

ENVIRONMENT AND SOCIAL MANAGEMENT REPORT

PROPOSED INSTALLATION OF 5MW GRID-TIED SOLAR PHOTOVOLTAIC SYSTEM IN GREATER MALE' REGION, KAAFU ATOLL

CONSULTANT

Foresight Surveyors Pvt Ltd



PREPARED FOR

ENSYS CO., LTD

AUGUST 2021

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
ASPIRE	Accelerating Sustainable Private Investment for Renewable Energy
BP Bank	Procedures
CO ₂	Carbon dioxide
CIF	Climate Investment Fund
DASA	Directorate of Aviation Security Administration
ESIA	Environment and Social Impact Assessment
EMP	Environmental Management Plan
EPA	Environment Protection Agency
ESMF	Environmental and Social Management Framework
FIT	Feed-in Tariff
FM	Financial Management Assessment
GENCO	Generation Company
GHG	Greenhouse gases
GoM	Government of the Maldives
GP	Good Practices
IA	Implementation Agreement
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IFC	International Finance Corporation
IFRS	International Financial Reporting Standards
IP	Implementation Plan
ISA	International Standards on Auditing
KWp	Kilowatt peak
MEA	Maldives Energy Authority
MCAA	Maldives Civil Aviation Authority
MoECC&T	Ministry of Environment, Climate Change and Technology (Former Ministry of Environment)
MoNPH&I	Ministry of National Planning, Housing and Infrastructure
MW	Megawatt
NEAP II	National Environmental Action Plan II
NGO	Non-Governmental Organisation

OP	Operational Procedures
PAP	Project-Affected People
PMU	Project Management Unit of MoECC&T
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PRG	Partial Risk Guarantee
PS	Performance Standards
ToR	Terms of Reference
WBG	World Bank group

CONSULTANT'S DECLARATION

I certify that the statements made in this Environment and Social Management Report to the proposed installation of 5.6MW of Solar PV system in greater Male' area is complete and correct to the best of my knowledge and it is in accordance with EIA Regulation 2012.



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Ref: EL2-21-025

Date: August 2nd, 2021

Mr. Ibrahim Naeem
Director general
Environment Protection Agency,
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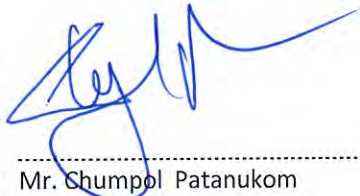
Dear Sir,

As the proponent of the proposed 5MW Solar PV system in greater Male' area, I grantee that I have read the report and to the best of our knowledge, all the information present in the report regarding the project are accurate and complete.

Similarly, as the proponent of the project, I assure you my commitment to undertake the proposed mitigation measures and monitoring programme given in the report.

Thank you

Sincerely Yours,
ENSYS Company Limited



Mr. Chumpol Patanukom
Executive Director



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NON-TECHNICAL SUMMARY

This is the Environmental and Social Management Report (ESMP) for the 5MW solar PV project proposed for greater Male' region, under the Accelerating Sustainable Private Investment for Renewable Energy (ASPIRE) program. This study is commissioned by the Ministry of Environment, Climate Change and Technology (MoECC&T), the Government of Maldives. This ESMP establishes a mechanism to determine, assess, mitigate and manage future potential environmental and social impacts from the activities of the ASPIRE program during implementation of the planned ground and rooftop solar PV investments.

The current project proposed by the GoM under the ASPIRE program, it is aimed to develop the capacity to generate 5.6 Megawatt of electricity by a Solar Photovoltaic System in the Greater Male' region. The project is managed by MoECC&T on behalf of the GoM. Within MoECC&T, the Project Management Unit (PMU) will be responsible for the day-to-day implementation. The State Electric Company (STELCO) is envisaged to purchase renewable energy from private suppliers produced under ASIPRE program. The Maldives Energy Authority (MEA) establishes tariffs, issues guidelines and regulations to ensure the reliability, security of the grids, and also ensures the rights and obligations of consumers and service providers are safeguarded (Shaig, 2014).

The project is awarded by the GoM on a long term contract of 15 years to Ensys Co., Ltd. Ensys will design, build, finance, own and operate the system for a period of 15 years after which the operation will be transferred to the GoM. Ensys is a foreign company based in Thailand, who has been providing services in the fields of electricity, power, energy, mechanical and environmental engineering for the past 25 years. On behalf of GoM, STELCO will take over the operation of the project after the Ensys.

This ESMP report describes and highlights potential environmental and social impacts from the activities of the proposed project during the construction and operational phase of the project. Furthermore, this report is submitted by the proponent of the project to fulfill the requirements of Environment Impact Assessment Regulation 2012, under the Environmental Protection and Preservation Act of the Maldives (Law No. 4/93). Additionally, the report aims to fulfill the world bank's environmental and social safeguard policies on undertaking the proposed project. As per the screening decision issues by EPA, an EMP will be sufficient for the project. Hence, no ToR has been issued by EPA, rather the report followed a ToR issued by WBG.

The project is proposed on the pavement area of the link road between Male'-Hulhumale,

southern side pavement area of Boashimaa Hinhun in Hulhumale and on roof top of 8 residential buildings in Hulhumale phase-1.

In pavement areas, the PV modules are fixed over an elevated roof structure in such a way that it covers and shades the pavement whereas in selected buildings, they will be fixed over the existing roof. The total length of the line along the pavement, including the island (empty space at the middle of the widest part of the link road) is 3,510m. The line will include a total of 10,691 panels with a capacity of 495 Wp by each link. Hence, the total installed capacity along the road side will be 5,292,045 Wp. Additional 720 panels will be installed on the roof top of the 8 selected residential buildings whose total capacity will be 356,400 Wp. Therefore, the installed total capacity under the proposed project would be 5,648,445 Wp.

There are very few and limited risk factors associated with this project that could possibly have both financial, environmental and fatal implications given that the mentioned safety attires are worn by the workers and safety measures are properly taken in handling machineries and hazardous items. The major social impact envisaged from the project is the restriction to vehicle movement due to part of road closure during the construction stage in link road and Boashimaa Hingun. Since the proposed project site is not seen to have any significant terrestrial life, no considerable risk on biodiversity has been identified. However, unavoidable and short-term risks such as waste generation and typical minor construction related impacts are associated with the construction stage of the project.

Effective impact mitigation measures are to be undertaken during the construction and operational works. The construction work of the project should be completed within the shortest possible time to mitigate the negative impacts due to construction. A schedule that highlights the times of road closure will be made public before the events of closing begins. Only a single lane out of the 2 lanes that allow traffic movant in one direction will be closed. Hence, even though slow and restricted, vehicle flow will still be maintained in link road and Boashimaa Hingun.

In order to ensure that the envisaged impacts are within the estimated limits, environment monitoring program outlined in this report has to be followed. Undertaking environment monitoring during construction and operational phase is of uttermost importance for ensuring that the expected impacts are controlled within acceptable limitations. Monitoring has been given for each and every impact identified. Furthermore, there is a proposed Grievance Redress Mechanism (GRM) for the public and stakeholders to raise any projected related issue.

Alternatives to the proposed project in terms of design, technology, and location has been discussed in the report including the ‘no-project’ option. Although ‘No-project’ option is not favoured, alternatives to the design have been discussed. Given the prevailing issue of land scarcity in greater Male’ area and use of Solar PV system in Maldives, no favourable alternative has been suggested.

Stakeholder consultations were carried out with a large number of stakeholders of the project as highlighted in the approved ToR. The major concerns highlighted in the stakeholder meetings were the possible restrictions on traffic flow in Boashima Hingun and Link road and undertaking construction activities within 10ft buffer area of airport’s security fence in Boashimaa Hingun.

No long-term sever environmental or social impact is predicted for the project. However, due to high the socio-economic benefit of the project, it is recommended to undertake the proposed project in the proposed location. Furthermore, developing the renewable energy sector in Maldives is in line with the development goals of the Country. Decreasing the dependency on diesel powered electricity generation in Maldives with the provision of renewable energy throughout the country is one of the development goals of the government.

1 INTRODUCTION

1.1 Background

The Government of Maldives (GoM) aims to develop private investments in the sector of renewable energy by addressing and removing key barriers to private investments through assistance and provision of appropriate risk mitigation measures. Maldives is one of the six pilot countries participating in the Scaling Up Renewable Energy Program in Low Income Countries (SREP) (MEE, 2012). Accelerating Sustainable Private Investment in Renewable Energy (ASPIRE) is one of the key components of the Maldives Scaling-Up Renewable Energy Program (SREP). One of the main targets of the ASPIRE program is to encourage the involvement of private parties in the renewable energy sector of the Maldives (Shaig, 2014). ASPIRE program is continued and managed through a phased approach to developing sector investments, in such a way that the early investors are supported and secured through greater risk mitigation measures by International Development Association (IDA), through a series of IDA partial risk guarantees (PRGs), and SREP funds (for subsidies, capacity building, and additional guarantee support) (Shaig, 2014). The ASPIRE program is financed by the World Bank Group (WBG) (Shaig, 2014).

1.2 Objectives

This is the Environmental and Social Impact Assessment report (ESIA) for the 5MW solar PV project proposed for greater Male' region, under the Accelerating Sustainable Private Investment for Renewable Energy (ASPIRE) program. This ESIA report describes and highlights potential environmental and social impacts from the activities of the proposed project during the construction and operational phase of the project. Furthermore, this report is submitted by the proponent of the project to fulfill the requirements of Environment Impact Assessment Regulation 2012, under the Environmental Protection and Preservation Act of the Maldives (Law No. 4/93). Additionally, the report aims to fulfill the world bank's environmental and social safeguard policies on undertaking the proposed project.

1.3 Institutional arrangements

The current project proposed by the GoM under the ASPIRE program, it is aimed to develop the capacity to generate 5.6 Megawatt of electricity by a Solar Photovoltaic System in the Greater Male' region. The project is managed by MoECC&T on behalf of the GoM. Within

MoECC&T, the Project Management Unit (PMU) will be responsible for the day-to-day implementation. The State Electric Company (STELCO) is envisaged to purchase renewable energy from private suppliers produced under ASIPRE program. The Maldives Energy Authority (MEA) establishes tariffs, issues guidelines and regulations to ensure the reliability, security of the grids, and also ensures the rights and obligations of consumers and service providers are safeguarded (Shaig, 2014).

The project is awarded by the GoM on a long term contract of 15 years to Ensys Co., Ltd. Ensys will design, build, finance, own and operate the system for a period of 15 years after which the operation will be transferred to the GoM. Ensys is a foreign company based in Thailand, who has been providing services in the fields of electricity, power, energy, mechanical and environmental engineering for the past 25 years. On behalf of GoM, STELCO will take over the operation of the project after the Ensys.

1.4 Project risks and major impacts

There are very few and limited risk factors associated with this project that could possibly have both financial, environmental and fatal implications given that the mentioned safety attires are worn by the workers and safety measures are properly taken in handling machineries and hazardous items. The major social impact envisaged from the project is the restriction to vehicle movement due to part of road closure during the construction stage in link road and Boashimaa Hingun. Since the proposed project site is not seen to have any significant terrestrial life, no considerable risk on biodiversity has been identified. However, unavoidable and short-term risks such as waste generation and typical minor construction related impacts are associated with the construction stage of the project.

1.5 Studies undertaken for the project

Main findings of the report are based on qualitative and quantitative assessments undertaken during site visits undertaken from March to May 2021. Site surveys undertaken for the project includes a visual inspection survey (terrestrial survey), topographic survey and onsite underground cable identification survey with certain stakeholders. Relevant data was collected from available sources, such as long-term data on meteorology and climate from local and global databases. Additionally, data published in the similar projects taken place across the country are

referred and used. Some of the reports referred for the purpose of this report includes;

- Renewable energy roadmap for the republic of Maldives (IRENA, 2015)
- Environment and Social Management Framework for the proposed Solar PV projects under Accelerating Sustainable Private Investments for Renewable Energy (ASPIRE) Program (Shaig, 2014)
- Environment Impact Assessment for the proposed development and operation of floating solar PV platform in Cheval Blanc Randheli (Shaig, 2020)
- Environment Management Plan for Clean Electricity for Dharavandhoo – a floating Solar Project at Dharavandhoo, Baa Atoll (Zahir, 2015)

1.6 Structure of the Report

The report is structured in such a way that it meets the requirements of the EIA regulation 2012 and the amendments followed. Furthermore, it is presented under 15 chapters to directly reflect the requirements highlighted under the ToR approved by MoECC&T and world bank. Below given are the distinctive chapters presented in the report.

1.6.1 Executive summary

The report begins with the non-technical summary which highlights the main findings of the surveys and studies undertaken for the preparation of this document. A translation of executive summary is included in local Dhivehi language.

1.6.2 Introduction

Followed by the non-technical summary is the introduction. Explained under the introduction is the background to the proposed project, the structure followed in the report, scope and extent of the report.

1.6.3 Project Setting

There are number of laws, regulations and international treaties and conventions to be met and followed in undertaking the proposed project. Those legal requirements, emphasizing the relevant regulations are presented under ‘project Setting’.

1.6.4 Project Description

Under ‘Project Description’, the proposed developments and work methodologies are explained in detail. It will include the information on project proponent, location and major project inputs and outputs. The section will also include the project management components including, schedule, manpower, machinery list and other safety measures to be taken during the project. More importantly, the section will look at the justifications for undertaking the proposed project.

1.6.5 Existing Environment

Physical, biological and social environment of the proposed project area will be explained under this section. It will include the information on local climate and potential natural hazard and disaster possibilities.

1.6.6 Impact identification and assessment

The envisaged positive and negative environmental and social impacts with their nature and extent of the proposed development activities will be discussed under this section. Impact identification methods, impacts duration and severity are explained under the section. Impacts associated with various components of the project will be assessed.

1.6.7 Project Alternatives

There are number of different ways to undertake a project in terms of methods, materials and design. Different methods, materials and designs will have their pros and cons over the others. Under ‘project Alternatives’ alternatives to the proposed components or activities in terms of location, design, environmental and economic considerations would be suggested.

1.6.8 Mitigation and management of adverse impacts

The identified social and environmental impacts of the project have to be mitigated to carry out the project activities in the most beneficial manner. Mitigation measures for all the identified impacts, for both the construction and operational stage would be provided.

1.6.9 Grievance Redress Mechanism (GRM)

Local communities, employees and other affected stakeholders should have a set policy to follow in times of grievance for the project to run smoothly. Hence, a GRM specific for the stakeholders and employees have been developed for the project. The GRM will ensure and facilitate a way to protect the rights of all parties related and involved in the project.

1.6.10 Monitoring and reporting plan

A monitoring program, together with an estimated program cost, for the construction and operational phase of the project would be included in the report. Monitoring would ensure that the proposed activities are undertaken with caution and appropriate care to protect and preserve the social and the environmental aspects of the project that are to be affected by the development

1.6.11 Summary of all training recommendations

Trainings required to strengthen the capacity of the contractor to implement and ESMP during the construction and operation phase of the project will be highlighted under the section.

1.6.12 Stakeholder Consultations

Stakeholder consultation regarding the project will be undertaken as outlined in the approved ToR. Meetings held and the main issues discussed in those meeting by the stakeholders will be highlighted in the report.

1.6.13 Conclusion

Main findings of the report will be concluded here together with recommendations to be followed during construction and operation.

1.7 Tasks already undertaken

No physical task of the proposed development has been undertaken yet. However, initial site survey and assessment has been completed. Detail designing, approval of drawings and material is currently on going.

2 PROJECT SETTING

This section outlines and summarizes key policies, applicable laws, regulations and regulatory bodies regarding environmental protection in the Maldives. The project meets the requirements of the Environmental Protection and Preservation Act of the Maldives, Law no. 4/93. The ESMP has been undertaken in accordance with the EIA Regulation 2012 (and all amendments to the regulation) of the Maldives by a registered consultant. Additionally, it adheres to the principles outlined in the regulations, action plans, programs and policies of both international and national related to the project, including the 10 safeguard policies of the world bank.

The following table outlines the major environmental laws, guidelines, regulations and action plans relevant to the project

2.1 World Bank's Environmental and Social Safeguards

2.1.1 The WB's Operational Policies

Since world bank is the finance guarantee of the ASPIRE program, world bank's safeguard policies and disclosure policy apply to the project. Additionally, involvement of private sector parties in the project requires adherence to the Performance Standards. The WB's Operational Policies (OPs) that are deemed applicable for ASPIRE are 4.01, 4.04 and 4.11.

OP/BP	Safeguard	Policy Objective
4.01	Environmental Assessment	Help to ensure the environmental and social soundness and sustainability of investment projects. Support integration of environmental and social aspects of projects in the decision-making process.
4.04	Natural Habitats	Promote environmentally sustainable development by supporting the protection, conservation, maintenance, and rehabilitation of natural habitats and their functions.
4.11	Physical Cultural Resources (PCR)	Assist in preserving PCR and in avoiding their destruction or damage. PCR includes resources of archeological, paleontological, historical, architectural, religious (including graveyards and burial sites), aesthetic, or other cultural significance.

2.1.2 The WB's Performance Standards

Performance standards ensure environmental and social sustainability. The Performance

Standards that are deemed applicable to the project area given below.

OP/BP	Safeguard	Policy Objective
PS1	Assessment and Management of Environmental and Social Risks and Impacts	PS1 applies to all projects that have environmental and social risks and impacts. It establishes the importance of (IFR, 2012); (i) Integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects. (ii) Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and. (iii) The client's management of environmental and social performance throughout the life of the project.
PS2	Labour and Working Condition	Performance Standards 2 through 8 establish objectives and requirements to avoid, minimize, and where residual impacts remain, to compensate/offset for risks and impacts to workers, Affected Communities, and the environment. While all relevant environmental and social risks and potential impacts should be considered as part of the assessment, Performance Standards 2 through 8 describe potential environmental and social risks and impacts that require particular attention. Where environmental or social risks and impacts are identified, the client is required to manage them through its Environmental and Social Management System (ESMS) consistent with Performance Standard 1. (IFR, 2012)
PS3	Polution Prevention and Abatement	
PS4	Community, health, safety and security	
PS6	Biodiversity conservation and sustainable management of living natural resources	
PS8	Cultural Heritage	

2.2 Constitution of the Maldives

The existing constitution which was passed in 2008, has several provisions to protect rights of citizen to environment, health and private property which is relevant to the roof top solar PV component of the project. The relevant articles are as follows:

Articles	Description
22	<i>"The State has a fundamental duty to protect and preserve the natural environment, biodiversity, resources and beauty of the country for the benefit of present and future generations. The State shall undertake and promote desirable economic and social goals through ecologically balanced sustainable development and shall take measures necessary to foster conservation, prevent pollution, the extinction of any species and</i>

	<i>ecological degradation from any such goals.”</i>
23	<p><i>“Every citizen has the following rights pursuant to this Constitution, and the State undertakes to achieve the progressive realization of these rights by reasonable measures within its ability and resources:</i></p> <p><i>(a) adequate and nutritious food and clean water;</i></p> <p><i>(b) clothing and housing;</i></p> <p><i>(c) good standards of health care, physical and mental;</i></p> <p><i>(d) a healthy and ecologically balanced environment;</i></p> <p><i>(e) equal access to means of communication, the State media, transportation facilities, and the natural resources of the country;</i></p> <p><i>(f) the establishment of a sewage system of a reasonably adequate standard on every inhabited island;</i></p> <p><i>(g) the establishment of an electricity system of a reasonably adequate standard on every inhabited island that is commensurate to that island.”</i></p>
67	<p><i>“The exercise and enjoyment of fundamental rights and freedoms is inseparable from the performance of responsibilities and duties, and it is the responsibility of every citizen: (h) to preserve and protect the natural environment, biodiversity, resources and beauty of the country and to abstain from all forms of pollution and ecological degradation;</i></p>
230 (a)	<p><i>“a) The administrative divisions of the Maldives shall be administered decentrally.”</i></p>
231 (a)	<p><i>“All members of councils created for decentralized administration shall be democratically elected by secret ballot by their respective communities.”</i></p>
232	<p><i>“The responsibilities of councils elected for decentralized administration shall include:</i></p> <ul style="list-style-type: none"> <i>• to provide democratic and accountable governance;</i> <i>• to foster the social and economic well-being and development of the community;</i> <i>• to establish a safe, healthy and ecologically diverse environment;</i> <i>• d. to achieve such other objects as prescribed by law. “</i>

2.3 Relevant Legislations

2.3.1 Environment Protection and Preservation Act (EPPA, Law 4/93)

The Environment Protection and Preservation Act (EPPA, Act No. 4/93) was enacted in

1993 is the guiding framework for environmental protection in the Maldives. The following articles in the Act should be abided by the contractor:

Articles	Description	
2	According to article 2 of this act, all concerned government authorities shall provide the necessary guidelines and advise on environmental protection in accordance with prevailing conditions and needs of the country. All parties shall take due considerations of the guidelines provided by the government	Contractors shall abide any guidelines or advise given by a relevant government authority for the project
4	Article 4 states Ministry of Environment, Climate Change and Technology shall be responsible in identifying protected areas and natural reserves and setting up necessary rules and regulations for their protection and preservation	The project contractors shall ensure that there is no negative impact on any protected areas or nature reserve from the project activities
5	<p>According to Article 5 (a) of the Act, an Environmental Impact Assessment study shall be submitted to the Ministry of Environment before implementing any development project that may have a potential impact on the environment.</p> <p>According to Article 5 (b), The Ministry of Environment shall formulate the guidelines for EIA and shall determine the projects that need such assessment as mentioned in paragraph (a) of this clause</p>	Project activities will have to be submitted by the private investors (referred as developers) to Environment Protection Agency (EPA) of the Ministry of Environment for screening to fulfil the legal requirement stipulated in Article 5 of Act (4/93).
6	The Ministry of Environment, Climate Change and Technology has the authority to terminate any project that has undesirable impact on the environment. A project so terminated shall not receive any compensation	Project contractors shall be aware of this provision and contractors shall take all practical measures to ensure there is no irreversible and significant negative impact of the projects on the environment
7	Articles 7 of the EPPA (4/93) states that any types of waste, oil, poisonous gas or any substance that may be harmful effects on the environment shall not be disposed within the territory of the Maldives. If the disposal of such is absolute necessary, it should be carried out within the areas designated for the	Project contractor shall formulate an Environmental Management Plan for the project which specifies how the wastes, oil and gases generated by the project will be disposed.

	purpose by the government. If such waste is to be incinerated, measures should be taken to avoid any possible harm to the health of the population.	
8	Articles 8 states that any hazardous/ toxic or nuclear wastes which is harmful to human health and environment shall not be disposed anywhere within the territory of the country.	Any hazardous wastes that may be generated from the project shall be transferred to the designated waste site in Thilafushi for disposal according to Government regulations and standards.

2.3.2 Decentralization Act (7/2010)

The decentralization act enables local councils as the highest authority in the locality and who shall have executive power to be exercised in accordance with this Act. The Act establishes local councils, atoll councils and city council.

The following articles should be considered when continuing the project.

Articles	Description	
24 (e), 42 (e)	Both in article 24(e), 42 (e) states that the provision of electricity, water, sewerage and other utility services in their jurisdictions according to the laws of the Maldives is the responsibility of Island Councils and City councils respectively	The initial stage projects of ASPIRE will be implemented in localities that are under jurisdictions of Male' City Council. Electricity provision for the Male' region according to the laws of the Maldives is a service that Male' City Council is mandated to provide. Hence, all project proponents shall inform and consult the Male' City Council for projects that are implemented in Male', Villingili, and Hulhumale'.
24(b), 42 (b)	As per the articles mandate the island and atoll councils to manage adequate waste management	
23(h)(i), 41(g)	Island Councils and City Councils are responsible for release of land for development according to the provisions of the Land Act, the Land Use Plan of the island, and any guidelines issued by the Ministry responsible for land.	

2.3.3 General Laws Act (4/64) – Public Property

The General Laws Act 4/68, Paragraph 7 stipulates that public property such as trees, coconut palms, farm land, households and such owned by public or private individuals, if

required to be obtained by the Government, the property can be obtained by the Ministry of Justice or the High Court of the Maldives. The above shall be done only after the individual is fairly compensated for the property or by financial compensation proposed by the property holder. If the public property to be attained is a land plot or a household, the property holder shall be given adequate time for clearance of the area. If a private property belonging to one individual creates nuisance to another, for issues in Male' the matter shall be resolved by the Ministry of Planning, Housing and Development for issues arising in the islands.

Although Act 4/68 is a law that was passed in 1968 and is simplistic and ambiguous, this law is applicable to all public grievances with regard to both public and private property. It is important that ASPIRE project proponents are aware of the provisions in this law, since any issues of aesthetic, light reflection, and safety issues of solar PV installation that may be raised by neighbours or community at large will be considered under Para 7 of this law.

2.3.4 Employment Act (Act no. 2/2008)

This is the Act that govern the rights and responsibilities of the workers in Maldives. The Act was ratified into a law in May 2008. According to chapter 9 of the Act, a Labour Relation Authority must be established to observe the compliance with this act and to facilitate creation of awareness on the Act. Chapter 10 of the Act states that there shall be an Employment Tribunal having full power to review and deliberate as it deems appropriate on matters determined by the Act or any other law judged by the Tribunal. Furthermore, an advisory board on wage has to be made under the Act. The Act allows the registration of Employment Agencies for assisting the employment seekers. To date, 5 amendments have been made to the Act.

Out of these amendments, the third and fourth Amendments are directly relevant to foreign migrant workers in the Maldives. The Amendment 3/2014 passed by Parliament on 03 December 2013 requires an Employment approval for foreign migrant worker to be issued prior to arrival in the Maldives. The Amendment also made a deposit mandatory for all foreign migrant workers to be paid by the Employer. A deposit (to the sum of return airfare) to be made to Department of Immigration and Emigration (DoIE) at the time of work visa. The Amendment 14/2015 on Ramazan allowance for Muslim workers makes it optional for Employers of Muslim foreign migrant workers to pay them a Ramazan allowance. The Amendment 22/2016 in on wages for

foreign migrant workers. The Amendment specifies that the wages and other sums to which the worker is entitled shall be paid through a bank registered in the Maldives to an account in the name of the foreign migrant worker (art. 53 a). A bank account for every foreign migrant worker Maldives to be opened in the Maldives and wages paid directly through the bank account.

The project involves employment of staff during the construction and operation phase. Hence, the responsibilities and rights of all parties (both the employee and the employer) has to be protected as per the Act. All the staffs and unskilled labourers hired under the project should have all the provisions and rights mandated as per the employment act. The grievance mechanism developed for the workers should be developed with reference to the rights and provisions stated under the Act.

2.3.5 Utility Regulation Authority Act (26/2020)

This Act defines the roles and responsibility of an authority to monitor and manage the provision of basic utilities in the Maldives. Under this Act “Utility Regulation Authority” is vested the power to manage and monitor the utility services and the service providers as an independent authority. After this act is enacted, all the budget, responsibilities and mandatory works of Maldives Energy Authority (MEA) falls under the Utility Regulation Authority.

The project opponent should ensure that the operation of solar PV grids is in as per the regulation and standards set by the Utility Regulation Authority.

2.3.6 Immigration Act (Act no. 1/2007)

Guidelines on the entry, departure and deportation of foreign workers and nationals in Maldives are stated in Maldives Immigration Act (1/2007). The Act provides for work visa and work permit of foreign nationals who visit Maldives for the purpose of working.

As the contractor employs number of foreign nationals in the project manpower, all foreign workers must hold relevant work visa and all necessary documents.

2.3.7 Anti-Human Trafficking Act (12/2013)

According to the Anti-Human Trafficking Act ratified on 8th December 2013, human trafficking in Maldives is a criminal offence. The Act aims to solve the following issues;

- Stating human trafficking a criminal offence.

- Ending human trafficking in or through Maldives.
- Punishing the people who carry out human trafficking in or through Maldives.
- Finalising a set criminal procedure to prosecute people under the Act.
- Working together with national and international organisations to stop human trafficking in or through Maldives.
- Providing a safe environment and protecting the human rights of the victims of human trafficking in or through Maldives.

Forced labour and fraudulent recruitment is defined by the Act as crimes of human trafficking.

As per the Act, in order to ensure that the Act is properly implemented across Maldives and the institutions adhere to the Act, the president must form a committee consisting of number of people from different government authorities such as Parliament, Supreme Court, HRCM, Maldives Police Service etc.

2.3.8 Prevention of Sexual Harassment Act (Act 16/2014)

The Act prohibits employers and employees from subjecting those who work under them or their co-workers to any extent any type of sexual harassment. Sexual Harassment is defined in the Act as, any sexual act committed against a person without their consent. Furthermore, any action, whether physical, verbal or otherwise, which according to a reasonable person, suggests a sexual intent towards the victim, is taken to be a sexual act, for the purposes of the Act. Any such act is to be proven on the balance of probability. It is the duty of the employer to take reasonable steps to ensure that the work environment is an environment that is free from sexual harassment and one in which such acts does not negatively affect the work of employees. Employers are obliged to establish policies to prevent sexual harassment and have such policies published for the safety of the staff.

2.3.9 Gender Equality Act (Act 18/2016)

Under the Act, employers are mandated to ensure gender equality in work place. No gender based discrimination whatsoever is allowed to be exercised in any work environment. The Act aims to promote equal opportunities for both men and women while abolishing all forms of gender based discrimination. Men and women undertaking similar jobs, tasks or responsibilities at the same place of employment must be subject to equal wage structure.

2.3.10 Maldives Pension Act (Act18/2016)

Employers must enroll their employees in the Maldives Retirement Pension Scheme, and it is obligatory on the employees to participate in the scheme, under Article 12 of the Maldives Pension Act (18/2016). Failure to do so would amount to an offense under the Act. And as such the employment agreement is required to have provisions for deductions for pension contributions by the employee.

2.3.11 Law on Cultural and Historical places and objects of the Maldives (27/79)

The Law on Cultural and Historical Places and Objects of the Maldives 27/79 prohibits destroying or damaging any historical and cultural places, sites, objects and artefacts belonging to the sovereign area of the Maldives. The historical and cultural objects are those that were used by or feature the life of locals or foreign ancestors who had resided in the Maldives. The historical and cultural places refer to religious monuments, idols or place of worship or residences used by locals or foreign ancestors who had resided in the Maldives.

Project contractor must ensure that the buildings selected for installation of solar PV does not have an adverse impact on a site of historical and cultural significance. Ministry of Arts Culture and Heritage must be consulted to check if a building selected for the project may have an adverse impact on a building or site of significance.

2.3.12 Heritage Act of Maldives (12/2019)

The heritage bill was passed by the Parliament on 28th August 2019 which was ratified by the president on 12th September 2019. The Heritage Act ensures the documentation, preservation and protection of cultural heritage. This Act will also ascertain the procedures and jurisdictions of the state and individuals, as well as stipulate that acts resulting in the loss of items or sites of historical significance as criminal acts. The purpose of the Heritage Act is to safeguard the perpetuation of items and sites of historical significance to future generations.

Ministry of Arts, Culture and Heritage is mandated to manage and properly implement the Act. As part of the implementation, a heritage list which include sites of historical significance has to be made and maintained by the Ministry.

No heritage or cultural site has been identified in the proposed project area.

2.4 Relevant Regulations

2.4.1 Environment Impact Assessment Regulation 2012

The Ministry of Environment has issued EIA regulation on May 2012, which guides the process of undertaking the Environmental Impact Assessment in the Maldives - This guideline also provides a comprehensive outline of the EIA process, including the roles and responsibilities of the consultants and the proponents. This regulation outlines every step of the EIA process beginning from application to undertake an EIA, details on the contents, minimum requirements for consultants undertaking the EIA, format of the EIA/IEE report and many more. The Ministry of Environment has issued 5 amendments to this regulation over the past years which were also followed.

This ESMP report is compiled by a registered EIA consultant as per the EIA regulation 2012. It will be reviewed by EPA following which a decision statement will be issued. The decision statement will either approve the report, or reject the report and will ask for additional information. The report complies with the EIA regulation 2012.

2.4.2 Maldives Civil Aviation Regulation (MCAR-139 – Aerodrome rules)

The Maldives Civil Aviation Regulation was published in May 2012 and it consists of general standards and practices of aerodromes, aerodrome certification. The MCAR-139 provides the requirements, application or grant for an aerodrome certificate, aerodrome manual which stipulates the preparation, location, amendment of an aerodrome manual, obligations of the aerodrome operator, obstacles and hazards, firefighting and rescue.

Since the proposed project is in close vicinity of Velana International Airport, it is important to ensure that the project will not pose any obstacles or hazards to the aerodrome and the operation of the airport.

2.4.3 Work Visa regulation

The Maldives Immigration (MI) has issued a Work Visa Regulation (2010/R-7) under the Maldives Immigration Act (1/2007). The Work Visa Regulation (2010/R-7) requires foreign migrant workers who enter the Maldives for the purpose of work to have a valid work visa. The conditions for entry of work visa holders as specified in the regulation includes the following:

- a passport with minimum six-month validity;

- security deposit paid to MI 48 hours before arrival;
- truthful answers to questions posed by Immigration Officers;
- not prohibited from entry to the Maldives under article 4 of the regulation;
- specification of the purpose of entry;
- an Employment approval from the concerned authority with a copy transmitted to MI;
- and being over 18 years of age.

The regulation discusses the procedures to be followed for obtaining a work visa, keeping a deposit with MI for foreign migrant workers, penalties related to work visa.

2.4.4 Environment damage liability regulation (R-9/2011)

Under the Environmental Protection and Preservation Act (No. 4/93), the Ministry of Environment and Energy formulated the Environmental Damage Liabilities Regulation in February 2011, which encompasses the basis to avoid environmental deterioration, extinction of biological resources, environmental degradation and avoid wastage of natural resources. The main purpose of this regulation is to stop unlawful activities on environment and adequately implement a fining procedure for violations as well as implement a compensation mechanism on environmental damages. Its Schedules form the basis for levying fines on various environmental components and activities. Hence, the proposed project will be subject to this Regulation for any activity outside of the EIA scope and Environmental Decision Statement.

2.4.5 Waste Management Regulation (R-58/2013)

Waste Management Regulation (WMR) was published on August 2013 and comes into effect in February 2014. It will be implemented by EPA. The aim of WMR is to implement the national waste policy which contains specific provisions to:

- Implement measures to minimize impacts on human health
- Formulate and implement waste management standards

- Implement an integrated framework for sustainable waste management
- Encourage waste minimization, reuse and recycling
- Implement Polluter-Pays Principle
- Introduce Extended Producer Responsibility WMR contains four main sections:
 - Waste management standards: Defines standards for waste collection, transfer, treatment, storage, waste site management, landfills and managing hazardous waste.
 - Waste management Permits: Defines approval procedures for waste sites
 - Waster transfer: Standards and permits required for waste transport on land and sea, including trans-boundary movements.
 - Reporting requirements: Defines reporting and monitoring requirements and procedures.
 - Enforcement: Defines procedures to implement WRM and penalties for non-compliance.

Given the presence of hazardous chemicals in solar panels, their disposal at the time of decommissioning is subject to specific provisions defined for hazardous waste disposal. Electronic waste is also classified as a Special Category waste, which will require handling facilities. If the waste is to be disposed in the Maldives, it should be handled by waste sites specifically approved to manage hazardous and Special Category waste. Transportation and handling shall also conform to the standards specified in WRM. If the waste is to be exported for reuse or disposal in another country, an application needs to be submitted to EPA 3 months prior to the shipping date. EPA will issue an approval based on compliance with WRM clauses and international conventions. Thus, the project will need to comply with the WRM in disposing construction and decommissioning related wastes.

2.4.6 Regulation on protection and conservation of the old trees and trees with environmental significance

The regulation is enacted under Article 4 to Act 4/93 (Maldives Environment Protection and Preservation Act). The regulation is made to protect and preserve the old plants and trees of Maldives. Furthermore, it prohibits uprooting and removal of trees with environmental significance. The regulation protects trees that are falling under 4 different categories. They are;

- Trees that are between the age of 50 to 100 years and those that are older than 100 years.
- Trees that have been existing in Maldives or/and in certain islands for year but are at the verge of extinction.
- Trees that have certain special features or environmental significance depending on its location, use, historical value etc.
- Trees with certain features can be protected if it has been requested by the island community or an association.

Together with the protection of the plant, a boundary encompassing a 2m offset line from the canopy of the plant will be demarcated as the boundary of the protected plant. However, those trees that exist within the boundary of private residential lots and fruit-bearing plants will be exempted from this regulation.

The proposed project will fully comply with this regulation. No such tree or plant is present within the direct impact area of the proposed project.

2.4.7 Regulation on Construction Contractors

Under the regulation all contractors working in the construction industry are to be registered. The regulation includes the requirements of contractor's registration, grading, implications on participating in international tenders, insurance, project licenses, Joint venture registrations, responsibilities of the registered contractors and applicable fine for breaching the regulation.

2.4.8 Mosquito control regulation 2007

Ministry of Health published a mosquito control regulation in 2007. The regulation provides

responsibilities of landlords and developers on prevention of mosquito growth in households and buildings. These include prevention of open water logged areas, cleaning gutters, and pipes. It also guides on prevention of mosquito growth during building construction and repair/maintenance works.

The penalties for not adhering to the Clauses of the regulation as stated by the regulation very small, and is almost negligible. Heavier penalties may be imposed by HPA if mosquito breeding becomes a persistent issue in the building area, and if not controlled after several inspections and warnings. As such Clause 9.3 states HPA can take legal action against developers under such a scenario.

2.4.9 Management, use and control of HCFC substances regulation, 2010

The HCFC Regulation is developed under the Environmental Protection and Preservation Act (4/93). It is made towards regulating phasing out of import, use, selling of HCFC substances by 2011 and completely eliminating use of HCFC substances in the Maldives by 2020 through controlling importers registering importers, establishment of a quota system, control mechanisms for selling, maintenance of import, selling, purchase and service providers statistics.

2.4.10 Regulation on safety standards required in the construction industry (2019/R-156)

This is a regulation published to fulfill the requirement of point 5 under section 95 (haa) of the Construction Act (4/2017) of Maldives which is to regulate the safety standards maintained in construction industry.

The regulation aims to achieve the following;

- Set the minimum safety standards required to ensure the safety of construction workers and the general public.
- Set appropriate penalties for those who break the regulation and identifying the people to be held responsible for breaking the regulation.

The regulation is divided into 4 sections. Section 1 outlines the meaning and what has been intended to be achieved by the regulation as stated above.

Section 2 states the responsibilities of the contractor or the client. Major responsibilities as mentioned in the regulation are;

- If the project value exceeds MVR1.5 million, a health and safety book/booklet that outlines the steps to be taken for the safety of the workers and the general public has to be made and an induction program should be carried out to make workers aware of it.
- Storage, transportation and usage of construction materials should adopt measures that guarantees the safety and protection to workers and the general public.
- Each and every worker should be made aware of the possible risks associated with the project activities.
- An emergency response plan/mechanism should be in place to handle any emergency issue.
- Should ensure that the project work is carried out as per the health and safety policies or the book/booklet made at the beginning.
- Workers should be trained to apply the best practice methods of the industry, appropriate health and safety techniques.
- When working in high rise buildings, safety net should be used to safeguard the adjacent building or footpath from falling objects.
- Adjoining buildings, roads, footpaths, land plots etc, should be safe from the ongoing construction activities in the project site. Appropriate dust protection measures should be in place.
- Workers should be provided with appropriate Personal Protective Equipment (PPE) specific to the type of work they are supposed to do.
- Excavation for foundation works should be carried out with foundation protection measures. An approved foundation protection method should be used for cases that require approved ones.
- If the project value exceeds MVR1.5 million, a written ‘Emergency Response Plan’ should be available. Minimum 2 drills should be arranged in the site per each year to make workers aware of it.
- A first aid kit should be readily available in the site. Additionally, a first aid officer

should always be available in the site during the working hours.

- All the emergency and key personal contact numbers should be available in the site notice board.
- A site safety officer should always be available in the site during the working hours. Regulation highlights criteria and the responsibilities of the safety officer.
- If the project value exceeds MVR5 million, the contractor should arrange an insurance mechanism to compensate the workers and the general public from any possible damage and loss.
- The project site should be fenced to a minimum height of 1.8m from the ground. The regulation includes additional specific requirements for fencing the project site.
- The regulation states specific precautionary measures in working at a height of 3m or higher.
- The regulation highlights safety measure to be maintained in handling chemicals, flammable items, obtaining temporary electricity, using electric tools, etc.
- It also regulates demolition works that might have to be carried out prior to the actual project.

Section 3 outlines the penalties to be applied against those who break the regulation. Initially, any contractor who breaks the regulation will be advised to follow the regulation. Repeated regulation breakers can be fined with an amount between MVR5,000 to MVR500,000 by the relevant government Ministry. Number of additional penalties are highlighted in the regulation.

Section 4 outlines the additional measures needed to make the regulation effective. Terminology used throughout the regulation has been explained in the section.

2.4.11 Regulation on protection and conservation of natural life and significant old trees and plants in Maldives

The regulation is enacted under Article 4 to Act 4/93 (Maldives Environment Protection and Preservation Act). The regulation establishes specific policies to protect and conserve the old plants and trees of Maldives so that it would help to reduce the extinction of old plants and tree

and its negative impacts on the environment and living species. By doing so, it reduces any detriments to the natural character of the island and pave the way to sustainable development.

The proposed project site, especially the vegetation clearance area is not identified to have any such tree.

2.4.12 Regulation on cutting down, uprooting, digging out and export of trees and palms from one island to another

The Regulation for cutting down, uprooting, digging out and export of trees and palms from one island to another states that the cutting down, uprooting, digging out and export of trees and palms from one island to another can only be done if it is absolutely necessary and there is no other alternative. The regulation is enacted under Article 4 to Act 4/93 (Maldives Environment Protection and Preservation Act). It further states that for every tree or palm removed in the Maldives two more should be planted and grown in the island. The first amendment of the regulation has been published in January 2014.

Under the regulation, uprooting and removal of the following plants are prohibited;

- Coastal vegetation growing around the island, 15m inward (landward) area from the outer most plant in the coastal area.
- All those trees and plants within a 15m buffer area of wetlands and mangroves.
- All the trees falling within a declared protected area under the Maldivian government.
- Those plants that are protected to conserve the biodiversity by the government.
- Those plants that hold certain significance due to its unique character or type.

However, those that are planted in nurseries by means of seeds and/or seedlings will be exempted from this regulation.

2.5 Relevant Plans, Policies and Guidelines

2.5.1 Energy Policy

The ASPIRE program is supported by a number of energy policy decisions, including the

National Energy Policy and the National Energy Action Plan (2009-2013) that have been adopted to guide the development of the energy sector in the Maldives. In addition, a number of policies have been developed to encourage private investments in the energy sector - including a zero-import duty for RE related merchandise and the introduction of FIT regulations. The National Energy Policy provides for developing greater sustainability, conservation and efficiency in energy while promoting low carbon technologies and the quality of energy supply.

The National Energy Policy has following objectives:

- Provide all citizens with access to affordable and reliable supply of electricity
- Achieve carbon neutrality in the energy sector by 2020
- Promote energy conservation and energy efficiency
- Increase national energy security
- -Promote renewable energy technologies
- Strengthen the management capacity of the energy sector
- Adopt an appropriate pricing policy for the energy sector
- Ensure customer protection
- Enhance the quality of energy services.

The Energy Action Plan (2009-2013) includes a series of actions, measures, programmes and targets to be met over five years to achieve greater energy efficiency and conservation awareness, together with reductions in CO2 emissions. The key strategies in the action plan include:

- Provide all citizens with access to affordable and reliable supply of electricity through:
 - Developing utilities to upgrade and manage power infrastructure on the islands and improve the efficiency and quality of services.

- Encouraging private sector participation to develop, manage and sustain electric services.
- Encouraging national and international investments to develop and sustain energy.
- Introducing incentives to power sector developers to ensure affordability of energy supply by facilitating access to grants and concessional finance.
- Achieve carbon neutrality by year 2020 through:
 - Developing plans for energy sector to include forecast of energy usage by different sources, GHG emissions and assessing status of carbon neutrality;
 - Setting and monitoring targets to track energy sources, composition, efficiency and losses to achieve carbon neutrality and sustaining it;
 - Adopting standards for exhaust emission for power plants, vehicles and vessels that use fossil fuel in order to improve air quality; and
 - Promoting carbon capture and sequestration.
- Promote energy conservation and energy efficiency to reduce costs through:
 - Promoting energy efficiency and energy conservation to achieve economic use of energy without lowering the quality of service rendered;
 - Promoting energy efficiency in electricity production, distribution and usage via workshops involving necessary stakeholders;
 - Promoting demand side management with focus on large energy users;
 - Identifying all areas of improvement and provide technical advice in fuel conservation and efficiency in different modes of transport; and
 - Introducing incentives to encourage greater use of electric vehicles by establishing charging stations using RE sources.

- Promote RE technologies through:
 - Introducing and demonstrating new renewable technologies application;
 - Facilitating and promoting research opportunities for locals and international parties by informing about potential of RE sources within the country;
 - Developing human resource capacity for RE throughout the country by introducing RE related courses in college curriculum;
 - Encouraging and promote bio fuels; and
 - Encouraging the development of power generation capability by utilizing the household waste and bio fuels.

2.5.2 National Biodiversity Strategy and Action Plan (NBSAP)

The objective of NBSAP was to “achieve biodiversity conservation and sustainable utilization of biological resources in the Maldives” by integration of biodiversity conservation into all areas of national planning, policy development and administration (MHAHE, 2002). To achieve this objective, one of the first actions listed is “formulation and adoption of suitable development planning procedures, land use plans and strengthening of the EIA process”. The current project conforms to this policy, by carrying out the EIA prior to commencement of the project, to minimize impact on the environment and to incorporate ways of environmental monitoring and management during the project works.

2.5.3 The Maldives Climate Change Strategy Framework

The Maldives Climate Change Strategy Framework is the main policy instrument of the Government of Maldives addressing climate change. The climate policy framework recognizes climate change as a central player in the sustainable development. The framework is expected to be instrumental in guiding the efforts to combat climate and to achieve the sustainable development of the Maldives. The policy framework provides a platform to streamline the existing climate change adaptation strategies that had been outlined in various policy documents. The implementation of the Maldives Climate Change Policy Framework is seen as a major step towards adapting to the current and future effects of climate change.

2.5.4 National Environmental Action Plan III (NEAP III)

The main objectives of NEAP is to strengthen the environment management process such as EIA process, and to sustainably manage the natural resources of the country for future generations. This will be achieved by continuously monitoring and assessing the state of the environment in the Maldives. Suitable environment management methods have to be developed to monitor activities that impacts the environment which has to be achieved through community participation.

NEAP III sets out the agenda for environmental protection and management in the Maldives. NEAP III aims to make a livable and a sustainable environment a component of development projects carried out in Maldives. Achieving measurable environmental results and developing a resilient population or a community is targeted to be achieved by the action plan. NEAP III provides the basis for environmental planning, budgeting, performance measurement, and accountability.

The six strategic results of NEAP III that are expected are: resilient islands; rich ecosystems; healthy communities; safe water; environmental stewardship; and a carbon neutral nation.

Number of targets have been highlighted to be achieved under each strategic result. Significant targets that are of relevance to the project include;

- Establish a fully functional Marine Protected Areas System in the Maldives.
- Ensure that 05 percent of the coral reefs of the Maldives are given protected status.
- Prepare recovery plans for all marine listed threatened species
- Identify National Government, Province/Atoll Office, Island Office and Community responsibilities for biodiversity conservation.
- Integrate biodiversity conservation as a core component in all provincial development strategies, atoll development plans and island land use plans.

Many of the significant targets highlighted above has not been achieved.

2.5.5 Strategic Action Plan (SAP) 2019 – 2023

SAP 2019 - 2023 outlines the developmental targets and priorities of the Government for the five-year period, from 2019 – 2023. It sets out strategic goals that would help to achieve key

developmental milestones in realising our hopes and dreams of a Jazeera Raajje. The SAP 2019-2023 is a bench mark, a scale against which government's performance can be measured within the given period of time.

The SAP 2019-2023 consists of 5 main priority areas which are further explained under subsectors. Goals expected to be achieved and responsible institutions to carry out the activities from each area are explained in the subsectors. Implementation of the SAP will be monitored mainly at the subsector level. Monitoring activities will be carried out quarterly and annually where progress of subsector goals will be discussed.

The 5 main priority areas include are blue economy, caring state, dignified family, Jazeera dhiriulhun and good governance. Main areas of interest to the proposed project are under the sector of blue Jazeera dhiriulhun.

One of the subsector targets highlighted under Jazeera dhiriulhun is clean energy. It has been stated in the SAP that by 2023;

- The share of renewable energy in the national energy mix will be increased by 20% compared to 2018.
- Fuel usage for electricity generation will be reduced by 40 million liters.
- At least 30% of IWMC's utilize solar energy for operation.
- 30% of energy consumption for water and sewerage facilities across the Maldives will be renewable energy.

The proposed project is targeted to meet the development targets highlighted under SAP (2019-2023)

2.5.6 National Waste Management Policy

National waste management policy is targeted to achieve and implement proper guidelines and means for solid waste management in order to maintain a sustainable and a healthy environment. The policy mainly aims to achieve the following.

- Ensure safe disposal of solid waste

- Encourage recycling
- Reduction of waste generated
- Develop guidelines on waste management and disposal
- Advocate to enforce proper waste disposal guidelines throughout the country
- Ensure safe disposal of chemical, hazardous and industrial waste.

The waste generated during the project has to be treated and disposed as explained in the report which reflects the waste management policy.

2.5.7 National Waste Water Quality Guidelines

Non-consumptive use of water leads to release of used water back into the environment. Released water is mixed with many waste products at various concentrations which could be potentially harmful to the environment if measures are not taken to limit the concentration of waste and chemical mixed in released water. Hence, National Waste Water Quality Guideline manages the waste water discharge in a way that it does not harm the environment that it is released into. The guideline has stated maximum allowable concentrations for various parameters of waste water that can be released into the environment.

The guideline is related to the project as site staff would use water for domestic and other site works. Usage of water in this project and its disposable will be as per this guideline.

2.5.8 EIA Data Collection Guideline

EPA has published a guideline to be followed during EIA or EMP baseline data collection survey. The environmental, topographic and terrestrial surveys undertaken for the reports has followed the EPA's guideline on data collection.

2.5.9 Sustainable Development Goals (SDG)

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030.

There are 17 SDGs which have to be incorporated into developments projects in order to balance the social, economic and environmental sustainability. They are;

- End poverty in all its forms in everywhere.

- End hunger, achieve food security with improved nutrition and promote sustainable agriculture.
- Ensure healthy lives and promote well-being for all at all ages.
- Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- Achieve gender equality and empower all women and girls.
- Ensure availability and sustainable management of water and sanitation for all.
- Ensure access to affordable, reliable, sustainable and modern energy for all.
- Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
- Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
- Reduce inequality within and among countries.
- Make cities and human settlement inclusive, safe, resilient and sustainable.
- Ensure sustainable consumption and production patterns.
- Take urgent action to combat climate change and its impacts.
- Conserve and sustainably use the oceans, seas and marine resources for sustainable developments.
- Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss.
- Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
- Strengthen the means of implementation and revitalize the global partnership for sustainable development.

The project indirectly works towards achieving many of those goals highlighted under SDG.

2.6 International Treaties and Conventions

2.6.1 Montreal protocol on Substances that deplete the Ozone layer

The Montreal Protocol, finalized in 1987, aims to control the consumption, production and

emissions of ozone depleting substances (ODSs. Chlorofluorocarbons (VFCs), Halons, Carbon tetrachloride and Methyl Chloroform are to be controlled or phased out during years of 2000.

Starting from 2002, Ministry of Environment has issued number of circulars to control the import of items having ozone depleting substances as marked under Montreal protocol.

- Since alternative environment friendly chemicals are available, import of the items having the following ozone depleting chemical substances are banned in Maldives under the circular (No: 10-ERC/2002/44) issued on 19th December 2002.
 - Halon gas based chemicals
 - Halon – 1211, Halon – 1301, Halon - 2402
 - Methyl Chloroform (111 – Trichloromethane CH_2CCl_3)
 - Bromochloromethane (CH_2BrCl)
 - Methylebromide (CH_3Br)
- According to circular no. A-28/2003, issued on 27th May 2003, import ban on machineries and equipments using the two ozone depleting substances (CFC-11 and CFC12) will be enforced starting from January 1, 2004.

The proposed development project will not involve the use of any of the substance banned under this protocol.

2.6.2 Kyoto Protocol and United Nations Framework Convention on Climate Change (UNFCCC)

Maldives signed and rectified UNFCCC in 1992 and became a party of UNFCCC from which the international Treaty-Kyoto protocol was extended. Kyoto protocol rectified by Maldives in 1998. The Convention and the protocol aims to lower down the greenhouse gas (GHG) emission by the binding countries so that GHG concentration in the atmosphere will be lowered. The reduction on GHG emission will be achieved within a planned time frame so that it will be economically viable and naturally adaptable for ecosystems.

2.6.3 United Nations Convention on Biological Diversity (UNCBD)

Maldives has become a party to UNCBD. The main objective of this convention as

expressed in its article 1 are;

- The conservation of biological diversity;
- The sustainable use of its components; and
- The fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate
 - Access to genetic resources,
 - Transfer of relevant technologies,
 - Funding.

The proposed development does not fall under any area recognised for its ecological value. Hence, it is expected that there will not be major loss of biodiversity.

2.6.4 International Labour Organization Conventions

Given below are the International Labour Organisation Conventions that Maldives has ratified on 4th January 2013.

Articles	Convention	Description
1	Forced Labour Convention, 1930 (No. 29)	<i>“This fundamental convention prohibits all forms of forced or compulsory labour [...] Exceptions are provided for work required by compulsory military service, normal civic obligations, as a consequence of a conviction in a court of law [...], in cases of emergency, and for minor communal services performed by the members of a community in the direct interest of the community. The convention also requires that the illegal extraction of forced or compulsory labour be punishable as a penal offence, and that ratifying states ensure that the relevant penalties imposed by law are adequate and strictly enforced.”</i>
2	Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87)	<i>“This fundamental convention sets forth the right for workers and employers to establish and join organizations of their own choosing without previous authorization. Workers' and employers' organizations shall organize freely and not be liable to be dissolved or suspended by administrative authority, and they shall have the right to establish and join federations and confederations, which may in turn affiliate with international organizations of workers and employers.”</i>
3	Right to Organise and	<i>“This fundamental convention provides that workers shall</i>

	Collective Bargaining Convention, 1949 (No. 98)	<i>enjoy adequate protection against acts of anti-union discrimination [...] Workers' and employers' organizations shall enjoy adequate protection against any acts of interference by each other [...] The convention also enshrines the right to collective bargaining”</i>
4	Equal Remuneration Convention, 1951 (No. 100)	<i>“This fundamental convention requires ratifying countries to ensure the application of the principle of equal remuneration for men and women workers for work of equal value. The term ‘remuneration’ is broadly defined to include the ordinary, basic or minimum wage or salary and any additional emoluments payable directly or indirectly, whether in cash or in kind, by the employer to the worker and arising out of the worker’s employment”</i>
5	Abolition of Forced Labour Convention, 1957 (No. 105)	<i>“This fundamental convention prohibits forced or compulsory labour as a means of political coercion or education or as a punishment for holding or expressing political views or views ideologically opposed to the established political, social or economic system; as a method of mobilizing and using labour for purposes of economic development; as a means of labour discipline; as a punishment for having participated in strikes; and as a means of racial, social, national or religious discrimination”</i>
6	Discrimination (Employment and Occupation) Convention, 1958 (No. 111)	<i>“This fundamental convention defines discrimination as any distinction, exclusion or preference made on the basis of race, colour, sex, religion, political opinion, national extraction or social origin, which has the effect of nullifying or impairing equality of opportunity or treatment in employment or occupation. [...] It requires ratifying states to declare and pursue a national policy designed to promote, by methods appropriate to national conditions and practice, equality of opportunity and treatment in respect of employment and occupation, with a view to eliminating any discrimination in these fields. The Convention covers discrimination in relation to access to education and vocational training, access to employment and to particular occupations, as well as terms and conditions of employment.”</i>
7	Minimum Age Convention, 1973 (No. 138)	<i>“This fundamental Convention sets the general minimum age for admission to employment or work at 15 years (13 for light work) and the minimum age for hazardous work at 18 (16 under certain strict conditions). It provides for the possibility of initially setting the general minimum age at 14 (12 for light work) where the economy and educational</i>

		<i>facilities are insufficiently developed.”</i>
8	Worst Forms of Child Labour Convention, 1999 (No. 182)	<i>“This fundamental Convention defines as a “child” a person under 18 years of age. It requires ratifying states to eliminate the worst forms of child labour, including: all forms of slavery or practices similar to slavery, such as the sale and trafficking of children, debt bondage and serfdom and forced or compulsory labour, including forced or compulsory recruitment of children for use in armed conflict; child prostitution and pornography; using children for illicit activities, in particular for the production and trafficking of drugs; and work which is likely to harm the health, safety or morals of children. The Convention requires ratifying states to provide the necessary and appropriate direct assistance for the removal of children from the worst forms of child labour and for their rehabilitation and social integration. It also requires states to ensure access to free basic education and, wherever possible and appropriate, vocational training for children removed from the worst forms of child labour.”</i>

2.7 Environmental Permits Required for the project

2.7.1 Decision Statement of Environment and Social Management Report

The completed EMSP report will be submitted to EPA for evaluation. Upon evaluation of ESM, EPA will either issue a Decision statement, approving the construction of the proposed development, or request for additional information for the report, or will reject the report, hence the proposed development.

Therefore, a decision statement which approves the ESMP is required to begin the construction activities of the project. The mitigation measures and monitoring program outlined in the ESMP report must be followed during the construction and operation stage.

2.7.2 Approval by World Bank Group

Similar to issuance of decision statement by EPA, the ESMP will have to be approved by Work Bank Group. The report will be submitted to the PMU of MoECC&T for communication with WBG.

2.7.3 Responsible Institutions and Authorities

2.7.4 Housing Development Corporation (HDC)

The project is proposed on a lands and buildings managed by HDC. Hence, approvals have to be obtained from HDC for the project activities.

2.7.5 Environment Protection Agency (EPA) functioning under MoECC&T

Although MoECC&T is the main government institution mandated for the implementation and management of Environment Protection Act, approvals of EIA and EM reports are mandated to EPA. MoECC&T has a central management role in environment protection which mainly operates at policy level.

2.7.6 World Bank Group

Under the relevant World Bank Policies, Environmental Assessment or Environment and Social Assessments have to be carried out for projects that have impacts on environment, natural habitats and local communities. Identifying potential risks and adverse impacts, mitigation measures and environmental management plan are requirements of such projects. This report is made to fulfill those requirements.

2.7.7 STELCO

State Electric Company Limited (STELCO) is a state owned organization responsible for the generation and distribution of electricity to customers throughout the Maldives. STELCO is envisaged to purchase renewable energy from private suppliers produced under ASIPRE program. Hence, arrangements and arrangements have to be made with STELCO in undertaking the project.

2.7.8 Ministry of Environment, Climate Change and Technology (MoECC&T)

MoECC&T is the main government institution who leads the ASPIRE program on behalf of the GoM. The Minister represents environment, climate change and energy portfolio in the President's Cabinet of Ministers. MoECC&T has the mandate on energy, environment, climate change, water resources and technology in the Maldives.

2.7.9 Male' City Council

Atolls and City Councils are formed across the country under the Decentralization Act of Maldives. The City Council perform the functions and duties of a local government as stated under the Act by providing and coordinating various public services and facilities and to develop

its community and resources.

A copy of this report would have to be submitted to City Council and the final ESMP can only be submitted to EPA with proof of report submission to Atoll Council.

3 PROJECT DESCRIPTION

3.1 Project concept

Greater Male' region is a densely populated area with limited land space available for any use, let alone for utility or commercial usage. Considering the land scarcity, the project is proposed on the pavement area of the link road between Male'-Hulhumale, southern side pavement area of Boashimaa Hinhun in Hulhumale and on roof top of 8 residential buildings in Hulhumale phase-1.

In pavement areas, the PV modules are fixed over an elevated roof structure in such a way that it covers and shades the pavement whereas in selected buildings, they will be fixed over the existing roof. The total length of the line along the pavement, including the island (empty space at the middle of the widest part of the link road) is 3,510m. The line will include a total of 10,691 panels with a capacity of 495 Wp by each link. Hence, the total installed capacity along the road side will be 5,292,045 Wp. Additional 720 panels will be installed on the roof top of the 8 selected residential buildings whose total capacity will be 356,400 Wp. Therefore, the installed total capacity under the proposed project would be 5,648,445 Wp.

A 1000 kVA transformer is set up for each link section. Other than link section 5. The proposed transformer size in link section 5 is 630kVA. They will be connected to the power grid of STELCO by means of 1 or 2 connections. The connecting cable will run across Boashimaa Hinhun to the powerhouse on the land side of that road. Allocations for the crossing of utility line had been included under the ground during road construction.

The power generated by the panels at the roof top will be fed to the grid by connecting them to the electrical panel boards in each building separately.

3.2 Design requirements by HDC and MNPI

It was a requirement of HDC to fix lights below the PV models so that the pavement area can be light up during night time. Even though this has not been incorporated in the initial design, contractor has agreed to include lights below the PV modules as part of the project, in pavement areas, excluding the island link. Further discussions are underway currently to include the island link as well.

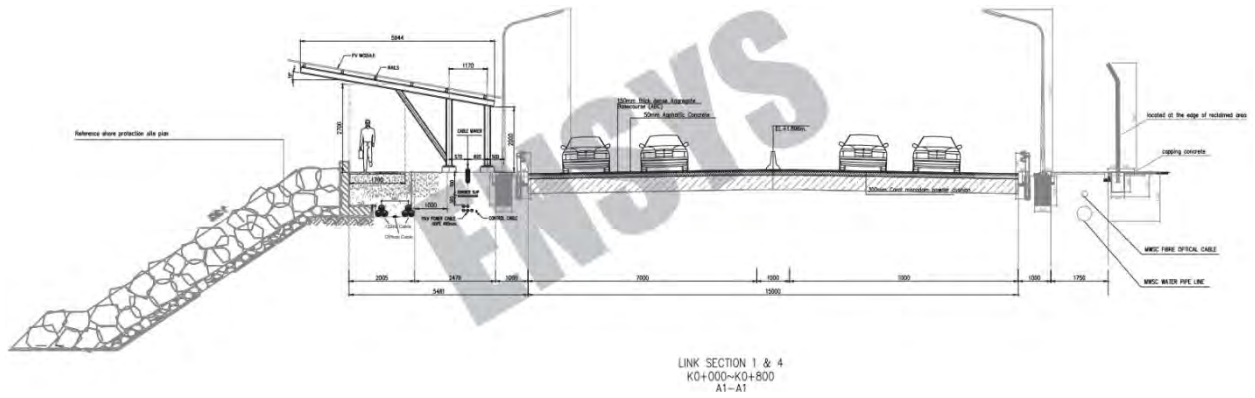


Figure 3.2: Link section 1 and 4

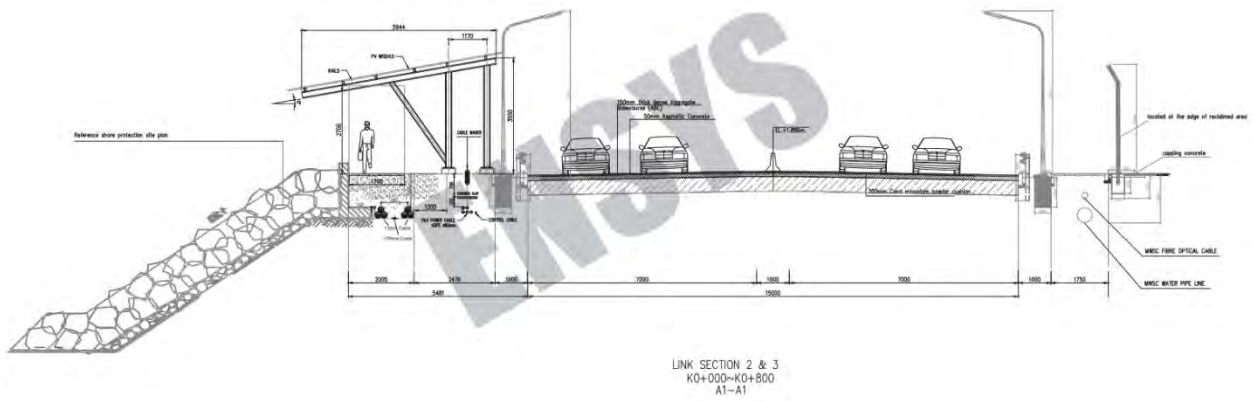


Figure 3.3: Link section 2 and 3

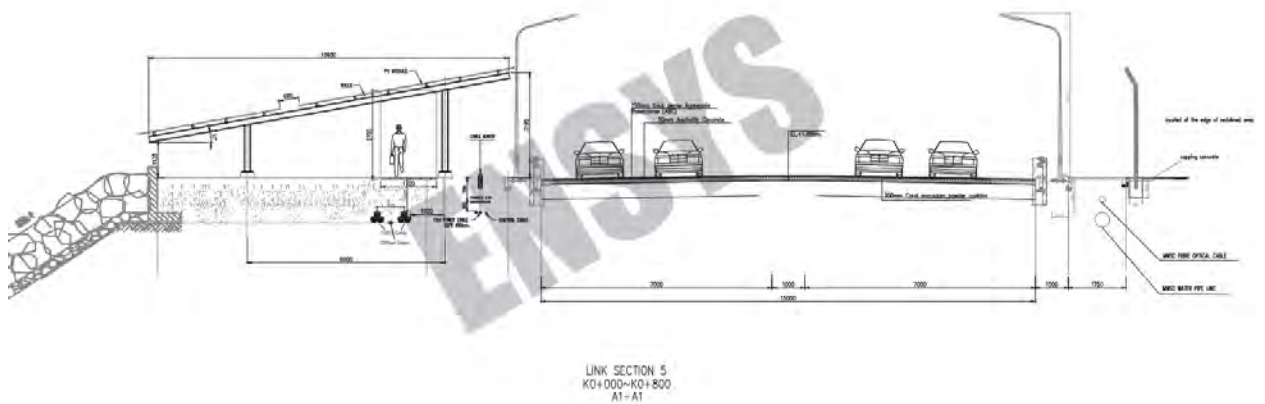


Figure 3.4: Link section 5

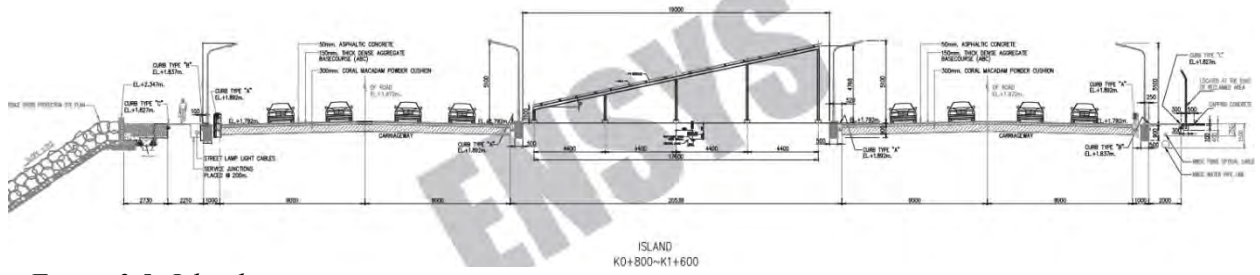


Figure 3.5: Island section

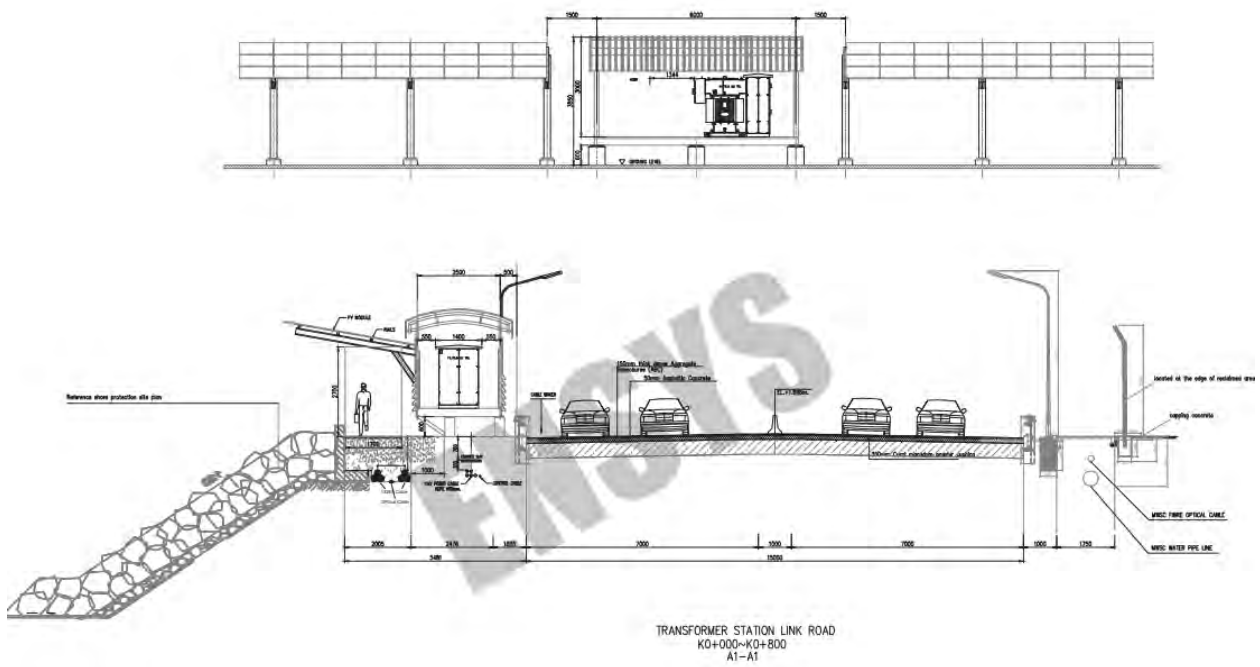


Figure 3.6: Transformer Station (link road)

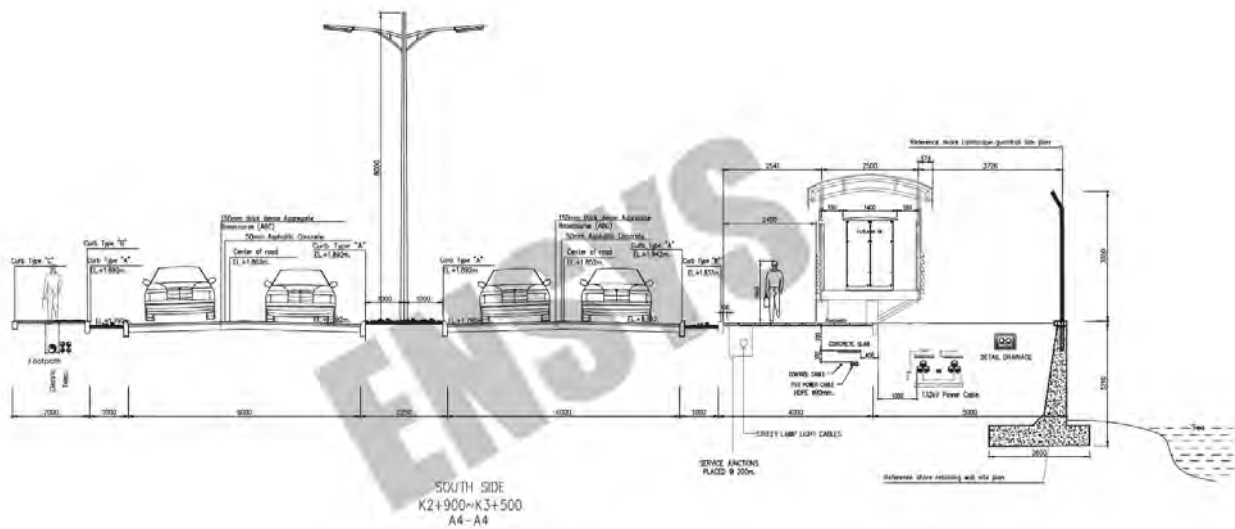


Figure 3.7: Transformer station (South side-Boashimaa Hingun)

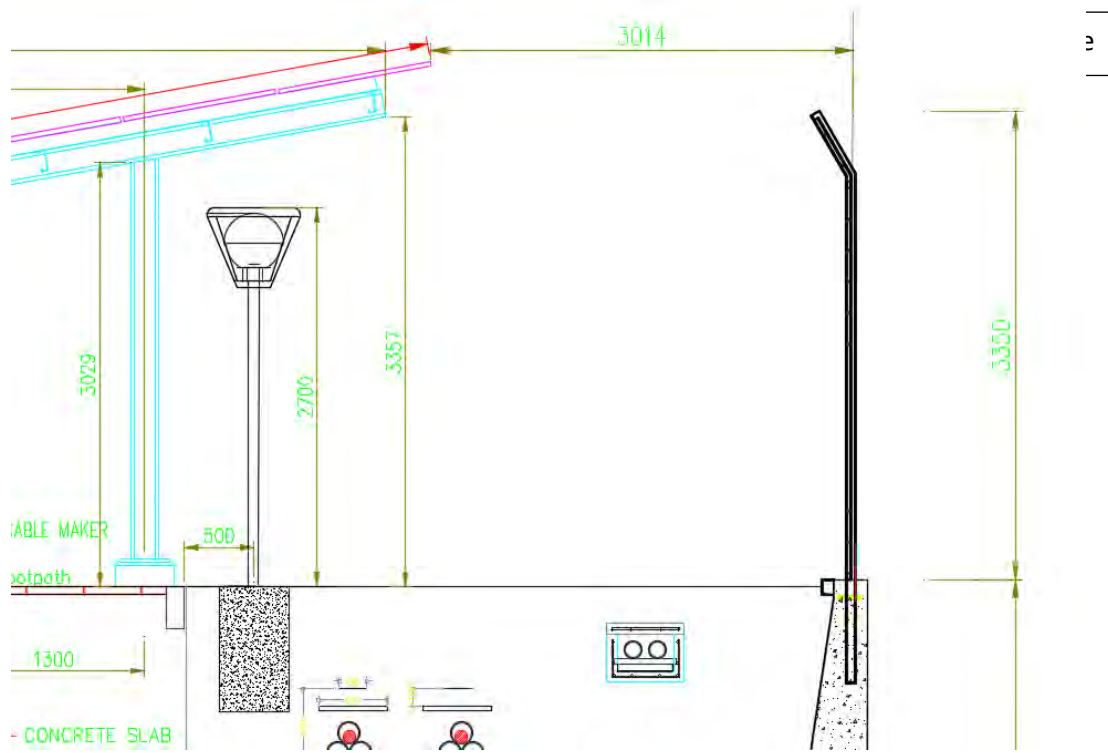


Figure 3.8: Distance between security fence and PV modules in Boashimaa Hingun

3.3 The Proponent

The project is awarded by the GoM on a long term contract of 15 years to ENSYS CO., LTD. ENSYS will design, build, finance, own and operate the system for a period of 15 years after which the operation will be transferred to GoM. On behalf of GoM, STELCO will take over the operation of the project since STELCO is the main electricity provider of the state.

Proponent: Ensys Co., Ltd

Address: 636/4-6 Soi Ramkhamhaeng 39 (Thepleela 1),

Pracha-Uthit Road, Wangthonglang, Bangkok, 10310, Thailand

3.4 Project location

The project is proposed for the greater Male' region in 2 separate locations. They are the pavement area of the link road between Male'-Hulhumale, southern side pavement area of Boashimaa Hinhun in Hulhumale and on roof top of 8 residential buildings in Hulhumale phase-1.

- Link Road: The area between the eastern side road edge and revetment. End coordinates of the complete sections are:
 - North: 4°11'56.95" N, 73°32'28.58" E.
 - South east: 4°10'41.84" N, 73°31'54.25" E.
 - Island section (North: 4°11'23.43" N, 73°32'17.36" E, South: 4°11'13.46" N, 73°32'13.38" E)
- Boashimaa Hingun: The area between the southern side road edge and airport security fence. However, once constructed, a gap 3.014m will be left between the fence and the edge of the PV structures. Link section end point coordinates are:
 - North west: 4°12'21.68" N, 73°32'10.14" E.
 - South east: 4°12'6.00" N, 73°32'22.58" E.
- Roof top of 8 residential building in Hulhumale phase-1, neighborhood 3.
- Temporary storage site in Hulhumale phase-1, neighborhood 3.



Figure 3.9: Project location overview

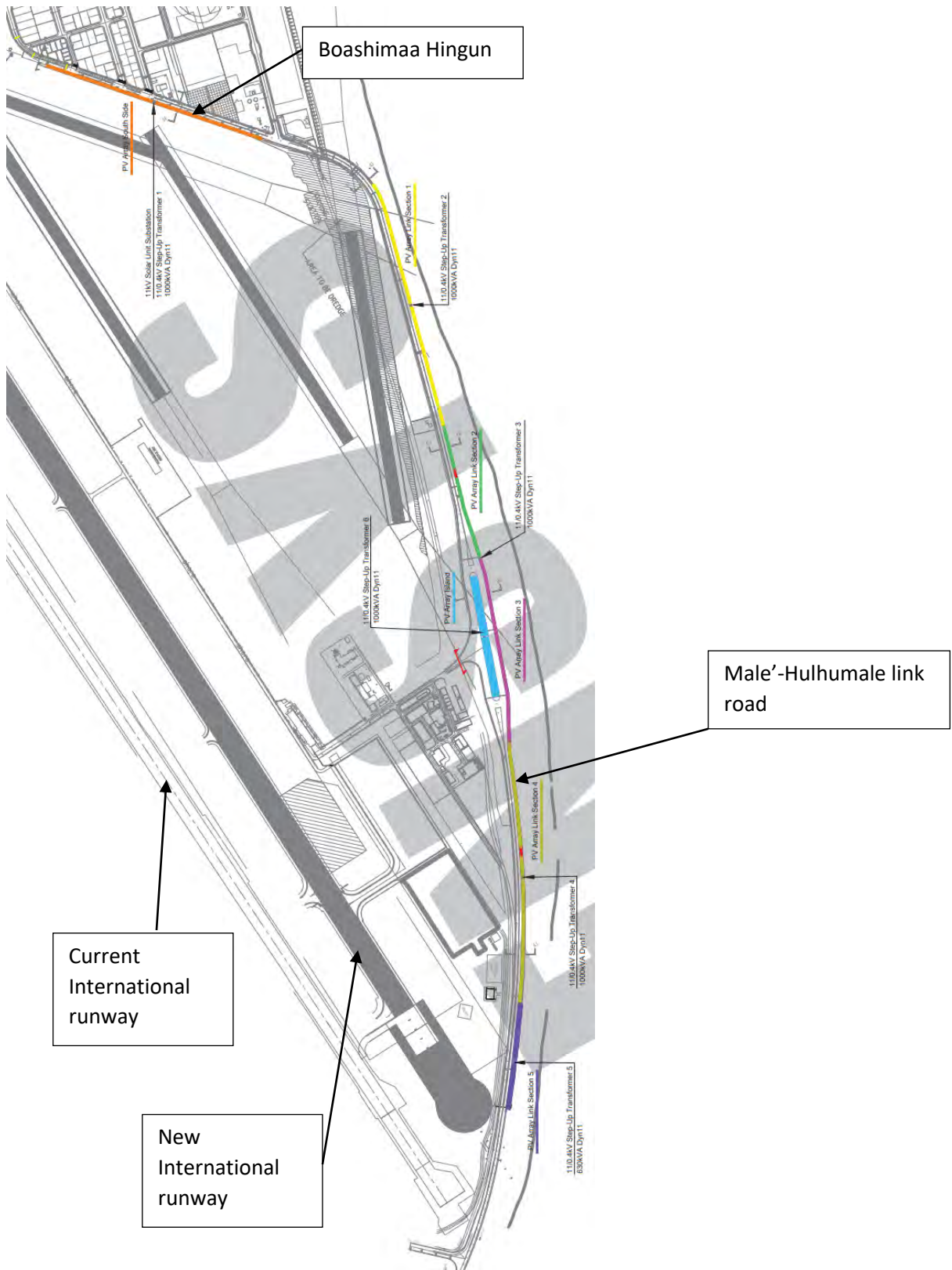


Figure 3.10: Main project site (road pavement area)



Figure 3.11: Google image view of Residential buildings selected for roof top installation and temporary site area

3.5 Study Area and Limitations

General study area for the proposed project is quite large, especially when the socio-economic impacts of the project are considered. Study area for the socio-economic impacts includes the greater Male' area. Field surveys for the project are carried out from the proposed project site and immediate surroundings. Social surveys for the project were carried out with the major key stakeholders of the project to identify any potential impact that might arise due to the proposed project.

3.5.1 Detail design, planning and methodology

Detail design works and planning phase of the project is still ongoing. Hence, the proposed methodology in the report for carrying out various components of the project, including type of machinery to be used and the road closing schedule might still change. However, considering the information available at the time of the report compilation, best possible work plan and methodology has been explained in the report. Since STELO is currently carrying out the cable work in the same area (Male'-Hulhumale connecting road), the exact and the best area to start the work has to be decided based on the work progress of STELO at the time of the project commencement. Hence, project plan and work methodology is expected to undergo minor adjustments.

3.5.1.1 Natural Hazard Vulnerability

Main project area is just few meters away from the coastline. Although the coastline along the project area has been protected by hard structures, the pavement area of the link road experiences the effect of topping and splashing waves at some points. Site specific data on natural hazard vulnerability is not available. Reference was made from reports that were generally made to account the whole country.

3.5.1.2 Limitation on surveys and assessments

The client is still unable to undertake the structural assessment of the 8 residential flats proposed for rooftop installation. Travel restrictions imposed due to covid 19 made it difficult for the client's team to undertake the test on time. However, it will be carried out before the installation begins over the buildings. Similarly, traffic surveys carried out may not represent the actual scenario under normal circumstances. Survey was carried out during a time where the

schools were undertaking online classes. Hence, number of vehicles which would have otherwise been on the road might not have been counted.

3.6 Project Components

The proposed project consists of number of components carried out under 4 different phases. The different phases of the project are designing and approval of drawings and initial assessment reports, manufacture and procurement of items, construction and installation of items and the final phase which is the operational phase of the project. First two phases are currently on going. This report will mainly discuss and describe the components under the last 2 phases.

Specific project components under construction and installation include;

- Site Surveying
- Mobilisation and Demobilisation
- Site preparation
- Piling and installation of transformers
- Excavation and cable work
- Installation of mounting structures (link road and Boashimaa Hinhun)
- PV module installation
- Finishing and landscaping
- Testing and Commissioning

3.6.1 Site surveys

Prior to the beginning of any physical or design work of the project, site surveys are undertaken to define the scope and boundary so that areas outside the project boundary stays safe and sound. Surveys ranging from topographic survey, a survey to identify underground cables and other existing structures in the area were carried out. Project design is carried out after assessing the available space for installation in the pavement area.

Methodology

Topographic survey to understand the topography of the area and other existing structures

were undertaken by using GNSS RTK positioning method. Locations of the underground cables are identified by referring to published secondary information sources provided by relevant authorities. Visual inspection together with general photography of the project area is carried out to understand the physical environment.

Justification

GNSS surveying is robust, fast and easier for surveying large areas. RTK drone mapping is an emerging technology used to survey huge areas. Since most of the relevant authorities were able to provide information on the underground cables in the area, that information was referred as reliable sources instead of undertaking a survey to identify the cables by using a cable detector.

3.6.2 Mobilisation and demobilisation of machinery and items

Site will be mobilised from the main site of the contractor in Hlhumale. Additionally, project machineries are also expected to be mobilised from a site in Hulhumale which is not fully decided yet. Number of different machineries are required at various stages of the project. Machineries will be mobilized to and demobilized from the site as needed. If a machine with a metal track is to be mobilised, it will be carried over a trailer. The list of machineries that will be used at various stage of the project are listed under the equipment list with specific details and pictures. Although they are not the exact machine to be used, a machine of similar capacity with almost the same characteristics will be used.

Mobilisation and demobilisation of machinery, various items and goods used in the project will require part of road closure in Male'-Hulhumale link road and Boashimaa Hinhun, at the point of mobilisation and demobilization. Hence, a table has been created to represent the days and the duration of road closure during various components of the project. It is estimated that the maximum width of the area to be closed will not be wider than the width of a single lane, keeping the other lane for vehicle movement. However, the length of the area to be closed can differ, starting from 20m to 50m.

Methodology

Movable machineries with wheels will be mobilized by driving. Immovable items will be

moved by loading into trucks or crane trucks. In case of normal trucks, items will be loaded to and unloaded from the truck either by using a crane or an excavator or a forklift. Depending on the item to be loaded and unloaded, most appropriate machine will be selected for loading and unloading. Machines with metal tracks will be carried over trailers. No such machine will be moved on the paved road.

At project completion, demobilisation will take place in a similar fashion where machineries will be taken back to the sites from where they are from or to another site of the contractor at the mobilisation stage. Step by step procedure to be followed during the mobilization and demobilization is provided below.

- The contractor/client plans and make the updated project schedule together with the machinery list, construction methodology and road closure schedule which will be sent to key stakeholders named in the report prior to the construction. It has to be noted that these documents have already been shared with these stakeholders as part of this report. However, any preceding change or update has to be shared before the beginning of the construction. Stakeholders are expected to respond back with any comments or suggestion upon the reception of these documents.
- Identify the exact machinery to be mobilied or demobilised depending on the specific work to be carried out in the site.
- Identify if there is any specific time allocated or recommended by any of the key stakeholders for mobilisation and demobilisation since the pavement area is a high security zone apart from being an area that experiences heavy traffic. It is highly recommended to avoid mobilisation and demobilization at peak traffic hours which is expected to be between 7:00AM to 9:00AM and 15:00 to 17:00.
- Inform the traffic police and obtain assistance in vehicle management during road closure, or follow a recommended procedure by the traffic police and carry out the mobilisation and demobilization as per the instructions. Even if no recommendation has been received, there must be traffic controllers or flagman at both ends of the closed area to guide vehicles.

- Road closing should be limited to the schedule provided by the contractor/client. Changes in duration and timings must be properly communicated.
- No machinery with metal track line moves directly on the paved road without a protective layer been spread over the road. As per the procedure of HDC, any machinery with metal track should be directly unloaded to the work site from the trailer without touching the ground, even with any sort of protection between the track line of the machine and the road. However, if for any reason it is not possible to do so, mobilisation and demobilization has to be carried out under the direct supervision of the Municipal Service Section of HDC.
- The railing on the side of the road will have to be removed for the machine to move into the site. Railing can be manually removed. It will only be removed to the required length.
- Handling instruction of items, especially fragile items must be followed in mobilising such items.

Justification

This method of mobilisation by using a trailer for equipment with metal track is the only viable option for the project. The other option could be to direct the machine to pavement area from Hulhumale side and move it along the line to the necessary points. But given the narrowness of the area, this is not a feasible option.

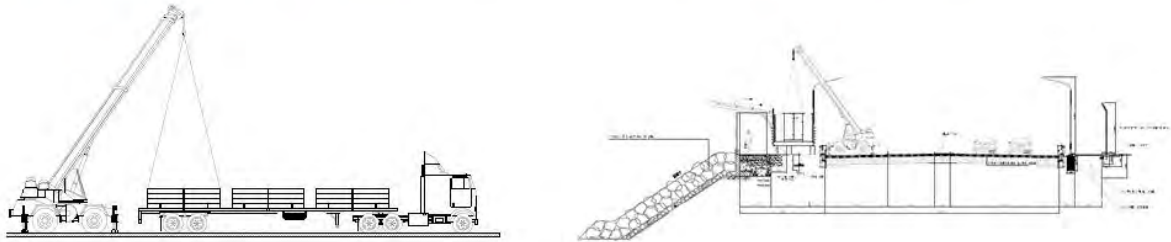
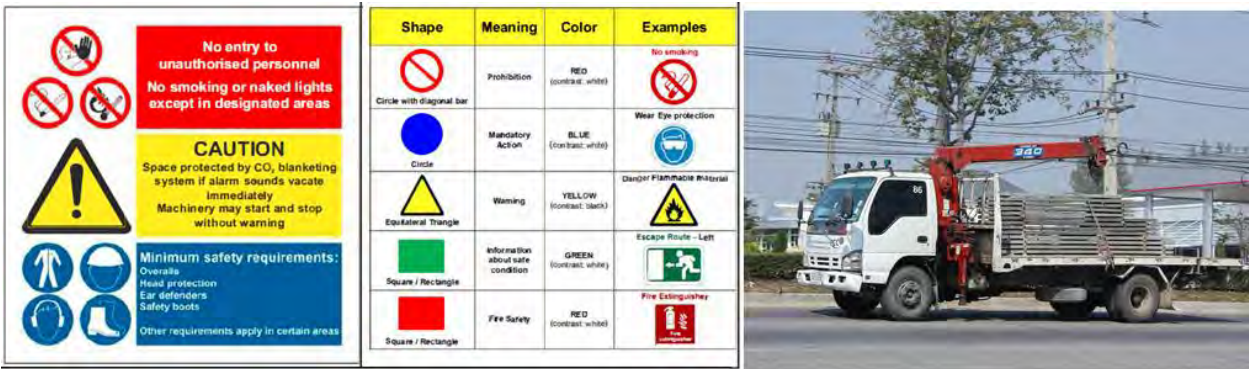


Figure 3.12: A typical site safety board and mobilisation method

3.7.1 Site preparation

Site preparation in link road and Midhilimagu includes the removal of the existing pavement area and leveling the area to begin civil works. The removed paving blocks will be piled in the project area at different locations as decided by the contractor. The new pavement will be paved by using the same blocks at the completion of the project. Additionally, safety sign boards will be erected along the project area.

Methodology

Existing pavement will be removed manually. However, a mini excavator might be required to lift and move the curb stones. Sign boards will be erected by using of GI pipes or any other suitable material that could long last for the duration of the project. The area will be levelled by using a mini excavator or a loader.

Justification

Removal of the pavement has to be carried out by manually. If machinery is to be used, it is very likely that the paving blocks will break. Hence, this is the only justifiable method of pavement removal.

3.7.2 Piling and Installation of Transformers

A total of 6 container type transfers and RMUs are proposed under the project. A transformer is installed in each link section in the pavement area. However, a single transformer is placed for link section 2 and 3. Each container is placed over a metal frame which is placed over 6-8 columns/piles that emerge from the ground. These columns/piles will either be made out of steel or RC. Since the design has not been completed at the time of this report, the exact type of the column to be used has not been finalised.

Methodology

- Identification of the exact location where the transformer is to be placed.
- The required materials and machinery will be mobilised to the site as per the mobilisation and demobilisation method.
- If it has been decided to use steel pile, they will be hammered by the vibration piling machine (refer the machinery list to see the details of piling machine).
- Once all the piles have been driven, they will be cut to the required height by using a metal cutting machine.
- The base of the pile will be strengthened by casting concrete as per the design. The required concrete will either be mixed in the site or premix concrete will be sourced from a secondary party.
- Once the foundation is set, a metal platform will be assembled in site and placed over the columns by using a crane. Afterwards, the workers will install the pre-cast concrete slab on the platform.
- The container type transformer and RMU equipment will be delivered to the designated location by a truck. It will be placed over the platform by using a crane.

Justification

Given the small size of the area, piling foundation seems to be the most suitable type of foundation for the project, rather than a raft or concrete footing type foundation. However,

design engineers will explore the best possible design for the project. Piling can safely be carried out by using a suitable piling machine such as the one proposed in the report.



Figure 3.13: A typical scenario of piling by vibration and installation of transformers

3.7.3 Excavation and cabling work

A 11kV cable will be laid along the link road and Boashimaa Hinhun pavement area to connect the system to the power grid of STELCO. The laid cable will be within a HDPE pipe, buried about 1m below the existing ground level. Rooftop installation in the building area is not expected to require underground cable burial.

Methodology

- Mark the cable route and manhole location on the ground with a suitable paint. This is the cable that will connect the PV system to STELCO’s power grid via the power house in Boashimaa Hinhun, Hulhumale. Since road crossing ducts have already been constructed in Boashimaa Hinhun during the road construction, no excavation across the road

(Boashimaa Hinhun) is required.

- Cable line will be excavated by a mini excavator to the depth of 1m at the width of the bucket.
- Manholes will be placed at the marked locations by using the excavator.
- HDPE pipe together with the cable will be placed along the trench.
- The area will be backfilled after placing a layer of warning tape of the pipe as a precautionary measure. The line will have markings on the surface to identify the locations.
- The cable connecting the adjacent PV modules will run below the mounting structures.

Justification

The explained method is the standard for laying cables in such similar projects carried out.



Figure 3.14: Cable connection and installation

3.7.4 Installation of mounting structures (link road and Boashimaa Hinhun)

The mounting structure is only required for the project area in link road and Boashimaa Hinhun. The entire mounting structure comprises of the foundations, array frames which provide the main mechanical support, and array super-structure onto which the PV modules are bolted. Array orientation and tilt angle shall be designed to meet the technical requirement to minimise the reflective glare from the structure. Array foundations may be screw piles, or concrete piles or any other design as necessary which will only be finalised after the complete design.

Methodology

- For screw pile foundations, a screw pile machine is needed. During the installation, the pile will be vertically held against the ground manually while the machine screws the pile into the ground. Normally it will take 3~5 minutes to install one piece of screw pile.
- For a concrete foundation, a 400x400x400mm pit will be excavated for each foundation, following which a steel column will be placed in each pit and concrete will be poured into the pit.
- If larger steel piles are proposed, they will be driven by using the same method as explained under the transformer setup.
- After the completion of foundation installation, front and rear columns will be erected and bolted. In case of screw pile foundation, the installation procedure is easy and quick. The column will be put into the screw pile, and it will be bolted by using electric drills.
- Afterwards, column bracing and purlin installation will be carried out which will connect the separate columns into one structure and a frame, ready for the placement and fixation of PV modules.

Justification

The method explained is a typical method which has been used and experienced in different areas of the world for fixation of similar structures.



Figure 3.15: Installation of mounting structures

3.7.5 Installation of PV modules

Upon the completion of the mounting structures in link road, PV modules will be taken to site for installation. Similarly, PV modules will be taken to the specific buildings for installation. Transfer of PV modules to site will be carried out as per the mobilisation and demobilisation procedure.

Methodology

- PV modules are fragile and number of specific safety instructions must be followed during handling, loading, transfer, unpacking and installation. All the handling instructions provided by the manufacturer must be followed.
- The unpacked PV Modules will be lifted to the mounting structure manually by a team of 3 workers. One worker will lift the PV module and deliver it to the other two workers who will stand on a ladder or hydraulic lifting platform. The 2 workers will

take over the PV module and move it to the installation position and install it.

- The connection of the module to the racking system will be done through the mounting holes, with clamps, or an embedded system on the frame. Modules can be attached using the mounting holes on the back of the module frame, by fixing the module to the support rails with bolts.
- Another method of module fixation is by using mounting clamps on the sides of the module.
- All module frames and mounting racks must be properly grounded in accordance with appropriate respective National Electrical Code.
- Proper grounding is achieved by bonding the module frame(s) and the complete metallic structural frame together, using a suitable grounding conductor. The grounding conductor or strap may be copper, copper alloy, or any other material acceptable for use as an electrical conductor per respective National Electrical Codes. The grounding conductor will be connected to earth using a suitable earth ground electrode.
- The grounding hardware comes in a package that includes the grounding screw, flat washer, star washer and wire. Electrical contact is achieved by penetrating the anodised coating of the aluminum frame, and tightening the mounting screw.

Justification

The method explained for installation of the PV modules over the mounting frame is the standard mounting method for such installations.

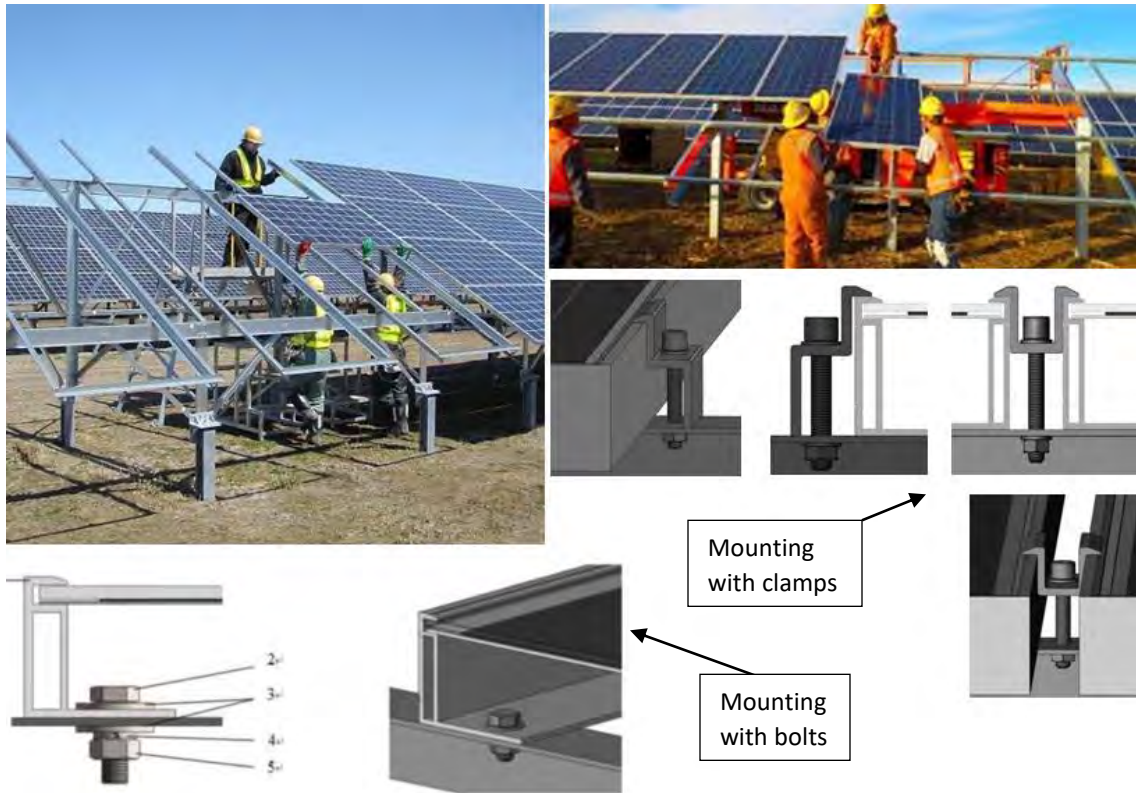


Figure 3.16: Installation of PV modules

3.7.5.1 Installation of PV modules on roof top

No considerable modification will be brought to the roof structure of the buildings to fix the PV modules. They will be fixed on the existing roof structure by using mounting clamps, bolts, racking etc. Site mobilisation will be carried out as explained under the mobilisation and demobilisation.

A schematic diagram on how the modules will be fixed is given below.

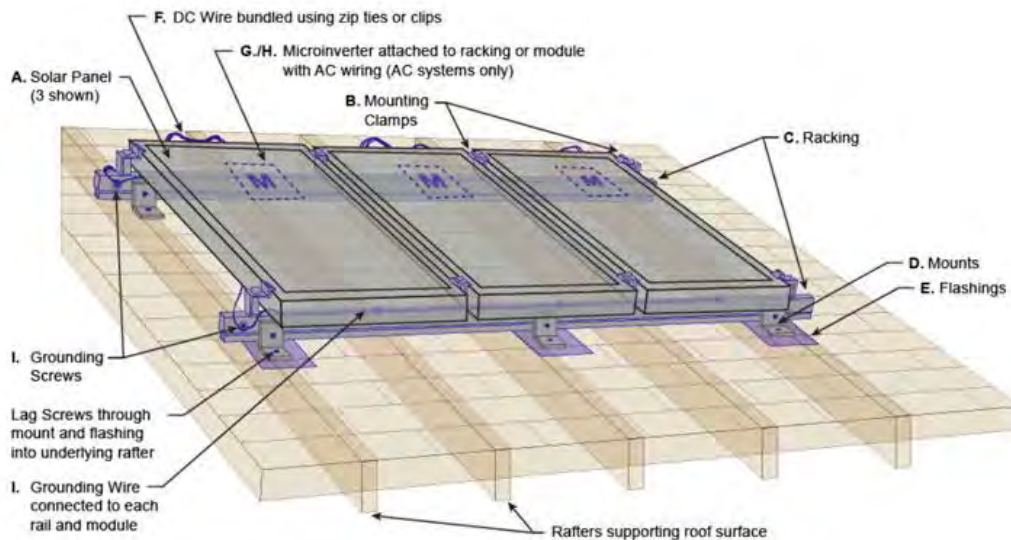


Figure 3.17: A schematic diagram to represent rooftop fixation (Courtesy: Solarpowerworldonline.com)

3.7.5.2 Safety recommendations

PV modules are fragile and number of specific safety instructions must be followed during handling, loading, transfer, unpacking and installation. All the handling instructions provided by the manufacturer must be followed.

Warning

Before installing, wiring, operation, or maintaining PV modules, all safety precautions must be read and understood. Direct current (DC) is generated when the battery surface of the module is exposed to direct sunlight or other light sources, and direct contact with the live parts of the module, such as terminals, may result in death of personnel whether connected to the module or not.

General Safety

- PV module installation is conducted by certified technicians or by people with experience in PV system installation. Operation by personnel who are not familiar with the relevant safety procedures will be risky to the PV modules and to the person.

- Do not allow unauthorised persons to access the installation area or module storage area.
- Do not install modules with damaged glass or damaged back sheet.
- Do not disassemble or move any part of the module.
- Do not artificially direct light on the module.
- Do not connect or disconnect the module when it is energised or connected with an external power supply.
- Installed modules should not be shaded by buildings, trees, chimney etc, at any time of the day.

Handling Safety

- Do not stand, walk on or lean the module directly.
- Do not damage or scratch the front or backside surfaces of the module.
- Do not scratch the output cable or bend it with force. The insulation of output cable can break and may result in electricity leakage or shock.
- Do not use water to extinguish fires of an electrical origin.
- Do not install or handle modules when they are wet or during periods of high wind. At the installation site, take care to keep modules and in particular their electrical contacts, clean and dry before installation. If connector cables are left in damp conditions, then the contacts may corrode. Any module with corroded contacts should not be used.
- Do not loosen or unscrew the PV module bolts. This may lead to a reduction of the module's load rating and potential damage from a fall.
- Do not touch the terminal box or the ends of the output cables (connectors) with bare hands under sunlight, regardless of whether the PV module is connected to or

disconnected from the system.

Safety measures during loading/transportation and storage

- The modules should be stored in the original package before installation. Protect the package from damage. Unpack the modules as per the recommended unpacking procedures. The whole process of unpacking, transport and storing should be handled with care.
- Do not stand, climb, walk or jump on unpacked pallets of modules.
- Before installation, ensure that all modules and electrical contacts are clean and dry.
- If the modules are required to be stored temporarily, they should be stored under dry and ventilated conditions.
- Unpacking must be carried out by two or more persons at the same time. It is forbidden to use the wires or junction boxes of the modules to carry the modules. Handling the modules requires two or more people with non-slip gloves.
- Do not handle the modules over-head or stack the modules.
- Do not allow the modules to come in contact with sharp-pointed objectives to prevent them from scratches, avoiding a direct impact on the safety of modules.
- Unloaded PV modules must be placed over a level surface.
- Only one layer of stacking is allowed for small truck. Hence, this is the recommended way of stacking for the project. Make sure that the package is fixed with packing straps securely to the shipping platform without movement.
- Do not stack more than two layers during storage in the warehouse.
- Do not expose the modules to rain or moisture. Store the finished product in a well ventilated, waterproof and dry place.
- Do not remove the original packaging if the module requires long-distance transport

or long-term storage.

- Normal warehouse storage condition;
 - Moisture <85%
 - temperature range from -20°C to + 50 °C
- During unpacking in outdoors, it is not allowed to operate in rainy conditions.
- It is not recommended to transport the modules in windy conditions. The unpacked modules must be tied down to avoid any unwanted movement during transportation.
- Wear protective gloves during unpacking to avoid hand injury and fingerprints on the glass surface.
- Each module shall be handled by two persons. It is not allowed to use the wires or junction boxes of the modules to carry the module. Do not take the module out of the carton by pulling on the long side frame.




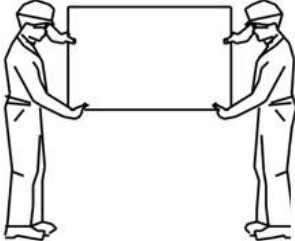

Safety measures during installation





- Always wear dry insulation protection equipment such as insulated tools, head gear, insulated gloves, safety belt and safety shoes (with rubber soles).
- Do not wear metallic jewelry which can cause electric shock during installation. Do not install modules under rain, snow or windy conditions.
- Keep the connector dry and clean during installation to avoid the risk of electric shock. It is recommended to install it immediately after unpacking.
- Do not perform any work if the terminals of the PV modules are wet. Please install immediately after unpacking.
- Keep the PV module packed in the carton until installation.
- Use an opaque material to completely cover the PV module surface during PV

module installation and wiring.

- Do not unplug the connector if the system circuit is connected to a load.
- Do not stand on the module glass while installing. There is a risk of injury or electric shock if glass is broken.
- Do not work alone (always work as a team of 2 or more people).
- Do not damage the back sheet of PV modules when fastening the PV modules to a support with bolts.
- The cable length of junction box shall be selected according to the installation mode. When wiring, the ties for fixing the cables coils shall be removed. The cable shall be fixed on the installation system (frame or bracket, guide rail) with UV resistant cable ties or wire cards to avoid direct sunlight or immersion in water and mechanical damage of the cable. Otherwise it may cause accelerated aging of the cable or even leakage and fire. Bifacial PV modules should also avoid blocking the solar cells on the back of the module. Open area should minimise arc coil, which can reduce the risk of induced lightning impact on PV module.
- Modules with different color codes are not recommended to be installed in one block or the same rooftop.

Markets on outer packaging

<p>Do NOT step on the package and module</p>  A circular icon with a thick black border. Inside the circle, there is a stylized black silhouette of a person stepping on a rectangular object, which represents a package or module.	<p>The carton can be recycled</p>  The universal recycling symbol, consisting of three chasing arrows forming a triangle.
<p>Modules shall be stacked as required, not exceeding the maximum number of layers printed on the outer packaging. (n = 2 means no more than two layers and n = 3 means no more than three layers)</p>  An icon showing a stack of three rectangular modules. The top module is crossed out with a large 'X'. Below the stack, there is a small square containing the letter 'n'.	<p>One module shall be handled by at least two persons together</p>  An illustration of two workers wearing hard hats and safety gear. They are standing on either side of a large rectangular module, each with one hand on the top edge, demonstrating how to lift or move it together.
<p>When the carton box is loading and unloading in the transportation. Attention: Prevent collision on the top.</p>  A rectangular warning sign with a black border. It features a triangle with an exclamation mark on the left, the word 'Attention' and an upward-pointing arrow on the right, the Chinese characters '注意' in the center, and the text 'Prevent collision on the top' and '防止顶部碰撞' at the bottom.	

<p>Do NOT discard the modules at will; special recycling is required</p> 	<p>Modules must be kept dry, not expose to rain or moisture</p> 
<p>Modules in carton are fragile, which must be handled with care</p> 	<p>The packaging must be transported upright</p> 

3.7.6 Finishing and landscaping

Once the major construction work is finished, finishing and final landscaping work will be carried out. Finishing and landscaping includes ground leveling, placement of the pavement under the PV modules and repair work of any damage that has occurred to the immediate project area during the construction work. Any damage that has occurred to the paved road, side quay-wall or building must be repaired by the client at the completion of the construction period of project.

Methodology

- Carry out a visual inspection of the immediate project area including the link road, Boashimaa Hinhun and the 8 residential buildings together with HDC and PMU of the Ministry to identify any damage that has been occurred during the project to immediate surroundings of the project area.
- Since the link road and Boashimaa Hinhun area will be covered by the PV modules, final level work will be manually carried out by using shovel and spade.
- Pavement line will be marked following which blocks will be arranged. Paving blocks will be manually arranged on a compacted surface. Placement of curb stones might

require the assistance of machinery in which case it has to be pre planned and completed before the area is fully covered by PV modules.

- Fixtures such as electric lights will be fixed below the PV modules to light up the pavement area during the night time.
- The system will be connected to the power grid of STELCO by connecting it to the STELCO's powerhouse in Boashimaa Hinhun, Hulhumale. In residential buildings, it will be connected to the electric panel boards of each building.

3.7.7 Testing and Commissioning

At the completion of the construction work, final testing and commissioning will be carried out in coordination with the relevant government institutions such as STELCO. System synchronisation and all required testing will be carried out.

3.8 Project Justification

3.8.1 The Project

In the past, Maldives entirely depends on imported fossil fuel in meeting the country's energy. However, in recent years, GoM has taken solid steps forward in developing and investing on projects for the generation of renewable energy. In an interview with BloombergNEF, Dr. Hussain Rasheed Hassan-Former Minister of Environment has been recorded to have said that, *"The nation spends almost 10% of its GDP importing fossil fuels to generate power and to provide mobility. The cost of power from the most efficient diesel plant is 23 U.S. cents per unit. Power from a solar plant is available at less than half of that. That is the reason why we have renewable energy as a top priority,"* (Gombar, 2020).

As per the National Environmental Action Plan III (NEAP III), which sets out the agenda for environmental protection and management in the Maldives, one of the main targets aimed to achieve was working towards a carbon neutral nation. NEAP III aims to make a livable and a sustainable environment a component of development projects carried out in Maldives. NEAP III provides the basis for environmental planning, budgeting, performance measurement, and accountability. In NEAPA III, it has been aimed to decrease the dependency on diesel powered

electricity generation in Maldives with the provision of renewable energy throughout the country. Similarly, the importance and composition of the much-needed legal framework to assist the development of the sector of renewable energy is highlighted in NEAP AIII. The proposed project would function as a key project in assisting to move towards a carbon neutral nation.

Furthermore, ensuring access to affordable, reliable, sustainable and modern energy for all is one of the 17 Sustainable Development Goals (SDGs), also known as the Global Goals, which were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. One of the key target of this goal is to invest in solar, wind and thermal power, improving energy productivity, and ensuring energy for all.

3.8.1.1 Project Location

The project is proposed in greater Male' regions. Greater Male' region is a densely populated area with limited land space available for any use, let alone for utility or commercial usage. Similarly, availability of a shallow lagoon area around Male' is also limited. Considering the land scarcity, the project is proposed on the pavement area of the link road between Male'-Hulhumale, southern side pavement area of Boashimaa Hinhun in Hulhumale and on roof top of 8 residential buildings in Hulhumale phase-1.

Erection of solar panels on the pavement area of the link road and Boashimaa Hinhun will provide shade for pedestrians once the area is open to the public. HDC plans to open the pavement area of the link road for public use after the completion of the project.

In order to select and finalise the buildings selected for installation of PV modules on roof tops, HDC sent a letter to the residents of each buildings to see if any of the residents of the selected buildings are against it. Those 8 buildings are finalized for roof to installation since none of the resident of these building objected it.

3.8.2 Justification of the project concept/design

Since Maldives is located over the equator, receiving abundant solar energy throughout the year, energy generation from solar power has been experienced to be the most effective

renewable energy generation technique so far. The emerge number of sunny days experienced in Maldives per annum is 28-300 (Azwar, 2010). Maldives receives about 400 Mullion MW of solar energy per annum with the daily average global irradiation of 4.5-6 kWh/m²/day (Azwar, 2010).

3.9 Project Management

Project will be managed by the project director/manager working in the head office. Under the project manager, site manager/engineer and foremen will work at project management and supervisory level. Site manager/supervisor will run the day to day activities of the site as per the schedule. A health and safety officer will ensure that day to day construction activities meet the requirements highlighted in the ESMP. A project schedule will be created with targets which will be used to monitor the project as it progresses. Additionally, a site staff from the PMU of MoECC&T will be stationed at site to supervise site activities.

3.9.1 Traffic Management schedule

During the construction period, especially during project mobilisation, loading and unloading, part of the road in link road and Boashimaa Hinhun will have to be closed. Road closure and traffic management will be carried out in coordination with Maldives traffic police. It has to be noted that road closure is referred in the report to refer to the close of a maximum of a single traffic lane from link road or Boashimaa Hinhun, not the complete road.

The preliminary road closing schedule is given below which will be adjusted as required with prior notification to the key stakeholders. Note that month-1 is the table is referred to the first month where the construction stage begins. Hence, it will align with the month-8 in the main schedule.

Table 3-2: Traffic management schedule

	06:00 – 07:00 hrs.	17:00 – 18:00 hrs.	Remarks
Month1/ Day 1	Machine no: 2,3 &4 Activity: Unloading materials at site Construction content: Land preparation		The truck mounted cranes start to unload materials for land preparation work. The materials for link sections will be unloaded at Link

	<p>Duration: 120min</p> <p>Site Area: PV Array Link Section 1 (60 min) PV Array Island (30 min) PV Array South Side (30 mins)</p>		<p>section 1, and evacuators and forklifts will be left at site until work completion.</p>
Month1/Day8	<p>Machine No: 4</p> <p>Activity: Unloading materials at site</p> <p>Construction content: Land preparation</p> <p>Duration: 120 min</p> <p>Site area: PV Area Link Section1 (60min) PV Array Island (30 min) PV Array South Side (30 min)</p>		<p>Unloading materials for supplement every other week.</p>
Month1/Day 15	<p>Machine No: 4</p> <p>Activity: Unloading materials at site</p> <p>Construction content: Land preparation</p> <p>Duration: 120 min</p> <p>Site Area: PV Array Link Section 1 (60 min) PV Array Island (30min) PV Array South Side (30min)</p>		<p>Unloading materials for supplement every other week</p>
Month1/Day21	<p>Machine No: 6,4, & or 5</p> <p>Activity: Unloading Material at site</p>		<p>The truck- mounted cranes &/or Trailer starts to unload materials for piling and concrete foundation</p>

	<p>Construction content: Piling & Concrete, foundation work, cable trench, excavation</p> <p>Duration: 120 min</p> <p>Site Area: PV Array Link Section1 (60min) PV Array Island (30min) PV Array South Side (30min)</p>		<p>work. The materials for link sections will be unloaded at Link Section1. The vibration piling machine will be left at site until the work is finished.</p>
Month1/Day 28	<p>Machine No: 4 &/or 5</p> <p>Activity: Unloading materials at site</p> <p>Construction content: Piling & Concrete, foundation work, cable trench, excavation</p> <p>Duration: 120 min</p> <p>Site Area: PV Array Link Section1 (60min) PV Array Island (30min) PV Array South Side (30min)</p>		<p>Unloading materials for supplement every other week</p>
Month2/Day5	<p>Machine No: 4&/or 5</p> <p>Activity: Unloading materials at site</p> <p>Construction content: Piling & Concrete, foundation work, cable trench, excavation, mounting structure installation.</p> <p>Duration: 120 min</p> <p>Site area: PV Array Link Section1 (60min) PV Array Island (30 min) PV Array South Side (30min)</p>		<p>The truck – mounted cranes &/or Trailer starts to unload materials for transformer yard & RMU housing work. The materials for link sections will be unloaded at Link section 1</p>
Month2/ Day 12	<p>Machine No: 4 &/or5</p> <p>Activity: Unloading materials</p>		<p>Unloading materials for supplement every other week</p>

	<p>at site</p> <p>Construction Content: Piling & Concrete foundation work, cable trench excavation, Mounting structure installation, PV Module installation.</p> <p>Duration: 120 min</p> <p>Site Area: PV Array Link Section1 (60min) PV Array Island (30 min) PV Array South Side (30min)</p>		
Month2/Day 19	<p>Machine No: 4 &/or 5</p> <p>Activity: Unloading materials at site</p> <p>Construction content: Piling & Concrete foundation work, cable trench, excavation, mounting structure installation, PV Module installation.</p> <p>Duration: 120 min</p> <p>Site Area: PV Array Link Section 1 (60min) PV Array Island (30min) PV Array South Side (30 min)</p>		The trailer starts to unload materials for PV module installation work. The materials for link sections will be unloaded at Link section 1
Month2/ Day 26	<p>Machine No: 4 &/or 5</p> <p>Activity: Unloading materials at site</p> <p>Construction content: Transformer yard & RMU housing, Piling & Concrete foundation work, cable trench excavation, mounting structure installation, PV Module installation.</p> <p>Duration: 120 min</p> <p>Site Area: PV Array Link Section 1 (60min) PV Array Island (30 min)</p>		The truck mounted cranes &/or trailer starts to unload materials for transformer yard & RMU housing work. The materials for link sections will be unloaded at Link section1

	PV Array South Side (30min)		
Month3/Day3	<p>Machine No: 4 &/or 5</p> <p>Activity: Unloading materials at site</p> <p>Construction content: Transformer yard & RMU housing, Piling & Concrete foundation work, Cable trench excavation, Mounting structure installation, PV Module installation.</p> <p>Duration: 120 min</p> <p>Site Area: PV Array Link Section 1(60min) PV Array Island (30 min) PV Array South Side (30 min)</p>		Unloading materials for supplement every other week
Month3/ Day 10	<p>Machine No.: 4 &/or 5</p> <p>Activity: Unloading materials at site</p> <p>Construction Content: Transformer yard & RMU housing, Piling & Concrete foundation work, Cable trench excavation, Mounting structure installation, PV Module Installation, String Inverter Installation.</p> <p>Duration: 120min</p> <p>Site area: PV Array Link Section 1 (60min) PV Array Island (30min) PV Array South Side (30min)</p>		The Trailer starts to unload materials for string inverter installation work. The materials for link sections will be unloaded at Link section 1.
Month3/Day17	<p>Machine No.: 4 &/or 5</p> <p>Activity: Unloading materials at site</p> <p>Construction Content: Transformer yard & RMU housing, Piling & Concrete foundation work, Cabling work, Mounting structure installation, PV Module Installation.</p> <p>Duration: 120min</p> <p>Site area: PV Array Link Section 1</p>		The truck-mounted cranes &/or Trailer starts to unload materials for cable installation work. The materials for link sections will be unloaded at Link section 1.

	(60min) PV Array Island (30min) PV Array South Side (30min)		
Month3/Day24	Machine No.: 4 &/or 5 Activity: Unloading materials at site Construction Content: Piling & Concrete foundation work, Cabling work, Mounting structure installation, PV Module Installation. Duration: 120min Site area: PV Array Link Section 1 (60min) PV Array Island (30min) PV Array South Side (30min)		Unloading materials for supplement every other week.
Month4/Day1	Machine No.: 4 &/or 5 Activity: Unloading materials at site Construction Content: Piling & Concrete foundation work, Cabling work, Mounting structure installation, PV Module Installation. Duration: 120min Site area: PV Array Link Section 1 (60min) PV Array Island (30min) PV Array South Side (30min)		Unloading materials for supplement every other week.
Month4/Day8	Machine No.: 4 &/or 5 Activity: Unloading materials at site Construction Content: Piling & Concrete foundation work, Cabling work, Mounting structure installation, PV Module Installation. Duration: 120min Site area: PV Array Link Section 1 (60min) PV Array Island (30min) PV Array South Side (30min)		Unloading materials for supplement every other week.
Month4/Day15	Machine No.: 1, 4 &/or 5 Activity: Unloading materials at site Construction Content: Container Type Transformer Installation, Cabling work, Mounting structure installation, PV Module Installation. Duration: 120min		The crane and trailer will be used for container type transformer installation work.

	<p>Site area: PV Array Link Section 1 (60min) PV Array Island (60min)</p>		
Month4/Day16	<p>Machine No.: 1, 4 &/or 5 Activity: Unloading materials at site Construction Content: Container Type Transformer Installation, Cabling work, Mounting structure installation, PV Module Installation. Duration: 120min Site area: PV Array Link Section 2 (60min) PV Array Link Section 3 (60min)</p>		<p>The crane and trailer will be used for container type transformer installation work.</p>
Month4/Day17	<p>Machine No.: 1, 4 &/or 5 Activity: Unloading materials at site Construction Content: Container Type Transformer Installation, Cabling work, Mounting structure installation, PV Module Installation. Duration: 120min Site area: PV Array Link Section 4 (60min) PV Array Island (60min)</p>		<p>The crane and trailer will be used for container type transformer installation work.</p>
Month4/Day24	<p>Machine No.: 4 &/or 5 Activity: Unloading materials at site Construction Content: Cabling work, Mounting structure installation, PV Module Installation. Duration: 120min Site area: PV Array Link Section 1 (60min) PV Array Island (30min) PV Array South Side (30min)</p>		<p>Unloading materials for supplement every other week.</p>
Month4/Day30		<p>Machine No.: 1, 2 ,3, 4, 5, 6 Activity: Loading materials at site and leave Construction Content: Duration: 120min Site area: PV Array Link Section 1 (60min) PV Array Island (30min)</p>	<p>Finish the site installation work</p>

		PV Array South Side (30min)	
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3.9.2 Project Schedule

The whole project is expected to take about 14 months for completion, including the survey, design, procurement and construction period. However, due to the covid pandemic, it has been delayed. The construction period together with commissioning and testing will take 7 months. On average, construction work at each link section will take a month. Complete project schedule is included under the appendix.

3.9.3 Project Manpower

About 25-40 workers will be involved in the project at various phases of construction. They will mostly include foreign workers. They will actively involve in the project at different stages.

Table 3-3: Project manpower

No.	Description	Quantity
1	Project Manager	1
2	Project Engineer	1
3	Site Manager	1
4	Health and Safety Officer	1
5	Warehouse/ Storage Officer	1
6	Electrical Engineer	1
7	Electrical Supervisor	1
8	Civil Engineer	1
9	Civil Supervisor	1
10	Foreman	5
11	Technician	8
12	Skilled Worker	15
13	Unskilled Worker	8
14	Site staff by PMU of MoECC&T	1
Total		46



3.9.4 Major project machineries

Number of heavy machineries are used at various stages of the project. The picture of the

machinery shown in the list is not the exact machinery to be used. However, a machine of similar capacity and functionality will be used depending on the availability at the time of construction.

Table 3-4: Machinery list

Item	Type of Machinery	Figure	Description
1	CRANE 25 TON		<p>Maximum lifting capacity: 25 ton</p> <p>Dimension: 11.565 ×2.62×3.475m (L×W×H)</p> <p>Gross weight: approx. 26,495 kg</p> <p>Maximum travelling speed: 49km/h</p>
2	EXCAVATOR		<p>Operating weight: 22,500 kg</p> <p>Dimension: 9.53×2.78×2.96m (L×W×H)</p> <p>Maximum digging depth: 6.62m</p> <p>Bucket capacity: 1.14m³</p>
3	FORKLIFT 5 TON		<p>Load Capacity: 5 ton</p> <p>Maximum output (kW/r.p.m): 90/2200</p> <p>Load Center: 600 mm</p> <p>Maximum Height: Approx. 6m</p>
4	TRUCK MOUNTED CRANES (5 TONS)		<p>Maximum lifting: 8,200kg at 1.8m</p> <p>Maximum Hook Height: Approx. 11.5m</p> <p>Maximum Load radius: 9.25m</p>

5	Trailer		Weight: 7,200 kg Payload Capacity: 32,800 kg Dimension: 13.62×2.48×2.94m (L×W×H)
6	Vibration Machine Piling		Weight: 2800 kg Pressure: 280 Bar Frequency: 2800 Rpm Suitable Excavator: 20-24 Ton Dimension: 10.5×5.4×12.5m (L×W×H)

3.9.5 Waste management

Waste management during construction and operation of the project will be undertaken via Waste Management Corporation Limited (WAMCO). WAMCO is mandated to provide a sustainable waste management solution throughout the country.

There are three major types of waste that will result from the construction phase of the project. They are general domestic waste, construction waste and hazardous waste. Hazardous waste include oil, grease and any damaged PV module. Waste bins will be placed within the construction areas which will be removed and replaced as needed. Hazardous waste such as grease, oil and broken any PV modules will be stockpiled in the project area in solid containers which will finally be taken to Thilafushi by WAMCO. During the construction phase, it is a responsibility of the contractor to ensure the removal of waste and clear the site. No waste generated during construction should be left in site.

Operational phase of the project is not expected to generate much waste. However, during

maintenance work which will be rare, some amount of waste such as damaged PV modules or any sort of work related waste can be generated. Similar to the construction stage, any such waste will be removed via WAMCO.

3.9.6 Health and Safety

Workers should be provided with safety shoes, helmets, overalls and other work specific safety gears to be worn during the working hours within the work site. No worker should be allowed to work without proper safety attire. Workers should be made aware of safety policies, emergency plans or evacuation policies in times of emergency. Fire extinguishers and first aid kits should be readily available within a known place in the work site for health and welfare purpose. First aid kits should be readily available in the site at all times. Proper construction signage should be erected within the site. Fire extinguishers must be kept at identified places in the site and workers should be trained to use them if required.

Construction site should be fenced and only authorized people should be allowed in. Proper construction sign boards should be erected around at the site entry and around the site. All works and activities should be carried out under the supervision of a skilled or an experienced worker. Oxygen, acetylene or LPG bottles will not be left free standing. All welding and cutting works will be carried out with all safety measures by experienced personnel.

3.9.7 Site accommodation and food

Workers will be accommodated in accommodation units rented from Hulhumale. Food will be sourced from nearby cafeterias and restaurants. Number of cafeterias and restaurants are available in Hulhumale.

3.9.8 Fuel storage and handling

Fuel storage is not required in this project. Refueling of project vehicles will be carried out by oil bowser brought as required from a supplier. However, refueling is recommended to be carried out over a hard surface and during refueling, it is recommended to have absorbent mats to wipe out any leakage.

3.9.9 Machinery maintenance

No major machinery maintenance will be carried out in the project site during the course of the project. However, if for any reason such a maintenance is required, it will be carried out in the main workshop of the party to whom the machine belongs to. Key machineries will be hired from a secondary party for the project.

3.9.10 Machinery movement

Movement of heavy machinery has to be restricted to the timings given in the in the traffic management schedule. If for any reason, machinery movement is to be carried out in different timings and for a longer period of time with road closure, it has to be communicated with the relevant key stakeholders such as traffic police, HDC and Ministry of Transport.

3.9.11 Noise and vibration

Anticipated noise level of machinery operation will not be high unless it is in very close range. Average noise level during the operation of machines will be between 65-70dbA which will mostly be heard within the immediate project area. Generally, noise readings over 65dbA is considered as nuisance.

It has been suggested under the methodology that vibration piling might be carried out for substation foundation. Vibration piling is estimated to cause vibration to the ground during piling. It is anticipated that the existing vibration in the project area without piling can be considered negligible or within 0.5-1.0mm/sec as the area experiences vehicle movement (Paulus, 2008). According to the report on, “Noise and Vibration related to the installation of sheet piles”, published by Paulus, Sokolowski and Sarator engineering in 2008, maximum vibration monitored during the pile driving demonstrations ranged from 0.75 to 12.75 mm/sec at 4.6m from the drive location, from 0.5 to 5.5 mm/sec at 27.4m, from 0.5 to 4.25 mm/sec at 54.9m, and from 0.5 to 0.75 mm/sec at 119.2m (Paulus, 2008). These are the maximum observed vibrations in compact soil. Hence, undertaking vibration piling is expected to generate low to medium range vibration in the area which might affect the surface of the paved road.

3.9.12 Potential accidents and emergency response plan

Strict adherence to the set policies and safety measures will leave less room for accidents in work place. However, in case of accidents, depending on the severity and seriousness, site evacuation or halting a specific task temporarily or immediate medical attention might be needed. Site staff should be made aware of such emergency plans and policies prior to the commencement of the physical work in the site.

3.9.12.1 Accidental fire incidents

- Inform the health and safety officer.
- If the severity is low and fire can be extinguished by the fire extinguishers in the site, the incident should be attended at site level under the direct supervision of health and safety officer.
- Flammable items in the close vicinity should be moved further away along the project area.
- If the fire is heavy and extensive, or takes longer to be extinguished, Fire and Rescue Service of MNDF must be notified via the emergency number-118. Similarly, Traffic Police, HDC and PMU of MoECC&T must be informed.
- Site staff must be moved to a previously identified emergency assembly point.

3.9.12.2 Road accidents

- Inform the health and safety officer.
- Any road accident, whether minor or serious, if resulted due to any of the project activities, must be informed to traffic police.
- If medical assistance is required, assistances will be provided by the site to transfer the victim to the nearest hospital. From thereon, the victim's relatives and/or family members must be informed.
- If required by the victim, the incident has to be lodged as a grievance under the GRM. Afterwards it will be dealt with the set procedure under GRM mechanism.

3.9.12.3 Accidents in the work area

- Inform the health and safety officer.
- Minor accidents that can be handled by the health and safety officer, by using available items in the site must be attended and solved at site level.
- Under any serious incidents that require medical assistance, it must be immediately provided, whether by means of first aid or by hospital treatment.
- If the victim requires, any site incident must be lodged as a grievance.

3.9.12.4 Accidental oil leakage

- In case of oil leakage or spill from the machineries, work has to be completed stopped and the issue must be rectified. If the issue cannot be immediately rectified, it should be brought to the attention of relevant authorities such as EPA and Ministry of Fisheries, Marine Resources and Agriculture

3.9.13 Risks associated with the project

There are very few and limited risk factors associated with this project that could possibly have both financial, environmental and fatal implications given that the mentioned safety attires are worn by the workers and safety measures are properly taken in handling machineries and hazardous items.

3.9.14 Maintaining the environmental and social aspects of the project

Environmental and social aspects of the project will be managed by a fulltime health and safety officer who will be managing and enforcing the environmental, social, health and safety requirements of the project. Safety officer must be someone who has past experience in similar projects and working environments.

The following key steps must be followed by the health and safety officer to ensure the management of environmental and social aspects of the project.

- Staff should be made aware of response procedures in case of emergency. Emergency evacuation plan must be made and kept on display for everyone to get familiar with.

- Evacuation drills should be conducted at project inception, at least once or twice during the course of the project to ensure that everyone can follow the plan in case of actual emergencies. Staff must be made aware of safety information such as emergency evacuation plan, emergency assembly point, locations of first aid kit, locations of fire extinguishers etc.
- Toolbox meetings must be held in site in every other day to ensure site safety.
- Health and safety officer must prepare emergency site evacuation plan prior to the beginning of the construction work, after assessing the project area (link road, Boashimaa Hinhun and residential buildings). There existing ample space around the project site to allocate emergency assembly points in case of emergency.

3.10 Project Inputs and Outputs

3.10.1 Project Inputs

The project has inputs in terms of machineries, human and natural resources which are summarized in the below given table.

Table 3-5: Main inputs of the proposed project

Input Resources	Source/Type	How to obtain the resources
Site workers (around 44)	Local and Foreign	Contractor's manpower which include mostly foreigners
Water supply (during construction)	Desalinated water	From MWSC (with prior arrangement)
Electricity	Mobile generator or existing electric grid of STELCO	Mobile generator will be provided by Contractor/Client, power from STELCO will be obtained with prior arrangements
Food	Outsourced from existing café/restaurants in Hulhumale	Arrangements will be made by the contractor
Telecommunication	Mobile phones and internet facilities	Provided by contractor
Fuel	Mainly diesel	Obtained from local suppliers via bowser (no storage in site)

Construction material	Sand, Cement, Aggregate, steel bars, steel pile, power cable, cable manhole, HDPE pipe, metal frames, PV modules, clamps, bolts, Lights, Transformer Station, and fixers	Procured from overseas by the contractor
Construction equipment	Crane (25T), Excavator, Forklift (5T), Crane lorry, Trailer and Piling Machine	Provided by contractor, Obtained locally if available
Sand (around 1,000 cbm)	Excavation along the pavement area for laying the cable to connect to STELCO's grid	Dredged from the pavement area of link road and Boashimaa Hinhun
Health and Safety equipment	Personal Protective Equipment, First aid box, Fire extinguishers	Provided by contractor

3.10.2 Project Out puts

The main outputs of the project are summarized below.

Table 3-6: Main outputs of the proposed project

Out put	Anticipated Quantities	Method of Disposal
Waste water	Around 20L/person/day	Through island's existing system
Hazardous waste (oil and grease)	Minor amounts	Will be stockpiled in the site and taken disposed via WAMCO
Air pollution	Minor amounts of Sulphur and Nitrogen oxides and dust will be released into atmosphere by vehicles during the construction period	Unavoidable, but will be localized to the project area

Noise pollution	Localized to the project area	Unavoidable during construction phase and project doesn't involve activities that generate very loud noise
Solid waste from work force	Moderate	Collected in bins and taken to Thilafushi via WAMCO
Construction waste (timber, cardboard, packing material and scrap metals)	Moderate	Taken to Thilafushi via WAMCO
House hold waste	Minor	Disposed to island garbage via WAMCO
Energy produced by Solar PV	5.6MW	Connected to the power grid of STELCO for usage in greater Male' area

4 PROJECT ALTERNATIVES

It is a requirement of the EIA regulation to provide at least two alternatives including the no-project option. Not all the impacts of a project can be completely prevented. But with the use of relevant technology and management methods, the magnitude of most of these impacts can be reduced. Nevertheless, the effectiveness of the technology and mitigation measures highly depends on the environmental condition and procedures in which they are applied in the field. On the other hand, there are complex and sophisticated procedures of minimizing environmental impacts by means of alternative methods.

If the project were to continue, it would be necessary to take technical, economic, ecological and social aspects of the project into consideration and ensure that these concerns exist within a delicate balance. Neither the economic benefits nor the social and ecological concerns can be avoided. Therefore, it is important to consider all options and ensure that the best available option(s) is/are chosen to solve the issues/problems.

4.1 No-project option

No-project option is not a favourable option for the proposed project. No project option means the proposed activities of the project will not be carried out in greater Male' area.

As highlighted under the project justification, the proposed project has number of long-term benefits. Th project is in line with the national development goals of the country.

As per the National Environmental Action Plan III (NEAP III), which sets out the agenda for environmental protection and management in the Maldives, one of the main targets aimed to achieve was working towards a carbon neutral nation. NEAP III aims to make a livable and a sustainable environment a component of development projects carried out in Maldives. NEAP III provides the basis for environmental planning, budgeting, performance measurement, and accountability. In NEAPA III, it has been aimed to decrease the dependency on diesel powered electricity generation in Maldives with the provision of renewable energy throughout the country. Similarly, the importance and composition of the much-needed legal framework to assist the development of the sector of renewable energy is highlighted in NEAPAIII. The proposed project would function as a key project in assisting to move towards a carbon neutral

nation

In any case if the project is decided not to be continued, the following consequences are possible:

- 1- Increase in carbon emission due to the usage of fuel for energy production.
- 2- Increase in the load of electricity with the exceeding population in the greater Male' region.
- 3- With increase in demand for electricity, and failure to provide electricity would create a disturbance and public outrage.
- 4- The demand and interest for adopting and investing in renewable energy would be decreased as the general public and private parties would not be able to witness the feasibility of adopting such energy options in the Maldives.

Based on the evaluation of social, environmental and economic perspective, having a no project alternative would be a disadvantage for the general public as well as the government. With a growing demand for electricity in the region, it is of high priority for the government to find suitable and feasible options for electricity to cater the demand and load of electricity. In addition to this, with the commitment to international treaties to deter the carbon emission, Maldives is subjected to take mitigation measures to reduce carbon emission, hence, having a no project option would prove to be disadvantageous in an environmental and economic perspective.

Table 4-1: Comparison of 'No project' option

Description	Advantages	Disadvantages
No project option	<ul style="list-style-type: none"> • Saves the cost of development. • No adverse environmental impacts due to the proposed project activities. • No social impacts due to project activities such as road closure and airport security issues. 	<ul style="list-style-type: none"> • More GHG emission as the increase in fuel would result in carbon emission. With increasing population, the demand for electricity would increase hence the usage of fuel for electricity would increase. • With increase in carbon emission, would contribute to GHG emissions while indirectly triggering the after impacts of climate change locally. • With the increasing population in Male' and Hulhumale' due to migration and excessive labour force, the need for electricity continues to grow. Adopting to only fuel usage for electricity would be difficult to maintain hence any disruptions to electricity would result in public outrage. • The cost of utility especially in the case of electricity is a huge concern for the general public mostly in the greater Male' region. With the increase in population, the demand and load of electricity has risen and the utility providers have often found it difficult to maintain the electricity connection due to power surges. Without an adoption of another energy option such as solar energy, it would prolong the existing issues. If the utility providers are to cater the existing and future electricity demands they would require to upgrade to cheaper, long lasting energy generation methodologies that are more environment friendly.

4.2 Alternative project design

Changes to the project design in terms of changing the location or bringing changes to the current design have been discussed. Project design changes when the installation location changes between land, sea and roof top.

4.2.1 Alternative location

The proposed project is located on the eastern side pavement area of the link road between Male'-Hulhumale, southern side pavement area of Boashimaa Hingun in Hulhumale and rooftops of residential flats in Hulhumale phase 1.

The project is proposed for the greater Male' area where the land scarcity is one of the major social issues. According to the census 2014, 38% of Maldivian population reside in the greater Male' area. This figure is expected to be much higher now. There has been a high demand for lands in this area. Hulhumale and Villimale have been developing as per a long-term master plan. Hence, it is very obvious that no land area is available in greater Male' area to make available solely for a project of this scale, nor can the total project capacity can be managed by installing the PV modules over rooftops. The only available space for a project of this scale would be in deep sea, within the atoll. However, installation of a project of this scale in deep sea is expected to almost double the project cost. Hence, no alternative or considerable land space is available in greater Male' area for the proposed project other than the location that has already been proposed.

Similarly, if the total project is to be installed on rooftops, it would require approximately 110-120 buildings or rooftops which are roughly the size of the rooftops that have been selected in Hulhumale. Any roof top can not be selected for the installation. It is applicable for durable roofs with high strength and preferred orientation or angle to capture the right amount of sunlight.

Hence, currently, no better alternative location can be selected from greater Male' area.

Table 4-2: Comparison of possible alternative project locations

Project location	Advantages	Disadvantages
Proposed location (mainly the pavement area in link road and Boashimaa Hinhun).	<ul style="list-style-type: none"> • The location proposed for the project is not planned to be used for another purpose, nor can it be used for mush activities due to the narrowness of the area. • Since the main project area involves covering the pavement area in Boashimaa Hingun and link road, it would provide shade for the pedestrians during the day time. • Main project area is not located in a residential area, hence, adverse impacts of the project during the construction phase will not be much felt by the public. 	<ul style="list-style-type: none"> • The main project area is a narrow strip of land in between the pavement and seawall. Hence, during the construction phase of the project, restrictions on traffic movement will be experienced. • Will have to undergo difficulties and bear additional cost in attending revetment repair work on the eastern side of the link road.
Deep sea, within inner atoll	<ul style="list-style-type: none"> • Away from the residential areas. Hence adverse impacts on the community during the construction phase will be very less. • No land area is permanently taken up for the project. • Project surrounding is free from other structures. Hence, no impact on the surrounding structures. • Large area can be taken up for the project. • Efficiency could be higher as the floating solar platforms over water can provide a cooling effect during day time when cell temperature increases. 	<ul style="list-style-type: none"> • Installation will be very costly compared to installation on land. • Possible adverse impacts to the marine environment, especially during the construction period. • Obstructing the wave dynamics and surface current flow could cause hydrodynamic changes around the nearby islands which in turn lead to changes in coastlines. • Salt spray can reduce the durability of the platforms. • Challenges in maintenance especially during rough seasons. • More maintenance works.

Only rooftops	<ul style="list-style-type: none"> • No land or lagoon space is taken up. • Cheaper as foundation for mounting structures will not be needed. Mounting structures would be just a frame with bolts and clamps. • Easy and quick installation. • Less likely to face the glare issue since most of the buildings could be higher with 2-5 storeys. 	<ul style="list-style-type: none"> • The required roof area would be large and it would be difficult to secure rooftops for the production of 5.6MW energy. • Just any building is not advisable to be chosen. Applicable for durable roofs with high strength. • Could generate less PV output due to share and orientation of the roof.
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4.2.2 Alternative foundation design

Even though the foundation design of mounting structures and transformer base in link road and Boashimaa Hingun was not fully completed at the time of the report, it was proposed to undertake vibratory piling. In vibratory piling, a vibratory pile driver machine installs the pile into the ground by applying a rapidly alternating force to the pile. The driver machine is referred as the hammer. Since the main driving technique involves generation of vibration, ground vibration will also be experienced to certain extent during piling by using this technique as explained under the methodology. Given that the project area is very close to the paved road and seawall, a piling method that generates less ground vibration would be much better in an environmental and socio-economic perspective.

On the other hand, piling methods such as screw piling or rotary piling will generate less ground vibration compared to vibratory piling. In these methods, the main pile driving force is achieved by rotation rather than by hammering or vibration. These methods of piling are well suited for work in cities, built up areas or areas surrounding existing structures as the vibration and ground disturbance caused by installation is minimal. Given that the rest of the impacts will more or less likely be constant for all these methods of piling, screw or rotary piling would be more suitable for the project environment.

4.2.3 Inclusion of solar battery storage

A solar battery storage system saves the excess energy the photovoltaic panels produce,

when the demand is lower than the capacity of solar energy generation. Later the battery storage will supply the power when needed.

For an off-grid PV system, a battery bank is necessary for providing power at night or on cloudy days. However, with a grid-tied solar array, similar to the one proposed under the project, batteries are not necessary since the total amount of energy produced is expected to be used up on daily basis. Hence, inclusion of battery storage is not identified as a favourable design alternative.

4.3 Alternative technology (renewable energy source)

Various different types of renewable energy sources have been in use today across the world. However, depending on the location, environment and geomorphology of each distinctive location, country, the effectiveness of energy production by each of these sources differs considerably. Comparison of some of these sources have shown that renewable energy production by using solar power is the most relevant and suitable type of renewable energy technology to the Maldivian environment.

Table 4-3: Comparison of renewable energy technologies

Type	Advantages	Disadvantages
<p>Wind energy (generated by using wind turbines, the turbines are rotated by the wind to generate energy)</p>	<ul style="list-style-type: none"> • Installation of turbines and running them is a comparatively easy and inexpensive process. • Turbines produce more energy than solar panels • Wind can be harnessed during day and night. • Less polluting than solar panels. 	<ul style="list-style-type: none"> • Turbines can be noisy. • More susceptible for damages due to lightening and wind. • Could be harmful for birds and other flying animals. • Not practical for densely populated urban areas such as Male'. Need a large area for installation • Unpredictable energy source due to changes in wind speed. • For efficient functioning, requires a strong wind to blow continuously. • Cannot be installed at roof tops. Need space that are not used for any other purpose for installation.

<p>Solar energy (energy production by solar, the panels absorb the sun's rays which are converted to generate electricity or heat)</p>	<ul style="list-style-type: none"> • Installation is a comparatively easy and inexpensive process. • Roof top installation is possible and suitable for urban areas. • Once installed, require less maintenance. • Require less space compared to wind turbines. • Will not be noisy like wind turbines. • More suitable for densely populated urban areas. Can be mounted on almost anywhere if the panels face and receive sun light. • More suitable for tropical areas where sunlight is available for most part of the day and the year. 	<ul style="list-style-type: none"> • Will not produce energy during night or cloudy days. • Not all roofs have the right orientation or angle to capture the maximum solar energy. • Rate of energy production is less compared to wind turbines.
<p>Tidal Energy (Energy generated from the movement of tides in the ocean)</p>	<ul style="list-style-type: none"> • Renewable energy source. • Tidal power plants are long lasting and generate large amounts of energy. 	<ul style="list-style-type: none"> • Building tidal power plant is expensive and technically challenging compared to solar and wind energy. • Tidal power plants change the movement of the ocean and as a result harm the environment and nearby coastal areas. • Adverse coastal impact unlike wind and solar energy.

5 SURVEY METHODOLOGY

Baseline environmental surveys to assess the physical and biological environment of the project area has been undertaken.

The project area has been studied and surveyed by using standard scientific methods. Field surveys were undertaken in the project site during early 2021. They were undertaken by experienced field surveyors from Foresight Surveyors Pvt Ltd, by using appropriate methods and instruments. General information on the existing environment was based on environmental reports of similar projects, available secondary data, such as climatic data from the meteorological center at K.Hulhule. The approach to data collection and compilation of the report are done by;

- Evaluation of available and relevant literature on environmental reports associated with similar projects, such as;
 - Environment Impact Assessment to the proposed development and operation of floating PV platform in Cheval Blanc Randheli (Shaig, 2020),
 - Environment Management Plan for Clean Electricity for Dharavandhoo – a floating solar project at Dharavandhoo, Baa Atoll (Zahir, 2015),
 - Labour Management Procedure – Accelerating Renewable Energy Integration and Sustainable Energy (ARISE) Project (MoE, 2020),
 - Environment and Social Management Framework for the proposed solar PV projects under Accelerating Sustainable Private Investment for Renewable Energy (ARISE) Program (Shaig, 2014).
- Examination of the existing environment to identify significant environmental components that are likely to be affected and
- Consultation with major stakeholders to exchange information on the project and to follow the procedures required for the report.

5.1 Topographic Survey

Topographic survey of the project area was carried out in GNSS RTK positioning method by using Comnav T300 DGPS. During the survey the horizontal accuracy was maintained at $\pm 0.02\text{m}$ whereas the vertical accuracy at 0.015m . GPS base station was set over a survey mark which has a reduced level relative to MSL. Survey was carried out with reference to the national

survey mark: MALE' GIS 01 located in republic square (Gumhooree Maidhaan).

5.2 Traffic flow and volume survey

Traffic flow and volume measurement was carried out at 2 locations in the project area at 3 different times. A visual observation of the traffics at a determined time period of 1 hour was undertaken. Vehicles were noted down under four different categories. They are bicycle, motorcycle, car/van, bus and pickups/trucks. For better visualization, the results were graphically represented in Microsoft Excel.

5.3 Noise pollution

Handheld digital noise measurement devices were used to measure noise levels at two different locations in the project area. Repeated measurements were taken at each location and the average value is included in the report.

5.4 Stakeholder consultations

Stakeholder consultations were conducted using via video conference and email communications. In every meeting, initially the participants were given a brief introduction by the consultant to the proposed development and the reason for undertaking these consultations. Afterwards participants were given the chance to express their views and concerns on the proposed development. Hence, in every meeting, interactive discussions took place. Main points of the discussions were noted down.

Public consultation near the residential flats were conducted in person.

5.5 Physical environment

The physical environment surrounding the project area was visually inspected for presence of trees, terrestrial animals, any visible defects or cracks on roads and for the presence of environmentally sensitive sites. Photographs of the surrounding were taken.

5.6 General meteorological conditions

General meteorological condition of the local environment was mostly obtained from publications of Maldives Meteorological Service.

6 EXISTING ENVIRONMENT

6.1 Introduction

Under this section, existing environment relevant to the proposed project is discussed for understanding the baseline conditions of the project site. Understanding the baseline conditions are of extreme importance as environmental monitoring during the project requires comparative analysis. Major areas looked under this section are;

- Geography and setting
- The climate
- Physical and biological environment
- Terrestrial environment
- Socio-economic environment
- Hazard vulnerability

6.2 Geography and setting

Maldives is an archipelago consisting of 1,192 small coral islands which are grouped into 26 natural atolls. They are spread in north to south direction on the Laccadives-Chagos submarine ridge in the Indian Ocean, between 7° 6' 5" North to 0° 42' 24" South and 72° 33' 19" East to 73° 14' 36" West (MEE, 2017).

The length of the island chain is 860km long and the width varies between 80 to 120 km, whereas the total reef area of the Maldives is 4,513sqkm. More than 80% of the country's land area is less than 1m above the mean sea level (MEE, 2017).

6.3 Project area

The project is proposed for the greater Male' region which comprises of islands of Male', Hulhule, Hulhumale, Vilimale, Gulhifalhu and Thilafushi. Male' is the capital city of Maldives which is also among the most densely populated cities in the world. Male', Vilimale and Hulhumale are the only residential islands currently among these 6 islands. Greater Male' region is a highly urbanized area with a huge population. According to the census 2014, 38% of Maldivian population reside in the greater Male' area. This figure is expected to be much higher now.

In greater Male' region, the proposed project is located in 2 distinctive locations which are;

- Location-1: Eastern side pavement area of Male'-Hulhumale link road, including the southern side pavement area of Boashimaa Hingun in Hulhumale.
- Location-2: Rooftops of 8 residential flats in Hulhumale, phase 1.

6.3.1 Location-1

6.3.1.1 General Environment

Location-1 consists of the eastern side pavement area of Male'-Hulhumale link road, including the southern side pavement area of Boashimaa Hingun in Hulhumale. The project area-1 is considered as a highly urbanized area with insignificant terrestrial presence. Location-1 is located between highway and quay wall with a limited space for construction. Over 80% of the area is reclaimed land within the last 10-20 years as part of Hulhumale' and link road development project. Hence, this area consists mostly of bare soil and grass with no environmentally significant life.



Figure 6.1: Southern side of the Boashimaa Hingun (airport security fence is on the southern side boundary of Hulhumale)

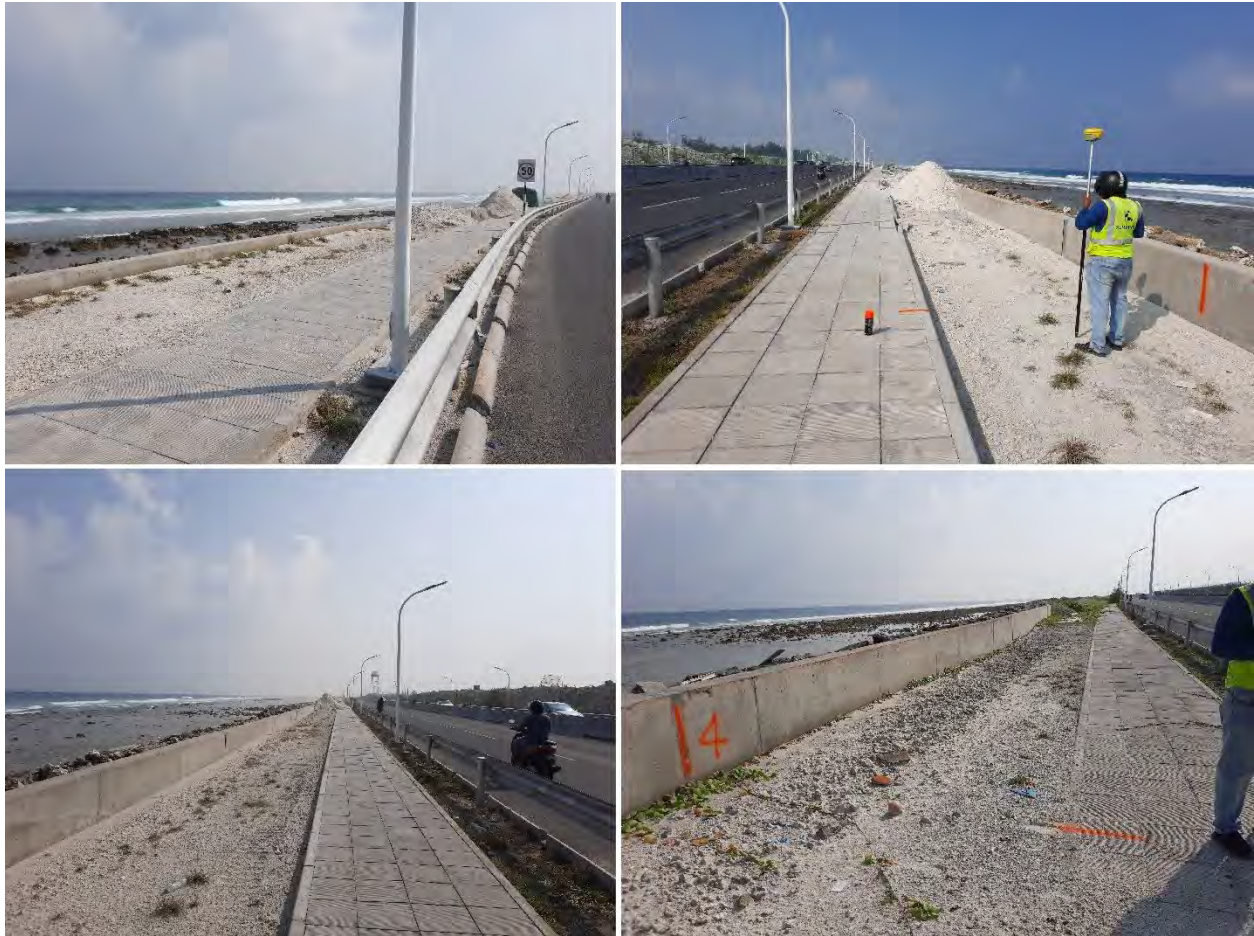


Figure 6.2: Eastern side of the link road

6.3.1.2 Significance and sensitivity of the area

The proposed project area-1 has no environmentally significant or sensitive lifeform. However, the area is commercially sensitive since number of utility cables have been buried within the footprint of the direct project location. Among them includes high voltage electric cables of STELCO which connects the power grids of Male' and Hulhumale. The area in link road and Boashimaa Hingun have been identified to have the following cables;

- High voltage electric cables of STELCO – This cable is located between the existing pavement and sea-wall, about 0.7m away from the eastern side curb of the pavement, at about 1m depth from the existing ground.
- Normal electric cables for light posts – They are placed under the pavement area, on the western side of the pavement within a service junction.
- CCTV network cable of MPS - This cable is only laid in island section and the

eastern side pavement area in this part of the project location. They too are placed within the service junctions.

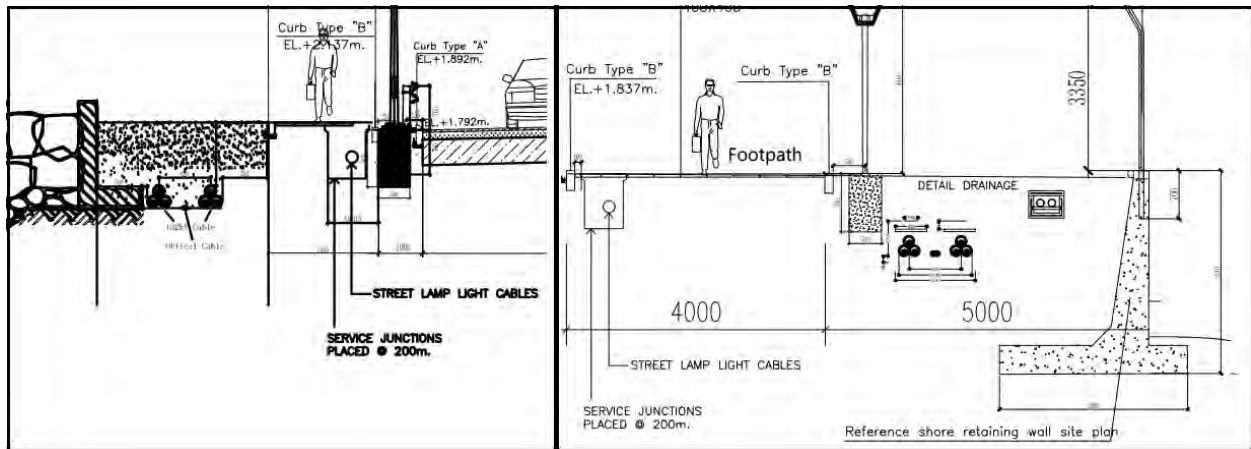


Figure 6.3: Identified underground cable location in project area-1 (A3 drawings have been included in the appendix)

6.3.1.3 General topography of the area

Maldivian islands are low laying islands which are just +1.0m above the MSL. Hulhumale is a man-made island which has been reclaimed to a height of about +1.8m above the MSL. Hence, ground elevation in Boashimaa Hingun and most part of link road is between +1.8-2.2m. It has depressed to a high of +1.5m near the end of link section 5.

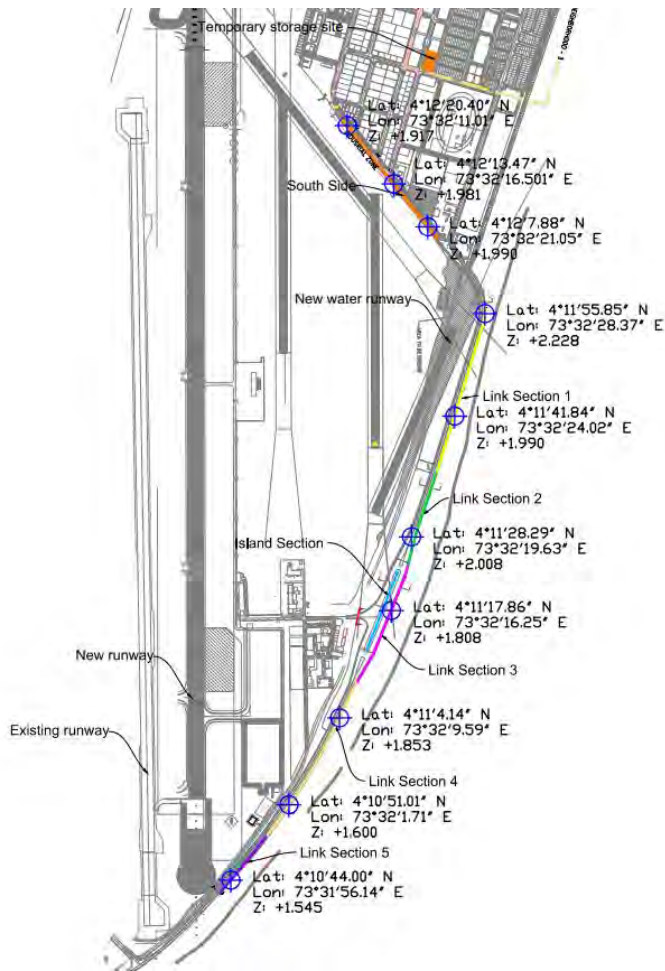


Figure 6.4: Ground elevation in location-1

6.3.2 Location-2

6.3.2.1 General Environment

Location-2 refers to the residential flats where rooftop installation is proposed. Eight residential flats were chosen by HDC after obtaining consent of the residents for the proposed project. These are recently constructed flats in Hulhumale Phase-1. Number of flats in this area, constructed under the similar scheme already has installed PV modules over their roof.

This is a residential area with parking space, play area and trees nearby. However, ample space is available for the project machinery to be active without damaging or removing any existing tree or structure. The 8 flats proposed for rooftop installation area number 84, 91, 92, 97, 98, 106, 121 and 135.



Figure 6.5: Rooftop installation area

6.3.3 Temporary storage area

6.3.3.1 General Environment

The temporary storage area is an empty land covered with grass, measuring about 76m in length and 40m in width. No mature tree or any form of structure is present within the boundary of the empty plot. However, mature trees are present on the pavement area of Saimaa Hingun which is the road on immediate south of the plot. The plot is surrounded by Saimaa Hingun on south, Reethigas Magu on west and Rabarugas Magu on east.

6.3.4 Climate

Information on the Maldivian climate was collected mainly from Maldives Meteorological Service (MMS) and published secondary sources.

Maldives has a tropical climate which is warm and humid throughout the year. The average minimum temperature ranges between 25°C to 30°C and relative humidity varies from 73 percent to 85 percent. The annual average rainfall is approximately 1,948mm, whereas the annual average rainfall of the central parts of Maldives, where Male' is located is 1,924.7mm

(MMS, 2018). As Maldives is located at the equator, which offers plenty of sunshine all year round, variations in daily temperature are relatively minor throughout the year. Even though the temperature varies only slightly, there is a significant variation in the monthly rainfall. The annual average rainfall in the southern atolls is higher than the northern atolls. In addition, greater extremes of temperature are also recorded in the southern atolls. On average southern atolls receive 2704 hours of sunshine each year.

Table 6.1 provides a summary of key meteorological findings for Maldives. The nearest meteorological station to the project site is Hulhule Meteorological Centre

Table 6-1: Key Meteorological information of Maldives

Parameter	Data
Average Rainfall	9.1mm/day in May, November; 1.1mm/day in February
Maximum Rainfall	184.5 mm/day in October 1994
Average air temperature	30.0 C in November 1973; 31.7 C in April
Extreme Air Temperature	34.1 C in April 1973; 17.2 C in April 1978
Average wind speed	3.7 m/s in March;5.7 m/s in January, June
Maximum wind speed	W 31.9 m/s in November 1978
Average air pressure	1012 mm in December; 1010 mm in April

6.3.5 Local Monsoons

The tropical climate of Maldives is generally influenced by 2 seasons called Monsoons. Two monsoon seasons observed in Maldives are the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns. During the southwest monsoon the weather becomes very versatile and it is the harsh rainy season while the northeast monsoon is the dry season, the sky is completely blue sometimes with gorgeous cloud formations. The southwest monsoon lasts from May to September and the northeast monsoon generally begins at the month of December and lasts till February. The transition period of southwest monsoon occurs during March and April while that of northeast monsoon occurs from October to November.

6.3.6 Wind

Monsoonal season determines the occurrence of wind over Maldivian islands. As Maldives

lies in the equatorial belt, the two monsoons are considered mild given and makes severe storms and strong winds extremely rare. Strong winds and gales are infrequent although storms and line squalls can occur, usually in the period of May to July. During stormy conditions gusts of up to 60 knots have been recorded at Male’.

Wind has been uniform in speed and direction over the past twenty-plus monsoon seasons in the Maldives (UNDP, 2007). It is noticed that wind speed is usually higher and stronger in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms-1 for the period 1975 to 2001. The project site is located in the central region. Mean wind speed as highest during the months May and October in the central region. Wind analysis indicates that, compared to the south the monsoon influence is greater in central and northern region of the Maldives (Naseer, 2003).

Besides the annual monsoonal wind variations there are occasional tropical climatic disturbances (tropical storms or low intensity tropical cyclones) in the central region which increases wind speeds up to 110 km/h, precipitation to 30 to 40 cm over a 24 hour period and storm surges up to 3 m in open ocean (UNDP, 2007).

Table 6-2: Local Monsoons and their onset periods

Season	Month
NE- Monsoon	December
	January
	February
Transition period 1	March
	April
SW- Monsoon	May
	June
	July
	August
	September
Transition Period 2	October
	November

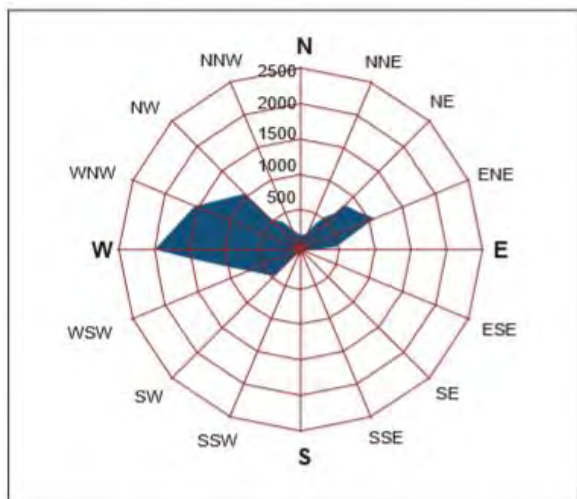


Figure 6.6: Wind rose diagram for 24 years (MMS, 2018)

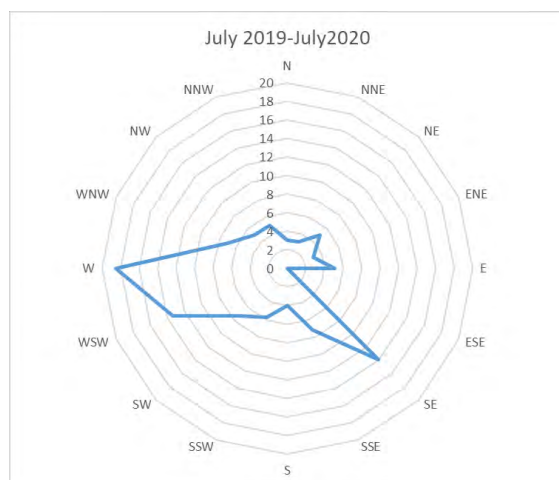


Figure 6.7 Wind Rose diagram from July 2019-July 2020 (Wind speed in m/s). Data was received from MMS.

6.3.7 Rainfall

Overall rainfall in the Maldives varies from region to region with the amount of rainfall increasing towards the south. The average annual rainfall for the archipelago is 2,124 mm. Southern atolls receive approximately 2,280 mm, and northern atolls receive approximately 1,790 mm annually (MEC, 2004). Mean monthly rainfall also varies substantially throughout the year with the dry season getting considerably less rainfall. This pattern is less prominent in the southern half, however. The proportions of flood and drought years are relatively small throughout the archipelago, and the southern half is less prone to drought (UNDP, 2006).

The mean annual rainfall for Hulhule', which is the closest weather station to the project location is 1991.5 mm and the mean monthly rainfall is 191.6 mm. Mean rainfall varies

throughout the year with mean highest rainfall during October, December, May and lowest between February and April. The physical phase of the project will be commenced during June-July 2020, which is the SW monsoon period.



Figure 6.8: Average monthly rainfall in Hulhule (MMS, 2018)

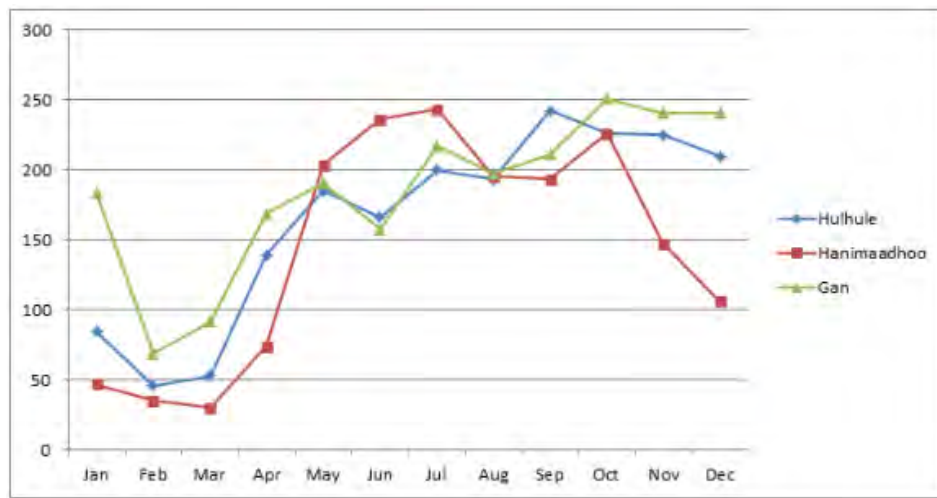


Figure 6.9: Comparisons of average monthly rainfall in 3 regions of Maldives

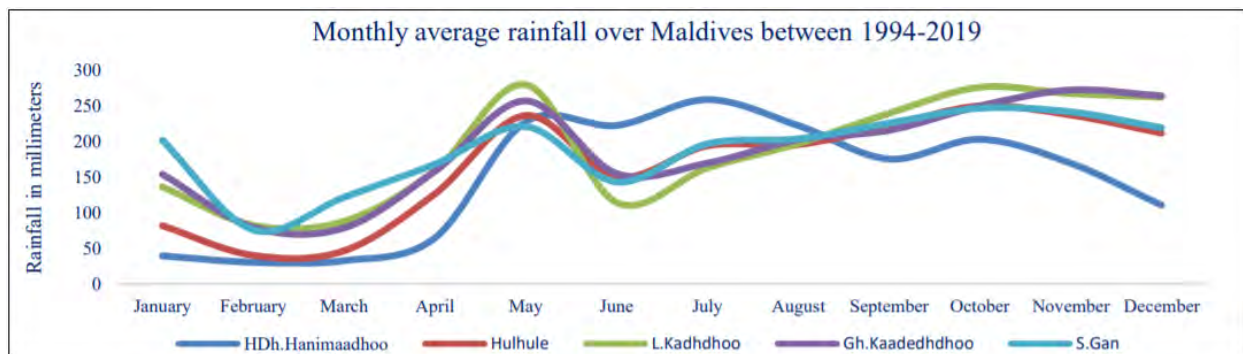


Figure 6.10: Monthly average rainfall over Maldives between 1994-2019 (MMS, 2019)

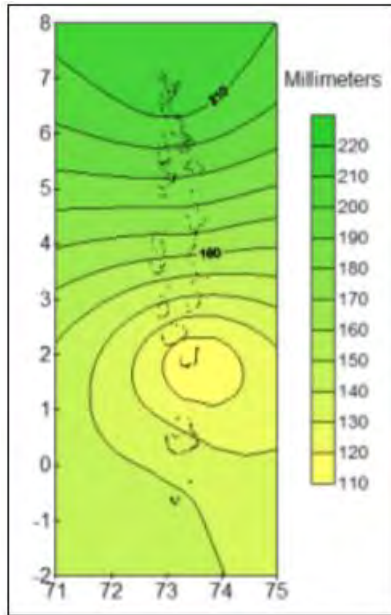


Figure 6.11: Spatial distribution of rainfall over the country during June (1994-2019) (MMS, 2019)

6.3.8 Temperature

The temperature remains consistent most of the year, however the daily temperatures of Maldives vary little throughout the year with a mean annual temperature of 28°C. In the capital, Male' the annual mean maximum temperature recorded during the period of 1967 to 1995 was 30.4°C and the annual mean minimum temperature for the same period was 25.7°C. The highest temperature recorded for Male' was 34.1°C on 16th and 28th of April 1973 while the lowest minimum average temperature was recorded in July 1992. The hottest month recorded was April 1975 with a maximum monthly average temperature of 32.7°C, the next highest being 32.6°C in April 1998.

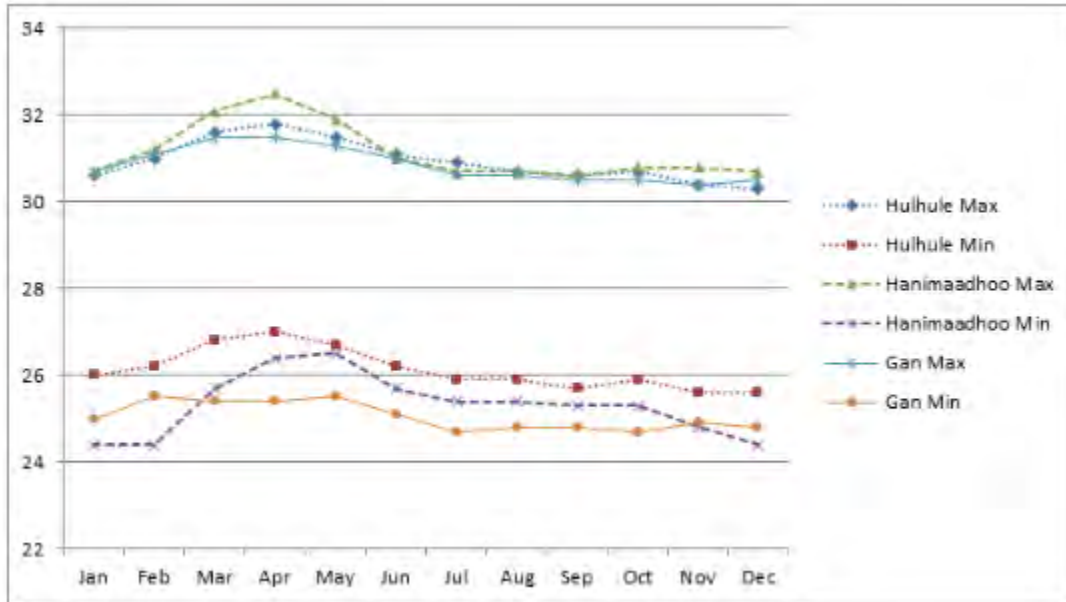


Figure 6.12: Average maximum and minimum temperature since 2000 (MMS, 2018)

6.3.9 Humidity and Evaporation rates

Based on data obtained from Hulhulé weather station over a period of 14 years from 1998 to 2012 given in Figure 4-5 (weatherspark.com), the relative humidity typically ranges from 68% (mildly humid) to 93% (very humid) over the course of a year, rarely dropping below 61% (mildly humid) and reaching as high as 100% (very humid). The air is driest around February 26, at which time the relative humidity drops below 71% (humid) three days out of four; it is most humid around November 30, exceeding 89% (very humid) three days out of four. Over the course of a year, the dew point typically varies from 23°C to 27°C and is rarely below 21°C or above 28°C.

6.3.10 Wave

The nature and the dynamics of wave pattern and height is an important factor to be considered in construction of any offshore or near shore structures such as the proposed project in link road and Boashimaa hingun.

Two major types of waves are expected to hit the coast of Hulhule and Hulhumale. They are waves generated by local monsoonal wind and swell waves generated by distant storms. The local monsoon predominantly generates wind waves that are typically strongest during May-July in the southwest monsoon.

Dominant swell waves approached from southerly directions, with some seasonal

variations. Swells were predominantly from the south-southwest, between April to November, with a significant peak in wave height (Hs) of 1.8 m observed in June, and from south to south eastern directions between November and March, with a minimum Hs of 0.75 m being observed in March. Overall wave energy was greatest on all islands during the westerly monsoon (Paul S. Kench, 2006).

According to the analysis for most part of the year (April to November) stronger wind generated waves will approach the project location from a westerly to north-westerly direction. During December to March wind generated waves approached the project location mainly from the north easterly to easterly direction.

Coast of the link road or the eastern side of Hulhule is exposed to receive swell waves approaching from a southern direction. Intensity of swell is estimated to be high due to the exposed nature and proximity of Hulhule to the rim of the reef on south and east. However, south Male' atoll could function as a form of protection for the swells approaching from south. Swell waves approaching on the southern side is expected throughout the year.

The project location in link road is protected from the westerly wind generated waves since runway and Hulhule is on west side of the link road. Similarly, Southern coast of Hulhumale (project area in Boashimaa Hingun) is facing to an enclosed area which includes the water runway of sea planes.

Based on the above findings, a general wave pattern around the island has been illustrated in the below given figure.

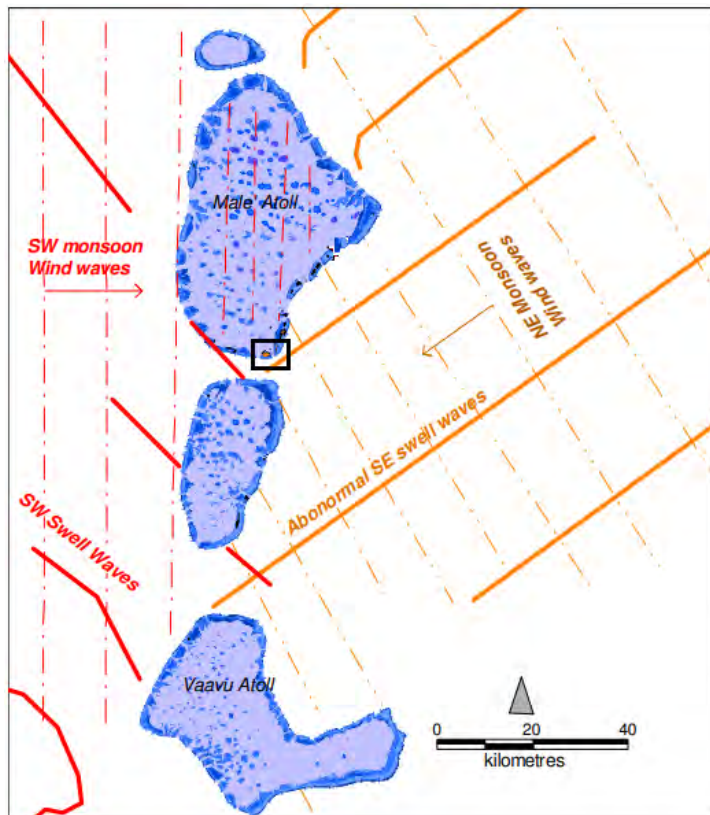


Figure 6.13: Estimated wave propagation pattern around Male' and Hulhule

6.3.11 Storm Surges

Vulnerability of the islands of the Maldives to flooding and storm surges and possibly complete inundation is considered to be high due to increasing vulnerability to the effects of global warming such as melting of polar ice caps. As a result, sea level rise due to climate change has uniform hazard throughout the country (RMSI/UNDP 2006). However, there are theories that support that high rates of evaporation in the tropical Indian Ocean may cause water levels to go down although pan evaporation studies may indicate of only evaporation due to sunlight falling on the pan excluding other meteorological factors.

There are no concerns related to storm water flooding as the island is small and does not cup towards the middle of the island.

According to the Disaster Risk Assessment report of 2006 (UNDP, 2006), Hulhule is located in a moderate storm surge hazard zone with probable maximum event reaching 0.6m above MSL or 1.53m with a storm tide. The combined historical records of nearby islands in Male' and Vaavu Atoll does not show any flooding caused by a storm surge (UNDP, 2007). Similar to the swell waves, the occurrence of any storm surge on Hulhule reef flat is dependent

on a number of factors such as the wave height, location of the original storm event within the Indian Ocean, tide levels and reef geometry.

Depending on the location of project area-1, swell related flooding events are considered a hazard for the project location on link road. This location, mainly the one on the eastern side of the link road is exposed to storm waves mainly from south and south east as shown in the map below. Events beyond this arch may not influence the island due to the protection offered by surrounding atolls.

Due to the unpredictability of the swell events and lack of research into their impacts on Maldives, it is not possible to forecast the probability of swell hazard event and their intensities (UNDP, 2007). Depending on a tentative exposure scenario, there is a probability of major swell events occurring every 15 years with probable water heights above 0.7 m and every 5 years with probable water heights of 0.4 m (UNDP, 2007). However, a swell of this magnitude is not expected to inundate the project area since the average topography of the area reaches +2.0m. Events with water heights less than 0.2 m are likely to occur annually especially as Udha. The timing of swell events is expected to be predominantly between November and June, based on historic events and storm event patterns (refer table 6.3). Maldives is located at the longitude band of 73°.

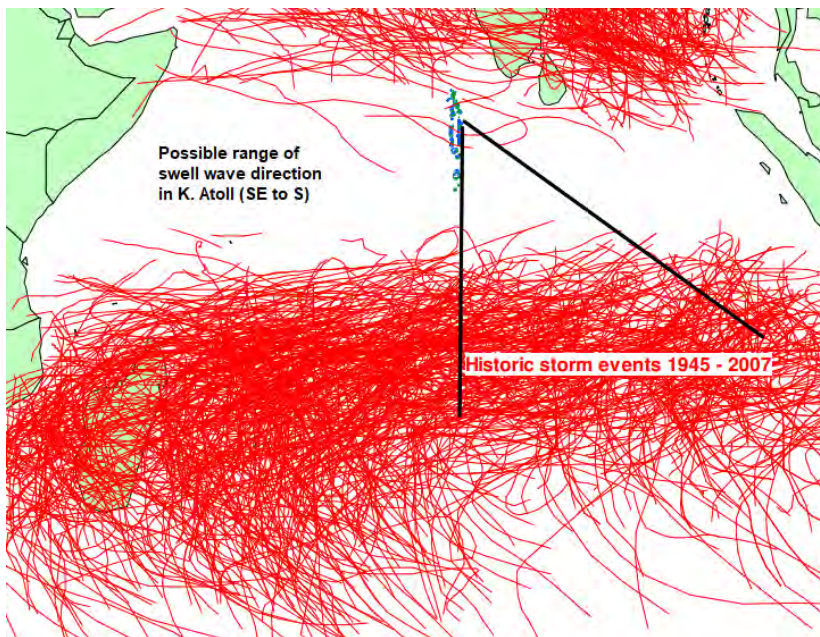


Figure 6.14: Historical storm tracks (1945-2007) in Indian Ocean and possible direction of swell waves to project area in location-1

Table 6-3: Variation of severe storm events in south Indian Ocean between 1999 and 2003 (Buckley & Leslie, 2004)

Longitude band	Severe wind event variation	
	Winter	Summer
30 °E to 39 °E	12.5	17
40 °E to 49 °E	7.5	10
50 °E to 59 °E	7.5	26
60 °E to 69 °E	6	14
70 °E to 79 °E	6	6
80 °E to 89 °E	12	6
90 °E to 99 °E	12	8
100 °E to 109 °E	8	3
110 °E to 119 °E	15	7
120 °E to 130 °E	13.5	2

6.3.12 Risk of cyclones

Natural hazard vulnerability risks related to global warming and subsequent sea level rise remains a cause for concern. However, since Maldives is located within the equatorial region of the Indian Ocean, it is generally free from cyclonic activity. There have only been a few cyclonic strength depressions that have tracked through the Maldives (UNDP, 2006). The vulnerability is further aggravated by the fact that rainfall in the region is of high intensity but short duration, which may be affected due to changes in global precipitation patterns related to climate change. However, the proposed project area has not had flooding due to rain.

Maldives is also affected by severe local storms-thunder storms/thunder squalls. Hazards associated with thunder storms are strong winds, often exceeding a speed of 100 kilometers per hour, heavy rainfall, lightning and hail; they also give rise to tornadoes in some regions. In general, thunderstorms are more frequent in the equatorial region than elsewhere, and land areas are more frequently hit by thunderstorms as compared to open oceans. However, thunder storms close to the equator are less violent when compared with those in the tropical regions and beyond. Maldives being close to the equator; thunder storms are quite frequent but less violent here. Strong winds generated by severe local storms generate large wind-driven waves which are hazardous for Maldives (UNDP 2006).

Hulhule and Hulhumale falls within the third most hazardous zone for cyclone related hazards and has a maximum predicted cyclonic wind speeds of 69.6 Kts (Figure 6.14). There are no records of such high wind intensity resulting from a cyclone for the Male' region, although a number of gale force winds have been recorded due to low depressions in the region. Winds exceeding 35 knots (gale to strong gale winds) were reported as individual events in Hulhule

annually between 2002 and 2006, all caused by known low pressure systems near Maldives rather than the monsoon (DoM, 2005). The maximum wind speed in Hulhule during this period was approximately 46 kts.

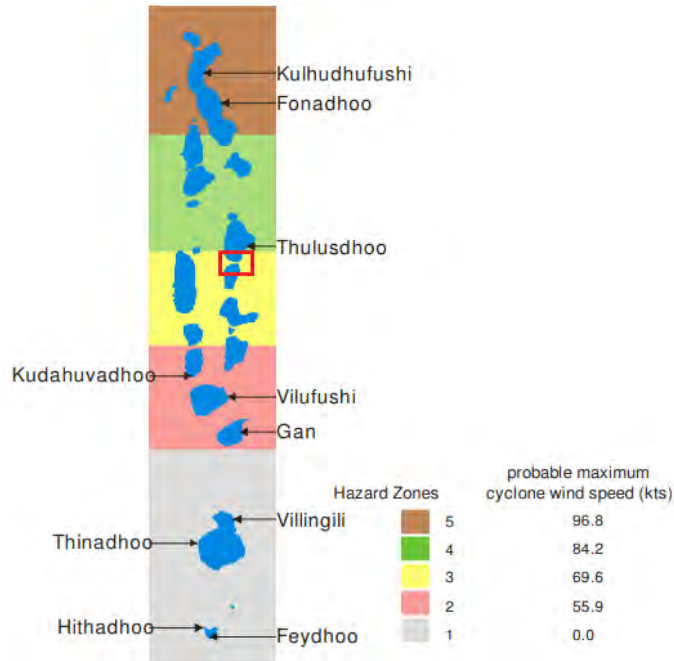


Figure 6.15: Cyclone hazard zones of the Maldives as defined by UNDP (2006)

6.3.13 Risk of Tsunami

In Developing a Disaster Risk Profile for Maldives by UNDP (UNDP, 2006), the natural vulnerability of the islands and atolls of the country to potential hazards have been modelled to understand the risk factors of the country. In that report, the disaster risk scenario for Maldives was described as moderate in general. Referring to Suffir-Simpson Scale, the proposed project site is considered a prone site when cyclonic winds, storm surges, tsunamis and earthquakes over the Maldives are concerned (UNDP, 2007).

Figure 6.26 show that Maldives faces tsunami threat largely from the east and relatively low threat from the north and south. So, islands along the eastern fringe, such as the project location on link road are more prone to tsunami hazard than those along the northern and southern fringes. Islands along the western fringe experience a relatively low tsunami hazard. This map is produced based on the experience of the tsunami in 2004 and also occurrence of historic tsunami events in the greater region where most of the events have identified to have occurred from the Sumatra Region (UNDP 2006).

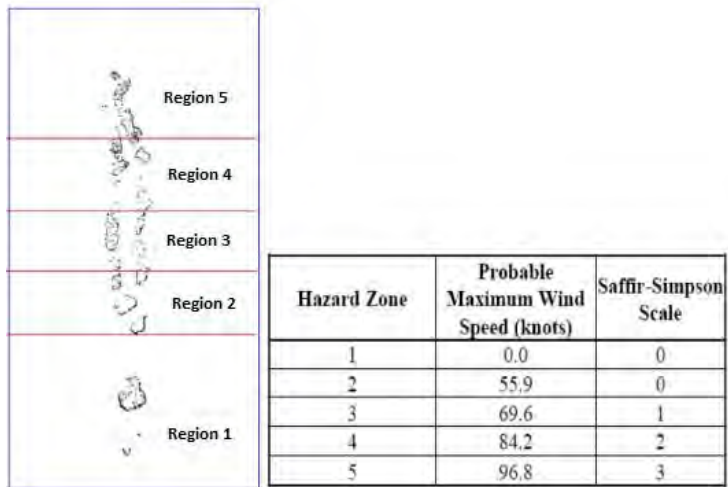


Figure 6.16: Hazard zones and Saffir-Simpson Scale for the Maldivian Islands in Indian Ocean (UNDP, 2006)

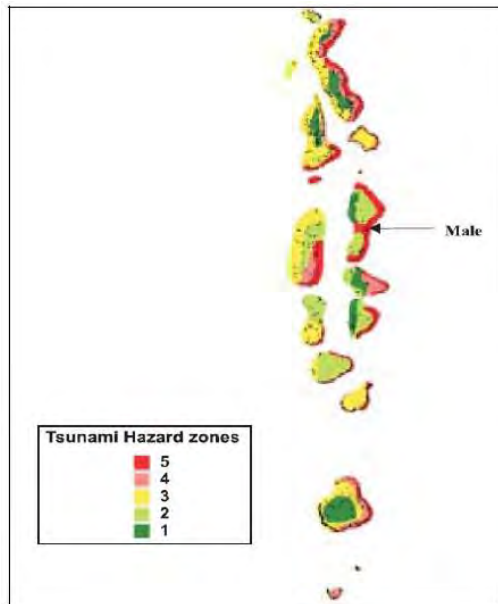


Figure 6.17: Tsunami Hazard Zones

6.4 Summary of the glare assessment report

6.4.1 Introduction

Since the main project area of the proposed project is located within the close proximity of Velana International Airport, an initial assessment was needed to ensure that glare or reflection of sunrays from the installed PV modules will not cause any disturbance to the operation of the airport. Hence, the client of the project has undertaken a glare assessment report through a third party. The assessment was undertaken by;

- Department of Physics, faculty of Science, Naresuan University
- Phitsanulok, Thailand, 65000
- Tel: +66 55 963512, Fax: +66 55 963501
- Email: sesil_nu@hotmail.com

The initial report was completed on 5th May 2021 and has been revised as per the comments of MoECC&T.

6.4.2 The assessment

The glare assessment report was based on guidelines followed in United States and Canada. It included studies of the aircraft takeoff and landing paths as well as for the circling approach for the 2 international runways and 5 paths of sea planes takeoff and landing. In general, the glide path was given as 3 degrees with 15m height over runway threshold for main planes and 5 degrees with 15m threshold for seaplanes. Airport traffic control tower height is in the range of 35 m. Two observation points were evaluated in the report.

The impact of glare depends on the interaction between the position of the sun, the tilt of the solar modules, the reflectivity of the modules' surface, the size of the project, and the relative location of the observer. The glare analysis was performed by using the Forge Solar GlareGauge4 software tool. This tool uses project inputs and solar positioning calculations to determine if glare will occur at identified observation points. If glare is found, the tool calculates the retinal irradiance (brightness) and subtended angle (size divided by distance) of the glare source. These two factors predict ocular hazards ranging from temporary after-image to retinal burn. The results would be categorized as follows;

- Green rated glare: indicates a low potential for after-image,
- Yellow rated glare: indicates the potential for after-image exists,

- Red rated glare: indicates the potential for retinal damage.

Glare that is beyond 50 degrees from a driver's line-of-sight does not constitute a safety hazard.

6.4.3 Results

The glare impact analysis showed that the Air Traffic Control Tower (OP1) and the flight path receptors chosen for the survey (FP1-FP10) are safe from any considerable glare issue from the proposed project. No 'yellow' glare (potential for after-image) for any flight path from threshold to 2 miles. Additionally, no 'red' glare or glare of any kind will be experienced by the Air Traffic Control Tower(s) and those using the link road due to the installation of the PV modules as per the provided design.

6.5 Structural assessment of the buildings proposed for rooftop installation

At the time of report submission, client has not completed the structural assessment report. Client's team faced prolonged travel restrictions due to the steps taken against the covid pandemic. However, prior to the installation of the roof modules, the structural assessment of the buildings selected for PV module installation will be completed and submitted to MoECC&T.

6.6 Summary of the geotechnical Investigation undertaken in project area-1

6.6.1 Introduction

Geotechnical assessment was carried out in 4 locations in the project area-1. The field work was carried out by a joint team from Foresight Surveyors Pvt Ltd and ELS International (Pvt) Ltd base in Maldives under the supervision of the project Engineer. Survey was undertaken by using standard scientific methods.

6.6.2 The assessment

The geotechnical field work was carried out from February 25, 2021 to March 4, 2021. The boreholes were drilled by means of rotary drilling machine and the drilling was carried out with overburden cutting tools and the wash boring process was adopted to remove the cuttings from the bottom of the borehole. During the drilling operation the walls of the boreholes were supported by 82 mm diameter NX type flush coupling casings. Every borehole was drilled to a depth of 10.45m. Samples were collected in investigation containers and tested laboratory. Tests

performed includes SPT, soil classification, particle size analysis, moisture content, Atterberg limit etc.

6.6.3 Results

- The material present in the bore hole locations include fine sand to coarse gravel.
- The ground water level was noticed as 1.50m-1.60m from existing ground level at the time of soil investigation.
- The average skin friction coefficient is 43.75 kN/m².
- The average bearing capacity is 1,437.5 kN/m².
- Factor of Safety (FOS) of 1.5 is recommended for estimating the allowable carrying capacities in skin friction from the recommended ultimate skin friction coefficients.

6.7 Ambient Noise levels

Ambient noise levels were measured from 3 different locations near the project area at two different times by using digital sound meter on 4th March 2021. Average value of 5 recordings were noted as the baseline data. As per the recordings, the project area is not regarded as a calm environment.

Noise recording for each project area was measured from 2 locations. Location A is more towards the south of link road, whereas B is more towards north (Hulhumale). The recorded sound levels for these 2 locations are not considerably different.

Noise level recordings from Boashimaa Hingun shows different levels for the points C (east) and D (west). The reason could be that number of vehicles entering Hulhumale will turn to Reethigas Magu without crossing the point D.

Noise readings for the roof top installation area is lower compared to link road and Boashimaa Hingun. Because this is a residential area, where the other area is heavy traffic area.

Generally, noise readings over 65dbA is considered as nuisance. Since the ambient noise levels recorded are higher than 65dbA in project area-1, the proposed project area is already considered as a noisy area. However, the recorded average noise level within the residential area just below 65dbA. Considering the ambient noise levels in these areas, the physical activities of the project is not expected to cause a significant noise pollution in the area.

Table 6-4: Ambient noise levels in the project area

Time	Link road		Boashimaa Hingun		Average Noise level in residential area	
	A	B	C	D	E	F
9:00 – 11:00	71	72	70	67	62	64
20:00 – 22:00	73	74	71	68	63	63

6.8 Traffic flow and volume

An hour of traffic survey was conducted at the 4 surveyed locations in the project area (Site A, B, C and D). The survey was conducted on March 04, 2021, from morning 07:30- 8:30, afternoon 12:00-13:00, and 15:00-16:00, at the specified locations. Out of the 4 surveyed locations, site A and B refers to those vehicles travelling from Hulhumale to Male from the 2 lanes on the eastern side of the link road. Similarly, site C and D refers to those vehicles travelling to Hulhumale from the 2 lanes on the southern side of Boashimaa Hingun. These areas are considered since the project will only affect the vehicles on eastern side of link road and southern side of Boashimaa Hingun.

Out of the 4 sites surveyed, site A and B (link road) shows the highest flow of traffic. They show equal number of records since a vehicle passing through point A passes through point B without a turning point in-between. The highest number of traffic flow is experienced during the morning hours since it is the time where most people come out to attend jobs and errands. As per the survey the rush hour or traffic peak times are expected both in the morning and evening, approximately between 07:00-09:00 and 15:00-17:00 hours. Noon time is experienced a considerably fewer number of vehicles compared to the peak hours.

In Boashimaa Hingun, site C experiences heavy traffic compared to site D. This happens since some of the vehicles turn on Reethigas Magu before passing the point D. However, more traffic is observed during the morning and evening hours compared to the noon time.

The traffic flow survey was not conducted during night time as the project activities that affect traffic will only be carried out during day time.

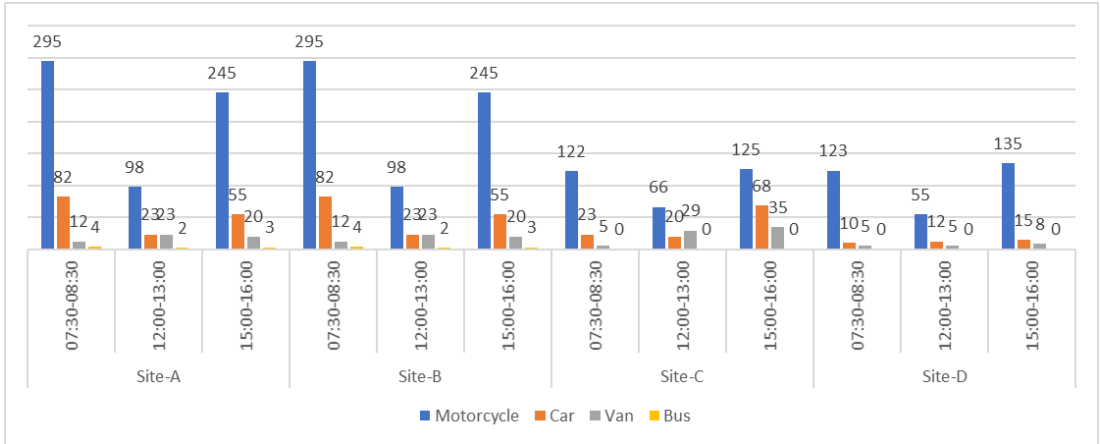


Figure 6.18: Traffic volume in link road (east) and Boashimaa Hingun (south)

6.9 Number of daily flights operating to Velana International Airport (VIA)

According to the Flightradar24 which is a global flight tracking service that provides with real-time information about thousands of aircraft around the world, during the month of July 2021, on average about 35-40 flights have operated to VIA. This number is expected to be much higher during a normal operational day without the travel restrictions of covid pandemic.

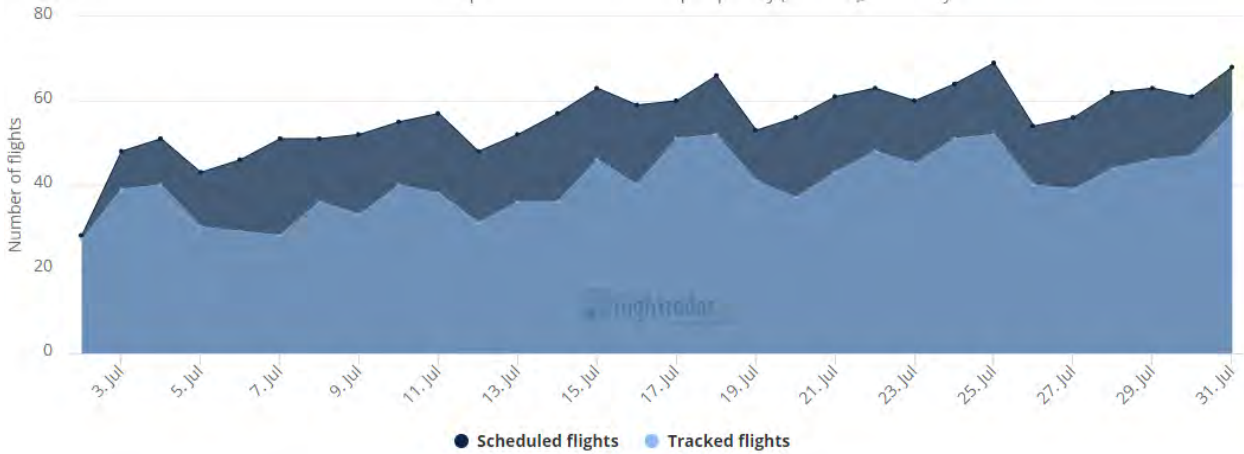


Figure 6.19: Number of scheduled departures for VIA per day, during July 2021

According to an article published in Royal Aeronautical Society (Read, 2019), there is no fixed schedule for seaplane departure and arrivals, as routes are worked out daily based on the number and destination of passengers. Schedules may also have to change at short notice if delays occur to the arrival or departure of international flights or because of adverse weather. The aircraft are sometimes also called upon for emergencies, such as medical evacuation.

The seaplanes only operate during in the hours of daylight using visual flight rules. During peak times, up to 20 aircraft may be operating at the same time with aircraft refueled between flights. Over a typical day, a pilot may do 5-6 flights and sometimes more. There are 3 seaplane operators currently operating seaplanes in VIA. They are Trans Airways Maldives (TMA), Manta Air and Island Aviation Services Limited (AIASL).

7 IMPACT IDENTIFICATION AND ASSESSMENT

7.1 Introduction

Any developmental project has impacts on the environment, which can either be positive or negative. They can also be direct or indirect and short term or long term in their existence. Identification of these impacts is important in the early stages of the project to assess whether they are reasonable, and if any mitigation measures can be made.

Different methods are available to categorize impacts and identify the magnitude and significance of the impact, such as checklists, matrices, expert opinion, modeling etc. Impacts on the environment from various activities of the project construction work (constructional impacts) and post construction (operational impacts) have been identified through interviews with the project management team, field data collection surveys and based on past experience in similar development projects.

7.2 Project Boundary and Impact Buffer Zones

Project boundary is identified to be the proposed construction site and temporary storage area together with the expected possible impact buffer zones. The proposed construction sites are;

- Link Road: The area between the eastern side road edge and revetment. End coordinates of the complete sections are:
 - North: 4°11'56.95" N, 73°32'28.58" E.
 - South east: 4°10'41.84" N, 73°31'54.25" E.
 - Island section (North: 4°11'23.43" N, 73°32'17.36" E, South: 4°11'13.46" N, 73°32'13.38" E)
- Boashimaa Hingun: The area between the southern side road edge and airport security fence. However, once constructed, a gap 3.014m will be left between the fence and the edge of the PV structures. Link section end point coordinates are:
 - North west: 4°12'21.68" N, 73°32'10.14" E.
 - South east: 4°12'6.00" N, 73°32'22.58" E.
- Roof top of 8 residential building in Hulhumale phase-1, neighborhood 3.
- Temporary storage site in Hulhumale phase-1, neighborhood 3.

Direct impact zone is identified to be the area that falls within the direct footprint of development area, whereas indirect impact zone is identified based on estimation, experience on previous projects of similar nature and relevant literature. Mostly physical and biological impacts of the project will take place within the direct project area. Social and cultural impacts will be faced within the greater Male' region and at a national level.

7.3 Impact Identification method

The proposed development will have impacts on the physical, biological and socio-economic components of the surrounding environment. An impact is any change to a resource or receptor brought about by the presence of a project component or by the execution of a project related activity. The evaluation of baseline data provides crucial information for the process of evaluating and describing how the project could affect the biophysical and socio-economic environment.

The project impacts are predicted by using a Leopold matrix which categorizes each impact to describe the magnitude and its significance. Leopold matrix uses a grading system which assists in understanding the magnitude of the impact and prioritizing the need to address the impacts (Bosko Josimovic, 2014).

7.4 Uncertainties associated with impact identification

Magnitude and extent of many of the identified impacts are based on field survey, published research, consultants experience on similar past projects. Different degrees of uncertainties are associated with them when related to the proposed project. For instance, the extent of ground vibration during sheet piling is refereed from a research conducted in America. The soil properties and features in America will be different to that in the proposed project area. Hence, certain degree of uncertainty will eb present in the estimated degree of impacts. Extent of noise and air pollution is estimated based on past experience on similar projects. However, they can vary depending on the condition of the machineries used.

To reduce the impact of road closure, a schedule has been made by the contractor based on their estimations. It was estimated that road closing will only be needed during mobilization,

demobilization, material loading and unloading. Contractor has never estimated to close the road for any other project activity. However, it is very likely that the road closing schedule will require amendments. Furthermore, due to the availability of limited space in the pavement area, it is likely that road closing might have to be extended for a project activity such as piling. Because the machine proposed to be used for piling is large which might not have enough space to operate on within the pavement area in the link road.

Machineries included in the proposed machinery list are not the exact machineries to be used for the project. Those machines that are locally available, which are similar to the proposed ones, or has the same capacity or ability to achieve the intended purpose will be used in the project. Hence, the provided dimensions of the machines or their capacity is likely to differ.

Hence, different degrees of uncertainties are present in the identified impacts. However, consultant has put maximum effort to estimate the magnitude and nature of the identified impacts to the most appropriate extent or level.

7.5 Justification of the Method used

The Leopold matrix has been used to evaluate the overall impacts of the proposed development. The Leopold matrix presents a framework approach to impact assessment of the project. It is widely used in EIA reports done for various types of projects for the purpose of predicting and evaluating the significance of environmental impacts. Leopold matrix fits in the framework MCDM method and is internationally recognized (Bosko Josimovic, 2014).

Impact factors have been evaluated separately for each environmental component relevant to the scope of this study.

1. Magnitude (or severity): the amount or scale of change that will result from the impact.
2. Significance: importance of the impact. Reversibility is considered part of its significance
3. Duration: the time over which the impact would be felt.
4. Spatial extent: the spatial extent over which the impact would be felt.

Table 7-1: Project Impact Factors

Factor	Scale	Attribute
Impact magnitude	0	No observable effect
	1	Low effect
	2	Tolerable effect
	3	Medium high effect
	4	High effect
	5	Very high effect
Impact Significance	L	Limited impact on location
	O	Impact of importance for municipality
	R	Impact for regional character
	N	Impact for national character
	M	Impact of cross-border character
Impact probability	M	Impact is possible (probability of less than 50%)
	V	Impact is probable (probability of over 50%)
	I	Impact is certain (100% probability)
Impact duration	P	Occasional/temporary
	D	Long-term/permanent

Table 7-2: Impacts associated with the project during the construction period

Impact Area	Direct impacts	Magnitude	Cumulative	Significance/ Spatial extent	Duration
Physical / Chemical impacts					
Noise pollution	Mobilization and demobilization of machinery and project items.	1 (low effect)	Yes, it would be an addition to the already existing noise levels in the area.	L (Limited impact on the location). It will be felt in the direct project area and within the immediate surrounding.	P (Occasional/temporary). Only during mobilization and demobilization.
	Piling for foundation, especially by using vibro-hammering method.	2 (Tolerable effect)	Yes, it would be an addition to the already existing noise levels in the area.	L (Limited impact on the location). It will be felt in the direct project area and within the immediate surrounding.	P (Occasional/temporary). Only during piling for foundation work.
	General Construction activities which include erection of installation frames, installation of PV modules, land scaping and machinery operation.	1 (low effect)	Yes, it would be an addition to the already existing noise levels in the area.	L (Limited impact on the location). It will be felt in the direct project area and within the immediate surrounding.	P (Occasional/temporary). Only during mobilization and demobilization.
Degradation of ground water	No project component is expected to directly affect the quality of ground water in the project area. However, accidental spillage of oil and chemicals may contaminate ground water.	0 (no observable effect)	-	L (Limited impact on the location). It will be felt in the direct project area and within the immediate surrounding.	P (Occasional/temporary). During the construction period.

Ground vibration	Vehicle movement and foundation work. It has been proposed to use vibro-hammering technology to drive the foundation piles of transformer stations and mounting structures in link road and Boashimaa Hingun.	2 (Tolerable effect)	Yes, it would be an addition to the already existing noise levels in the area.	L (Limited impact on the location). It will be felt in the direct project area and within the immediate surrounding. It is anticipated that the existing vibration in the project area without piling can be considered less (0.5-1) mm/sec as the area is free from any form of activity, but experiences heavy vehicle movement (Paulus, 2008). According to the report on, "Noise and Vibration related to the installation of sheet piles", published by Paulus, Sokolowski and Sarator engineering in 2008, maximum vibration monitored during the pile driving demonstrations ranged from 0.75 to 12.75 mm/sec at 4.6m from the drive location, from 0.5 to 5.5 mm/sec at 27.4m, from 0.5 to 4.25 mm/sec at 54.9m, and from 0.5 to 0.75 mm/sec at 119.2m (Paulus, 2008). These are the maximum observed vibrations in compact soil. Hence, in the proposed project, expected vibrations due to pile driving will be moderate which will be felt on nearby road and	P (Occasional/temporary). Only during mobilization, demobilization and piling by vibro-hammering.
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				<p>revetment. However, they are not expected to cause any damage if the activity is undertaken with care and supervision. The contractor is still exploring foundation methods and designs to select the most suitable foundation method.</p> <p>Residential area (roof top installation area) will not experience vibrations due to the project activity.</p>	
Air Quality	Minor amounts of Sulphur and Nitrogen oxides and dust will be released into atmosphere by vehicles during the construction period.	1 – Low effect	Yes, it would be an addition to the already existing noise levels in the area.	L (Limited impact on the location)	P (Occasional/ temporary)
Impact on Revetment and nearby buildings, structures during construction	Foundation and general construction work. Revetment and road area in link road and Boashimaa Hingun are in the immediate surrounding of the project area. Heavy machineries will mostly involve during the foundation work. Movement and operation of these machineries might inflict damages to nearby structures if proper management and supervision is not maintained.	1 (low effect)	-	O (Impact of importance for municipality)	P (Occasional/ temporary). However, depending on the severity of the impact, it might take longer to get it rectified.
Impact on existing utility lines	Piling and foundation work. There are existing underground utility lines under the pavement in link	3 (Medium high effect)	-	O – (Impact of importance for municipality). The existing underground utility	P (Occasional/ temporary). However, depending on the severity

	road and Boashimaa Hingun. Additionally, high voltage electric cables have been buried by STELCO in the area between the pavement and revetment or the fence wall.			lines in the project area include, high voltage electric cables of STELCO (which connects the power grid of Male' and Hulhumale), electric cables for lighting purpose and CCTV cables of MPS (in a small part of the link road). Any damage or adverse impact on these lines could be of municipal importance.	of the impact, it might take longer to get it rectified.
Marine Pollution	All material transfer, loading and unloading will be carried out via the road. No project activity will be carried out over the revetment or in the sea. Hence, marine pollution from the proposed work is unlikely.	0 (no observable effect)	-	O (Impact of importance for municipality). How unlikely is an event of marine pollution, the impact of such an event could be of municipal importance.	P (Occasional/temporary).
Handling hazardous substances	Hazardous substances that will be used in the project include oil, grease and paint. However, they will not be stored in the site. Construction time period of each link is between 1-2 months. Hence vehicle maintenance will not be carried out in the site, nor oil will be stored. Oil will be delivered to the site as required via bowser. However, there still exists the chance of spillage during refueling. The PV modules must be handles with care not to break them as they contain chemicals such as lead, cadmium and many others. These chemicals	1 (low effect)	-	O (Impact of importance for municipality). How unlikely is an event of marine pollution, the impact of such an event would be of municipal importance.	P (Occasional/temporary).

	will be exposed to the environment if the penal is broken.				
Aesthetical impacts	The major work of the project takes place in a non-residential area, in link road and Boashimaa Hingun. The work in this area will progress link by link and physical work in each section will take 1-2 months. Hence, it will not cause much of an aesthetical disturbance. However, roof top installation in residential flats would cause a higher degree of visual disturbance, but to a short period. Most of the activities will take place on roof top which will not be seen from the ground.	1 (low effect)	-	L - Limited impact on location	P (Occasional/Temporary)
Biological					
Impacts on flora	No vegetation removal is required for the project. Pavement area in link road and Boashimaa Hingun does not have any mature tree. The roof too residential area allows vehicle movement without the removal of any tree. The proposed area for temporary site has grass and bush, but no mature tree.	0 (no observable effect)	N/A	N/A	N/A
Impacts on fauna	The proposed project area is located in an urban area. No animal species has been observed to live in any of the project areas.	0 (no observable effect)	N/A	N/A	N/A
Environmental significance	No environmentally significant or sensitive area has been identified within the direct project area nor	1 (low effect)	-	L - Limited impact on location. The installation activities will take place on	P (Occasional/Temporary)

e	within the immediate boundary of the project area. However, it has to be noted that the roof top installation is taking place on the roof of residential buildings.			roof top. Materials will be supplied to roof top from the ground, by using crane.	
Social and Cultural impacts					
Movement restriction	Mobilisation, demobilization, loading and unloading	1 (low effect)	-	<p>L - Limited impact on location.</p> <p>Vehicle movement on Boashimaa Hingun and link road will be restricted, especially during mobilization and demobilization. Vehicle movement will be managed as per the road closure schedule given in the report. These roads are among the busiest roads in greater Male' region. This will have a direct adverse impact on the residents of greater Male' region, especially those who travel between Male' and Hulhumale via the bridge on daily basis for jobs, education and other purposes.</p> <p>Loading and unloading of materials near the residential areas for roof top installation will cause visual disturbance and possible movement restrictions during working</p>	P (Occasional/Temporary)

				hours to the residents of these areas.	
Gender based and group-based impacts	No specific project activity is envisaged to have an adverse impact specific to certain group of people. However, since the project is located in link road, Boashimaa Hingun and a residential area, people who use these roads and live in these buildings will face the impacts of the projects more, compared to others.	1 (low effect)	-	L - Limited impact on location. Construction stage impacts such as movement restriction, noise and air pollution that have been highlighted with regard to the project will have to be experienced by the groups of people who use the link road, Boashimaa Hingun and live in 8 residential buildings proposed for roof installation.	P (Occasional/Temporary)
Impacts on livelihood	Mobilisation, demobilization, loading and unloading	1 (low effect)	-	No significant impact on the livelihood of any group of people is expected. However, difficulties in using the link road and Boashimaa Hingun at certain times during the project will interrupt taxi movement and transportation of goods between Male' and Hulhumale. This is not expected to cause a significant or a noticeable adverse impact on the monthly outcome of any of the livelihood activities.	P (Occasional/Temporary)
Impacts on culture and heritage	Th proposed project would mostly involve the use of foreign workers during the construction stage. No	1 (low effect)	-	Greater Male' area has large number of foreign workers engaged in various types of	P (Occasional/Temporary). If any foreign worker is brought

	heritage site or culturally significant area is noticed to be present within the project area.			<p>activities. As per Census 2014, 16% of the total population of greater Male' area consists of foreign workers. This number is expected to be much higher now. Information on many of these foreign workers in Male' area is not fully documented and hence, their exact number and type of business they are involved in is not very clear. Hence, involvement of foreign workers in the project is not expected to have a huge negative impact on local culture. However, it would add up as a cumulative impact to the already existing issue of the large population of foreign workers in the country. Immigration issues related to foreign workers are poorly regulated in the country.</p> <p>Bringing in a foreign workforce would limit the chances for locals to get involved in the project. Additionally, café/restaurants run or specific for certain groups of people are more likely to be benefited.</p>	for the project, they are expected to leave as soon as the project is complete.
Larbour	The proposed project would	1 (low effect)	Yes, greater Male'	Greater Male' area already	P (Occasional/

influx and food security	mostly involve the use of foreign workers during the construction stage.		area is a heavily populated area. A large part of the population (15-20%) consists of foreign workers.	<p>has a large number of foreign workers. Their exact amount and work are not properly documented and regulated. Hence, bringing in additional workers, especially as a labour force would add up to the already existing issue of foreign workers in the country.</p> <p>On the other hand, Lack of locals involved in construction stage of the project could result on public dissatisfaction towards the overall project.</p>	Temporary). If any foreign worker is brought for the project, they are expected to leave as soon as the project is complete.
Health and Safety of work force	Project activities.	1 (low effect). It is categorized to be low with the use of PPE.	-	<p>L - Limited impact on location</p> <p>Project workers will be exposed to significant risks during construction period, within the site. Use of heavy machineries in a relatively small area with other construction activities are likely to cause harm if proper management and safety precautions are not taken. High voltage cables and other electrical items will be handled during the work.</p>	P (Occasional/Temporary)
Health and Safety of local	Project activities.	1 (low effect)	-	L - Limited impact on location	P (Occasional/Temporary)

community				Project activities such as mobilization, demobilization, loading and unloading would impose higher safety concern than the normal construction activities. These activities involve the use of heavy machines and lifting heavy items. However, the project area would be cordoned for the public.	
Impact on airport operation	No project activity is expected to cause an issue in airport operation. The landing areas of the proposed new international runway (near link section 5) and the water runway (near link section 1) have their take off or landing ends clear from project activities. Additionally, no machinery which has a height higher than 15 meters will be used for the project.	0 (no observable effect)	-	N/A	N/A
Fire hazard	Project activities	1 (low effect)	-	O (Impact of importance for municipality) The project does not involve the use of highly flammable liquids or materials. However, use of chemicals, welding and electrical wiring have the possibility of a fire.	P (Occasional/ Temporary)
Traffic Flow and road usage	As the solar PVs are installed in the busiest highway (link road and Boashimaa Hingun) of Maldives, during the construction, especially	3- Medium high impact	-	O (Impact of importance for municipality) Although the impact is	P (Occasional/ temporary)

	at times of loading and unloading. there will be obstruction to the movement of vehicles.			<p>localized to the project area, it will affect the whole greater Male' area as people living in Male', Hulhumale and Villingili use the high way. Starting from individual people using the roads, it will affect the public transportation and transfer of goods between Male' and Hulhumale over the bridge.</p> <p>Link road and Boashimaa Hingun has 2 lanes on each side of the road. It is only proposed to close a single lane from the side of the project during mobilization, demobilization, loading and unloading times. Nest lane on the same side will be left open for vehicle movement. Hence, even if with difficulties, vehicle flow will still be maintained in the area.</p>	
Impacts of covid 19 restrictions	Total project	3- Medium high impact	Yes, it is likely that any one of the foreign workers who comes to work in the project carried covid virus and leads to a spread of the disease. The existing precautionary measures such as vaccine, PCR test or	<p>M – Impact of cross-border character</p> <p>The travel restrictions imposed due to the pandemic has already delayed the project by a year. It has imposed high restrictions on travelling between countries during the past year.</p>	P (Occasional/temporary)

			the rapid tests will not fully eradicate the risk of the virus.	Furthermore, since many of foreign workers are expected to work in the project, they impose health risks to the local community once they enter the country and start working the area.	
Contractor's CSR initiative	Contractor/client has not highlighted any plan or obligation under the project for the contractor to initiate or undertake any CSR projects for the local community.	1 (low effect)	-	Although no CSR project has been highlighted by the contractor or the client, it has been noted that some components of the project are outsourced to local companies. The ESMP has been assigned to a local company named Foresight Surveyors Pvt Ltd.	P (Occasional/temporary)

Table 7-3: Impacts associated with the project during the operation period

Impact Area	Direct impacts	Magnitude	Cumulative	Significance/ Spatial extent	Duration
Economic benefits	Employment opportunities. After construction, the system will be operated for 15 years by Ensys. Afterwards it will be transferred to GoM (STELCO). However, no much staff is needed to operate and manage the system. As per STELCO, since number of solar PV installation projects are taking place in Maldives, they have a separate unit of staff to get specialized in this technology.	1 (low effect)	-	L (Limited impact on the location). Even if available, job opportunities will be available for people in greater Male' region.	P (Long-term/permanent)
	Sales of construction material and hiring heavy machinery. Construction material needed for the foundation work (sand, cement, aggregate, steel etc) will be sourced from locally available shops. Similarly, the required heavy machineries will be hired from available local companies. This would have high economic benefits	3 (Medium high effect)	Yes, it would help for the growth of the construction industry which has been badly affected by covid pandemic.	L (Limited impact on the location). This would be of high significance in terms of economics.	P (Occasional/temporary).
	Electricity price reduction. As per STELCO, the amount of electricity proposed to be produced by the proposed project is not a huge amount compared to the existing amount of electricity generated by the main power	3 (Medium high effect)	Yes, the total amount of energy generated by using renewable technology increases.	L (Limited impact on the location).	P (Long-term/permanent).

	<p>house of STELCO in Male' region. The amount of electricity generated in Male' in 2019, at peak load is 59,490kW, whereas in Hulhumale it is 10,810kW (MEA, 2019). The amount proposed to be produced under the proposed project is 5.6kW which is very less compared to the total requirement.</p> <p>Additionally, price reduction and adjustments to the price are basically set by the government as it is a basic need of the public. Hence, a price reduction is not expected even if the proposed project comes into operation.</p>				
Reflection from solar panels (glare issue)	The installed solar panels will reflect light and create a drizzling effect which might impose an adverse impact on the landing aircrafts. However, it has to be noted that a glare assessment was carried out by the client during the designing phase of the project which showed that no such issue will be caused by the project.	3 (Medium high effect)	-	L (Limited impact on the location).	P (Long-term/permanent). If any glare issue is caused by the project, it has to be rectified by the client.
Machinery access to revetment area	It has been proposed by MNPI to provide allowance for machinery to get access to the revetment on the eastern side of the road in case if any repair work is needed. As per the proposed design, from link1-5, it is continuous without any gap wide enough for vehicle				

	movement.				
Additional social opportunities	Since the pavement area in link road and Boashimaa Hingun will be covered by the elevated solar panels, it will shade the area against the sun and rain. HDC has a plan to open the pavement area in link road for residential use after the completion of the project. It is a huge social benefit for the public.	3- Medium high impact	-	L (Limited impact on the location)	P (Long-term/permanent).

7.6 Significant impacts

7.6.1 Construction period

Most of those envisaged impacts during the construction phase of the project are minor and insignificant. Highlighted below are the significant ones that require proper management options and techniques.

- Restricted vehicle movement – Link Road and Boashimaa Hingun has 2 lanes on both sides of each road. At least a single lane from the side of the project will have to be temporarily closed during mobilization, demobilization, loading and unloading. A schedule for road closure has been included in the report. The closed area will run for about 50m in length at the link section where the work goes on.
- Impacts of Covid 19 – Since this is a time of pandemic due to the wide spread of covid virus, which has still not been controlled, the risk imposed by covid-19 from the project staff is high. The available precautionary measures against covid which include vaccine, PCR tests and wearing mask are not 100% effective in controlling the viruses. Hence, foreign staff who travel from abroad to Maldives has a high chance of carrying the virus with them.
- Piling for foundation – Piling by vibro-hammering would cause ground vibration. The proposed project area is narrow and has paved road and rock boulder revetment at about 5-10m apart. The area is wide towards the link section 5 and narrow towards the link section 1. It is anticipated that the existing vibration in the project area without piling can be considered negligible or less (0.5-1mm/sec) as the area is free from any form of activity but with vehicle movement (Paulus, 2008). According to the report on, “Noise and Vibration related to the installation of sheet piles”, published by Paulus, Sokolowski and Sarator engineering in 2008, maximum vibration monitored during the pile driving demonstrations ranged from 0.75 to 12.75 mm/sec at 4.6m from the drive location, from 0.5 to 5.5 mm/sec at 27.4m, from 0.5 to 4.25 mm/sec at 54.9m, and from 0.5 to 0.75 mm/sec at 119.2m (Paulus, 2008). These are the maximum observed vibrations in compact soil. Hence, piling by vibro-hammering in such a small area can be risky to the

structures in the immediate surrounding of the project area.

- Risk to the existing utility lines – The proposed project area is narrow. At the widest part (link section 5) it has about 10m between the road the revetment. Neat the link section 1, it has about 5-6m between the road and revetment. Within the underground of this area, number of utility lines which include high voltage electric cables, CCTV cables and normal power cables are present. Even if their locations are available from as-built drawings, it is likely that accidental damages could occur to these lines since the working environment is small.

7.6.2 Operational period

Most of those envisaged impacts during the operational phase of the project are significant positive ones. The project has a high socio-economic associated with it, especially over a long-term period.

- Economic significance – The project has a highly significant and cumulative economic value since it will add up the total amount of energy generated from renewable sources within the country. This is in line with the targets highlighted under the National Environmental Action Plan III (NEAP III), and SDGs which were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. Furthermore, sales of construction materials, food items and accommodation rent of the project team will provide direct benefits to number of people in the community, especially at a time where many businesses have been going through a depression due to the pandemic.
- Possible reflection/glare issue - Although the initial assessment report made by the client during the design phase of the project proves that no glare issue will be imposed by the erected panels, it has to be practically confirmed during the operation.
- Machinery access space for possible revetment repair work – Although it has been a request of MNPHI to provide access gaps for heavy machines to allow for revetment repair works, no such gaps are included in the design. The PV modules are installed in a

one single line from link 5 – 1, without large gaps enough to allow vehicle movement. However, when required, installed panels and the frames can be removed to allow machine access. Such an event will also reduce the amount of electricity produced by the system.

8 MITIGATION AND MANAGEMENT OF ADVERSE IMPACTS

8.1 Introduction

Since it has been certain that certain environmental and social impacts are going to take place due to the project, it is highly important that proper measures and actions are taken to minimise and mitigate them. As mentioned earlier, most of the impacts identified can be mitigated with precautionary steps. If taken at an earlier stage, the overall negative impact that could be having from this project on environment, social and economically could be negligible.

Under this section, environment and social mitigation and management measure relevant for the proposed development will be outlined. These measures must be adopted during the construction and operational phase so that the targeted impact will show reduction in its severity.

8.2 Justification for the proposed mitigation measures

The environment management and mitigation measures outlined in this report are selected based on number of factors. Most importantly, practicality of the proposed measures in a cost-effective manner with locally available expertise, technology and equipment is considered. These proposed measures have been widely used in Maldivian construction industry effectively with minimum usage of manpower. Hence, the proposed mitigation measures are considered to be the most suitable for the proposed development.

8.3 Limitations of the proposed mitigation measures

The mitigation measures are proposed for the identified impacts. As highlighted before, under the limitation of environmental impacts, the identified impacts do have limitations. The magnitude and severity of the impacts are estimates based on literature and experience. Hence, same degree of uncertainty will present in the proposed mitigation measures.

Table 8-1: Proposed mitigation measures for the identified impacts of the project (for both pre-construction, construction and operational stage of the project)

Project Activity	Potential Environmental and Social Impacts	Proposed Mitigation Measures	Institutional Responsibilities (Implementation and Supervision)	Estimated quantities required and Material specifications recommended	Cost estimation/ USD	Comments (e.g. primary, secondary or cumulative impacts)
Detailed design and Planning Phase						
Design	<p>Not meeting the legal and regulatory requirements as outlined under the Legislative and regulatory considerations.</p> <p>Not meeting the specific institutional requirements received from key stakeholders.</p>	<p>Incorporate the necessary regulatory and institutional requirements into the design. If not, must notify the supervisory body (MEE&CC) by the client (Ensys) and come to an understanding with the GoM and donor.</p>	<p>Implementation by Ensys Co., Ltd, supervision by MEE&CC</p>	-	<p>Within the project cost</p>	<p>Primary</p>
Approvals	<p>Unapproved engineering drawing set by certified engineers</p> <p>Unapproved engineering drawing set by local engineers as requested by MNPHI</p> <p>Unapproved ESMP</p>	<p>Approve the final engineering drawing set by certified engineers, followed by licensed local engineers (as instructed by MNPHI).</p> <p>Approve the ESMP from EPA and WBG.</p>	<p>Implementation by Ensys Co., Ltd, supervision by MEE&CC</p>	-	<p>Within the project cost</p>	<p>Primary</p>
Hiring foreign workers or a sub-contractor	<p>Possible spread of covid from the work force</p>	<p>Conduct a health screen prior to recruitment and ensure a valid work permit visa is present.</p>	<p>Implementation by Ensys Co., Ltd, supervision by MEE&CC</p>	-	<p>Within the project cost</p>	<p>Primary</p>

		<p>Identify an emergency contact person for all of the workers hired for the project.</p> <p>Prepare a contract both in English and the language spoken by the worker and explain the terms and conditions of the contract clearly to the worker</p>				
Pre-construction phase – Site preparation						
Public and stakeholder awareness	<p>Public and key stakeholders are unaware of the correct project timeline, GRM and road closing schedule.</p> <p>More specifically, Traffic Police and Transport Authority is unaware of road closing schedule.</p> <p>No specific project staff identified to ensure the health and safety management of the site.</p>	<p>Update the construction, machinery and road closing schedules once all approvals have been obtained and pass the information to all key stakeholders including the general public.</p> <p>Especially the procedure for GRM must be made publicly aware on a public forum such as local news.</p> <p>Project team must include a health and safety office to ensure the implementation of the recommendations in ESMP.</p>	Implementation by Ensys Co., Ltd, supervision by MEE&CC	-	Within the project cost	Primary
Site preparation	<p>Aesthetically disturbing Site preparation activities such as ground leveling</p>	<p>Fence the area where the work goes on.</p> <p>Erect the construction</p>	Airport Security is maintained by MACL.	Fencing materials which could be plywood, roofing sheets or contractors	20,000.0	Primary

	<p>and removal of the existing pavement along the project area in link road and Boashimaa Hingun could cause minor air pollution.</p> <p>Project staff would be active in security area of the airport (within 10ft boundary of the security fence in Boashimaa Hingun).</p> <p>Maintaining a clear zone of 10ft after the security fence in Boashimaa Hingun.</p>	<p>sign boards.</p> <p>Unless for a project activity, no project staff must get closer than 10ft to the airport security fence in Boashimaa Hingun. The security fence must not be crossed by any project staff under any circumstances.</p> <p>The security zone (10ft from the security fence in Boashimaa Hingun) must be kept clear off any immovable item at all times.</p> <p>Project team must include a health and safety office to ensure the implementation of the recommendations in ESMP.</p>	<p>Implementation must be carried out by the contractor and/or Ensysis Co., Ltd.</p>	<p>own customized fence. About 230 sheets of plywood (8ft by 4ft) will be required to cover the temporary project site and a 50m line of road area. Supporting material such as wooden planks or iron pipes (120-150 Nos) and nails or screw will be required.</p>		
Construction phase						
<p>Mobilisation, demobilisation, loading and unloading</p>	<p>Noise pollution, minor vibration on the road surface, air quality</p>	<p>Use properly maintained vehicles.</p> <p>Adopt a foundation methodology that does not involve vibro-hammering to minimize the speed of vibration.</p> <p>Plan out transportation of</p>	<p>Implementation by Ensysis Co., Ltd, supervision by HDC. The roads in the proposed project area are managed by HDC.</p>	-	<p>Within the project cost</p>	<p>Cumulative</p>

		<p>materials and equipment in the most efficient way with less number of trips. Plan out construction activities efficiently, reducing the number of hours vehicles are in use.</p> <p>Heavy machinery and equipment shall be fitted with air pollution control devices.</p>				
	Road closure – closing a single lane out of the 2 lanes on the side closer to the project, in link road and Boashimaa Hingun	<p>Plan the work to close the road for the least numbers time.</p> <p>Closing the lane during peak vehicle hours (7:00-9:00 and 14:00-18:00) is not recommended.</p> <p>Make the road closing schedule which represents the actual scenario with correct timings and publish it on a public forum such as via local news.</p>	Implementation by Ensys Co., Ltd, supervision by MPS and HDC.	-	-	Cumulative
Foundation work and general construction	Possible degradation of ground water	<p>No dewatering is required for any project activity. Hence, no direct impact on ground water lens.</p> <p>However, vehicle refueling (if carried out in site) and handling</p>	Implementation by Ensys Co., Ltd.	-	-	Secondary

		<p>hazardous substances must be done with care over a hard surface.</p> <p>It is recommended to have absorbent mats to clean out any leaked substances.</p>				
	Ground Vibration	<p>Use properly maintained vehicles.</p> <p>Adopt a foundation methodology that does not involve vibro-hammering to minimize the speed of vibration.</p>	Implementation by Ensys Co., Ltd.	-	Within the project cost	Cumulative
	<p>Possible damage to existing utility lines and cables.</p> <p>Damages the high voltage electric cable between the existing road edge and revetment in link road, between road edge and security fence in Boashimaa Hinun. A damage to the high voltage electric cable can ignite a fire.</p> <p>Damages the electric cables to light posts in the road. The damage may disrupt the electricity supply to light posts.</p> <p>Damages to electrical</p>	<p>Foundation design must follow the available as-built maps showing the location and depth of the utility lines.</p> <p>Use a cable detector to ensure that no cable is present before foundation work begins.</p> <p>Make prior arrangements to attend any damage to the utility lines within a short span of time. This could be arrangements with the relevant utility company.</p>	Implementation by Ensys Co., Ltd.	=	Within the project	Primary

	<p>cables can give rise to fatal incidents within the site.</p> <p>Possible damage to the CCTV camera of MPS. Such a damage would undermine the maintenance of security service in the area.</p>					
	<p>Impact on Revetment and nearby buildings, structures during construction.</p>	<p>Use certified and experienced machinery operators.</p> <p>Use properly maintained vehicles.</p> <p>Adopt a foundation methodology that does not involve vibro-hammering to minimize the speed of vibration.</p>	<p>Implementation by Ensys Co., Ltd.</p>	-	<p>Within the project</p>	<p>Primary</p>
	<p>Marine Pollution</p>	<p>Use properly maintained vehicles which are in good condition without leaks.</p> <p>Brief the workers about the sensitivity of the corals and marine environment.</p> <p>Provide clear instructions prior to work on safe movement around a</p>	<p>Implementation by Ensys Co., Ltd, supervision by MEE&CC</p>	-	<p>Within the project</p>	<p>Secondary</p>

		coastal environment and actions to avoid such as littering.				
	Aesthetical disturbance which might to public complains and loss of natural view.	Fence the main project areas.	Implementation by Ensys Co., Ltd, supervision by MEE&CC	Fencing materials which could be plywood, roofing sheets or contractors own customized fence. About 230 sheets of plywood (8ft by 4ft) will be required to cover the temporary project site and a 50m line of road area. Supporting material such as wooden planks or iron pipes (120-150 Nos) and nails or screw will be required.	20,000.0	Primary
	Impacts on Flora and Fauna	N/A	N/A	N/A	N/A	N/A
	Environmental significance such as working on the roof tops of residential building and within the immediate surrounding of airport's security fence in Boashimaa Hingun.	Make the workforce aware of the security zone and the requirement of DASA to always keep a 10ft zone after the fence in Boashimaa Hingun free of immovable items. While working on roof tops, never keep items that has the potential to fall on roof edge.	Airport Security is maintained by MACL. Implementation must be carried out by the contractor and/or Ensys Co., Ltd. Working area supervision by HDC.	-	Within the project	Secondary

		When ever any roof top work goes on, the public should know that it is ongoing by means of some warning boards.				
	Health and safety of site workers	<p>Appoint a health and safety officer who will ensure the implementation of ESMP.</p> <p>Prepare a safety management plan for safety measures that can be taken during the construction stage including the safe handling and storage of construction materials and equipment.</p> <p>The safety management should include the implementation and availability of safety equipment such as first aid kit, fire extinguishers, masks, high-vest, emergency evacuation plan etc.</p> <p>All site workers should wear appropriate safety gear including hardhat, safety shoes and overalls or high vest at all times</p>	Implementation must be carried out by the contractor and/or Ensys Co., Ltd.	PPE for the whole site team, including hard hat, high vest, safety shoes, glasses, gloves etc. The 46 (approximation as per the staff requirement list) site staff must be provided with the relevant PPE depending on the work they do.	Must have been managed within the project budget. If health and safety component is to be separately managed, it would approximately cost USD 5,800.0	Primary

		<p>while in the site.</p> <p>Site workers should be aware of safety policies and emergency plans to be followed in the site during normal work routine and energy instances.</p> <p>Fire extinguishers and first aid boxes should be readily available within known places in the site.</p> <p>The project area should be fenced, and appropriate construction sign boards ('No Entry', 'Construction Site', 'Danger' sign boards) should be erected to warn the pedestrians and neighbors.</p> <p>Must undertake safety drills prior to the beginning of the construction stage and tool box meetings during construction period to ensure that site workers can properly follow the required safety</p>				
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		management plans.				
	Covid 19	<p>Conduct a health screen prior to recruitment and ensure a valid work permit visa is present.</p> <p>Identify an emergency contact person for all of the workers hired for the project.</p> <p>Must follow the covid 19 guidance note included in Appendix.</p>	<p>Implementation must be carried out by the contractor and/or Ensys Co., Ltd.</p> <p>Working area supervision by HDC.</p>	<p>Additional covid related PPE for the whole site team, including masks, sanitizers, gloves, soap, cleaning detergents etc. The 46 (approximation as per the staff requirement list) site staff must be provided with the relevant covid related PPE as highlighted under the covid 19 guidance note for the project duration.</p>	<p>It is expected to cost between USD 3,000 – 5,000 for the duration of the project.</p>	Cumulative
Operational phase						
	Reflection from solar panels (glare issue)	<p>Include a contingency plan and a budget to bring changes to the angles of the installed panel if any glare issue is reported by MCAA and requires adjustments.</p> <p>During the initial period of operation, undertake close monitoring and communication with MCAA regarding the</p>	<p>Implementation must be carried out by the contractor and/or Ensys Co., Ltd.</p> <p>Supervision and recommendation by MCAA.</p>	<p>Height of the mounting structures might need readjustments to change the angle of the installed PV modules. Else, additional components have to be designed and made for the purpose.</p>	<p>The project's contingency budget. The project is expected to have a contingency budget to attend the issues faced during the initial</p>	Primary

		glare issue.			operational stage.	
	Machinery access to revetment area	<p>Include gaps in-between link section 1 and 5 to allow machinery access to the revetment area.</p> <p>Design modular sections that can easily be removed and reassembled without shutting down the energy production from the whole system.</p>	<p>Implementation must be carried out by the contractor and/or Ensys Co., Ltd.</p> <p>Supervision and recommendation by MEE&CC.</p>			Primary

9 STAKEHOLDER CONSULTATION

Number of stakeholder consultations were held for the purpose of this ESMP with key stakeholders of the project. Consultations were held with the key stakeholders listed in the ToR via video conferencing. In each stakeholder meeting, participants were briefed on the proposed development activities. Furthermore, together with the initial meeting request, a brief introduction of the project was shared with each stakeholder. Their views, comments and concerns were noted.

After the project screening process, EPA decided that an Environmental Management Plan would suffice for the project. Hence, no scoping meeting with EPA was required for the project.

Stakeholder meetings were held with the following parties at the given dates.

Table 9-1: Stakeholders with whom consultation meetings were held with

Institution	Requested Date	Date of the Meeting	Remarks
Housing Development Corporation (HDC)	April 26, 2021	May 4, 2021	Online meeting
STELCO	April 26, 2021	May 2, 2021	Online meeting
Maldives Civil Aviation Authority (MCAA)	April 27, 2021	May 3, 2021	Online meeting
Maldives Police Service (MPS)	April 26, 2021	May 20, 2021	Online meeting
Maldives Airports Company Limited (MACL)		May 20, 2021	Online meeting
Male City Council (MCC)	April 27, 2021	June 3, 2021	Online meeting
Ministry of Transport		June 21, 2021	Online meeting
Director of Aviation Security Administration (DASA)		May 25, 2021	Online meeting
Ministry of National Planning, Housing and Infrastructure (MNPFI)	April 29, 2021	February 9, 2021	Online meeting
Residents of flats proposed for roof top installation	-	May 25, 2021	Meeting held in the residential area

Second Meeting with MACL, DASA, AVESCOM		July 8, 2021	Online meeting. The meeting was held for the request of the stakeholders
Dhiraagu	April 26, 2021	-	Received a response but a meeting was not arranged.
Ooredoo	April 26, 2021	-	Received required information.

9.1 Meeting with HDC

Apart from environmental consultant and participants from HDC, relevant staff from the PMU MEE&CC participated in the meeting. Main points discussed in the meeting are given below.

- EIA Consultant: Gave a brief description of the proposed project and opened the for meeting for discussion.
- HDC: The existing pavement in link road and Boashimaa Hingun, that falls within the project footprint has to be removed and replaced by the client.
- HDC: Even though the pavement area in the link road is not currently open for public, it will be in a near future. Hence, the area beneath the PV modules must have lights.
- HDC: Any damage to the road, pavement or any of the existing structures nearby must be repaired by the client before demobilization.
- EIA Consultant: Since many of the residential buildings have roof top PV modules installed so far, it was inquired from HDC if it has received any complain regarding those installations, especially during the operation period.
- HDC: Notified that there have been no complains and issue faced during the operation of those PV Modules.
- EIA Consultant: It was noted that since the project area in link road and Boashimaa Hingun provide a narrow and limited space, part of the road on the side next to the project will have to be temporarily closed. However, out of the 2 lanes, it was proposed to close one lane while keeping the other for vehicle movement.

- HDC: Mentioned that closing the road will be a huge issue since it's a busy area. Noted that they cannot agree to totally block the vehicle movement in that area. However, where necessary, closing a single lane also should only be carried out for least possible amount of time.
- Meeting adjourned.

Table 9-2: List of participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Ahmed Fathhee	Asst. Director, Planning & development	HDC	990 0123	fathhee@hdc.com.mv
Mohamed Rasheed Hussain	Asst. Project Manager, Project & Contract Management	HDC	-	m.rasheed@hdc.com.mv
Aminath Samaha	Architect, Planning & development	HDC	775 4100	samaha@hdc.com.mv
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T	766 8606	hamdhaan.zuhair@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC&T	778 2539	Akram.waheed@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv

9.2 Meeting with STELCO

Apart from environmental consultant and participants from STELCO, relevant staff from the PMU MEE&CC participated in the meeting. Main points discussed in the meeting are given below.

- Environmental Consultant: Gave a brief description of the proposed project and opened the for meeting for discussion.
- STELCO: Noted that still the work of connecting the power grid of Male' and

Hulhumale is ongoing. This work is ongoing in link road and Boashimaa Hingun, at the direct project location. At the time of the meeting, only the link section area 1 has been completed.

- STELCO: Noted that during the construction stage, it is not advisable for heavy machineries to operate over the buried high voltage cables of STELCO even though they are buried at a depth of about 1m from the existing ground level.
- STELCO: Strongly recommended to work by keeping a safe distance between the high voltage power cables while undertaking the foundation work.
- Environmental Consultant: Asked from STELCO whether they have been properly informed about the project and kept in the information loop starting from the first day. Furthermore, inquired about the capacity and existing resources of STELCO to run the project after it has been handed over to GoM.
- STELCO: Noted that they have been informed thoroughly regarding the proposed project. STELCO currently has a unit to manage renewable energy projects since many such projects have been taking place at different locations of the country. STELCO noted that they have enough resources to manage the project once Ensys handover the project to them. During the operation period of Ensys, STELCO's staff will work with Ensys to gain experience and the knowledge need to operate the system. Participants of STELCO noted that no mush staff is required to manage and run the system once it is in operation stage.
- STELCO: Regarding the project design and concept, STELCO expressed concern over the fact that the project does not include energy storage service such the inclusion of battery storage facilities to store energy for later consumption.
- Environmental Consultant: Inquired about the possible benefits of the proposed project in terms of energy production by fuel, money spend on fuel and the cost of electricity.
- STELCO: Noted that the capacity of the proposed project is very less (about 5-8%) compared to the total existing power production. Hence, no much change in terms of energy production by fuel, money spend on fuel and the cost of electricity can be expected.
- Meeting adjourned.

Table 9-3: List of the participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Abdul Maliku Thaufeeq	-	STELCO	755 0996	malik@stelco.com.mv
Mariyam Ali	-	STELCO	-	Mariyam.Ali@stelco.com.mv
Hussain Ageel Naseer	-	STELCO	-	Hussain.AgeelNaseer@stelco.com.mv
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T	766 8606	hamdhaan.zuhair@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC&T	778 2539	Akram.waheed@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv

9.3 Meeting with Maldives Civil Aviation Authority (MCAA)

The meeting was joined by the environmental consultant, participants from MCAA and relevant staff from the PMU MEE&CC. Main points discussed in the meeting are given below.

- The consultant briefed on the proposed project and key project activities to be undertaken.
- MCAA: Participants of MCAA informed that they have been informed about the project and have gone through the glare assessment report submitted to them. As per the existing information available regarding the project, they have no major issue. However, MCAA notified that any unforeseen issue faced during the operation of the project that affects the operation of aircrafts must be attended immediately, including any glare/reflection issue from the installed PV modules. MCAA inquired about the exact project dates and the details of project machineries, especially the height of the machines to be used.
- Environmental Consultant: Explained that the exact project dates and specific details of the machines were not clear at the time of the meeting. However, agreed to

provide them at earliest after discussing the contractor.

- Hamdhaan from MoECC&T: Inquired about the procedure for raising issues by the airline operators when there is an issue, especially if the operators face an issue from the proposed project.
- MCAA: Mentioned that airline operators will raise the issue with MACL following which MACL will inform the MCAA. MCAA will discuss the issue with relevant authorities and attend to it.
- Meeting was concluded with the highlights of above-mentioned points.

Table 9-4: List of the participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Fathimath Ramiza	Director Air Navigation and Aerodromes	MCAA	-	ramiza@caa.gov.mv
Hassan Samaah	Aerodrome Inspector	MCAA	-	-
Minvaal Ibrahim	Aerodrome Inspector	MCAA	765 3717	minvaal@caa.com.mv
Mariyam Anosha	Asst, Aerodrome Inspector	MCAA	-	-
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T	766 8606	hamdhaan.zuhair@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC&T	778 2539	Akram.waheed@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv

9.4 Meeting with Maldives Police Service (MPS)

A meeting with MPS is conducted since the advice and assistance of traffic police will be required for the traffic management during the road closure. Additionally, MPS is expected to have laid their CCTV cables buried under the ground of the direct project area.

- The Environmental consultant briefed on the proposed project and key project activities to be undertaken.
- Environmental consultant: Inquired about the location of any CCTV network cables of MPS in the project area and the procedure for obtaining assistance of traffic police during the time of closing the road.
- MPS: Participants of MPS noted that it would be better for them to show the locations of the CCTV network lines in the site. Furthermore, for traffic management during construction period, the traffic police could be informed via phone and they will be ready to provide assistance. MPS further noted that for any restriction on traffic flow during the construction, it should also be informed to Ministry of Transport.
- Meeting was concluded.

Note: A site visit was made on 21st June 2021 with officials of MPS to located CCTV network lines of MPS in the project area.

Table 9-5: List of the participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Ibrahim Rasheed	Sub Inspector of Police, Technology Department	MPS	-	i.rasheed@police.gov.mv
Thalhath Ahmed	Sub Inspector of Police, Traffic Police	MPS	-	ta_5085@police.gov.mv
Hamman Hassan	Sergeant, Traffic Police	MPS	963 5272	hammanhassan88@gmail.com
Abdulla Hashmath	Seargeant, Technology Department	MPS	-	hashmath@police.gov.mv
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T	766 8606	hamdhaan.zuhair@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv

9.5 Meeting with Maldives Airports Company Limited (MACL)

MACL is one of the most important stakeholders of the project. MACL is the company responsible for the operation and management of the Velana International Airport in Hulhule.

- The Environmental consultant briefed on the proposed project and key project activities to be undertaken.
- MACL: Participants of MACL inquired about the exact project date, duration, types and dimensions of the machineries to be used. Furthermore, requested to forward a detailed method statement of the project activities.
- Environmental Consultant: Construction period of the project will take around 4-6 months. However exact project start date, types and dimensions of the machineries to be used are not clear yet since the foundation design of the installation structures and transformers are not complete yet. Agreed to forward a detailed method statement of the project.
- Environmental Consultant: Further inquired about the maximum allowable height of the machines that can be operated in the project area in link road and Boashimaa Hingun without hindering the operation of the airport.
- MACL: Participants noted that the height depends on the distance from the runway. However, noted that a height of 15m will not be an issue as there are buildings which are at that height and even machineries having that height have been operated within the airport area while the airport is in operation. But, noted that the exact height of the machine to be used will be accessed based on location and distance to the runway. It was noted that the construction activities of Male' and Hulhumale bridge was managed while allowing the heavy machinery operation and operation of the airport as well.
- Hamdhaan from MOECC&T: Inquired about the procedure followed in attending the issues raised by airline operators and pilots.
- MACL: Stated that pilots will inform the issues they face during operation to Air traffic Control Tower (ATC). All issues raised will be discussed with MCAA.
- MACL: Noted that it is important to complete the construction work at link section 1

and 5 at the earliest since the end of link section 5 is close to landing and/or take off area of the new international runway that will be open within few months' time and the end of link section 1 is close to the landing and/or take off area of the new water runway. These new runways are at their final stage of construction and will be operational within few months' time.

- Meeting adjourned.

Table 9-6: Participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Mohamed Sola	General Manager, Infrastructure Development	MACL	790 5154	mohamed.solah@macl.gov.mv
Ibrahim Hameed	Associate General Manager, ATS	MACL	773 9100	i.hameed@macl.gov.mv
Hussain Abdul Gadir	Asst. Manager	MACL	778 8745	Hussain.gadir@macl.gov.mv
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T & T	766 8606	hamdhaan.zuhair@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC&T	778 2539	Akram.waheed@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv

9.6 Male' City Council (MCC)

Faced difficulties in arranging a meeting with MCC. The meeting was not attended by any of the councilors. Main points discussed are given below.

- The Environmental consultant briefed on the proposed project and key project activities to be undertaken.
- MCC: Noted that they have no issue regarding the project. However, noted that it is important to have an additional meeting with councilors, officials of MNPH&I and MPS to discuss about the project in detail.

- Environmental consultant: Noted that it is fine to have a meeting as identified. However, it is difficult to have a meeting with all 3 institutions together since having a meeting with a single institution takes days to completed. It was requested from MCC to send an email following the meeting to request for such a meeting so that it can be forward to the relevant institutions.

Table 9-7: Participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Mohamed Mabrook	Project Manager	MCC	786 9266	secretariat@malecity.gov.mv

9.7 Ministry of Transport and Civil Aviation (MT&CV)

It is under the mandate of Transport Ministry to ensure the safety of land, sea and air transportation of the Maldives and main an affordable transport connectivity within the country. Hence, information about the proposed project which is going to affect the land transportation between Male’ and Hulhumale during the construction phase of the project is important to be shared with the Transport Ministry.

- The Environmental consultant briefed on the proposed project and key project activities to be undertaken.
- MT&CV: Noted that they have to issue in undertaking the project. Advised to take all necessary approvals, especially to obtain assistance of traffic police in case where road closure and traffic management is needed.
- Environmental consultant: Inquired whether any specific policy has to be followed or any approval has to be obtained from MT&CV for road closure. Since MPS has noted that MT&CV must make a public announcement to inform the public regarding the traffic restrictions that will be faced during the construction period, it was inquired from MT&CV.
- MT&CV: Shameem noted that there is no such regulation or policy. However, advised to carry out the task after providing up to date information to the relevant

authorities such as MPS and MT&CV.

- Meeting adjourned.

Table 9-8: Participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Ahmed Shameem	Director General	Ministry of Transport and Civil Aviation	777 4969	ahmed.shameem@transport.gov.mv
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T	766 8606	hamdhaan.zuhair@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC&T	778 2539	Akram.waheed@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv

9.8 Director of Aviation Security Administration (DASA)

DASA manages and maintains the airport security. Airport Guards were required to check permits, air tickets and passports or permits of visitors and passengers who came to Hulhule or within the boundary of the airport security areas to be sure that they did not include undesirable elements. Main points discussed in the meeting with DASA are summarized below.

- The Environmental consultant briefed on the proposed project and key project activities to be undertaken.
- DASA: Roshan requested to clearly state the project dates, duration, types and dimensions of the machineries to be used. Furthermore, requested to identify the distance between the PV Module structure and the security fence on the Boashimaa Hingun. He noted that as per the security regulation, no permanent structure will be allowed within a 10ft buffer area of the security fence. Similarly, unauthorized people, including the project staff are not allowed to be active within this buffer area.
- Environmental Consultant: Stated that a detailed project methodology, including the types and dimensions of the heavy machinery to be used are not made for the project

yet. However, agreed to forward a detailed project method statement at the earliest. Noted that the distance between the installed PVmodule structure and the security fence in Boashimaa Hingun will be 3014mm. However, noted that it will not be possible to keep the 10ft buffer area free from the activities and movement of project staff during construction activities, whereas immovable items will not be kept in the area.

- Hamdhaan from MOECC&T: Noted that relevant government instructions including MCAA, DASA and AVESCOM have been discussed at the early stage of the project and the project concept has been finalized after incorporating any requirements highlighted by these authorities.
- DASA: Roshan inquired about the project management and how it will be ensured that no project staff will impose a risk to the airport’s security.
- Environmental Consultant and Hamdhaan: Noted that the project will be managed in the site by a qualified project manager. He will be assisted by a health and safety officer to maintain and ensure the adherence of project staff to safety regulations and ESMP. Furthermore, a supervisory staff of MOECC&T will stay in site to supervise the work. Hence, the proposed project activities and team will not be a threat to airport’s security.
- Meeting adjourned.

Table 9-9: Participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Roshan Mohamed	Sergeant	DASA	777 4969	roshan@avescom.gov.mv dasa@defence.gov.mv
Ibrahim Rasheed	Superintendent	AVESCOM	-	ibrahim@avsecom.gov.mv
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T & T	766 8606	hamdhaan.zuhair@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC&T	778 2539	Akram.waheed@environment.gov.mv

Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv
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9.9 Ministry of National Planning, Housing and Infrastructure (MoNPH&I)

MNPH&I is mandated with planning and undertaking the infrastructure development projects of the country. Despite our efforts, we were unable to arrange a meeting with MoNPH&I during the process of ESMP compilation. However, reference was made to a meeting held between MoNPH&I and MoECC&T on 9th February 2021 and the requirement and recommendations highlighted in a letter provided by MoNPH&I on 16th January 2021.

Main points highlighted by MoNPH&I in the letter (No: 471/438/2019/7).

- MoNPH&I: Noted that the PV modules and the installations structures must be modular enough to be easily removed at a low cost to attend any maintenance work of the rock boulder revetment on the eastern side of the link road.
- MoNPH&I: The design must allow the erection or fixation of road signs and cameras.
- MoNPH&I: The foundation design of the PV module installation structure and the base structure of the transformers should not undermine the nearby road or the revetment.
- MoNPH&I: The structural drawing set of the proposed project must be stamped by a certified local engineer.
- MoNPH&I: The project's preliminary design/concept must be approved by MoNPH&I before the production of detail design.
- MoNPH&I: Recommended to see the possibility of installing the PV modules on the western side of the link road since Ministry believes the eastern side a high-risk area.

Main points highlighted by MoNPH&I during the meeting with MoECC&T on 9th February 2021. The said meeting was mainly held to get approval for the initial design/concept of the project as requested by MoNPH&I in their letter.

- MoNPH&I: Ms. Shanaa Farooq noted that there are no major issues of concern for

the concepts from MoNPH&I.

- MoECC&T: Hamdhaan requested for a written endorsement from MoNPHI for the concepts as a written request has been made by the Ministry of Environment on 18th January 2021.
- MoNPH&I: Ms. Shanaa agreed to provide a written endorsement as requested following which the meeting was adjourned.

Table 9-10: Participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Aminath Hanaan Mohamed	Monitoring and Evaluation Officer	PMU, MoECC&T	911 0414	aminath.hanaan@environment.gov.mv
Hassan Shiyam Mohamed	Legal Specialist	PMU, MoECC&T	779 7014	hassan.shiyam@environment.gov.mv
Ahmed Zuhail Zaeem	Civil Engineer	PMU, MoECC&T	795 8584	zuhalz@hotmail.com
Shaanaa Farooq	Director General	MoNPH&I	791 3342	shaana.farooq@planning.gov.mv
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T	766 8606	hamdhaan.zuhair@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC& T	778 2539	Akram.waheed@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC& T	775 3909	Nuzhath.ahmed@environment.gov.mv

9.10 Public Consultation in rooftop installation area

A public consultation was carried out on the project area (residential flats of Hulhumale’) on 25th May 2021. As the time period coincided with COVID-19 pandemic restrictions, the consultation was carried out as per the HPA guidelines while maintaining social distance. No visits were made to the households, hence most of the participants were chosen randomly, from the residential area, asking politely to participate while they are outside their homes.

The following questions were asked from each interviewer, after providing a brief explanation of the project:

- Name, Contact, Flat residing, Age
- Their opinion about the project (solar energy)
- Concerns regarding the construction and operational phase of the project
- Recommendations

Main points highlighted by the participants were summarized below.

- Majority of the participants (over 90%) believe that adopting solar energy is environmentally beneficial. However, they have less information on how it would be reflected on their utility bills. In regard to this, participants stressed that it would be better if the client gives more information regarding on how these renewable energy methods can be beneficial to the overall public in an economic perspective.
- Among the people who were willing to participate, most of the youth (18-35) believed that generation more power by renewable methods would lessen the load on the engines of STELCO, hence, it would bring a permanent solution to the discontinuation of electricity from Hulhumale which had been frequent at times when the load is high. Furthermore, they highlighted that since the residing population of Hulhumale is increasing day by day, the overall demand for electricity would also increases proportionately. Hence any additional means of energy generation would lessen the issues currently faced which is mostly discontinuation of electricity at peak hours.
- Few people mentioned that there are already some solar panels that have been installed on the roofs of certain flats around 3 years back. However, there has been no reflection of that on their utility bills. Furthermore, they stressed that they have no idea or information regarding these solar panels and what are the purpose of these panels being installed on the rooftops of the housing flats.
- Participants recommended that prior to the installation, the contractor should inform the residents about the time of the project activities. It should be managed in a way that it gives the least disturbance to the public.
- Majority of the people strongly suggested that during the construction period, if there are any accidental damages to any of the nearby structure or property, the contractor should compensate and also recommended the use of safety methods to avoid any

plausible dangers.

- Overall, most of the stakeholders are satisfied with the project and understand the environmental benefits of the project. However, very few understand the economical and social perspective and its benefits of the project.
- Meeting adjourned.

Table 9-11: Participants of the meeting

NAME	GENDER	AGE	FLAT NO.	CONTACT NO.
Ameen Ibrahim	M	21	131	752 7534
Aminath Jameel	F	48	117	763 2828
Laisa Nizar	F	19	119	750 1313
Aminath Sana	F	34	130	782 8209
Zain	M	20	135	993 1199
Ahmed Aban	M	29	104	773 1148
Sira Waheed	M	38	94	964 4440
Ahmed Najaah	M	27	92	988 0106
Ahmed Riyaz	M	43	88	784 4460
Asrar	F	46	97	787 7148
Ahmed Saeed	M	41	98	779 7649
Wisam	M	37	127	(Did not agree to share the contact)
Zahaan Zahir	M	23	129	(Did not agree to share the contact)
Aminath Anusha	F	31	103	914 3643
Mariyam Ibrahim	F	56	102	789 4460

9.11 Meeting with DHIRAAGU and Ooredoo

Dhiraagu and Ooredoo are the only 2 telecommunications companies providing service in Maldives. It is expected that they might have laid cables along the link road and Boashimaa Hingun.

Despite the request for a meeting, no official meeting was arranged with any of these companies. However, Ooredoo informed that they do not have any cable laid in the proposed project area. Their closest cable to the project area would be a submarine cable laid in the sea on the eastern side of Hulhule. We were not able to obtain any information regarding the cables of Dhiraagu during the time of report compilation.

9.12 Meeting with the operators of Air Taxi

A meeting was held with the operator of the Air Taxi. Main points discussed are included below.

- The Environmental consultant briefed on the proposed project and key project activities to be undertaken after which opened the meeting for the comments of the participants.
- Air Taxi Operators: Inquired about the height of the project machinery, duration of the project and glare assessments undertaken for the project.
- Environmental Consultant: Noted that the construction stage of the project will take about 4-6 months for completion. Details of the heavy machinery to be used for the project will be clear at a later stage.
- MOECC&T: Hamdhaan noted that glare assessment report and other relevant information about the project have been shared with the aviation regulator (MCAA) who will be sharing it with other relevant parties. Since MCAA is the regulatory body, it would give rise to less complication if information is shared via MCAA.
- No major issue was raised by the participants.
- Meeting was adjourned.

Table 9-12: Participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Ahmed Azmee	Asst. Manager, Technical Operations	Trans Maldivian Airways	-	A.Azmee@transmaldivian.com

Indra Bhushan Chauhan	Quality Assurance Manager	Trans Maldivian Airways	-	Indra.Bhushan@transmaldivian.com
Mohamed Yasir Jauhary	Deputy Chief Pilot	Trans Maldivian Airways	-	Yasir.Jauhary@transmaldivian.com
Adam Haneef	Safety and Security Manager	TMA	-	Haneef@transmaldivian.com
Ismail Amra Umar	GM, Safety and Security	Island Aviation Services Limited	-	amrah@iasl.aero
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T	766 8606	hamdhaan.zuhair@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC&T	778 2539	Akram.waheed@environment.gov.mv

9.13 An additional meeting with MACL, AVESCOM and DASA

An additional consultation meeting was held with the named 3 key stakeholders for their request. Main points discussed are given below.

- AVESCOM & DASA: Made the following requests and statements;
 - Stated that a 10ft area from airport's security fence is a security zoon that must be kept clear from all sorts of activities at all times.
 - Requested to ensure the exact distance between the installed PV modules and the security fence in Boashimaa Hingun, also the height clearance beneath the installed PV modules.
 - Requested that the project activities must take place after a surveillance system has been installed in the area to monitor the activities.
 - Requested to state how the project activities will be managed in the area to ensure safety.
- Environmental Consultant and MoECC&T: Made the following comments;
 - The 10ft security zone is currently an open public space where anyone can anonymously enter and leave at all times.

- With reference to the project drawing set, the requested distances were made clear.
- Noted that it is not possible to carry out the project activities without entering the stated 10ft area. However, agreed to keep the area free of any immovable item.
- It cannot be agreed and would cause conflict of interest for the contractor to establish and operate a surveillance system to monitor their activities.
- Noted that it must be the responsibility of the party maintaining the airport's security to establish such a system if it is required.
- Requested to know how the security of the area is maintained currently. How did the security of the area was maintained during the Male' – Hulhumale bridge construction and the cable project of STELCO which was still ongoing? Highlighting the above points, it was noted that it is important to approve the activities of the proposed project based on how the security of the area was maintained during the named projects.
- Noted that the project will be managed by a site manager as per the project schedule. He will be assisted in the site by a health and safety officer to ensure the safety of the site staff and activities. Furthermore, it was noted that a staff of MoECC&T will be present in the site for supervising the work. Hence, even if the contractor is a foreigner, project activities will be managed and updated on time.
- AVESCOM & DASA: Made the following comments;
 - MACL must be responsible for establishing a system to ensure the security of the area.
 - MACL must ensure the activities of the proposed project can be monitored by using its available facilities and services.
- MACL made the following comments;
 - Establishment of a surveillance system to cover all the security zones of the airport is underway.
 - Currently, the system for maintaining the security is that a staff would visit the areas where the construction activities take place and monitor the area.

However, noted that the proposed project area in Boashimaa Hingun is too far for maintaining the security by daily visits.

- Everyone agreed that a surveillance system cannot be established to monitor the security of the project area for the proposed project, neither it should be made a component of the project to establish such a system prior to the commencement of project activities.

Table 9-13: Participants of the meeting

NAME	DESIGNATION	OFFICE	PHONE	E-MAIL
Firdous Hussain	Environmental Consultant	Foresight Surveyors	797 3873	firdous@foresightsurveyors.com
Ahmed Faseel	-	MACL	-	Ahmed.faseel@macl.aero
Masuood Hassan	-	Ministry of Defense	-	Masuood.hassan@defence.gov.mv
Abdulla Mufeed	-	MACL	-	Abdulla.mufeed@macl.aero
Ibrahim Hameed	Associate General Manager, ATS	MACL	-	i.hameed@macl.aero
Ibrahim Rasheed Abdulla	Superintendent	AVESCOM	-	ibrahim@avsecom.gov.mv
Hassan Bushry	-	AVESCOM		hassan.bushry@avsecom.gov.mv
Mohamed Hamdhaan Zuhair	Environment and Social Safeguard Specialist	PMU, MoECC&T	766 8606	hamdhaan.zuhair@environment.gov.mv
Nuzhath Ahmed	Project Coordinator	PMU, MoECC&T	775 3909	Nuzhath.ahmed@environment.gov.mv
Akram Waheed	Specialist Coordinator	PMU, MoECC&T	778 2539	Akram.waheed@environment.gov.mv

9.14 Major issues highlighted during the stakeholder meetings and the response of the client

The below given table highlights the major issues and concerns highlighted by the stakeholders, during the meetings and the comments given by the client for the issues.

Table 9-14: Comments made to the key issues highlighted in stakeholder meetings

INSTITUTION	CONCERN	COMMENTS
HDC	Requested to fix lights beneath the PV modules in link road to light up the area during night time.	It was agreed by the client to bring the requested change in the link road sections. However, fixation of lights beneath the PV modules in the island link section has not been finalized at the time of the report.
STELCO	No energy storage facility such as the inclusion of batter.	As per the client, the design is based on the requirement of WB and GoM at the time. Hence, add on services such as battery storage facility is not included.
	Construction activities must be carried out by having strict and adequate safety measures to safeguard the high voltage electric cables buried about 1m below the ground, between the existing pavement and the revetment or the seawall in link road and Boashimaa Hingun.	Noted.
MCAA, MACL, AVESCOM, MPS	Requested for a detailed project methodology with road closer and project machinery schedule. Project Machinery schedule is expected to include the dimensions of the proposed machines to be used.	Shared on 1st July 2021. After the sharing the information, following requests for further clarifications from AVESCOM and MCAA were answered on 6 th July 2021. MCAA further requested to provide the schedule for link section 1, 5 and south side. This information will be finalized just prior to the beginning of the construction activity since it has to be decided based on many other factors. Hence, it will be shared with the relevant stakeholders prior to the beginning of construction.
MCAA	Any issue which affects the airport operation, including glare issue of the PV modules and any other, must be rectified at any stage of the project.	Noted.

<p>DASA & AVESCOM</p>	<p>Highly concerned about working within 10ft buffer area of the security fence in Boashimaa Hingun. As per DASA, this space is supposed to be kept free of any activity and item for security reasons.</p>	<p>On behalf of the client, Environmental Consultant and MoECC&T noted that it is not possible to carry out construction activities in the area without entering the 10ft buffer area, however, immovable items will not be kept in the area.</p> <p>Construction site will be properly managed by the site manager. A health and safety officer will be in site to ensure the adherence of site activity and staff movement to the set security policies and recommendations in the ESMP.</p> <p>It was noted that even now the 10ft buffer area is freely accessible to anyone from the public without any restrictions. Hence, the project activities which will be properly managed where the information about the workers will be documented will not impose any additional risk to the security of the airport.</p>
	<p>As per the standard procedure, DASA noted that the 10ft buffer area from the security fence in Boashimaa Hingun must be continuously monitored during the project activities. Hence, requested to build such a service system to maintain the security of the area during construction.</p>	<p>On behalf of the client, Environmental Consultant and MoECC&T noted that various construction activities have taken place in the area before the proposed project even. Installation of a surveillance system cannot be made part of the proposed project. It has to be installed and managed by MACL as the operator of the airport.</p>

10 GRIVANCE REDRESS MECHANISM (GRM)

10.1 Introduction

In order to maintain an effective and an efficient work force, a complete Grievance Redress Mechanism (GRM) is developed and followed in the project. The GRM will help to build confidence of the community members in the project, creating a productive and a healthy relationship between the relevant parties. It will ensure equitable and fair distribution of benefits and risks among the parties. Furthermore, it will help to avoid unforeseen project delays and cost increases by preventing any possible adverse impacts of the project on stakeholders, general public and the project workforce.

As much as the benefits the it provides to the project, stakeholders and the individuals involved in the project are benefited from a functioning GRM. It provides a cost-effective method to report the grievances and complaints by establishing a trusted forum and a structure to report with dignity and confidence. The GRM will ensure fair hearing and remedy through negotiation and discussion.

10.2 Potential scenarios of grievances

A wide range of discussions have been conducted with the key stakeholders of the project during the course of this report. No party is against the implementation of the project. The two major concerns identified during the stakeholder meetings, regarding the project are the difficulties it would cause by blocking the traffic on the main road between Male' and Hulhumale during the construction phase and a possible glare or a reflective issue that might arise from the installed solar panels during the operational stage of the project. Hence, as a precautionary measure, contingency plans are recommended to be in place to handle any possible issue from the most expected project scenarios prior to the beginning of the project.

Additionally, there exist the chances of grievances from the members of the project team, which could range from project related injuries, overtime work, etc. Therefore, the following GRM has been developed and proposed for the project.

Table 10-1: Grievance Redress mechanism (GRM) developed for the stakeholders

Tiers of Grievance	Nodal Person for Contact	Contacts, communication and other facilitation by the project	Timeframe to address grievance
<p>First tier: ENSYS CO., LTD (Contractor)</p>	<p>Project Manager or a person assigned by the Project Manager for the purpose</p>	<p>Contractor should provide the following details of the assigned person and make it available to all the stakeholders named in the report under stakeholder consultation prior to the beginning of the construction stage of the project. This information should be updated on time if they are ever changed during the course of the project. However, it is recommended that they are never changed during the duration of the project.</p> <ul style="list-style-type: none"> • Name and designation of the contact person • A hotline number and an email address • Any specific information or a detail that the contractor wishes to obtain together with the submitted grievance (if there is) <p>Any individual may raise or submit a grievance in writing, via the designated hotline or email address, identifying the nature of the grievance. However, in case where the grievance is submitted via the hotline number, the contractor must record it in writing, identifying the aggrieved.</p> <p>A written confirmation of the acknowledgement of the grievance should be given to the aggrieved party once the grievance is lodged in writing.</p> <p>The grievance should be registered in the contractor's records and all received grievances (whether major or minor) should be shared and communicated with the PMU of MoECC&T and the project section of HDC. They should be shared in a tabulated excel sheet where the history and decisions taken for the past grievances are also included.</p> <p>In case of emergency issues such as any damage to utility lines, fire, damage to property, water leakage, severe injury, breach of aviation security etc, the grievance should be attended immediately, within 24 hours. For all other issues it should be attended at least within 02 calendar days.</p> <p>The grievances should be resolved within 7 calendar days and the decision made should be formally communicated with the relevant person/authority.</p>	<p>7 calendar days for review and make a decision regarding the grievance.</p>

		<p>The complaints should be resolved internally by the contractor, or with joint discussion between the aggrieved party and/or with MoECC&T AND HDC or with a combination of discussions with all these parties. All outcomes should be shared with the HDC and MoECC&T.</p> <p>The aggrieved party should acknowledge the decision made within a period of 10 calendar days. If the aggrieved party fails to do so, then the decision will be considered as accepted.</p>	
Second Tier: Project Section of HDC	A person assigned for the project or Project Section (PS)	<p>Where the aggrieved party is not happy with the response from the contractor, the party may lodge the grievance with the second tier who is Project Section of HDC.</p> <p>All the grievances received to HDC will be forwarded to project section by HDC. A person will be assigned in the PS to address the grievances.</p> <p>Aggrieved party should submit all the documents (letters, any complaint form for Tier, decision receipt) along with the complaint letter/form for Tier2</p> <p>The PS will review the lodged complaint, to see if the matter is related to ASPIRE project. If it is related to the project, the lodged complaint should be officially accepted by sending a written acknowledgement letter to the aggrieved party.</p> <p>If the matter is related to the project, PS will discuss internally on the way to move forward with the matter. Depending on the nature of the matter, PS may visit the site to resolve it, or arrange a meeting with relevant parties. For any such meeting, a prior notification will be sent to the aggrieved party, explaining the nature of meeting, venue, time and date specified.</p> <p>The PS will ensure that there is no cost bared by the aggrieved party due to the grievance mechanism at the second tier.</p> <p>PS will notify the grievance party on the decision made by a letter along with the receipt within 10 working days,</p> <p>The aggrieved party should notify the acceptance within 10 calendar days. If the grievance party fails to do so,</p>	10 working days

		<p>the decision will be deemed as accepted</p> <p>All the documents and forms should be archived in the PS records.</p>	
<p>Third Tier: Project Management Unit (PMU) of Ministry of Environment, Climate Change and Technology</p>	<p>For ASPIRE Projects, the Ministry of Environment, Climate Change and Technology will forward all the grievances to Project Management Unit (PMU)</p>	<p>Where the aggrieved party is not happy with the response from HDC, the party may lodge the grievance with the third tier who is Project Management Unit (PMU) of Ministry of Environment, Climate Change and Technology</p> <p>All the grievances received will be forwarded to PMU unit by the Ministry of Environment. A person will be assigned in the PMU to address the grievances.</p> <p>Aggrieved party should submit all the documents (letters, any complaint form for Tier, decision receipt) along with the complaint form/letter for Tier3</p> <p>The PMU unit will review the lodged complaint, to see if the matter is related to ASPIRE project. If it is related to the project, the lodged complaint should be officially accepted by sending a written acknowledgement letter to the aggrieved party.</p> <p>If the matter is related to the project, PMU will discuss internally on the way to move forward with the matter. Depending on the nature of the matter, PMU may visit the site to resolve it, or arrange a meeting with relevant parties. For any such meeting, a prior notification will be sent to the aggrieved party, explaining the nature of meeting, venue, time and date specified.</p> <p>The PMU will ensure that there is no cost bared by the aggrieved party due to the grievance mechanism at the second tier.</p> <p>PMU will notify the grievance party on the decision made by a letter along with the receipt within 10 working days.</p> <p>The aggrieved party should notify the acceptance within 10 calendar days. If the aggrievance party fails to do so, the decision will be deemed as accepted</p> <p>If the decision made is not as to the satisfaction of aggrievance party and wishes to move to Tier3 of the grievance mechanism, then it should be noted within 10 days in writing to Ministry of Environment, Climate Change and Technology</p>	<p>10 working days</p>

		All the documents and forms should be archived in the PMU records.	
Fourth Tier: Judiciary/ Assistance to Vulnerable Persons beyond the Project's Grievance Redress Mechanism	An individual or an entity has the option of going to established judiciary system of the country	<p>The legal system is accessible to all aggrieved persons.</p> <p>Assistance from the ASPIRE project is only for vulnerable person(s) as per the grievance mechanism</p> <p>In cases where the vulnerable person(s) is inaccessible to the judiciary system, the Attorney General Office (AGO) will provide the legal support. In case if the person(s) is finding any difficulty in getting the required support of AGO, the PMU must ensure that the vulnerable person(s) in getting the legal support from AGO. In addition to this, PMU must ensure that the vulnerable person(s) does not bare any cost in the procedure.</p> <p>The verdict of the courts will be the final decision.</p> <p>A vulnerable person(s) is defined in the project as “A person who is poor, physically or mentally disabled/handicapped, destitute, disadvantaged for ethnic or social reasons, an orphan, a widow, a person above sixty years of age, or a woman heading a household”</p>	As per the established judicial procedures in the Maldives.

Table 10-2: Grievance Redress mechanism (GRM) developed for the stakeholders

Tiers of Grievance	Nodal Person for Contact	Contacts, communication and other facilitation by the project	Timeframe to address grievance
First tier: Contractor	Project Manager or a person assigned by the Project Manager for the purpose	<p>Each and every project staff must be made aware of the GRM prior to the beginning of the construction phase of the project. They should be thoroughly explained on the procedures to be taken in any cases of grievance.</p> <p>Grievances must be registered via the designated complaint form. Assistance must be provided by the site manager or the assigned nodal person for those who have difficulties in filling the form. After reviewing the lodged grievance, if it is relevant to the project activities, acknowledgement of the receipt of the grievance must be confirmed by the contractor in writing.</p>	7 calendar days for review and make a decision regarding the grievance.

		<p>The Project Management Unit (PMU) of the contractor will discuss internally on the way to move forward with the matter. Depending on the nature of the matter, PMU may arrange a meeting with relevant parties. For any such meeting, a prior notification will be sent to the aggrieved party, explaining the nature of meeting, venue, time and date specified</p> <p>A decision will be made after review of the matter within the specified timeframe. The decision of the lodged matter should be notified via a letter to the aggrieved party.</p> <p>The aggrieved party should acknowledge the decision made within a period of 7 calendar days. If the aggrieved party fails to do so, then the decision will be considered as accepted.</p> <p>The complaints should be registered and archived within the project documents. These documents should be readily accessible to the PMU if needed.</p>	
Second Tier: Labour Relations Authority	Designated Employment Officer for the case	<p>In case where the Tier 1 failed to satisfy the aggrieved, the issue can be further taken to Labour Relations Authority. Contractor should ensure that aggrieved staff gets the proper assistance in seeking the legal assistance for the matter.</p> <p>In addition to this, contractor should also ensure that no cost is barred in the legal process for the aggrieved individual.</p> <p>If the contractor fails to do so, PMU of the Ministry of Environment, climate change and Technology should step in to assist the aggrieved individual.</p> <p>The outcome of the legal procedure should be notified to contractor and PMU of the ministry of environment via a letter along with the statement from the legal authority.</p>	As per established procedures of labor relations authority in Maldives
Third Tier: Judiciary	An individual or a legal entity has option of going to established judiciary system of the country	The legal system is accessible to all aggrieved persons and entities.	As per established judicial procedures in Maldives

11 SUMMARY OF ALL TRAINING RECOMENDATIONS

11.1 Introduction

In order to implement the ESMP and adhere to the recommendations stated in the report, specific and general training have to be undertaken prior to the commencement of the project, during the construction and operational phase of the project as well. Starting from general health and safety trainings to specific technical training are required along the course of the proposed project.

Table 11-1: Training recommendations to strengthen the institution

Institutional Strengthening Activity	Positions	Scheduling	Responsibilities	Cost of Estimates/USD
Hire staff	Health and Safety Officer	<p>Hired 1-2 weeks prior to the beginning of the construction period.</p> <p>Must be contracted to at least for the duration of the construction period.</p>	<ul style="list-style-type: none"> • Directly report to the project manager. • He may or may not be site based, however, the vested duties must be taken care of. • Ensure that the project activities comply with the approved ESMP and relevant laws and regulations. • Ensure that environment monitoring is carried out and significant environmental impacts are properly managed. • Immediately inform the project manager if any of the impact is not properly mitigated. • Prepare documents and environmental reports to be submitted to the relevant authorities. • Ensure the health and social wellbeing of the project staff are maintained. • Ensure that project staff maintain a healthy life style. • Ensure that specific measures as highlighted in the report, by HPA and related government authorities are taken to stop the spread of vector-borne diseases such as covid. • Ensure that arrangements are in place to attend staff in case of health emergency. • First point of contact for GRM from client's or contractor's side. • Ensure that all site staff are provided with work specific PPE. • Apart from issues submitted under GRM, maintain a record of site incidents, whether minor or major. An incident could be an injury to a site staff during site work, a traffic accident due to site work, damage to a nearby property or structure, fire incident etc. • Maintain a record of all work permits and agreements of the staff. 	5,000.0 per month

	Technicians to maintain the Solar grid	Must be hired during the operational phase of the project. Since STELCO would take over the project after 15 years of operation by the Ensys, these staff must be hired through STELCO. They can be existing staff of STELCO even. A minimum 2 staff must be trained.	<ul style="list-style-type: none"> • Work together with Ensys team during their operational period and learn the operation, maintenance and troubleshooting the system. • Carry out maintenance work of the system when required. • Must be able to remove the PV modules and install them back if MoNPH&I require them to be removed to carry out any repair work of the rock boyluder revetment on the eastern side of the link road. • Advice and provide assistance to the policy makers to develop the renewable energy production industry in Maldives. 	1,700 per head per month

Table 11-2: Training recommendations as part of capacity building of staff and related stakeholders

Training Activity	Participants	Types of Training	Content (Modules, etc)	Scheduling	Cost of Estimates/USD
Health and Safety Trainings	All the site staff	Induction training	<ul style="list-style-type: none"> • Staff's code of conduct • Emergency site evacuation plan • GRM policy • Emergency contact numbers such as, fire, traffic police, ambulance etc. • Information on Occupational Health and Safety (OHS) relevant to the work • Number, dates and information on toolbox talks, sessions • Information on ESMP requirements and covid 19 special consideration in Civil work contracts • Usage of fire extinguishers 	<ul style="list-style-type: none"> • Prior to the commencement of the construction work. • Every time a new staff or a group of staff join the team. 	1,000.0 per training
		Basic First Aid	<ul style="list-style-type: none"> • Attending an injured staff • Information on the medicines and items available in the first aid box available in the site 	<ul style="list-style-type: none"> • Prior to the commencement of the construction work. • Every time a new staff or a group of staff join the team. 	1,000.0 per training to hire a training expert
Drills	All the site staff	Induction training	<ul style="list-style-type: none"> • Fire emergency drills • Emergency site evacuation drills 	<ul style="list-style-type: none"> • Prior to the commencement of the construction work. • Every time a new staff or a group of staff join the team. 	1,000 per training
Weekly sessions	All the site	Toolbox	<ul style="list-style-type: none"> • Provide information and 	<ul style="list-style-type: none"> • Weekly 	Nil (No

	staff	sessions	stress on precautionary measures, especially based on any past incident in the site, if any.		additional cost is required)
Operational and Maintenance of Solar PV System	Operational staff (staff of Ensys, STELCO, MoECC&T	System operation	<ul style="list-style-type: none"> • Information on each and every component of the system and their specific function. • Specifications and requirements of the system. • Most common issues faced by Solar Systems. • Technical knowledge and practical experience on how to change components, modules, if required and carrying out maintenance work. • Troubleshooting the system. 	<ul style="list-style-type: none"> • Daily or weekly during the operation until the staff have been fully trained. • Once fully trained, they must be included in the operation team of Ensys occasionally so that they will gain more experience and retain what they have learned. 	Nil (No additional cost is required)

12 CONTINGENCY PLAN

12.1 Introduction

Although the probable impacts have been estimated based on site specific survey, studies, similar projects and consultant's experience, a contingency plan must exist to attend any unforeseen circumstances. A contingency plan will facilitate the system to return back to its original state (whether construction or operation) under unfavorable circumstances.

12.2 Performance related issues

The envisaged adverse environmental impacts of the project have been predicted to be within certain limit. In any case if these impacts are experienced at a greater extent compared to the predicted or estimated threshold levels, the project would lead to unforeseen circumstances. Under such circumstances, either the project activity (whether construction or operational) will be temporarily stopped until the impact has been mitigated to the predicted extent or an alternative solution has been sought through the responsible authorities.

12.3 Risk of natural hazards

Together with site surveys, an assessment on natural hazard vulnerability has been made at the design stage of the project. The project has been designed to withstand in a harsh coastal environment that would typically be experienced in Maldivian environment. The client would attend to any shortcomings faced and maintain the production of energy to the total capacity of the project during the 15 years' period, as per the contract terms. However, any unforeseen natural event that has not been covered in the contract will be solved via consultations with MoECC&T and relevant authorities.

13 MONITORING AND REPORTING PLAN

13.1 Introduction

It is highly important to undertake the given monitoring programme to compare those impacts predicted in this report against that of the actual impacts that take place while the physical work is going on. Such monitoring programs will help for better environmental decision making and predicting possible impacts of similar future projects. It will enhance the management of environmental matters in a synchronized manner.

Monitoring will be undertaken in all stages of the project including designing phase, pre-construction phase, construction phase and operational phase.

13.2 Monitoring cost

Other than for very few items, monitoring cost can be managed through the project budget, especially with the presence of a health and safety officer in the site, measurement of parameters can be carried out without the need for a survey team. Additional expenses are only estimated for project area fencing, making construction boards and hiring a health and safety officer. The estimated cost for these items are USD11,500. However, it can still be reduced.

13.3 Monitoring Report

A monitoring report has to be compiled at the end of each month during construction period and annually during operation period. Hence, there should be a monitoring report submitted to EPA at every month during construction and annually for 2 years during operation. Additionally, those noted to be monitored daily and weekly should be documented and kept ready to be shared with any relevant authority if requested. They should be included in the monthly monitoring report submitted to MoECC&T and EPA. There will be 7 monthly monitoring reports since the construction activity of the project will last for 7 months.

For the operation phase monitoring program, a report should be submitted to EPA MoECC&T for every year until 2 years, starting from the time when the system was brought into operation. Hence, 2 reports will be compiled during the operation stage of the project.

The monitoring report should be compiled by a certified environmental consultant. It

should include all baseline data. It should be submitted to EPA and all relevant authorities. The report can follow the below given structure, though not limited to;

- Cover page with the name of the project and consultant
- Introduction
- Details of the site at the time of survey
- Data collection and processing methods
- Data Analysis and comparison (infographics showing the comparing of all data, starting from EIA baseline data should be presented in the report)
- Quality control measures
- Limitations and sampling frequency
- Conclusion and recommendation

Table 13-1: Monitoring plan

Proposed Mitigation Measure	Parameters to be monitored	Location	Measurements (method and equipment)	Frequency of Measurement	Responsibilities (review and reporting)	Cost/USD
Detailed design and Planning Phase						
Incorporate the necessary regulatory and institutional requirements into the design. If not, must notify the supervisory body (MoECC&T) by the client (Ensys) and come to an understanding with the GoM and donor.	Obtain written comments for the final drawing set from the respective institution.	-	Submit the final drawing set to MoECC&T, MoNPH&I and HDC	-	Implementation and reporting by Ensys, Review by MoECC&T and EPA	Project budget
Approve the final engineering drawing set by certified engineers, followed by licensed local engineers (as instructed by MoNPH&I). Approve the ESMP from EPA and WBG.	Approved engineering drawing set by certified engineers Approved engineering drawing set by local engineers as requested by MNPFI Approved ESMP	-	Submit the final drawing set to MoECC&T, MoNPH&I and HDC	-	Implementation and reporting by Ensys, Review by MoECC&T and EPA	Project budget
Conduct a health screen of project staff prior to recruitment and ensure a valid work permit visa is present. Identify an emergency contact person for all of the workers hired for the project.	A worker that falls in the high risk category for Covid 19	-	Identifying the past/history of staff through interview and via document evidence	Once and weekly in toolbox sessions	Implementation and reporting by Ensys, Review by MoECC&T and EPA	Project budget

<p>Prepare a contract both in English and the language spoken by the worker and explain the terms and conditions of the contract clearly to the worker</p>	<p>A that has been made contact with a covid 19 positive case within the last 2 weeks</p> <p>A resident of house put under monitoring or quarantine due to covid 19</p> <p>An illegal immigrant</p> <p>Emergency contact person</p>					
Pre-construction phase – Site preparation						
<p>Update the construction, machinery and road closing schedules once all approvals have been obtained and pass the information to all key stakeholders including the general public.</p> <p>Especially the procedure for GRM must be made publicly aware on a public forum such as local news.</p> <p>Project team must include a health and safety office to ensure the implementation of the recommendations in ESMP.</p>	<p>Project schedule</p> <p>Road closure schedule</p> <p>Machinery list</p> <p>Project manpower</p> <p>Public announcement</p>	-	<p>Updating schedules and sharing with key stakeholders</p> <p>Putting up the public announcement in a public forum such as social media, local news etc</p>	Once and as the schedule changes	Implementation and reporting by Ensys, Review by MoECC&T abd EPA	Project budget
Fence the area where the work goes on.	Presence of a	Link road	Incorporated	Weekly	Implementation	6,000 for

<p>Erect the construction sign boards.</p> <p>Unless for a project activity, no project staff must get closer than 10ft to the airport security fence in Boashimaa Hingun. The security fence must not be crossed by any project staff under any circumstances.</p> <p>The security zone (10ft from the security fence in Boashimaa Hingun) must be kept clear off any immovable item at all times.</p> <p>Project team must include a health and safety office to ensure the implementation of the recommendations in ESMP.</p>	<p>fence around the construction area in link road and Boashimaa Hingun</p> <p>A 10ft area after the security fence in Boashimaa Hingun must be free from immovable items</p>	<p>Boashimaa Hingun</p>	<p>into construction activity</p>		<p>and reporting by Ensys, Review by MoECC&T and EPA</p>	<p>fencing</p>
<p>Construction phase</p>						
<p>Use properly maintained vehicles.</p> <p>Adopt a foundation methodology that does not involve vibro-hammering to minimize the speed of vibration.</p> <p>Plan out transportation of materials and equipment in the most efficient way with less number of trips. Plan out construction activities efficiently, reducing the number of hours vehicles are in use.</p> <p>Heavy machinery and equipment shall be fitted with air pollution control devices.</p>	<p>Noise</p> <p>Air pollution</p> <p>Ground vibration</p>	<p>Project area-1 for ground vibration and area-1 and 2 for noise and air pollution</p>	<p>Sound meter for noise measurement</p> <p>Visual inspection for air pollution and ground vibration</p>	<p>Noise and air weekly, whereas ground vibration on daily basis during foundation work</p>	<p>Implementation and reporting by Ensys, Review by MoECC&T and EPA</p>	<p>20 per survey (includes 3 parameters)</p>
<p>Plan the work to close the road for the least numbers time.</p> <p>Closing the lane during peak vehicle hours (7:30-9:30 and 15:00-17:00) is not recommended.</p>	<p>Vehicle movement restriction in link road and boashimaa Hingun</p>	<p>Link road and Boashimaa Hingun</p>	<p>Visual inspection and photographic evidence of traffic</p>	<p>Continuously during road closure</p>	<p>Implementation and reporting by Ensys, Review by MoECC&T and EPA</p>	<p>Project budget</p>

Make the road closing schedule which represents the actual scenario with correct timings and publish it on a public forum such as via local news.						
<p>No dewatering is required for any project activity. Hence, no direct impact on ground water lens.</p> <p>However, vehicle refueling (if carried out in site) and handling hazardous substances must be done with care over a hard surface.</p> <p>It is recommended to have absorbent mats to clean out any leaked substances.</p>	Oil leakage	Project area-1 and 2	Visual inspection and photographic evidence of traffic	Weekly	Implementation and reporting by Ensys, Review by MoECC&T and EPA	Project budget
<p>Use properly maintained vehicles.</p> <p>Adopt a foundation methodology that does not involve vibro-hammering to minimize the speed of vibration.</p>	Ground Vibration	Project area-1	Physical experience	Continuously during piling for foundation	Implementation and reporting by Ensys, Review by MoECC&T and EPA	Project budget
<p>Foundation design must follow the available as-built maps showing the location and depth of the utility lines.</p> <p>Use a cable detector to ensure that no cable is present before foundation work begins.</p> <p>Make prior arrangements to attend any damage to the utility lines within a short span of time. This could be arrangements with the relevant utility company.</p>	Location of utility lines	Project area-1	<p>Available as-built drawing</p> <p>By using a cable detector during construction activity</p>	Before the beginning of work in each new location in project area-1	Implementation and reporting by Ensys, Review by MoECC&T and EPA	Project budget
Use certified and experienced machinery operators.	Operator	Project	Availability of	-	Implementation	Project

<p>Use properly maintained vehicles.</p> <p>Adopt a foundation methodology that does not involve vibro-hammering to minimize the speed of vibration.</p>	<p>license</p> <p>Vehicle maintenance document/log</p> <p>Foundation design</p>	<p>area-1 and 2</p> <p>Foundation design if for project area-1</p>	<p>documents</p>		<p>and reporting by Ensys, Review by MoECC&T and EPA</p>	<p>budget</p>
<p>Use properly maintained vehicles which are in good condition without leaks.</p> <p>Brief the workers about the sensitivity of the corals and marine environment.</p> <p>Provide clear instructions prior to work on safe movement around a coastal environment and actions to avoid such as littering.</p>	<p>Vehicle maintenance document/log</p> <p>Waste and damage to the coastal environment</p>	<p>Link road area</p>	<p>Availability of documents</p> <p>Visual Inspection of the environment</p>	<p>Monthly</p>	<p>Implementation and reporting by Ensys, Review by MoECC&T and EPA</p>	<p>Project budget</p>
<p>Fence the main project areas.</p>	<p>fence</p>	<p>Project area-1</p>	<p>Fencing material such as plywood, roofing material or customized fences</p>	<p>Once and when needed</p>	<p>Implementation and reporting by Ensys, Review by MoECC&T and EPA</p>	<p>6,000 for fencing</p>
<p>Make the workforce aware of the security zone and the requirement of DASA to always keep a 10ft zone after the fence in Boashimaa Hingun free of immovable items.</p> <p>While working on roof tops, never keep items that has the potential to fall on roof edge.</p> <p>Whenever any roof top work goes on, the public should know that it is ongoing by means of some warning boards.</p>	<p>A 10ft area away from the security fence in Boashimaa Hingun</p> <p>Construction sign boards</p>	<p>Project area-1 and 2</p>	<p>Visual inspection of the area near the security fence and project rea</p>	<p>-</p>	<p>Implementation and reporting by Ensys, Review by MoECC&T and EPA</p>	<p>500 for project board</p>

<p>Appoint a health and safety officer who will ensure the implementation of ESMP.</p> <p>Prepare a safety management plan for safety measures that can be taken during the construction stage including the safe handling and storage of construction materials and equipment.</p> <p>The safety management should include the implementation and availability of safety equipment such as first aid kit, fire extinguishers, masks, high-vest, emergency evacuation plan etc.</p> <p>All site workers should wear appropriate safety gear including hardhat, safety shoes and overalls or high vest at all times while in the site.</p> <p>Site workers should be aware of safety policies and emergency plans to be followed in the site during normal work routine and emergency instances.</p> <p>Fire extinguishers and first aid boxes should be readily available within known places in the site.</p> <p>The project area should be fenced, and appropriate construction sign boards ('No Entry', 'Construction Site', 'Danger' sign boards) should be erected to warn the pedestrians and neighbors.</p> <p>Must undertake safety drills prior to the beginning of the construction stage and tool box meetings during construction period to ensure that site workers can properly follow the required safety management plans.</p>	Health and safety officer	Project site	-	-	-	5,000 per month
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<p>Conduct a health screen prior to recruitment and ensure a valid work permit visa is present.</p> <p>Identify an emergency contact person for all of the workers hired for the project.</p> <p>Must follow the covid 19 guidance note included in Appendix.</p>	Covid 19	-	Via interview and document evidence	Once and as needed	Implementation and reporting by Ensys, Review by MoECC&T and EPA	500 for project board
Operational phase						
<p>Include a contingency plan and a budget to bring changes to the angles of the installed panel if any glare issue is reported by MCAA and requires adjustments.</p> <p>During the initial period of operation, undertake close monitoring and communication with MCAA regarding the glare issue.</p>	Contingency plan	-	Via document	-	Implementation and reporting by Ensys, Review by MoECC&T and EPA	Project budget
<p>Include gaps in-between link section 1 and 5 to allow machinery access to the revetment area.</p> <p>Design modular sections that can easily be removed and reassembled without shutting down the energy production from the whole system.</p>	Gaps between link section 1 and 5	-	Via drawings	-	Implementation and reporting by Ensys, Review by MoECC&T and EPA	Project budget

14 ENVIRONMENT MANAGEMENT PLAN

14.1 Introduction

The aim of this Environmental Management Plan (EMP) is to measure, manage and mitigate adverse environmental impacts associated with the proposed development project. This EMP has been developed under the framework of Regulation 2012/R-27. This EMP will establish a framework for the project proponents to manage and control predicted impacts of the proposed project. It will include environmental monitoring, reporting, implementing measures to manage, avoid and mitigate negative impacts of the proposed project. It will further highlight the grievance redress mechanism for the project.

Additionally, the EMP will provide evidence of compliance to legislation, policies, guideline and requirements of EPA applicable to the proposed project.

14.2 Scoping of the EMP

14.2.1 Environmental impacts and Mitigation Measures

Major environmental impacts and relevant mitigation measures for the project have been given in the report.

14.2.2 EMP Management team

The below named parties are involved in undertaking the EMP of the project;

- Project Proponent – Ensys
- Contractor – Ensys
- Environmental Consultant - Foresight Surveyors Pvt Ltd completed the EIA report.
- Environmental Regulator - Environment Protection Agency (EPA)

14.2.3 Specific Roles of the Management Team

14.2.3.1 Project Proponent – Ensys

As the proponent of the project, Ensys is responsible for;

- Undertaking and executing all project related activities
- Monitoring project activities, allocating a dedicated staff to oversee and manage the project from proponent's side (Project Manager/Coordinator)

- Preparation of ESMP
- Submission of environmental monitoring report as required by EPA
- Ensure project activities are carried out in accordance to the EMP
- Report to Environmental Consultant any incidents beyond regular monitoring
- Record and rectify any environmental or health and safety incident immediately

14.2.3.2 Project Contractor – (Ensys)

The contractor of the project should be responsible for;

- Executing all project related activities as per the agreement with Project Proponent
- Monitoring project activities, allocating a dedicated staff to oversee and manage the project from contractor's side (Project Manager/Coordinator)
- Managing all project related activities and appoint a dedicated staff on site to oversee (Supervisor, Construction Foremen)
- Undertake project activities in accordance to EMP
- Report to Project Proponent any incidents beyond regular reporting
- Report any environmental or health and safety incident immediately to Project Proponent, rectify if possible

14.2.3.3 Environmental Consultant

- Preparation of EMP
- Monitoring of performance of project activities relative to the EMP
- Review the EMP to ensure desired outcomes are achieved
- Amendments to EMP as per results of reviews
- Preparation of Environmental Monitoring Report to the Proponent

14.2.4 Specific responsibilities of the key team members

14.2.4.1 Proponent's Project Manager/Coordinator

- Proponent must identify the project manager/coordinator of the project and provide his/her contact details to the key team members.
- Ensure that the project is carried out as per the approved design and EIA report.
- Must conduct daily/weekly update meetings and site visits.

- Must be experienced and familiar with the industry regulations.
- Ensure that environment monitoring reports and required project reports are shared with relevant authorities on time.
- Must be the main contact of the grievance redress mechanism.

14.2.4.2 Contractor's Project Manager/Coordinator

- Contractor must identify the project manager/coordinator of the project and provide his/her contact details to the key team members.
- Ensure that the project is carried out as per the approved design and EIA report.
- Ensure that project is carried out as per the relevant laws and regulations of Maldives.
- Ensure that project staff are provided with PPE equipment.
- Ensure that project staff are made aware of the relevant regulations, policies, standards and emergency evacuation plans of the site.
- Must consult with proponent and solve the project issues timely.
- Ensure that the site supervisor and sand pump operator sends daily work progress reports and incident reports.
- Advise and instruct the site supervisor and the sand pump operator.
- Ensure that Covid related mitigation measures are properly followed.
- Prepare reports and documents to be submitted to the client.

14.2.4.3 Contractor's Site supervisor

- Must report to the project manager directly.
- Ensure that the project is carried out as per the approved design and EIA report.
- Ensure that project staff are in good health and are provided with PPE equipment.
- Ensure that site machineries are properly maintained and operated by relevant personals.
- Update the contractor's project manager daily. Share daily progress reports with the project manager.
- Must maintain a site log where project milestones and incident reports are presented.
- Any issue/complain received must be immediately shared with project manager.

- Must plan the project work as per the instructions of the project manager.
- Ensure that project staff are familiar with emergency evacuation plans.
- Ensure that project site is fenced and relevant sign boards are erected to keep unauthorised people away.
- Must have a copy of the EIA report and follow the mitigation measures.

14.2.4.4 Environmental Consultant or Health, Safety, Social and Environmental Officer (appointed by the contractor)

- Directly report to the project manager.
- He may or may not be site based, however, the vested duties must be taken care of.
- Ensure that the project activities comply with the approved EIA and relevant laws and regulations.
- Ensure that environment monitoring is carried out and significant environmental impacts are properly managed.
- Immediately inform the project manager if any of the impact is not properly mitigated.
- Prepare documents and environmental reports to be submitted to the proponent.
- Ensure the health and social wellbeing of the project staff are maintained.
- Ensure that project staff maintain a healthy life style.
- Ensure that specific measures as highlighted by HPA and related government authorities are taken to stop the spread of vector-borne diseases such as covid.
- Ensure that arrangements are in place to attend staff in case of health emergency.

15 CONCLUSION

The current project proposed by the GoM under the ASPIRE program, it is aimed to develop the capacity to generate 5.6 Megawatt of electricity by a Solar Photovoltaic System in the Greater Male' region. The project is managed by MoECC&T on behalf of the GoM. Within MoECC&T, the Project Management Unit (PMU) will be responsible for the day-to-day implementation. The State Electric Company (STELCO) is envisaged to purchase renewable energy from private suppliers produced under ASIPRE program. The Maldives Energy Authority (MEA) establishes tariffs, issues guidelines and regulations to ensure the reliability, security of the grids, and also ensures the rights and obligations of consumers and service providers are safeguarded.

The project is awarded by the GoM on a long term contract of 15 years to Ensys Co., Ltd. Ensys will design, build, finance, own and operate the system for a period of 15 years after which the operation will be transferred to the GoM. Ensys is a foreign company based in Thailand, who has been providing services in the fields of electricity, power, energy, mechanical and environmental engineering for the past 25 years. On behalf of GoM, STELCO will take over the operation of the project after the Ensys.

The project is proposed on the pavement area of the link road between Male'-Hulhumale, southern side pavement area of Boashimaa Hinhun in Hulhumale and on roof top of 8 residential buildings in Hulhumale phase-1.

In pavement areas, the PV modules are fixed over an elevated roof structure in such a way that it covers and shades the pavement whereas in selected buildings, they will be fixed over the existing roof. The total length of the line along the pavement, including the island (empty space at the middle of the widest part of the link road) is 3,510m. The line will include a total of 10,691 panels with a capacity of 495 Wp by each link. Hence, the total installed capacity along the road side will be 5,292,045 Wp. Additional 720 panels will be installed on the roof top of the 8 selected residential buildings whose total capacity will be 356,400 Wp. Therefore, the installed total capacity under the proposed project would be 5,648,445 Wp.

There are very few and limited risk factors associated with this project that could possibly

have both financial, environmental and fatal implications given that the mentioned safety attires are worn by the workers and safety measures are properly taken in handling machineries and hazardous items. The major social impact envisaged from the project is the restriction to vehicle movement due to part of road closure during the construction stage in link road and Boashimaa Hingun. Since the proposed project site is not seen to have any significant terrestrial life, no considerable risk on biodiversity has been identified. However, unavoidable and short-term risks such as waste generation and typical minor construction related impacts are associated with the construction stage of the project.

Effective impact mitigation measures are to be undertaken during the construction and operational works. The construction work of the project should be completed within the shortest possible time to mitigate the negative impacts due to construction. A schedule that highlights the times of road closure will be made public before the events of closing begins. Only a single lane out of the 2 lanes that allow traffic movant in one direction will be closed. Hence, even though slow and restricted, vehicle flow will still be maintained in link road and Boashimaa Hingun.

In order to ensure that the envisaged impacts are within the estimated limits, environment monitoring program outlined in this report has to be followed. Undertaking environment monitoring during construction and operational phase is of uttermost importance for ensuring that the expected impacts are controlled within acceptable limitations. Monitoring has been given for each and every impact identified. Furthermore, there is a proposed Grievance Redress Mechanism (GRM) for the public and stakeholders to raise any projected related issue.

Alternatives to the proposed project in terms of design, technology, and location has been discussed in the report including the ‘no-project’ option. Although ‘No-project’ option is not favoured, alternatives to the design have been discussed. Given the prevailing issue of land scarcity in greater Male’ area and use of Solar PV system in Maldives, no favourable alternative has been suggested.

Stakeholder consultations were carried out with a large number of stakeholders of the project as highlighted in the approved ToR. The major concerns highlighted in the stakeholder meetings were the possible restrictions on traffic flow in Boashima Hingun and Link road and

undertaking construction activities within 10ft buffer area of airport's security fence in Boashimaa Hingun.

No long-term sever environmental or social impact is predicted for the project. However, due to high the socio-economic benefit of the project, it is recommended to undertake the proposed project in the proposed location. Furthermore, developing the renewable energy sector in Maldives is in line with the development goals of the Country. Decreasing the dependency on diesel powered electricity generation in Maldives with the provision of renewable energy throughout the country is one of the development goals of the government.

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17 APPENDICES

17.1 Environmental Screening Decision by EPA



203-ECA/PRIV/2021/96: رقم الملف

قرار فحص مشروع

Screening Decision

في تاريخ 05 تموز 2021 في الساعة 10:00 صباحاً في مقر الوزارة في عمان، الأردن، وافق المجلس التنفيذي للبيئة على قرار فحص مشروع تركيب نظام الطاقة الشمسية المتصلة بالشبكة في منطقة شرق عمان.

This is an official document issued to **Ensys Co., Ltd.** for communicating the decision made after screening of the project: **Proposed Installation of 5MW Grid-tied Solar Photovoltaic System in Greater Male' Region**

<p>في ضوء نتائج الفحص، من المرجح أن يسبب المشروع تأثيرات بيئية سلبية كبيرة. لذلك، يرجى تقديم تقرير تقييم الأثر البيئي.</p> <p>This project is likely to cause significant negative environmental impacts. Hence, please submit an EIA report.</p>	<input type="checkbox"/>
<p>في ضوء نتائج الفحص، من المرجح أن يسبب المشروع تأثيرات بيئية سلبية قليلة. لذلك، يرجى تقديم تقرير الفحص البيئي الأولي لهذا المشروع.</p> <p>Submit an Initial Environmental Examination for this project.</p>	<input type="checkbox"/>
<p>في ضوء نتائج الفحص، من المرجح أن يسبب المشروع تأثيرات بيئية سلبية قليلة. لذلك، يرجى تقديم خطة إدارة البيئة لهذا المشروع.</p> <p>Submit an Environmental Management Plan for this project.</p>	<input checked="" type="checkbox"/>
<p>في ضوء نتائج الفحص، من المرجح أن يسبب المشروع تأثيرات بيئية سلبية قليلة. لذلك، يمكنك المتابعة مع المشروع.</p> <p>This project is unlikely to have a significant negative impact on the environment. Hence, you may proceed with the project.</p>	<input type="checkbox"/>
<p>في ضوء نتائج الفحص، من المرجح أن يسبب المشروع تأثيرات بيئية سلبية قليلة. لذلك، سيتم استخدام التدابير المحددة في هذا القرار للتخفيف من الآثار البيئية السلبية للمشروع.</p> <p>The measures stipulated by this agency shall be used to mitigate the negative environmental impacts of the project.</p>	<input type="checkbox"/>

في ضوء نتائج الفحص، من المرجح أن يسبب المشروع تأثيرات بيئية سلبية قليلة. لذلك، يرجى تقديم خطة إدارة البيئة لهذا المشروع.

This is an environmental screening. Hence, obtain all necessary approvals/permits from other relevant government authorities before commencement of the project activities. The date of expiry stated in this Environmental Screening Decision Statement is the duration given to implement the decision made by this agency.



Screening Institution: **Environmental Protection Agency of Maldives**

Date of issue: **18th February 2021**
Date of Expiry: **18th February 2022**

Name: **Mr. Ibrahim Naeem**
Designation: **Director General**

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Signature:

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17.2 Terms of Reference (by World Bank group)

Terms of Reference: Environment and Social Management Plan (ESMP) for the Proposed Construction and Operation of 5MW Grid-tied Solar Photovoltaic System in Greater Male' Region, Kaafu Atoll, Maldives

Objective and Scope of Preparation of ESMP

In order to ensure short and long term environmental and social impacts that would arise due to the proposed 05 MW solar PV installation in Hulhule'-Hulhumale link road, Boashimaa Hingun and selected blocks in 1000 housing units are adequately mitigated and monitored, following the screening decision from EPA and the World Bank, an ESMP will need to be developed as per the scope presented below and in accordance with the Environmental and Social Management Framework (ESMF) of the Project and the Environmental Impact Assessment Regulations (2012). Field level verification should be conducted prior to the preparation of the ESMP.

While every attempt has been made to ensure that this TOR addresses all of the major issues associated with development proposal, they are not necessarily exhaustive. They should not be interpreted as excluding from consideration matters deemed to be significant but not incorporated in them, or matters currently unforeseen, that emerge as important or significant from environmental and social studies, or otherwise, during the course of preparation of the ESMP report.

Following should be the key components/assessment outline of the ESMP:

1. **Executive Summary:** An executive summary of the significant findings of the report shall be prepared both in Dhivehi and English language. The executive summary shall include summaries of project description and how adverse environmental and social impacts and risks will be resolved. The conclusion of the study must be stated.

Introduction: Describe the purpose of the project and, if applicable, the background information of the project/activity and the tasks already completed. Objectives of the development activities should be specific and if possible quantified. Identify the donors and the institutional arrangements relevant to this project. Provide details of the proponent, and institutional arrangements for implementation and operations of the proposed development, and environmental and social impacts and risks of similar projects. Include desktop studies and review of similar ESMPs and ESIA's.

2. **Legislative and Regulatory Considerations:** This chapter should cover the legal aspects related to the project. Outline the project's consistency with the existing national, state, regional and local policies and regulations that apply to the project and include reference to relevant statutory and non-statutory provisions, planning policies, guidelines, strategies and agreements as appropriate. Outline the pertinent policies, regulations and standards governing project location, land use, environmental quality, and public health and safety. This should cover regulations and laws relevant to the following key areas; environmental regulations, safety regulations and labor related regulations.

Study Area: Define and justify the proposed project area. Provide A3 size scaled plans and maps with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental and social assessment highlighting the proposed development location and size. The study area should include nearby environmentally and socially sensitive areas (Environmentally Protected Areas / Environmentally Sensitive Areas, roads, houses, mosques, schools, playgrounds, other public spaces etc.). Relevant developments in the area must also be covered including residential areas and all economic ventures and cultural sites. Moreover, existing cable routes, sewer lines, telecommunications lines within the road area needs to be mapped and identified and presented. Need to identify temporary site location for contractor mobilization.

3. **Project Description:** Provide a full description and justification of relevant parts of the project, using maps at appropriate scale where necessary. The following should be provided including all inputs and outputs related to the proposed activities shall be justified.

General Construction and Operations

- Provide a clearly labelled concept design and scaled site plan of the project boundary.
- Submit a detailed description of the components of the project and how the project activities will be undertaken including work methodologies and justifications.
- Provide project schedule and all project inputs including but not limited to equipment, manpower and machinery required. Provide details of the project outputs including but not limited to waste generated from the project and total energy output from the project.
- Describe the construction phase components of the project including temporary site setup, site clearance, levelling works, foundation works, cable laying works, mounting structure works and works undertaken for mounting of PV. Provide detailed construction methodology for each of these components including safety standards that will be followed in line with the labour management procedure developed for the project.
- Provide details of the traffic management procedure that will be followed during construction and operational phase

- Details, types and numbers of labor/workers required during construction/establishment and during operation.
- Housing needs for the construction workforce and operational workforce.
- It is a requirement of Ministry of National Planning and Infrastructure for the structure to be modular enough (for land based PV) to allow access for repair works of the revetment, suggest how and where repair of revetment is required and this will be achieved.
- It is a requirement of Housing Development Corporation (HDC) to allow provision for lighting underneath the panels (for land based PV) and therefore suggest how this has been incorporated to the design.
- Waste disposal and management during construction and operational phase of the project.
- Emergency plan in case of fire, road accidents, spills and any other unforeseen event. This shall identify the procedure that will be followed for different scenarios, the responsible parties and how the emergencies will be attended and the appropriate government institutions for reporting.
- Identify the safety equipment that will be available at the site, including but not limited to fire fighting equipment, safety signage that will be installed at each site, safety equipment that will be available. These requirements need to be identified for construction and operational phase of the project separately.
- Identify how during construction phase, environmental and social aspects are monitored by the contractor/developer and how the requirements of the Environmental Social Management Plan will be implemented.

4. **Existing Environment:** The existing environment study will not require complex data collection and survey analysis techniques since this is an ESMP and not a full ESIA study. However, the following aspects will need to be investigated and provided in the report:

1. Describe the general environment of the proposed project area with the inclusion of relevant images.
2. Describe the significance and sensitivity of the area for undertaking the project, including but not limited to information on any significant environmentally, socially, historically and culturally sensitive sites within the project impact boundary.
3. Demographic information of the project area, including but not limited to population information, employment and key economic activities undertaken.
4. General topography of the area where ground mounted PV is to be implemented.

5. Describe the general climate conditions including temperature, rainfall, wind, waves, evaporation rates, risk of cyclones and storm surges etc.
6. Summarize the key findings of glare assessment that was undertaken for the project, identifying key aspects considered to prevent glare on aircrafts and road users. The glare assessment report should be annexed to the report.
7. Summarize the key findings of structural assessments that was undertaken for the project. Should identify the suitability of each building for the purpose of the project. The full structural assessment reports should be annexed to the report.
8. Summarize the key findings from the geotechnical survey that was undertaken at the site. The full geotechnical report should be annexed to the report.
9. Baseline noise levels at each of the project sites.
10. Information on any vegetation that needs to be removed for the purpose of the project (if any). Including any in the temporary site (s).
11. Traffic information at Male-Hulhumale' link road and Boashimaa Hingun, identifying the peak traffic hours. This can be based on secondary data or a traffic survey can be undertaken if the said data is not available.
12. Information on estimated daily flight operations data for the airport. Should include data for both seaplane operations and normal flight operations. This can be based on data from airline operators and airport operators and civil aviation.
13. Information on any potential vulnerable groups or communities that maybe impacted as a result of the project.

Whenever any physical data is taken, the corresponding geographic coordinates of the location should be provided in the report.

5. **Impact Identification and assessment:** The ESMP should identify all the impacts and risks, direct and indirect, partial and full and permanent and temporary during and after construction, as well as for the operations phase and evaluate the magnitude and significance of each impact and risk. Particular attention shall be given to impacts associated with the following:

- a) Physical / Chemical: Investigate the following impacts in detail;
 - Impacts on noise pollution and disturbances (both in construction and operations)
 - Impacts on groundwater table and quality due to mobilization, construction, operations and maintenance.
 - Impacts on ground vibrations if any on nearby infrastructure (eg: road, revetment, utility lines, built structures (residential, commercial, and industrial).
 - Impacts on revetment during construction, especially during foundation works.

- Impacts on existing utility lines within the project boundary.
- Impacts on air quality.
- Marine water pollution due to spillage during material transfer.
- Risks associated with the use, storage, transportation and handling of hazardous substances such as chemicals and fuel during the construction and operation stage of the project (if any).
- Aesthetic impacts of the project, especially in relation to land based PV installation.

b) Biological: describe impacts on vegetation and fauna.

- Impact due to vegetation removal.
- Impacts to vegetation and fauna due to improper handling and driving during material transportation.
- Impacts due to material spillage during transfer of construction materials to the project island.
- Identification of environmentally sensitive areas within the project area including potential impacts.

c) Social and Cultural impact - describe impacts of road closure, nearby sensitive areas (mosques, schools etc.), health and safety of surrounding community / contracted labor and sociocultural conflict.

- Identify the persons and their families likely to be affected by the project including those who are vulnerable. This should cover information pertaining to members of families who are residing, practicing any trade, occupation or vocation in the project affected area, including those that reside in the 1000 housing unit apartments.
- Any potential impacts specific to women and children (if any)
- Impacts related to human trafficking and forced labor
- Any potential Gender Based Violence related impacts.
- Any possible impact on the livelihood assets and activities of the people in the project area since roof tops of residential buildings are to be used. Would any additional structural reinforcements be carried out in the buildings prior to the instalment of solar panels?

- Possible cultural and heritage impacts. Including any potential cultural impacts that arise due to foreign labor force mobilization.
 - Identify the social impacts/issues such as labour influx and food security. Influx of workers can lead to adverse social and environmental impacts including pressures for resources in local communities.
 - Health and safety risks for the construction workers and the staff involved during operations.
 - Health and safety risks to residents of the blocks in which PV installation is planned to be installed.
 - Any possible impacts on road users and traffic as a result of the project, including impacts due to glare.
 - Identify and assess any potential impacts on the operation of the airport due to the increased solar radiation reflection (glare) from the solar panels.
 - Access impacts for repair works at revetment.
 - COVID19 restrictions and special considerations for the contractor (potential mitigation measures may include daily temperature checks, cleaning procedures, shift roaster, arrangement for social distancing in labor camps, establishment of hand washing facilities at work site and labor camps etc.).
 - Fire hazards and risks during both construction and operation phase.
- d) Economic / Enhancement Plans: describe any potential benefits or losses to the economy.
- Employment and other livelihood opportunities.
 - Impacts to the local economy due to purchasing of locally available construction materials.
 - Impacts on electricity price.
 - Cost savings from project interventions.
 - Corporate Social Responsibility (CSR) initiatives planned by the developer during implementation phase (If any)
 - Some of these opportunities can be further developed to draw environmental and social benefits to the local area. The ESMP should identify such opportunities and develop a plan to systematically harness any such benefit.

The methods used to identify the significance of the impacts shall be outlined. One or more of the following methods should be utilized in determining impacts; checklists, matrices, overlays, networks, expert systems and professional judgment. Justification must be provided to the selected methodologies. The report should outline the uncertainties associated with impact prediction and

also outline all positive and negative/short and long-term impacts. Identify impacts that are cumulative and unavoidable.

6. Project Alternatives: Describe alternatives including the “no project option” should be presented. Alternatives examined for the project should include alternative designs, methods of foundation for PV structure and technology options which shall be evaluated from an environmental, social and economic perspective. All alternatives must be compared according to commonly accepted standards and norms and international standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options shall be specified for each of the alternative proposed. In addition, alternatives considered to avoid/minimize/mitigate adverse social and environmental impacts needs to be specified in this section.

7. Mitigation and management of adverse impacts: Identify possible measures and actions to avoid, minimize or mitigate significant adverse impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures. Mitigation measures should be provided to all individual impacts identified in section 5 under impacts of this ToR. Mitigation measures for both construction and operation phase shall be identified. Provide a cost estimate of the personnel, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. Details of the staff from the developer side responsible for implementation of the Environmental Social Management Plan (ESMP) should be provided. In cases where impacts are unavoidable arrangements to compensate for the environmental and / or social effects should be explained.

Mitigation measures should be presented in a matrix consistent with the format provided below.

Project Activity	Potential Environmental and Social Impacts	Proposed Mitigation Measures	Institutional Responsibilities (Implementation and Supervision)	Estimated Quantities Required and Material Specifications Recommended	Cost Estimates	Comments (e.g. primary, Secondary or cumulative impacts)
Detailed design and planning Phase						
Pre-Construction Phase -Site Preparation						
Construction Phase						
Operation and Maintenance Phase						

The proposed ESMP matrix should be translated to Dhivehi language and provided as an Annex to the report.

8. Grievance Redress Mechanism (GRM): Should outline the Grievance Redress Mechanism developed for the project and its implementation procedures; persons responsible for addressing the grievances at each level of the GRM and information communication on the GRM specifically to the tenants of the housing units and to the general public. Provide details of the public displays that will be used to advertise the GRM in public places and work sites.

A specific GRM needs to be proposed to the labor force in addition to the project GRM. The GRM should establish clear mechanism to address concerns of the work force.

In addition to the project based GRM, based on the consultations with relevant stakeholders described in section 13 of this ToR, establish a mechanism to quickly report and address the concerns of various stakeholders on the project. This should include the following:

1. Ministry of National Planning and Infrastructure regarding concerns of impacts on revetment.
2. Maldives Police Service regarding accidents at link road.
3. Maldives Civil Aviation Authority regarding glare impacts on aircrafts
4. Utility service providers regarding impacts on utility lines.
5. Directorate of Aviation Security Administration regarding airport safety.

9. Monitoring and Reporting Plan:

10.1. Monitoring Program: Identify the critical issues requiring monitoring to ensure compliance with mitigation measures, and present impact management and monitoring plan for glare issues, traffic issues, vegetation clearance (if any), soil, groundwater, noise and air quality, t and grievance redress. Details of the monitoring program should include the physical, biological environmental and social parameters/indicators for monitoring, monitoring indicators to be measured for evaluating the performance of each mitigation measure, frequency of monitoring, monitoring methodologies, documentation procedures, cost commitment from persons responsible for monitoring (with a commitment letter), time frames for monitoring and reporting procedures.

The recommended format for presenting the monitoring program is given below.

Proposed Mitigation Measure	Parameters to be monitored	Location	Measurements (Incl. methods & equipment)	Frequency of Measurement	Responsibilities (Incl. review and reporting)	Cost (equipment & Individuals)
-----------------------------	----------------------------	----------	--	--------------------------	---	--------------------------------

Detailed design and planning Phase						
Pre-Construction Phase						
Construction Phase						
Operation and Maintenance Phase						

10.2. Reporting Procedures and Implementation Schedule: The consultant should propose adequate reporting mechanisms with frequencies for the implementation of the ESMP and the proposed monitoring program.

10.3. Cost Estimates and Sources of Funds: Implementation of mitigation measures mentioned in the ESMP will involve an initial investment cost as well as recurrent costs. The ESMP should include costs estimates for each mitigation measure, which is to be covered under section 9. In addition to this, estimated costs shall be provided (separate for construction and operational phase activities) for specific items and materials that the contractor and the operators would require to implement the ESMP effectively. Such items may include the cost of purchasing PPEs, fire extinguishers, signage, trainings etc.

10. Management of Other On- or Off-Site Environmental Pollution Control and Infrastructure

This section should address management of critical elements of pollution control and infrastructure that are not otherwise included in the mitigation plan because they were considered an essential part of the proposed project.

11. Summary of all Training Recommendations

This section should include programs targeted to increase the capacity of the contractor and the operator in the implementation of the ESMP. The following trainings should be part of the training program to a minimum:

- Strengthening the capacity of the contractor on ESMP implementation and reporting.
- Strengthening the capacity of the contractor on Grievance Redress Mechanism and reporting mechanism.
- General awareness on health and safety of the contractor’s work force.
- Contractor’s code of conduct.

- Operation and Maintenance training of the Solar PV system.
- Health and Safety training for contractor’s workforce both for construction and operation phase. This should cover fire safety training and fire drills as well.

The format below can be used when proposing the training requirements.

Institutional Strengthening Activity	Position(s)	Scheduling	Responsibility(is)	Cost Estimates	
Training Activity	Participants	Types of Training	Content (modules, Etc.)	Scheduling	Cost Estimates

12. Contingency Plans

Contingency plans shall be prepared and described to address: a) failure to meet specific performance criteria established by law or necessary for the project to meet its commitments in the ESMP and b) respond to natural and other risks previously identified and mitigated in the ESMP in the event reasonable and feasible mitigation measures to address the risks are inadequate.

- Performance-related Contingency Plans, indicating the steps that will be taken should monitoring indicate that:
 - Environmental standards are not being met
 - Impacts are greater than predicted
 - Mitigation measures and/or rehabilitation are not performing as predicted
- Natural Disaster Risk Response Plan (assumes that risk identification and risk reduction have been addressed in other parts of the assessment)
- Other Risks Response Plans (assumes that risk identification and risk reduction have been addressed in other parts of the assessment)
- Contingency plans for maintaining service or reducing downtime in the event of accidents or natural catastrophes that disrupt project operation

13. Stakeholder consultation: Identify appropriate mechanisms and strategies for providing information on the development project and the GRM to relevant stakeholders. Consultations must be undertaken with all key stakeholders – including communities, government officials etc. As approvals have been attained from all the stakeholders in writing prior to bidding, the consultation should focus on how to address any complications that may arise during project implementation phase. This consultation should be used to develop a mechanism to address and respond to potential

issues immediately and to refine the Grievance Mechanism as highlighted under section 8 of this ToR. The report should include a list of people/groups consulted, their contact details and summary of the major issues discussed and outcomes. The following people or institutions should be consulted.

- Utility Service providers whose services run through the proposed route
- Housing Development Corporation
- Maldives Civil Aviation Authority
- Directorate of Aviation Security Administration
- Ministry of National planning and Infrastructure
- Maldives police service
- Maldives Airports Company Limited
- Ministry of Transport
- Male' City Council

This chapter should provide a summary of the actions taken prior to bidding to secure the sites. Also it should provide details of how the project affected communities (especially tenants of the 1000 housing units) will be provided with project information in a timely manner. This should include information like project schedule, project information sheets, information on grievance redress mechanism etc. A plan of communicating this information to the tenants need to be developed and presented in the report with clear timelines.

The consultant should take into consideration COVID19 safety measures during consultations, follow WHO/WB & GoM guidelines when conducting consultations and explore remote/online options when conducting consultation.

14. Validation and Disclosure

The draft executive summary and the ESMP (matrix table in mitigation chapter) in local language should be disclosed in all major stakeholders and the tenants of 1000 housing units. This should be completed prior to or at the time of submitting the report to the EPA and the World Bank for clearance, so the period for public commenting can be sequenced in parallel to the review process. The consultant will assist the project in the disclosure of documents in all major affected settlements and at island and national level. The final cleared version of the report will be disclosed in major project websites and social media platforms with a summary of major findings through the disclosure process reflected as an annex.

15. Conclusion

This section shall specify the environmental acceptability of the project, taking into account the impacts and measures identified during the assessment process. It shall also identify any other conditions or external requirements for ensuring the success of the project.

Presentation- The ESMP report, to be presented in digital format, will be concise and focus on significant environmental and social issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The ESMP or EISA report will be organized according to this TOR, in accordance to, but not necessarily limited by, the outline the Environmental Impact Assessment Regulations (2012) and the ESMF of the project. The report shall include Dhivehi translations of the executive summary and the ESMP matrix. All raw data collected, including maps and surveys should be submitted in Raw form to the client in digital format.

17.3 Project area Map

PROJECT AREA

Proposed Installation of 5MW
Grid-Tied Solar Photovoltaic System
in Greater Male' Region
Kaafu Atoll

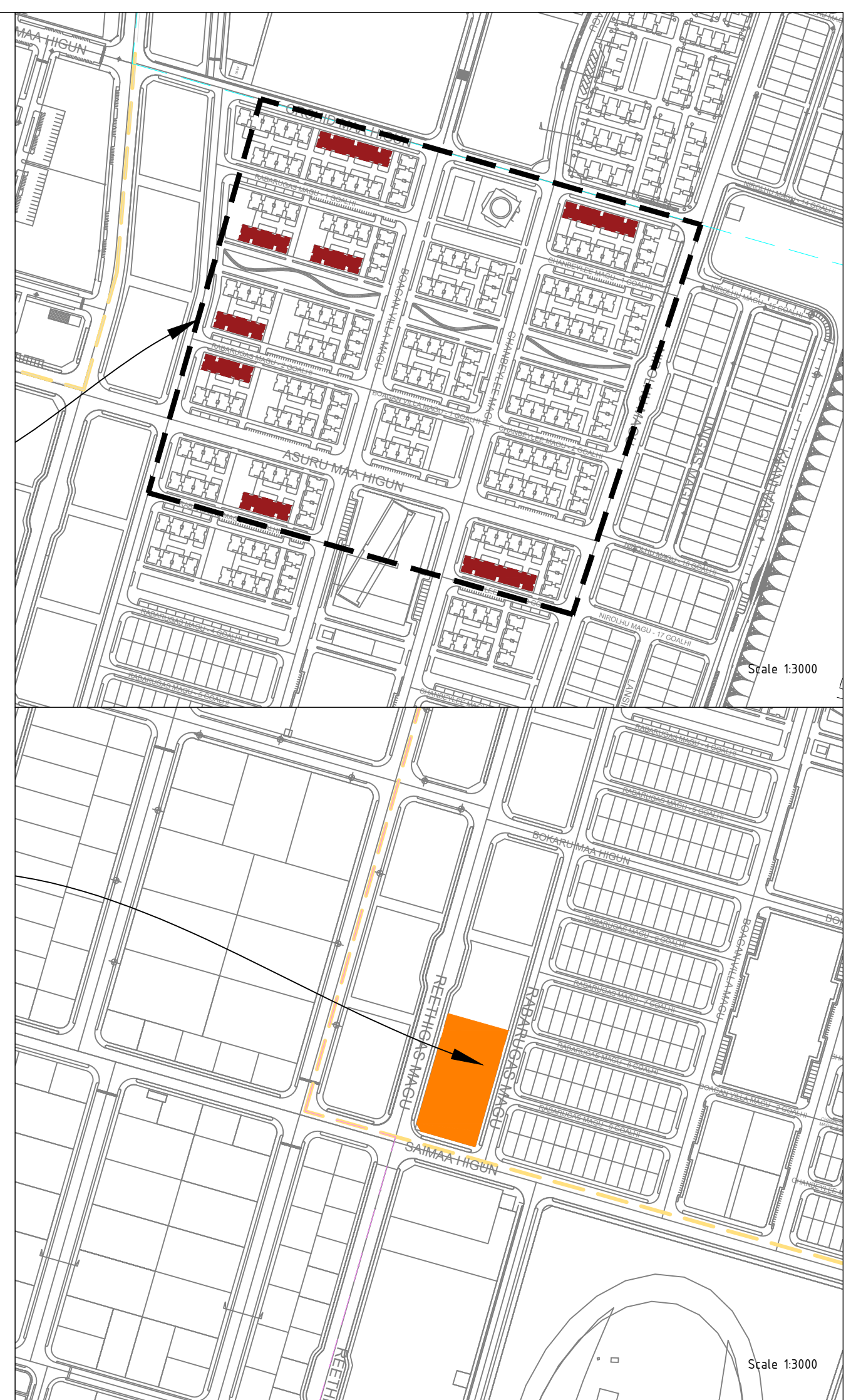
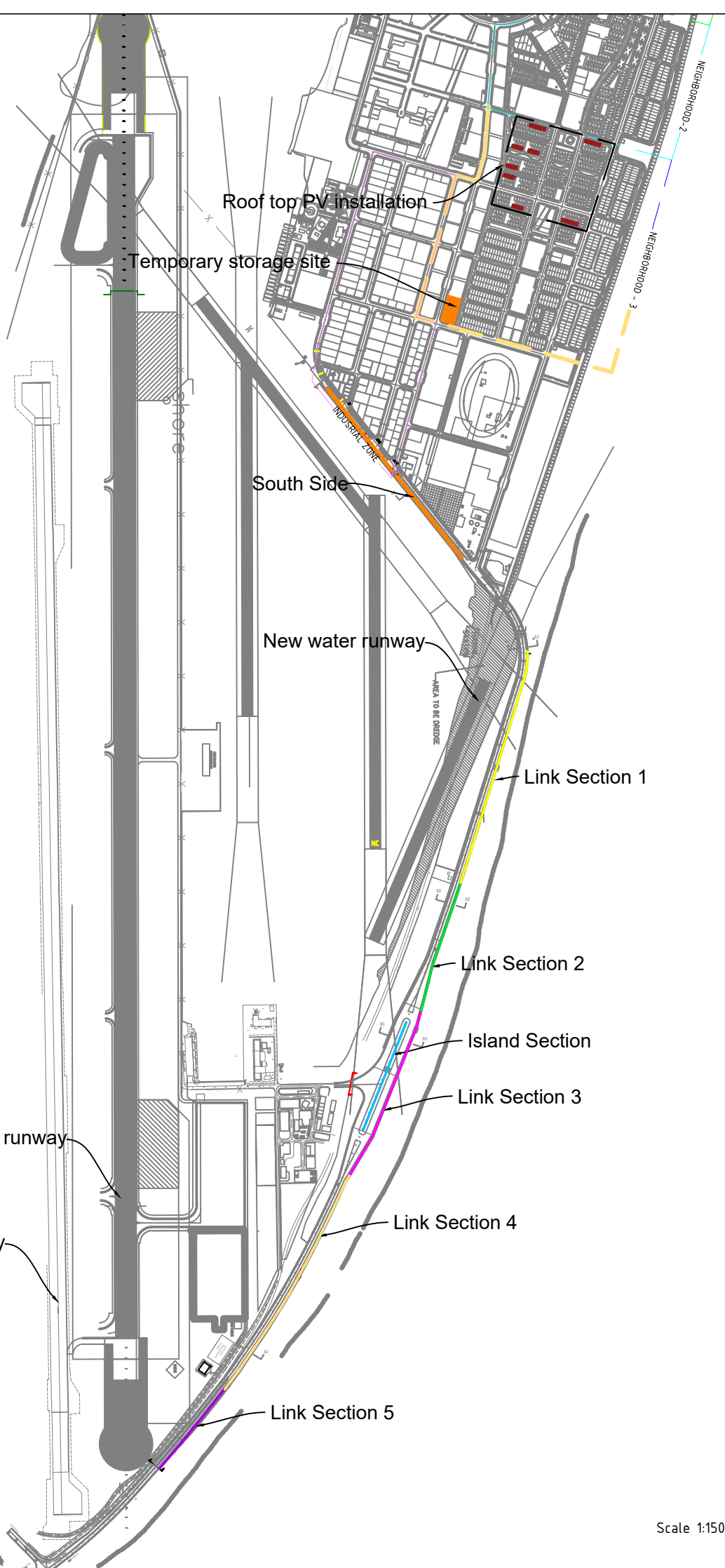
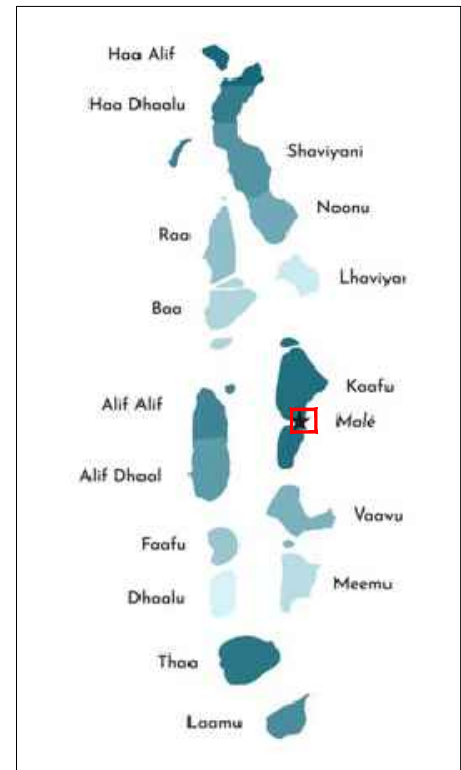
FORESIGHT SURVEYORS 2021

Environment and Social Management
Report

Ellipsoid: WGS84
Projection: UTM Z43 N
Unit: Meter

NOTE:

- Project is proposed in 2 distinctive area.
- Area-1, Eastern side pavement area of Male' and Hulhumale link road, Southern side pavement area of Boashimaa Hingun (Hulhumale)
- Eight residential flats for roof top installation
- Temporary storage area in Hulhumale



As Given

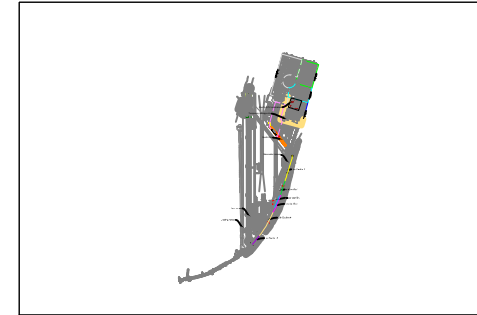
17.4 Survey location Map

SURVEY LOCATION MAP

Proposed Installation of 5MW
Grid-Tied Solar Photovoltaic System
in Greater Male' Region
Kaafu Atoll

FORESIGHT SURVEYORS 2021

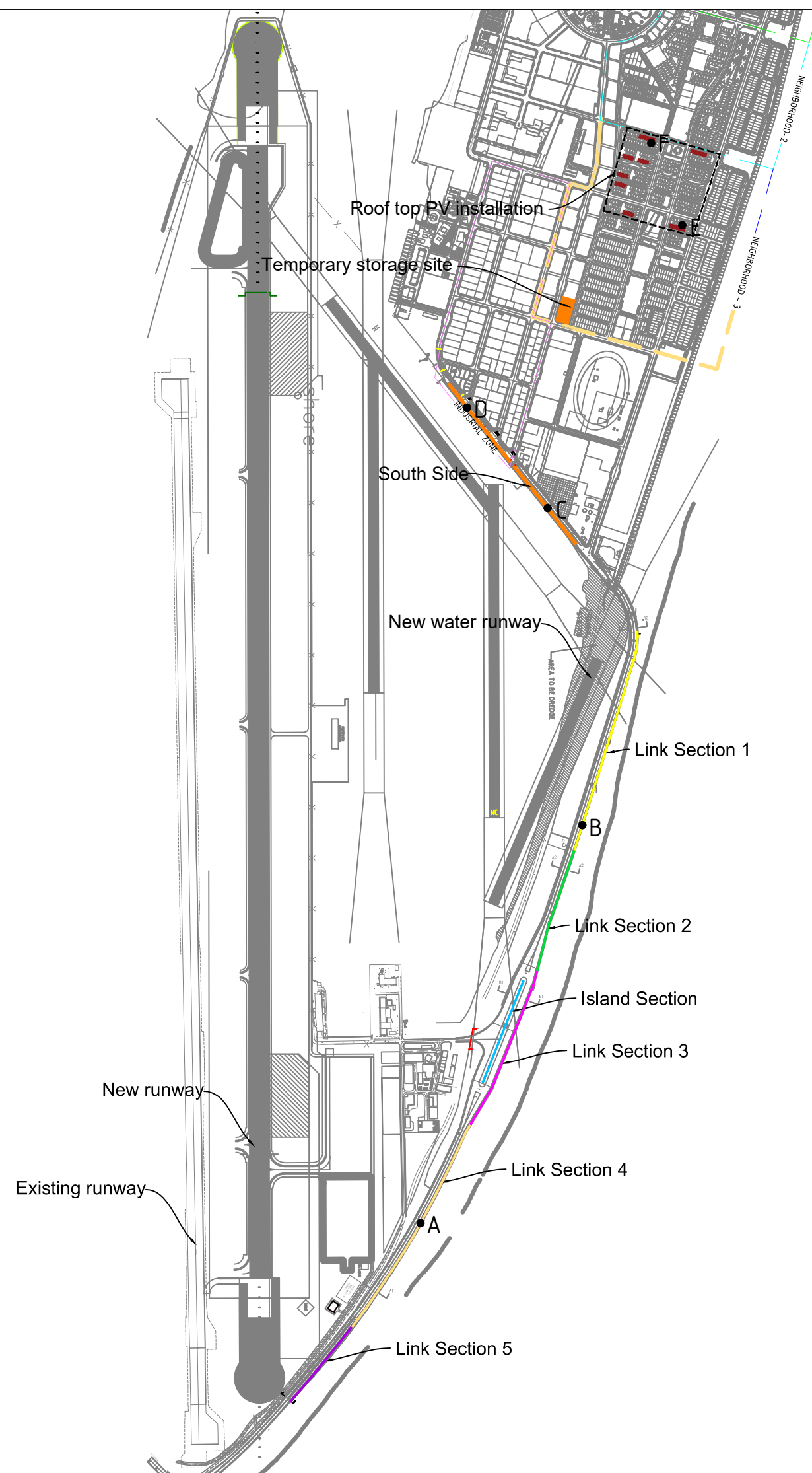
Environment and Social Management
Report



Ellipsoid: WGS84
Projection: UTM Z43 N
Unit: Meter

POINT COORDINATES:

A	4°10'56.59" N 73°32'5.50" E
B	4°11'41.84" N 73°32'24.02" E
C	4°12'7.88" N 73°32'21.05" E
D	4°12'20.02" N 73°32'11.64" E
E	4°12'37.53" N 73°32'32.28" E
F	4°12'45.47" N 73°32'29.56" E



Scale 1:15000



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Male' 20128, Republic Maldives
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URL: www.foresightsurveyors.com

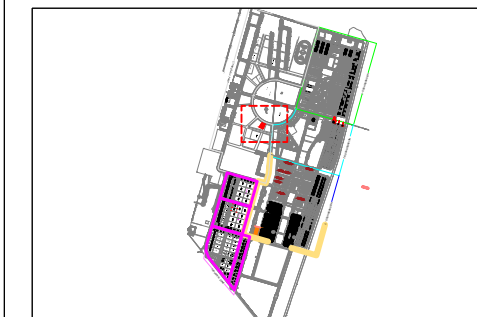
17.5 Topographic Survey Map

TOPOGRAPHIC SURVEY

Proposed Installation of 5MW
Grid-Tied Solar Photovoltaic System
in Greater Male' Region
Kaafu Atoll

FORESIGHT SURVEYORS 2021

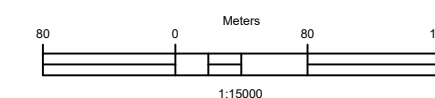
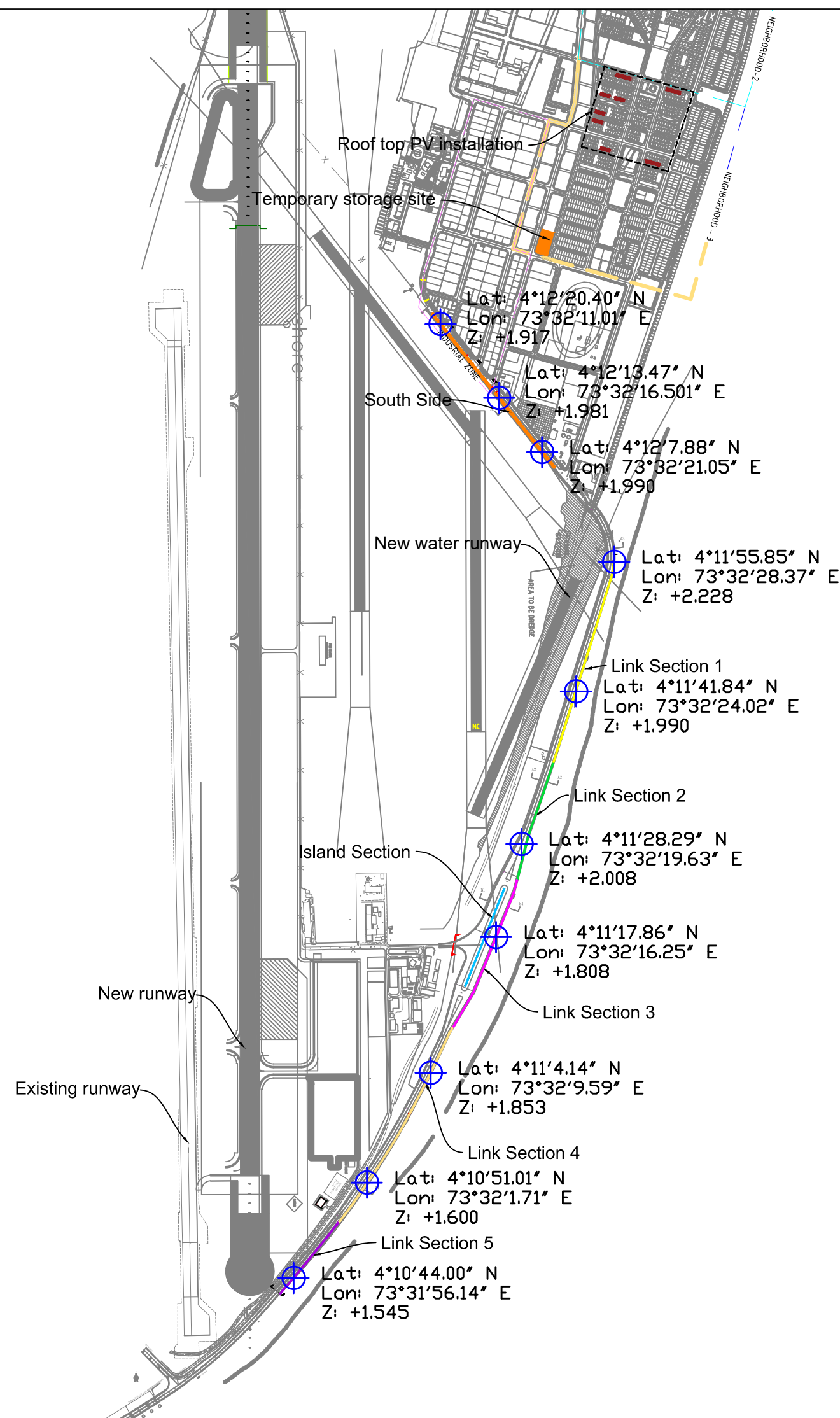
Environment and Social Management
Report



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Unit: Meter

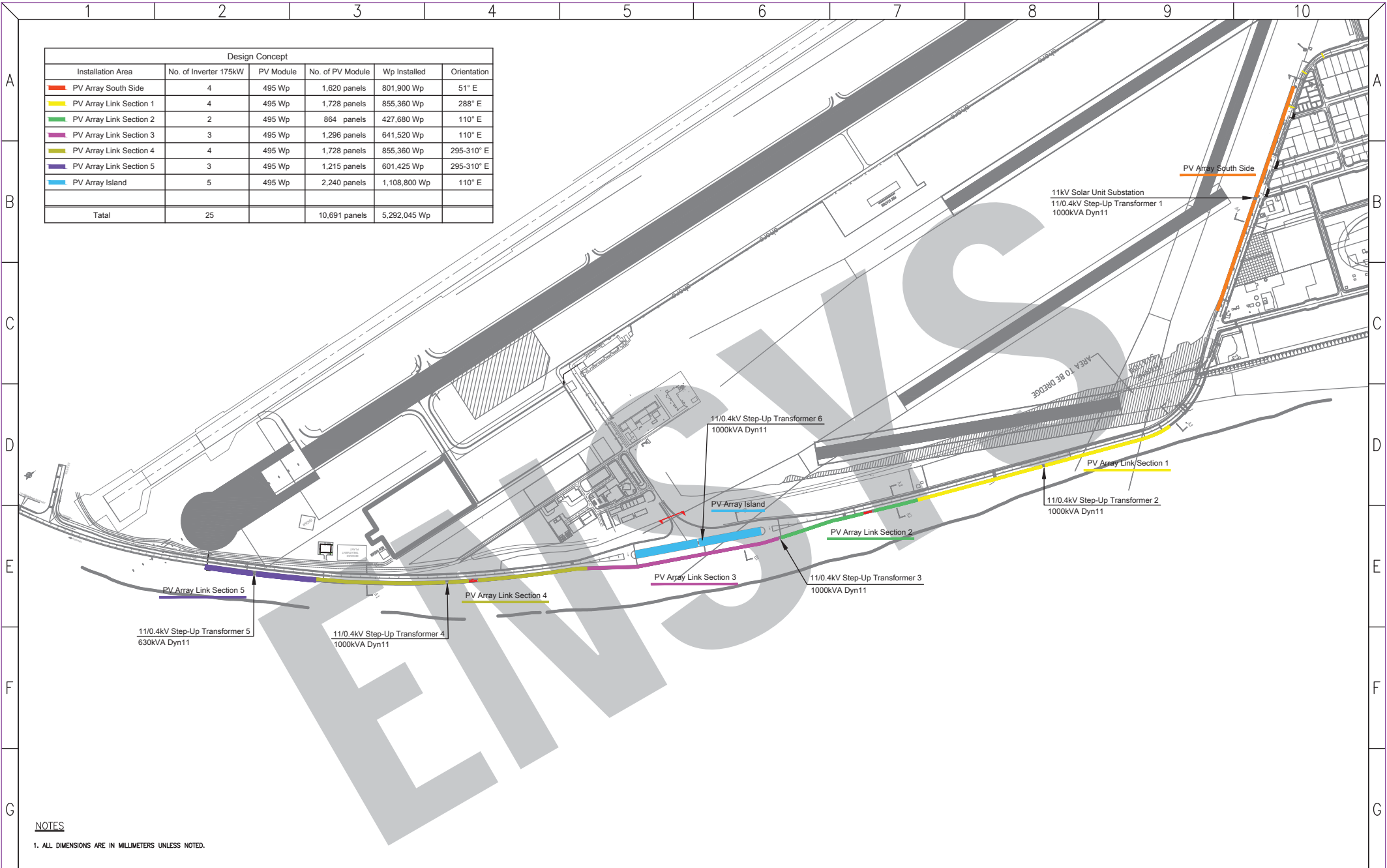
LEGEND:

⊕ Topography data point



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17.6 Project Concept



Design Concept					
Installation Area	No. of Inverter 175kW	PV Module	No. of PV Module	Wp Installed	Orientation
PV Array South Side	4	495 Wp	1,620 panels	801,900 Wp	51° E
PV Array Link Section 1	4	495 Wp	1,728 panels	855,360 Wp	288° E
PV Array Link Section 2	2	495 Wp	864 panels	427,680 Wp	110° E
PV Array Link Section 3	3	495 Wp	1,296 panels	641,520 Wp	110° E
PV Array Link Section 4	4	495 Wp	1,728 panels	855,360 Wp	295-310° E
PV Array Link Section 5	3	495 Wp	1,215 panels	601,425 Wp	295-310° E
PV Array Island	5	495 Wp	2,240 panels	1,108,800 Wp	110° E
Total	25		10,691 panels	5,292,045 Wp	

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED.

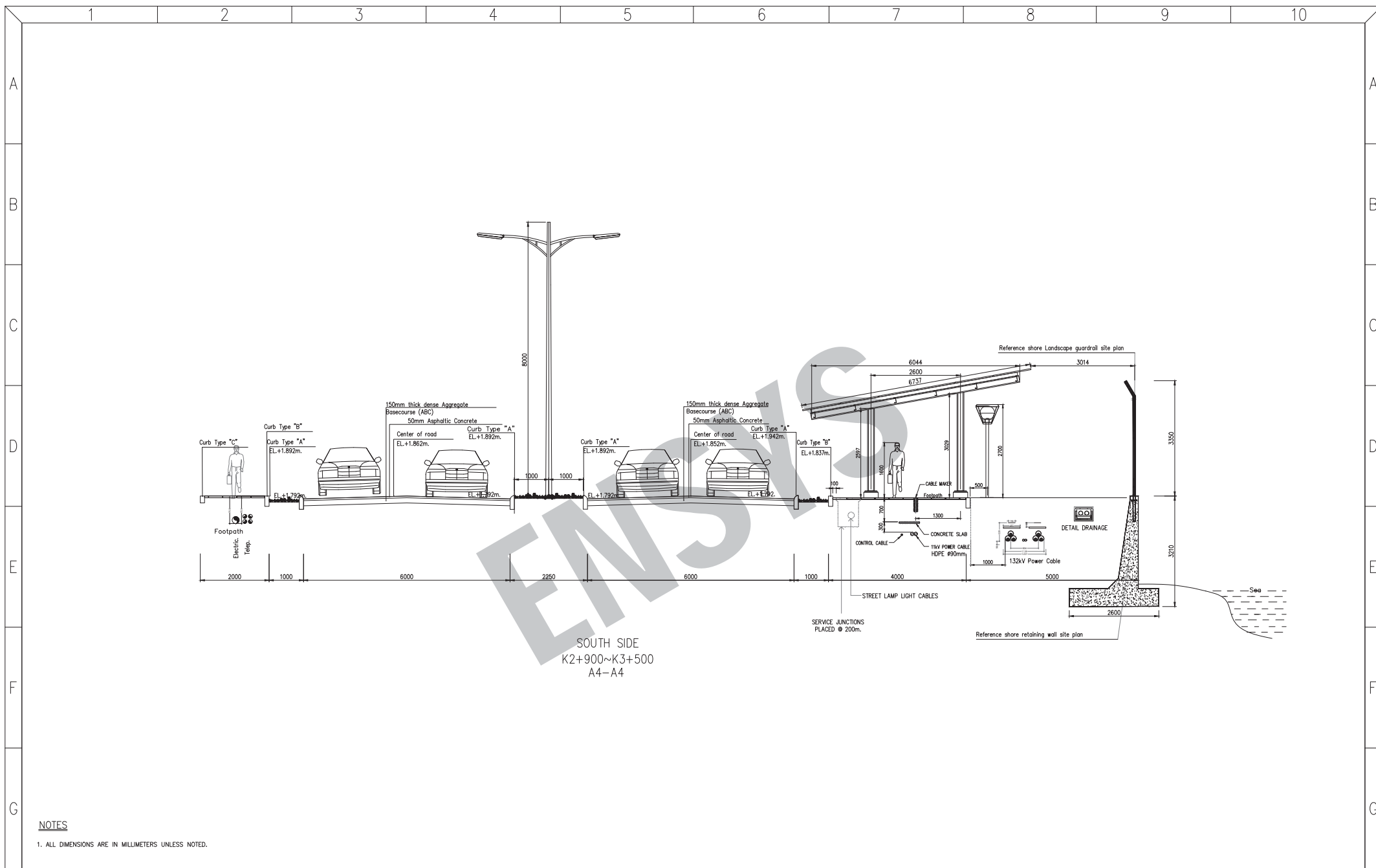
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SANITARY ENGINEER										APPROVED		ENSYS	PV ON GROUND LAYOUT PLAN
MECHANICAL ENGINEER										SCALE	1:5000	REV.	DWG.NO.
ENGINEER CERTIFICATION	NAME	REGISTER NO.	SIGNATURE	DATE	INDEX	DESCRIPTION	DATE	NAME	SHEET	OF	SIZE	A1	ENSYS-EE-DWG-XXX





ARCHITECTS										POSITION	DATE	NAME	PROJECT
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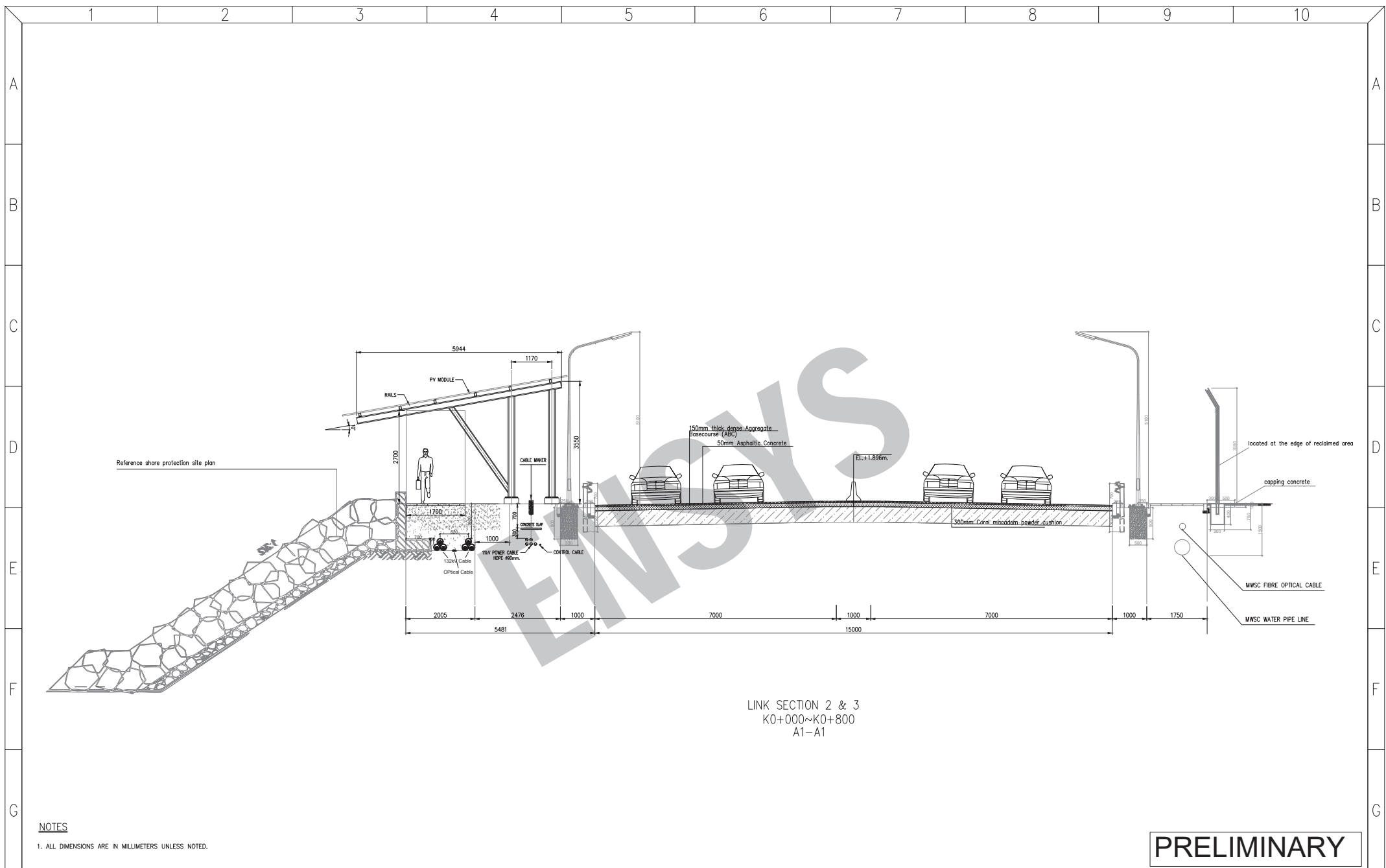
Sectional drawing



NOTES
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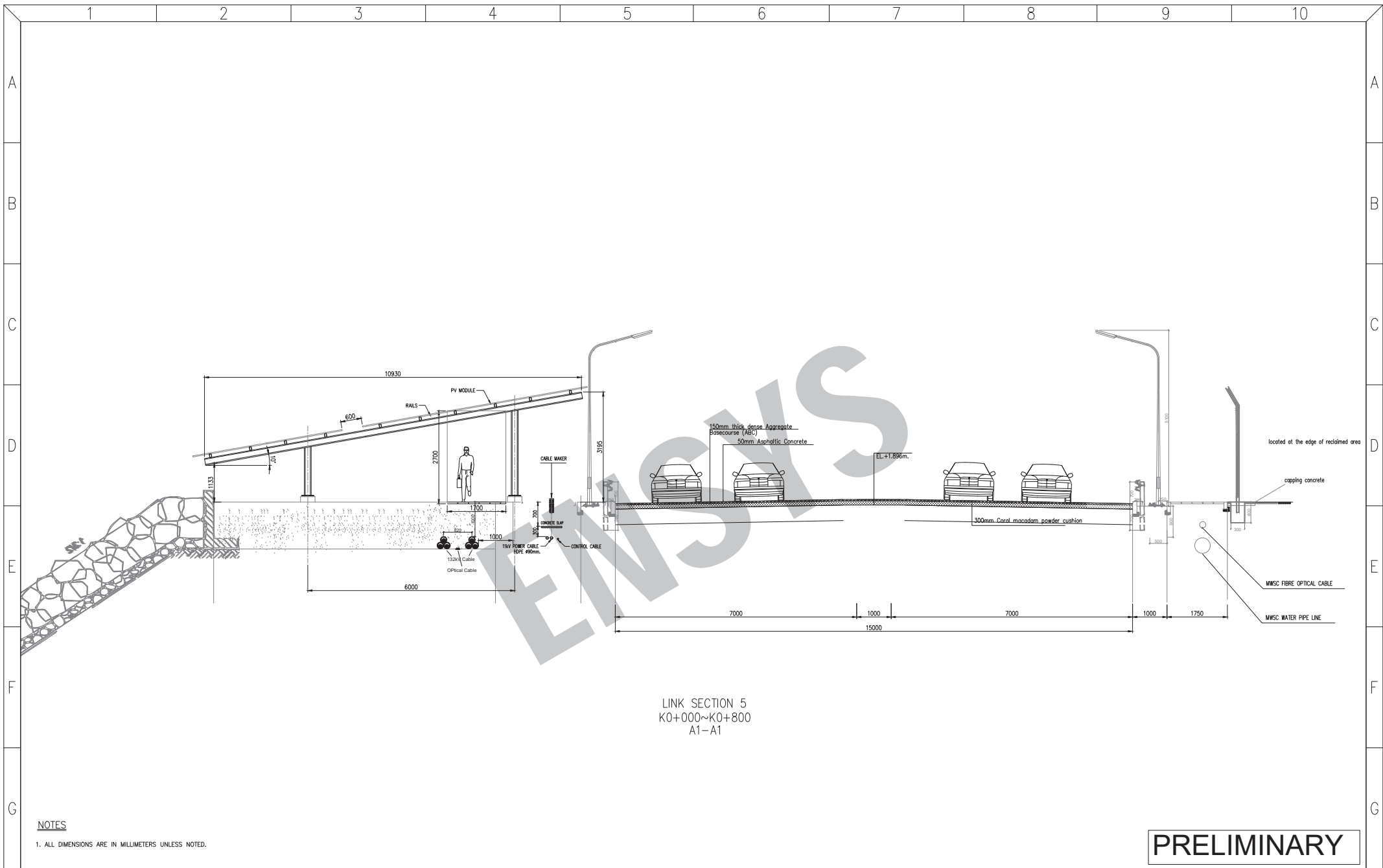


LINK SECTION 2 & 3
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PRELIMINARY

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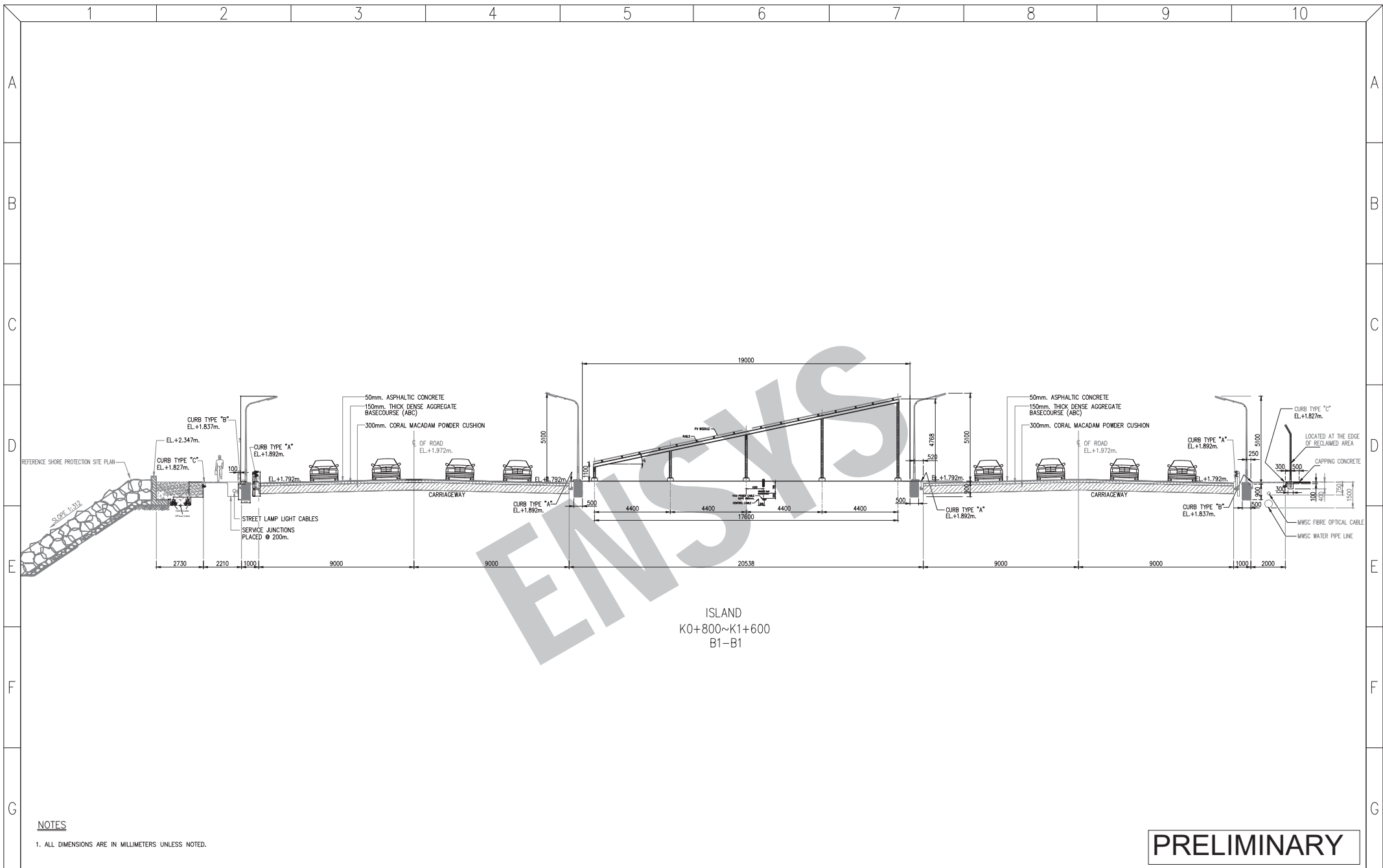
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PRELIMINARY

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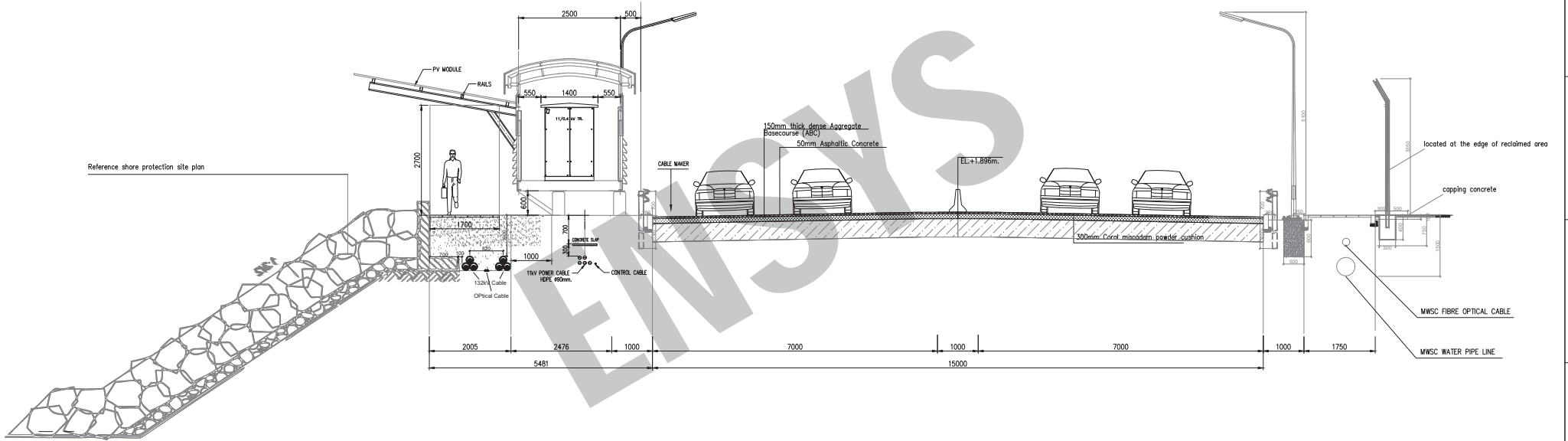
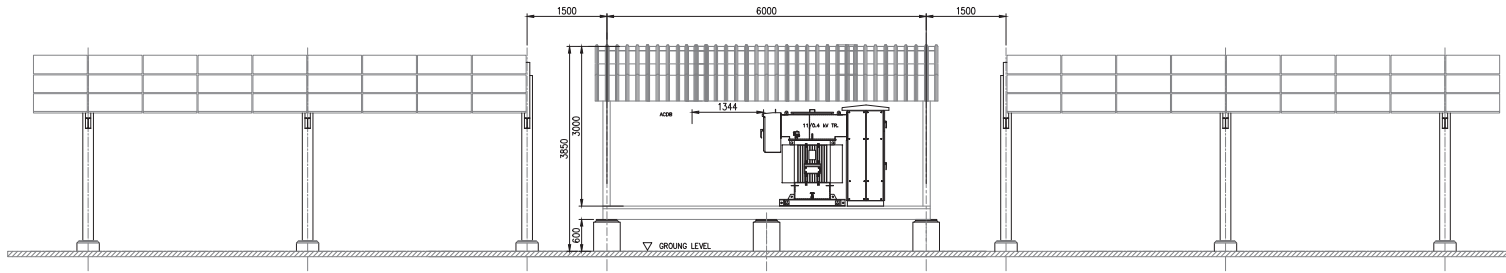
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PRELIMINARY

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TRANSFORMER STATION LINK ROAD
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A1-A1

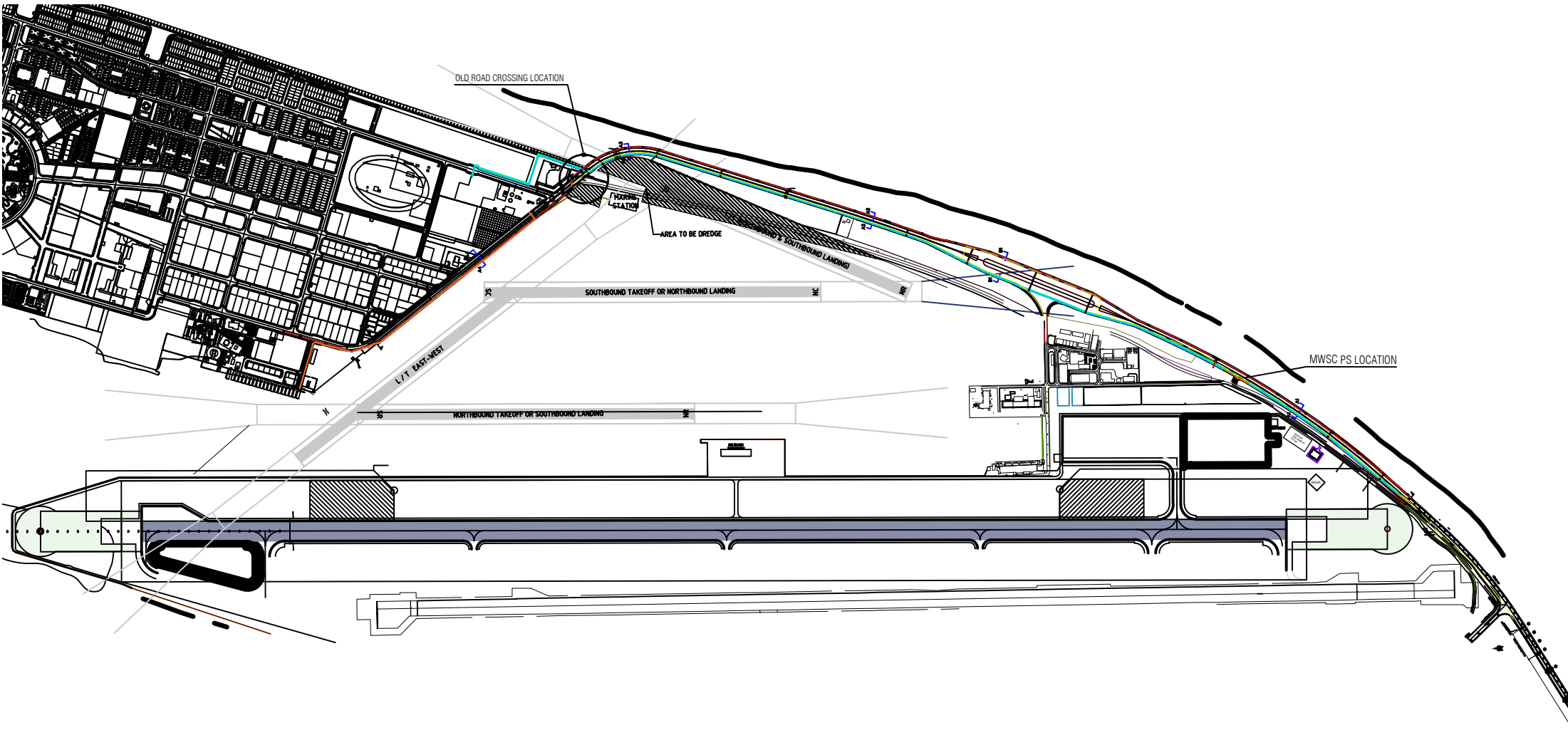
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PRELIMINARY

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											A1	ENSYS

17.7 Locations of Utility lines in the project area



FIBRE OPTICAL CABLE
DEPTH: 0.75 METERS

WATER PIPELINE	-ZONE A
DEPTH: 1.3 - 1.5 METERS	
WATER PIPELINE	-ZONE B
DEPTH: 1.7 - 1.8 METERS	

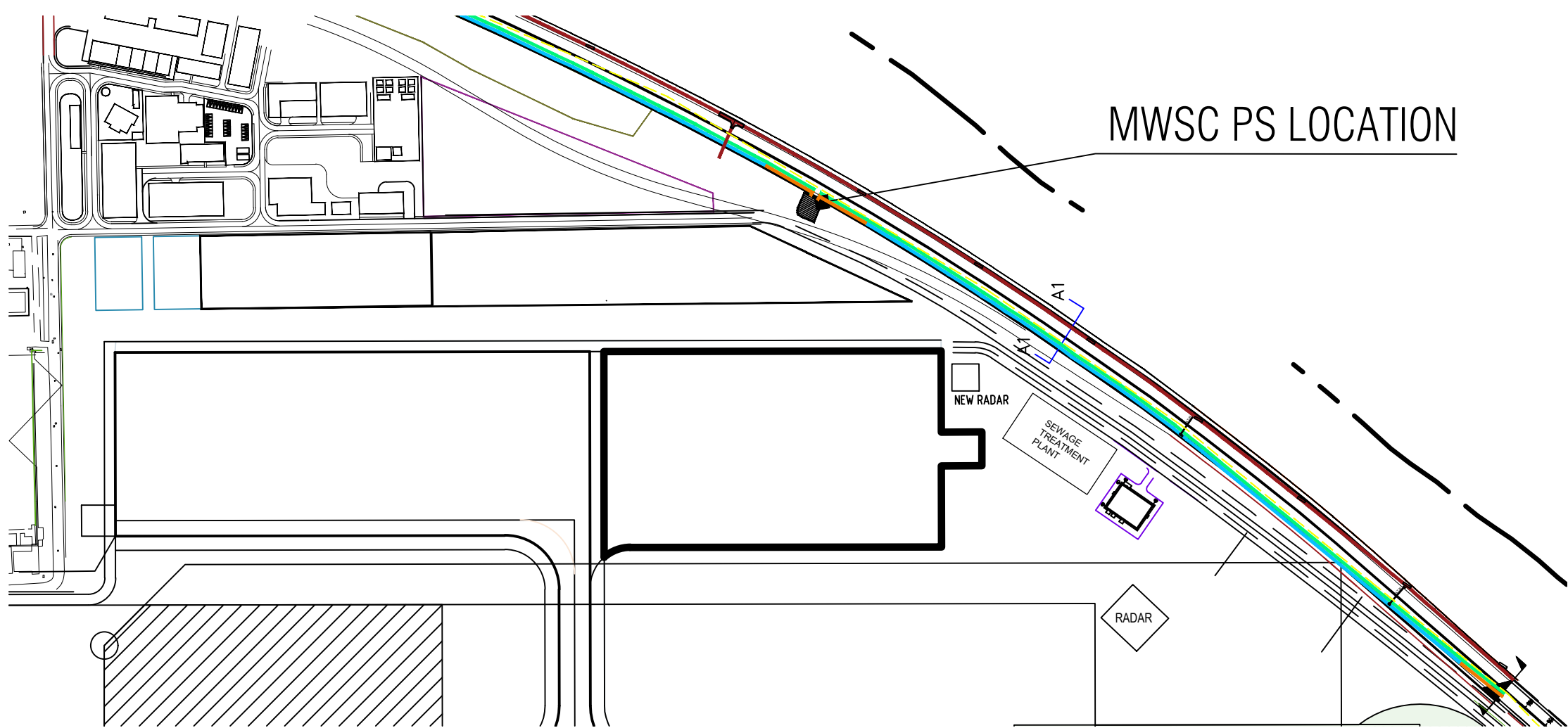
STELCO 132KV PIPES

MWSC FUEL PIPELINE ROUTE

DHIRAAGU PROPOSED DUCT
DHIRAAGU EXISTING DUCT



HOUSING DEVELOPMENT CORPORATION
PLANNING AND DEVELOPMENT DEPARTMENT
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REPUBLIC OF MALDIVES
TEL. +(960)3353535, FAX +(960)3358892
EMAIL : planning@hdc.com.mv



FIBRE OPTICAL CABLE
DEPTH: 0.75 METERS

WATER PIPELINE -ZONE A
DEPTH: 1.3- 1.5 METERS

WATER PIPELINE -ZONE B
DEPTH: 1.7- 1.8 METERS

STELCO 132KV PIPES

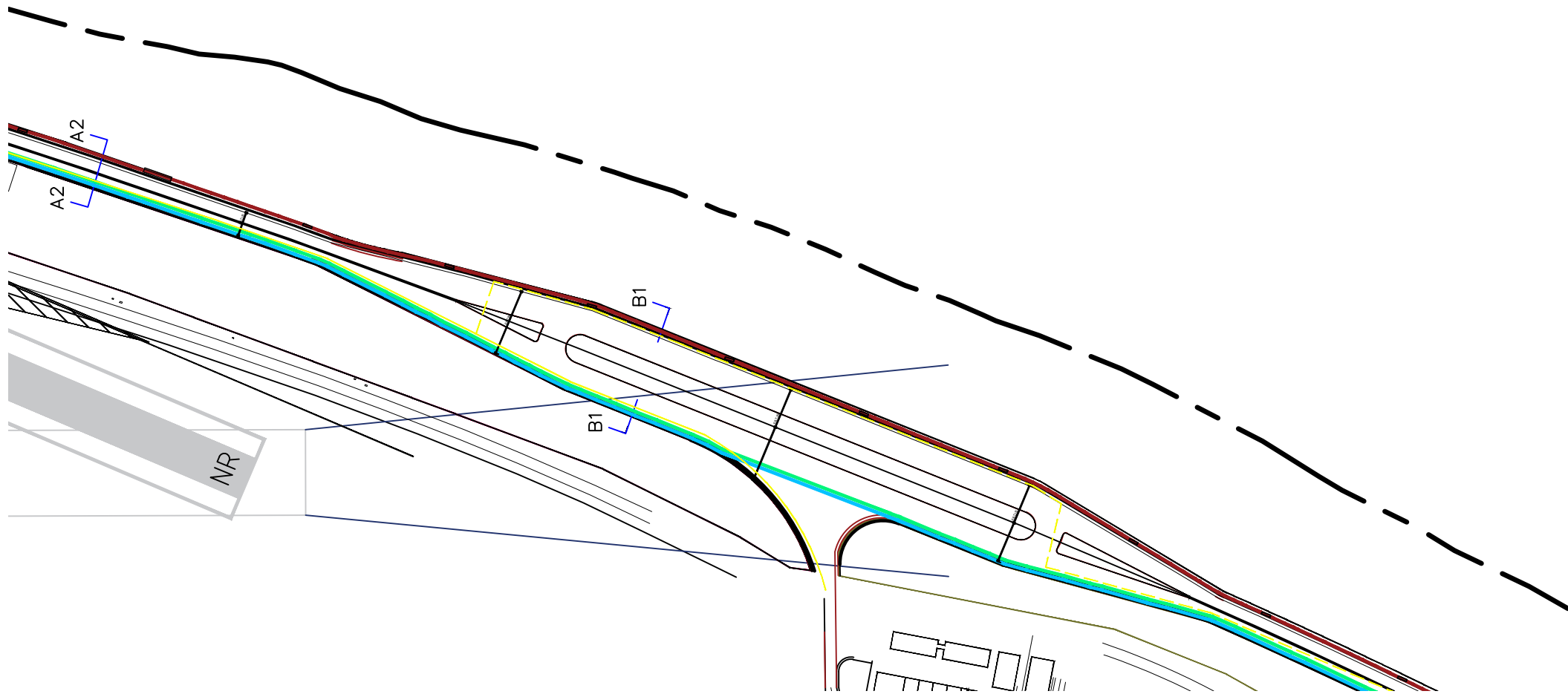
MWSC FUEL PIPELINE ROUTE

DHIRAAGU PROPOSED DUCT

DHIRAAGU EXISTING DUCT



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FIBRE OPTICAL CABLE
 DEPTH: 0.75 METERS

WATER PIPELINE	-ZONE A
DEPTH: 1.3- 1.5 METERS	
WATER PIPELINE	-ZONE B
DEPTH: 1.7- 1.8 METERS	

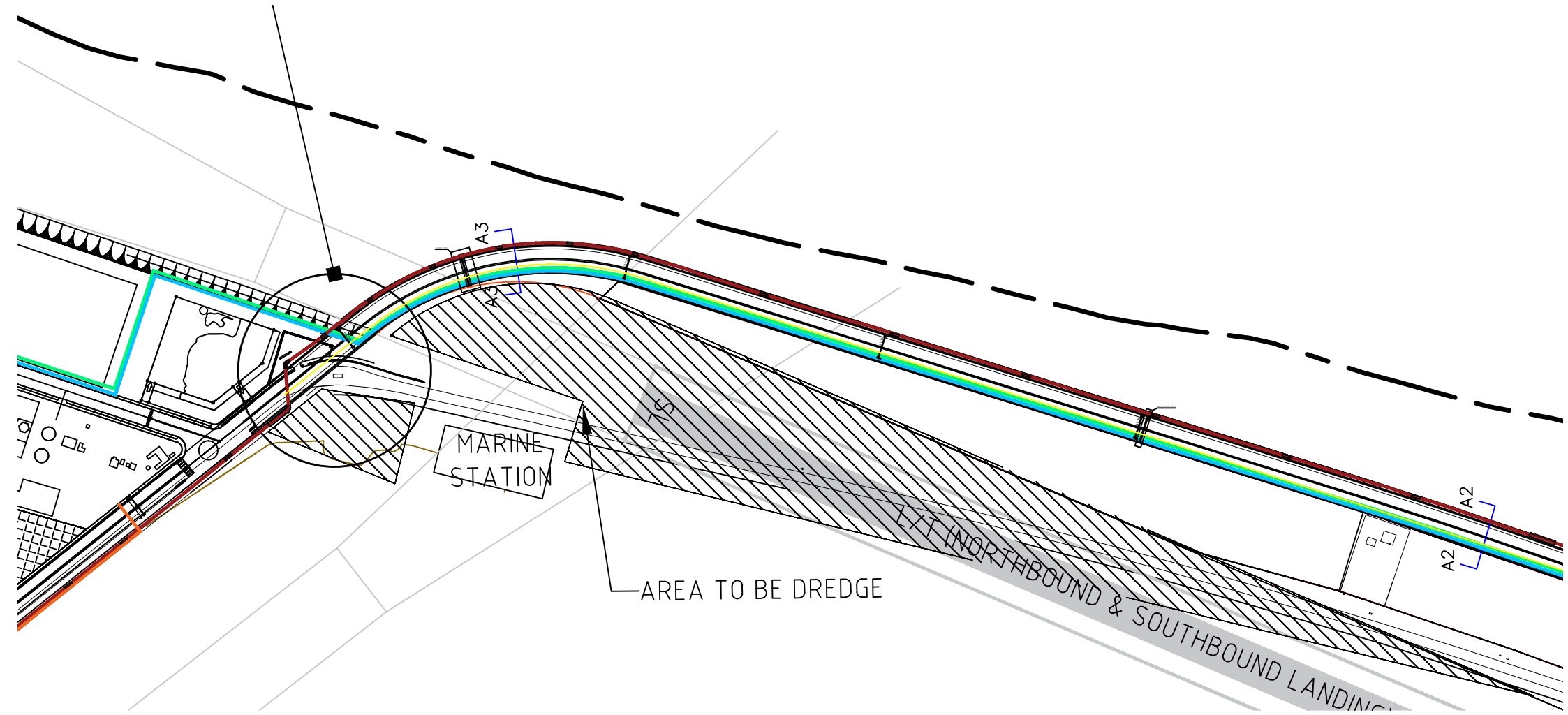
STELCO 132KV PIPES

MWSC FUEL PIPELINE ROUTE

DHIRAAGU PROPOSED DUCT
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FIBRE OPTICAL CABLE
DEPTH: 0.75 METERS

WATER PIPELINE DEPTH: 1.3- 1.5 METERS	-ZONE A
WATER PIPELINE DEPTH: 1.7- 1.8 METERS	-ZONE B

STELCO 132KV PIPES

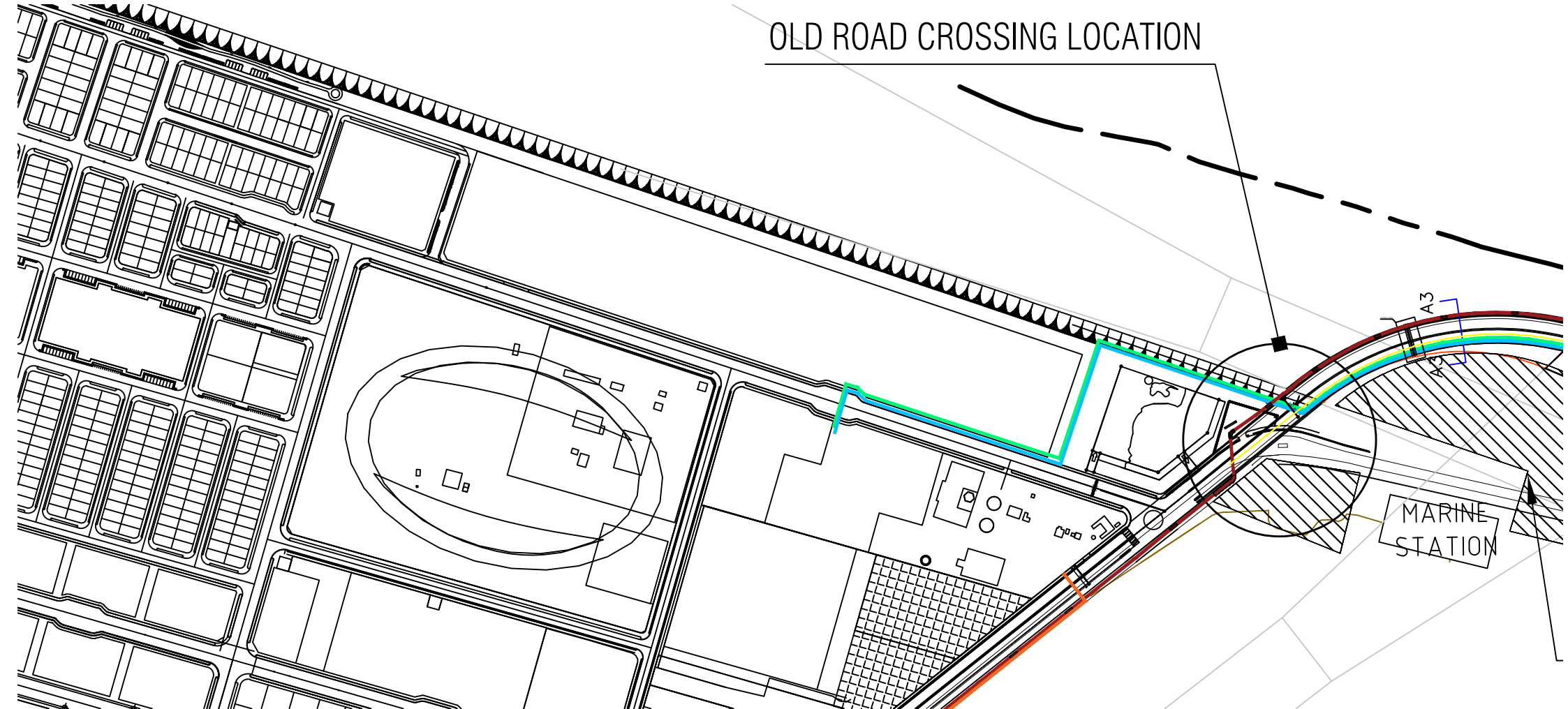
MWSC FUEL PIPELINE ROUTE

DHIRAAGU PROPOSED DUCT
DHIRAAGU EXISTING DUCT



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OLD ROAD CROSSING LOCATION



FIBRE OPTICAL CABLE
DEPTH: 0.75 METERS

WATER PIPELINE	-ZONE A
DEPTH: 1.3-1.5 METERS	
WATER PIPELINE	-ZONE B
DEPTH: 1.7-1.8 METERS	

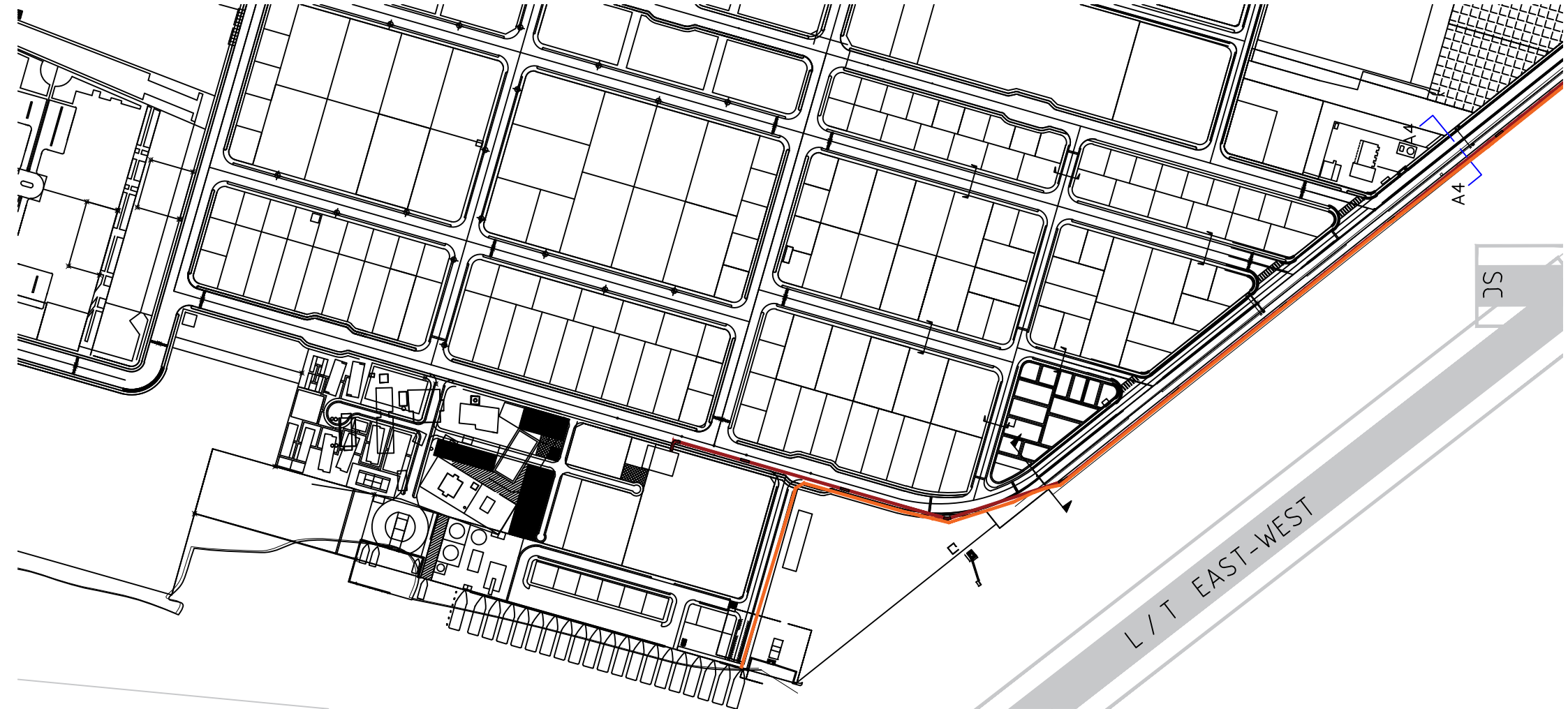
STELCO 132KV PIPES

MWSC FUEL PIPELINE ROUTE

DHIRAAGU PROPOSED DUCT
DHIRAAGU EXISTING DUCT



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 EMAIL : planning@hdc.com.mv



FIBRE OPTICAL CABLE
DEPTH: 0.75 METERS

WATER PIPELINE DEPTH: 1.3-1.5 METERS	-ZONE A
WATER PIPELINE DEPTH: 1.7-1.8 METERS	-ZONE B

STELCO 132KV PIPES

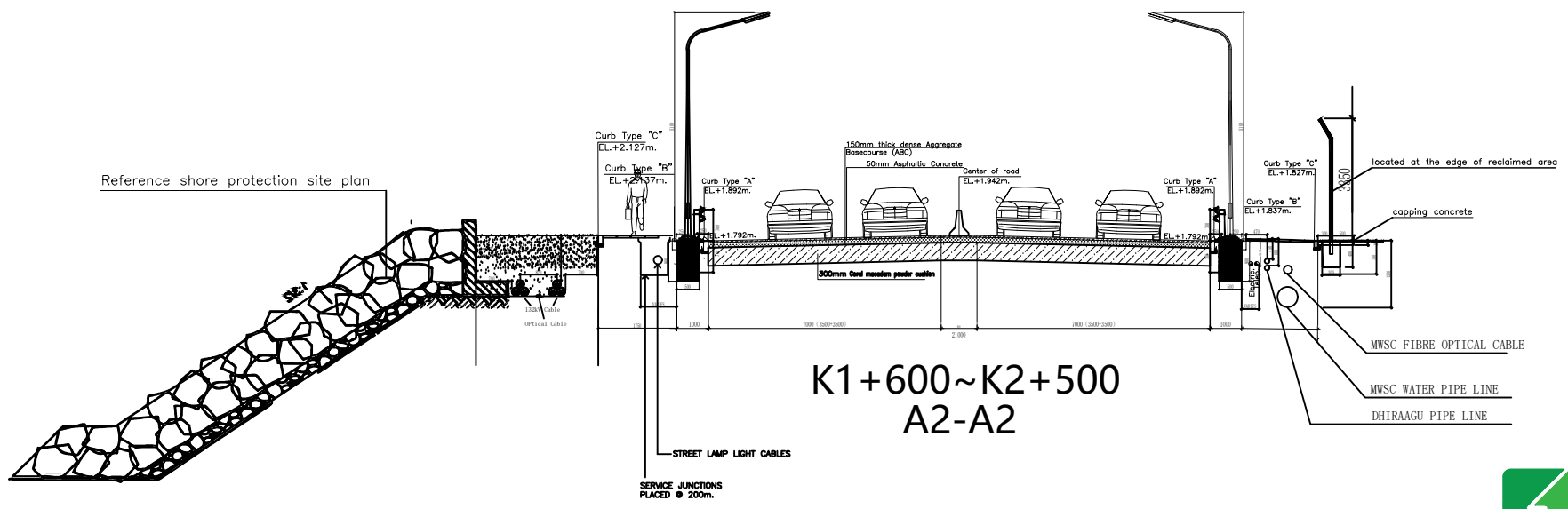
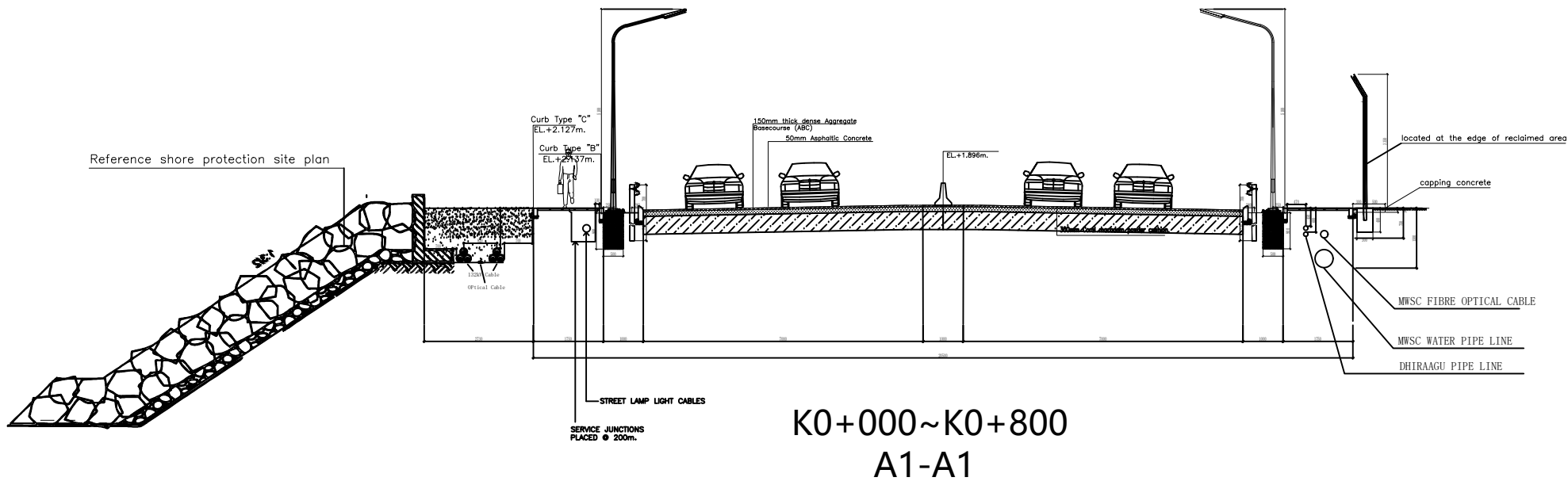
MWSC FUEL PIPELINE ROUTE

DHIRAAGU PROPOSED DUCT
DHIRAAGU EXISTING DUCT



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 3RD FLOOR, HDC BUILDING HULHUMALE'
 REPUBLIC OF MALDIVES
 TEL. +(960)3353535, FAX +(960)3358892
 EMAIL : planning@hdc.com.mv

PROJECT: HULHUMALE' LINK ROAD SERVICES

Scale: N.T.S

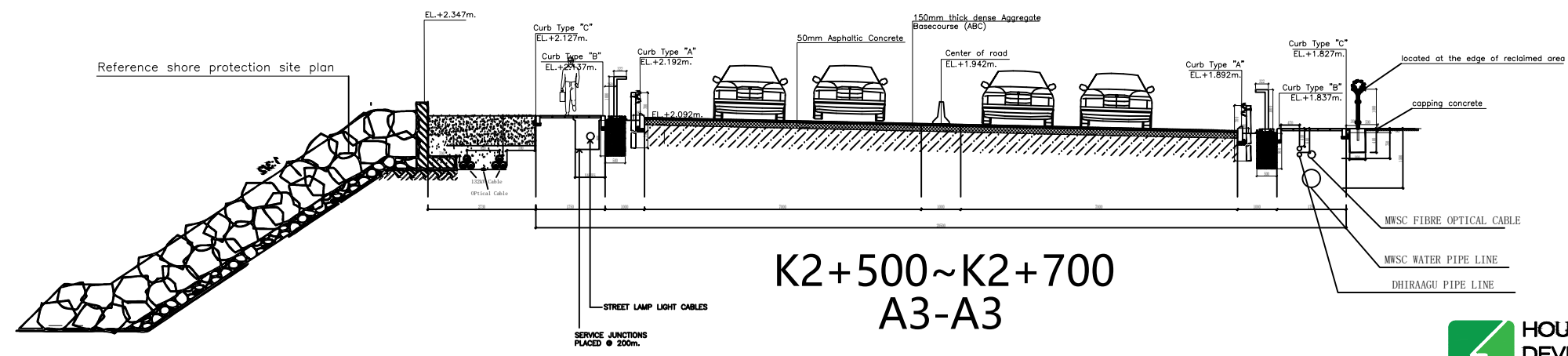
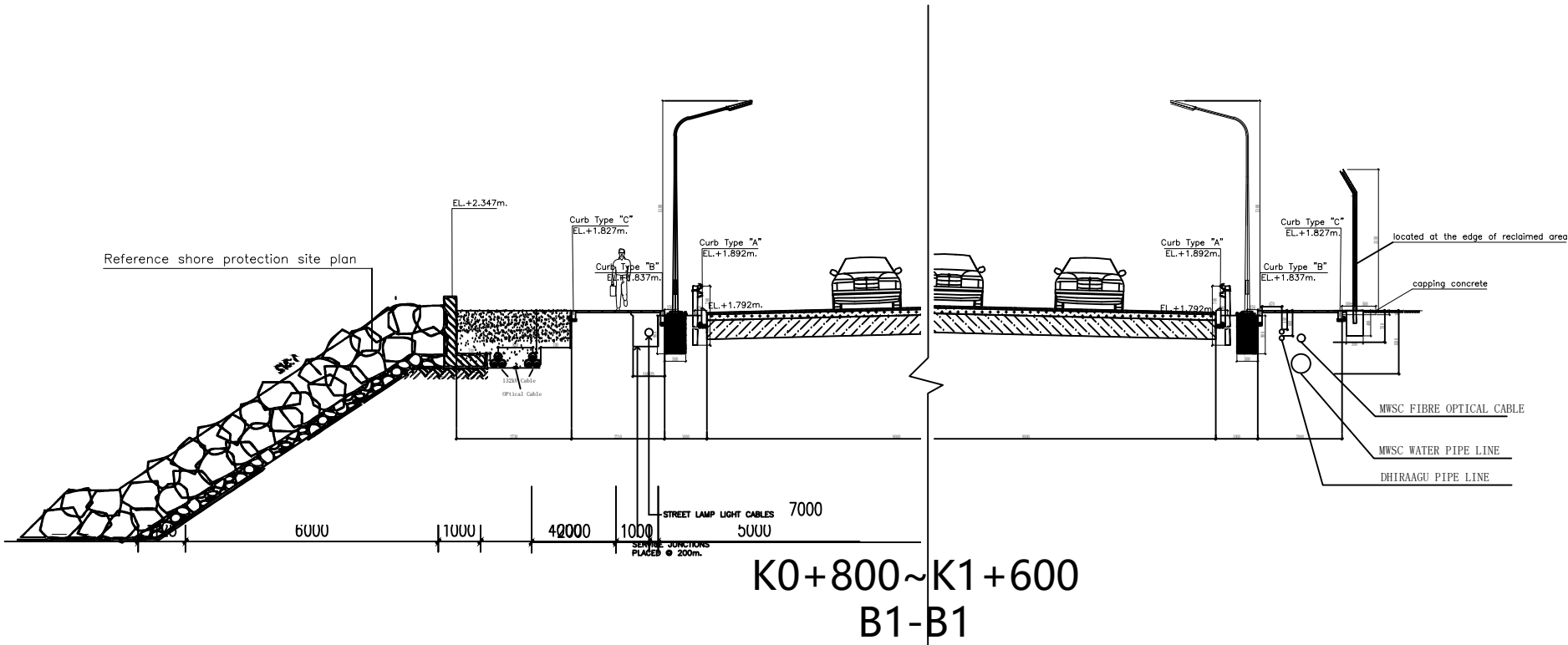
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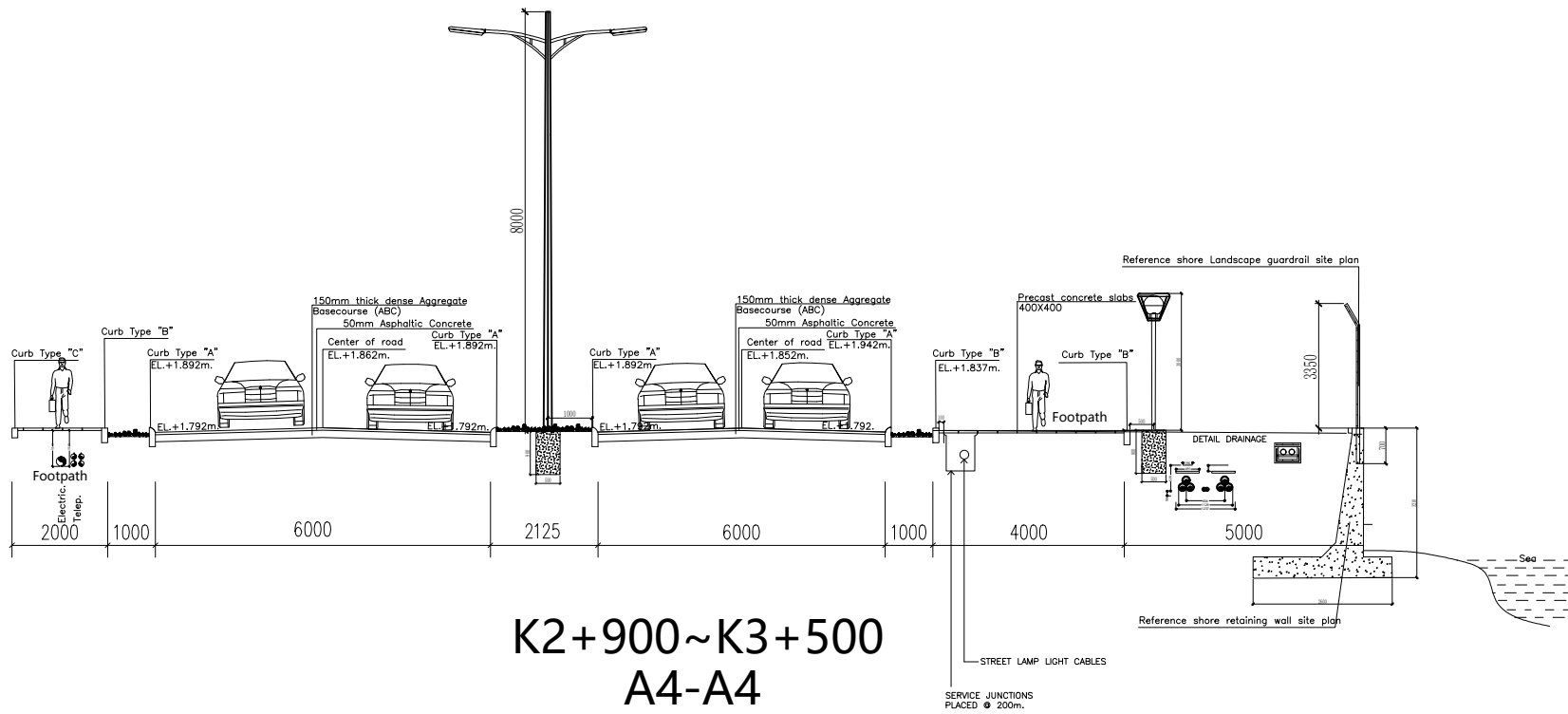
Checked by: Fathhee

Date: 25th February 2021

Remarks:

DRAWING: SECTIONS





17.8 Geotechnical Assessment Report



Geotechnical Engineering Division

Quality is Our Trademark

GEOTECHNICAL INVESTIGATION REPORT

OVE 170

PROJECT

Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region

REPORT REFERENCE NO:

OVE 170

CLIENT

M/s. Ensys Co.Ltd

PREPARED BY

M/s. ELS International (Pvt) Ltd

DATE

March 22, 2021

ELS INTERNATIONAL [PVT.] LTD.

H.SisilHiyaa Building, 9th Floor, Apartment B Male'20071,
Republic of Maldives

Email: els@elslanka.com | Web: www.elslanka.com



452
CONCRETE PIPES

855
CEMENT BLOCKS

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GEOTECHNICAL INVESTIGATION FOR PROPOSED 5MW GRID-TIED SOLAR PHOTOVOLTAIC SYSTEM IN THE GREATER MALE REGION

1.0 Introduction

It is proposed to construction 5MW grid-tied Solar photovoltaic system in greater Male region.

Accordingly, four boreholes were conducted at site by **M/s. ELS International (Pvt) Limited** for **M/s. Ensys Co.Ltd**, to determine the geotechnical conditions present within the investigated locations and completed this investigation report.

This report presents the results of the soil investigations carried out from: 26th February to 03rd March 2021.

This work includes borehole drilling, sampling of disturbed materials and in-situ testing. The scope of borehole drilling which means the number, location and depth of borehole depend on the loads imposed by the structure, size of the structure and sub-soil conditions.

This report embodies the findings of the site investigation including, nature and depth of soil strata, water levels at the site, physical and mechanical properties of soils and other relevant details of the geotechnical investigation.

2.0 Site Description

The boreholes were conducted adjacent to Male – Hulhulmale road. The investigated locations are located in almost flat area.

The locations of boreholes are given in below table

Table 1: Locations of boreholes

Borehole Number	Coordinate	
	East	North
BH-01	73.537963	4.203760
BH-02	73.540811	4.197464
BH-03	73.537849	4.188301
BH-04	73.533809	4.180843

General Geological and Sub Grade Characteristic of Site Area

When the underneath geological formation of the site is considered, the coral reef formation is predominated at all the Maldivian islands, it may be stated that a classic atoll chain and the reef limestone, of which they are built, have accumulated on a volcanic ridge foundation associated with a transform fault on the floor of the Indian ocean which is now inactive.

When describing the soil conditions in the Maldives, it has been observed from previous investigations that the structure of the reef flats generally consists of either coral sand, soft or hard coral rock and is usually overlaid with a relatively thick layer of coral sand. On the lagoon side of the reef edge the reef is mostly covered with dead corals and a few colonies of live corals. The cavities between the coral heads are constantly being filled up with coral sand and pieces of broken and dead corals and will ultimately become a substantially hard cemented material.

When considering the climatic characteristics, Maldives experience a monsoon climate, as the northeast monsoon is from January to March; hot days, cooler nights and relatively dry periods are common feature during this season. The wet, southwest monsoon prevails from mid-May to November. Gales and heavy rainfall occur during this season.

Formation of Coral in the Region

With respect to coral formation, corals are preserved as calcareous skeletons, originally secreted by a simple animal known as polyps. Reef building polyps avoid deep water more than 25m deep and grow optimally at depths within 10m. The sea water temperature should be between 25⁰C-29⁰C. Emersion or exposure above water could be tolerated only for short periods during tidal cycles. Salinity levels should generally be between 2.7% and 4.0%. The water turbulence is desirable in order to disperse carbon-dioxide to bring in plank tonic food and oxygen.

A moderate fall out of fine sediments from the water can be tolerated because corals have self-cleansing mechanisms but burial beneath sediment for lengths of time could result in an asphyxiation and death. The polyp sack like body had an internal cavity which acted as its

stomach. There was only a single opening to the out side, surrounded by tentacles. The polyp sat in a cup like depression on to pot its calcareous skeleton, or corallites, which is built upwards to form a support as it grew. Coral are classified according to this internal structure, which cannot often be observed directly.

3.0 Field Investigation

Field investigation consisted of advancing five boreholes at the locations on table 1.

The field investigation was commenced from 26th February to 03rd March 2021.

3.1 Borehole Investigation

The borehole was advanced by means of rotary drilling machine and the drilling was carried out with overburden cutting tools and the wash boring process was adopted to remove the cuttings from the bottom of the borehole. During the drilling operation the walls of the boreholes were supported by 82 mm dia. NX type flush coupling casings. In order to achieve better alignment of borehole NWY flush coupling drill rods were used. Details of the depths of drilling are indicated in the Table 2.

Table 2: Details of depths of drilling

Borehole No.	Ground water level m	Overburden /Soil Drilling /Boulders m	Rock Drilling m	Total Depth m
BH-01	1.60	10.45	-	10.45
BH-02		10.45	-	10.45
BH-03	1.50	10.45	-	10.45
BH-04		10.45	-	10.45

3.1.1 Standard Penetration Test (SPT)

In this investigation the SPT was carried out in regular intervals in the overburden, at each of the borehole. The performance of this test is based on the test method specified in BS 1377. Disturbed samples of soil were collected from SPT tube.

3.1.1.1 Test Procedure

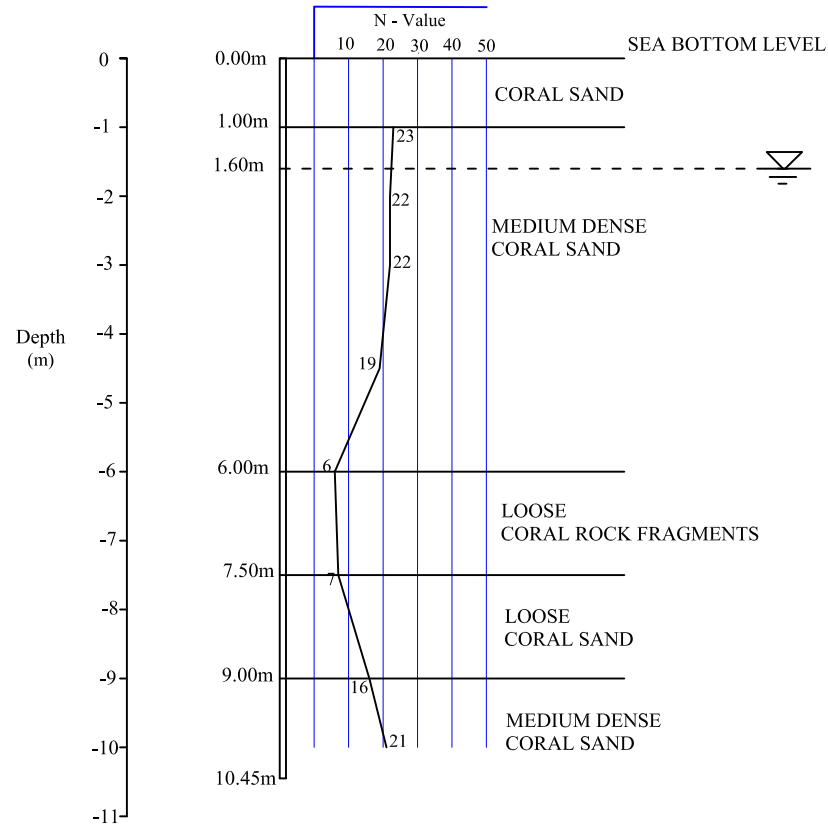
- SPT sampler (Split spoon sampler) inserted in to the boring and it has been connected via steel rods to 63.5kg hammer.
- Using automatic safety hammer mechanism, hammer was raised a distance of 760mm and allowed it to fall freely and the energy drives the sampler in to the bottom of the boring. The process was repeated until the sampler has penetrated a distance of 450mm. The numbers of blows were recorded for first 150mm (Seating drive) and then two consecutive 150mm intervals (Test drives).
- The N value was computed by summing the blow counts for the two 150mm intervals of penetration. The blow count for the first 150mm is retained for reference purposes but not used to compute N value because the bottom of the boring is likely to be disturbed by drilling process and may be filled with loose soil that fell from the side of the boring.
- The SPT samples were extracted from the sampler and saved the obtained soil samples in appropriate manners.
- Boring to the depth of the next test been done with the above procedure.

4.0 Sub-Surface Conditions

The sub surface conditions encountered at the site are graphically presented in the borehole log attached in Annex I. The soil horizons identified at the borehole locations are inferred from the samples taken from the borehole location. Soil horizons/layers generally represent a transition from one soil type to another and that should not be assumed to be representing an exact plane of geological change.

Further, the conditions may vary between and beyond the borehole locations. A comprehensive detail about the sub soil conditions at the borehole is graphically shown in the Figure 3(a) to 3 (d).

BH - 01



NOTES: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

Project: Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region

FIGURE 1(a): Possible Soil Profile at the borehole, BH-01

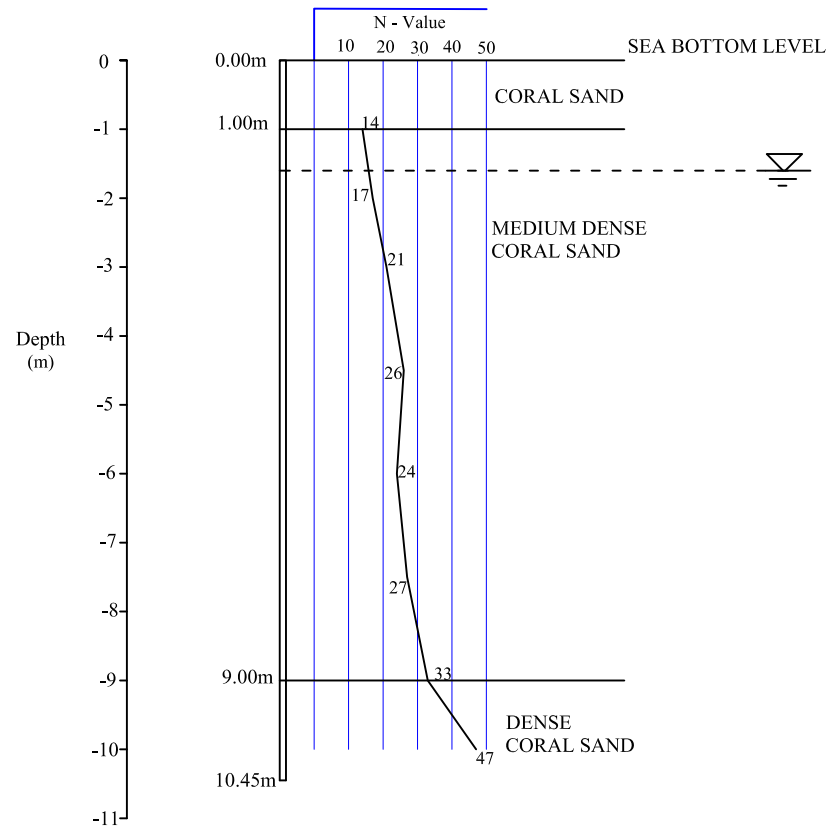
SCALE : 1:160

PAGE : 5



ELS International (Pvt) Ltd

BH - 02



NOTES: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

Project: **Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region**

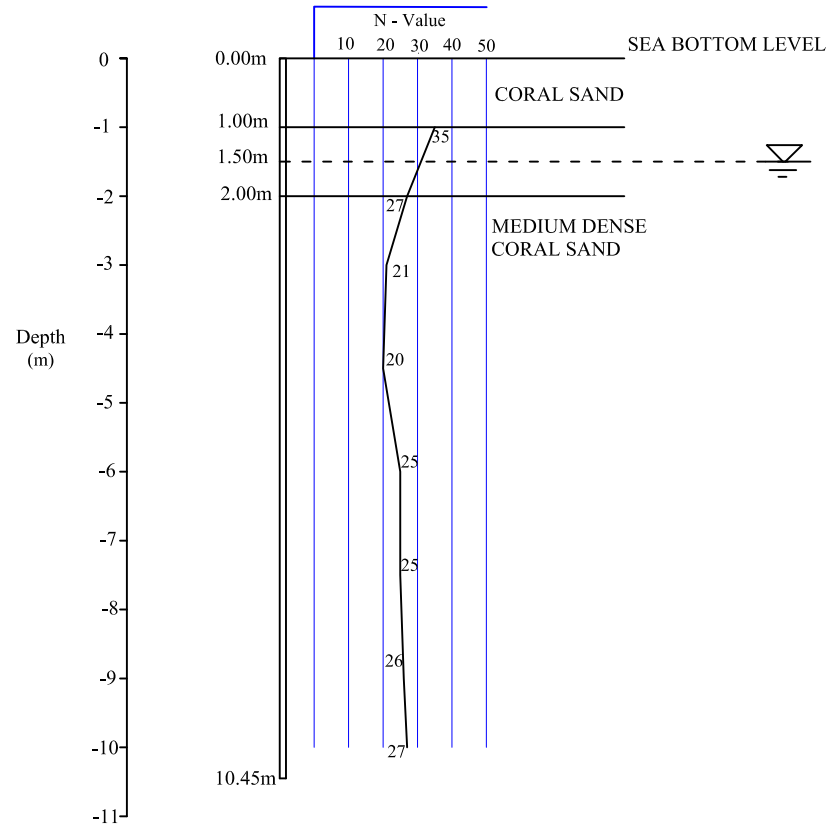
FIGURE 1(b): Possible Soil Profile at the borehole, BH-02

SCALE : 1:160
PAGE : 6



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BH - 03



NOTES: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

Project: **Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region**

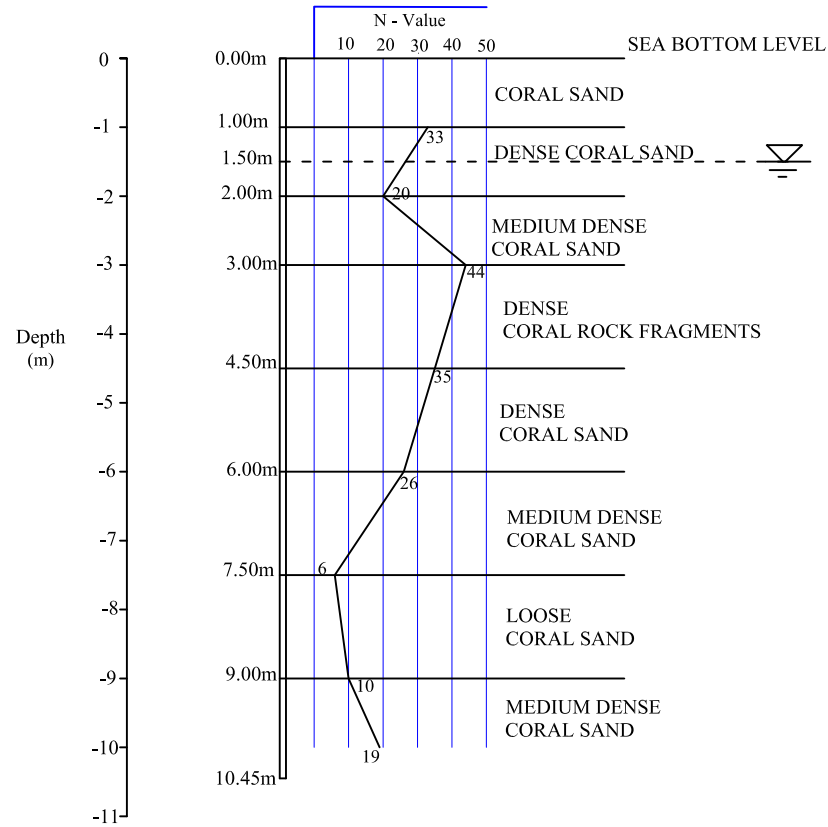
FIGURE 1(c): Possible Soil Profile at the borehole, BH-03

SCALE : 1:160
PAGE : 7



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BH - 04



NOTES: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

Project: **Geo-technical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region**

FIGURE 1(d): Possible Soil Profile at the borehole, BH-04

SCALE : 1:160
PAGE : 8



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5.0 Interpretation of the Results of the Site Investigations

The field SPT values were corrected using the energy method (Bowles, 1996) and the average SPT values of each layer were used to estimate the corresponding soil strength parameters.

5.1 Properties of the materials in the subsurface and bedrock

The details of depths of drilling are indicated below. The water column heights are also indicated below in the table.

5.1.1 Sub-surface conditions and recommended geotechnical design parameters

From a study of the borehole logs, the overburden at borehole locations can be modeled by successive layers as indicated below. Recommendations for the geotechnical design parameters for sub-surface layers are given in the table below based on the visual observation of the soil samples collected, the measured SPT values, and experience with similar sub-surface conditions.

Table 3: Successive layers at BH-01

Layer No.	Position (m)	Measured SPT N	Corrected N Value	Shear strength parameters	Layer description
1	0.00-1.00	-			Coral sand
2	1.00-2.00	23	28	$c' = 0 \text{ kPa}, \phi' = 37$	Medium dense coral sand
3	2.00-6.00	19-22	17-22	$c' = 0 \text{ kPa}, \phi' = 33$	Medium dense coral sand
4	6.00-9.00	6-7	5-6	$c' = 0 \text{ kPa}, \phi' = 29$	Loose coral sand and coral rock fragments
5	9.00-10.00	16	12	$c' = 0 \text{ kPa}, \phi' = 31$	Medium dense coral sand
6	10.00-10.45	21	16	$c' = 0 \text{ kPa}, \phi' = 33$	Medium dense coral sand

Ground water level was measured as 1.60m from existing ground level

Table 4: Successive layers at BH-02

Layer No.	Position (m)	Measured SPT N	Corrected N Value	Shear strength parameters	Layer description
1	0.00-1.00	-			Coral sand
2	1.00-3.00	14-17	17	$c' = 0 \text{ kPa}, \phi' = 33$	Medium dense coral sand
3	3.00-9.00	21-27	19-23	$c' = 0 \text{ kPa}, \phi' = 34$	Medium dense coral sand
4	9.00-10.00	33	25	$c' = 0 \text{ kPa}, \phi' = 36$	Medium dense coral sand
5	10.00-10.45	47	36	$c' = 0 \text{ kPa}, \phi' = 38$	Dense coral sand

Ground water level was measured as 1.60m from existing ground level

Table 5: Successive layers at BH-03

Layer No.	Position (m)	Measured SPT N	Corrected N Value	Shear strength parameters	Layer description
1	0.00-1.00	-			Coral sand
2	1.00-2.00	35	42	$c' = 0 \text{ kPa}, \phi' = 38$	Dense coral sand
3	2.00-3.00	27	27	$c' = 0 \text{ kPa}, \phi' = 36$	Medium dense coral sand
4	3.00-10.45	20-27	18-21	$c' = 0 \text{ kPa}, \phi' = 33$	Medium dense coral sand

Ground water level was measured as 1.50m from existing ground level

Table 6: Successive layers at BH-04

Layer No.	Position (m)	Measured SPT N	Corrected N Value	Shear strength parameters	Layer description
1	0.00-1.00	-			Coral rock fragments
2	1.00-2.00	33	40	$c' = 0 \text{ kPa}, \phi' = 38$	Dense coral sand
3	2.00-3.00	20	20	$c' = 0 \text{ kPa}, \phi' = 34$	Medium dense coral sand
4	3.00-6.00	35-44	31-39	$c' = 0 \text{ kPa}, \phi' = 38$	Dense coral sand and coral rock fragments
5	6.00-7.50	26	21	$c' = 0 \text{ kPa}, \phi' = 35$	Medium dense coral sand
6	7.50-10.00	6-10	5-8	$c' = 0 \text{ kPa}, \phi' = 29$	Loose coral sand
7	10.00-10.45	19	15	$c' = 0 \text{ kPa}, \phi' = 32$	Medium dense coral sand

Ground water level was measured as 1.50m from existing ground level

5.2 Recommendations of foundations

5.2.1 Factors affecting selection of foundations

The significant factors affecting the selection of the foundations are:

- The ground water level was noticed as 1.50m-1.60m from existing ground level at the time of soil investigation.
- It is proposed to install solar panels upon the columns at borehole locations.

5.2.1.2 Recommendations for foundation

Deep foundations

It is recommended that the foundations consist of pre-cast concrete driven piles or pre-stressed driven piles with minimum 300mm width/ diameter be used.

It is recommended that for depths of driving in to this formation, the following initial design parameters be adopted for ultimate skin friction coefficient (f_u) and net ultimate end bearing capacity ($q_{net\ ult.}$).

Table 7: Allowable skin friction and end bearing capacities.

Layer No.	Corrected N	Layer description	(f_u) kN/m ²	($q_{net\ ult.}$) kN/m ²
a	-	Coral Layer	-	
b	10-15	Medium dense coral sand	25	750
c	15-20	Medium dense coral sand	35	1000
d	20-30	Dense coral sand	50	1500
e	30-50	Very dense coral sand / Coral rock	65	2500

Factor of Safety (FOS) of 1.5 is recommended for estimating the allowable carrying capacities in skin friction from the recommended ultimate skin friction coefficients.

Eng. Mahinda Rathnasiri

BSc. Eng (Hons),

MSc (Geotechnical Engineering),

MIE (SL). MSSE (SL)

Chartered Civil Engineer

Annexure I: Borehole Logs



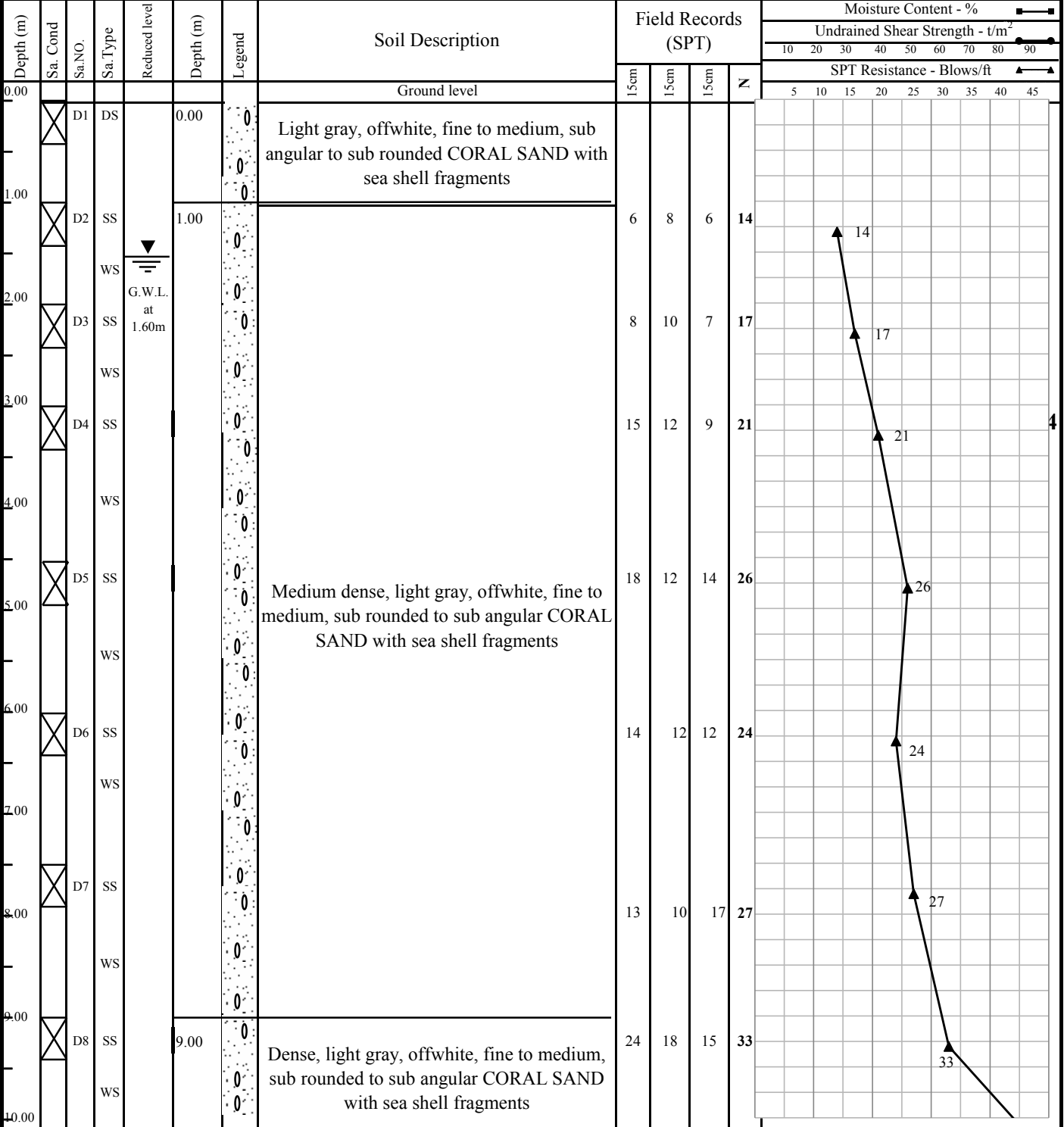
Project	Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region				Borehole No	BH-01	
Client	M/s. Ensys Co.Ltd,				Sheet	2 of 2	
Location	Male-Hulhumale road	Rig	Tony	Core Diameter	54mm	Ground Water level	1.60m
Date of Started	26.02.2021	Drilling Method	Rotary	Casing depth	10.00m	Coordinates	
Date of Finished	26.02.2021	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft		
								15cm	15cm	15cm	N	10	20	30	40	50	60	70
10.00							Continue from Page 1											
	X		D9 SS				Same as previous description	7	10	11	21							
11.00					10.45		The borehole was terminated at the depth of 10.45m											
12.00																		
13.00																		
14.00																		
15.00																		
16.00																		
17.00																		
18.00																		
19.00																		
20.00																		

Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wash Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content	Prasad Supervised By:
GWL	: Ground Water Level observed inside the Borehole, after the saturation				Lahiru Drilled By:
NE	Not Encountered				Chaminda
HB	- Hammer Bounce				
	- Free Down				
	Made Ground	Silt	Gravel	Completely Weathered Rock	
	Clay	Sand	Coral Sand	Highly Weathered Rock	Fresh Rock



Project	Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region				Borehole No	BH-02	
Client	M/s. Ensys Co.Ltd.				Sheet	1 of 2	
Location	Male-Hulhumale road	Rig	Tony	Core Diameter	54mm	Ground Water Level	1.60m
Date of Started	28.02.2021	Drilling Method	Rotary	Casing depth	10.00m	Coordinates	
Date of Finished	17.02.2021	Casing Diameter	76mm	Elevation (m)	-		



Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wash Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content	Existing ground level considered as the zero level
GWL	Ground Water Level observed inside the Borehole, after the saturation	Rock Quality Designation (%)	Free Content	Completely Weathered Rock	
NE	Not Encountered	Gravel	Laterite Nodules	Highly Weathered Rock	Prasad Supervised By:
HB	- Hammer Bounce	Organic Matter	Silty Sand	Fresh Rock	Lahiru Drilled By:
	- Free Down	Silt			Chaminda
	Made Ground	Sand			
	Clay				



Project	Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region				Borehole No	BH-02
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Client	M/s. Ensys Co.Ltd,				Sheet	2 of 2
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Location	Male-Hulhumale road	Rig	Tony	Core Diameter	54mm	Ground Water Level	1.60m
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Date of Started	28.02.2021	Drilling Method	Rotary	Casing depth	10.00m	Coordinates	
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Date of Finished	17.02.2021	Casing Diameter	76mm	Elevation (m)	-		
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Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft				
								15cm	15cm	15cm	N	10	20	30	40	50	60	70	80	90
								5	10	15	20	25	30	35	40	45				
10.00							Continue from Page 1													
			D9	SS			Dense, light gray, CORAL ROCK FRAGMENTS	30	29	18	47						47			
11.00					10.45		The borehole was terminated at the depth of 10.45m													
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20.00																				

Sample Key / Test Key

SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wash Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%)	D - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content	Remarks	Logged By:
GWL	: Ground Water Level observed inside the Borehole, after the saturation	Gravel Quality Designation (%)		Moisture Content	Existing ground level considered as the zero level	Prasad
NE	Not Encountered	Gravel		Completely Weathered Rock		Supervised By:
HB	- Hammer Bounce	Coral Sand		Highly Weathered Rock		Lahiru
	- Free Down	Silt	Coral fragments			Drilled By:
	Made Ground	Sand	Coral Rock			Chaminda
	Clay					Fresh Rock

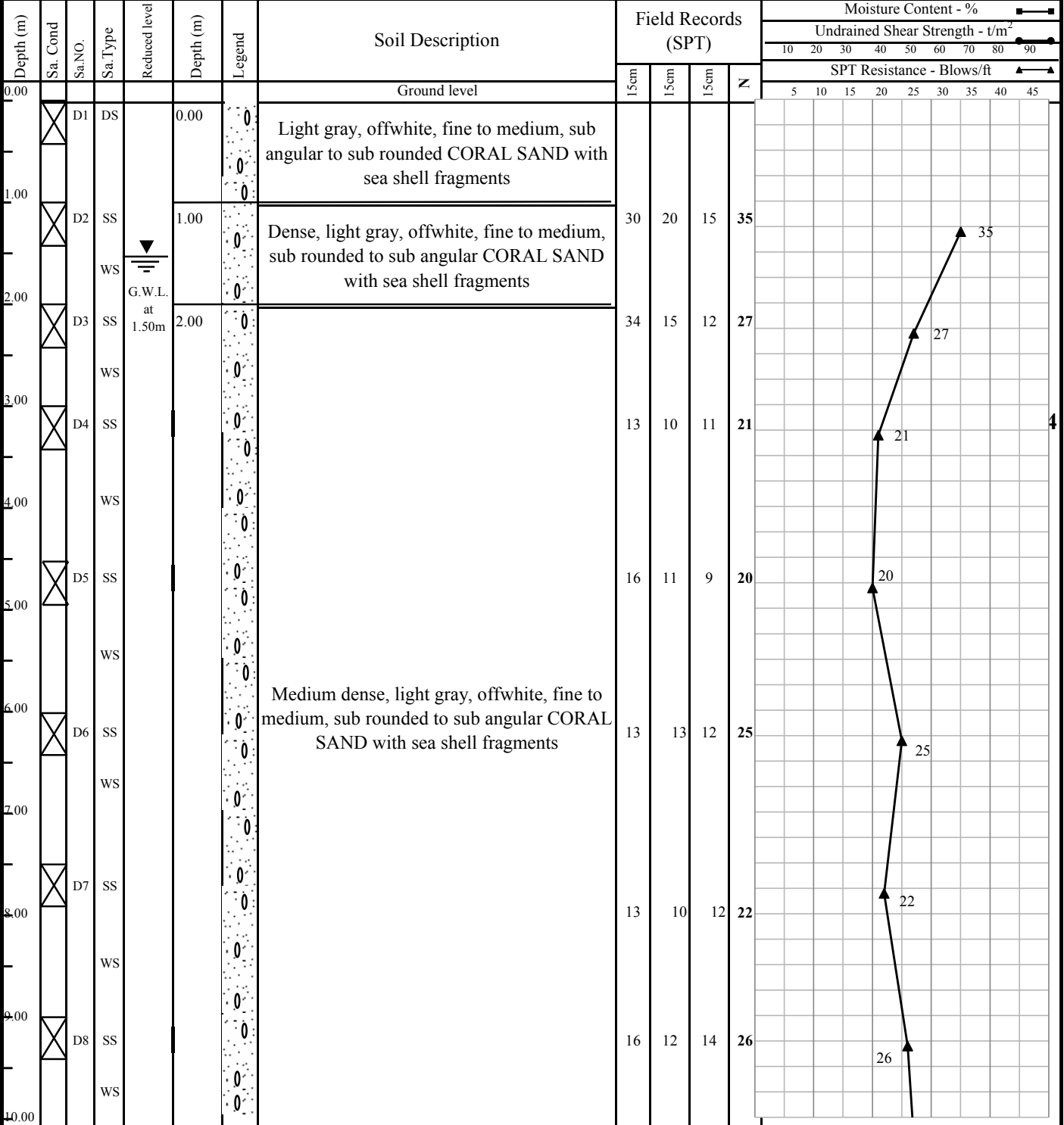


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 Katuwawala, Sri Lanka.
 Tel: 0114 309 494

Format No:
 ELS-SI-02

Project	Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region				Borehole No	BH-03	
Client	M/s. Ensys Co.Ltd.				Sheet	1 of 2	
Location	Male-Hulhumale road	Rig	Tony	Core Diameter	54mm	Ground Water Level	1.50m
Date of Started	28.02.2021	Drilling Method	Rotary	Casing depth	10.00m	Coordinates	
Date of Finished	17.02.2021	Casing Diameter	76mm	Elevation (m)	-		



Sample Key / Test Key				Remarks	Logged By:	
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wash Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content	Existing ground level considered as the zero level	Prasad Supervised By:
GWL	Ground Water Level observed inside the Borehole, after the saturation	Cr - Core Recovery (%)				Lahiru Drilled By:
NE	Not Encountered					Chaminda
HB	- Hammer Bounce					
	- Free Down					
	Made Ground	Rock Quality Designation (%)	Laterite Nodules	Completely Weathered Rock		
	Clay	Gravel	Silty Sand	Highly Weathered Rock		
		Organic Matter				Fresh Rock



Project	Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region				Borehole No	BH-03	
Client	M/s. Ensys Co.Ltd,				Sheet	2 of 2	
Location	Male-Hulhumale road	Rig	Tony	Core Diameter	54mm	Ground Water Level	1.50m
Date of Started	28.02.2021	Drilling Method	Rotary	Casing depth	10.00m	Coordinates	
Date of Finished	17.02.2021	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft		
								15cm	15cm	15cm	N	10	20	30	40	50	60	70
10.00							Continue from Page 1											
	X		D9 SS				Same as previous description	11	13	14	27							
11.00					10.45		The borehole was terminated at the depth of 10.45m											
12.00																		
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17.00																		
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19.00																		
20.00																		

Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wash Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content	Prasad Supervised By:
GWL	: Ground Water Level observed inside the Borehole, after the saturation				Lahiru Drilled By:
NE	Not Encountered				Chaminda
HB	- Hammer Bounce				
	- Free Down				
	Made Ground	Silt	Gravel	Completely Weathered Rock	
	Clay	Sand	Coral Sand	Highly Weathered Rock	Fresh Rock



Project		Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region				Borehole No	BH-04	
Client		M/s. Ensys Co.Ltd.				Sheet	1 of 2	
Location		Male-Hulhumale road	Rig	Tony	Core Diameter	54mm	Ground Water Level	1.50m
Date of Started		03.03.2021	Drilling Method	Rotary	Casing depth	10.00m	Coordinates	
Date of Finished		03.03.2021	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft		
								15cm	15cm	15cm	N	10	20	30	40	50	60	70
0.00							Ground level											
0.00	D1		DS		0.00		Light gray, offwhite, fine to medium, sub angular to sub rounded CORAL SAND with sea shell fragments											
1.00	D2		SS		1.00		Dense, light gray, offwhite, fine to medium, sub rounded to sub angular CORAL SAND with sea shell fragments	5	11	22	33							
2.00	D3		SS		2.00		Dense, light gray, offwhite, fine to medium, sub rounded to sub angular CORAL SAND with sea shell fragments	10	8	12	20							
3.00	D4		SS		3.00		Medium dense light gray, offwhite, CORAL ROCK FRAGMENTS	20	22	22	44							
4.50	D5		SS		4.50		Dense light gray, offwhite, fine to coarse, sub rounded to sub angular CORAL SAND with sea shell fragments	26	17	18	35							
6.00	D6		SS		6.00		Medium dense, light gray, offwhite, fine to medium, sub rounded to sub angular CORAL SAND with sea shell fragments	17	14	12	26							
7.50	D7		SS		7.50		Loose light gray, offwhite, fine to coarse, sub rounded to sub angular CORAL SAND with sea shell fragments	4	4	2	6							
9.00	D8		SS		9.00		Medium dense, light gray, offwhite, fine to medium, sub rounded to sub angular CORAL SAND with sea shell fragments	5	6	4	10							

Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wash Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content	Prasad Supervised By:
GWL	Ground Water Level observed inside the Borehole, after the saturation				Lahiru Drilled By:
NE	Not Encountered				Chaminda
HB	- Hammer Bounce				
	- Free Down				
	Made Ground	Silt	Gravel	Coral fragments	Completely Weathered Rock
	Clay	Sand	Coral Sand	Coral Rock	Highly Weathered Rock
					Fresh Rock



Project	Geotechnical Investigation for Proposed 5mw Grid-Tied Solar Photovoltaic System in the Greater Male Region				Borehole No	BH-04
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Client	M/s. Ensys Co.Ltd,				Sheet	2 of 2
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Location	Male-Hulhumale road	Rig	Tony	Core Diameter	54mm	Ground Water Level	1.50m
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Date of Started	03.03.2021	Drilling Method	Rotary	Casing depth	10.00m	Coordinates	
------------------------	------------	------------------------	--------	---------------------	--------	--------------------	--

Date of Finished	03.03.2021	Casing Diameter	76mm	Elevation (m)	-		
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Depth (m)	Sa. Cond	Sa.NO.	Sa.Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft		
								15cm	15cm	15cm	N	10	20	30	40	50	60	70
10.00							Continue from Page 1											
	X		D9 SS				Same as previous description	10	11	8	19							
11.00					10.45		The borehole was terminated at the depth of 10.45m											
12.00																		
13.00																		
14.00																		
15.00																		
16.00																		
17.00																		
18.00																		
19.00																		
20.00																		

Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wash Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content	Prasad Supervised By:
GWL	: Ground Water Level observed inside the Borehole, after the saturation				Lahiru Drilled By:
NE	Not Encountered				Chaminda
HB	- Hammer Bounce				
	- Free Down				
	Made Ground	Silt	Gravel	Coral fragments	Completely Weathered Rock
	Clay	Sand	Coral Sand	Coral Rock	Highly Weathered Rock
					Fresh Rock

Annexure II: Laboratory Test Reports

Annexure II(a): Sieve Analysis Test Reports



PARTICLE SIZE ANALYSIS OF SOILS

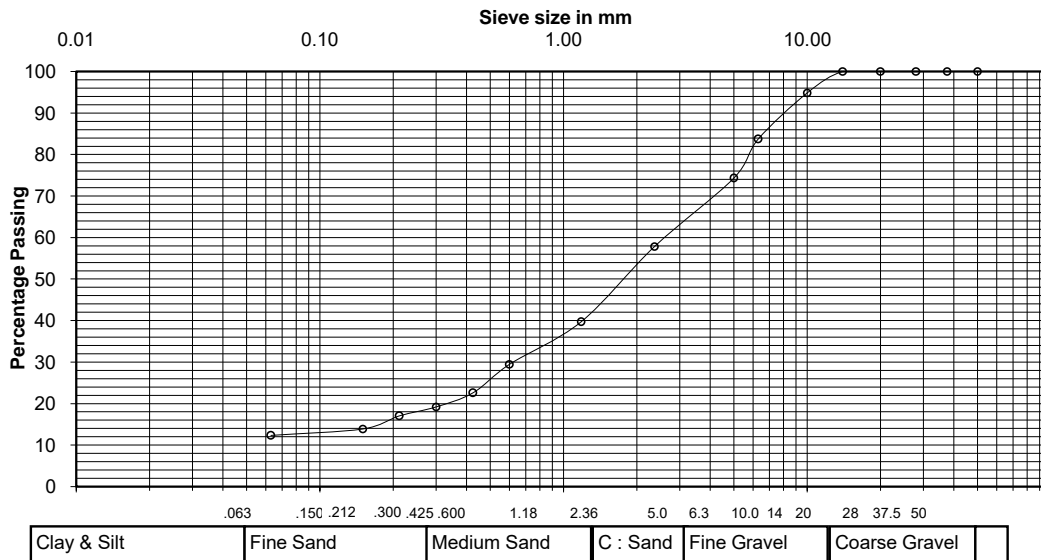
TEST METHOD - BS 1377 PART 2

Project	Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region		
Client	Ensys Co. LTD.		
Contractor	-	Lab Ref. NO.	ELS/INT/S-024
BH NO:	BH - 01	Sample No.	01
Sample Description:	Soil Sample, Sample Depth: 3.00-3.45m	Date of Test	10/03/2021
Test Method:	Washing and Sieving	Date of Report	22/03/2020

Sieve Size (mm)	Weight of Retained (g)	Retained (%)	Cum. Retained (%)	Passing Percentage
50.00	0.0	0.00	0.00	100.00
37.50	0.0	0.00	0.00	100.00
28.00	0.0	0.00	0.00	100.00
20.00	0.0	0.00	0.00	100.00
14.00	0.0	0.00	0.00	100.00
10.00	6.8	5.16	5.16	94.84
6.30	14.7	11.15	16.31	83.69
5.00	12.4	9.41	25.72	74.28
2.36	21.7	16.46	42.19	57.81
1.18	23.9	18.13	60.32	39.68
0.600	13.5	10.24	70.56	29.44
0.425	9.1	6.90	77.47	22.53
0.300	4.4	3.34	80.80	19.20
0.212	2.9	2.20	83.00	17.00
0.150	4.1	3.11	86.12	13.88
0.063	2.1	1.59	87.71	12.29
Pan	0.7			
Total	116.3			

Weight of dry Sample (g)
(Before Washed) = 131.8

Weight of dry Sample (g)
(After Washed) = 116.4



Tested by:	Checked By:	Certified By:
.....

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PARTICLE SIZE ANALYSIS OF SOILS

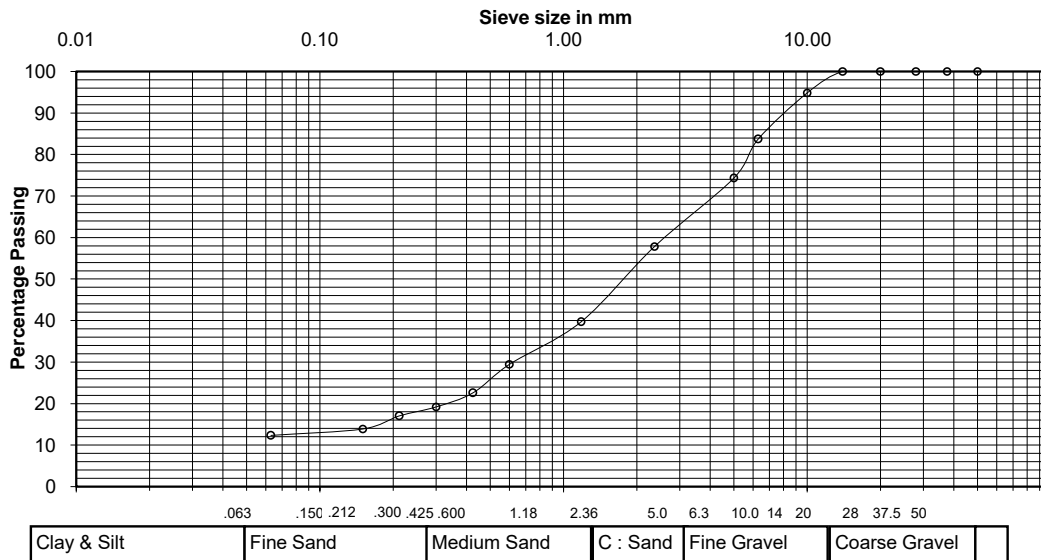
TEST METHOD - BS 1377 PART 2

Project	Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region		
Client	Ensyst Co. LTD.		
Contractor	-	Lab Ref. NO.	ELS/INT/S-024
BH NO:	BH - 01	Sample No.	02
Sample Description:	Soil Sample, Sample Depth: 4.50-4.95m	Date of Test	10/03/2021
Test Method:	Washing and Sieving	Date of Report	22/03/2020

Sieve Size (mm)	Weight of Retained (g)	Retained (%)	Cum. Retained (%)	Passing Percentage
50.00	0.0	0.00	0.00	100.00
37.50	0.0	0.00	0.00	100.00
28.00	0.0	0.00	0.00	100.00
20.00	0.0	0.00	0.00	100.00
14.00	0.0	0.00	0.00	100.00
10.00	4.0	1.70	1.70	98.30
6.30	6.4	2.71	4.41	95.59
5.00	17.6	7.46	11.87	88.13
2.36	48.9	20.73	32.60	67.40
1.18	29.8	12.63	45.23	54.77
0.600	23.2	9.83	55.07	44.93
0.425	20.4	8.65	63.71	36.29
0.300	12.3	5.21	68.93	31.07
0.212	19.2	8.14	77.07	22.93
0.150	20.0	8.48	85.54	14.46
0.063	17.6	7.46	93.01	6.99
Pan	1.8			
Total	221.2			

Weight of dry Sample (g)
(Before Washed) = 235.9

Weight of dry Sample (g)
(After Washed) = 221.5



Tested by:	Checked By:	Certified By:
.....

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PARTICLE SIZE ANALYSIS OF SOILS

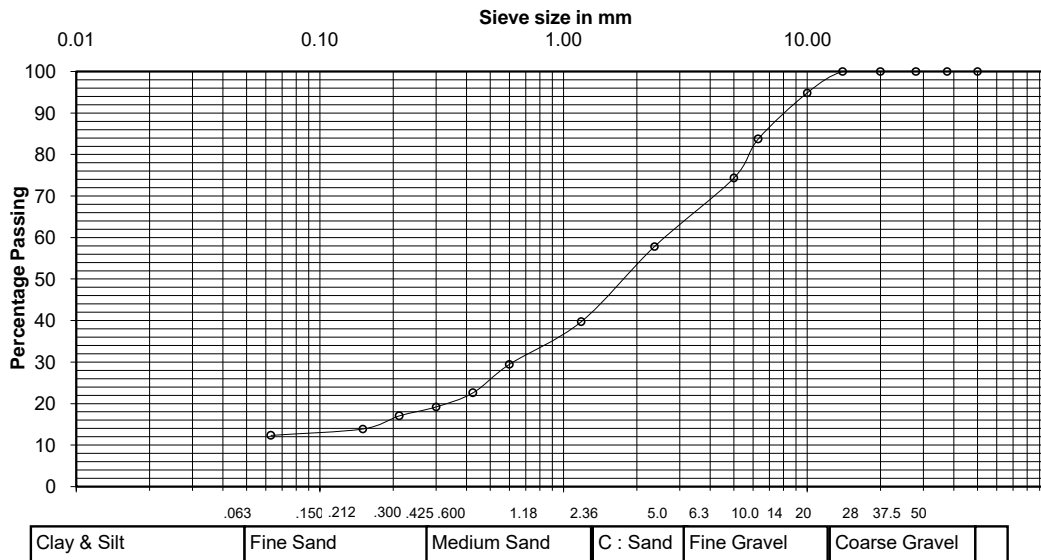
TEST METHOD - BS 1377 PART 2

Project	Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region		
Client	Ensys Co. LTD.		
Contractor	-	Lab Ref. NO.	ELS/INT/S-024
BH NO:	BH - 02	Sample No.	03
Sample Description:	Soil Sample, Sample Depth: 6.00-6.45m	Date of Test	10/03/2021
Test Method:	Washing and Sieving	Date of Report	22/03/2020

Sieve Size (mm)	Weight of Retained (g)	Retained (%)	Cum. Retained (%)	Passing Percentage
50.00	0.0	0.00	0.00	100.00
37.50	0.0	0.00	0.00	100.00
28.00	0.0	0.00	0.00	100.00
20.00	0.0	0.00	0.00	100.00
14.00	0.0	0.00	0.00	100.00
10.00	0.0	0.00	0.00	100.00
6.30	7.4	5.19	5.19	94.81
5.00	10.8	7.57	12.76	87.24
2.36	24.4	17.11	29.87	70.13
1.18	28.7	20.13	50.00	50.00
0.600	14.4	10.10	60.10	39.90
0.425	10.8	7.57	67.67	32.33
0.300	8.9	6.24	73.91	26.09
0.212	8.5	5.96	79.87	20.13
0.150	9.6	6.73	86.61	13.39
0.063	7.9	5.54	92.15	7.85
Pan	1.5			
Total	132.9			

Weight of dry Sample (g)
(Before Washed) = 142.6

Weight of dry Sample (g)
(After Washed) = 133.2



Tested by:	Checked By:	Certified By:
.....

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PARTICLE SIZE ANALYSIS OF SOILS

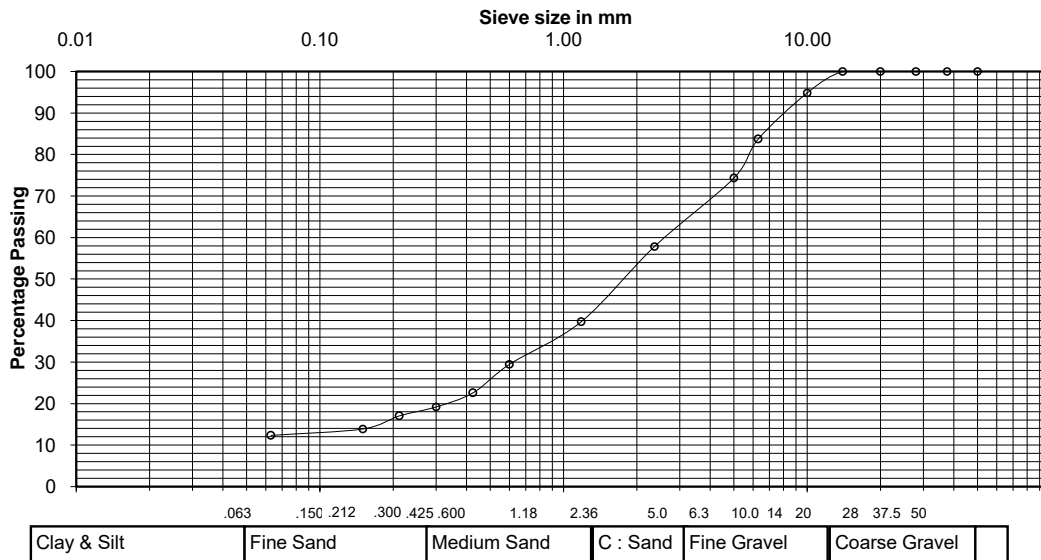
TEST METHOD - BS 1377 PART 2

Project	Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region		
Client	Ensys Co. LTD.		
Contractor	-	Lab Ref. NO.	ELS/INT/S-024
BH NO:	BH - 03	Sample No.	04
Sample Description:	Soil Sample, Sample Depth: 2.00-2.45m	Date of Test	10/03/2021
Test Method:	Washing and Sieving	Date of Report	22/03/2020

Sieve Size (mm)	Weight of Retained (g)	Retained (%)	Cum. Retained (%)	Passing Percentage
50.00	0.0	0.00	0.00	100.00
37.50	0.0	0.00	0.00	100.00
28.00	0.0	0.00	0.00	100.00
20.00	0.0	0.00	0.00	100.00
14.00	0.0	0.00	0.00	100.00
10.00	0.0	0.00	0.00	100.00
6.30	10.1	10.67	10.67	89.33
5.00	0.0	0.00	10.67	89.33
2.36	3.0	3.17	13.83	86.17
1.18	10.3	10.88	24.71	75.29
0.600	14.5	15.31	40.02	59.98
0.425	18.8	19.85	59.87	40.13
0.300	8.5	8.98	68.85	31.15
0.212	7.0	7.39	76.24	23.76
0.150	10.1	10.67	86.91	13.09
0.063	5.8	6.12	93.03	6.97
Pan	1.4			
Total	89.5			

Weight of dry Sample (g)
(Before Washed) = 94.7

Weight of dry Sample (g)
(After Washed) = 89.8



Tested by:	Checked By:	Certified By:

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PARTICLE SIZE ANALYSIS OF SOILS

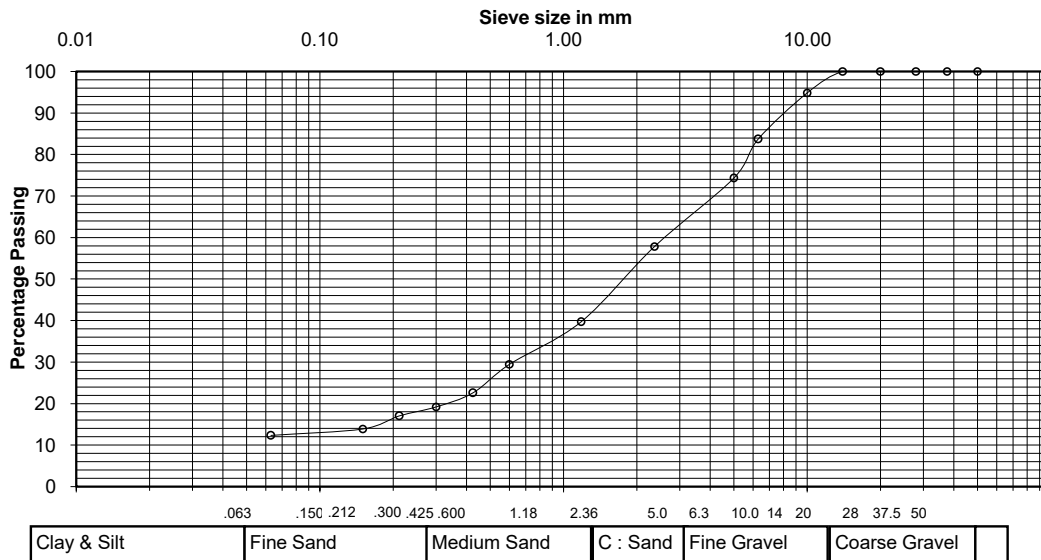
TEST METHOD - BS 1377 PART 2

Project	Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region		
Client	Ensys Co. LTD.		
Contractor	-	Lab Ref. NO.	ELS/INT/S-024
BH NO:	BH - 03	Sample No.	05
Sample Description:	Soil Sample, Sample Depth: 9.00-9.45m	Date of Test	10/03/2021
Test Method:	Washing and Sieving	Date of Report	22/03/2020

Sieve Size (mm)	Weight of Retained (g)	Retained (%)	Cum. Retained (%)	Passing Percentage
50.00	0.0	0.00	0.00	100.00
37.50	0.0	0.00	0.00	100.00
28.00	0.0	0.00	0.00	100.00
20.00	0.0	0.00	0.00	100.00
14.00	19.9	12.15	12.15	87.85
10.00	0.0	0.00	12.15	87.85
6.30	6.6	4.03	16.18	83.82
5.00	10.7	6.53	22.71	77.29
2.36	9.8	5.98	28.69	71.31
1.18	28.6	17.46	46.15	53.85
0.600	23.3	14.22	60.38	39.62
0.425	17.9	10.93	71.31	28.69
0.300	7.3	4.46	75.76	24.24
0.212	9.4	5.74	81.50	18.50
0.150	9.5	5.80	87.30	12.70
0.063	7.3	4.46	91.76	8.24
Pan	0.8			
Total	151.1			

Weight of dry Sample (g)
(Before Washed) = 163.8

Weight of dry Sample (g)
(After Washed) = 151.3



Tested by:	Checked By:	Certified By:
.....

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PARTICLE SIZE ANALYSIS OF SOILS

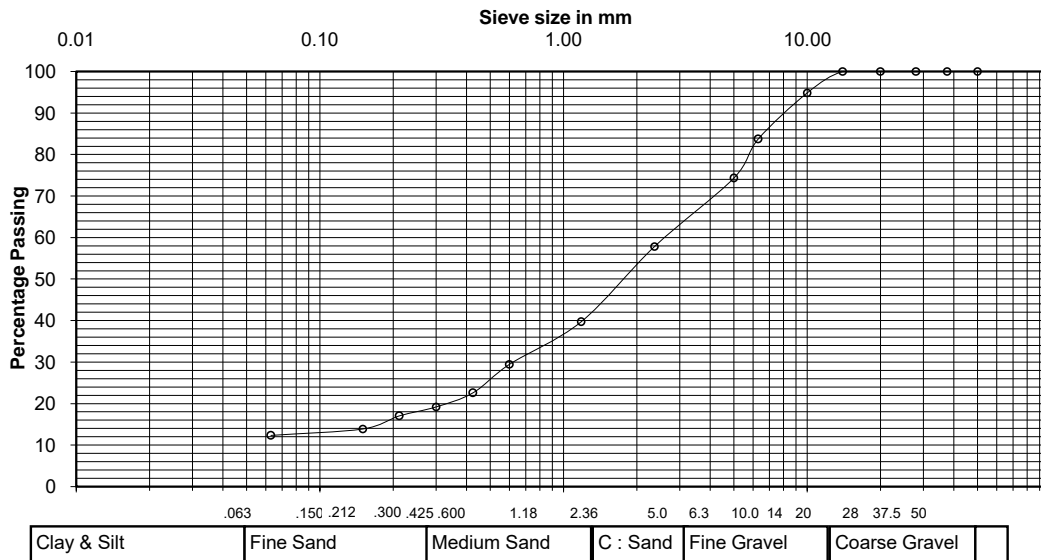
TEST METHOD - BS 1377 PART 2

Project	Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region		
Client	Ensyl Co. LTD.		
Contractor	-	Lab Ref. NO.	ELS/INT/S-024
BH NO:	BH - 04	Sample No.	06
Sample Description:	Soil Sample, Sample Depth: 7.50-7.95m	Date of Test	10/03/2021
Test Method:	Washing and Sieving	Date of Report	22/03/2020

Sieve Size (mm)	Weight of Retained (g)	Retained (%)	Cum. Retained (%)	Passing Percentage
50.00	0.0	0.00	0.00	100.00
37.50	0.0	0.00	0.00	100.00
28.00	0.0	0.00	0.00	100.00
20.00	0.0	0.00	0.00	100.00
14.00	0.0	0.00	0.00	100.00
10.00	0.0	0.00	0.00	100.00
6.30	3.9	4.03	4.03	95.97
5.00	2.8	2.89	6.92	93.08
2.36	7.9	8.16	15.08	84.92
1.18	7.2	7.44	22.52	77.48
0.600	16.0	16.53	39.05	60.95
0.425	14.1	14.57	53.62	46.38
0.300	7.9	8.16	61.78	38.22
0.212	8.1	8.37	70.14	29.86
0.150	12.4	12.81	82.95	17.05
0.063	9.0	9.30	92.25	7.75
Pan	0.7			
Total	90.0			

Weight of dry Sample (g)
(Before Washed) = 96.8

Weight of dry Sample (g)
(After Washed) = 90.3



Tested by:	Checked By:	Certified By:

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Annexure II(b): Atterberg s' Limit Test Reports



**LIQUID LIMIT AND PLASTIC LIMIT
OF SOIL
TEST METHOD BS 1377:PART 2**

Test Format No: ELS-ML-04
Revision No. 00

Project data:

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region
Client: Ensys Co. LTD.

Sample data:

BH No	BH - 01	Lab ref. No.	ELS/INT/S/024
Depth	3.00 - 3.45m	Date of Testing	11/03/2021
Sample No	01	Date of Report:	13/03/2021

Test Data:

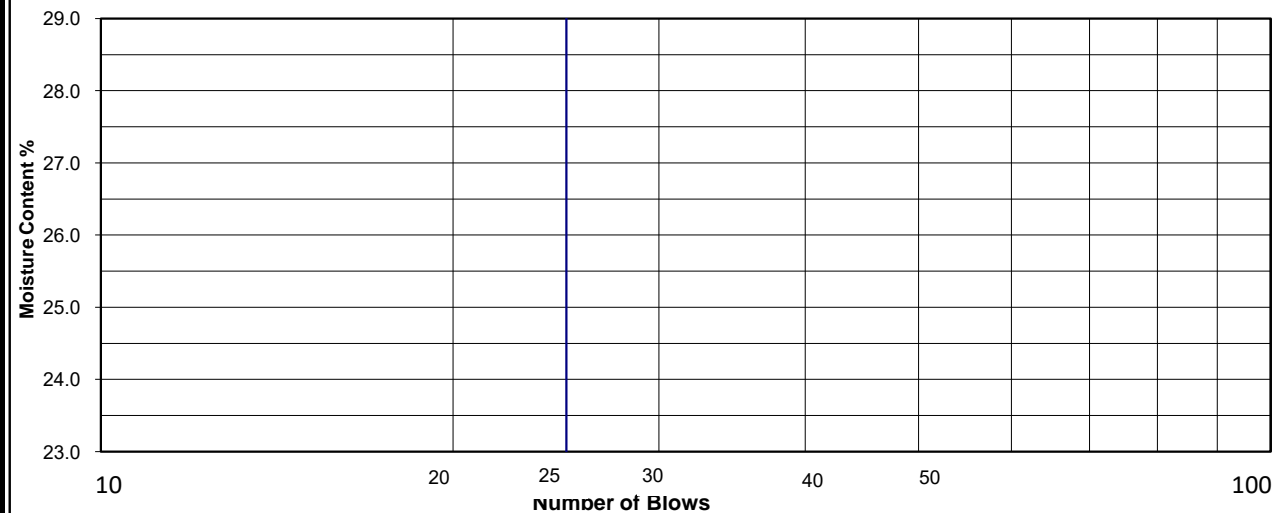
Sample Description:

Test No.		1	2	3	4
Number of Blows					
Can No.		NON PALASTIC MATERIAL			
Weight of Can + Wet Soil	g				
Weight of Can + Dry Soil	g				
Weight of Can	g				
Weight of Water	g				
Weight of Dry Soil	g				
Moisture Content	%				

Plastic Limit

1	2	Average
 	 	

Liquid Limit Graph



Liquid Limit NP Plastic Limit NP Plasticity Index NP

Tested by: _____ Checked By: _____ Certified By: _____

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**LIQUID LIMIT AND PLASTIC LIMIT
OF SOIL
TEST METHOD BS 1377:PART 2**

Test Format No: ELS-ML-04
Revision No. 00

Project data:

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region
Client: Ensys Co. LTD.

Sample data:

BH No	BH - 01	Lab ref. No.	ELS/INT/S/024
Depth	4.50 - 4.95m	Date of Testing	11/03/2021
Sample No	02	Date of Report:	13/03/2021

Test Data:

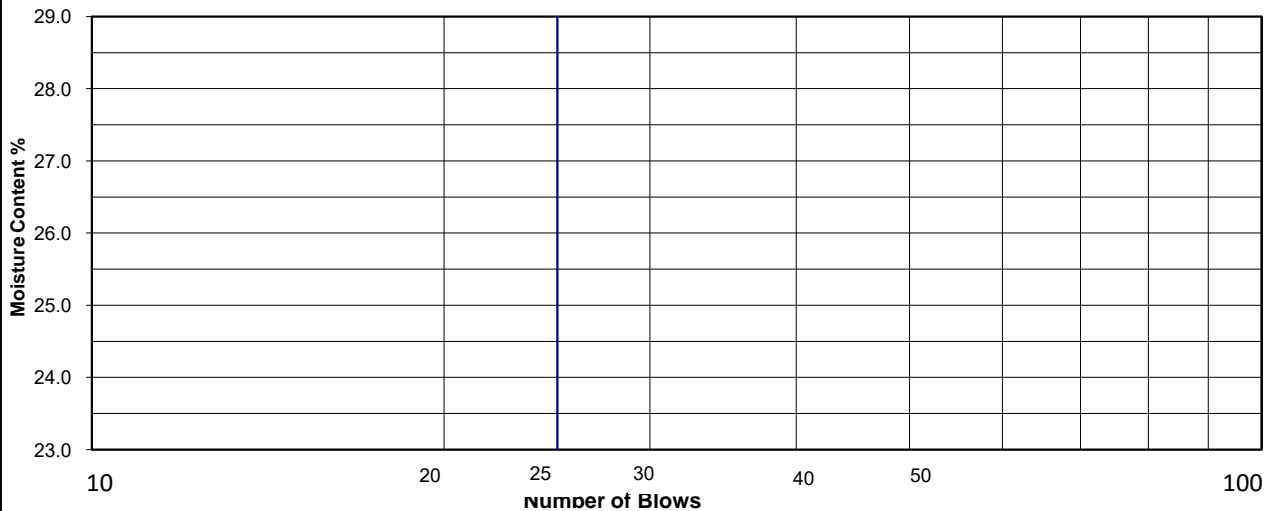
Sample Description:

Test No.		1	2	3	4
Number of Blows					
Can No.		NON PALASTIC MATERIAL			
Weight of Can + Wet Soil	g				
Weight of Can + Dry Soil	g				
Weight of Can	g				
Weight of Water	g				
Weight of Dry Soil	g				
Moisture Content	%				

Plastic Limit

1	2	Average
 	 	

Liquid Limit Graph



Liquid Limit NP Plastic Limit NP Plasticity Index NP

Tested by: _____ Checked By: _____ Certified By: _____

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 Fax : 0094 01 2509806, E-Mail : els@elslanka.com.



**LIQUID LIMIT AND PLASTIC LIMIT
OF SOIL
TEST METHOD BS 1377:PART 2**

Test Format No: ELS-ML-04
Revision No. 00

Project data:

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region
Client: Ensys Co. LTD.

Sample data:

BH No	BH - 02	Lab ref. No.	ELS/INT/S/024
Depth	6.00 - 6.45m	Date of Testing	11/03/2021
Sample No	03	Date of Report:	13/03/2021

Test Data:

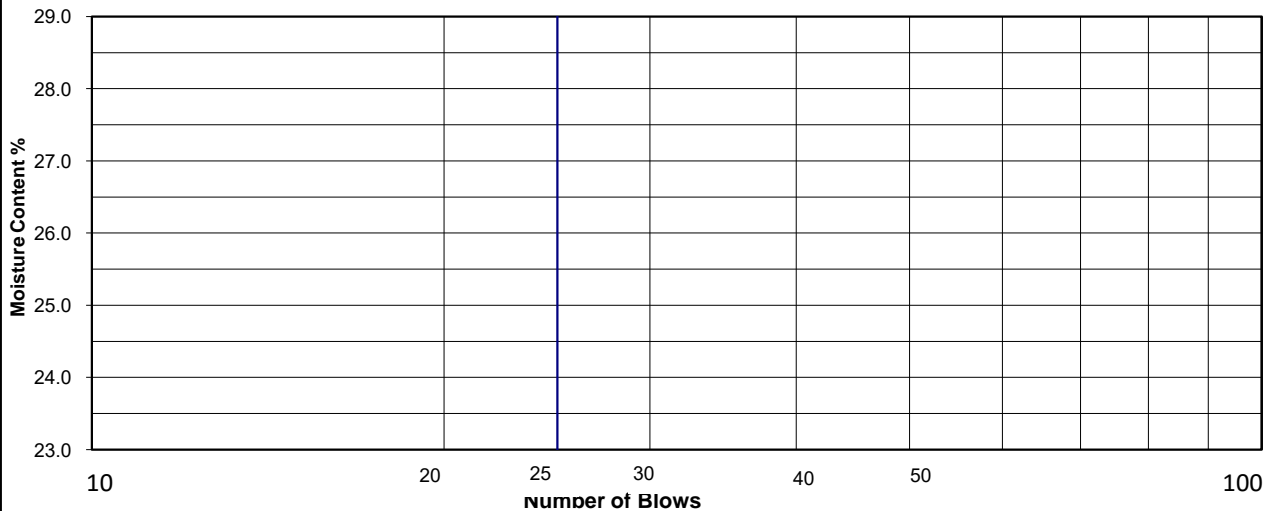
Sample Description:

Test No.		1	2	3	4
Number of Blows					
Can No.		NON PALASTIC MATERIAL			
Weight of Can + Wet Soil	g				
Weight of Can + Dry Soil	g				
Weight of Can	g				
Weight of Water	g				
Weight of Dry Soil	g				
Moisture Content	%				

Plastic Limit

1	2	Average
 	 	

Liquid Limit Graph



Liquid Limit NP Plastic Limit NP Plasticity Index NP

Tested by: _____ Checked By: _____ Certified By: _____

ELS INTERNATIONAL (PVT) LTD.
Head Office:H.Sisil Hiyaa, 9th Floor B, Male - 20071, Republic of Maldives.
 Tel/Fax:+960 3307780, Fax:+9603317780
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 Telephone : 0094 011 4309494/ 2517037 / 2517365,
 Fax : 0094 01 2509806, E-Mail : els@elslanka.com.



**LIQUID LIMIT AND PLASTIC LIMIT
OF SOIL
TEST METHOD BS 1377:PART 2**

Test Format No: ELS-ML-04
Revision No. 00

Project data:

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region
Client: Ensys Co. LTD.

Sample data:

BH No	BH - 03	Lab ref. No.	ELS/INT/S/024
Depth	2.00 - 2.45m	Date of Testing	11/03/2021
Sample No	04	Date of Report:	13/03/2021

Test Data:

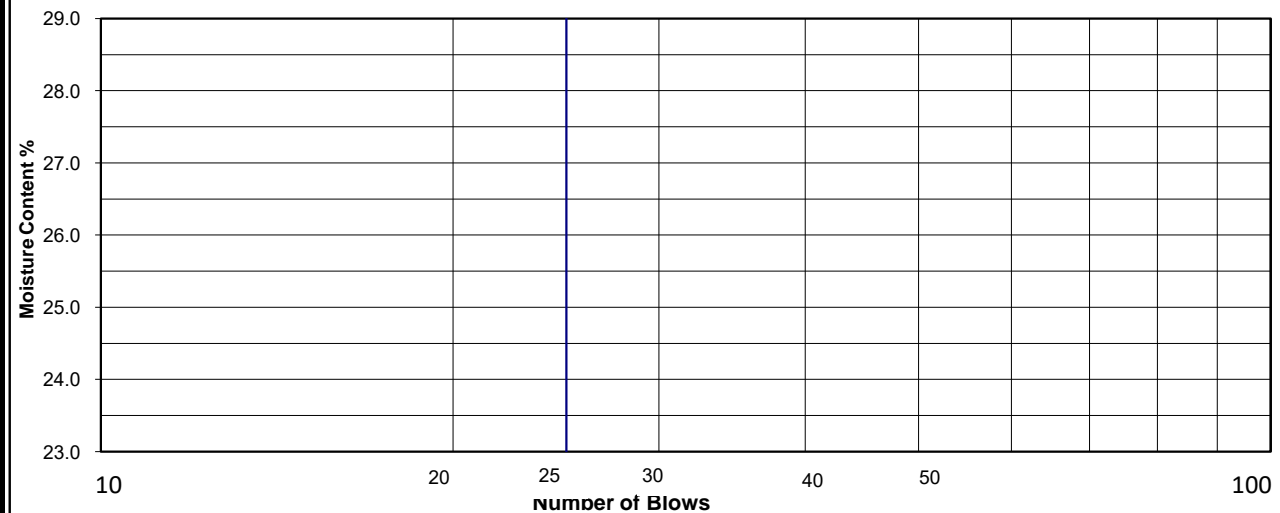
Sample Description:

Test No.		1	2	3	4
Number of Blows					
Can No.		NON PALASTIC MATERIAL			
Weight of Can + Wet Soil	g				
Weight of Can + Dry Soil	g				
Weight of Can	g				
Weight of Water	g				
Weight of Dry Soil	g				
Moisture Content	%				

Plastic Limit

1	2	Average
 	 	

Liquid Limit Graph



Liquid Limit NP Plastic Limit NP Plasticity Index NP

Tested by: _____ Checked By: _____ Certified By: _____

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 Fax : 0094 01 2509806, E-Mail : els@elslanka.com.



**LIQUID LIMIT AND PLASTIC LIMIT
OF SOIL
TEST METHOD BS 1377:PART 2**

Test Format No: ELS-ML-04
Revision No. 00

Project data:

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region
Client: Ensys Co. LTD.

Sample data:

BH No	BH - 03	Lab ref. No.	ELS/INT/S/024
Depth	9.00 - 9.45m	Date of Testing	11/03/2021
Sample No	05	Date of Report:	13/03/2021

Test Data:

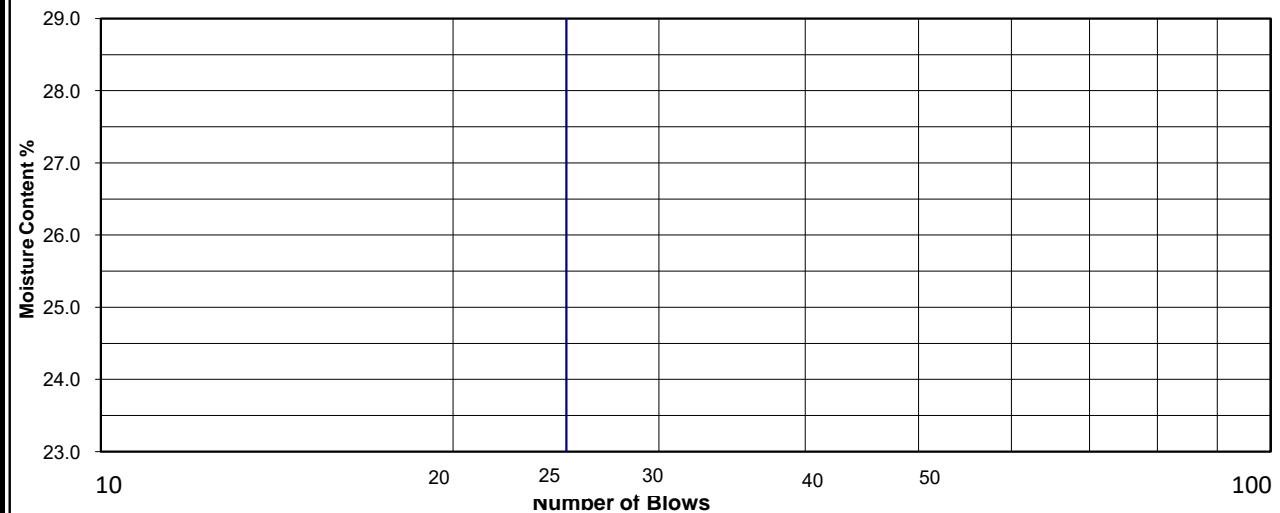
Sample Description:

Test No.		1	2	3	4
Number of Blows					
Can No.		NON PALASTIC MATERIAL			
Weight of Can + Wet Soil	g				
Weight of Can + Dry Soil	g				
Weight of Can	g				
Weight of Water	g				
Weight of Dry Soil	g				
Moisture Content	%				

Plastic Limit

1	2	Average
X	X	

Liquid Limit Graph



Liquid Limit NP Plastic Limit NP Plasticity Index NP

Tested by: _____ Checked By: _____ Certified By: _____

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 Telephone : 0094 011 4309494/ 2517037 / 2517365,
 Fax : 0094 01 2509806, E-Mail : els@elslanka.com.



**LIQUID LIMIT AND PLASTIC LIMIT
OF SOIL
TEST METHOD BS 1377:PART 2**

Test Format No: ELS-ML-04
Revision No. 00

Project data:

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region
Client: Ensys Co. LTD.

Sample data:

BH No	BH - 04	Lab ref. No.	ELS/INT/S/024
Depth	7.50 - 7.95m	Date of Testing	11/03/2021
Sample No	06	Date of Report:	22/03/2021

Test Data:

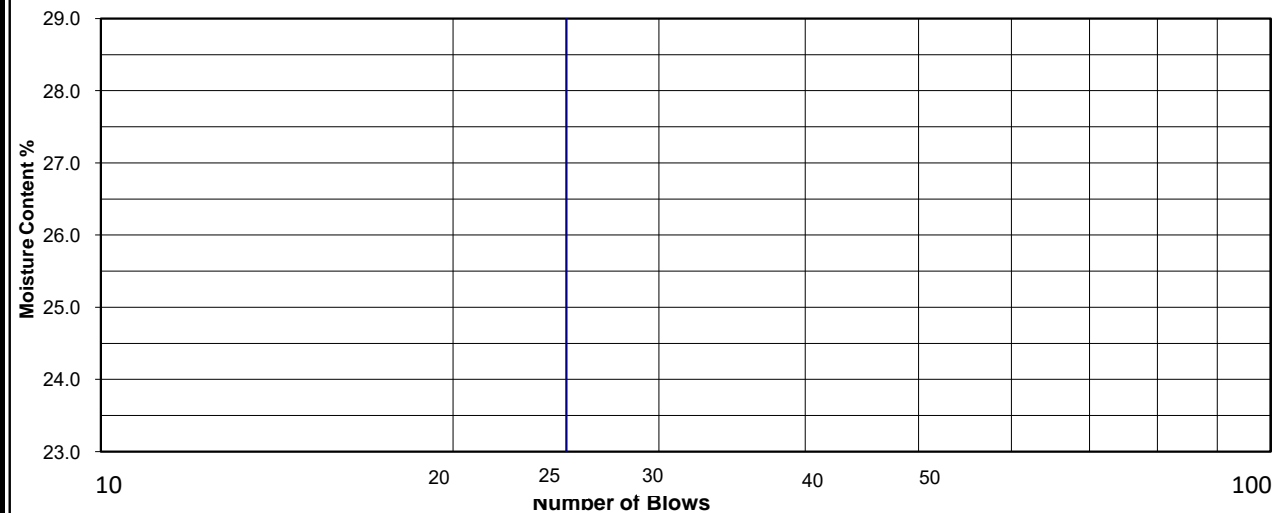
Sample Description:

Test No.		1	2	3	4
Number of Blows					
Can No.		NON PALASTIC MATERIAL			
Weight of Can + Wet Soil	g				
Weight of Can + Dry Soil	g				
Weight of Can	g				
Weight of Water	g				
Weight of Dry Soil	g				
Moisture Content	%				

Plastic Limit

1	2	Average
X	X	

Liquid Limit Graph



Liquid Limit NP Plastic Limit NP Plasticity Index NP

Tested by: **Checked By:** **Certified By:**

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 62/3, Neelammahara Road, Katuwawala, Boralesgamuwa, Sri Lanka.
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 Fax : 0094 01 2509806, E-Mail : els@elslanka.com.

Annexure II(c): Specific Gravity Reports



**PARTICLE DENSITY OF SOIL
TEST METHOD : BS 1377: Part 2:1990**

Test Format No: ELS-ML-18

Revision No. 00

Project data:

Client: Ensys Co. LTD.

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region

Sample data:

Sample Type: Soil Sample

Lab Ref. No. ELS/INT/S/024

BH No: BH - 01

Date of Testing: 11/03/2021

Source: -

Date of Report 11/03/2021

Identification No	BH - 01 Depth 3.00-3.45m
Sampling Date	10/03/2021
Mass of Density Bottle(g)	28.9
Mass of Bottle & Dry Soil(g)	51.9
Mass of Bottle,Dry Soil & Water(g)	93.3
Mass of Bottle with Full of Water(g)	79.3
Mass of Soil	23.0
Temperature of Water(⁰ C)	20.0
Density of Water at the Testing temperature(Mg/m ³)	0.9982
Volume of Soil(cm ³)	9.0
Particle Density of Soil (Mg/m³)	2.55

Tested by:

Checked by

Certified by:

.....

.....

.....

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PARTICLE DENSITY OF SOIL
TEST METHOD : BS 1377: Part 2:1990

Test Format No: ELS-ML-18

Revision No. 00

Project data:

Client: Ensys Co. LTD.

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region

Sample data:

Sample Type: Soil Sample

Lab Ref. No. ELS/INT/S/024

BH No: BH - 01

Date of Testing: 11/03/2021

Source: -

Date of Report 11/03/2021

Identification No	BH - 01 Depth 4.50-4.95m
Sampling Date	10/03/2021
Mass of Density Bottle(g)	29.0
Mass of Bottle & Dry Soil(g)	56.9
Mass of Bottle,Dry Soil & Water(g)	96.2
Mass of Bottle with Full of Water(g)	79.1
Mass of Soil	27.9
Temperature of Water(⁰ C)	20.0
Density of Water at the Testing temperature(Mg/m ³)	0.9982
Volume of Soil(cm ³)	10.8
Particle Density of Soil (Mg/m³)	2.58

Tested by:

Checked by

Certified by:

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**PARTICLE DENSITY OF SOIL
TEST METHOD : BS 1377: Part 2:1990**

Test Format No: ELS-ML-18

Revision No. 00

Project data:

Client: Ensys Co. LTD.

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region

Sample data:

Sample Type: Soil Sample

Lab Ref. No. ELS/INT/S/024

BH No: BH - 02

Date of Testing: 11/03/2021

Source: -

Date of Report 11/03/2021

Identification No	BH - 02 Depth 6.00-6.45m
Sampling Date	10/03/2021
Mass of Density Bottle(g)	29.1
Mass of Bottle & Dry Soil(g)	54.3
Mass of Bottle, Dry Soil & Water(g)	94.7
Mass of Bottle with Full of Water(g)	79.2
Mass of Soil	25.2
Temperature of Water(⁰ C)	20.0
Density of Water at the Testing temperature(Mg/m ³)	0.9982
Volume of Soil(cm ³)	9.7
Particle Density of Soil (Mg/m³)	2.59

Tested by:

Checked by

Certified by:

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PARTICLE DENSITY OF SOIL
TEST METHOD : BS 1377: Part 2:1990

Test Format No: ELS-ML-18

Revision No. 00

Project data:

Client: Ensys Co. LTD.

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region

Sample data:

Sample Type: Soil Sample

Lab Ref. No. ELS/INT/S/024

BH No: BH - 03

Date of Testing: 11/03/2021

Source: -

Date of Report 11/03/2021

Identification No	BH - 03 Depth 2.00-2.45m
Sampling Date	10/03/2021
Mass of Density Bottle(g)	29.0
Mass of Bottle & Dry Soil(g)	52.6
Mass of Bottle,Dry Soil & Water(g)	94.0
Mass of Bottle with Full of Water(g)	79.4
Mass of Soil	23.6
Temperature of Water(⁰ C)	20.0
Density of Water at the Testing temperature(Mg/m ³)	0.9982
Volume of Soil(cm ³)	9.0
Particle Density of Soil (Mg/m³)	2.62

Tested by:

Checked by

Certified by:

.....

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PARTICLE DENSITY OF SOIL
TEST METHOD : BS 1377: Part 2:1990

Test Format No: ELS-ML-18

Revision No. 00

Project data:

Client: Ensys Co. LTD.

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region

Sample data:

Sample Type: Soil Sample

Lab Ref. No. ELS/INT/S/024

BH No: BH - 03

Date of Testing: 11/03/2021

Source: -

Date of Report 11/03/2021

Identification No	BH - 03 Depth 9.00-9.45m
Sampling Date	10/03/2021
Mass of Density Bottle(g)	28.0
Mass of Bottle & Dry Soil(g)	62.2
Mass of Bottle, Dry Soil & Water(g)	98.5
Mass of Bottle with Full of Water(g)	77.4
Mass of Soil	34.2
Temperature of Water(⁰ C)	20.0
Density of Water at the Testing temperature(Mg/m ³)	0.9982
Volume of Soil(cm ³)	13.1
Particle Density of Soil (Mg/m³)	2.61

Tested by:

Checked by

Certified by:

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Tel : 0094 011 2 517037 / 517365 / Fax : 0094112509806 E mail : els@lanka.ccom.lk



**PARTICLE DENSITY OF SOIL
TEST METHOD : BS 1377: Part 2:1990**

Test Format No: ELS-ML-18

Revision No. 00

Project data:

Client: Ensys Co. LTD.

Project: Geotechnical Investigation for 5MW Grid-Tied Solar Photovoltaic System in the Greater Male' Region

Sample data:

Sample Type: Soil Sample

Lab Ref. No. ELS/INT/S/024

BH No: BH - 04

Date of Testing: 11/03/2021

Source: -

Date of Report 11/03/2021

Identification No	BH - 04 Depth 7.50-7.95m
Sampling Date	10/03/2021
Mass of Density Bottle(g)	28.9
Mass of Bottle & Dry Soil(g)	57.7
Mass of Bottle,Dry Soil & Water(g)	96.7
Mass of Bottle with Full of Water(g)	78.8
Mass of Soil	28.8
Temperature of Water(⁰ C)	20.0
Density of Water at the Testing temperature(Mg/m ³)	0.9982
Volume of Soil(cm ³)	10.9
Particle Density of Soil (Mg/m³)	2.64

Tested by:

Checked by

Certified by:

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.....

ELS INTERNATIONAL (PVT) LTD)

Head office : 52, Boduhakurufaanu Magu, Male, 20-01, Maldives

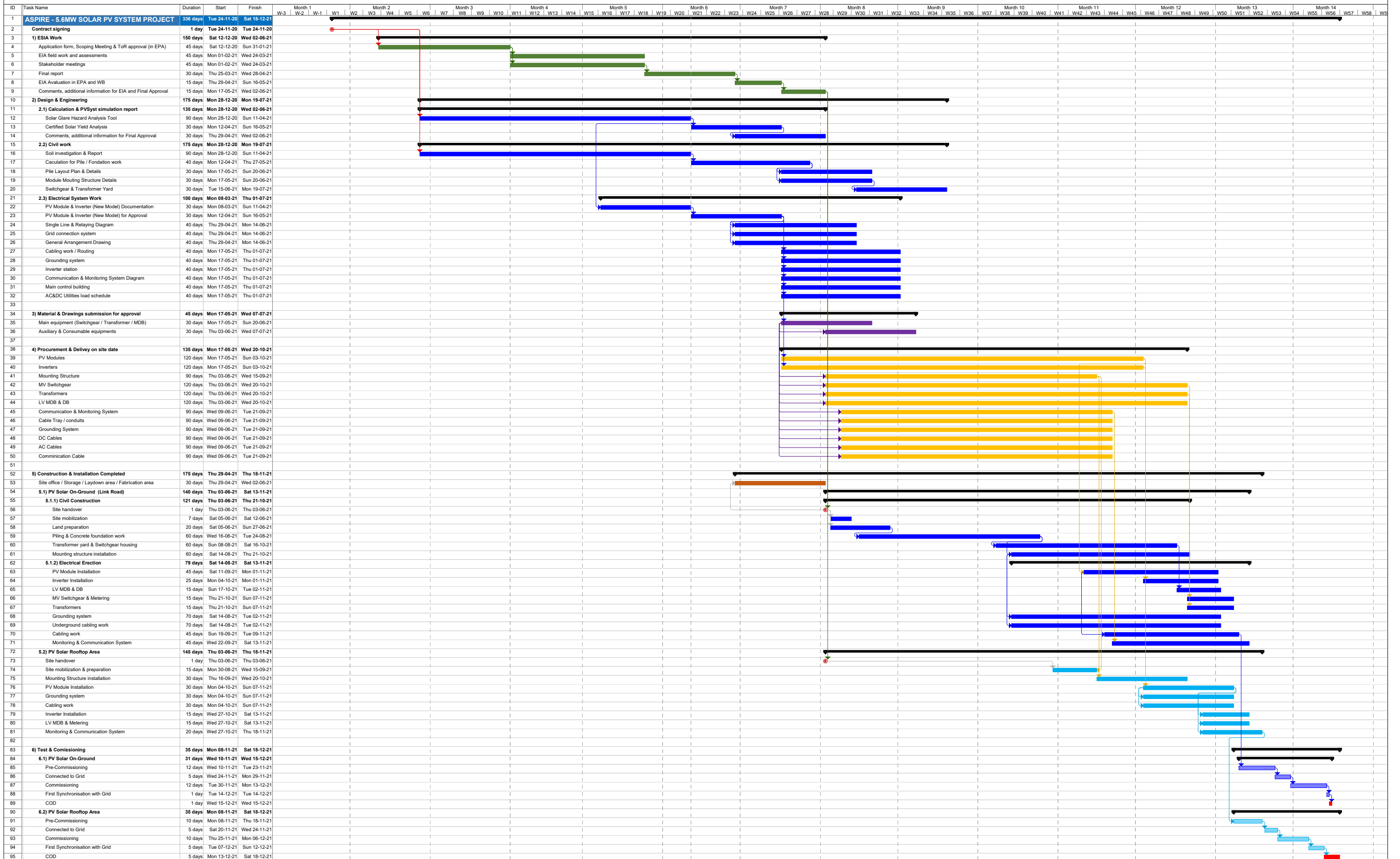
Tel/Fax : +960 334 6000 , Mobole hotline : 790 6000

Sri Lanka office : 62/3, Neelammahara Road, Katuwawala, Borlasgamuwa, Sri Lanka.

Tel : 0094 011 2 517037 / 517365 / Fax : 0094112509806 E mail : els@lanka.ccom.lk

Annexure III: Services Plans

17.9 Project schedule



17.10 Evidence of report submission to Male City Council



Firdous Hussain <firdous@foresightsurveyors.com>

ESMP for the 5MW Solar PV Project in Greater Male' area

Firdous Hussain <firdous@foresightsurveyors.com>
To: secretariat@malecity.gov.mv

Mon, Aug 2, 2021 at 9:39 AM

To Whom It May Concern,

PFA report.

Rgds
Firdous Hussain
Director
Registered EIA Consultant
Registered Surveyor



Foresight Surveyors (Pvt) Ltd.

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ESMP to th eproposed 5MW solar PV System in Greater Male' area.pdf
7787K

17.11 Glare Assessment Report

SOLAR GLARE ANALYSIS REPORT

DEPARTMENT OF PHYSICS, FACULTY OF SCIENCE, NARESUAN UNIVERSITY

PHITSANULOK, THAILAND, 65000

Tel: +66 55 963512, Fax: +66 55 963501

Email: sesil_nu@hotmail.com

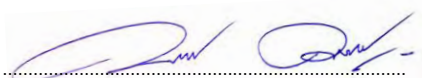


PROJECT : VELANA INTERNATIONAL AIRPORT

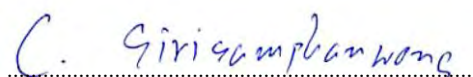
DELIVERED TO : ENSYS CO., LTD.

636/4-6, Ramkhamhaeng 39 (Thepleela 1) Alley, Pracha Uthit Road,
Wang Thonglang Sub-district, Wang Thonglang District,
Bangkok Metropolis, 10310 Thailand

MAY 27, 2021



Mr.Rattaporn Ngoenmeesri
Researcher of Research and Academic Service
Faculty of Science
Naresuan University



Assist. Prof. Dr.Chatchai Sirisamphanwong
Head of Smart Energy System Integration Research Unit
Department of Physics, Faculty of Science
Naresuan University

Acknowledgement

Prepared by : Assist. Prof. Dr.Chatchai Sirisamphanwong
 Mr.Rattaporn Ngoenmeesri

Document Purpose

This report provides an assessment of glare analysis from solar rooftop in the Velana International Airport, Maldives.

Document History

DATE	VERSION	COMMENTS
5th Mar 2021	0.0	Initial version.
9th Apr 2021	1.0	Revised version based on MEE consultant's comments dated 23th Mar 2021
27th May 2021	2.0	Added data based on EIA committee's comments

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5. Glare Prediction Method	8
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1. INTRODUCTION

The Project is located on Hulhulé Island in the North Malé Atoll, nearby the capital island Malé. The Project have a total capacity of 5.6 MW.

Photovoltaic (PV) solar modules are designed to convert sunlight into electricity; however, up to 10 percent of the sunlight may be reflected into the surrounding areas¹. In certain situations, the reflected sunlight can produce glint (a momentary flash of bright light) and glare (a continuous source of bright light) that may result in an ocular impact to individuals.

ENSYS CO., LTD. to conduct a glare analysis for observation points at Velana International Airport.

This report documents the potential for solar glare from the Project at the observation points.

¹ Solar Glare Hazard Analysis Tool (SGHAT) User's Manual v 1.0, Ho and Sims, Sandia National Laboratories, 2013.

2. PROJECT DESCRIPTION

The Solar Rooftop Project will be located on Velana International Airport is the main international airport in the Maldives. It is located on Hulhulé Island in the North Malé Atoll, nearby the capital island Malé. The approximate location of the Project is shown in Figure 1.



Figure 1: Location of VELANA INTERNATIONAL AIRPORT

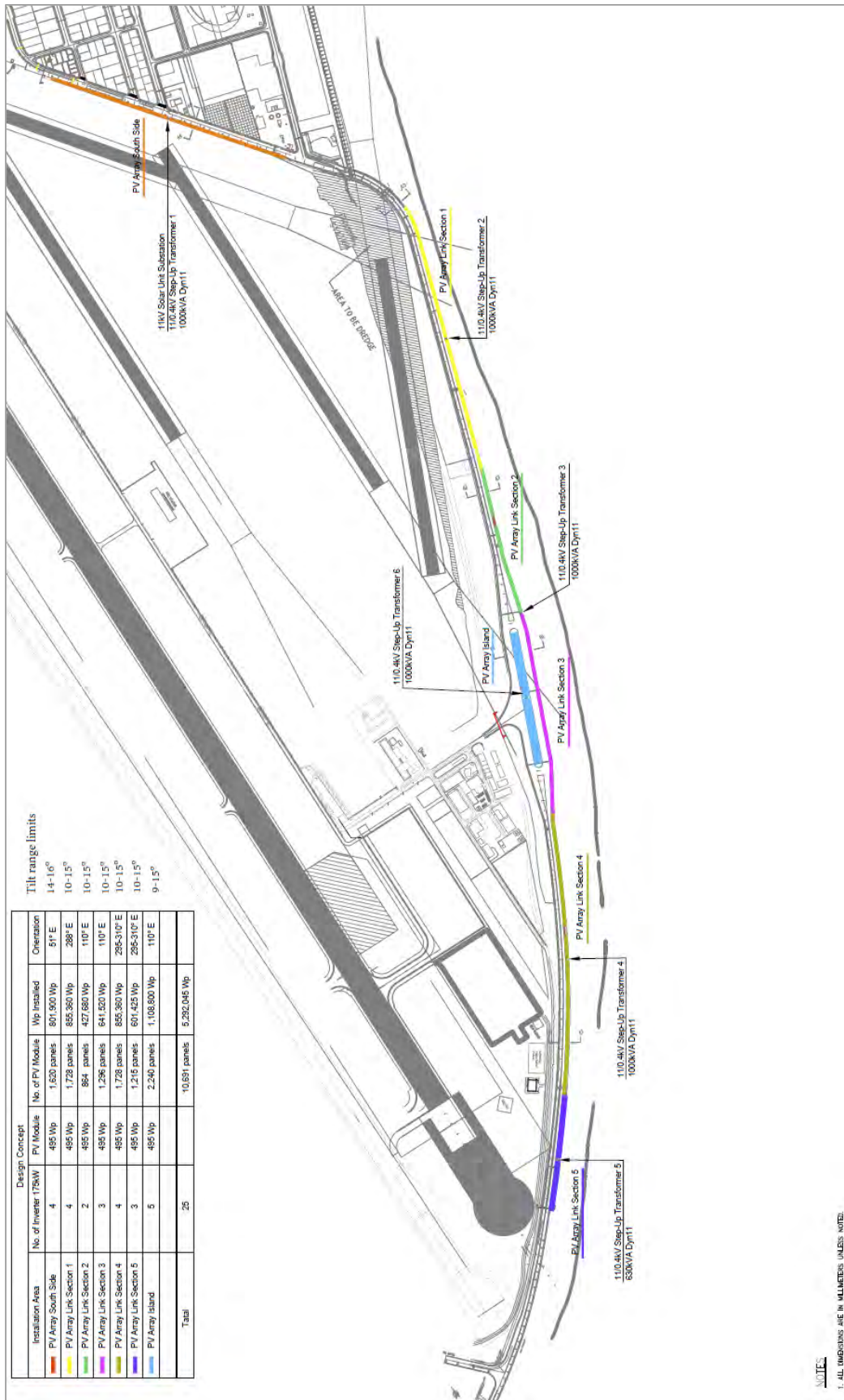


Figure 2: Project Solar Rooftop at VELANA INTERNATIONAL AIRPOR

3. PROJECT ASSUMPTIONS

The Government of Maldives (GoM) aims to develop private investments in the sector of renewable energy by addressing key barriers to private investments through provision of appropriate risk mitigation measures. Accelerating Sustainable Private Investment in Renewable Energy (ASPIRE) is part of the Maldives Scaling-Up Renewable Energy Program (SREP). ASPIRE program aims to encourage involvement of private parties in the renewable energy sector of the Maldives. ASPIRE program is managed through a phased approach to developing sector investments, in such a way that the early investors are supported and secured through greater risk mitigation measures by International Development Association (IDA), through a series of IDA partial risk guarantees (PRGs), and SREP funds (for subsidies, capacity building, and additional guarantee support). The ASPIRE resources are administered by the World Bank Group (WBG).

Under the current project proposed by the GoM under the ASPIRE program, it is aimed to develop the capacity to generate 5.6 Megawatt of electricity by a Solar Photovoltaic System in the Greater Male' region.

ENSYS will be responsible for design build finance own operate and transfer of all facets of the project and for generating the required 5.6 Megawatt generation output of electricity by a Solar Photovoltaic System. The scope of services is providing all labor, services and equipment necessary to develop, permit, design, engineer, procure, install, construct, test, commission, monitor, operate, and maintain fully operational generating facilities, including overhaul of the plant, equipment, works, switchyard and transmission lines and equipment up to the Interconnection Point of the project.

Detailed input parameters and assumptions can be found in Appendix A.

4. GLARE REGULATIONS AND RECEPTOR

In the United States, the Federal Aviation Administration stipulates that any glare occurring along an aircraft's flight landing path must have a low potential of producing after-image³. Glare outside of 50 degrees of the pilot's line of sight is not considered a risk.

Transport Canada publication TP1247E Aviation Land Use in the Vicinity of Aerodromes offers guidelines useful for glare reports. The guidelines indicate "The analysis of glare should involve a review of the position of the aircraft for both landing and take-offs as well as performing a circling approach... The designer should review the positioning and orientation of the panels in relation to the control tower to ensure that adverse reflection will not be produced."

The Velana International Airport master plan shows the aircraft runways (2 runways), sea planes take off and landing paths (5 paths) and airport tower location (OP1). In general the glide path was given as 3 degrees with 15m height over runway threshold for main planes and 5 degrees with 15m threshold for seaplanes. Airport traffic control tower height is in the range of 35 m.

We analyzed the potential for glare at the observation points shown in Figure 3 and Figure 4. Two observation points were evaluated.

³ <https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports>



Figure 3: Observation Point Identified



Figure 4: Observation Point (OP) Identified at VELANA INTERNATIONAL AIRPOR



Figure 5: The 2-Mile Flight Path (FP) Identified at VELANA INTERNATIONAL AIRPOR



Figure 6: The Route receptors (Route) Identified at VELANA INTERNATIONAL AIRPORT

Table 1 lists the observation points used in the analysis. The table also identifies the height of Air Traffic Control Tower of the Project.

Table 1: Description of Observation Point

Observation Point Number	Component	Height (m.)
OP1	Air Traffic Control Tower	32
FP1	Flight Path	Slope 3°
FP2	Flight Path	Slope 3°
FP3	Flight Path	Slope 3°
FP4	Flight Path	Slope 3°
FP5	Water Aerodrome	Slope 5°
FP6	Water Aerodrome	Slope 5°
FP7	Water Aerodrome	Slope 5°
FP8	Water Aerodrome	Slope 5°
FP9	Water Aerodrome	Slope 5°
FP10	Water Aerodrome	Slope 5°
Route 1	Route Receptor	
Route 2	Route Receptor	

Remark: Route receptors are for the traffic on the link road, and the others are for flight paths

5. GLARE PREDICTION METHOD

The impact of glare depends on the interaction between the position of the sun, the tilt of the solar modules, the reflectivity of the modules' surface, the size of the project, and the relative location of the observer. We did not consider the screening effect from existing or proposed hedgerows or other objects in this evaluation.

The sun's position is described using the angle of elevation and solar azimuth. The angle of elevation is the angle between the horizon and the centre of the sun. The azimuth is measured as the angle from true north in a clockwise direction.

We performed the glare analysis using the ForgeSolar GlareGauge⁴ software tool. This tool uses project inputs and solar positioning calculations to determine if glare will occur at identified observation points. If glare is found, the tool calculates the retinal irradiance (brightness) and subtended angle (size divided by distance) of the glare source. These two factors predict ocular hazards ranging from temporary after-image to retinal burn. Minor topographic features are not always identified in GlareGauge due to the resolution of the topographic contours from Google Earth.

“Green” rated glare indicates a low potential for after-image, “yellow” rated glare indicates the potential for after-image exists, and “red” rated glare indicates the potential for retinal damage. Glare that is beyond 50 degrees from a driver's line-of-sight does not constitute a safety hazard.⁵

The amount of light reflected by a solar module depends on the sunlight's angle of incidence at the module as illustrated in Figure 7.

⁴ Copyright, Sims Industries, 2015

⁵ SGHAT_Users_Manual_v2-F.pdf

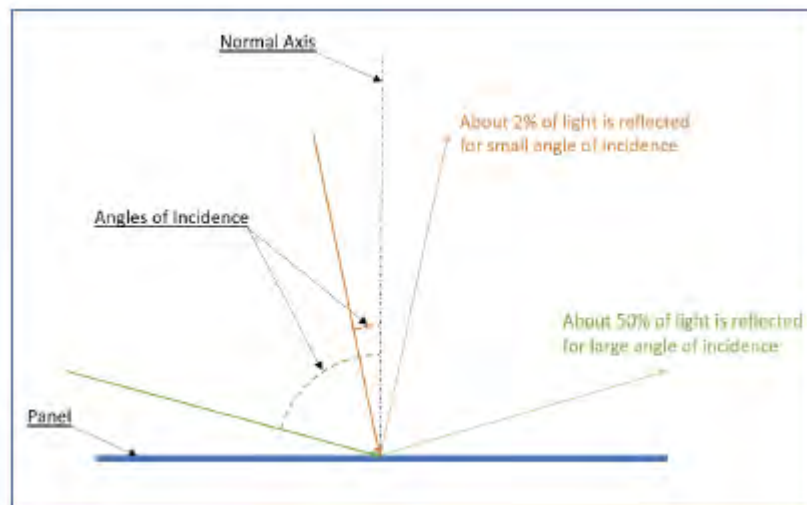


Figure 7: Reflected Light and Angle of Incidence on the PV Module Illustration

Approximately 10 percent of sunlight is reflected from a solar module without anti-reflective coatings on average⁶, which is about the same as open water⁷. Anti-reflection coating on the solar module can reduce the reflection to one to two percent on average. The software models the reflectivity for each angle of incidence based on experiments Sandia National Laboratories performed for a variety of different module constructions⁸. Very little light is reflected when the sun is nearly perpendicular to the module, but more light is reflected when the sun is at a shallow angle to the module.

5.1 LIMITATIONS OF THE MODEL

This analysis aims to provide an indication of the glare that may be produced by the proposed solar rooftop. The prediction methods employed in the analysis have uncertainty. The following lists some of the limitations inherent in the analysis.

- The base model assumes clear skies at all times. The model does not use historical weather pattern data. This results in a total cumulative duration of glare that is likely higher than what will occur over the course of a year.
- Shading is not considered in the model.
- Obstructions such as foliage, structures, and hills between the arrays and observation points are not modelled by ForgeSolar's GlareGauge software tool.
 - Separate analysis can be performed to evaluate the impact of topographical features available in Google Earth on the predicted glare.

- The impact of trees and foliage is extremely variable, so it is not considered.
- Ocular and perceived hazards differ from person to person, depending on multiple environmental, optical, and human factors.
- Changes in site and array elevation from the assumptions may change the results of the analysis.

⁶ Lasnier and Ang, 1990, Photovoltaic Engineering Handbook. Taylor & Francis, New York.

⁷ US EPA, 2013, AERSURFACE User's guide, EPA-454/B-08-001.

⁸ Sandia National Laboratories, 2014, Solar Glare Hazard Analysis Tool (SGHAT) User's Manual v. 2F, Appendix E

6. ANALYSIS RESULTS

The Project does not reveal any red glare.

Glare impact analysis is carried out in the selected areas using Solar Glare Hazard Analysis Tool (SGHAT). The compatibility of PV installation in the airport environment is checked as per the glare policy framed by Federal Aviation Administration (FAA). The results of glare analysis are summarized in Table 2 and Table 3. It can be observed that PV installed in the area cause glare and hence this location is suitable for PV projects in the given system design. There is any glare effects on Air Traffic Control Tower (OP1) from PV modules installed. The duration of glare on the flight path receptor FP7, FP9 and FP 10 in model A are 1,065 min, 855 min and 2,690 min respectively (green glare). The other route receptors are for the traffic on the link road, route 1 and route 2 are safe from any kind of glare impact. For the route receptors the maximum high of receptors and the view angle are 3 meters and 50 Degree, respectively. For the others of route receptors in airport are also safe from Glare affects too. It cause of the route 1 and route 2 receptor are very near to the PV array.

Table 2: Summary of Glare

Component	Total Capacity (kWp)	Orientation (°E)	Model A		Model B		Model C	
			Tilt	Annual Glare (min)	Tilt	Annual Glare (min)	Tilt	Annual Glare (min)
PV Array Island	1,108.80	110 °E	9	829 (green)	12	835 (green)	15	841 (green)
PV Array Link Section 1	855.36	286 °E	10	-	12	-	15	-
PV Array Link Section 2	427.68	110 °E	10	1,951 (green)	12	1,957 (green)	15	1,932 (green)
PV Array Link Section 3	641.52	110 °E	10	975 (green)	12	979 (green)	15	960 (green)
PV Array Link Section 4	855.36	305 °E	10	-	12	-	15	-
PV Array Link Section 5	601.425	305 °E	10	-	12	-	15	-
PV Array South Side	801.90	50 °E	14	855 (green)	15	899 (green)	16	947 (green)

Table 3: Total annual glare received by each receptor.

Receptor	Component	Annual Glare (min) Model A		Annual Glare (min) Model B		Annual Glare (min) Model C		STATUS
		Green	Yellow	Green	Yellow	Green	Yellow	
OP1	Air Traffic Control Tower	0	0	0	0	0	0	PASS
FP1	Flight Path	0	0	0	0	0	0	PASS
FP2	Flight Path	0	0	0	0	0	0	PASS
FP3	Flight Path	0	0	0	0	0	0	PASS
FP4	Flight Path	0	0	0	0	0	0	PASS
FP5	Water Aerodrome	0	0	0	0	0	0	PASS
FP6	Water Aerodrome	0	0	0	0	0	0	PASS
FP7	Water Aerodrome	1,065	0	1,081	0	1,039	0	PASS
FP8	Water Aerodrome	0	0	0	0	0	0	PASS
FP9	Water Aerodrome	855	0	899	0	947	0	PASS
FP10	Water Aerodrome	2,690	0	2,690	0	2,694	0	PASS
Route 1	Route Receptor	0	0	0	0	0	0	PASS
Route 2	Route Receptor	0	0	0	0	0	0	PASS

The following Table 4 summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.

Table 4: The analysis results

RECEPTOR	COMPONENT	STATUS	DEACRIPTION
OP1	Air Traffic Control Tower	PASS	Receptor(s) marked as ATCT do not receive glare
FP1	Flight Path	PASS	Analysis time interval and eye characteristics used are acceptable
FP2	Flight Path	PASS	Analysis time interval and eye characteristics used are acceptable
FP3	Flight Path	PASS	Analysis time interval and eye characteristics used are acceptable
FP4	Flight Path	PASS	Analysis time interval and eye characteristics used are acceptable
FP5	Water Aerodrome	PASS	Analysis time interval and eye characteristics used are acceptable
FP6	Water Aerodrome	PASS	Analysis time interval and eye characteristics used are acceptable
FP7	Water Aerodrome	PASS	Analysis time interval and eye characteristics used are acceptable
FP8	Water Aerodrome	PASS	Analysis time interval and eye characteristics used are acceptable
FP9	Water Aerodrome	PASS	Analysis time interval and eye characteristics used are acceptable
FP10	Water Aerodrome	PASS	Analysis time interval and eye characteristics used are acceptable
Route 1	Route Receptor	PASS	Receptor(s) marked as Route 1 do not receive glare
Route 2	Route Receptor	PASS	Receptor(s) marked as Route 2 do not receive glare

Remark:

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

7. CONCLUSIONS

The glare impact analysis at VELANA International Airport based PV systems results showed that the Air Traffic Control Tower (OP1), the flight path receptor (FP1-FP10) and all route complied with U.S. FAA 2013 standard. Glare occurrence is predicted using Solar Glare Hazard Analysis Tool (SGHAT) for all location in the airport.

Though the FAA's guidance on glare is the basis for assessment, a pragmatic approach is followed to conclude whether a predicted solar reflection cause hazard to aviation safety. Solar PV systems can safely coexist in airport premises through a combined effort of design engineers and air traffic management, airlines and stakeholders.

APPENDIX A
FORGESOLAR GLARE ANALYSIS RESULTS REPORT

APPENDIX A

FORGESOLAR GLARE ANALYSIS RESULTS REPORT (1.1)

Site Configuration:

Component	Tilt (°)	Orientation (°)
PV Array Island	9	110 °E
PV Array Link Section 1	10	286 °E
PV Array Link Section 2	10	110 °E
PV Array Link Section 3	10	110 °E
PV Array Link Section 4	10	305 °E
PV Array Link Section 5	10	305 °E
PV Array South Side	14	50 °E

FORGESOLAR GLARE ANALYSIS

Project: **Maldives Airports**

Site configuration: **Config S-FP 1**

Analysis conducted by rattaporn ngoenmeesri (ratapornn@nu.ac.th) at 02:10 on 07 Apr, 2021.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

Default glare analysis parameters and observer eye characteristics (for reference only):

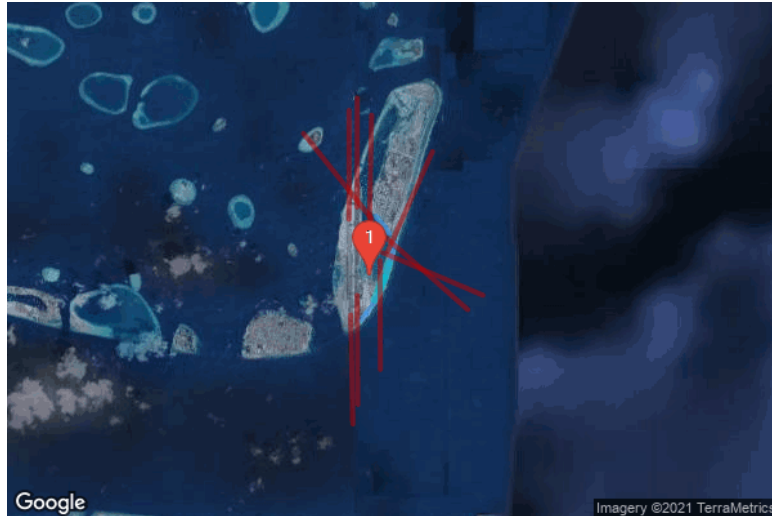
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m²
 Time interval: 1 min
 Ocular transmission coefficient: 0.5
 Pupil diameter: 0.002 m
 Eye focal length: 0.017 m
 Sun subtended angle: 9.3 mrad
 Site Config ID: 48509.8719



PV Array(s)

Name: PV Array Island
Description: Capacity 1108.80 kWp No. of PV Modules 2240 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 9.0°
Orientation: 110.0°
Rated power: 1108.8 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.189934	73.538149	-17.32	21.32	4.00
2	4.187121	73.537015	-9.23	13.23	4.00
3	4.187074	73.537134	-10.03	14.03	4.00
4	4.189887	73.538259	-18.16	22.16	4.00

Name: PV Array Link Section 1

Description: Capacity 855.360 kWp No. of PV Modules 1728 panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 10.0°

Orientation: 286.0°

Rated power: 855.36 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.199016	73.541233	-47.02	52.02	5.00
2	4.199006	73.541284	-47.67	52.67	5.00
3	4.198672	73.541217	-46.96	51.97	5.00
4	4.198479	73.541162	-46.23	51.23	5.00
5	4.198237	73.541083	-45.26	50.26	5.00
6	4.193486	73.539610	-28.79	33.79	5.00
7	4.193501	73.539560	-28.36	33.36	5.00
8	4.198251	73.541041	-44.76	49.76	5.00
9	4.198495	73.541118	-45.71	50.71	5.00
10	4.198681	73.541172	-46.32	51.32	5.00

Name: PV Array Link Section 2

Description: Capacity 427.680 kWp No. of PV Modules 864 panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 10.0°

Orientation: 110.0°

Rated power: 427.68 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.193498	73.539559	1.85	3.10	4.95
2	4.191354	73.538839	1.85	3.10	4.95
3	4.190228	73.538545	1.85	3.10	4.95
4	4.190216	73.538595	1.85	3.10	4.95
5	4.191341	73.538885	1.85	3.10	4.95
6	4.193482	73.539608	1.85	3.10	4.95

Name: PV Array Link Section 3

Description: Capacity 641.520 kWp No. of PV Modules
1296 panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 10.0°

Orientation: 110.0°

Rated power: 641.52 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186034	73.536733	1.85	3.10	4.95
2	4.187013	73.537321	1.85	3.10	4.95
3	4.189813	73.538438	1.85	3.10	4.95
4	4.190227	73.538544	1.85	3.10	4.95
5	4.190215	73.538594	1.85	3.10	4.95
6	4.189797	73.538485	1.85	3.10	4.95
7	4.186987	73.537364	1.85	3.10	4.95
8	4.186008	73.536772	1.85	3.10	4.95

Name: PV Array Link Section 4

Description: Capacity 855.360 kWp No. of PV Modules
1728 panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 10.0°

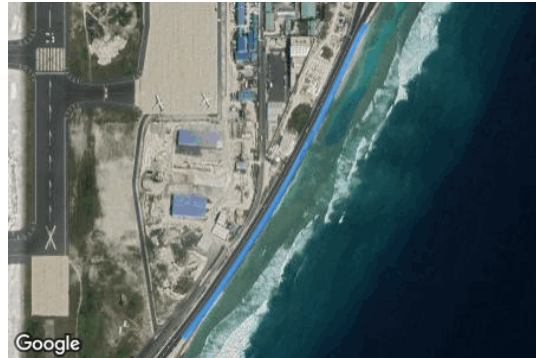
Orientation: 305.0°

Rated power: 855.36 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186032	73.536732	-8.02	13.02	5.00
2	4.186008	73.536769	-8.18	13.18	5.00
3	4.185786	73.536639	-7.66	12.66	5.00
4	4.185505	73.536508	-7.16	12.15	5.00
5	4.184684	73.536118	-5.84	10.84	5.00
6	4.184282	73.535933	-5.31	10.31	5.00
7	4.183881	73.535721	-4.72	9.72	5.00
8	4.182684	73.535072	-3.72	8.71	5.00
9	4.182138	73.534714	-3.85	8.85	5.00
10	4.181122	73.534045	-4.65	9.65	5.00
11	4.180365	73.533483	-5.50	10.50	5.00
12	4.180399	73.533443	-5.38	10.38	5.00
13	4.181150	73.534006	-4.56	9.56	5.00
14	4.182161	73.534677	-3.74	8.74	5.00
15	4.182710	73.535026	-3.52	8.52	5.00
16	4.183294	73.535362	-3.92	8.92	5.00
17	4.183899	73.535683	-4.60	9.60	5.00
18	4.184301	73.535894	-5.19	10.19	5.00
19	4.184708	73.536080	-5.72	10.72	5.00
20	4.185520	73.536474	-6.99	11.99	5.00
21	4.185807	73.536601	-7.49	12.49	5.00

Name: PV Array Link Section 5
Description: Capacity 601.425 kWp No. of PV Modules
 1215 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 305.0°
Rated power: 601.425 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.178466	73.531870	1.85	2.10	3.95
2	4.179443	73.532692	1.85	2.10	3.95
3	4.180400	73.533442	1.85	2.10	3.95
4	4.180354	73.533501	1.85	2.10	3.95
5	4.179386	73.532745	1.85	2.10	3.95
6	4.178416	73.531929	1.85	2.10	3.95

Name: PV Array South Side
Description: Capacity 801.900 kWp No. of PV Modules
 1620 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 14.0°
Orientation: 50.0°
Rated power: 801.9 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.206048	73.536085	1.85	2.80	4.65
2	4.201706	73.539543	1.85	2.80	4.65
3	4.201749	73.539596	1.85	2.80	4.65
4	4.206101	73.536134	1.85	2.80	4.65

Flight Path Receptor(s)

Name: FP 01

Description:

Threshold height: 15 m

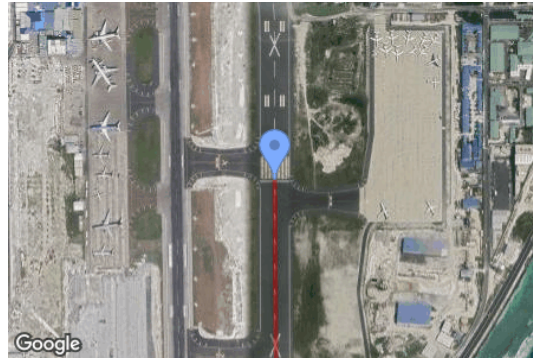
Direction: 359.6°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.185152	73.531025	0.00	15.24	15.24
Two-mile	4.156240	73.531213	-292.88	476.81	183.92

Name: FP 02

Description:

Threshold height: 15 m

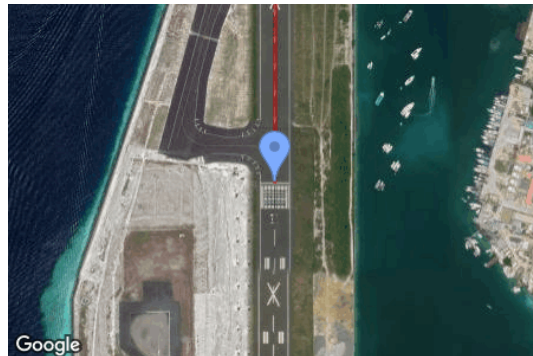
Direction: 180.1°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.208640	73.531009	0.00	15.24	15.24
Two-mile	4.237552	73.531075	0.00	183.92	183.92

Name: FP 03

Description:

Threshold height: 15 m

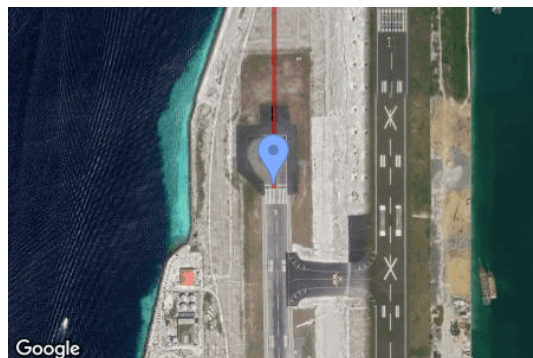
Direction: 180.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.205368	73.528869	2.49	15.24	17.73
Two-mile	4.234281	73.528869	0.00	186.41	186.41

Name: FP 04

Description:

Threshold height: 15 m

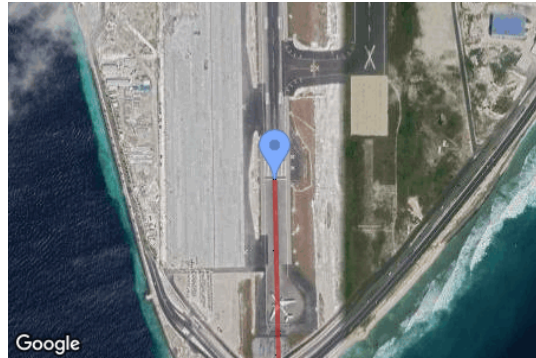
Direction: 358.8°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.179945	73.529309	-0.81	15.24	14.43
Two-mile	4.151039	73.529912	-356.57	539.69	183.12

Name: FP 05 Male Water Aerodrome_South Landing

Description:

Threshold height: 15 m

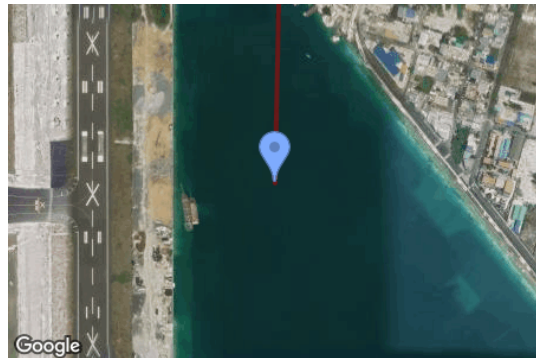
Direction: 181.2°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.204087	73.534292	-0.82	15.24	14.42
Two-mile	4.232993	73.534890	0.00	296.02	296.02

Name: FP 06 Male Water Aerodrome_North Landing

Description:

Threshold height: 15 m

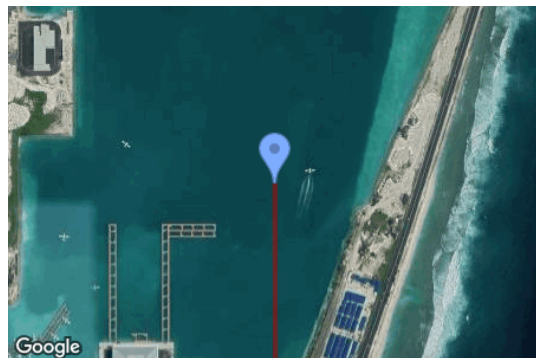
Direction: 359.8°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.194436	73.537119	-9.66	15.24	5.58
Two-mile	4.165523	73.537226	-234.62	521.80	287.18

Name: FP 07 Male Water Aerodrome_NW Landing

Description:

Threshold height: 15 m

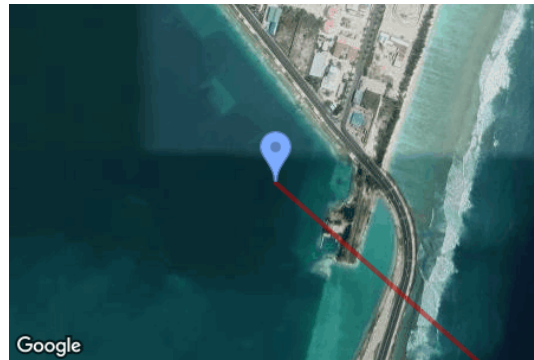
Direction: 311.4°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.200513	73.538750	-20.35	15.24	-5.11
Two-mile	4.181393	73.560522	-959.43	1235.92	276.49

Name: FP 08 Male Water Aerodrome_SE Landing

Description:

Threshold height: 15 m

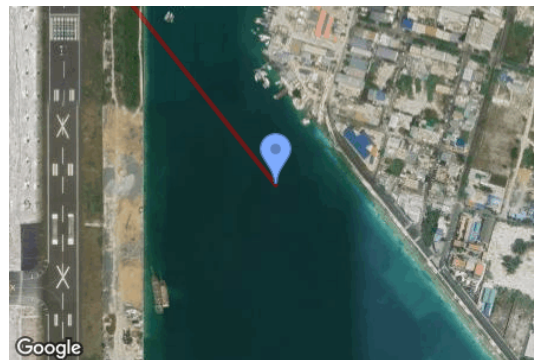
Direction: 141.4°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.205541	73.534845	-1.35	15.24	13.89
Two-mile	4.228127	73.516725	0.00	295.49	295.49

Name: FP 09 Male Water Aerodrome_South Landing

Description:

Threshold height: 15 m

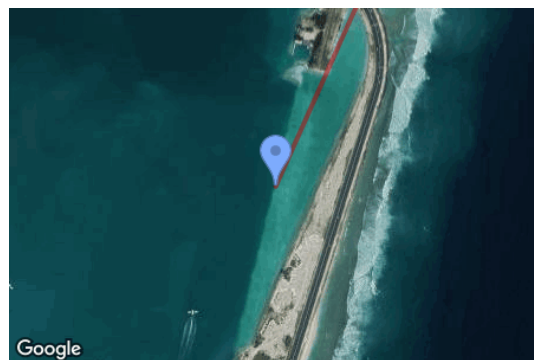
Direction: 204.1°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.196961	73.539264	-25.07	15.24	-9.83
Two-mile	4.223347	73.551129	-92.37	364.14	271.77

Name: FP 10 Male Water Aerodrome_EW Landing

Description:

Threshold height: 15 m

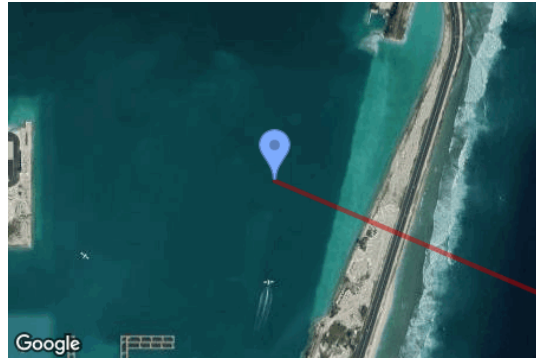
Direction: 293.0°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.196512	73.537869	-14.61	15.24	0.63
Two-mile	4.185215	73.564586	-920.58	1202.81	282.23

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	4.190177	73.534392	0.50	32.00

Map image of 1-ATCT



Route Receptor(s)

Name: Route 1

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.190087	73.538000	-16.15	19.65	3.50
2	4.188585	73.537398	-11.83	15.33	3.50
3	4.187826	73.537094	-9.68	13.18	3.50
4	4.187154	73.536821	-8.31	11.81	3.50
5	4.186505	73.536649	-7.66	11.16	3.50
6	4.186240	73.536576	-7.39	10.89	3.50
7	4.186014	73.536516	-7.15	10.65	3.50
8	4.185830	73.536455	-6.92	10.42	3.50
9	4.184504	73.535842	-5.03	8.53	3.50
10	4.184054	73.535601	-4.34	7.84	3.50
11	4.184016	73.535666	-4.56	8.06	3.50
12	4.184476	73.535897	-5.20	8.70	3.50
13	4.185072	73.536179	-5.98	9.48	3.50
14	4.185808	73.536523	-7.16	10.66	3.50
15	4.185974	73.536589	-7.44	10.94	3.50
16	4.186473	73.536758	-8.11	11.61	3.50
17	4.187107	73.536972	-8.93	12.43	3.50
18	4.187772	73.537233	-10.69	14.19	3.50
19	4.188534	73.537528	-12.75	16.25	3.50
20	4.190022	73.538149	-17.31	20.81	3.50
21	4.190087	73.538000	-16.15	19.65	3.50

Name: Route 2
Path type: Two-way
Observer view angle: 50.0°



Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186499	73.536879	-8.60	12.10	3.50
2	4.187046	73.537161	-10.25	13.75	3.50
3	4.187985	73.537543	-12.88	16.38	3.50
4	4.188944	73.537929	-15.72	19.22	3.50
5	4.189910	73.538306	-18.54	22.04	3.50
6	4.190710	73.538520	-20.14	23.64	3.50
7	4.191489	73.538804	-22.31	25.81	3.50
8	4.192576	73.539180	-25.30	28.80	3.50
9	4.193609	73.539528	-28.09	31.59	3.50
10	4.193591	73.539585	-28.51	32.01	3.50
11	4.192553	73.539232	-25.73	29.23	3.50
12	4.191463	73.538865	-22.80	26.30	3.50
13	4.190675	73.538645	-21.12	24.62	3.50
14	4.189822	73.538429	-19.51	23.01	3.50
15	4.186999	73.537295	-11.26	14.76	3.50
16	4.186446	73.536972	-8.97	12.47	3.50
17	4.186500	73.536878	-8.60	12.10	3.50

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare	"Yellow" Glare	Energy
			min	min	kWh
PV Array Island	9.0	110.0	829	0	2,668,000.0
PV Array Link Section 1	10.0	286.0	0	0	2,039,000.0
PV Array Link Section 2	10.0	110.0	1,951	0	1,027,000.0
PV Array Link Section 3	10.0	110.0	975	0	1,541,000.0
PV Array Link Section 4	10.0	305.0	0	0	2,032,000.0
PV Array Link Section 5	10.0	305.0	0	0	1,428,000.0
PV Array South Side	14.0	50.0	855	0	1,873,000.0

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	1065	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	855	0
FP 10 Male Water Aerodrome_EW Landing	2690	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Results for: PV Array Island

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	267	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	562	0
1-ATCT	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

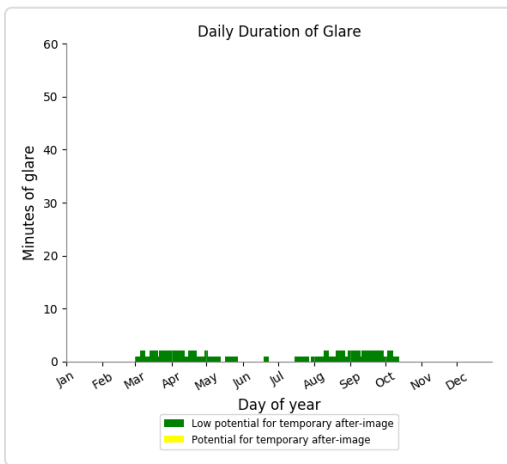
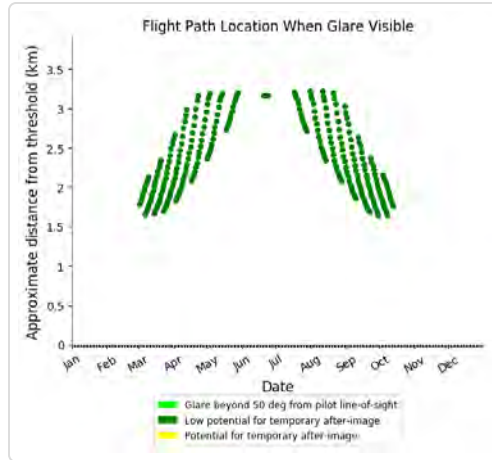
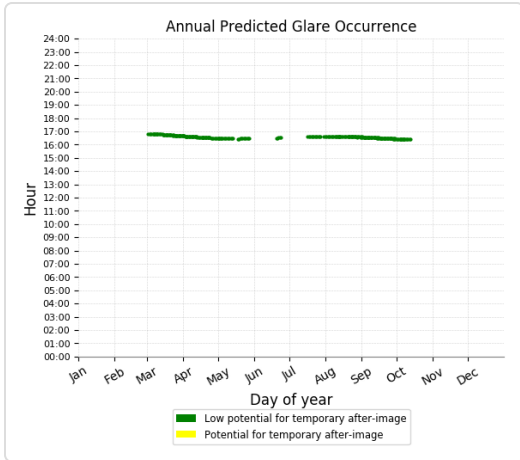
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

267 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

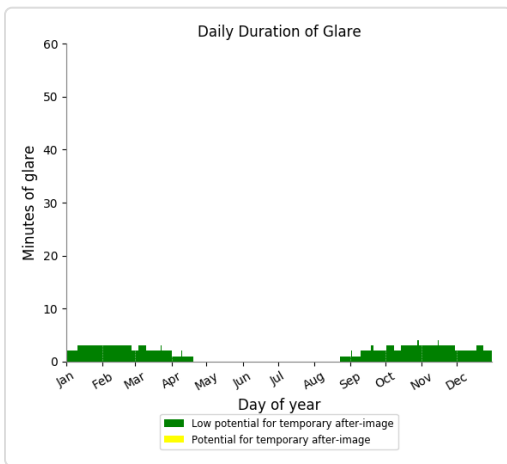
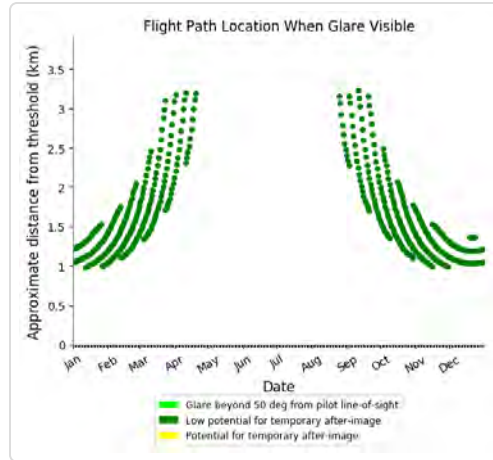
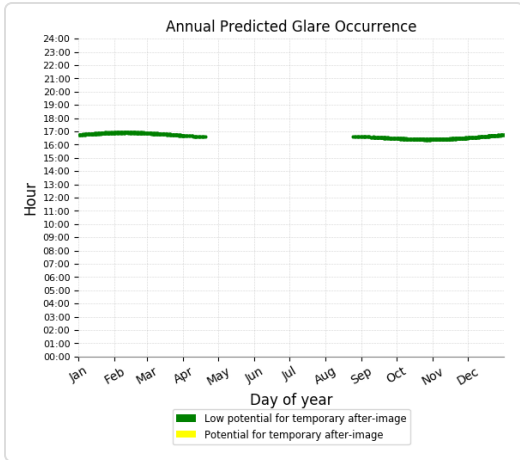
0 minutes of yellow glare
 0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
 0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
 562 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 1

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 2

0 minutes of yellow glare
 0 minutes of green glare

Results for: PV Array Link Section 1

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 2

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	497	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	1454	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

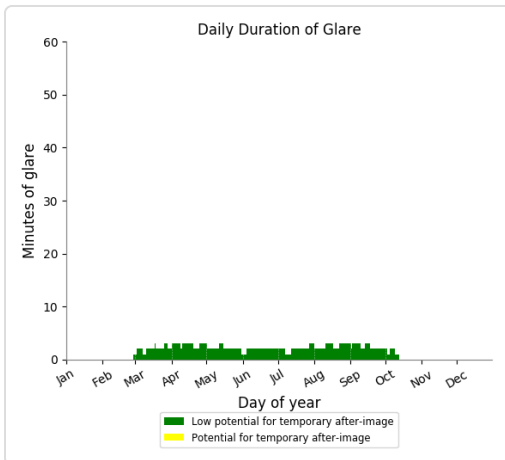
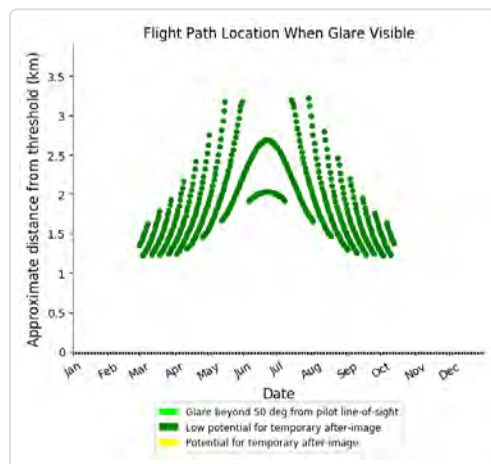
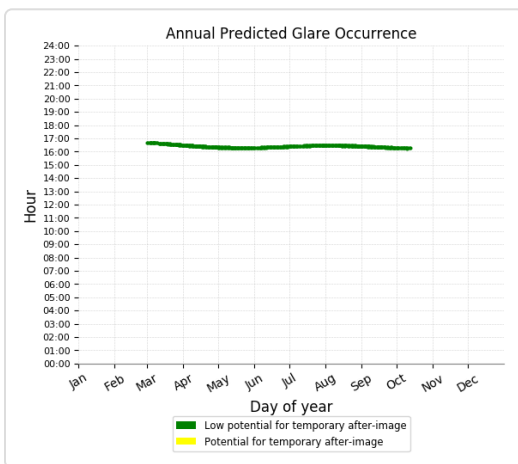
0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare
497 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

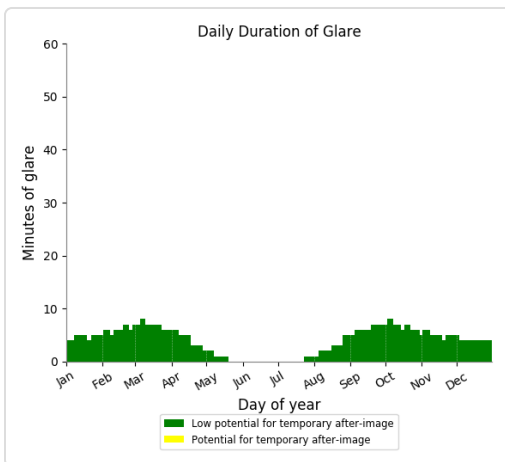
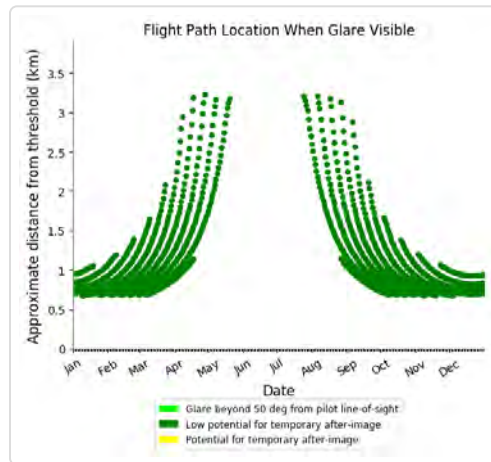
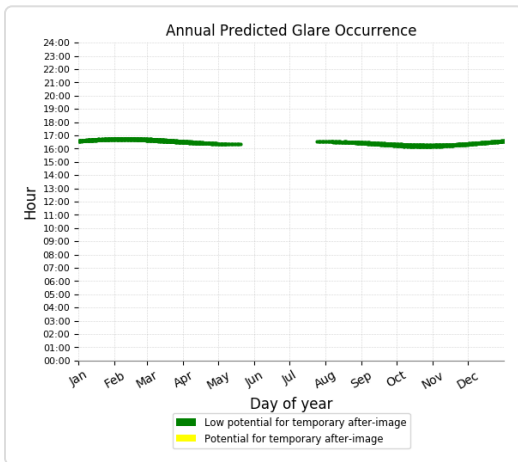
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

1454 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 3

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	301	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	674	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

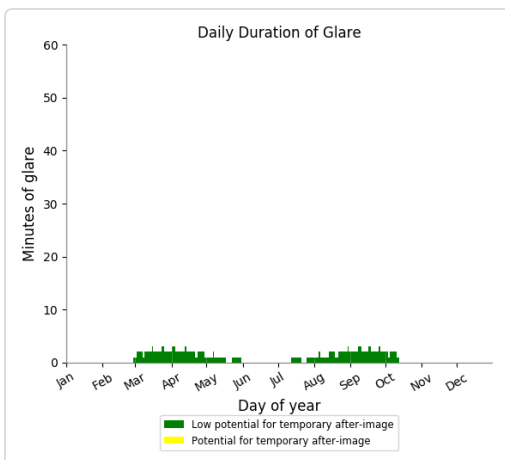
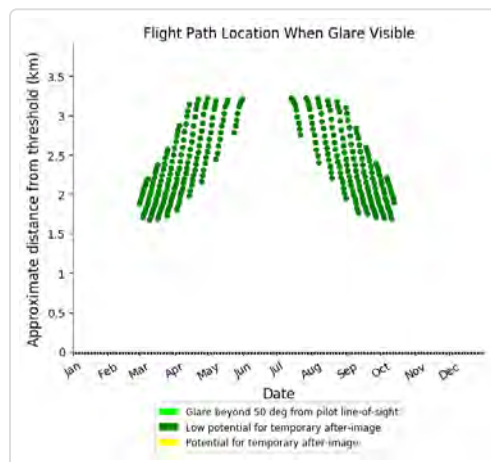
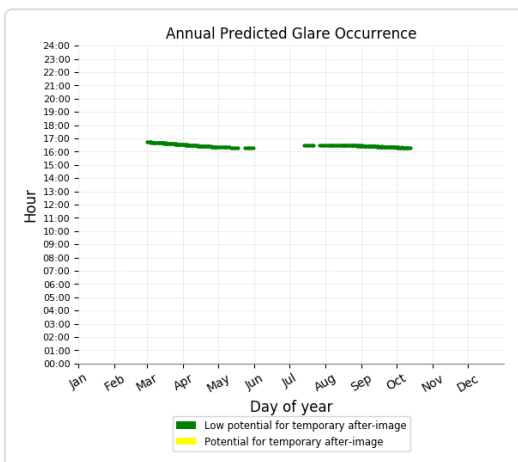
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

301 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

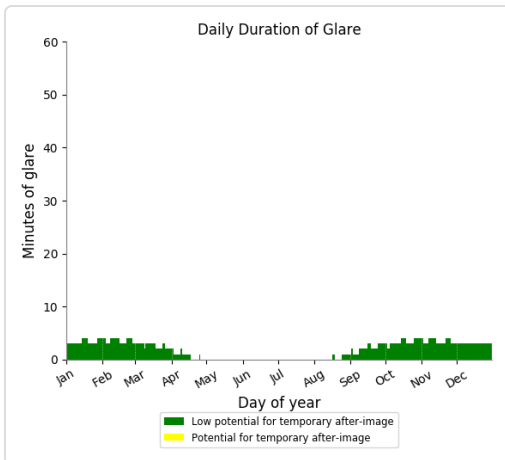
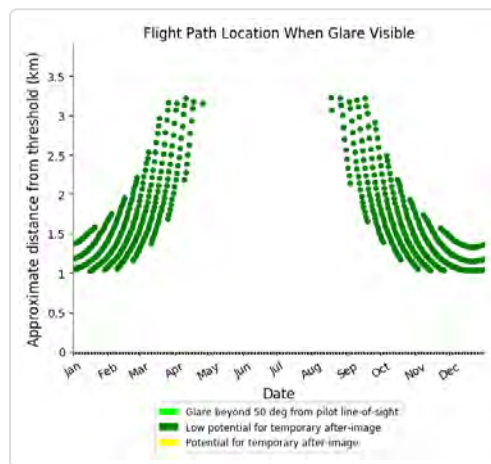
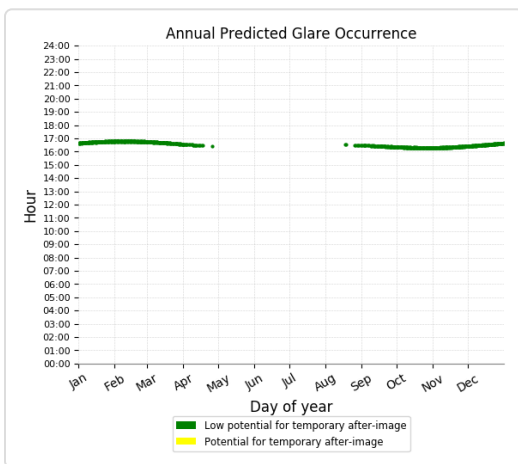
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

674 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 4

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 5

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Route: Route 1

0 minutes of yellow glare
0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array South Side

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	855	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

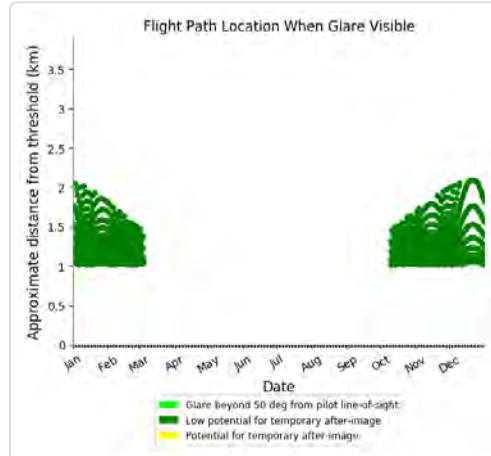
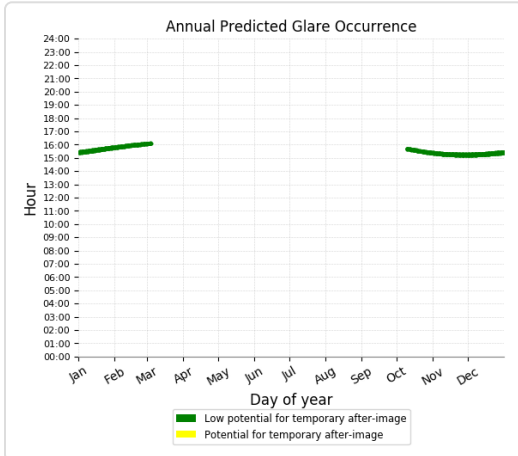
0 minutes of yellow glare
0 minutes of green glare

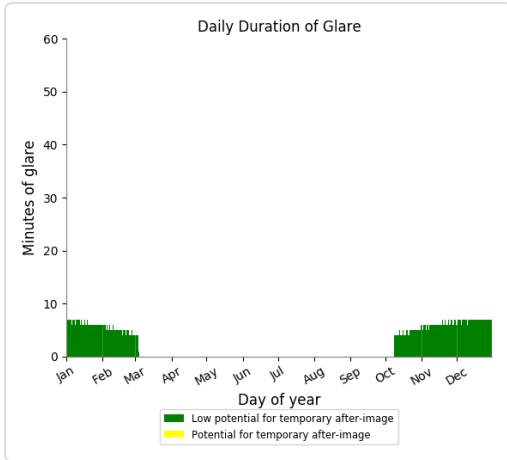
Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
855 minutes of green glare





Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
 0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 1

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 2

0 minutes of yellow glare
 0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size.

Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

APPENDIX A

FORGESOLAR GLARE ANALYSIS RESULTS REPORT (1.2)

Site Configuration:

Component	Tilt (°)	Orientation (°)
PV Array Island	12	110 °E
PV Array Link Section 1	12	286 °E
PV Array Link Section 2	12	110 °E
PV Array Link Section 3	12	110 °E
PV Array Link Section 4	12	305 °E
PV Array Link Section 5	12	305 °E
PV Array South Side	15	50 °E

FORGESOLAR GLARE ANALYSIS

Project: **Maldives Airports**

Site configuration: **Config S-FP 1-temp-1**

Analysis conducted by rattaporn ngoenmeesri (ratapornn@nu.ac.th) at 14:58 on 06 Apr, 2021.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

Default glare analysis parameters and observer eye characteristics (for reference only):

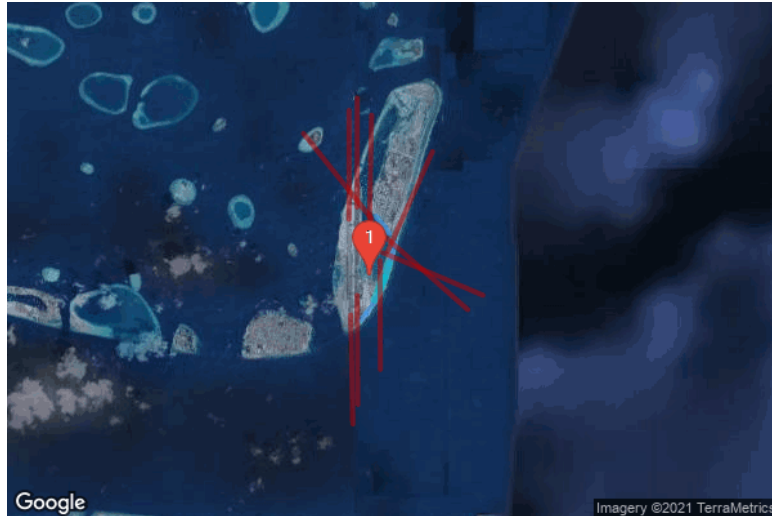
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m²
 Time interval: 1 min
 Ocular transmission coefficient: 0.5
 Pupil diameter: 0.002 m
 Eye focal length: 0.017 m
 Sun subtended angle: 9.3 mrad
 Site Config ID: 52043.8719



PV Array(s)

Name: PV Array Island
Description: Capacity 1108.80 kWp No. of PV Modules 2240 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 12.0°
Orientation: 110.0°
Rated power: 1108.8 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.189934	73.538149	-17.32	21.32	4.00
2	4.187121	73.537015	-9.23	13.23	4.00
3	4.187074	73.537134	-10.03	14.03	4.00
4	4.189887	73.538259	-18.16	22.16	4.00

Name: PV Array Link Section 1

Description: Capacity 855.360 kWp No. of PV Modules
1728 panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 12.0°

Orientation: 286.0°

Rated power: 855.36 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.199016	73.541233	-47.02	52.02	5.00
2	4.199006	73.541284	-47.67	52.67	5.00
3	4.198672	73.541217	-46.96	51.97	5.00
4	4.198479	73.541162	-46.23	51.23	5.00
5	4.198237	73.541083	-45.26	50.26	5.00
6	4.193486	73.539610	-28.79	33.79	5.00
7	4.193501	73.539560	-28.36	33.36	5.00
8	4.198251	73.541041	-44.76	49.76	5.00
9	4.198495	73.541118	-45.71	50.71	5.00
10	4.198681	73.541172	-46.32	51.32	5.00

Name: PV Array Link Section 2

Description: Capacity 427.680 kWp No. of PV Modules 864
panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 12.0°

Orientation: 110.0°

Rated power: 427.68 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.193498	73.539559	1.85	3.10	4.95
2	4.191354	73.538839	1.85	3.10	4.95
3	4.190228	73.538545	1.85	3.10	4.95
4	4.190216	73.538595	1.85	3.10	4.95
5	4.191341	73.538885	1.85	3.10	4.95
6	4.193482	73.539608	1.85	3.10	4.95

Name: PV Array Link Section 3
Description: Capacity 641.520 kWp No. of PV Modules
 1296 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 12.0°
Orientation: 110.0°
Rated power: 641.52 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186034	73.536733	1.85	3.10	4.95
2	4.187013	73.537321	1.85	3.10	4.95
3	4.189813	73.538438	1.85	3.10	4.95
4	4.190227	73.538544	1.85	3.10	4.95
5	4.190215	73.538594	1.85	3.10	4.95
6	4.189797	73.538485	1.85	3.10	4.95
7	4.186987	73.537364	1.85	3.10	4.95
8	4.186008	73.536772	1.85	3.10	4.95

Name: PV Array Link Section 4

Description: Capacity 855.360 kWp No. of PV Modules
1728 panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 12.0°

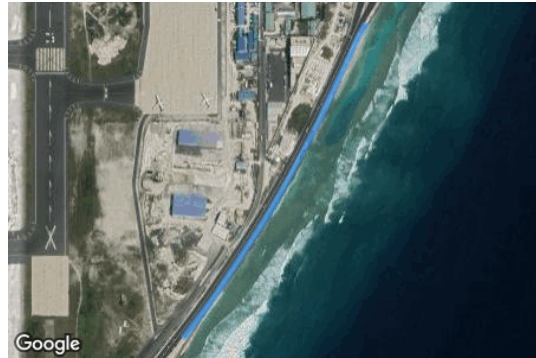
Orientation: 305.0°

Rated power: 855.36 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186032	73.536732	-8.02	13.02	5.00
2	4.186008	73.536769	-8.18	13.18	5.00
3	4.185786	73.536639	-7.66	12.66	5.00
4	4.185505	73.536508	-7.16	12.15	5.00
5	4.184684	73.536118	-5.84	10.84	5.00
6	4.184282	73.535933	-5.31	10.31	5.00
7	4.183881	73.535721	-4.72	9.72	5.00
8	4.182684	73.535072	-3.72	8.71	5.00
9	4.182138	73.534714	-3.85	8.85	5.00
10	4.181122	73.534045	-4.65	9.65	5.00
11	4.180365	73.533483	-5.50	10.50	5.00
12	4.180399	73.533443	-5.38	10.38	5.00
13	4.181150	73.534006	-4.56	9.56	5.00
14	4.182161	73.534677	-3.74	8.74	5.00
15	4.182710	73.535026	-3.52	8.52	5.00
16	4.183294	73.535362	-3.92	8.92	5.00
17	4.183899	73.535683	-4.60	9.60	5.00
18	4.184301	73.535894	-5.19	10.19	5.00
19	4.184708	73.536080	-5.72	10.72	5.00
20	4.185520	73.536474	-6.99	11.99	5.00
21	4.185807	73.536601	-7.49	12.49	5.00

Name: PV Array Link Section 5
Description: Capacity 601.425 kWp No. of PV Modules
 1215 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 12.0°
Orientation: 305.0°
Rated power: 601.425 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.178466	73.531870	1.85	2.10	3.95
2	4.179443	73.532692	1.85	2.10	3.95
3	4.180400	73.533442	1.85	2.10	3.95
4	4.180354	73.533501	1.85	2.10	3.95
5	4.179386	73.532745	1.85	2.10	3.95
6	4.178416	73.531929	1.85	2.10	3.95

Name: PV Array South Side
Description: Capacity 801.900 kWp No. of PV Modules
 1620 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 50.0°
Rated power: 801.9 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.206048	73.536085	1.85	2.80	4.65
2	4.201706	73.539543	1.85	2.80	4.65
3	4.201749	73.539596	1.85	2.80	4.65
4	4.206101	73.536134	1.85	2.80	4.65

Flight Path Receptor(s)

Name: FP 01

Description:

Threshold height: 15 m

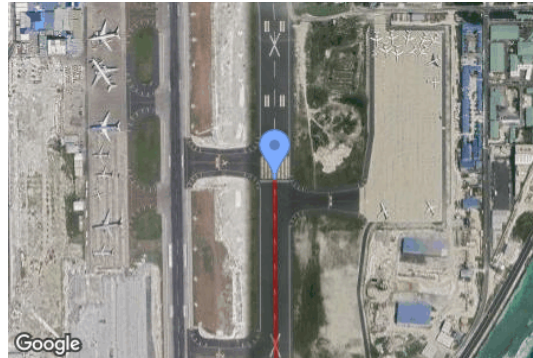
Direction: 359.6°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.185152	73.531025	0.00	15.24	15.24
Two-mile	4.156240	73.531213	-292.88	476.81	183.92

Name: FP 02

Description:

Threshold height: 15 m

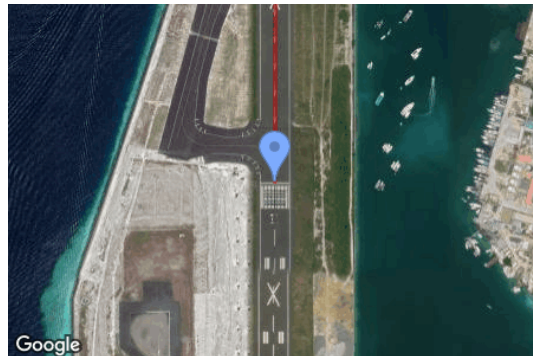
Direction: 180.1°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.208640	73.531009	0.00	15.24	15.24
Two-mile	4.237552	73.531075	0.00	183.92	183.92

Name: FP 03

Description:

Threshold height: 15 m

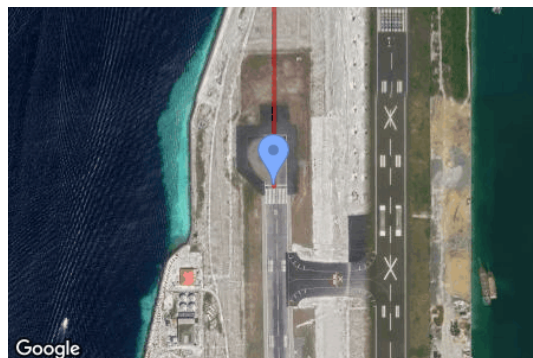
Direction: 180.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.205368	73.528869	2.49	15.24	17.73
Two-mile	4.234281	73.528869	0.00	186.41	186.41

Name: FP 04

Description:

Threshold height: 15 m

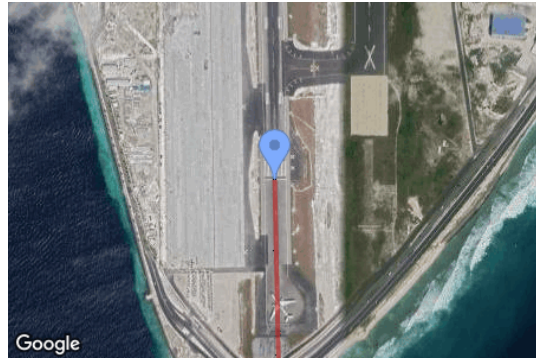
Direction: 358.8°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.179945	73.529309	-0.81	15.24	14.43
Two-mile	4.151039	73.529912	-356.57	539.69	183.12

Name: FP 05 Male Water Aerodrome_South Landing

Description:

Threshold height: 15 m

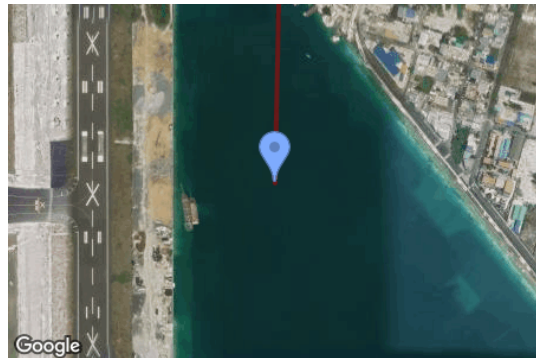
Direction: 181.2°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.204087	73.534292	-0.82	15.24	14.42
Two-mile	4.232993	73.534890	0.00	296.02	296.02

Name: FP 06 Male Water Aerodrome_North Landing

Description:

Threshold height: 15 m

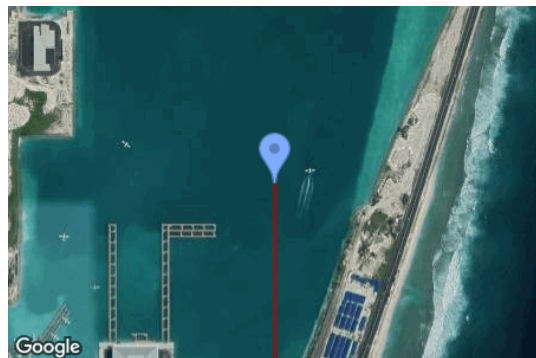
Direction: 359.8°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.194436	73.537119	-9.66	15.24	5.58
Two-mile	4.165523	73.537226	-234.62	521.80	287.18

Name: FP 07 Male Water Aerodrome_NW Landing

Description:

Threshold height: 15 m

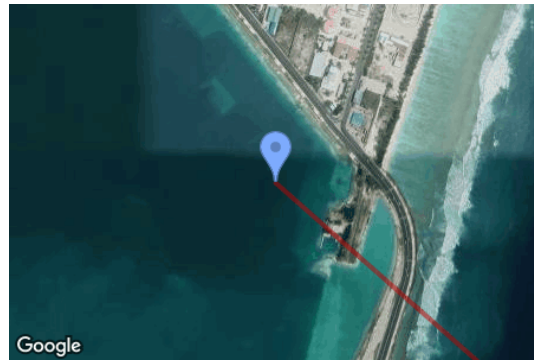
Direction: 311.4°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.200513	73.538750	-20.35	15.24	-5.11
Two-mile	4.181393	73.560522	-959.43	1235.92	276.49

Name: FP 08 Male Water Aerodrome_SE Landing

Description:

Threshold height: 15 m

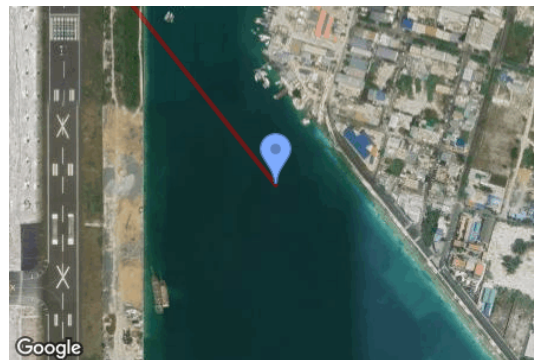
Direction: 141.4°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.205541	73.534845	-1.35	15.24	13.89
Two-mile	4.228127	73.516725	0.00	295.49	295.49

Name: FP 09 Male Water Aerodrome_South Landing

Description:

Threshold height: 15 m

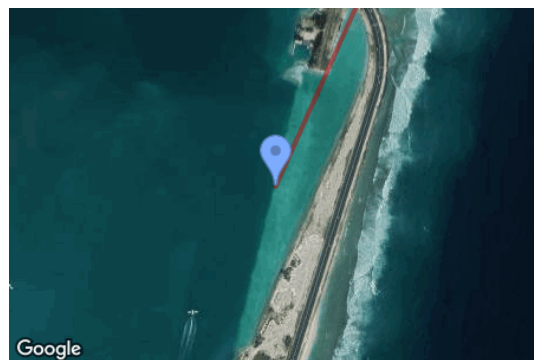
Direction: 204.1°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.196961	73.539264	-25.07	15.24	-9.83
Two-mile	4.223347	73.551129	-92.37	364.14	271.77

Name: FP 10 Male Water Aerodrome_EW Landing

Description:

Threshold height: 15 m

Direction: 293.0°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.196512	73.537869	-14.61	15.24	0.63
Two-mile	4.185215	73.564586	-920.58	1202.81	282.23

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	4.190177	73.534392	0.50	32.00

Map image of 1-ATCT



Route Receptor(s)

Name: Route 1

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.190087	73.538000	-16.15	19.65	3.50
2	4.188585	73.537398	-11.83	15.33	3.50
3	4.187826	73.537094	-9.68	13.18	3.50
4	4.187154	73.536821	-8.31	11.81	3.50
5	4.186505	73.536649	-7.66	11.16	3.50
6	4.186240	73.536576	-7.39	10.89	3.50
7	4.186014	73.536516	-7.15	10.65	3.50
8	4.185830	73.536455	-6.92	10.42	3.50
9	4.184504	73.535842	-5.03	8.53	3.50
10	4.184054	73.535601	-4.34	7.84	3.50
11	4.184016	73.535666	-4.56	8.06	3.50
12	4.184476	73.535897	-5.20	8.70	3.50
13	4.185072	73.536179	-5.98	9.48	3.50
14	4.185808	73.536523	-7.16	10.66	3.50
15	4.185974	73.536589	-7.44	10.94	3.50
16	4.186473	73.536758	-8.11	11.61	3.50
17	4.187107	73.536972	-8.93	12.43	3.50
18	4.187772	73.537233	-10.69	14.19	3.50
19	4.188534	73.537528	-12.75	16.25	3.50
20	4.190022	73.538149	-17.31	20.81	3.50
21	4.190087	73.538000	-16.15	19.65	3.50

Name: Route 2
Path type: Two-way
Observer view angle: 50.0°



Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186499	73.536879	-8.60	12.10	3.50
2	4.187046	73.537161	-10.25	13.75	3.50
3	4.187985	73.537543	-12.88	16.38	3.50
4	4.188944	73.537929	-15.72	19.22	3.50
5	4.189910	73.538306	-18.54	22.04	3.50
6	4.190710	73.538520	-20.14	23.64	3.50
7	4.191489	73.538804	-22.31	25.81	3.50
8	4.192576	73.539180	-25.30	28.80	3.50
9	4.193609	73.539528	-28.09	31.59	3.50
10	4.193591	73.539585	-28.51	32.01	3.50
11	4.192553	73.539232	-25.73	29.23	3.50
12	4.191463	73.538865	-22.80	26.30	3.50
13	4.190675	73.538645	-21.12	24.62	3.50
14	4.189822	73.538429	-19.51	23.01	3.50
15	4.186999	73.537295	-11.26	14.76	3.50
16	4.186446	73.536972	-8.97	12.47	3.50
17	4.186500	73.536878	-8.60	12.10	3.50

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare	"Yellow" Glare	Energy
			min	min	kWh
PV Array Island	12.0	110.0	835	0	2,653,000.0
PV Array Link Section 1	12.0	286.0	0	0	2,028,000.0
PV Array Link Section 2	12.0	110.0	1,957	0	1,023,000.0
PV Array Link Section 3	12.0	110.0	979	0	1,535,000.0
PV Array Link Section 4	12.0	305.0	0	0	2,018,000.0
PV Array Link Section 5	12.0	305.0	0	0	1,419,000.0
PV Array South Side	15.0	50.0	899	0	1,865,000.0

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	1081	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	899	0
FP 10 Male Water Aerodrome_EW Landing	2690	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Results for: PV Array Island

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	273	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	562	0
1-ATCT	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

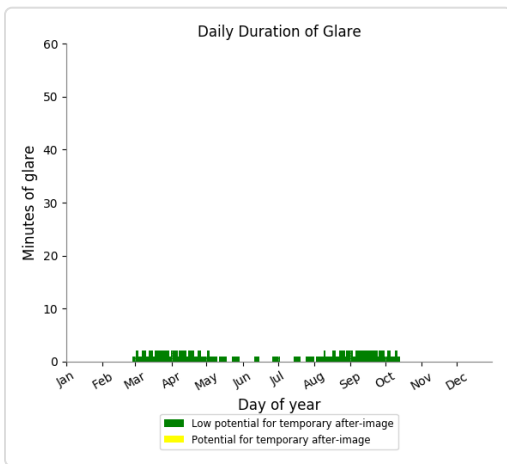
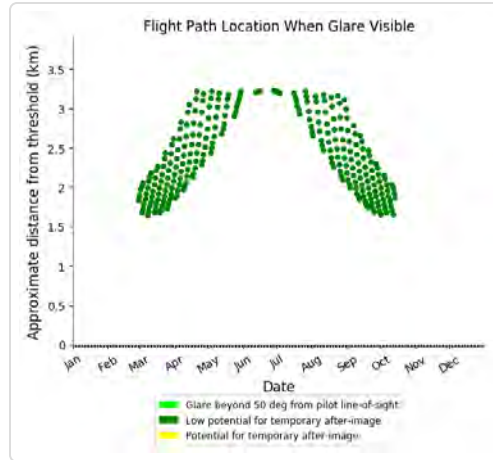
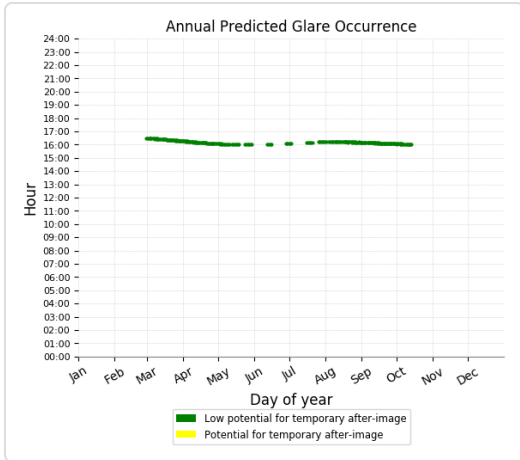
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

273 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

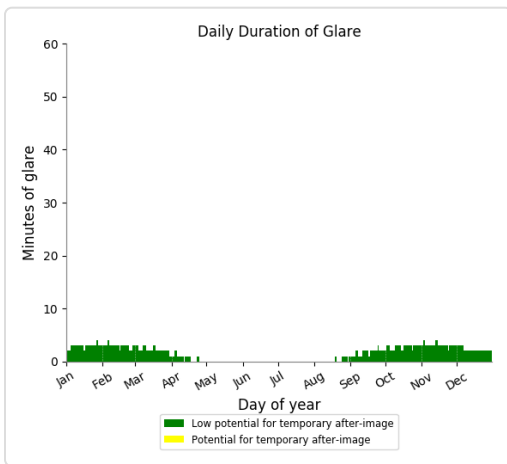
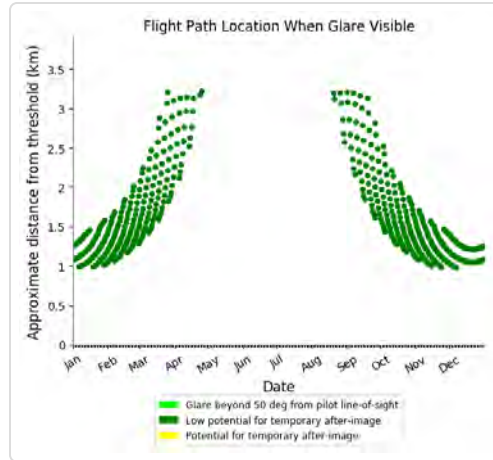
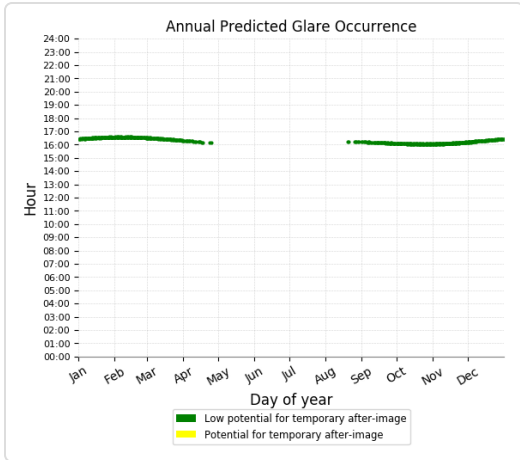
0 minutes of yellow glare
 0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
 0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
 562 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 1

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 2

0 minutes of yellow glare
 0 minutes of green glare

Results for: PV Array Link Section 1

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 2

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	500	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	1457	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

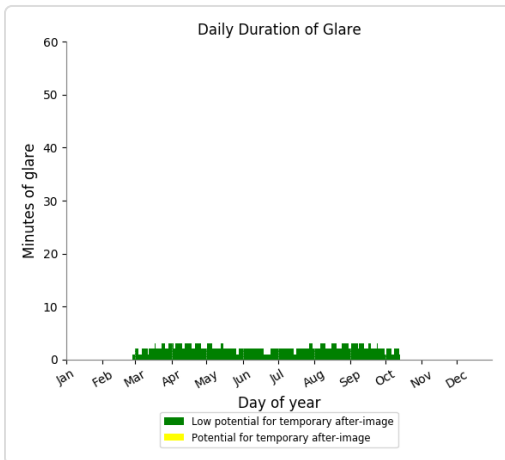
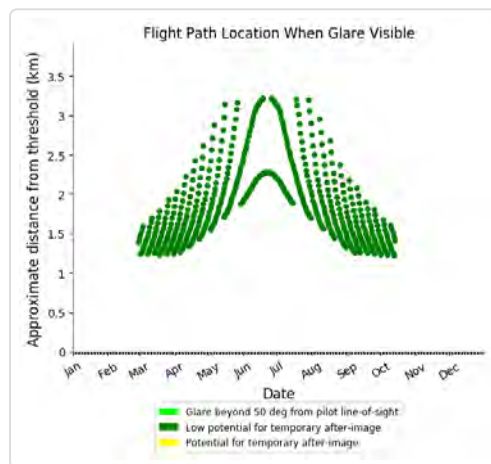
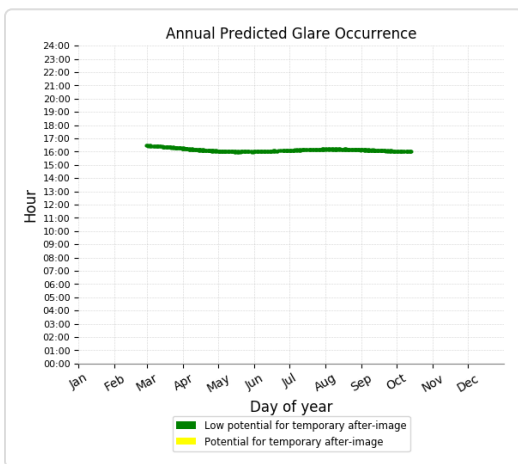
0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare
500 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

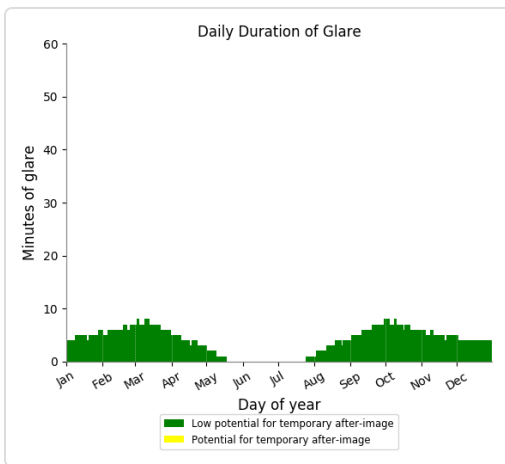
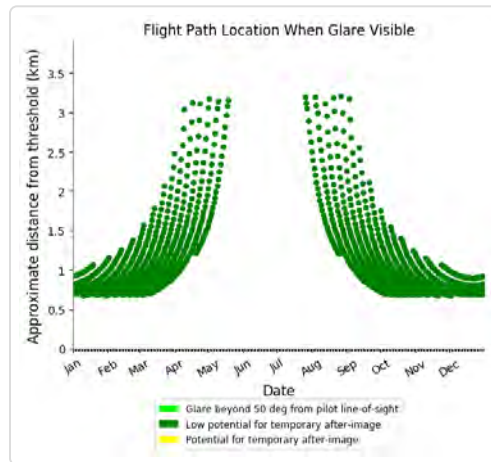
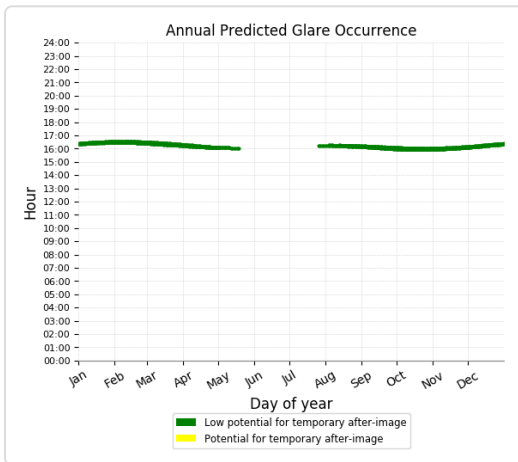
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

1457 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 3

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	308	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	671	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

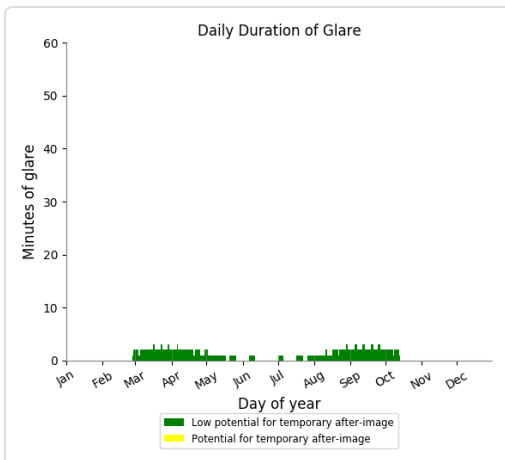
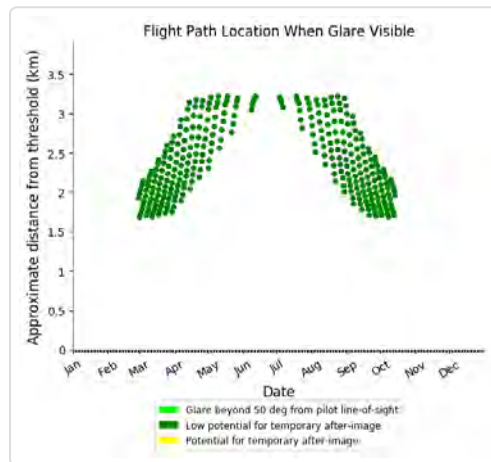
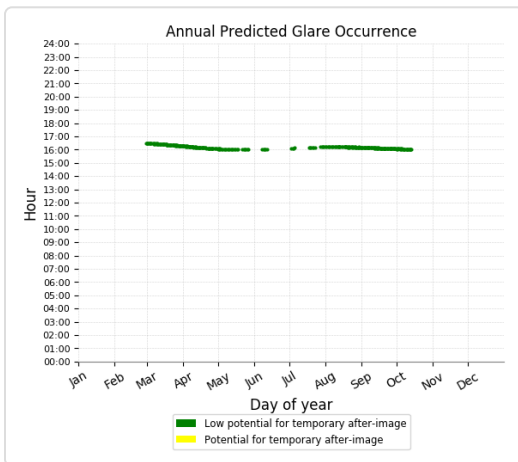
0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare
308 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

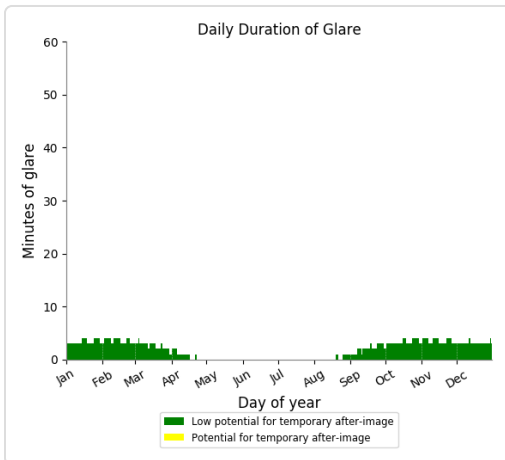
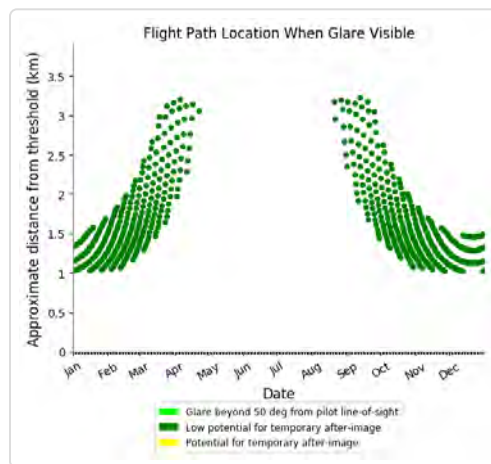
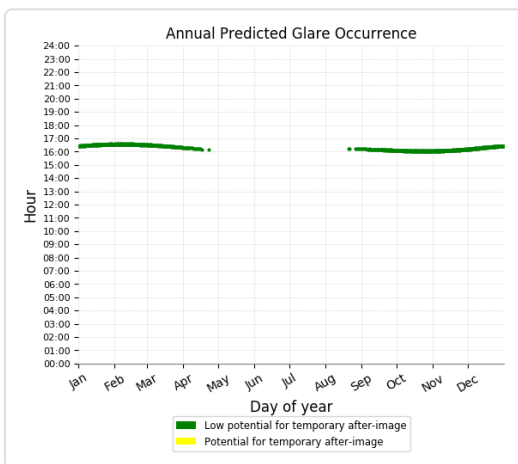
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

671 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 4

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 5

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array South Side

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	899	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

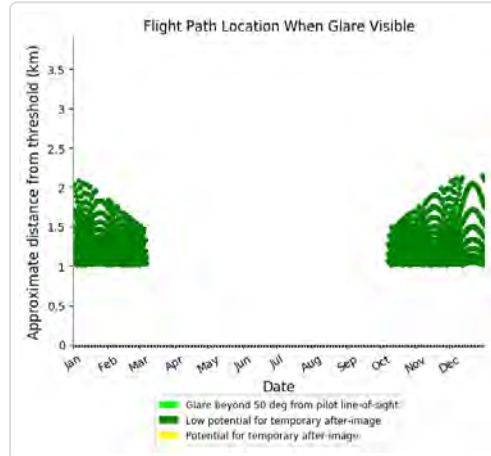
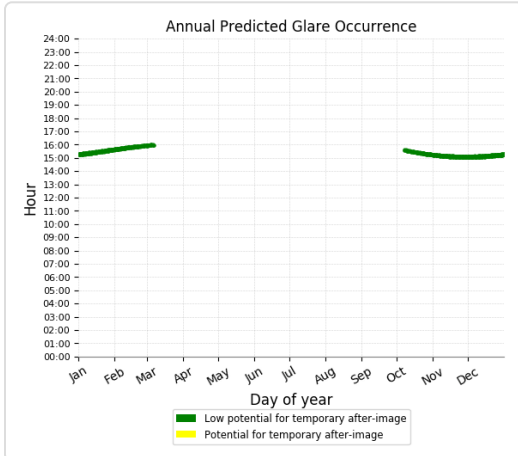
0 minutes of yellow glare
0 minutes of green glare

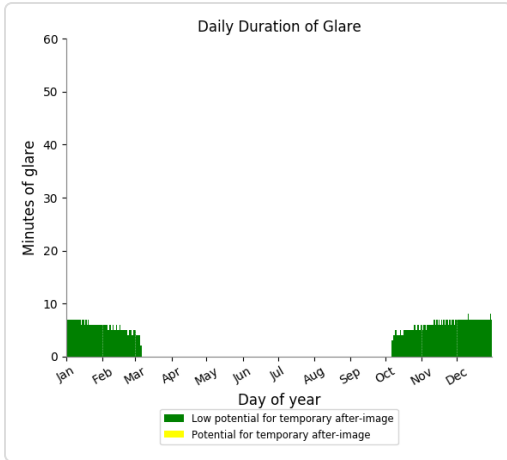
Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
899 minutes of green glare





Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
 0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 1

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 2

0 minutes of yellow glare
 0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

APPENDIX A

FORGESOLAR GLARE ANALYSIS RESULTS REPORT (1.3)

Site Configuration:

Component	Tilt (°)	Orientation (°)
PV Array Island	15	110 °E
PV Array Link Section 1	15	286 °E
PV Array Link Section 2	15	110 °E
PV Array Link Section 3	15	110 °E
PV Array Link Section 4	15	305 °E
PV Array Link Section 5	15	305 °E
PV Array South Side	16	50 °E

FORGESOLAR GLARE ANALYSIS

Project: **Maldives Airports**

Site configuration: **Config S-FP 1**

Analysis conducted by rattaporn ngoenmeesri (ratapornn@nu.ac.th) at 15:42 on 06 Apr, 2021.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

Default glare analysis parameters and observer eye characteristics (for reference only):

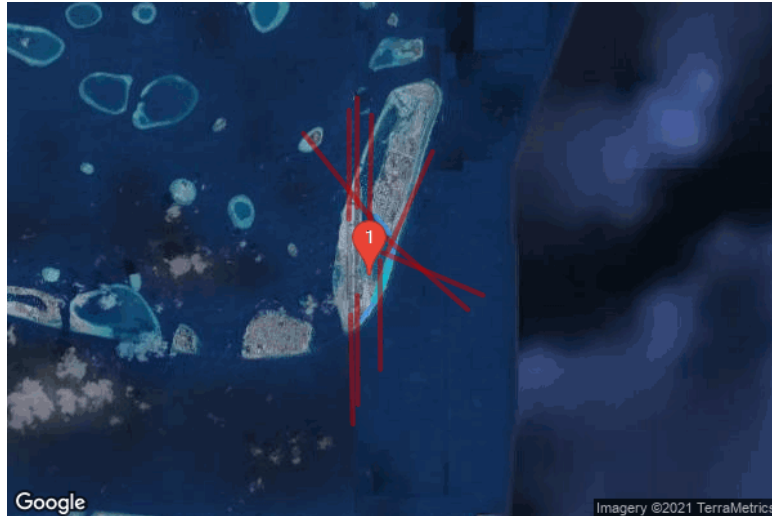
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m²
 Time interval: 1 min
 Ocular transmission coefficient: 0.5
 Pupil diameter: 0.002 m
 Eye focal length: 0.017 m
 Sun subtended angle: 9.3 mrad
 Site Config ID: 48509.8719



PV Array(s)

Name: PV Array Island
Description: Capacity 1108.80 kWp No. of PV Modules 2240 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 110.0°
Rated power: 1108.8 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.189934	73.538149	-17.32	21.32	4.00
2	4.187121	73.537015	-9.23	13.23	4.00
3	4.187074	73.537134	-10.03	14.03	4.00
4	4.189887	73.538259	-18.16	22.16	4.00

Name: PV Array Link Section 1

Description: Capacity 855.360 kWp No. of PV Modules
1728 panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 286.0°

Rated power: 855.36 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.199016	73.541233	-47.02	52.02	5.00
2	4.199006	73.541284	-47.67	52.67	5.00
3	4.198672	73.541217	-46.96	51.97	5.00
4	4.198479	73.541162	-46.23	51.23	5.00
5	4.198237	73.541083	-45.26	50.26	5.00
6	4.193486	73.539610	-28.79	33.79	5.00
7	4.193501	73.539560	-28.36	33.36	5.00
8	4.198251	73.541041	-44.76	49.76	5.00
9	4.198495	73.541118	-45.71	50.71	5.00
10	4.198681	73.541172	-46.32	51.32	5.00

Name: PV Array Link Section 2

Description: Capacity 427.680 kWp No. of PV Modules 864
panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 110.0°

Rated power: 427.68 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.193498	73.539559	1.85	3.10	4.95
2	4.191354	73.538839	1.85	3.10	4.95
3	4.190228	73.538545	1.85	3.10	4.95
4	4.190216	73.538595	1.85	3.10	4.95
5	4.191341	73.538885	1.85	3.10	4.95
6	4.193482	73.539608	1.85	3.10	4.95

Name: PV Array Link Section 3
Description: Capacity 641.520 kWp No. of PV Modules
 1296 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 110.0°
Rated power: 641.52 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186034	73.536733	1.85	3.10	4.95
2	4.187013	73.537321	1.85	3.10	4.95
3	4.189813	73.538438	1.85	3.10	4.95
4	4.190227	73.538544	1.85	3.10	4.95
5	4.190215	73.538594	1.85	3.10	4.95
6	4.189797	73.538485	1.85	3.10	4.95
7	4.186987	73.537364	1.85	3.10	4.95
8	4.186008	73.536772	1.85	3.10	4.95

Name: PV Array Link Section 4

Description: Capacity 855.360 kWp No. of PV Modules
1728 panels PV Module 495 Wp

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

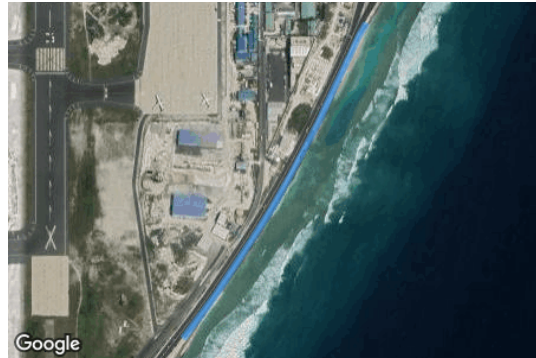
Orientation: 305.0°

Rated power: 855.36 kW

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186032	73.536732	-8.02	13.02	5.00
2	4.186008	73.536769	-8.18	13.18	5.00
3	4.185786	73.536639	-7.66	12.66	5.00
4	4.185505	73.536508	-7.16	12.15	5.00
5	4.184684	73.536118	-5.84	10.84	5.00
6	4.184282	73.535933	-5.31	10.31	5.00
7	4.183881	73.535721	-4.72	9.72	5.00
8	4.182684	73.535072	-3.72	8.71	5.00
9	4.182138	73.534714	-3.85	8.85	5.00
10	4.181122	73.534045	-4.65	9.65	5.00
11	4.180365	73.533483	-5.50	10.50	5.00
12	4.180399	73.533443	-5.38	10.38	5.00
13	4.181150	73.534006	-4.56	9.56	5.00
14	4.182161	73.534677	-3.74	8.74	5.00
15	4.182710	73.535026	-3.52	8.52	5.00
16	4.183294	73.535362	-3.92	8.92	5.00
17	4.183899	73.535683	-4.60	9.60	5.00
18	4.184301	73.535894	-5.19	10.19	5.00
19	4.184708	73.536080	-5.72	10.72	5.00
20	4.185520	73.536474	-6.99	11.99	5.00
21	4.185807	73.536601	-7.49	12.49	5.00

Name: PV Array Link Section 5
Description: Capacity 601.425 kWp No. of PV Modules
 1215 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 305.0°
Rated power: 601.425 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.178466	73.531870	1.85	2.10	3.95
2	4.179443	73.532692	1.85	2.10	3.95
3	4.180400	73.533442	1.85	2.10	3.95
4	4.180354	73.533501	1.85	2.10	3.95
5	4.179386	73.532745	1.85	2.10	3.95
6	4.178416	73.531929	1.85	2.10	3.95

Name: PV Array South Side
Description: Capacity 801.900 kWp No. of PV Modules
 1620 panels PV Module 495 Wp
Axis tracking: Fixed (no rotation)
Tilt: 16.0°
Orientation: 50.0°
Rated power: 801.9 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.206048	73.536085	1.85	2.80	4.65
2	4.201706	73.539543	1.85	2.80	4.65
3	4.201749	73.539596	1.85	2.80	4.65
4	4.206101	73.536134	1.85	2.80	4.65

Flight Path Receptor(s)

Name: FP 01

Description:

Threshold height: 15 m

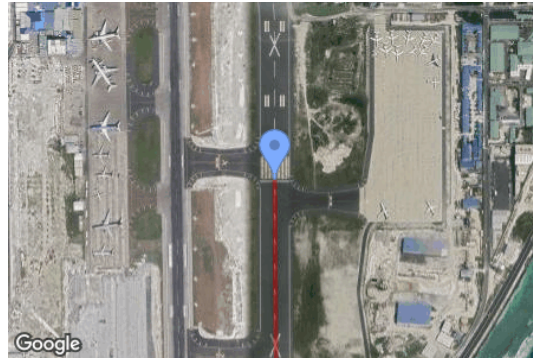
Direction: 359.6°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.185152	73.531025	0.00	15.24	15.24
Two-mile	4.156240	73.531213	-292.88	476.81	183.92

Name: FP 02

Description:

Threshold height: 15 m

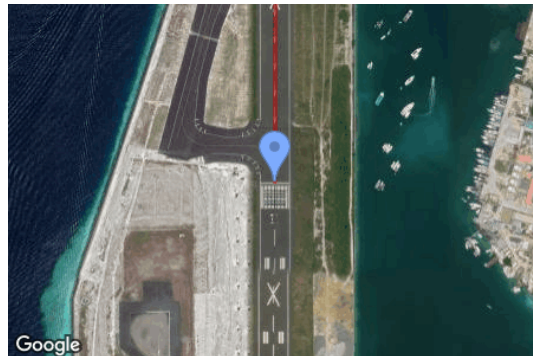
Direction: 180.1°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.208640	73.531009	0.00	15.24	15.24
Two-mile	4.237552	73.531075	0.00	183.92	183.92

Name: FP 03

Description:

Threshold height: 15 m

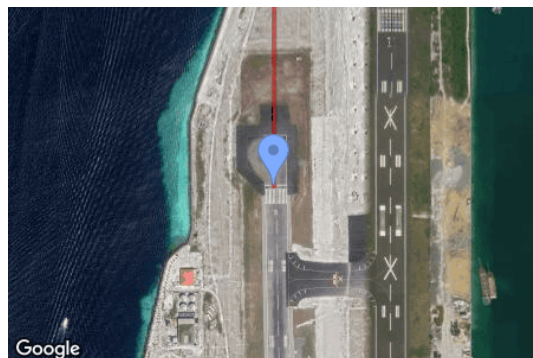
Direction: 180.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.205368	73.528869	2.49	15.24	17.73
Two-mile	4.234281	73.528869	0.00	186.41	186.41

Name: FP 04

Description:

Threshold height: 15 m

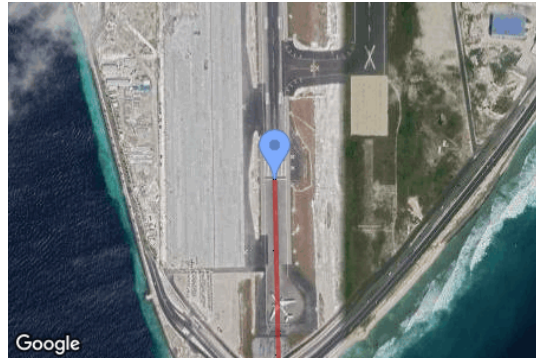
Direction: 358.8°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.179945	73.529309	-0.81	15.24	14.43
Two-mile	4.151039	73.529912	-356.57	539.69	183.12

Name: FP 05 Male Water Aerodrome_South Landing

Description:

Threshold height: 15 m

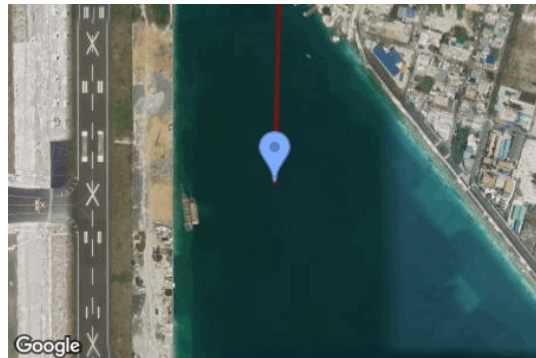
Direction: 181.2°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.204087	73.534292	-0.82	15.24	14.42
Two-mile	4.232993	73.534890	0.00	296.02	296.02

Name: FP 06 Male Water Aerodrome_North Landing

Description:

Threshold height: 15 m

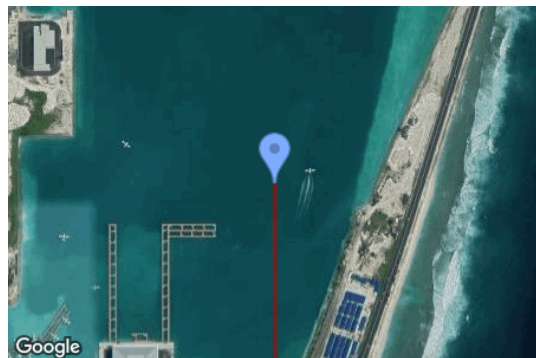
Direction: 359.8°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.194436	73.537119	-9.66	15.24	5.58
Two-mile	4.165523	73.537226	-234.62	521.80	287.18

Name: FP 07 Male Water Aerodrome_NW Landing

Description:

Threshold height: 15 m

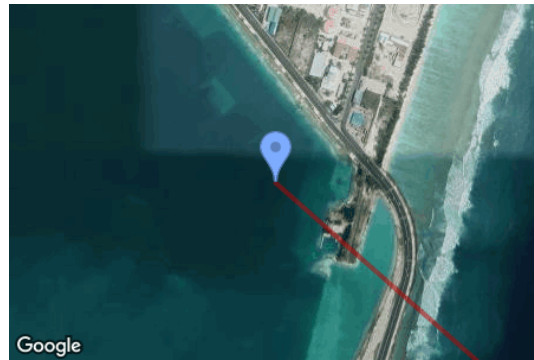
Direction: 311.4°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.200513	73.538750	-20.35	15.24	-5.11
Two-mile	4.181393	73.560522	-959.43	1235.92	276.49

Name: FP 08 Male Water Aerodrome_SE Landing

Description:

Threshold height: 15 m

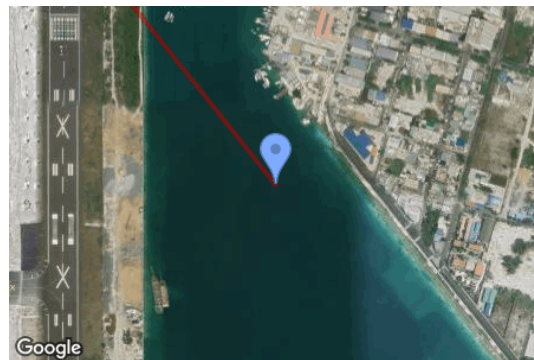
Direction: 141.4°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.205541	73.534845	-1.35	15.24	13.89
Two-mile	4.228127	73.516725	0.00	295.49	295.49

Name: FP 09 Male Water Aerodrome_South Landing

Description:

Threshold height: 15 m

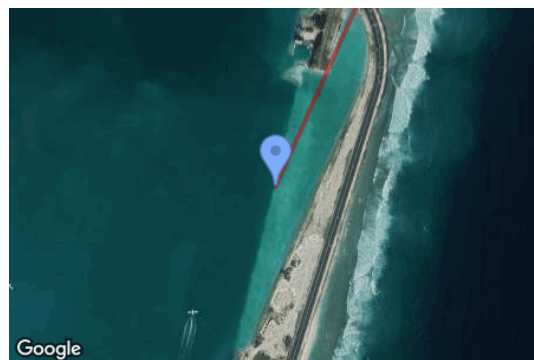
Direction: 204.1°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.196961	73.539264	-25.07	15.24	-9.83
Two-mile	4.223347	73.551129	-92.37	364.14	271.77

Name: FP 10 Male Water Aerodrome_EW Landing

Description:

Threshold height: 15 m

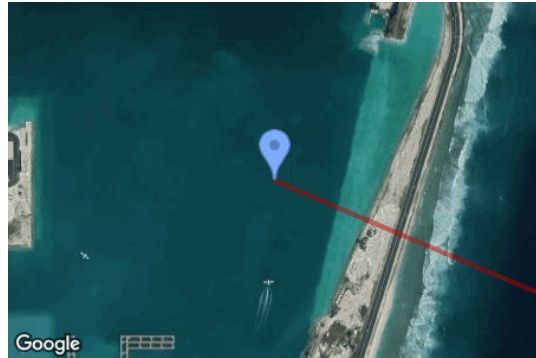
Direction: 293.0°

Glide slope: 5.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	4.196512	73.537869	-14.61	15.24	0.63
Two-mile	4.185215	73.564586	-920.58	1202.81	282.23

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	4.190177	73.534392	0.50	32.00

Map image of 1-ATCT



Route Receptor(s)

Name: Route 1

Path type: Two-way

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.190087	73.538000	-16.15	19.65	3.50
2	4.188585	73.537398	-11.83	15.33	3.50
3	4.187826	73.537094	-9.68	13.18	3.50
4	4.187154	73.536821	-8.31	11.81	3.50
5	4.186505	73.536649	-7.66	11.16	3.50
6	4.186240	73.536576	-7.39	10.89	3.50
7	4.186014	73.536516	-7.15	10.65	3.50
8	4.185830	73.536455	-6.92	10.42	3.50
9	4.184504	73.535842	-5.03	8.53	3.50
10	4.184054	73.535601	-4.34	7.84	3.50
11	4.184016	73.535666	-4.56	8.06	3.50
12	4.184476	73.535897	-5.20	8.70	3.50
13	4.185072	73.536179	-5.98	9.48	3.50
14	4.185808	73.536523	-7.16	10.66	3.50
15	4.185974	73.536589	-7.44	10.94	3.50
16	4.186473	73.536758	-8.11	11.61	3.50
17	4.187107	73.536972	-8.93	12.43	3.50
18	4.187772	73.537233	-10.69	14.19	3.50
19	4.188534	73.537528	-12.75	16.25	3.50
20	4.190022	73.538149	-17.31	20.81	3.50
21	4.190087	73.538000	-16.15	19.65	3.50

Name: Route 2
Path type: Two-way
Observer view angle: 50.0°



Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	4.186499	73.536879	-8.60	12.10	3.50
2	4.187046	73.537161	-10.25	13.75	3.50
3	4.187985	73.537543	-12.88	16.38	3.50
4	4.188944	73.537929	-15.72	19.22	3.50
5	4.189910	73.538306	-18.54	22.04	3.50
6	4.190710	73.538520	-20.14	23.64	3.50
7	4.191489	73.538804	-22.31	25.81	3.50
8	4.192576	73.539180	-25.30	28.80	3.50
9	4.193609	73.539528	-28.09	31.59	3.50
10	4.193591	73.539585	-28.51	32.01	3.50
11	4.192553	73.539232	-25.73	29.23	3.50
12	4.191463	73.538865	-22.80	26.30	3.50
13	4.190675	73.538645	-21.12	24.62	3.50
14	4.189822	73.538429	-19.51	23.01	3.50
15	4.186999	73.537295	-11.26	14.76	3.50
16	4.186446	73.536972	-8.97	12.47	3.50
17	4.186500	73.536878	-8.60	12.10	3.50

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare	"Yellow" Glare	Energy
			min	min	kWh
PV Array Island	15.0	110.0	841	0	2,633,000.0
PV Array Link Section 1	15.0	286.0	0	0	2,008,000.0
PV Array Link Section 2	15.0	110.0	1,932	0	1,015,000.0
PV Array Link Section 3	15.0	110.0	960	0	1,524,000.0
PV Array Link Section 4	15.0	305.0	0	0	1,995,000.0
PV Array Link Section 5	15.0	305.0	0	0	1,402,000.0
PV Array South Side	16.0	50.0	947	0	1,856,000.0

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	1039	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	947	0
FP 10 Male Water Aerodrome_EW Landing	2694	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Results for: PV Array Island

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	259	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	582	0
1-ATCT	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

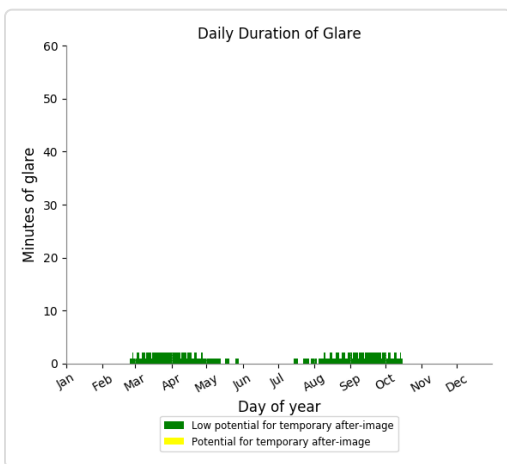
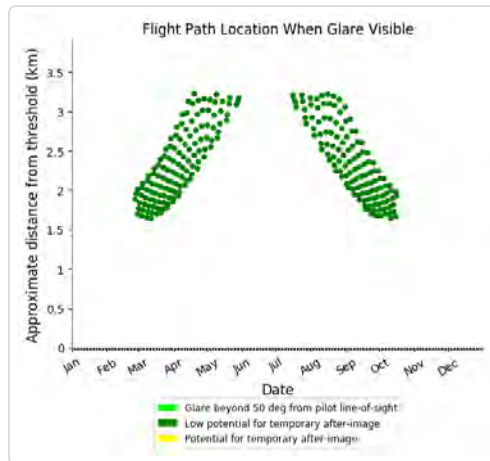
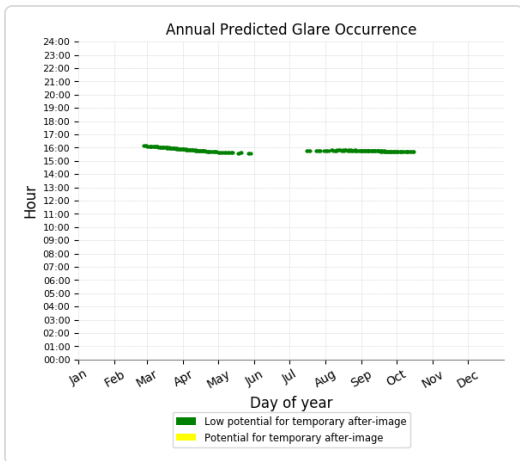
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

259 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

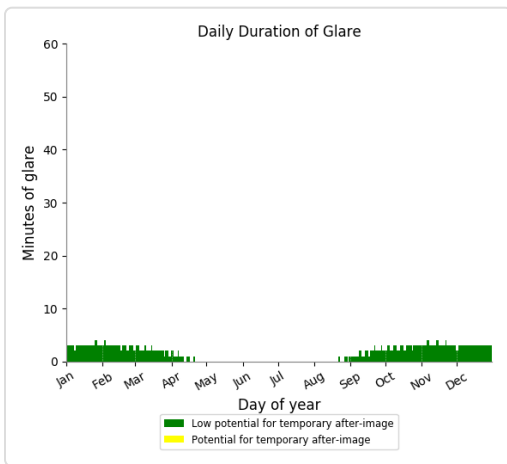
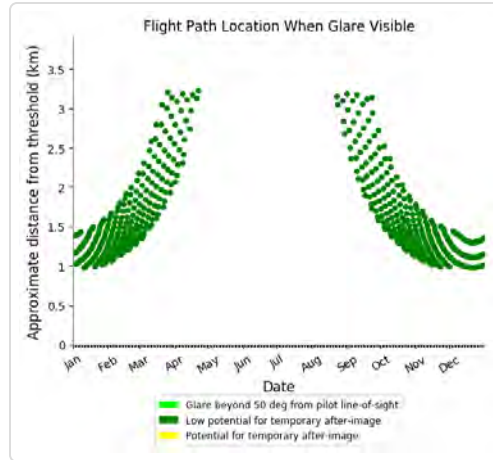
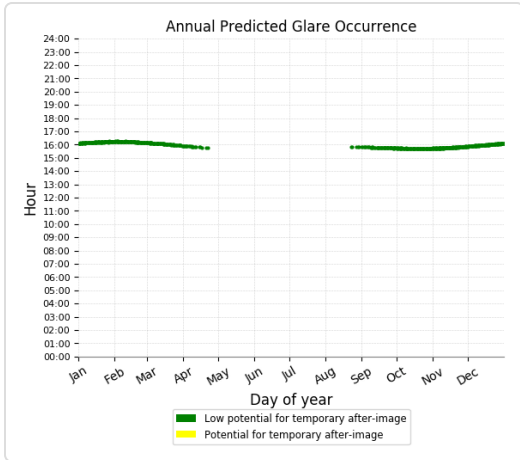
0 minutes of yellow glare
 0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
 0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
 582 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 1

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 2

0 minutes of yellow glare
 0 minutes of green glare

Results for: PV Array Link Section 1

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 2

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	485	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	1447	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

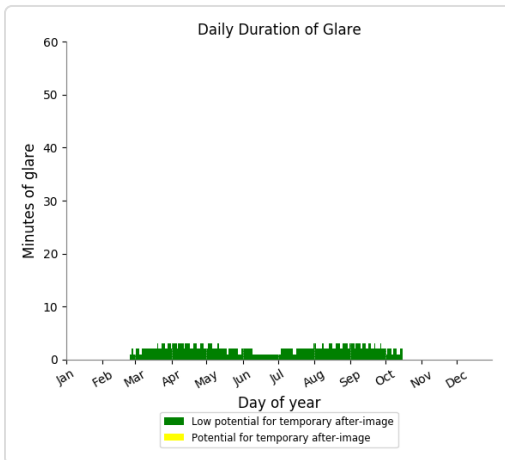
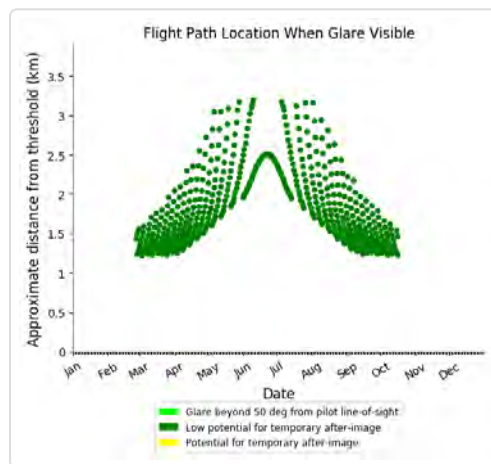
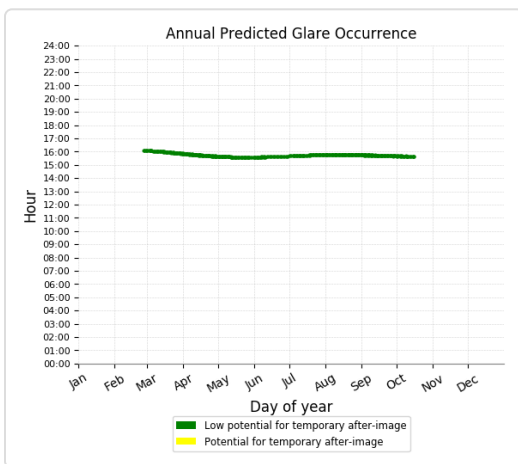
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

485 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

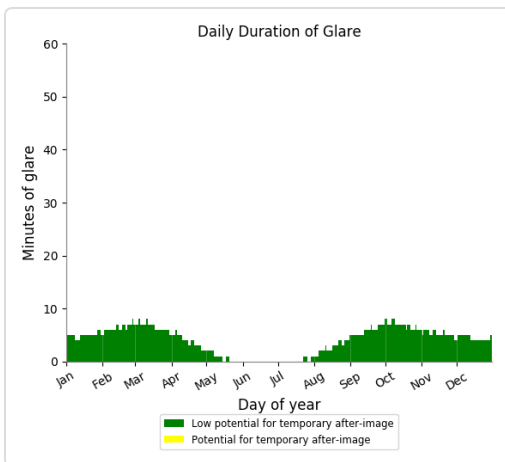
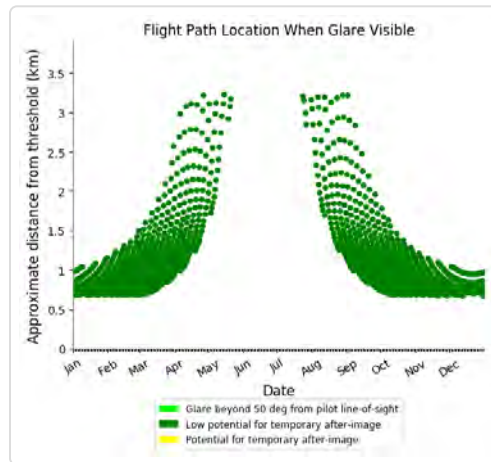
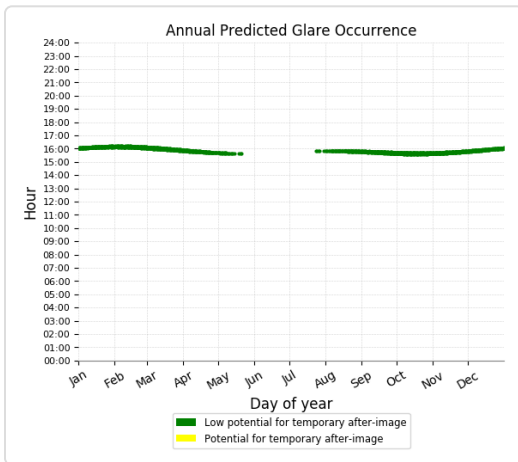
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

1447 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 3

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	295	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	665	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

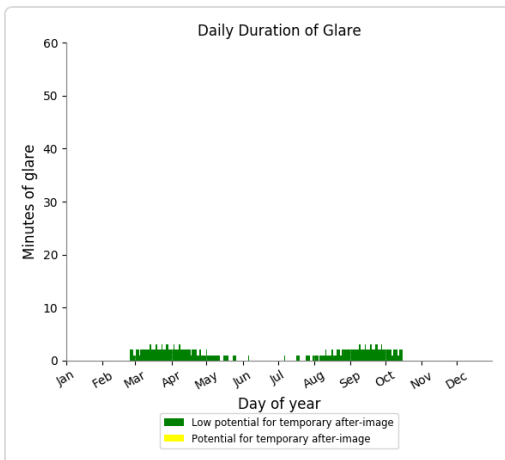
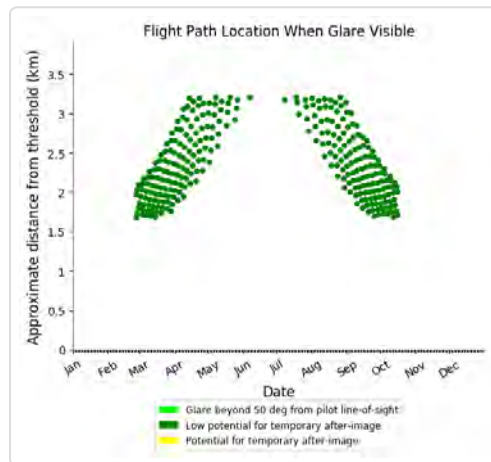
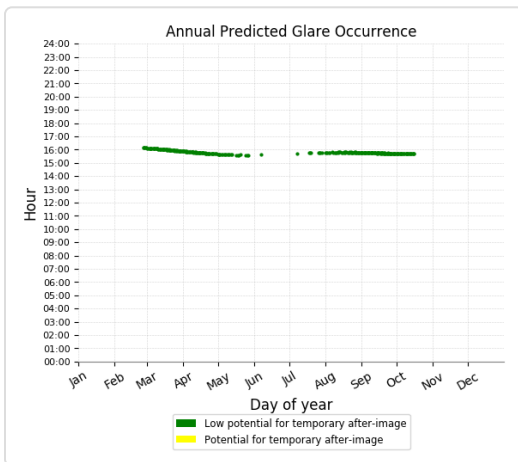
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

295 minutes of green glare



Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

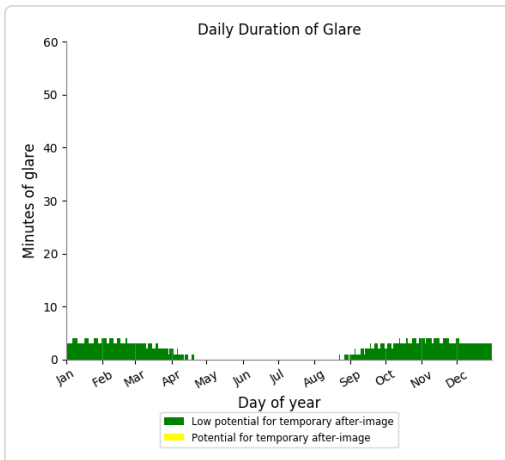
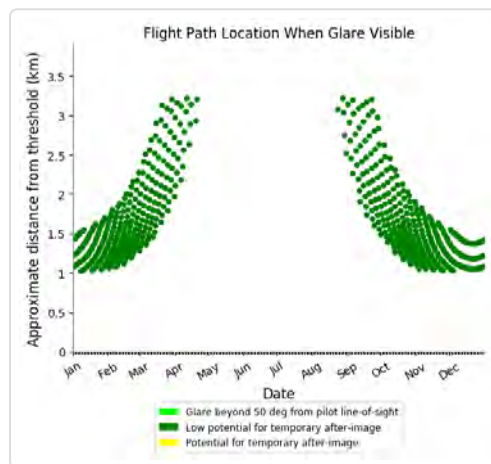
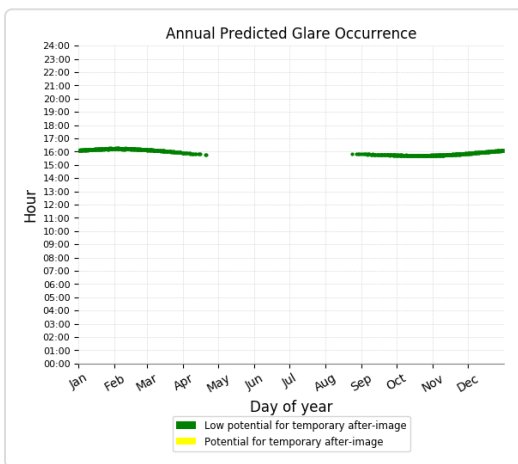
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

665 minutes of green glare



Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 4

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array Link Section 5

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	0	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare

0 minutes of green glare

Route: Route 1

0 minutes of yellow glare

0 minutes of green glare

Route: Route 2

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Array South Side

Receptor	Green Glare (min)	Yellow Glare (min)
FP 01	0	0
FP 02	0	0
FP 03	0	0
FP 04	0	0
FP 05 Male Water Aerodrome_South Landing	0	0
FP 06 Male Water Aerodrome_North Landing	0	0
FP 07 Male Water Aerodrome_NW Landing	0	0
FP 08 Male Water Aerodrome_SE Landing	0	0
FP 09 Male Water Aerodrome_South Landing	947	0
FP 10 Male Water Aerodrome_EW Landing	0	0
1-ATCT	0	0
Route 1	0	0
Route 2	0	0

Flight Path: FP 01

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 02

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 03

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 04

0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 05 Male Water Aerodrome_South Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 06 Male Water Aerodrome_North Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 07 Male Water Aerodrome_NW Landing

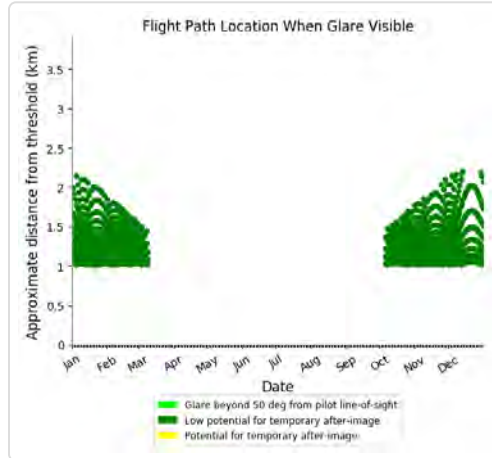
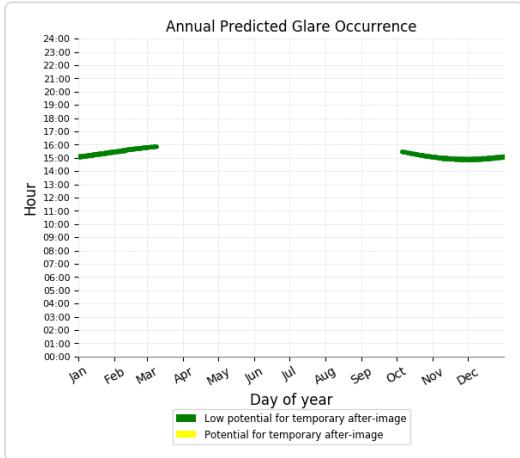
0 minutes of yellow glare
0 minutes of green glare

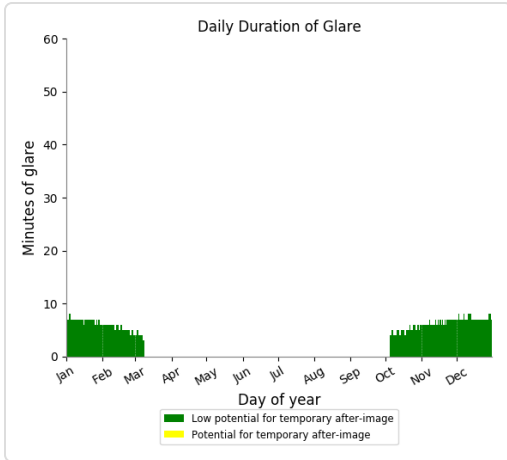
Flight Path: FP 08 Male Water Aerodrome_SE Landing

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 09 Male Water Aerodrome_South Landing

0 minutes of yellow glare
947 minutes of green glare





Flight Path: FP 10 Male Water Aerodrome_EW Landing

0 minutes of yellow glare
 0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 1

0 minutes of yellow glare
 0 minutes of green glare

Route: Route 2

0 minutes of yellow glare
 0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size.

Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

17.12 Safeguard measures against Covid19

Guidance Note: ESMP Requirements & COVID19 Special Consideration in Civil Works Contracts

Contractor: Ensys Company Limited

This guidance note includes measures to safeguard the health and safety of the construction workers in response to COVID19 pandemic and their families, people living at or close to the project site, as well as the general public, and includes reporting templates for the implementation of mitigation measures reflected in the ESMP for the proposed project. The paper is prepared by referring to the national and the World's Bank's requirements.

The contractor must ensure that the mitigation measures proposed in this paper are fully implemented and the PMU should closely monitor the project activities to ensure that the contractor adheres to these requirements.

1. PRECONSTRUCTION / PREPARATORY PHASE

1.1. ACTIONS NEEDED PRIOR TO MOBILIZATION

The contractor must take all precautionary measures to ensure that the workers are not at risk or doesn't not carry the risk of infection. As such, the contractor must provide all necessary details related to the project team by using the spread sheet presented in **Annex 1** and submit to the PMU along with the signed declaration presented in **Annex 2**. If expatriate workers are included in the project team, copies of their work permit should be submitted.

The project team shall not include:

- A worker that falls in the high-risk category for COVID19; aged 65 and above, under long term medication or having chronic disease. If high risk staff are included, they are required to be vaccinated.
- A worker that has made contact with a COVID19 positive case.
- A resident of a house put under monitoring or quarantine.
- An illegal immigrant.

Refer to the latest update sheet from the following link for the list of places under monitoring or quarantine.

<https://covid19.health.gov.mv/downloads/>

The contractor should identify an Environmental and Social focal point to ensure that the mitigation measures presented in the ESMP are being properly implemented and to enforce COVID-19 preventive measures. The focal point can be a work supervisor or a health and safety specialist. This person is responsible for coordinating preparation of the site and making sure that the measures taken are communicated to the workers, those entering the site and the island community. It is also advisable to designate at least one back-up person; in case the focal point becomes ill; that person should be aware of the arrangements that are in place. A health and safety briefing should be provided to the workers prior to mobilization. In addition to this, it is recommended to assign a specific staff to assume cleaning duties.

Furthermore, if the project involves mobilization of a team or a member from an island under COVID19 monitoring to the project island, travel permit from HEOC must be attained (with a negative PCR test) and the PMU notified accordingly.

The contractor must ensure that the project team is fully equipped and geared to take preventive measures against the potential spread of COVID19 and must travel with and carry sufficient quantities of all the required PPEs and cleaning items. Some of such items are listed below:

- Thermometer
- First-aid kit
- General flu medicine
- Masks
- Gloves
- Foot operated lidded dustbins
- Dustbin bags
- Disinfecting liquid such as bleach
- Cleaning equipment (broom, mop etc.)
- Hand sanitizers
- Soap

The contractor is required to submit a full list of such health and safety related items and their respective quantities by using the spread sheet provided in **Annex 3**.

The information presented in this section must be provided to the PMU prior to mobilization.

1.2. MOBILIZATION AND SETTING UP WORK SITE AND ACCOMMODATION

The following guidance should be taken into account when setting up the labor camp:

- Social distancing norms must be facilitated. Each bed must be separated by a distance of at least 3 to 6 feet.
- The accommodation facility must be properly ventilated. It is advisable to keep the windows open.
- A foot operated lidded bin is recommended to be kept at or just outside the accommodation to collect general waste generated by the workers. Foot operated lidded bins should also be kept at the work site and at the kitchen and dining area to collect general waste.
- Hand sanitizers are to be kept at entrance point to the accommodation (wall mounted or kept on top of a table) as well as inside the accommodation facility preferably at each bed side.

- Establish handwashing facilities at the work site and eating or resting areas. Hand Sanitizers can be used as an alternative.
- Ensure handwashing facilities supplied with soap, disposable paper towels and closed waste bins exist at toilets, kitchen and dining area. Alcohol based sanitizer (if available, 60-95%alcohol) can also be used.
- Place posters and signs around the site, with images and text in workers' local languages providing guidance on signs and symptoms of COVID-19, how it is spread, how to protect themselves (including regular handwashing and social distancing) and what to do if they or other people have symptoms. Examples of WASH guidance from the WHO and important contact numbers are provided in **Annex 4 and 5**.

2. CONSTRUCTION PHASE

2.1. CHECKS ON COMMENCEMENT OF WORK

Entry/exit to the work site should be controlled and documented. The following actions are recommended:

- The movement of the workers should be restricted from the labor camp to the work site and from the work site to the labor camp.
- The workers should avoid contact with the general public of the project island.
- Daily temperature checks should be taken and recorded prior to leaving the labor camp and entering the work site. Logs should be maintained and attached to the monthly Health and Safety report.
- Provide daily briefings to workers prior to commencing work, focusing on COVID-19 specific considerations including cough etiquette, hand hygiene and distancing measures, using demonstrations and participatory methods.
- During the daily briefings, remind workers to self-monitor for possible symptoms (fever, cough) and to report to the supervisor or the COVID-19 focal point if they have symptoms or are feeling unwell.
- If there is any symptom of COVID19 (fever, cough), the staff must be immediately isolated, referred to the health center and the concerned authorities must be notified. This staff should not be involved in the project team until cleared by the respective authorities.
- Any other staff who have had close contact with the staff who developed symptoms must be self-quarantined for 14 days and should not be allowed to enter the project site or move about in the project island, even if there are no symptoms. The directions given by the authorities should be strictly followed.

2.2. CLEANING AND WASTE DISPOSAL

- The tools and equipment used by the workers must be cleaned when changing shifts.
- Cleaning staff shall use appropriate PPEs such as masks and gloves.
- The labor camp must be cleaned frequently (at least once a day) including accommodation facility, kitchen, dining area and toilets. The floor, walls and door knobs should be properly cleaned using 1:9 bleach solution. Sheets and linings must be changed at least weekly.
- Any waste produced during the care of ill workers should be collected separately in designated containers or bags and treated and disposed of according to the SOPs of HPA and WHO. This includes placing double bags inside the bins, properly tying and removing the bags when 2/3 are full and disinfected by spraying with 1:9 bleach solution.

2.3. ADJUSTING WORK PRACTICES

Consider changes to work processes and timings to reduce or minimize contact between workers, recognizing that this is likely to impact the project schedule. Such measures could include:

- Changing to a 24-hour work rotation.
- Adapting or redesigning work processes for specific work activities and tasks to enable social distancing, and training workers on these processes.

- Consider changing canteen layouts and phasing meal times to allow for social distancing.
- Consider using of dust masks in addition to the general construction PPEs.

3. MONITORING PLAN

Health and Safety Monitoring Report containing details and photographic evidence of mitigation measures undertaken in response to the COVID19 situation must be prepared according to the format given in the Annex 6 and submitted to the PMU monthly.

Additionally, general construction phase monitoring reports should be produced monthly and submitted to the PMU as per the requirements of ESMP developed for the project.

ANNEX 1: PROJECT TEAM INFORMATION

#	Staff Name	Role	Nationality	ID Card / Work Permit No	Age	Do not fall under COVID19 high risk category	Not a direct contact of a COVID19 positive case	Present location (indicate if in an island under COVID19 monitoring)
1		Work Supervisor						
2		Health and Safety Supervisor						
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

ANNEX 2: CONTRACTOR'S DECLARATION

I / we hereby declare that the information provided in the attached “project team information” sheet and “details of health and safety items to be brought to the facility” sheet is true and accurate. I / we also confirm that the project team does not contain any member with a potential risk of carrying and transmitting COVID19, nor has been in contact with a COVID19 confirmed case, nor has a member that falls under high-risk category or if a high-risk member is included, he/she has been vaccinated.

I / we hereby also provide full assurance and commitment to undertake the preventive measures prescribed in the guidance note on “COVID19 Special Consideration in Civil Works Contracts” and mitigation and monitoring requirements for the construction phase presented in the ESMP for the project. I / we also agree to the timely submission of Health and Safety Monitoring Report and the ESMP Monitoring Report on a monthly basis.

Name:

Designation:

Contact:

Signature:

Stamp:

Date:

ANNEX 3: DETAILS OF HEALTH AND SAFETY ITEMS PROPOSED TO BE USED

#	Item Name	Quantity	Intended Purpose of Use
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

ANNEX 4: WASH GUIDANCE FROM WHO

How to Handwash?

WASH HANDS WHEN VISIBLY SOILED; OTHERWISE, USE HANDRUB

 Duration of the entire procedure: 40-60 seconds



Source: WHO (2009)

How to Handrub?

RUB HANDS FOR HAND HYGIENE! WASH HANDS WHEN VISIBLY SOILED

⌚ Duration of the entire procedure: 20-30 seconds



Apply a palmful of the product in a cupped hand, covering all surfaces

Rub hands palm to palm



Right palm over left dorsum with interlaced fingers and vice versa

Palm to palm with fingers interlaced

Backs of fingers to opposing palms with fingers interlocked



Rotational rubbing of left thumb clasped in right palm and vice versa

Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa

Once dry, your hands are safe



Patient Safety
A World Alliance for Better Health Care

SAVE LIVES
Clean Your Hands

Close bag with a single overhand knot:



Do not close by crossing tabs ("bunny or dog-ear" method)



ANNEX 5: IMPORTANT CONTACTS

			
ICP - 9300918 Incident Command Post Information or Help during lockdown	HPA - 1676 Urgent medical requests (from monitoring places)	7289259 FLU CLINIC	1610 Treetop Hospital Telemedicine Service -3351610 care@treetophospital.com
HMH- 1417 Hulhumale Hospital Medical hot line - 9651354 Prescription renewal: hmhhospital.doc@gmail.com	1412 Min. of Gender, Family & Social Services 3328393 Report child abuse cases & immediate social care	7953535 / 7963535 HDC Maintenance	1665 permit to go out for essential needs - 3034444 police.gov.mv/permit
7223131/ 9423131 Contact relatives in quarantine facilities	Kalaafaanu School Send essential item(s) to quarantine facilities (Sat & Wed 11:00-15:00)	STO Pharmacy Order prescription medicine sto.mv/online/prescriptions	1425 Physiological support (12:00-17:00 & 20:00-00:00) (except Fridays) Maldivian Red Crescent

Hulhumale Police

IMPORTANT NUMBERS – LOCKDOWN_Covid 19 | 2020

ANNEX 6: HEALTH AND SAFETY MONITORING REPORT TEMPLATE

Project Title:

Report No:

Proponent: Accelerating Sustainable Private Investment in Renewable Energy Project

Date:

Contractor: Ensys Co ltd.

Mitigation Measure	Status (√ / X)	Comments / Photographic Reference
Preconstruction Phase		
Actions Needed Prior to Mobilization		
<ul style="list-style-type: none"> • In general, the project team should not contain any member that falls under the high-risk category. If a high-risk category member is included, he/she should be vaccinated. 		
<ul style="list-style-type: none"> • Sufficient supply of PPEs, cleaning items and other items required to set by the labor camp is brought such as: <ul style="list-style-type: none"> ➤ Thermometer ➤ First-aid kit ➤ General flu medicine ➤ Masks ➤ Gloves ➤ Foot operated lidded dustbins ➤ Dustbin bags ➤ Disinfecting liquid such as bleach ➤ Cleaning equipment (broom, mop etc.) ➤ Hand sanitizers ➤ Soap 		
<ul style="list-style-type: none"> • Contractor's Declaration is submitted 		
Measures for Setting up Labor Camp		
<ul style="list-style-type: none"> • Social Distancing Norms are facilitated when setting up labor camp. Each bed must be separated by a distance of at least 3 to 6 feet. 		
<ul style="list-style-type: none"> • Accommodation are kept properly ventilated. Windows must be kept open. 		

<ul style="list-style-type: none"> • A foot operated lidded bin is kept at or just outside the accommodation to collect general waste generated by the workers. 		
<ul style="list-style-type: none"> • Foot operated lidded bins are kept at the work site and at the kitchen and dining area to collect general waste. Double bags should be placed inside these bins. 		
<ul style="list-style-type: none"> • Hand sanitizers are to be kept at entrance point to the accommodation (wall mounted or kept on top of a table) as well as inside the accommodation facility preferably at each bed side. Handwashing facilities can be set up as an alternative 		
<ul style="list-style-type: none"> • Establish handwashing facilities at the work site and eating or resting areas. Hand Sanitizers can be used as an alternative. 		
<ul style="list-style-type: none"> • Ensure handwashing facilities supplied with soap, disposable paper towels and closed waste bins exist at toilets, kitchen and dining area. Alcohol based sanitizer (if available, 60-95%alcohol) can also be used. 		
<ul style="list-style-type: none"> • Place posters and signs around the site, with images and text in local languages providing guidance on signs and symptoms of COVID-19, how it is spread, how to protect themselves (including regular handwashing and social distancing) and what to do if they or other people have symptoms. 		
Construction Phase		
Checks on Commencement of Work		
<ul style="list-style-type: none"> • The movement of the workers should be restricted from the labor camp to the work site and from the work site to the labor camp. 		
<ul style="list-style-type: none"> • The workers should avoid contact with the general public of the project island. 		
<ul style="list-style-type: none"> • Daily temperature checks should be taken and recorded prior to leaving the labor camp and entering the work site. Logs should be maintained and attached to the monthly Health and Safety report. 		
<ul style="list-style-type: none"> • Provide daily briefings to workers prior to commencing work, focusing on COVID-19 specific considerations including cough etiquette, hand hygiene and distancing measures, using demonstrations and participatory methods. 		

<ul style="list-style-type: none"> • During the daily briefings, remind workers to self-monitor for possible symptoms (fever, cough) and to report to the supervisor or the COVID-19 focal point if they have symptoms or are feeling unwell. 		
<ul style="list-style-type: none"> • If there is any symptom of COVID19 (fever, cough), the staff must be immediately isolated, referred to the health center and the concerned authorities must be notified. This staff should not be involved in the project team until cleared by the respective authorities. 		
<ul style="list-style-type: none"> • Any other staff who have had close contact with the staff who developed symptoms must be self-quarantined for 14 days and should not be allowed to enter the project site or move about in the project island, even if there are no symptoms. The directions given by the authorities should be strictly followed. 		
Clean and Waste Disposal		
<ul style="list-style-type: none"> • The tools and equipment used by the workers must be cleaned when changing shifts. 		
<ul style="list-style-type: none"> • Cleaning staff shall use appropriate PPEs such as masks and gloves. 		
<ul style="list-style-type: none"> • The labor camp must be cleaned frequently (at least once a day) including accommodation facility, kitchen, dining area and toilets. The floor, walls and door knobs should be properly cleaned using 1:9 bleach solution. Sheets and linings must be changed at least weekly. 		
<ul style="list-style-type: none"> • Any waste produced during the care of ill workers should be collected separately in designated containers or bags and treated and disposed of according to the SOPs of HPA and WHO. This includes placing double bags inside the bins, properly tying and removing the bags when 2/3 are full and disinfected by spraying with 1:9 bleach solution. 		
Adjusting Work Practices		
<ul style="list-style-type: none"> • Changing to a 24-hour work rotation. 		
<ul style="list-style-type: none"> • Adapting or redesigning work processes for specific work activities and tasks to enable social distancing, and training workers on these processes. 		

<ul style="list-style-type: none"> Consider changing canteen layouts and phasing meal times to allow for social distancing. 		
<ul style="list-style-type: none"> Consider using of dust masks in addition to the general construction PPEs. 		
Grievance Redress Mechanism		
<ul style="list-style-type: none"> Project board and posters containing the details of contact person from contractor, island council and PMU are placed in various locations of the project site and the labor camp. 		
<ul style="list-style-type: none"> Log records of grievances are maintained 		

17.13 Approval letters by government authorities



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- 1- ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި 2018/30/438/DASA-28
- 2- ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި 2018/30/438/DASA-28
- 3- ދިވެހިސަރުކާރުގެ ގެޒެޓްގައި 2018/30/438/DASA-28

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25 ވަނަ ދުވަހުގެ 2018

Handwritten signature

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Ministry of National Planning and Infrastructure
Male', Republic of Maldives

ދިވެހިސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކޮށްފައިވާ ގޮތުން
ދިވެހިރާއްޖޭގެ ގެޒެޓް



ދިވެހިސަރުކާރުގެ ގެޒެޓް - ބަޔާންކޮށްފައިވާ ގޮތުން

ނަންބަރު: 471/438/2019/7

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ފަތުރުވެރުކަމަށް ބޭނުންކުރާ ސަރުކާރުގެ ގެޒެޓް

އިތުރު ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން (އިތުރު ބަޔާންކޮށްފައިވާ ގޮތުން)
ފަތުރުވެރުކަމަށް ބޭނުންކުރާ ސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކޮށްފައިވާ ގޮތުން:

ދިވެހިސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
ނަންބަރު: 438/ASPIRE/138/2018/127 (11 ޖުލައި 2018) ގެ ސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކޮށްފައިވާ ގޮތުން.

އެ ސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
ދިވެހިސަރުކާރުގެ ގެޒެޓް ގައި ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
އިތުރު ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން.

1. ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން

2. ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
3. ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
4. ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
5. ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން

6. ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން
ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން ބަޔާންކޮށްފައިވާ ގޮތުން

