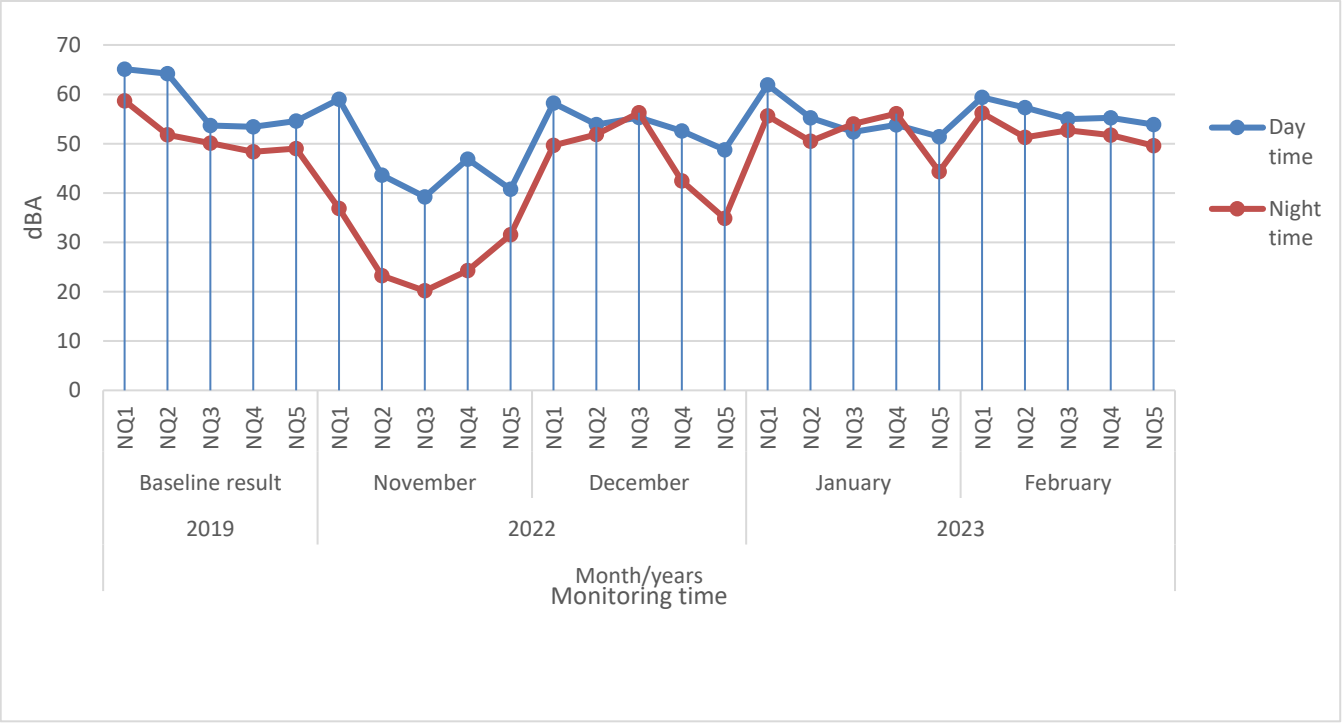


Figure 3: Noise monitoring diagram February 2023

To comprehensively understand the ambient noise levels in the vicinity of the Thilafushi Waste to Energy facility, 7-8 readings were taken every hour for 30-50 seconds at each monitoring station. These readings were then averaged to determine the average ambient noise level, which was recorded in dB(A). The results were summarized in Table 8 and depicted in Figure 3, providing a comprehensive overview of the ambient noise levels in the area. This data enabled further analysis and evaluation of the facility's potential impact on the surrounding environment.

It is important to note that the monitoring was carried out during two different time periods:

- Dayy time (07.00 AM - 22.00 PM)
- Night time (22.00 PM - 07.00 AM, possibly the next day).

It is worth mentioning that there are currently no specific national standards for ambient noise levels in outdoor industrial areas in the Maldives. However, the measurements taken in Thilafushi island and the subproject area were compared to noise level standards specified by the World Health Organization (WHO) and the Asian Development Bank (ADB) for outdoor industrial and commercial areas. The results showed that all of the monitored locations had ambient noise levels below the threshold levels set by the WHO standards, indicating that the ambient noise levels in the area are considered safe according to WHO's criteria for outdoor industrial and commercial areas.
It is important to consider that several factors can lead to differences in noise levels between a baseline measurement and a subsequent measurement. Some of the most likely explanations for noise levels being beyond acceptable standards or differing from a baseline measurement include... (the rest of the paragraph is missing).

There could be several factors that contribute to differences in noise levels between a baseline measurement and a subsequent measurement. Some of the most likely explanations for noise levels exceeding acceptable standards or differing from a baseline measurement are:

• Industrial and commercial activities: Thilafushi island is not solely used for waste disposal; it also accommodates numerous industries. There are presently over 250 industrial entities operating on the island, with several factories established for the maintenance and recycling of ships, vessels, and vehicles. In addition, Thilafushi serves as a storage location for gas and cement that are destined for Male. Industrial and commercial activities, transportation, and population growth are more likely to vary based on the monitoring location since they are directly influenced by human activities and the level of development of a particular area. Weather conditions such as high wind speed and wave sounds may also impact noise levels at night in a specific location.

- Increase in traffic volume or industrial activities: A surge in the number of vehicles or industrial activities in the region can lead to an increase in noise levels.
- Difference in weather conditions: Noise levels can be affected by weather conditions such as wind speed and direction, which can carry sounds further or lessen their impact.
- Difference in time of day: Noise levels can differ depending on the time of day. For example, noise levels may be higher during the day when there is more activity compared to nighttime.

- Difference in location of the noise source: Relocation of the noise source can result in different noise levels at a particular location.
- Change in measurement equipment or methodology: If the measurement equipment or methodology changes, it can result in different noise level readings compared to a baseline measurement.
- New construction or demolition activities: New construction or demolition activities can increase noise levels.

These are some of the reasons why noise levels are typically higher at night compared to during the day. Some of the contributing factors may include:

- Increased human activity: People tend to be more active at night, and construction work could increase noise levels.
- Traffic: There may be more vehicles in the area at night, leading to increased noise levels.
- Industrial activities: Some industries may operate 24/7, leading to increased noise levels at night.
- Echoes and reflections: At night, there are usually fewer people and objects to absorb sound, so noise can travel farther and be amplified by echoes and reflections.

It is essential to consider these factors when interpreting changes in noise levels over time.

6.3 Marine water monitoring: Marine water monitoring was conducted on 15th February, 2023, the result showed in table 9:

Parameter	2019 Baseline result							2023 February							Maldivian Marine water quality standard
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW1	SW2	SW3	SW4	SW5	SW6	SW7	
Temperature at receiving (°C)	24.2	24.2	24.2	24.2	24.2	24.2	24.2								18 – 32 °C
BOD mg/l	1.0	1.0	1.0	1.0	< 1	< 1	< 1	6	6	ND	6	6	6	6	<2mg/l
DO (dissolved oxygen) mg/l								5.6	5.4	5.9	5.9	5.6	5.2	5.2	-
Turbidity (NTU)	0.3	0.2	0.1	0.2	0.3	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.3	0.4	3 – 5 NTU (max)
pH at 24°C	8.4	8.4	8.4	8.4	8.4	8.4	8.2	8.4	8.0	7.1	8.2	8.1	8.3	8.2	8 – 8.3
Nitrate (NO3-) mg/l	0.3	0.4	0.4	0.4	0.5	0.3	0.5	0.3	0.3	0.1	0.3	0.4	0.3	0.4	n/a
Oil & Grease (mg/l)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0								
Free Ammonia (NH3) mg/l	0.05	<0.02	<0.02	<0.02	0.05	0.05	<0.02								2 – 3 mg/l (max)
Salinity (ppt)	36	37	37	37	36	37	36								32 – 42 ppt
Nitrogen (as N)*								11.6	9.8	ND	11.6	10.4	11.8	10.9	
(COD)								40	38	3	36	39	38	41	200
Electrical Conductivity at 25°C								54.5	54	57.2	48.6	47.8	48	56	2500
Total Phosphates (as PO_4^{3-})								0.05	0.05	ND	0.05	0.05	0.05	0.05	1
Arsenic (As) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a
(TSS)								3	4	4	4	4	3	3	
Cadmium (Cd) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Lead (Pb) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Mercury (Hg) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Nickel (Ni) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Copper (Cu) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Zinc (Zn) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Hexavalent Chromium (asCr^{6+})*								ND	ND	ND	ND	ND	ND	ND	
Sulfide								ND	ND	ND	ND	ND	ND	ND	
Chromium (Cr) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

According to result shows in table, the pH value of SW1 is slightly higher than standard value, it can be explained: the pH value of seawater is slightly basic, typically ranging from 7.5 to 8.4. This means that seawater is not acidic, but rather on the alkaline side of the pH scale. This is due to the presence of dissolved minerals and salts in seawater, such as bicarbonate, carbonate, and hydroxide ions, which act as buffers and help to maintain the pH of seawater within this range.

It is important to note that the pH of seawater can vary depending on a variety of factors, such as temperature, depth, and location, and can be influenced by human activities such as pollution and climate change. However, overall, seawater is considered to be slightly basic rather than acidic

An increase in the pH of seawater, also known as ocean acidification, can have significant impacts on marine ecosystems and organisms. This is because many marine organisms, such as shellfish, corals, and plankton, rely on the chemical balance of seawater to build and maintain their shells and skeletons.

Overall, the impacts of increasing the pH of seawater can be far-reaching and complex, and can have significant consequences for the health and functioning of marine ecosystems. Human activities can contribute to the increase in pH of seawater through a process called ocean acidification. This occurs when excess carbon dioxide (CO2) is absorbed by seawater, which reacts with water molecules to form carbonic acid. This process lowers the pH of seawater and makes it more acidic.

The main human activities that contribute to ocean acidification in Thilafushi island and surround sea area include:

- Burning fossil fuels: When we burn fossil fuels like coal, oil, and gas, we release large amounts of CO2 into the atmosphere. This excess CO2 is absorbed by the ocean, leading to a decrease in pH and increased acidity.
- Industrial processes: Certain industrial processes, such as cement production and metal smelting, can release CO2 and other greenhouse gases into the atmosphere, contributing to ocean acidification.
- Discharge raw wastewater (untreated wastewater) to the sea by domestic, industry, transportation activities, water eutrophication, carbon dioxide dissolving in water, etc.

Overall, human activities that contribute to increased levels of CO2 in the atmosphere are the main drivers of ocean acidification and the resulting increase in seawater pH.

6.4 Groundwater monitoring

Parameter	Month/years																Standard Limit
	2019								2023								
	Baseline result								February								
	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	
Chloride mg/l	183	1715	7200	470	3125	6325	6125	1005	77.8	219	110	296	8640	83.5	79.6	77.8	Max. 200
Nitrate mg/l	1.7	6.1	5.0	7.5	25.5	34.5	12.2	3.4	ND	0.6	0.5	0.5	0.6	0.1	ND	ND	Max. 50
Phosphate mg/l	0.07	0.23	0.21	<0.05	0.46	0.57	2.27	0.72	ND	0.06	0.05	0.05	0.05	ND	ND	ND	Max. 5.0
Total Coliforms (MPN)	>2420	291	>2420	1986	>2420	10	>2420	4	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	0
Turbidity (NTU)	1.3	4	0.6	0.4	151	177	1845	348	0.2	0.2	0.4	0.4	8.7	0.3	0.2	0.2	Max. 1
pH at 25°C*	7.3	7.2	7.4	8.0	7.1	6.7	7.9	7.8	6.5	6.7	8.3	7.6	7.5	6.8	6.8	6.8	6.5 – 8.5
Iron (as Fe) mg/l	0.4	3.9	0.6	ND	5.9	5.7	0.7	0.4	ND	ND	ND	ND	ND	ND	ND	ND	Max. 0.3
Manganese (as Mn)	0.02	0.09	0.006	ND	0.20	0.30	0.01	0.07	ND	ND	ND	ND	ND	ND	ND	ND	Max. 0.1
Arsenic (as As)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Max. 0.01
Total Dissolved Solids mg/l	794	4020	12946	1003	6155	11554	11327	2188									
Total Suspended Solids (TSS)									ND	ND	2	2	680	ND	ND	ND	5 - 750
Electrical Conductivity at 25°C* mS/cm	1.4	7.4	20.6	1.87	12.3	25.0	18.7	3.8	577	3252	13.5	4925	15.5	1712	595	580	Max. 1000
Cadmium (as Cd)*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Max. 0.003
Lead (as Pb) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Max. 0.01
Mercury (as Hg) mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Max. 0.001
Oil and Grease	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	0.1	0.1	0.9	0.1	0.1	ND	-

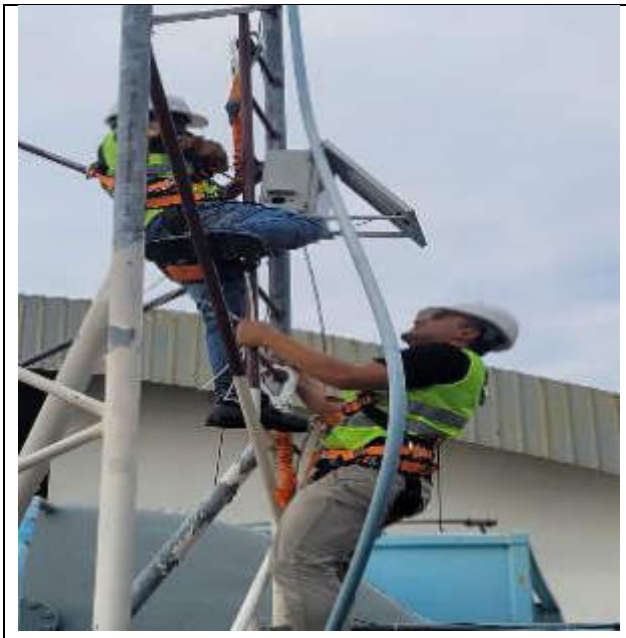
Chloride is a natural element that is commonly found in water sources and often combines with other elements like sodium chloride (salt) or potassium and calcium. Chloride can come from various sources, including weathered soils, salt-bearing geological formations, wastewater, and coastal regions where salty ocean water mixes with freshwater. The concentration of chloride in oceans is typically around 19,000 mg/L. Studies have shown that in coastal areas, there is a risk of saltwater infiltrating and mixing with freshwater in underground aquifers. Precipitation helps recharge groundwater and maintain a separation between freshwater and saltwater. However, excessive groundwater withdrawal can cause the freshwater-saltwater interface to shift upward or closer to the coast.

In underground aquifers near the coast, there is a transition zone between freshwater and saltwater called the freshwater-saltwater interface. This interface is defined by freshwater with less than 1,000 mg/L of total dissolved solids or approximately 250 mg/L of chloride. In natural settings, precipitation helps maintain a safe distance between the interface and the coast.

Groundwater samples showed variation in chloride concentration, and in general, groundwater samples 2, 3, 4, and 5 indicated seawater intrusion into the groundwater. It is essential to manage and monitor chloride levels in groundwater as high levels of chloride can have negative impacts on human health and industrial and others processes that rely on groundwater.

7. Picture demonstrate to physical environment monitoring in Pre-construction phase

1. Ambient Air monitoring



2. Noise monitoring

3. Marine water monitoring

4. Ground water monitoring

Appendix 1. Waste collection agreement

Waste Disposal Form

Request Date: 29 / 01 / 2023

DETAILS OF PARTY REQUESTING FOR SERVICE

Alke Alkatas Joint Venture Pvt. Ltd.
Name of Individual / Company / Resort / Island/Department

H.H. maamiyage 5A Acare Hingun K. male - 20265
Address

burak.ozdemir@aawtr.com
Email Address — Telephone Number and Fax Number

DETAILS OF VESSEL/ VEHICLE

Pick up — Name of Vessel/ Vehicle
AC1 AT1612 — Registry Number

Mehadi — Name of Captain/ Driver
National ID Card Number

Length of the Vessel / Vehicle
1.5 Ton — Tonnage

Name of Company
9114593 — Telephone Number and Fax Number

Location of WAMCO

- ☐ Industrial Village/Malé
- ☑ K. Thilafushi
- ☐ Hulhumale
- ☐ Vilimalé
- ☐ R. Vandhoo
- ☐ Fuvahmulah
- ☐ S.Hithadhoo
- ☐ S.Hulhumeedhoo
- ☐ HDh. Kulhudhuffushi

PARTICULARS OF WASTE (SEGREGATED)

- ☐ Green Waste
- ☑ Plastic
- ☑ Wood
- ☐ Glass
- ☑ Paper/Cardboard
- ☐ *ELV
- ☐ Electronic Waste
- ☐ C&D
- ☐ Other

*ELV: End of Life *C&D: Construction and Demolition waste

Note 1: The following waste types are not accepted at the facility
a) Hazardous Chemical Waste
b) Liquid or semi-liquid sewage and septic waste

Note 2: Please send the original along with a copy of the same with the boat captain or driver.

AUTHORIZED PERSONNEL OF REQUESTING PARTY

FENOL REILEXI — Name
9811779. — Telephone Number and Fax Number
MANAGING DIRECTOR. — Designation
C02782022 — Signature and Stamp

Payment basis: ☐ Cash ☐ Credit

*Any alterations on the form will not be accepted

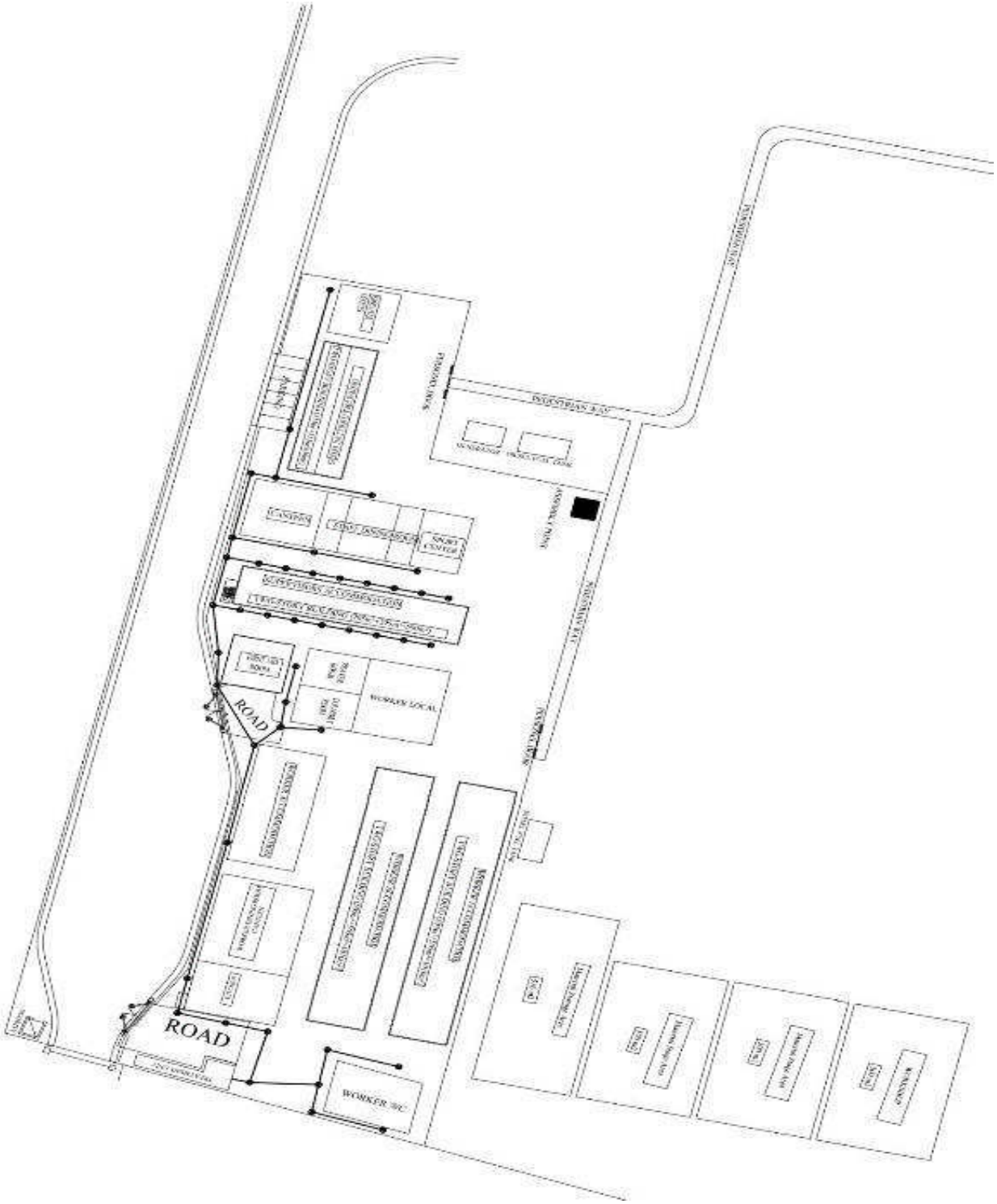
----------To be filled by official of Waste Management Corporation----------

Name — Date Received — Time Received

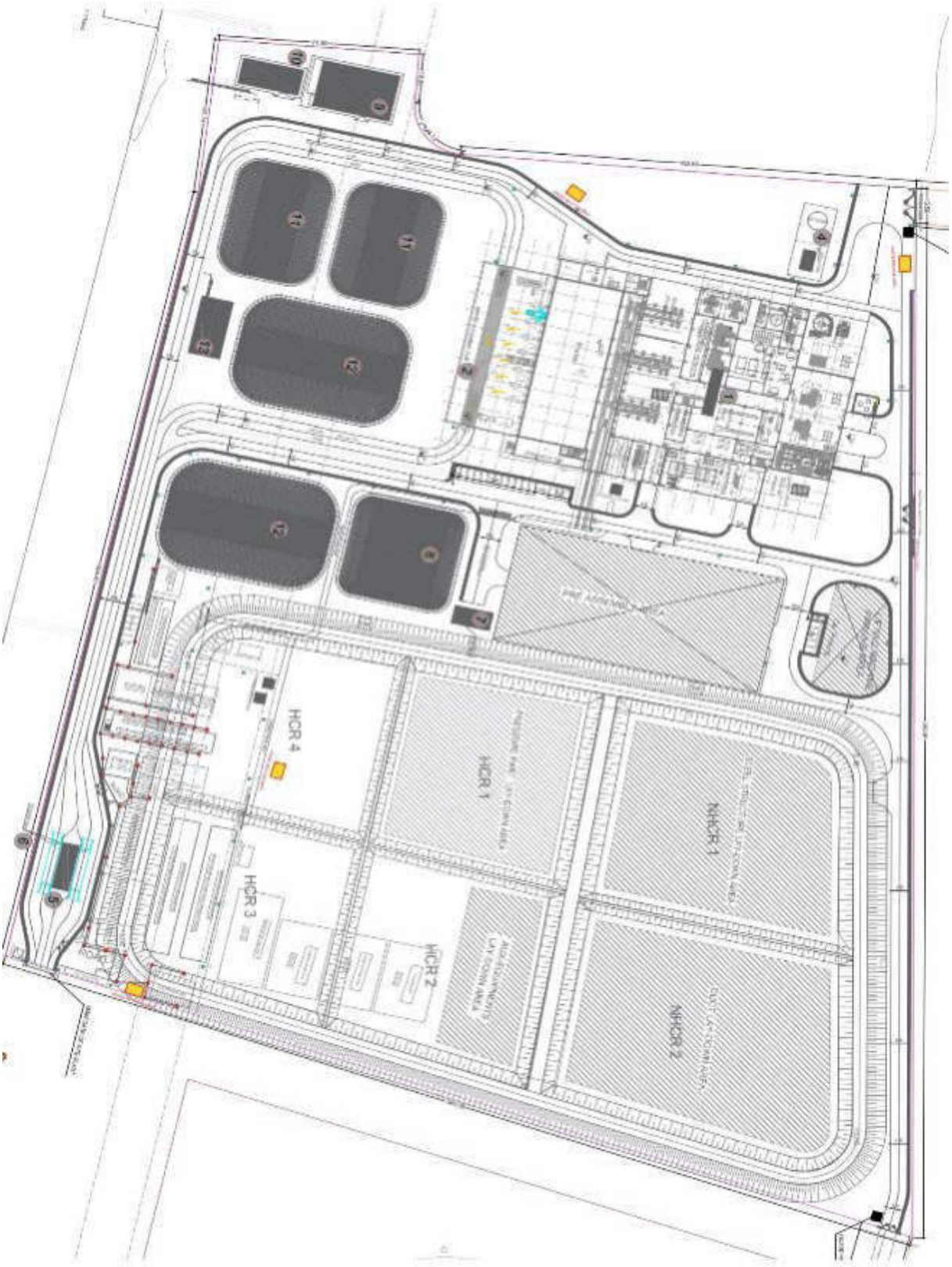
Sales Receipt / Estimate Number — Signature and Stamp

*Waste manifest form with guideline must be attached with this form.

Appendix 2. Sewage layout plan



Appendix 3. Disposal areas layout plan (WASTE STORAGE ARES IN YELLOW RECTANGULAR)



Appendix 4. Original monitoring reports

1. Ambient Air quality monitoring field description

airs
Air Quality Management Services

AIR QUALITY MONITORING FIELD FORM

General Information	
Customer Name	Alke Alkatas JV Pvt Ltd
Station No	: AQ1
Monitoring Date and Time	: 5/2/2023 / 09:00
Device Code and Calibration Status	: 222 [illegible] / New device. Calibration needed after 22/06/2023
Coordinates	: 6.182662 , 73.63298]

Initial Environmental Variables	
Temperature	: 26
Pressure	: 1006
Wind Speed and Direction	: ENE 1 km/h
Cloud	: 7/8

Conclusions
Location already. Device is checked and works properly. Device set up on a tree.

Surveyors Name	Ismail Ulusoy
Company	AIRS ARMS Ltd
Phone	+90 544 738 63 56
E-mail	info@airs.com.tr
Signature	[signature]

AQM.F.01.00

Checked.
[signature]
[illegible]

airs
Air Quality Management Services

AIR QUALITY MONITORING FIELD FORM

General Information	
Customer Name	~~ASR-2~~ Alke Alkataş JV Ard Ltd
Station No	: ASR - 2
Monitoring Date and Time	08/2/2023
Device Code and Calibration Status	: 923- ISTANBUL / New device. Calibration needs after 11/06/2023
Coordinates	: 4 17 2882 , 73 . 66883

Initial Environmental Variables	
Temperature	: 26
Pressure	: 1006
Wind Speed and Direction	: ENE 11 km/h
Cloud	: 7/8 Almost

Conclusions
Permission was taken. Device is checked. Location is ready.

Surveyors Name	İsmail Ulusoy
Company	AIRS AQMS Ltd
Phone	+90 564 738 8356
E-mail	info @airs.com.tr
Signature	[signature]

Checked,
[signature]
Takan Bal

8.

airs
Air Quality Management Services

AIR QUALITY MONITORING FIELD FORM

General Information	
Customer Name	Alke Alkataş JV and LHI
Station No	: AS 23
Monitoring Date and Time	: 6/2/2023 09:00
Device Code and Calibration Status	: 222-Mak / New device. Calibration needs after 22/06/2023
Coordinates	: 41.155256 , 73,639804

Initial Environmental Variables	
Temperature	: 20
Pressure	: 808 [illegible]
Wind Speed and Direction	: 10ll
Cloud	: 6/10

Conclusions
Permission was taken to reach measurement point. Device is checked

Surveyors Name	İsmail Ulusoy
Company	AIRS Arge Ltd
Phone	+90 524 738 83 86
E-mail	info@airs.com.tr
Signature	[signature]

AQM.F.01.00

Checked
[signature]

9.

airs
Air Quality Management Services

AIR QUALITY MONITORING FIELD FORM

General Information	
Customer Name	Alke Alkatas JV Pvt Ltd
Station No	: AQ1
Monitoring Date and Time	: 6/12/2023 10:00
Device Code and Calibration Status	: 227 - Male
Coordinates	: 4.182458, 73.448769

Initial Environmental Variables	
Temperature	: ~~[illegible]~~ 30°C
Pressure	: 1011
Wind Speed and Direction	: ENE 17 km/h
Cloud	: 6/10

Conclusions
Permission was taken. Device is checked location is ready.

Surveyors Name	
Company	
Phone	
E-mail	
Signature	

Checked
AQM F 01 00
[signature]

10.

airs Air Quality Management Services

AIR QUALITY MONITORING FIELD FORM

General Information	
Customer Name	Alke Alkataş Jv Ort Ltd
Station No	: ASR 5
Monitoring Date and Time	: 7/2/2023
Device Code and Calibration Status	: 217 -Male / New device. Calibration needs after 27/06/2023
Coordinates	: 41.18600, 33.03654

Initial Environmental Variables	
Temperature	: 2 9 °C
Pressure	: 1012
Wind Speed and Direction	: N 9km/h
Cloud	: 1/10

Conclusions
Security was informed and permission was taken. Device was checked location is ready

Surveyors Name	Ismail Ulusoy
Company	AIRS AQMS Ltd
Phone	+90 534 738 53 81
E-mail	info@airs.com.tr
Signature	

Checked.

11.

airs
Air Quality Management Services

AIR QUALITY MONITORING FIELD FORM

General Information	
Customer Name	Alke Alkataş JV Ort Ltd
Station No	: AQ 1
Monitoring Date and Time	: 7/2/2023 / New device Calibration needs after 27/06/2023
Device Code and Calibration Status	: 223 - ISTANBUL / ~~[illegible]~~
Coordinates	: 4.17664, 73.426654

Initial Environmental Variables	
Temperature	: 30 °C
Pressure	: 1012
Wind Speed and Direction	: NW 9 km/h
Cloud	: 3/10

Conclusions
Public was informed. Device was checked. Location is ready

Surveyors Name	Ismail Ulusoy
Company	AIRS AQMS
Phone	+90 544 738 8386
E-mail	info@airs.com.tr
Signature	[signature]

Checked.
[signature]
Ta Hoa Binh

AQM.F.01.00

2. Noise level Hourly recorded

Client	AAJV WtE	Station No	NQ1 Thilafushi
Location	4°10'26.4 N, 73°28'59.9 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel	Weather condition sunny and clear	Temperature:31.1 oC
Start time	2/15/2023 10:59		Wind: NE 10-20miles
End time	2/16/2023 10:59		Humidity: 61%

Date/time	**dBA**	**Remarks noise level**
2/15/2023 11:59	63.0	Conversation
2/15/2023 12:58	57.7	Quite office
2/15/2023 13:58	56.7	Quite office
2/15/2023 14:58	61.4	Conversation
2/15/2023 15:47	61.5	Conversation
2/15/2023 16:57	59.4	Quite office
2/15/2023 17:56	58.9	Quite office
2/15/2023 18:56	59.3	Quite office
2/15/2023 19:55	55.8	Quite office
2/15/2023 20:55	56.8	Quite office
2/15/2023 21:55	58.7	Quite office
2/15/2023 22:54	55.3	Quite office
2/15/2023 23:54	62.1	Conversation
2/16/2023 0:53	53.6	Quite office
2/16/2023 1:53	55.5	Quite office
2/16/2023 2:53	55.8	Quite office
2/16/2023 3:52	55.9	Quite office
2/16/2023 4:52	55.9	Quite office
2/16/2023 5:51	56.3	Quite office
2/16/2023 6:51	54.3	Quite office
2/16/2023 7:51	57.8	Quite office
2/16/2023 8:50	59.0	Quite office
2/16/2023 9:50	59.8	Quite office
2/16/2023 10:49	63.7	Conversation

Client	AAJV WtE	Station No	NQ2 Thilafushi
Location	4°10'56.6 N, 73°26'53.3 E	Consultant	Mahmood Riyaz
Technician: Hussain Fazeel	Start time: 2/15/2023 10:57	Weather condition sunny and clear	Temperature: 31.1 oC
			Wind: NE 10-20miles
End time	2/16/2023 10:57		Humidity:61%

Date/time	dBA	Remarks noise level
2/15/2023 11:57	61.0	Conversation
2/15/2023 12:57	59.8	Quite office
2/15/2023 13:56	63.8	Conversation
2/15/2023 14:56	54.4	Quite office
2/15/2023 15:55	57.2	Quite office
2/15/2023 16:55	54.8	Quite office
2/15/2023 17:54	55.2	Quite office
2/15/2023 18:54	51.0	Quite office
2/15/2023 19:54	54.5	Quite office
2/15/2023 20:53	51.4	Quite office
2/15/2023 21:53	58.5	Quite office
2/15/2023 22:52	48.8	Quite library
2/15/2023 23:52	56.9	Quite office
2/16/2023 0:52	47.6	Quite library
2/16/2023 1:51	46.6	Quite library
2/16/2023 2:51	57.1	Quite office
2/16/2023 3:50	49.3	Quite library
2/16/2023 4:50	51.9	Quite office
2/16/2023 5:49	53.3	Quite office
2/16/2023 6:49	48.5	Quite library
2/16/2023 7:49	53.2	Quite office
2/16/2023 8:48	53.7	Quite office
2/16/2023 9:48	60.8	Conversation
2/16/2023 10:47	65.4	Conversation

Client	AAJV WtE	Station No	NQ3 Thilafushi
Location	4°10'58.3 N, 73°26'09.6 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel		Temperature: 31.1 oC
Start time	2/15/2023 10:52	Weather conditionsunny and clear	Wind: NE 10-20miles
End time	2/16/2023 10:55		Humidity: 61%

Date/time	dBA	Remarks Noise level
2/15/2023 11:52	57.5	Quite office
2/15/2023 12:51	54.8	Quite office
2/15/2023 13:51	55.6	Quite office
2/15/2023 14:50	56.3	Quite office
2/15/2023 15:50	57.1	Quite office
2/15/2023 16:50	54.8	Quite office
2/15/2023 17:49	55.4	Quite office
2/15/2023 18:49	55.8	Quite office
2/15/2023 19:48	53.5	Quite office
2/15/2023 20:48	50.8	Quite office
2/15/2023 21:48	53.8	Quite office
2/15/2023 22:47	53.7	Quite office
2/15/2023 23:47	50.4	Quite office
2/16/2023 0:46	54.9	Quite office
2/16/2023 1:46	53.8	Quite office
2/16/2023 2:45	54.0	Quite office
2/16/2023 3:45	57.2	Quite office
2/16/2023 4:45	53.2	Quite office
2/16/2023 5:44	50.2	Quite office
2/16/2023 6:44	53.0	Quite office
2/16/2023 7:43	47.1	Quite library
2/16/2023 8:43	56.0	Quite office
2/16/2023 9:43	55.6	Quite office
2/16/2023 10:22	53.7	Quite office

Client	AAJV WtE	Station No	NQ4 Thilafushi
Location	4°10’57.3 N,73°25’59.4 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel	Weather condition sunny and clear	Temperature:31.1 oC
Start time	2/15/2023 10:52		Wind: NE 10-20miles
End time	2/16/2023 10:57		Humidity:61%

Date/time	dBA	Remarks Noise level
2/15/2023 11:57	56.6	Quite office
2/15/2023 12:57	44.9	Quite library
2/15/2023 13:56	58.2	Quite office
2/15/2023 14:56	61.3	Conversation
2/15/2023 15:55	55.0	Quite office
2/15/2023 16:55	53.4	Quite office
2/15/2023 17:54	57.3	Quite office
2/15/2023 18:54	52.8	Quite office
2/15/2023 19:54	54.9	Quite office
2/15/2023 20:53	54.1	Quite office
2/15/2023 21:53	50.1	Quite office
2/15/2023 22:52	51.5	Quite office
2/15/2023 23:52	52.3	Quite office
2/16/2023 0:52	49.7	Quite library
2/16/2023 1:51	50.4	Quite office
2/16/2023 2:51	48.4	Quite library
2/16/2023 3:50	52.2	Quite office
2/16/2023 4:50	47.1	Quite library
2/16/2023 5:49	53.7	Quite office
2/16/2023 6:49	50.5	Quite office
2/16/2023 7:49	60.8	Conversation
2/16/2023 8:48	57.8	Quite office
2/16/2023 9:48	64.2	Conversation
2/16/2023 10:47	52.6	Quite office

Client	AAJV WtE	Station No	NQ5 Thilafushi
Location	4°10'57.3 N, 73°26'14.4 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel	Weather condition sunny and clear	Temperature:31.1 oC
Start time	2/15/2023 10:54		Wind: NE 10-20miles
End time	2/16/2023 10:57		Humidity:61%

Date/time	dBA	Remarks Noise level
2/15/2023 11:54	59.9	Quite office
2/15/2023 12:54	60.0	Conversation
2/15/2023 13:53	58.1	Quite office
2/15/2023 14:53	60.1	Conversation
2/15/2023 15:52	57.6	Quite office
2/15/2023 16:52	56.6	Quite office
2/15/2023 17:51	54.0	Quite office
2/15/2023 18:51	43.6	Quite Library
2/15/2023 19:51	40.6	Quite Library
2/15/2023 20:50	45.2	Quite Library
2/15/2023 21:50	47.6	Quite Library
2/15/2023 22:49	49.5	Quite Library
2/15/2023 23:49	42.9	Quite Library
2/16/2023 0:49	48.0	Quite Library
2/16/2023 1:48	49.7	Quite Library
2/16/2023 2:48	52.7	Quite office
2/16/2023 3:47	50.0	Quite office
2/16/2023 4:47	50.5	Quite office
2/16/2023 5:46	49.8	Quite Library
2/16/2023 6:46	50.9	Quite office
2/16/2023 7:46	52.4	Quite office
2/16/2023 8:45	55.9	Quite office
2/16/2023 9:45	57.8	Quite office
2/16/2023 10:24	57.3	Quite office

GOVERNMENT of MALDIVES

WtE Energy Facility Project

BACKGROUND AIR QUALITY MEASUREMENT REPORT

Thilafushi Island/MALDIVES

MALDIVES 2023

AIRS Air Quality Management Services Ltd
Mustafa Kemal Mah. Via Green Is Mrk. B-36
Cankaya Ankara TURKEY
Tel: +90 312 221 02 45 Fax: +90 312 221 02 45
www.airsaqms.com

Test Report

Customer Name/Address	Alke Alkatas Joint Venture Pvt Ltd H.H.Moomiyaage 5A Asaree Hingun K.Male 20265 MALDIVES
Order No.	EN-M/2207/417_01
Name and identity of test item	Immission (Air Quality)
Remarks	-
Date of Test	04.02.2023-08.02.2023
Number of Pages of the Report	27 Pages
Test Method	Air Quality Sensors
Test results	The test results are given in the measurement result tables.
Enviromental conditions	Environmental conditions during the measurement are given in the measurement result tables.
Comments	-

The test and/or measurement results, the uncertainties (if applicable) with confidence probability and test methods are given on the following pages which are part of this report.

Reporter and Approval
Ismail Ulusoy Environmental Engineer 

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This report has been prepared with the aim of determining the air quality in the sensitive receptors located in the impact area of the The Greater Malé Waste to Energy Project. Air quality results were determined for PM_{10}, $PM_{2.5}$, NO_2, SO_2 and TSP parameters.

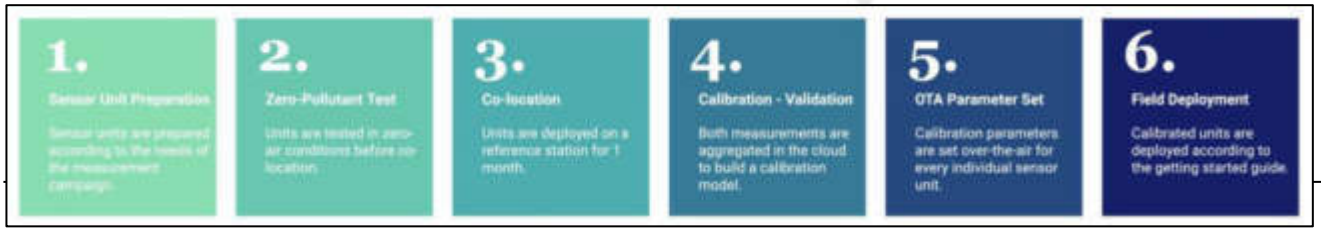
2. MEASUREMENT METHODS

PM_{10}, $PM_{2.5}$, TSP, SO_2, and NO_2 parameters were monitored by using air quality monitoring stations based on sensor technology. The US EPA refers to the term 'air sensor' as a class of non-regulatory technology that is low-cost, portable, capable of measuring several pollutants simultaneously, and often easier to operate than regulatory stations. For example, monitoring air pollution with reference measurement methods (regulatory stations) requires skilled operators to maintain and calibrate measuring instruments. On the other hand, air sensors describe the hardware and software set that can be operated without human intervention and enable unskilled users to monitor air pollution without additional technical knowledge.

Sensor specifications which are used for measurement study are shown below.

Parameter		Unit	Value
SO2	Sensitivity	nA/ppm at 2ppm SO_2	275 to 520
	Range	ppm limit of performance warranty	100
	Linearity	error at 100ppm SO2, linear at zero and 10ppm SO2	0 to -2
NO2	Sensitivity	nA/ppm at 2ppm NO_2	-200 to -650
	Range	ppm NO_2 limit of performance warranty	20
	Linearity	ppb error at full scale, linear at zero and 20ppm	
Particles (PM_{10}, $PM_{2.5}$ and TSP)	Mass concentration precision	%	5
	Mass concentration range	$\mu g/m^3$	0 to 1000
Temperature	Typ. temperature accuracy	^0C	0.45
	Operating temperature range	^0C	-10 to 50
	Response time (τ63%)	s	<60
Humidity	Typ. relative humidity accuracy	%RH	4.5
	Operating relative humidity range	%RH	0 to 100
	Response time (τ63%)	s	20
All	Temperature Range	^0C	-30 to 50
	Humidity Range	% RH	5 to 99

The accuracy of these low-cost sensors is as critical as measuring the air quality. With the smart calibration process, low-cost sensors are corrected and accurate compared to reference stations. The Smart Calibration Algorithm consists of the below operational steps shown figure below.



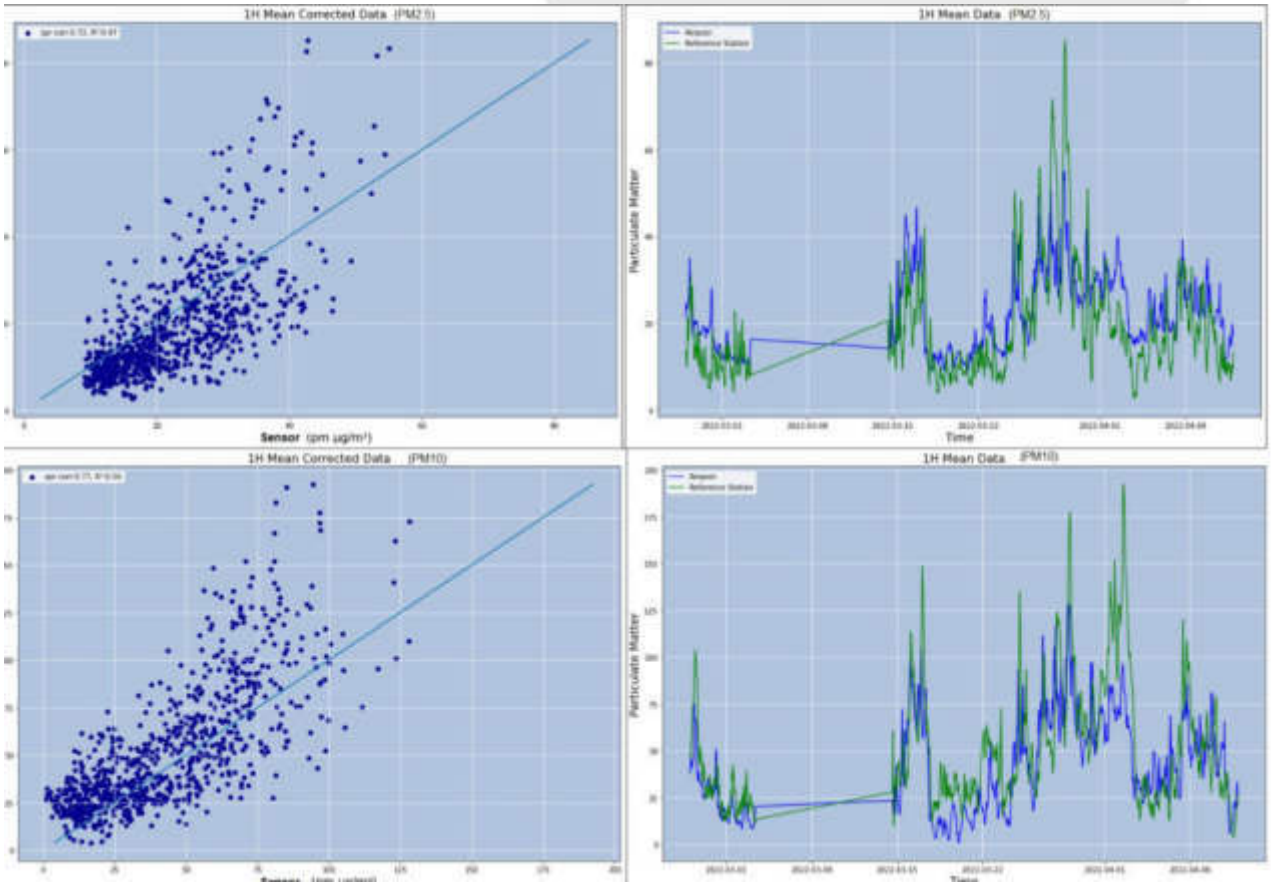
Sensor Units were calibrated using reference stations for a period before the deployment. The calibration process for particle matter and gas pollutants measurement is explained below.

Table 1 Calibration Process for Pollutants

Description	Methodology	
	NO_2-SO_2-O_3	PM_{10}-$PM_{2.5}$-TSP
Installation	Near Reference Station (3/4 meters)	Near Reference Station (3/4 meters)
Pre-Test	Quality Check in zero air conditions	Quality Check in zero air conditions
Co-Located Period	4-5 weeks	8 weeks
Sampling Period	30 seconds. Hourly mean is used because the reference station measurements are hourly.	60 seconds. Hourly mean is used because the reference station measurements are hourly.
Validation	Cross-validation is used. Also, some ranges of measurement are eliminated, where the reference station is not available.	Cross-validation is used. Also, some ranges of measurement are eliminated, where the reference station is not available.
Calibration Procedure	is obtained via R^2 and spearman correlation	is obtained via R^2 and spearman correlation

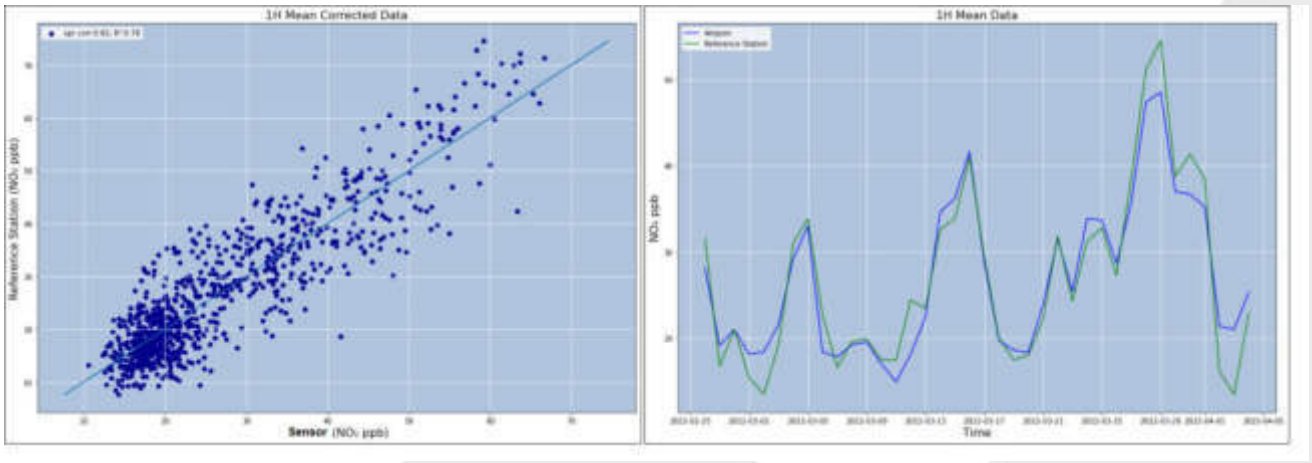
Calibration Result for PM

The corrected measurement results after the Smart Calibration Process are shown in the figures below. The correlation between Sensor Unit's $PM_{2.5}$ measurements between Reference Station's $PM_{2.5}$ measurements for hourly and daily mean of data is 0.73, and the correlation between Sensor Unit's PM_{10} measurements between Reference Station's PM_{10} measurements for hourly and daily mean of data is 0.77.



Calibration Result for Gases

The corrected measurement results after the Smart Calibration Process are shown in the figures below. The correlation between Sensor Unit's NO_2 measurements between Reference Station's NO_2 measurements for hourly and daily mean of data is respectively 0.823, 0.898



.

2.1. FIELD APPLICATION

This section describes how the measurements, the general methodology of which is given above, are applied in the field.

Preliminary Preparations

Preliminary preparations for air quality measuring stations with sensors include factory calibrations and field calibrations. Factory calibrations are provided by the sensor manufacturer. Stations capable of making reference measurements were used for field calibrations, as described above. For this purpose, a 1-month comparison measurement was carried out at a reference station in the Turkish air quality monitoring network and the calibration factors were applied.

During Measurements

Air quality measurements were made with two sets of devices.

AQ2 and ASR2 measurements were conducted on the first day,

AQ1 and AQ3 measurements were conducted on the second day,

ASR3 and ASR5 measurements were conducted on the third day and

AQ4 measurement were conducted on the fourth day.

The locations of the sampling points are determined in the macro scale ESIA report. A site visit was made and a location was determined at the micro scale where the devices would be placed.

Measurements were made at a height of 1.5 to 4 meters from the ground, depending on the suitability of the sampling point.

24-hour measurements were made at each point. Parameters measured with sensor devices consist of the averages of instantaneous measurements taken at 10-minute intervals.

After Measurements

The values after the measurements were taken by reading directly on the air quality measuring devices with sensors.

3. MEASUREMENT LOCATION

For the Preconstruction baseline environmental assessment of the ambient air quality was conducted at seven locations: 6 locations at Thilafushi (AQ1, AQ2, and AQ3 in the EIA and the ASR 2, ASR3 and ASR5 recommended for monitoring in the EIA Report) and one location at Villingili (AQ4).

Table 2 Sampling Point Coordinates and Sampling dates

No	Location	Description	Distance to Source (meters)
1	AQ1	Represents dense industrial area	650
2	AQ2	Represents dense industrial area	1000
3	AQ3	Represents dense industrial area	500
4	ASR2	Represents dense industrial area	700
5	ASR3	Represents dense industrial area	500
6	ASR5	Represents dense industrial area	1000
7	AQ4	Represents dense housing and population area	4500

Figure 1 Sampling Points on satellite Map

4. LEGAL FRAMEWORK

Within the scope of the project, particle matter (PM_{10}-$PM_{2.5}$), NO_2, SO_2 AND TSP emissions were monitored. It is known that Maldives does not have a national air quality policy. Therefore, international standards were used for the evaluation. WHO defines limit values in "Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide" document. European Union directives also have limit values for air pollution prevention (EU Council Directive 2008/50/EC relating to health based standards and objectives for a number of pollutants in ambient air). Germany has an air pollution control regulation titled "Technical Instructions on Air Quality Control" (Technische Anleitung zur Reinhaltung der Luft) and commonly referred to as the TA Luft and determines the limit values to protect the general public and the neighborhood against harmful effects of air pollution on the environment. Comparison of these limit values and chosen parameters and values for the modeling study according to these standards are shown in Table 3.

Table 3. Limit Values Stipulated in the International Legislation

Pollutant	Averaging Period	TA Luft	EU	WHO Ambient Air Quality Guideline Value	Project Standards
Particular Matter <10 µm (PM_{10})	24 hours	50 µg/m^3	50 µg/m^3	45 µg/m^3	45 µg/m^3
	1-year	40 µg/m^3	40 µg/m^3	15 µg/m^3	15 µg/m^3
Particular Matter <2.5 µm ($PM_{2.5}$)	24 hours	-	-	15 (not to be exceeded more than 3-4 times a year)	15
	1-year	-	20	5	5
Nitrogen Dioxide (NO_x)	1-hour	200 µg/m^3	200 µg/m^3	-	200 µg/m^3
	24 hours	-	-	25 µg/m^3	25 µg/m^3
	1-year	40 µg/m^3	40 µg/m^3	10 µg/m^3	10 µg/m^3
Sulphur Dioxide (SO_2)	1-hour	350 µg/m^3	350 µg/m^3	-	350 µg/m^3
	24 hours	125 µg/m^3	125 µg/m^3	40 µg/m^3	40 µg/m^3
	1-year	50 µg/m^3	-	-	50 µg/m^3
TSP*	-	-	-	-	-

***There is no limit value for TSP.**

5. RESULTS

Table 4 Measurement Results for Location 1

Location	Sampling Date	Air Quality Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP	Humidity (%)	Temperature (^{0}C)
AQ1	2023-2-4 10:00:00	35.40	35.38	0.00	0.00	65.42	70.02	31.06
	2023-2-4 11:00:00	40.52	40.49	0.00	0.00	74.66	67.83	31.60
	2023-2-4 12:00:00	37.91	37.88	0.00	0.00	70.87	64.35	32.90
	2023-2-4 13:00:00	36.92	36.91	0.00	0.00	68.89	62.24	33.44
	2023-2-4 14:00:00	35.59	35.48	0.00	0.00	65.84	67.39	31.68
	2023-2-4 15:00:00	36.57	36.52	0.00	0.00	67.88	73.19	30.22
	2023-2-4 16:00:00	37.87	37.77	0.00	0.00	70.68	72.74	29.98
	2023-2-4 17:00:00	39.75	39.64	0.00	0.00	74.31	72.75	29.56
	2023-2-4 18:00:00	41.87	41.72	0.00	0.00	77.96	77.54	27.87
	2023-2-4 19:00:00	42.48	42.26	0.00	0.00	79.24	81.90	26.95
	2023-2-4 20:00:00	42.39	42.22	0.00	0.00	79.18	84.03	26.64
	2023-2-4 21:00:00	41.36	41.18	0.00	0.00	77.41	85.89	26.54
	2023-2-4 22:00:00	41.25	41.03	0.00	0.00	77.26	87.06	26.42
	2023-2-4 23:00:00	43.73	43.55	0.00	0.00	82.32	86.84	26.38
	2023-2-5 00:00:00	41.73	41.56	0.00	0.00	78.70	87.39	26.19
	2023-2-5 01:00:00	41.45	41.24	0.00	0.00	77.61	86.24	26.10
	2023-2-5 02:00:00	41.17	40.96	0.00	0.00	77.31	86.22	26.00
	2023-2-5 03:00:00	43.93	43.68	0.00	0.00	82.59	85.87	25.95
	2023-2-5 04:00:00	42.52	42.33	0.00	0.00	80.53	85.32	25.90
	2023-2-5 05:00:00	42.27	42.08	0.00	0.00	80.16	85.66	25.80
	2023-2-5 06:00:00	42.39	42.17	0.00	0.00	80.24	85.37	25.82
	2023-2-5 07:00:00	40.03	39.86	0.00	0.00	76.03	84.98	26.10
	2023-2-5 08:00:00	37.80	37.73	0.00	0.00	71.74	74.16	28.95
	2023-2-5 09:00:00	35.77	35.73	0.00	0.00	68.21	66.55	31.27
Hourly Limit Values	**TA Luft**	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
24 h Average		**40.11**	**39.97**	**0.00**	**0.00**	**75.21**	**78.40**	**28.31**
Daily Limit Values	**TA Luft**	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

Figure 2 Measurement Graphs for Location AQ1

Table 5 Measurement Results for Location 2

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 Hours Average)	Humidity (%)	Temperature (^0C)
AQ2	2023-2-4 10:00:00	34.63	34.59	0.00	0.00	65.90	64.11	31.93
	2023-2-4 11:00:00	35.21	35.20	0.00	0.00	67.17	64.40	32.02
	2023-2-4 12:00:00	36.13	36.11	0.00	0.00	68.86	61.95	33.00
	2023-2-4 13:00:00	32.67	32.65	0.00	0.00	62.49	59.15	33.53
	2023-2-4 14:00:00	33.29	33.26	0.00	0.00	63.21	58.58	33.78
	2023-2-4 15:00:00	33.63	33.58	0.00	0.00	63.72	59.60	33.30
	2023-2-4 16:00:00	34.07	34.02	0.00	0.00	64.58	61.78	32.74
	2023-2-4 17:00:00	36.70	36.61	0.00	0.00	69.58	64.23	31.73
	2023-2-4 18:00:00	39.43	39.28	0.00	0.00	74.78	72.42	29.14
	2023-2-4 19:00:00	38.51	38.36	0.00	0.00	73.43	78.13	27.61
	2023-2-4 20:00:00	37.29	37.17	0.00	0.00	71.39	80.57	27.10
	2023-2-4 21:00:00	36.95	36.78	0.00	0.00	70.87	80.81	26.92
	2023-2-4 22:00:00	37.61	37.49	0.00	0.00	72.11	81.97	26.74
	2023-2-4 23:00:00	37.30	37.20	0.00	0.00	71.79	82.58	26.63
	2023-2-5 00:00:00	36.69	36.54	0.00	0.00	70.61	84.10	26.33
	2023-2-5 01:00:00	36.59	36.47	0.00	0.00	70.51	83.07	26.19
	2023-2-5 02:00:00	36.75	36.61	0.00	0.00	70.83	84.38	25.93
	2023-2-5 03:00:00	37.88	37.73	0.00	0.00	73.09	85.40	25.80
	2023-2-5 04:00:00	36.81	36.69	0.00	0.00	71.32	84.65	25.69
	2023-2-5 05:00:00	36.68	36.57	0.00	0.00	71.15	85.08	25.58
	2023-2-5 06:00:00	36.29	36.17	0.00	0.00	70.60	84.91	25.59
	2023-2-5 07:00:00	33.33	33.24	0.00	0.00	65.06	83.73	25.99
	2023-2-5 08:00:00	29.45	29.44	0.00	0.00	57.54	70.66	29.54
	2023-2-5 09:00:00	29.04	29.04	0.00	0.00	56.11	60.85	32.62
Hourly Limit Values	**TA Luft**	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		**35.54**	**35.45**	**0.00**	**0.00**	**68.20**	**74.05**	**28.98**
Daily Limit Values	**TA Luft**	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

Figure 3 Measurement Graphs for Location AQ2

Table 6 Measurement Results for Location 3

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 Hours Average)	Humidity (%)	Temperature (^0C)
AQ3	2023-2-5 10:00:00	29.06	29.04	0.00	0.00	56.12	59.27	33.18
	2023-2-5 11:00:00	30.49	30.49	0.00	0.00	59.27	61.69	32.31
	2023-2-5 12:00:00	27.11	27.11	0.00	0.00	53.06	62.56	32.16
	2023-2-5 13:00:00	27.22	27.20	0.00	0.00	52.86	63.09	31.91
	2023-2-5 14:00:00	28.16	28.13	0.00	0.00	54.75	62.20	32.15
	2023-2-5 15:00:00	29.95	29.92	0.00	0.00	57.96	61.68	32.12
	2023-2-5 16:00:00	29.70	29.64	0.00	0.00	57.54	62.61	31.91
	2023-2-5 17:00:00	30.57	30.51	0.00	0.00	59.34	66.85	30.53
	2023-2-5 18:00:00	32.41	32.33	0.00	0.00	62.82	72.33	28.94
	2023-2-5 19:00:00	31.00	30.91	0.00	0.00	60.21	77.20	27.33
	2023-2-5 20:00:00	31.08	31.03	0.00	0.00	60.17	79.85	26.82
	2023-2-5 21:00:00	29.59	29.52	0.00	0.00	57.28	80.88	26.71
	2023-2-5 22:00:00	30.84	30.76	0.00	0.00	59.31	81.71	26.53
	2023-2-5 23:00:00	30.01	29.97	0.00	0.00	57.92	82.34	26.36
	2023-2-6 00:00:00	29.72	29.67	0.00	0.00	57.30	83.99	26.17
	2023-2-6 01:00:00	29.37	29.31	0.00	0.00	56.64	83.53	26.13
	2023-2-6 02:00:00	30.07	30.02	0.00	0.00	57.72	83.75	26.00
	2023-2-6 03:00:00	28.45	28.39	0.00	0.00	54.98	84.13	25.92
	2023-2-6 04:00:00	28.10	28.07	0.00	0.00	53.93	82.96	25.95
	2023-2-6 05:00:00	27.70	27.65	0.00	0.00	53.12	83.47	25.85
	2023-2-6 06:00:00	27.41	27.35	0.00	0.00	52.54	84.01	25.76
	2023-2-6 07:00:00	25.09	25.07	0.00	0.00	48.13	81.81	26.23
	2023-2-6 08:00:00	22.61	22.61	0.00	0.00	43.58	72.86	28.84
	2023-2-6 09:00:00	22.83	22.82	0.00	0.00	44.06	63.52	31.83
Hourly Limit Values	**TA Luft**	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		**46.84**	**46.64**	**0.00**	**0.00**	**88.65**	**73.48**	**29.45**
Daily Limit Values	**TA Luft**	50	-	-	-	-	-	-
	EU	50	-	-	-	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	-	-	-	-

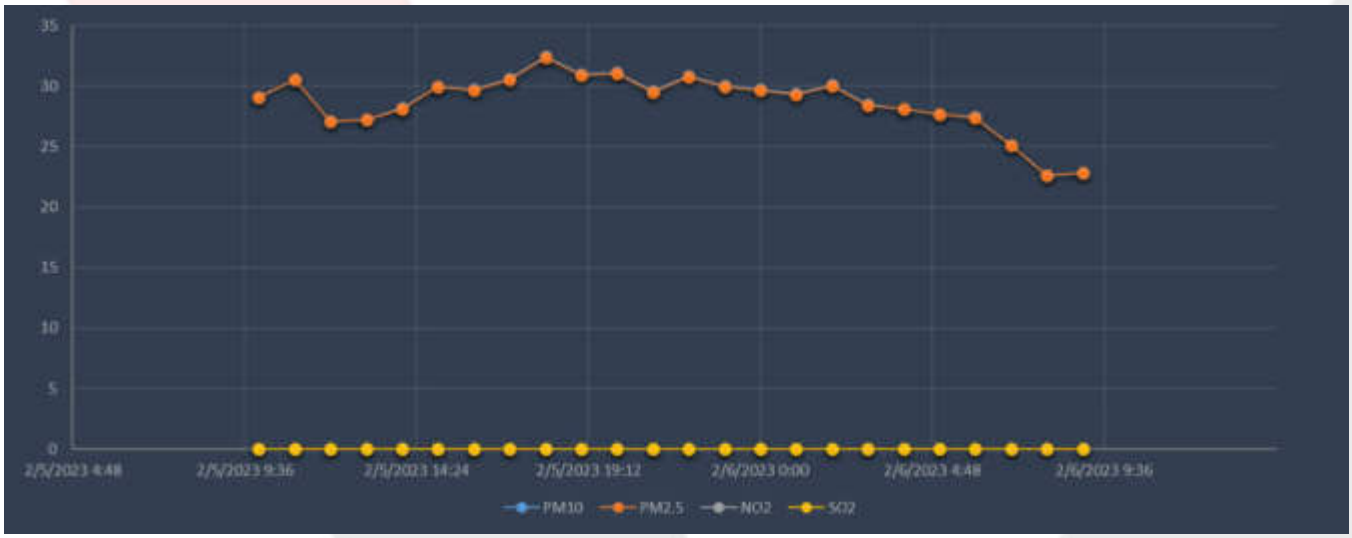


Figure 4 Measurement Graphs for Location AQ3

Table 7 Measurement Results for Location 4

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 Hours Average)	Humidity (%)	Temperature (^{0}C)
ASR2	2023-2-5 10:00:00	21.75	21.75	0.00	0.00	42.04	64.31	31.60
	2023-2-5 11:00:00	21.89	21.88	0.00	0.00	42.16	65.26	31.36
	2023-2-5 12:00:00	20.45	20.45	0.00	0.00	39.39	62.37	32.38
	2023-2-5 13:00:00	19.72	19.70	0.00	0.00	38.00	62.21	32.32
	2023-2-5 14:00:00	19.74	19.71	0.00	0.00	38.12	63.44	31.92
	2023-2-5 15:00:00	19.26	19.25	0.00	0.00	37.32	62.64	32.08
	2023-2-5 16:00:00	22.23	22.22	0.00	0.00	42.68	62.25	32.11
	2023-2-5 17:00:00	21.84	21.82	0.00	0.00	42.18	66.36	30.78
	2023-2-5 18:00:00	24.04	24.01	0.00	0.00	46.43	74.13	28.72
	2023-2-5 19:00:00	23.33	23.29	0.00	0.00	44.93	78.76	27.55
	2023-2-5 20:00:00	23.39	23.36	0.00	0.00	44.91	80.74	27.12
	2023-2-5 21:00:00	23.71	23.67	0.00	0.00	45.44	82.23	26.93
	2023-2-5 22:00:00	24.61	24.58	0.00	0.00	47.29	83.29	26.77
	2023-2-5 23:00:00	24.23	24.20	0.00	0.00	46.52	83.37	26.77
	2023-2-6 00:00:00	24.70	24.66	0.00	0.00	47.23	83.15	26.57
	2023-2-6 01:00:00	24.67	24.63	0.00	0.00	47.18	83.49	26.37
	2023-2-6 02:00:00	25.11	25.08	0.00	0.00	48.02	83.44	26.35
	2023-2-6 03:00:00	26.36	26.30	0.00	0.00	50.32	83.25	26.31
	2023-2-6 04:00:00	27.46	27.44	0.00	0.00	52.33	82.60	26.29
	2023-2-6 05:00:00	27.68	27.62	0.00	0.00	52.73	82.69	26.17
	2023-2-6 06:00:00	27.49	27.41	0.00	0.00	52.30	83.00	26.05
	2023-2-6 07:00:00	26.37	26.31	0.00	0.00	50.12	82.02	26.49
	2023-2-6 08:00:00	23.18	23.18	0.00	0.00	43.92	66.56	30.88
	2023-2-6 09:00:00	23.80	23.80	0.00	0.00	45.09	61.72	32.63
Hourly Limit Values	**TA Luft**	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		**23.63**	**23.60**	**0.00**	**0.00**	**45.28**	**78.25**	**28.46**
Daily Limit Values	**TA Luft**	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

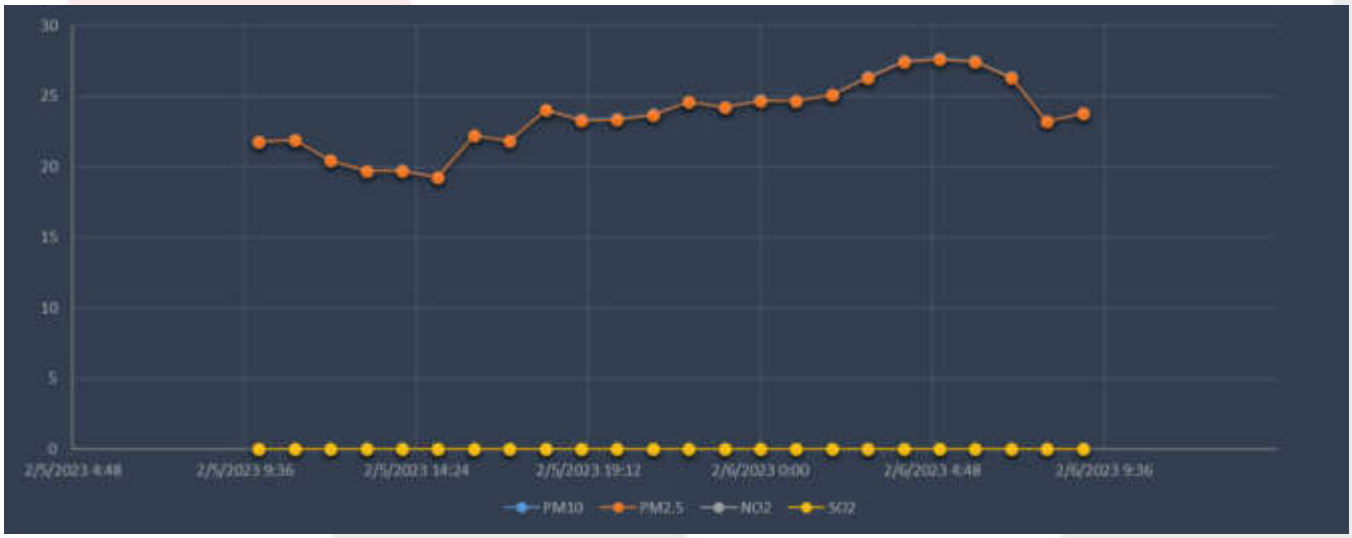


Figure 5 Measurement Graphs for Location ASR2

Table 8 Measurement Results for Location 5

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 Hours Average)	Humidity (%)	Temperature (^0C)
ASR3	2023-2-6 10:00:00	25.92	25.91	0.00	0.00	48.84	58.49	33.71
	2023-2-6 11:00:00	24.85	24.84	0.00	0.00	47.04	59.69	33.37
	2023-2-6 12:00:00	23.76	23.76	0.00	0.00	44.92	39.77	22.29
	2023-2-6 13:00:00	23.09	23.09	0.00	0.00	43.62	35.60	19.96
	2023-2-6 14:00:00	24.47	24.45	0.00	0.00	46.17	36.31	19.71
	2023-2-6 15:00:00	24.36	24.33	0.00	0.00	46.08	36.50	19.50
	2023-2-6 16:00:00	25.11	25.10	0.00	0.00	47.76	37.35	19.20
	2023-2-6 17:00:00	26.71	26.65	0.00	0.00	50.40	38.62	18.89
	2023-2-6 18:00:00	28.41	28.37	0.00	0.00	53.51	44.09	17.32
	2023-2-6 19:00:00	29.23	29.15	0.00	0.00	55.03	47.05	16.60
	2023-2-6 20:00:00	29.72	29.69	0.00	0.00	56.04	47.70	16.38
	2023-2-6 21:00:00	29.79	29.75	0.00	0.00	55.99	48.27	16.24
	2023-2-6 22:00:00	30.38	30.33	0.00	0.00	57.15	48.64	16.17
	2023-2-6 23:00:00	26.34	26.30	0.00	0.00	49.82	49.11	16.12
	2023-2-7 00:00:00	41.95	36.41	0.00	0.00	77.45	86.71	26.13
	2023-2-7 01:00:00	41.20	38.28	0.00	0.00	76.58	85.23	26.06
	2023-2-7 02:00:00	42.97	38.46	0.00	0.00	79.06	85.15	25.95
	2023-2-7 03:00:00	42.07	38.45	0.00	0.00	77.36	85.76	25.88
	2023-2-7 04:00:00	42.39	38.74	0.00	0.00	77.73	84.95	25.85
	2023-2-7 05:00:00	42.31	41.15	0.00	0.00	78.17	85.83	25.80
	2023-2-7 06:00:00	41.91	40.18	0.00	0.00	76.92	85.90	25.79
	2023-2-7 07:00:00	38.70	38.38	0.00	0.00	71.53	83.30	26.62
	2023-2-7 08:00:00	36.49	38.70	0.00	0.00	68.44	75.72	28.62
	2023-2-7 09:00:00	36.49	40.39	0.00	0.00	68.96	71.27	29.98
Hourly Limit Values	**TA Luft**	-	-	200	200	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		**32.44**	**31.70**	**0.00**	**0.00**	**60.61**	**60.71**	**23.01**
Daily Limit Values	**TA Luft**	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

Figure 6 Measurement Graphs for Location ASR3

Table 9 Measurement Results for Location 6

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 Hours Average)	Humidity (%)	Temperature (^{0}C)
ASR5	2023-2-6 10:00:00	35.00	42.53	0.00	0.00	67.63	65.93	31.50
	2023-2-6 11:00:00	34.96	44.95	0.00	0.00	68.33	65.50	31.84
	2023-2-6 12:00:00	36.48	45.74	0.00	0.00	70.96	64.18	32.50
	2023-2-6 13:00:00	33.17	45.81	0.00	0.00	66.09	60.36	33.71
	2023-2-6 14:00:00	33.44	43.60	0.00	0.00	64.56	59.05	33.92
	2023-2-6 15:00:00	33.52	36.61	0.00	0.00	62.60	59.23	33.93
	2023-2-6 16:00:00	33.56	34.78	0.00	0.00	62.45	61.45	33.19
	2023-2-6 17:00:00	35.64	35.47	0.00	0.00	65.81	62.75	32.79
	2023-2-6 18:00:00	37.16	40.49	0.00	0.00	70.41	71.69	29.86
	2023-2-6 19:00:00	40.26	37.88	0.00	0.00	74.12	78.23	27.96
	2023-2-6 20:00:00	37.38	36.91	0.00	0.00	69.20	81.83	27.15
	2023-2-6 21:00:00	36.91	35.49	0.00	0.00	67.52	83.29	26.92
	2023-2-6 22:00:00	37.39	37.00	0.00	0.00	69.76	84.10	26.79
	2023-2-6 23:00:00	37.36	38.17	0.00	0.00	70.25	84.12	26.70
	2023-2-7 00:00:00	36.48	40.65	0.00	0.00	69.60	85.15	26.50
	2023-2-7 01:00:00	36.65	42.32	0.00	0.00	70.52	85.24	26.32
	2023-2-7 02:00:00	36.64	41.98	0.00	0.00	70.50	85.21	26.15
	2023-2-7 03:00:00	37.51	41.84	0.00	0.00	71.82	86.26	25.94
	2023-2-7 04:00:00	36.72	40.88	0.00	0.00	70.48	86.41	25.83
	2023-2-7 05:00:00	36.76	42.29	0.00	0.00	71.59	86.07	25.74
	2023-2-7 06:00:00	36.38	42.90	0.00	0.00	70.94	86.26	25.71
	2023-2-7 07:00:00	34.92	41.26	0.00	0.00	67.84	86.69	25.76
	2023-2-7 08:00:00	31.04	41.24	0.00	0.00	62.24	78.81	27.79
	2023-2-7 09:00:00	29.59	43.03	0.00	0.00	60.96	66.41	31.56
Hourly Limit Values	TA Luft	-	-	200	350	-	-	-
	EU	-	-	200	350	-	-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-	-	-	-
Average		**35.62**	**40.58**	**0.00**	**0.00**	**68.17**	**75.59**	**29.00**
Daily Limit Values	TA Luft	50	-	-	125	-	-	-
	EU	50	-	-	125	-	-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40	-	-	-

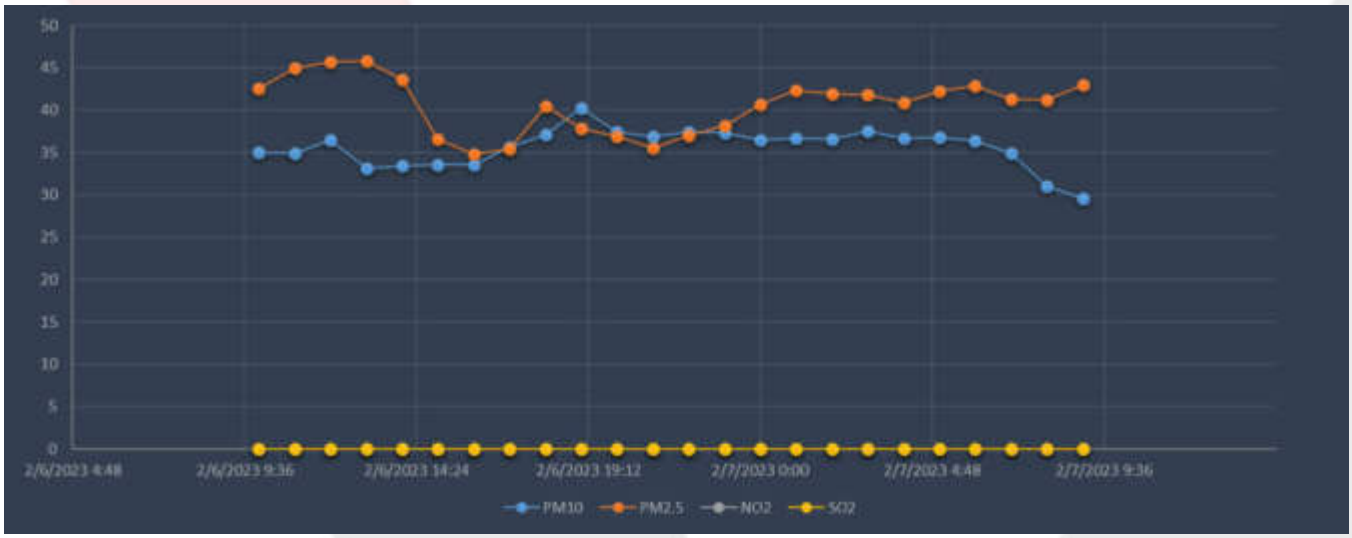


Figure 7 Measurement Graphs for Location ASR2

Table 10 Measurement Results for Location 7

Location	Sampling Date	Results (µg/m³)					Ambient Conditions	
		PM_{10}	$PM_{2.5}$	NO_2	SO_2	TSP (24 Hours Average)	Humidity (%)	Temperature (^0C)
AQ4	2023-2-7 10:00:00	28.48	42.15	0.00	0.00	59.47	62.29	32.77
	2023-2-7 11:00:00	29.26	42.11	0.00	0.00	60.66	62.64	32.86
	2023-2-7 12:00:00	29.41	41.97	0.00	0.00	60.70	62.30	32.98
	2023-2-7 13:00:00	26.77	41.79	0.00	0.00	56.64	61.26	33.34
	2023-2-7 14:00:00	27.82	38.45	0.00	0.00	57.05	61.15	33.15
	2023-2-7 15:00:00	28.53	36.58	0.00	0.00	57.52	61.48	32.81
	2023-2-7 16:00:00	30.30	35.14	0.00	0.00	59.53	63.24	32.30
	2023-2-7 17:00:00	30.45	35.26	0.00	0.00	60.11	64.69	31.68
	2023-2-7 18:00:00	30.83	36.71	0.00	0.00	61.12	72.21	29.41
	2023-2-7 19:00:00	32.90	33.00	0.00	0.00	62.82	77.82	27.74
	2023-2-7 20:00:00	31.33	33.05	0.00	0.00	60.11	81.27	26.95
	2023-2-7 21:00:00	29.91	33.37	0.00	0.00	58.13	82.14	26.79
	2023-2-7 22:00:00	30.64	33.42	0.00	0.00	59.29	83.41	26.64
	2023-2-7 23:00:00	30.12	35.45	0.00	0.00	59.51	82.97	26.62
	2023-2-8 00:00:00	29.56	36.98	0.00	0.00	59.34	84.58	26.36
	2023-2-8 01:00:00	29.72	40.41	0.00	0.00	60.92	85.07	26.16
	2023-2-8 02:00:00	29.55	37.51	0.00	0.00	59.90	85.10	26.01
	2023-2-8 03:00:00	29.48	36.76	0.00	0.00	59.65	85.47	25.88
	2023-2-8 04:00:00	28.23	37.45	0.00	0.00	58.09	84.97	25.79
	2023-2-8 05:00:00	27.98	37.45	0.00	0.00	57.83	85.14	25.66
	2023-2-8 06:00:00	27.39	36.52	0.00	0.00	56.70	85.45	25.63
	2023-2-8 07:00:00	27.69	36.23	0.00	0.00	57.10	85.26	25.66
	2023-2-8 08:00:00	26.90	36.91	0.00	0.00	56.02	84.75	25.69
	2023-2-8 09:00:00	25.05	36.38	0.00	0.00	53.31	84.49	25.94
Hourly Limit Values	**TA Luft**	-	-	200	350		-	-
	EU	-	-	200	350		-	-
	WHO Ambient Air Quality Guideline Value	-	-	-	-		-	-
Average		**29.10**	**37.13**	**0.00**	**0.00**	**58.81**	**76.21**	**28.53**
Daily Limit Values	**TA Luft**	50	-	-	125		-	-
	EU	50	-	-	125		-	-
	WHO Ambient Air Quality Guideline Value	45	15	25	40		-	-

Figure 8 Measurement Graphs for Location AQ4

6. ASSESSMENT

The air quality measurement study was carried out with the aim of determining the air pollutants on ambient air quality. Results were assessed according to the TA LUFT, EU Council Directive 2008/50/EC and WHO limit values and this report was prepared. According to air quality measurement studies, background air quality values are comply with air quality standards.

Environmental monitoring Report Pre-Construction–Stage WtE Facility at Thilafushi

Noise Level Measurments (February 2023)

Prepared by: Mahmood Riyaz

GeotechMaldives

18th February 2023

Table of contents

List of Tables

List of Figures

1. INTRODUCTION

This is the ambient noise level monitoring report prepared as part of the pre-construction environmental monitoring of the waste to energy (WtE) facility at Thilafushi, Maldives. This report presents methodologies and results of the ambient noise level measurements conducted to fulfill the requirements of the EIA and the Project Environmental Management Plan that is being developed to meet the anticipated environment impacts, health and safety, as well as to ensure the sustainability of the Project.

2. NOISE LEVEL

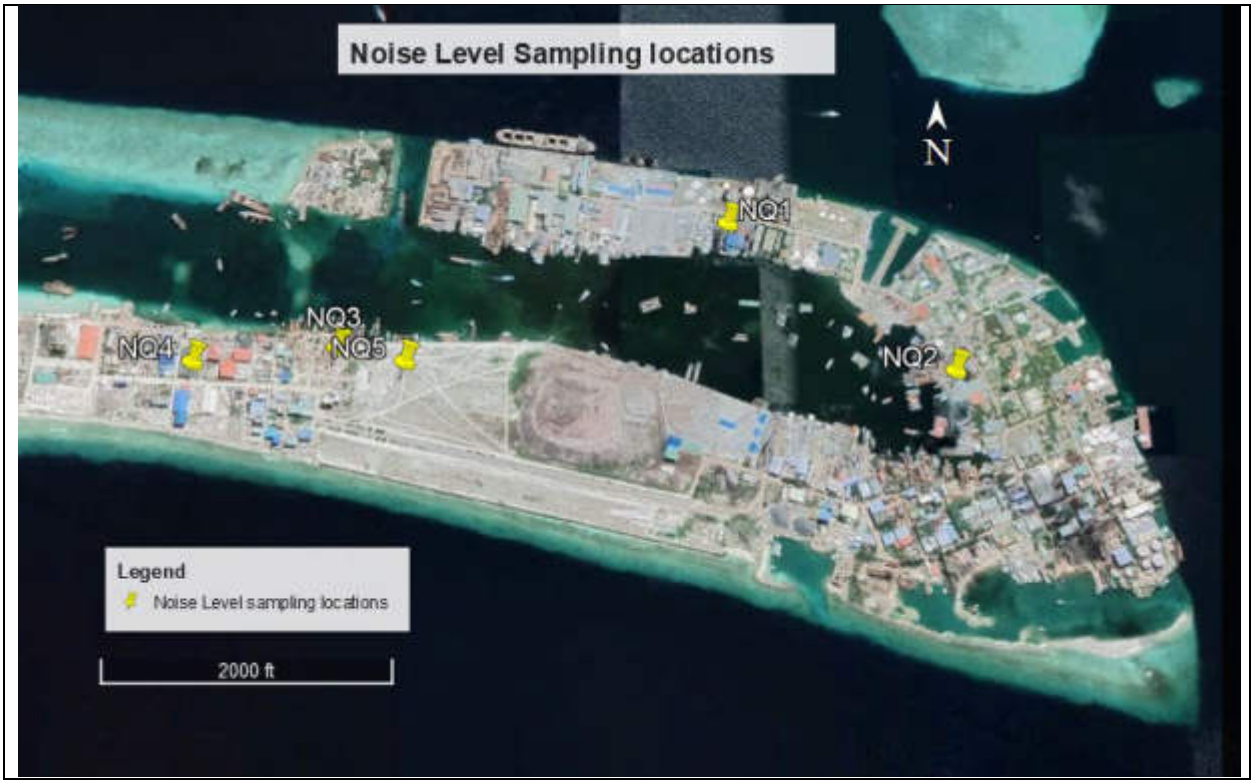
As part of the pre-construction monitoring of Thilafushi Waste to Energy facility, ambient noise levels measurements were repeated at the same five locations used in the EIA report. Ambient noise level measurement was done using a handheld sound level meter (ET-958 Professional Sound Level Meter) Measurements are recorded in NQ1, and NQ2 NQ3, NQ4 and NQ5 from 16th February 2023 11:00 to 17th February 2022 11:00 continuously for 24 four hours. Table 1 summarizes the explanation on the selection of baseline monitoring stations given in the EIA report. **Figure 1** is the map that shows the sampling locations. Graph showing the noise levels in five locations is in **Figure 2**

At each station hourly 7-8 readings are recorded for a duration of 30-50seconds at each location. Average of ambient noise level in dB(A) was recorded and the average noise of each location is calculated Table 2. Ambient noise levels recorded with the EIA levels presented in the EIA report is given in **Table 2**

Table 1: Locations selected for Ambient Noise Level Measurements

Station name	Geographic Coordinates	Reason for selection
NQ1	4°10'26.4 N, 73°28'59.9 E	Included in the original EIA
NQ2	4°10'56.6 N, 73°26'53.3 E	Included in the original EIA
NQ3	4°10'58.3 N, 73°26'09.6 E	Included in the original EIA
NQ4	4°10'57.3 N,73°25'59.4 E	Included in the original EIA
NQ5	4°10'57.3 N, 73°26'14.4 E	Included in the original EIA

Figure 1: Ambient noise level sampling locations



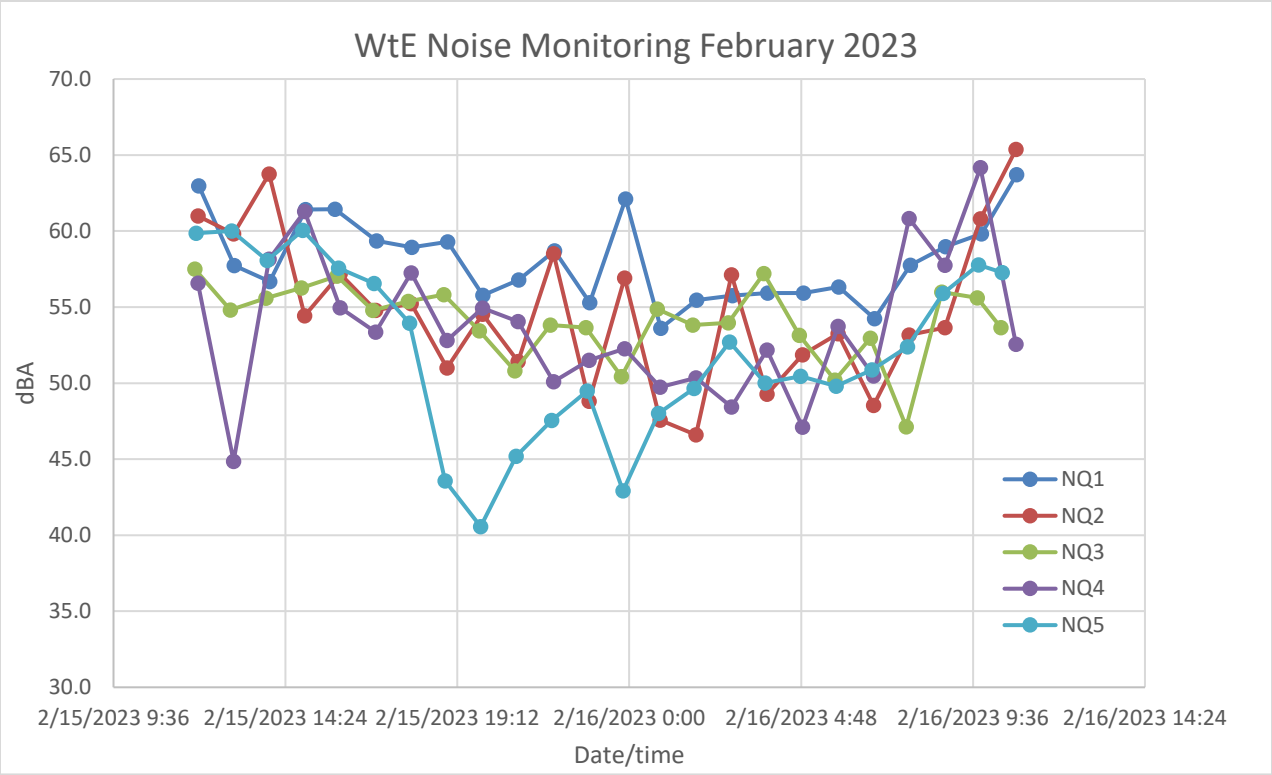
2.1 Results

Table 2: Noise measurement records in (dBA), 15-16 February 2023 Thilafushi

NQ1		NQ2		NQ3		NQ4		NQ5	
Date and time)	dB(A	Date/time	dB(A)	Date/time	dB(A)	Date/time	dB(A)	Date/time	dB(A)
2/15/2023 11:59	63.0	2/15/2023 11:57	61.0	2/15/2023 11:52	57.5	2/15/2023 11:57	56.6	2/15/2023 11:54	59.9
2/15/2023 12:58	57.7	2/15/2023 12:57	59.8	2/15/2023 12:51	54.8	2/15/2023 12:57	44.9	2/15/2023 12:54	60.0
2/15/2023 13:58	56.7	2/15/2023 13:56	63.8	2/15/2023 13:51	55.6	2/15/2023 13:56	58.2	2/15/2023 13:53	58.1
2/15/2023 14:58	61.4	2/15/2023 14:56	54.4	2/15/2023 14:50	56.3	2/15/2023 14:56	61.3	2/15/2023 14:53	60.1
2/15/2023 15:47	61.5	2/15/2023 15:55	57.2	2/15/2023 15:50	57.1	2/15/2023 15:55	55.0	2/15/2023 15:52	57.6
2/15/2023 16:57	59.4	2/15/2023 16:55	54.8	2/15/2023 16:50	54.8	2/15/2023 16:55	53.4	2/15/2023 16:52	56.6
2/15/2023 17:56	58.9	2/15/2023 17:54	55.2	2/15/2023 17:49	55.4	2/15/2023 17:54	57.3	2/15/2023 17:51	54.0
2/15/2023 18:56	59.3	2/15/2023 18:54	51.0	2/15/2023 18:49	55.8	2/15/2023 18:54	52.8	2/15/2023 18:51	43.6
2/15/2023 19:55	55.8	2/15/2023 19:54	54.5	2/15/2023 19:48	53.5	2/15/2023 19:54	54.9	2/15/2023 19:51	40.6
2/15/2023 20:55	56.8	2/15/2023 20:53	51.4	2/15/2023 20:48	50.8	2/15/2023 20:53	54.1	2/15/2023 20:50	45.2
2/15/2023 21:55	58.7	2/15/2023 21:53	58.5	2/15/2023 21:48	53.8	2/15/2023 21:53	50.1	2/15/2023 21:50	47.6
2/15/2023 22:54	55.3	2/15/2023 22:52	48.8	2/15/2023 22:47	53.7	2/15/2023 22:52	51.5	2/15/2023 22:49	49.5
2/15/2023 23:54	62.1	2/15/2023 23:52	56.9	2/15/2023 23:47	50.4	2/15/2023 23:52	52.3	2/15/2023 23:49	42.9
2/16/2023 0:53	53.6	2/16/2023 0:52	47.6	2/16/2023 0:46	54.9	2/16/2023 0:52	49.7	2/16/2023 0:49	48.0
2/16/2023 1:53	55.5	2/16/2023 1:51	46.6	2/16/2023 1:46	53.8	2/16/2023 1:51	50.4	2/16/2023 1:48	49.7

2/16/2023 2:53	55.8	2/16/2023 2:51	57.1	2/16/2023 2:45	54.0	2/16/2023 2:51	48.4	2/16/2023 2:48	52.7
2/16/2023 3:52	55.9	2/16/2023 3:50	49.3	2/16/2023 3:45	57.2	2/16/2023 3:50	52.2	2/16/2023 3:47	50.0
2/16/2023 4:52	55.9	2/16/2023 4:50	51.9	2/16/2023 4:45	53.2	2/16/2023 4:50	47.1	2/16/2023 4:47	50.5
2/16/2023 5:51	56.3	2/16/2023 5:49	53.3	2/16/2023 5:44	50.2	2/16/2023 5:49	53.7	2/16/2023 5:46	49.8
2/16/2023 6:51	54.3	2/16/2023 6:49	48.5	2/16/2023 6:44	53.0	2/16/2023 6:49	50.5	2/16/2023 6:46	50.9
2/16/2023 7:51	57.8	2/16/2023 7:49	53.2	2/16/2023 7:43	47.1	2/16/2023 7:49	60.8	2/16/2023 7:46	52.4
2/16/2023 8:50	59.0	2/16/2023 8:48	53.7	2/16/2023 8:43	56.0	2/16/2023 8:48	57.8	2/16/2023 8:45	55.9
2/16/2023 9:50	59.8	2/16/2023 9:48	60.8	2/16/2023 9:43	55.6	2/16/2023 9:48	64.2	2/16/2023 9:45	57.8
2/16/2023 10:49	63.7	2/16/2023 10:47	65.4	2/16/2023 10:22	53.7	2/16/2023 10:47	52.6	2/16/2023 10:24	57.3
Average dB(A)	58.1		54.8		54.1		53.7		52.1
Daytime	59.4		57.3		55.0		55.2		53.9
Night time	56.2		51.3		52.7		51.7		49.6
WHO guideline for ambient noise level	70								

Figure 2. Graph showing the Ambient noise level recorded



There are no designated national standards for ambient noise level in outdoor industrial area in the Maldives. Compared to WHO and ADB specified noise level standards for outdoors industrial and commercial area the noise level in Thilafushi island and the subproject area is below the noise level standards. The results show that in all the stations ambient noise level are below threshold levels specified by the WHO standards.

Annex 1. Noise level Hourly recorded

GeotechMaldives

Thilafushi WtE Project Environmental Monitoring (Ambient Noise level)

Client	AAJV WtE	Station No	NQ1 Thilafushi
Location	4°10'26.4 N, 73°28'59.9 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel	Weather condition sunny and clear	Temperature:31.1 oC
Start time	2/15/2023 10:59		Wind: NE 10-20miles
End time	2/16/2023 10:59		Humidity: 61%

Date/time	dBA	Remarks noise level
2/15/2023 11:59	63.0	Conversation
2/15/2023 12:58	57.7	Quite office
2/15/2023 13:58	56.7	Quite office
2/15/2023 14:58	61.4	Conversation
2/15/2023 15:47	61.5	Conversation
2/15/2023 16:57	59.4	Quite office
2/15/2023 17:56	58.9	Quite office
2/15/2023 18:56	59.3	Quite office
2/15/2023 19:55	55.8	Quite office
2/15/2023 20:55	56.8	Quite office
2/15/2023 21:55	58.7	Quite office
2/15/2023 22:54	55.3	Quite office
2/15/2023 23:54	62.1	Conversation
2/16/2023 0:53	53.6	Quite office
2/16/2023 1:53	55.5	Quite office
2/16/2023 2:53	55.8	Quite office
2/16/2023 3:52	55.9	Quite office
2/16/2023 4:52	55.9	Quite office
2/16/2023 5:51	56.3	Quite office
2/16/2023 6:51	54.3	Quite office
2/16/2023 7:51	57.8	Quite office
2/16/2023 8:50	59.0	Quite office
2/16/2023 9:50	59.8	Quite office
2/16/2023 10:49	63.7	Conversation

GeotechMaldives

Thilafushi WtE Project Environmental Monitoring (Ambient Noise level)

Client	AAJV WtE	Station No	NQ2 Thilafushi
Location	4°10'56.6 N, 73°26'53.3 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel	Weather condition sunny and clear	Temperature: 31.1 oC
Start time	2/15/2023 10:57		Wind:NE 10-20miles
End time	2/16/2023 10:57		Humidity:61%

Date/time	dBA	Remarks noise level
2/15/2023 11:57	61.0	Convesation
2/15/2023 12:57	59.8	Quite office
2/15/2023 13:56	63.8	Convesation
2/15/2023 14:56	54.4	Quite office
2/15/2023 15:55	57.2	Quite office
2/15/2023 16:55	54.8	Quite office
2/15/2023 17:54	55.2	Quite office
2/15/2023 18:54	51.0	Quite office
2/15/2023 19:54	54.5	Quite office
2/15/2023 20:53	51.4	Quite office
2/15/2023 21:53	58.5	Quite office
2/15/2023 22:52	48.8	Quite library
2/15/2023 23:52	56.9	Quite office
2/16/2023 0:52	47.6	Quite library
2/16/2023 1:51	46.6	Quite library
2/16/2023 2:51	57.1	Quite office
2/16/2023 3:50	49.3	Quite library
2/16/2023 4:50	51.9	Quite office
2/16/2023 5:49	53.3	Quite office
2/16/2023 6:49	48.5	Quite library
2/16/2023 7:49	53.2	Quite office
2/16/2023 8:48	53.7	Quite office
2/16/2023 9:48	60.8	Convesation
2/16/2023 10:47	65.4	Convesation

GeotechMaldives

Thilafushi WtE Project Environmental Monitoring (Ambient Noise level)

Client	AAJV WtE	Station No	NQ3 Thilafushi
Location	4°10'58.3 N, 73°26'09.6 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel		Temperature: 31.1 oC
Start time	2/15/2023 10:52	Weather condition	Wind: NE 10-20miles
End time	2/16/2023 10:55	sunny and clear	Humidity: 61%

Date/time	dBA	Remarks Noise level
2/15/2023 11:52	57.5	Quite office
2/15/2023 12:51	54.8	Quite office
2/15/2023 13:51	55.6	Quite office
2/15/2023 14:50	56.3	Quite office
2/15/2023 15:50	57.1	Quite office
2/15/2023 16:50	54.8	Quite office
2/15/2023 17:49	55.4	Quite office
2/15/2023 18:49	55.8	Quite office
2/15/2023 19:48	53.5	Quite office
2/15/2023 20:48	50.8	Quite office
2/15/2023 21:48	53.8	Quite office
2/15/2023 22:47	53.7	Quite office
2/15/2023 23:47	50.4	Quite office
2/16/2023 0:46	54.9	Quite office
2/16/2023 1:46	53.8	Quite office
2/16/2023 2:45	54.0	Quite office
2/16/2023 3:45	57.2	Quite office
2/16/2023 4:45	53.2	Quite office
2/16/2023 5:44	50.2	Quite office
2/16/2023 6:44	53.0	Quite office
2/16/2023 7:43	47.1	Quite library
2/16/2023 8:43	56.0	Quite office
2/16/2023 9:43	55.6	Quite office
2/16/2023 10:22	53.7	Quite office

GeotechMaldives

Thilafushi WtE Project Environmental Monitoring (Ambient Noise level)

Client	AAJV WtE	Station No	NQ4 Thilafushi
Location	4°10'57.3 N,73°25'59.4 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel		Temperature:31.1 oC
Start time	2/15/2023 10:52	Weather condition	Wind:NE 10-20miles
End time	2/16/2023 10:57	sunny and clear	Humidity:61%

Date/time	dBA	Remarks Noise level
2/15/2023 11:57	56.6	Quite office
2/15/2023 12:57	44.9	Quite library
2/15/2023 13:56	58.2	Quite office
2/15/2023 14:56	61.3	Conversation
2/15/2023 15:55	55.0	Quite office
2/15/2023 16:55	53.4	Quite office
2/15/2023 17:54	57.3	Quite office
2/15/2023 18:54	52.8	Quite office
2/15/2023 19:54	54.9	Quite office
2/15/2023 20:53	54.1	Quite office
2/15/2023 21:53	50.1	Quite office
2/15/2023 22:52	51.5	Quite office
2/15/2023 23:52	52.3	Quite office
2/16/2023 0:52	49.7	Quite library
2/16/2023 1:51	50.4	Quite office
2/16/2023 2:51	48.4	Quite library
2/16/2023 3:50	52.2	Quite office
2/16/2023 4:50	47.1	Quite library
2/16/2023 5:49	53.7	Quite office
2/16/2023 6:49	50.5	Quite office
2/16/2023 7:49	60.8	Conversation
2/16/2023 8:48	57.8	Quite office
2/16/2023 9:48	64.2	Conversation
2/16/2023 10:47	52.6	Quite office

GeotechMaldives

Thilafushi WtE Project Environmental Monitoring (Ambient Noise level)

Client	AAJV WtE	Station No	NQ5 Thilafushi
Location	4°10'57.3 N, 73°26'14.4 E	Consultant	Mahmood Riyaz
Technician	Hussain Fazeel	Weather condition sunny and clear	Temperature:31.1 oC
Start time	2/15/2023 10:54		Wind: NE 10-20miles
End time	2/16/2023 10:57		Humidity:61%

Date/time	dBA	Remarks Noise level
2/15/2023 11:54	59.9	Quite office
2/15/2023 12:54	60.0	Conversation
2/15/2023 13:53	58.1	Quite office
2/15/2023 14:53	60.1	Conversation
2/15/2023 15:52	57.6	Quite office
2/15/2023 16:52	56.6	Quite office
2/15/2023 17:51	54.0	Quite office
2/15/2023 18:51	43.6	Quite Library
2/15/2023 19:51	40.6	Quite Library
2/15/2023 20:50	45.2	Quite Library
2/15/2023 21:50	47.6	Quite Library
2/15/2023 22:49	49.5	Quite Library
2/15/2023 23:49	42.9	Quite Library
2/16/2023 0:49	48.0	Quite Library
2/16/2023 1:48	49.7	Quite Library
2/16/2023 2:48	52.7	Quite office
2/16/2023 3:47	50.0	Quite office
2/16/2023 4:47	50.5	Quite office
2/16/2023 5:46	49.8	Quite Library
2/16/2023 6:46	50.9	Quite office
2/16/2023 7:46	52.4	Quite office
2/16/2023 8:45	55.9	Quite office
2/16/2023 9:45	57.8	Quite office
2/16/2023 10:24	57.3	Quite office

Type text here

TEST REPORT

Report No: (7423)046-0110 Feb 24, 2023
Code Name: AAWTE

Customer:	Alke Alkatas Joint Venture (Pvt) Ltd
Address :	H.H. Moomiyaage, 5A, Asaree Hingun. 20265 Male, Republic of Maldives
Date of Sample Received:	Feb 15, 2023
Date of Testing Started:	Feb 15, 2023
Date of Testing Completed:	Feb 22, 2023
Sample Description:	**Sample Received as:** A water sample contained in sealed plastic bottle **Sample Identified by the Client as:** Sample 01: Ground Water – GW01 Date of Sample Collection: 02.10.2023
Sample Drawn By BVCPS	NO

Photo of the Submitted Samples

Bureau Veritas Consumer Products Services Lanka (Pvt) Ltd.

No. 570, Galle Road, Katubedda, Moratuwa, Sri Lanka
Tel: (9411) 2350111-115 (dedicated lines), Fax: (9411) 112622198 & 199
Email: bvcps.lanka@lk.bureauveritas.com

TEST REPORT

Report No: (7423)046-0110
Code Name: AAWTE

Feb 24, 2023

TEST RESULTS

Sample 01

No.	Parameters	Results	Reference range **	LOQ	Unit	Test Method
1	Turbidity	0.2	Max. 1	-	NTU	APHA 23rd ed: 2017 :2130 B
2	Nitrate (as NO_3^-)*	ND	Max. 50	0.05	mg/L	APHA 23rd ed: 2017: 4500 -NO_3– B
3	Iron (as Fe)	ND	Max. 0.3	0.001	mg/L	APHA 23rd ed: 2017: 3125 B (ICP-MS)
4	Manganese (as Mn) *	ND	Max. 0.1	0.001	mg/L	
5	Arsenic (as As)	ND	Max. 0.01	0.001	mg/L	
6	Cadmium (as Cd)	ND	Max. 0.003	0.0001	mg/L	
7	Lead (as Pb)	ND	Max. 0.01	0.001	mg/L	
8	Mercury (as Hg)	ND	Max. 0.001	0.00050	mg/L	
9	Total Suspended Solids (TSS)	ND	5 - 750	1.0	mg/L	APHA 23rd ed: 2017 : 2540D
10	Feacal Coliform	<1.8	0		MPN/100mL	APHA 23rd Edition 9221 E
11	Oil & Grease	ND	-	0.1	mg/L	APHA 23rd ed: 2017: 5520B
12	pH at 25ºC	6.5	6.5 – 8.5	-	-	APHA 23rd ed: 2017: 4500H+B
13	Electrical Conductivity at 25ºC	577	Max. 1000	-	µS/cm	APHA 23rd ed: 2017: 2510 B
14	Total Phosphates (as PO_4^{3-})	ND	Max. 5.0	0.05	mg/L	APHA 23rd ed: 2017: 4500-PC
15	Chloride (as Cl^-)	77.8	Max. 200	-	mg/L	APHA 23rd ed: 2017: 4500-Cl- B
16	Polycyclic Aromatic Hydrocarbons (PAH)*					
i	Naphthalene*	ND	-	1.0	µg/L	CPSD-AN-00090
ii	Benzo(a)anthracene*	ND	-	1.0	µg/L	
iii	Acenaphthylene*	ND	-	1.0	µg/L	
iv	Acenaphthene*	ND	-	1.0	µg/L	
v	Fluorene*	ND	-	1.0	µg/L	
vi	Phenanthrene*	ND	-	1.0	µg/L	
vii	Pyrene*	ND	-	1.0	µg/L	
viii	Chrysene*	ND	-	1.0	µg/L	
ix	Benzo(b)fluoranthene*	ND	-	1.0	µg/L	
x	Benzo(k)fluoranthene*	ND	-	1.0	µg/L	
xi	Dibenzo(a,h)anthracene*	ND	-	1.0	µg/L	
xii	Benzo(g,h,i)perylene*	ND	-	1.0	µg/L	
xiii	Benzo(j)fluoranthene*	ND	-	1.0	µg/L	
xiv	Benzo(a)pyrene*	ND	-	1.0	µg/L	
xv	Benzo(e)pyrene*	ND	-	1.0	µg/L	
xvi	Indeno(1,2,3-cd) pyrene*	ND	-	1.0	µg/L	