Environmental and Social Impact Assessment for the Gigawatt Global 20 MW Solar PV Plant, Liberia

Prepared for: Gigawatt Global

GIGAWATT GLOBAL A FOUNDING PARTNER OF POWER AFRICA

Project No.: 710.07072.00001
Report No.: 3
Revision No.: 002
October 2020

DOCUMENT INFORMATION

Title	Environmental and Social Impact Assessment for the Gigawatt Global 20 MW Solar PV Plant, Liberia
Project Manager	Conroy van der Riet
Project Manager Email	cvanderriet@slrconsulting.com
Author	Conroy van der Riet
Reviewer	Stuart Heather-Clark
Keywords	Gigawatt Global, Solar, Power, Liberia
Report No.	3
SLR Company	SLR Consulting (Africa)(Pty) Ltd

DOCUMENT REVISION RECORD

Rev No.	Issue Date	Description	Issued By
001	04 September 2020	Client Draft for Review	CvdR
002	30 October 2020	Draft issued to the Liberia EPA for Review	CvdR

BASIS OF REPORT

This document has been prepared by an SLR Group company with reasonable skill, care and diligence, and taking account of the manpower, timescales and resources devoted to it by agreement with **Gigawatt Global Cooperatief U.A** (the Client) as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

SLR shall not be liable for the use of or reliance on any information, advice, recommendations and opinions in this document for any purpose by any person other than the Client. Reliance may be granted to a third party only in the event that SLR and the third party have executed a reliance agreement or collateral warranty.

Information reported herein may be based on the interpretation of public domain data collected by SLR, and/or information supplied by the Client and/or its other advisors and associates. These data have been accepted in good faith as being accurate and valid.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

The copyright and intellectual property in all drawings, reports, specifications, bills of quantities, calculations and other information set out in this report remain vested in SLR unless the terms of appointment state otherwise.

This document may contain information of a specialised and/or highly technical nature and the Client is advised to seek clarification on any elements which may be unclear to it.

Information, advice, recommendations and opinions in this document should only be relied upon in the context of the whole document and any documents referenced explicitly herein and should then only be used within the context of the appointment.

NON-TECHNICAL SUMMARY

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

GIGAWATT GLOBAL 20 MW SOLAR PV PLANT, LIBERIA

INTRODUCTION

Gigawatt Global (GWG) is a multinational solar energy developer that builds, finances and operates utility-scale photovoltaic solar projects in emerging markets.

GWG are proposing to develop a 20 Megawatt (MW) Solar Photovoltaic (PV) Plant approximately 4 km south of the Mount Coffee Hydropower Plant (MCHPP) in Liberia. The project will also involve the construction of a power transmission line from the solar PV plant to the Mount Coffee Substation.

SLR Consulting (Africa) (Pty) Ltd (SLR), in collaboration with Green Consultancy Inc. (GreenCons), has been appointed as the independent Environmental Assessment Practitioner to compile an Environmental and Social Impact Assessment (ESIA) for this project.

PURPOSE AND SCOPE OF THIS DOCUMENT

This Non-Technical Summary has been compiled as a summary of the Environmental and Social Impact Assess (ESIA) Report. It summarises the following:

- The impact assessment process including the stakeholder engagement undertaken;
- The relevant environmental laws and regulations, including international requirements;
- The project site and associated environmental and social features;
- The proposed project components and activities;
- The predicted impacts and their significance ratings; and
- The proposed mitigation and enhancement measures to mitigate and optimise the identified impacts.

ENVIRONMENTAL ASSESSMENT AND AUTHORISATION

The Environmental Protection and Management Law, 2003 (EPML) provides the rules, regulations, and procedures for conducting EIAs and establishes regulations for environmental quality standards, pollution control and licensing. Section 6 of EPML requires an application for an environmental impact assessment license for the commencement of the projects and activities specified in Annexure I of the Act and sets out the process to be followed for Project Briefs, Scoping process and Environmental Impact Statements. In terms of Annex I of the Environmental Protection and Management Law of the Republic of Liberia (2003) this project will primarily fall under Category 7: Energy Industry, and would trigger two activities under this category,

- the production and distribution of electricity; and
- Solar (electricity generation).

The EPML requires an Environmental Impact Statement (EIS) to be compiled, a stakeholder engagement process to be conducted and registration and authorisation by the Environmental Protection Agency (EPA). This proposed project has been registered with the EPA with the Reference Number DED/EPA-02/00100/20/RL.

In addition, the project must also be designed and implemented in accordance with International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012), which includes IFC Performance Standards 1 to 8 and relevant World Bank Environment Health and Safety (EHS) Guidelines.

As a result of the dual compliance requirements an Environmental and Social Impact Assessment (ESIA) process has been undertaken. The ESIA process and compilation of the Environmental Impact Statement has involved specialist data gathering, site visits and consultation with affected stakeholders to identify issues of concern that need to be addressed as part of the ESIA.

PROJECT DESCRIPTION

Overview of the Project

Gigawatt Global (GWG) is proposing to develop a 20 megawatt (MW) solar photovoltaic (PV) plant, to be located on the Crawford Farm in the Montserrado County of Liberia, approximately 4 km south east of the Mount Coffee Hydropower Plant (MCHPP) and approximately 25 km north of Monrovia. The nearest established community is Crozierville, located 2 km south east of the project site (Figure 1). An example of a solar PV plant layout for a plant developed by GWG in Rwanda is shown below:

The project will also involve the construction of a medium voltage (± 66 kV) transmission line from the solar PV plant to the Mount Coffee substation located at the Mount Coffee Hydropower Plant. The two Transmission Line (TL) Route Options are presented in Figure 2.

The GWG project is responding to shortages in supply of electricity in Liberia. During the dry season in Liberia the Mount Coffee Hydropower Plant (MCHPP) runs below its maximum production capacity leading to a shortage in the national electricity supply. The ongoing expansion of the national grid and the resulting new private and public off-takers are driving the need for additional electricity. GWG's solar PV project is responding to this need. As a result, GWG signed an amended Memorandum of Understating (MoU) with the Chairman of Liberian Electric Corporation (LEC).

Consideration of Alternatives

The study considered alternative sites, layout, technology, transmission line routes and the No-Go alternative. Criteria used were: ecological (presence of important or threatened biodiversity); social and community (presence or proximity to communities; land ownership, land use); technical (viability of options and if they can be efficiently implemented, maintained and operated) and financial (life cycle costs balanced against initial capital expenditure and operational costs).

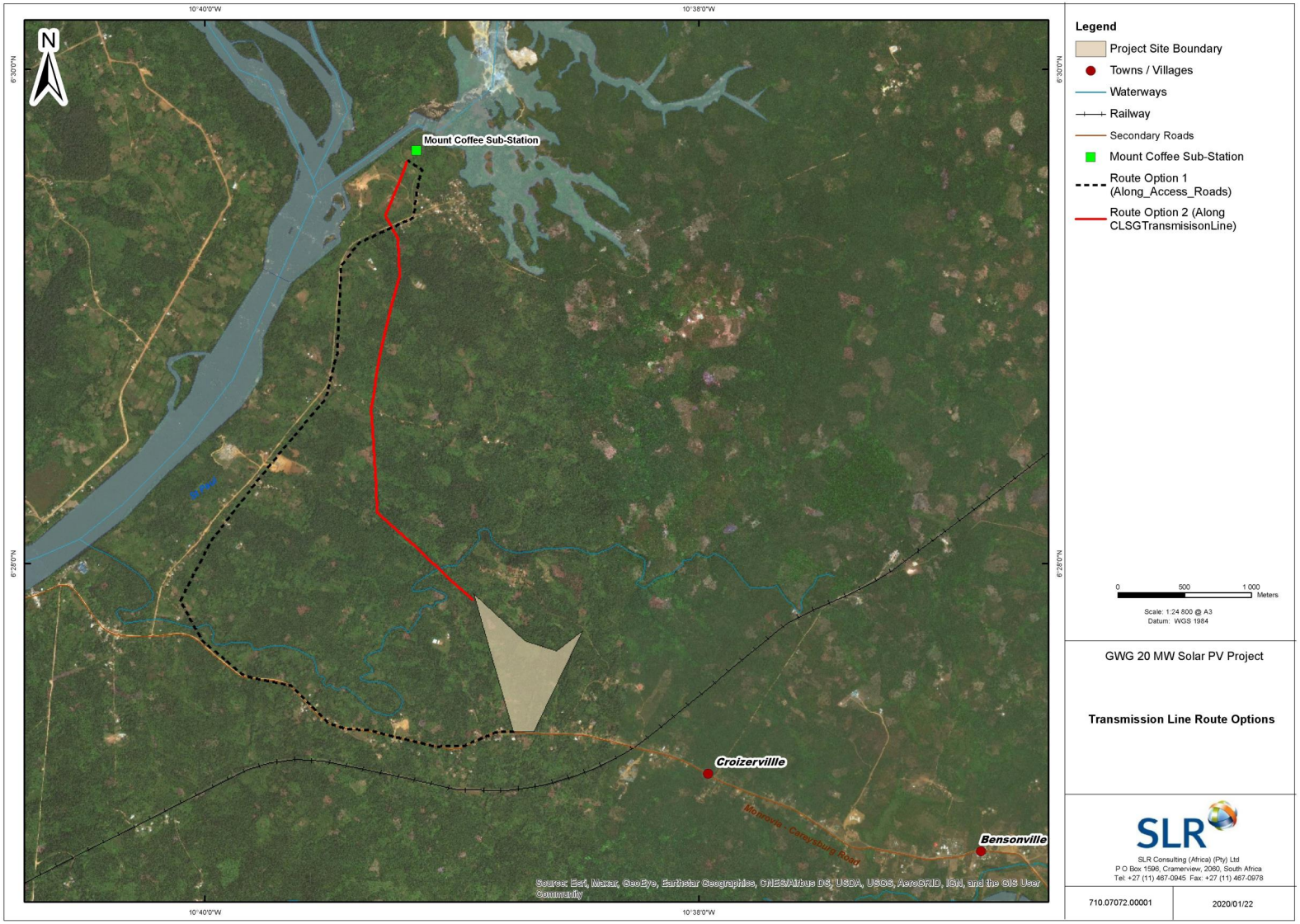
Site alternatives: GWG undertook a site selection exercise based on the following criteria: solar irradiance, existence of transmission lines and substations, land availability and ownership, land use, environmentally sensitive features and existing infrastructure. Three possible sites were considered for the development of the project. These included (1) a site near the Monrovia-Roberts International Airport, (2) a site in a commercial zone near Monrovia and (3) the Crawford Farm site near Crozierville). The Crawford site selected as it is located on privately owned land; and also close to the existing Côte d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG) transmission line and MCHPP substation.

Transmission line alternatives: Two proposed transmission line routes were compared for social and ecological criteria. Transmission Line Route Option 02 (Figure 2) has been identified as the preferred route with the least environmental and social impact (mainly because it has already been cleared for the existing CLSG transmission line).

No Go alternative: The 'No Go' alternative is not recommended given the small adverse environmental and social impacts of the project relative to the project benefits for renewable power generation in Liberia.

Figure 1: Regional Locality Map Showing the Location of the Proposed Solar PV Site

Figure 2: Location of the Proposed Solar PV plant and associated Transmission Line Route Options



Description of the Project

The solar PV plant would occupy approximately 85 acres (~ 34 hectares) and would be connected to the MCHPP Substation via a 66kV transmission line of ±4 km. Key project components include PV panels, inverters and mounting structures, underground cables, site substation(s), facilities and office building(s), access road and internal access tracks, perimeter security fence and security. The preferred alternative is the use of solar PV with thin-film modules mounted upon a fixed axis.

Construction Phase

Construction of the project is expected to take 8-10 months and is envisaged to start in the fourth quarter of 2021 subject to conclusion of key contracts with LEC and Government of Liberia.

An estimated 350 trips by 5 trucks in total over the construction period (averaging approximately 3-4 trucks per day) will be required to deliver the solar plant materials, machinery and labour. The point of import and transportation route to the project site will be finalised once suppliers have been confirmed but is anticipated to be the main roads leading to Monrovia (the MCHPP-Monrovia road and the Crozierville-White Plains road).

During construction up to 250 m^3 per day of water will be used. Water will be sourced from existing licensed boreholes on the site as part of the lease agreement with the landowner.

The final number of people to be employed during the construction phase is likely to be up to 200 people during peak construction activities, with an estimated 100 unskilled and semi-skilled jobs likely to be available. However, the number of people employed at one time may vary as different contracts and subcontracts are completed on-site. The project is focused on giving preference for employment to the communities surrounding the site and the transmission line if the required skill level is available, and there is a requirement to have at least 30% of women employed during construction. GWG will put in place measures to ensure no employee or job applicant is discriminated against on the basis of his or her race, gender, marital status, nationality, age, religion or sexual orientation. A grievance register and a Community Liaison Officer will be in place to address any community issues or concerns during construction.

Figure 3. An example of a solar PV plant under construction

Operation Phase

The solar PV power plant will operate during daylight hours, 7 days a week basis. An estimated maximum of 20 staff will manage the project during operation (with approximately 3 to 4 on site). Operation phase activities include the regular cleaning of the modules using a combination of brushes, water and air; vegetation management around the panels; maintenance of components and electrical equipment; supervision of electricity production and site security monitoring.

Traffic during operations will be reduced to a small number of vehicles travelling to and from the site for monitoring and maintenance purposes. Approximately 7-8 m3 per day of water will be required during project operation for domestic use, firefighting reserve, and cleaning PV panels. This will be supplied from a borehole on the site and bottled water.

The proposed Project is expected to operate for at least 25 years. Once the plant reaches the end of its life, PV modules may continue to operate as their expected lifetime is 30 years; they may alternatively be refurbished or replaced to continue operations or the facility may be closed and decommissioned.

Decommissioning

When decommissioned, all components will be removed and the site rehabilitated. Where possible all materials will be recycled, otherwise they will be disposed of in accordance with local regulations and international best practice in place at that time.

AFFECTED ENVIRONMENT

Biophysical Environment

The solar PV site occupies undulating ground with weathered lateritic saprolite soil cover. It is located 25 km from the closest national park (Margibi Mangrove National Park) and RAMSAR site (Mesurado Wetlands), and more than 60 km from the nearest Important Bird Area and terrestrial Key Biodiversity Area.

Habitat are dominated by Agricultural Degraded Areas (or “Low Bush”) (Figure 4) in various states of disturbance as a result of past agricultural activities and wood harvesting. The corridor for the CLSG transmission line has been cleared, and this is the preferred route for the proposed transmission line. There is a small area of young secondary forest type vegetation (or “Young Bush”) in the north eastern part of the solar PV site (Figure 5), as well as three wetland areas (Figure 6). No threatened plants or animal were recorded during the surveys and some alien invasive plant species were observed. No portion of the site triggers Critical Habitat thresholds under IFC criteria and the site is mostly assessed as modified habitat and degraded natural habitat. The wetland areas are connected ephemeral drainage channels and it is likely that water accumulates in these during the rainy season.

Figure 4. Agricultural Degraded Areas (or "Low Bush")

Figure 5. Young secondary forest type vegetation (or "Young Bush")

Figure 6. Wetland areas with subsistence farming

Social Environment

The Careysburg District has a growing population that showed 0.6% annual growth rate between 2008 and 2014 (and projected to increase to 2.0 % per annum by 2020). Crozierville is the closest established community where inhabitants are mainly involved in subsistence or formal agriculture.

The solar PV site is located on a derelict commercial farm that supported rubber-tree plantations, as well as piggery and poultry operations prior to the civil war. The farm has not been in operational since the second civil war that ended in 2003 (except for subsistence farming taking place). The commercial farm remains under private tenure as secured via formal title by the landowner.

There is minimal active use of the site, which includes small-scale farm plots and seasonal gardens plots as well as charcoal production and natural resource harvesting. It is estimated that 7% (2.5 hectares) of the solar PV site supports small-scale farming of predominately Cassava, Maize or Plantain on elevated areas (Figure 7), while Sugar Cane is grown along the ephemeral streams that cross the site (Figure 8).

The preferred transmission line corridor has already been cleared for the existing CLSG transmission line (Figure 9).

Figure 7. Small-scale cassava farmland

Figure 8. Sugar cane farm plots

Figure 9. Existing CLSG transmission line and wayleave

No physical cultural heritage sites such as archaeological sites or graves were found on the site or along the preferred transmission line route, and nor are there any known sacred sites or cultural practices that are undertaken within the project site.

KEY ISSUES AND IMPACTS

The key positive and negative impacts of the development of the proposed solar PV plant are summarised in Table 1 below. The key positive and negative impacts of the development of the proposed transmission line are summarised in Table 2 below.

Alignment with the Mitigation Hierarchy

The mitigation hierarchy was followed to prioritise the avoidance and minimisation of impacts, as follows:

Avoidance: For the solar PV site alternatives an initial search for appropriate land parcels for the development of a solar PV plant included environmental and social criteria such land ownership, land use, protected areas and biodiversity. Sites with high biodiversity, sensitive features, within protected areas and under community land ownership were screened out. The site selected is located on private title held land (Crawford farm), previously used for agriculture, and with no Critical Habitat as defined by the IFC Performance Standards.

For the Transmission Line Route alternatives, two route options were considered. It was decided to follow the existing CLSG transmission line route as it has been cleared (TL Route Option 02) as this avoids the need for further clearance of vegetation and the need for physical resettlement as would have been required for the alternative route (TL Route Option 01).

Minimisation: The layout of the solar PV plant has been designed to prioritise the degraded habitats to minimise impacts on the more intact "Young Bush" and wetland areas.

Rehabilitation: Land within the construction footprint that is not required for the solar PV plant or related infrastructure will be reinstated. The avoidance of the "Young Bush" and wetland areas could allow for improvements in biodiversity and ecological condition over time by limiting agriculture and further wood harvesting in these areas.

Offset: No biodiversity offset is required as the project will not have significant adverse impacts on biodiversity. As indicated above, the "Young Bush" and wetland features on the solar PV site have been avoided.

Table 1. Impacts of Construction and Operation of the Solar PV Plant

Environmental component	Impact during construction & operation phase of the **Solar PV plant**	**CONSTRUCTION PHASE** Significance without mitigation		**OPERATIONAL PHASE** Significance with mitigation	
		Without mitigation	With mitigation	Without mitigation	With mitigation
Biophysical Impacts	Impact of air emissions	Medium	**Low**	Very Low	**Very Low**
	Impact of noise emissions	Medium	**Low**	Very Low	**Very Low**
Ecological Impacts	Habitat loss, fragmentation and edge effects	Low	**Low**	Low	**Very Low**
	Impacts on biota	Low	**Low**	Low	**Very Low**
	Impact on aquatic ecology	Medium	**Low**	Low	**Very Low**
	Alien invasive species impacts	Medium	**Low**	Low	**Very Low**
Socio-economic Impacts	Physical and Economic Displacement	Medium	**Very low**	-	-
	Loss of Access to Natural Resources	Low	**Low**	-	-
	Community Facilities, Access, and Mobility	Low	**Very Low**	Medium	**Very Low**
	Community Development, Local Employment and Local Content	Low Benefits	**Medium Benefits**	Very Low Benefits	**Medium Benefits**
	Landscape and visual amenity	Medium	**Low**	Medium	**Low**
	Cultural Heritage	Medium	**Insignificant**	-	-

Table 2. Impacts of Construction and Operation of the Transmission Line

Environmental component	Impact during construction & operation phase of the **Transmission Line**	TL Route Option 01				TL Route Option 02			
		CONSTRUCTION PHASE Significance without mitigation		OPERATIONAL PHASE Significance with mitigation		CONSTRUCTION PHASE Significance without mitigation		OPERATIONAL PHASE Significance with mitigation	
		Without mitigation	**With mitigation**	Without mitigation	**With mitigation**	Without mitigation	**With mitigation**	Without mitigation	**With mitigation**
Biophysical Impacts	Impact of air emissions	Very Low	**Insignificant**	Very Low	**Insignificant**	Very Low	**Insignificant**	Very Low	**Insignificant**
	Impact of noise emissions	Medium	**Low**	Low	**Low**	Low	**Very Low**	Insignificant	**Insignificant**
Ecological Impacts	Habitat loss, fragmentation and edge effects	High	**Medium**	-	-	Very Low	**Insignificant**	-	-
	Impacts on biota	Low	**Very Low**	Low	**Insignificant**	Very Low	**Insignificant**	Insignificant	**Insignificant**
	Impact on aquatic ecology	Low	**Very Low**	Very Low	**Insignificant**	Very Low	**Insignificant**	Insignificant	**Insignificant**
	Alien invasive species impacts	Medium	**Very Low**	Very Low	**Insignificant**	Medium	**Very Low**	Very Low	**Insignificant**
Socio-economic Impacts	Physical and Economic Displacement	High	**Low**	-	-	Low	**Very Low**	-	-
	Loss of Access to Natural Resources	Medium	**Low**	-	-	Very Low	**Very Low**	-	-
	Community Facilities, Access, and Mobility	Very High	**Medium**	-	-	Insignificant	**Insignificant**	-	-
	Community Development, Local Employment and Local Content	Low Benefits	**Medium Benefits**	Very Low Benefits	**Low Benefits**	Insignificant Benefits	**Insignificant Benefits**	Insignificant Benefits	**Insignificant Benefits**
	Cultural Heritage	High	**Insignificant**	Insignificant	**Insignificant**	Very Low	**Insignificant**	Insignificant	**Insignificant**

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

Overview of ESMP

An ESMP has been prepared as an annex to the ESIA which provides a framework for the implementation of environmental and social management measures for construction and operation that are required to minimise impacts to an acceptable level.

The ESMP will be reviewed annually to provide for adaptive management based on impacts that are identified or new information that may influence detailed design or project implementation. The ESMP sets out the roles and responsibilities of the developer and contractor's staff to implement the provisions of the ESMP and to report results.

It also provides an overview of training, communications, and monitoring and review requirements (i.e. inspections, audits, corrective actions) and emergency planning and response.

The ESMP also describes the grievances and issues redress mechanism that will be implemented throughout the project to collect and handle any community concerns that are raised.

Mitigation, Enhancement and Monitoring Measures

Key mitigation and enhancement measures contained in the ESMP for construction and operation are summarised below.

Construction phase mitigation measures in the ESMP are:

- **Air–emissions**: dust suppression along access roads and speed control of contractor vehicles.
- **Noise**: regular servicing of vehicles/equipment and siting of noise-generating infrastructure away from adjacent communities and use of insulation materials. Inform nearby residents of noisy night time activities in proximity, when necessary.
- **Waste**: storage, transport and disposal according to hierarchy waste; safe storage and disposal of all waste.
- **Biodiversity**: minimise construction footprints; store topsoil for reinstatement of construction areas; mulch brush and spread on bare topsoil areas to suppress dust and provide leaf matter for soil replenishment.
- **Alien invasive plants**: wash down vehicles and equipment before leaving site; regularly monitor and remove any alien plants that become established.
- **Aquatic habitats**: design site drainage and stormwater runoff to minimise risk of contaminated water entering stream courses or wetland areas; minimise use of chemicals on site and store in bunded areas and use in designated areas only (at least 150 m from aquatic features).
- **Site restoration**: grade construction disturbed areas to near natural contours, scarify to de-compact soils, spread with stockpiled topsoil and allowed to recover naturally. If revegetation does not occur naturally, seed the area with natural grass seed and irrigate appropriately for the soil type.
- **Land use and livelihoods**: Livelihood Restoration Plan (LRP) for subsistence farmers; stockpile useful timber woody vegetation for community use; develop robust Community Development Plan in collaboration with local communities, traditional leaders and the District Council.
- **Cultural heritage**: develop chance finds procedure for any cultural artefacts during land clearance.
- **Community health and safety**: restrict public access to the project site except for authorised and supervised activities (e.g. collection of stockpiled wood or community development projects); implement traffic speed control, other safety and awareness measures along access road to site; establish emergency response plans for incidences that might arise; establish and include a Code of Conduct in contractor and employee specifications relating to working or interacting in local communities including engagement procedures, obtaining permissions, grievance redress etc.; establish a worker health programme that targets risky

behaviours, training and voluntary screening of HIV and other sexually transmitted diseases. Do not permit hiring of ad hoc staff at the site to avoid assembly of opportunist work seekers at the site.
- **Employment/economic benefits**: develop and implement a recruitment procedure (as part of Workers Management Plan) that optimises hiring of local labour (including at least 30% women during construction and vulnerable groups, where feasible); ensure local content policies are included in contractual obligations of contractors; labour management shall abide by Liberia national labour and occupational health and safety laws (including international obligations (e.g. under International labour organisation (ILO)); and maximise procurement of local goods and services locally or nationally, where feasible.
- **Grievance register and resolution of community issues**: implement a grievance mechanism and engage a Community Liaison Officer (CLO) throughout construction to enable community members and other stakeholders to raise issues of concern and to facilitate resolution. The CLO will be responsible for disseminating information and coordinating community communications through the course of the Project, including notifying communities of the Grievance Mechanism.

Operation phase mitigation measures in the ESMP are:

- **Alien invasive plants**: monitor and remove alien invasive species on a regular basis (before flowering or seeding occurs).
- **Monitor restoration success**: regularly monitor natural plant regrowth and presence of erosion in reinstated construction areas.
- **Herbicides**: should be environmentally-approved and comply with Liberia legal requirements and relevant international conventions.
- **Pollution prevention**: inspect site for oil spills and leaks around delivery station, transformer, on soil and water bodies and implement remediation as required; store chemical containers in an enclosed restricted access area, and dispose at an approved waste facility or by approved waste service providers.
- **Community engagement**: make provision for ongoing engagement with local communities to understand issues and to implement community projects identified in the Corporate Social Responsibility plan for the project.

CONCLUSION

The aim of the ESIA process is to provide sufficient information to allow the EPA to make an informed decision with regards to allowing the proposed solar PV plant and associated transmission lines to proceed. The ESIA provides this information and has been compiled in alignment with national legislation and the IFC Performance Standards.

Neither the solar PV site nor the preferred transmission line route includes any Critical Habitat as defined by the IFC. The solar PV site is located on private land owned by a single land owner, who is not actively farming the land , however the site does support some informal livelihood activities. Transmission line Route Option 02 (Preferred Route) will not likely require physical displacement but might disrupt some active small-scale farming identified in the existing CLSG Transmission Line wayleave. It is likely that the local communities will be able to be appropriately compensated through implementing mitigations that is aligned with IFC Performance Standard 5.

Occupational health and safety issues for the workforce during both the construction and operational phases of the project are of concern due to the potential unfamiliarity of the local workforce with international good practice procedures. However, this can easily be mitigation through appropriate training and implementation of health and safety management system throughout the construction and operational phase of the project.

The benefits of job creation and opportunities for local suppliers cannot be overstated. This combined with a well-structured Corporate Social Responsibility plan will result in increased benefits to the surrounding local communities.

The assessment of the construction and operation of the solar PV plant shows there are no impacts, as a result of the solar PV plant, that are assessed to be of medium significance or higher after mitigation; all range from low to insignificant. For the alterative transmission line route (TL Route Option 01) the aspects relating to (1) Habitat loss, fragmentation and edge effects, and (2) Community Facilities, Access, and Mobility are rated to be medium after mitigation, whereas these two aspects are rated as insignificant for the preferred transmission line route (TL Route Option 02). The rest of the aspects associated with the transmission line routes range from low to insignificant.

It is concluded that, if mitigation and monitoring measures contained in the Environmental and Social Management Plan (ESMP) (Appendix E) are implemented and the developer commits to enhancing community benefits through creation of local jobs, use of local suppliers and development of a robust Corporate Social Responsibility plan for the community, the benefits of the solar PV plant and associated transmission line will outweigh the negative impacts.

Contents

1. INTRODUCTION 1
1.1 OVERVIEW OF THE PROJECT INCLUDING PROJECT RATIONALE 1
1.2 DEVELOPER'S PHYSICAL ADDRESS, CONTACT PERSON AND DETAILS 1
1.3 ESIA PROJECT TEAM 1

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK 2
2.1 POLICY FRAMEWORK 3
2.1.1 National Environmental Policy, 2003 3
2.1.2 National Energy Efficiency Action Plan of Liberia, 2004 3
2.1.3 National Energy Policy, 2007 3
2.1.4 National Biodiversity Strategy and Action Plan, 2004 3
2.1.5 National Forestry Policy and National Forest Management Strategy, 2007 3
2.1.6 Land Rights Policy, 2013 4
2.1.7 National Environmental and Occupational Health Policy 4
2.2 LEGAL FRAMEWORK 4
2.2.1 Constitution of Liberia 5
2.2.2 The Environmental Protection Agency Act 5
2.2.3 Act Adopting the Environmental Protection and Management Law of the Republic of Liberia 6
2.2.4 Liberia Land Commission Act 8
2.2.5 National Forestry Law and the National New Forestry Reform Law 9
2.2.6 National Wildlife Conservation and Protected Areas Management Act 9
2.2.7 The Decent Work Act 9
2.3 INSTITUTIONAL FRAMEWORK 9
2.4 INTERNATIONAL AGREEMENTS AND CONVENTIONS 11
2.5 EQUATOR PRINCIPLES 13
2.6 IFC PERFORMANCE STANDARDS ON ENVIRONMENTAL AND SOCIAL SUSTAINABILITY (2012) 13

3. DESCRIPTION OF THE PROJECT 15
3.1 LOCATION OF THE PROPOSED PROJECT 15
3.2 PROJECT LAYOUT 22
3.3 PROJECT DESIGN AND COMPONENTS 23
3.4 AIR AND NOISE EMISSIONS 25
3.5 WASTES AND WASTEWATER 25
3.6 TRAFFIC 26
3.7 WATER AND ELECTRICITY 27

3.8 EMPLOYMENT OPPORTUNITIES 28
3.9 PROJECT PHASES 28
3.9.1 Development/planning phase 29
3.9.2 Site preparation phase 29
3.9.3 Construction phase 29
3.9.4 Operational phase 30
3.9.5 Decommissioning phase 30
4. PROJECT ALTERNATIVES 31
4.1 MITIGATION HIERARCHY 31
4.2 IDENTIFICATION OF ALTERNATIVES 32
4.3 ANALYSIS OF ALTERNATIVES 32
4.3.1 Site alternatives 32
4.3.2 Technology alternatives 33
4.3.3 Site layout alternatives 34
4.3.4 Transmission line route and design alternatives 35
4.3.5 No-go alternative 35
5. DESCRIPTION OF THE BASELINE ENVIRONMENT 36
5.1 TOPOGRAPHY 36
5.2 SURFACE HYDROLOGY AND DRAINAGE 36
5.3 CLIMATE AND CLIMATE CHANGE 46
5.3.1 Climate of the Project Area 46
5.3.2 Climate Change and Project Risks 47
5.4 GEOLOGY AND SOILS 48
5.5 ECOLOGICAL RESOURCES 49
5.5.1 Terrestrial Ecology 49
5.5.2 Vegetation 57
5.5.3 Fauna 76
5.5.4 Protected and Conservation Areas 79
5.5.5 Habitat Status Assessment 85
5.5.6 Aquatic Ecosystems 86
5.6 AIR QUALITY AND NOISE 87
5.6.1 Air Quality 87
5.6.2 Noise 87
5.7 SOCIO-ECONOMIC PROFILE 88
5.7.1 Administrative Structure 88
5.7.2 Land use and land tenure 88
5.7.3 Settlement patterns 92
5.7.4 Population profile 94

5.7.5 Language 95
5.7.6 Education and employment 95
5.7.7 Livelihoods 96
5.7.8 Housing and living conditions 102
5.7.9 Accessibility and mobility 104
5.7.10 Community and public services 106
5.7.11 Vulnerable People 107
5.7.12 Gender 108
5.7.13 Human Rights Context 110
5.7.14 Risk of unexploded ordinances 111
5.8 CULTURAL HERITAGE 111
5.8.1 Solar PV Site 111
5.8.2 Transmission Line Corridors 111
6. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT – SOLAR PV PLANT 113
6.1 BIO-PHYSICAL IMPACTS 113
6.1.1 Air emissions 113
6.1.2 Noise emissions 115
6.2 ECOLOGICAL IMPACTS 116
6.2.1 Habitat loss, fragmentation and increased edge effects 116
6.2.2 Impacts on biota 119
6.2.3 Impacts on aquatic ecology 120
6.2.4 Alien invasive species impacts 122
6.3 SOCIAL IMPACTS 124
6.3.1 Physical and Economic Displacement 124
6.3.2 Loss of Access to Natural Resources 125
6.3.3 Community Facilities, Access, and Mobility 126
6.3.4 Community Development, Local Employment and Local Content 128
6.3.5 Landscape and visual amenity 129
6.3.6 Cultural Heritage 131
7. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT – TRANSMISSION LINE ROUTES 132
7.1 BIOPHYSICAL IMPACTS 132
7.1.1 Air Emissions 132
7.1.2 Noise emissions 133
7.2 ECOLOGICAL IMPACTS 134
7.2.1 Habitat loss, fragmentation and increased edge effects 134
7.2.2 Impacts on biota 137
7.2.3 Impacts on aquatic ecology 139
7.2.4 Alien invasive species impacts 141
7.3 SOCIAL IMPACTS 143

7.3.1 Physical and Economic Displacement 143
7.3.2 Loss of Access to Natural Resources 145
7.3.3 Community Facilities, Access, and Mobility 147
7.3.4 Community Development, Local Employment and Local Content 149
7.3.5 Cultural Heritage 151

8. DECOMISSIONING PHASE IMPACTS 153

9. CUMULATIVE IMPACTS 153

10. STAKEHOLDER ENGAGEMENT 153

10.1 INITIAL STAKEHOLDER ENGAGEMENT PROCESS 153
10.2 STAKEHOLDER ENGAGEMENT DURING THE ESIA PROCESS 158
10.3 OPPORTUNITIES FOR FUTURE STAKEHOLDER ENGAGEMENT 158

11. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 159

12. ENVIRONMENTAL AND SOCIAL MONITORING PLAN 159

13. DECOMMISSIONING AND CLOSURE PLAN 159

14. SUMMARY AND CONCLUSION 160

APPENDIX A: COPY OF TITLE DEED 163

APPENDIX B: SITE PHOTOS 164

APPENDIX C: STAKEHOLDER ENGAGEMENT 165

APPENDIX D: SLR IMPACT ASSESSMENT METHODOLOGY 168

APPENDIX E: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 169

LIST OF TABLES

Table 1: The national legal framework and its applicability to the project 4
Table 2: Institutions with a supervisory and monitoring role relevant to the Project 9
Table 3: International treaties and conventions of relevance to the Project 11
Table 4: IFC Performance Standards and their applicability to the Project 13
Table 5: Coordinates for the solar PV site boundary 15
Table 6: Coordinates for the TL Route Option 01 15
Table 7: Coordinates for the TL Route Option 02 16
Table 8: Plant Design Technical Specifications 24
Table 9: Conceptual Layout Design Summary 25
Table 10: Water requirements during operation of the solar PV plant 28

Table 11: Project implementation of the mitigation hierarchy 31
Table 12: Wetland areas identified on the solar PV project site 38
Table 13: Plant species of conservation concern historically known from the region 55
Table 14: Plant species occurring on the solar PV site and along the TL routes 60
Table 15: The main vegetation habitat units present on the solar PV site 66
Table 16: Plant species of Conservation Concern in Liberia 71
Table 17: Mammal species observed - Solar PV Site 76
Table 18: Mammal species observed - Transmission Line Corridors 76
Table 19: Bird species observed - Solar PV Site 77
Table 20: Bird species observed - Transmission Line Corridors 77
Table 21: Fish species reported - Solar PV Site 79
Table 22: Fish species reported - Transmission Line Corridors 79
Table 23: Summary of Protected Areas 80
Table 24: High Level Critical Habitat Assessment 85
Table 25: District Population Profile 94
Table 26: Education Profile 95
Table 27: Broad Cropping Calendar 97
Table 28: National Housing Profile 102
Table 29: International Human Right Treaties 110
Table 30: Impact Assessment of Air Emissions (Solar PV plant) 114
Table 31: Impact Assessment of Noise Emissions (Solar PV plant) 116
Table 32: Assessment of Impacts on habitat loss, fragmentation and increased edge effects (Solar PV plant) 117
Table 33: Assessment of Impacts on biota (Solar PV plant) 119
Table 34: : Assessment of Impacts on streams, wetlands and creeks (Solar PV plant) 121
Table 35: Alien invasive species impacts (Solar PV plant) 123
Table 36: Impact Assessment of Displacement (Solar PV plant) 124
Table 37: Impact Assessment of Restrictions to Natural Resources (Solar PV plant) 126
Table 38: Impact Assessment of the Impact on Community Facilities and Access (Solar PV plant) 127
Table 39: Impact Assessment on Community Development, Local Employment and Local Content Benefits (Solar PV plant) 128
Table 40: Impacts on landscape and visual amenity 130
Table 41: Impact Assessment on Cultural Heritage (Solar PV plant) 131
Table 42: Impact Assessment of Air Emissions (TL Route Options 01 and 02) 132
Table 43: Impact Assessment of Noise Emissions (TL Route Options 01) 133
Table 44: Impact Assessment of Noise Emissions (TL Route Options 02) 134

Table 45: Assessment of Impacts on habitat loss, fragmentation and increased edge effects (TL Route Option 01) 135
Table 46: Assessment of Impacts on habitat loss, fragmentation and increased edge effects (TL Route Option 02) 136
Table 47: Assessment of Impacts on biota (TL Route Option 01) 138
Table 48: Assessment of Impacts on biota (TL Route Option 02) 138
Table 49: Assessment of Impacts on aquatic ecology (TL Route Option 01) 140
Table 50: Assessment of Impacts on aquatic ecology (TL Route Option 02) 140
Table 51: Assessment of alien invasive species impacts (TL Route Options 01 and 02) 142
Table 52: Impact Assessment of Displacement (TL Route Option 01) 144
Table 53: Impact Assessment of Displacement (TL Route Option 02) 144
Table 54: Impact Assessment of the Loss of Natural Resources (TL Route Option 01) 146
Table 55: Impact Assessment of the Loss of Natural Resources (TL Route Option 02) 146
Table 56: Impact Assessment of the Impact on Community Facilities and Access (TL Route Option 01) 148
Table 57: Impact Assessment of the Impact on Community Facilities and Access (TL Route Option 02) 148
Table 58: Impact Assessment on Development, Local Employment and Content Benefits (TL Route Option 01) 149
Table 59: Impact Assessment on Development, Local Employment and Content Benefits (TL Route Option 02) 150
Table 60: Impact Assessment on Cultural Heritage - TL Route Option 01 151
Table 61: Impact Assessment on Cultural Heritage - TL Route Option 02 152
Table 62: Summary of stakeholder engagement process 153
Table 63: List of stakeholders consulted to date and summary of issues raised 155
Table 64: Summary of impacts of the solar PV plant 161
Table 65: Summary of impacts of the Transmission Lines 162

LIST OF FIGURES

Figure 1: Regional Locality Map Showing the Location of the Proposed Solar PV Site 3
Figure 2: Location of the Proposed Solar PV plant and associated Transmission Line Route Options 4
Figure 3: EIA process in Liberia 8
Figure 4: Solar PV project site location 18
Figure 5: Aerial view (drone footage dated March 2019) and some photos (dated February 2020) of the solar PV site 19
Figure 6: Solar PV Project Boundary and some of the surrounding features 20
Figure 7: Transmission line route options 21

Figure 8: Solar PV plant layout 22
Figure 9: Typical layout of a solar PV plant 22
Figure 10: A typical solar PV plant 24
Figure 11: Examples of on-site waste 26
Figure 12: Site layout alternatives showing the original layout with the revised based on site sensitivities 35
Figure 13: Topography of the project site 36
Figure 14: Photos of the wetland areas located on the solar PV site 37
Figure 15: Wetlands within the solar PV site 39
Figure 16: SRTM 30 digital elevation model with approximate drainage lines within minor valley bottoms indicated for the solar PV site 40
Figure 17: Elevation Profile along the white line with the slight rise between the two wetlands indicated by the red arrow on the map and the vertical line on the profile 41
Figure 18: Elevation profile through Wetland C and the blind depressional area it drains into 42
Figure 19: Elevation profile through Wetland D 43
Figure 20: Streams, wetlands and creeks along on the Transmission Line Routes 45
Figure 21: Example of dust levels in Monrovia due to Harmattan trade wind 46
Figure 22: PV potential map (Global Solar Atlas) 47
Figure 23: Extract from Geological Map of the Monrovia Quadrangle, Liberia (Thorman, 1977, USGS) 49
Figure 24: Regional biodiversity 51
Figure 25: Terrestrial ecoregions 52
Figure 26: Change in Upper Guinean Forest extent from 1975 to 2013 (IUCN, 2015) 54
Figure 27: Remaining extent of forest cover in Liberia as of 1992 (Mayers et al., 1992) 54
Figure 28: Extent of regional and local GBIF database searches 55
Figure 29: An example of intact primary rain forest (Zeller, 2020) 57
Figure 30: Example of secondary grassland forest mosaic 58
Figure 31: Vegetation map of Africa 59
Figure 32: Examples of land use impacts on the natural vegetation and habitats 64
Figure 33: Example of young secondary forest type vegetation. 65
Figure 34: Vegetation units of the solar PV site 68
Figure 35: Vegetation along TL Route Option 01 (right) and TL Route Option 02 (left) 69
Figure 36: Vegetation units along the TL Route Options 70
Figure 37: Vegetation sensitivity map and solar PV plant layout 74
Figure 38: Vegetation sensitivity map along the TL Route Options 75
Figure 39: Designated and proposed Protected Areas, including Forest Reserves, tentative UNECSO World Heritage Sites and RAMSAR Wetlands 83
Figure 40: Important Biodiversity Areas, including ESAs, IBAs, KBAs and AZEs 84

Figure 41: Administrative Districts and Key Settlements 88
Figure 42: Key Land-Uses in the Project Site 89
Figure 43: Small-Scale Cassava Farmland Located Within the Project Site 90
Figure 44: Sugar Cane Farmplots Located on Project Site Ephemeral Streams 90
Figure 45: Road-Side Household Found Along TL Route Option 01 91
Figure 46: Road-Side Small-Scale Farmland Found Along TL Route Option 01 91
Figure 47: Existing CLSG Transmission Line and Wayleave (TL Route Option 02) 91
Figure 48: Settlements and Households in Relation to the Project Site and Transmission Lines 92
Figure 49: Image of Mount Coffee Town 93
Figure 50: Image of Crozierville 93
Figure 51: Image of Crawford Farm / Hamlet 93
Figure 52: Small-scale cassava farmland located within the solar PV site 99
Figure 53: Market gardens located on solar PV site along the ephemeral streams 99
Figure 54: Road-Side Trade Stall 101
Figure 55: Bamboo Collection 101
Figure 56: Charcoal Production 102
Figure 57: Examples of Residential Housing Found Around the Project Site 103
Figure 58: Kilo Road (Southern Project Site Boundary) 105
Figure 59: Secondary Gravel Road (Accessing Crawford Farm) 105
Figure 60: St Thomas Road (Outside Harrisburg, the final approach to MCHPP from Monrovia) 106
Figure 61: Location of Public or Community Resources 107
Figure 62: Population Pyramid (Liberia Institute of Statistics & Geo-Information Services, 2016) 109
Figure 63: Images of the graveyard sites located near the solar PV site 111
Figure 64: Images of graveyard sites along the transmission line routes 112
Figure 65: Map showing the location of gravesites along the transmission line routes 112

ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
AC	Alternating Current
AZE	Alliance for Zero Extinction
CDP	Community Development Plan
CdTe	Cadmium Telluride
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CLSG	Côte d'Ivoire-Liberia-Sierra Leone-Guinea
CLO	Community Liaison Officer
DC	Direct Current
EBA	Endemic Bird Area
EHS	Environment Health and Safety
EIS	Environmental Impact Statement
ESIA	Environmental and Social Impact Assessment
EPA	Environment Protection Agency
EPML	Environmental Protection and Management Law
ESMP	Environmental and Social Management Plan
FDA	Forestry Development Authority
GBIF	Global Biodiversity Information Facility
GHI	Global Horizontal Irradiation
GWG	Gigawatt Global
ha	hectares
IBA	Important Bird Area
IFC	International Finance Corporation
ICCPR	International Covenant on Civil and Political Rights
ILO	International Labour Organisation
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Areas
km	Kilometre
kV	Kilovolt
kWh	Kilowatt an hour
LEC	Liberian Electric Corporation
LD$	Liberian Dollars

Acronym / Abbreviation	Definition
LILO	Loop In Loop Out
LRP	Livelihoods Restoration Plan
masl	Meters above sea level
MHT	Major Habitat Type
MoU	Memorandum of Understating
MCHPP	Mount Coffee Hydropower Plant
MPEA	Ministry of Planning and Economic Affairs
MW	Megawatt
NBSAP	National Biodiversity Strategy and Action Plan
NEOHP	National Environmental and Occupational Health Policy
NEP	National Energy Policy
NEEAP	National Energy Efficiency Action Plan
NOI	Notice of Intent
PS	Performance Standard
PV	Photovoltaic
RAP	Resettlement Action Plan
RREA	Rural and Renewable Energy Agency
SCCs	Species of Conservation Concern
STR	Septic tank reviver
TOR	Terms of Reference
TL	Transmission Line
UDHR	Universal Declaration of Human Rights
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNEP	UN Environment Programme
USAID	United States Agency for International Development
USD	United States dollar
USGS	United States Geologic Survey

1. INTRODUCTION

1.1 OVERVIEW OF THE PROJECT INCLUDING PROJECT RATIONALE

Gigawatt Global (GWG) is proposing to develop a 20 megawatt (MW) solar photovoltaic (PV) plant, to be located on the Crawford Farm in the Montserrado County of Liberia, approximately 4 km south east of the Mount Coffee Hydropower Plant (MCHPP) and approximately 25 km north of Monrovia. The nearest established community is Crozierville, located 2 km south east of the project site (see Figure 1).

The GWG project is responding to shortages in supply of electricity in Liberia. During the dry season in Liberia the Mount Coffee Hydropower Plant (MCHPP) runs below its maximum production capacity leading to a shortage in the national electricity supply. The ongoing expansion of the national grid and the resulting new private and public off-takers are driving the need for additional electricity. GWG's solar PV project is responding to this need. As a result, GWG signed an amended Memorandum of Understating (MoU) with the Chairman of Liberian Electric Corporation (LEC).

The project will also involve the construction of a medium voltage (± 66 kV) transmission line from the solar PV plant to the Mount Coffee substation. In this regard two options have been considered. Transmission Line (TL) Route Option 01 follows the Crozierville-White Plains road that runs directly south of the solar PV site for approximately 3km, and then heads north next to the MCHPP-Monrovia road for 4 km to the Mount Coffee Substation. TL Route Option 02 follows the existing Côte d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG) transmission line servitude (that crosses the farm and the northern section of the solar PV site) to the Mount Coffee Substation (see Figure 2).

In terms of the Environmental Protection and Management Law of the Republic of Liberia (2003) the submission of an "Environmental Impact Statement" (EIS) is required following the scoping process and Project Brief submission. As this process is required to follow local as well as international standards in order to access funding, the EIS will be referred to as an "Environmental and Social Impact Assessment" (ESIA) and aligned with local legislation as well as the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012), which includes IFC Performance Standards 1 to 8 and relevant World Bank Environment Health and Safety (EHS) Guidelines. This proposed project has been registered with the EPA with the **Reference Number DED/EPA-02/00100/20/RL**.

1.2 DEVELOPER'S PHYSICAL ADDRESS, CONTACT PERSON AND DETAILS

Gigawatt Global (GWG)
Address: Head Office: Kingsfordweg 151, Amsterdam, The Netherlands Liberia: 10th Street, Sinkor- Monrovia , Liberia
Contact person: Ms Hanna Klein Email: hanna.helena.klein@gigawattglobal.com Telephone: +31202623893 Website: https://gigawattglobal.com/

1.3 ESIA PROJECT TEAM

The following team members were responsible for the baseline data collection, impact assessment, stakeholder engagement and compilation of the ESIA Report.

Name	Affiliation
Stuart Heather-Clark: Project Director Stuart has 23 years of experience in ESIA in sub-Saharan Africa, and direct work experience on wind farm and solar PV developments. He has an integral understanding of the IFC Performance Standards and EHS Guidelines.	SLR Consulting Africa, South Africa
Solomon P. Wright: Authority Liaison Solomon is a graduate of the University of Liberia and certified Environmental Impact Assessment specialist and a seasoned consultant in various environmental matters. He has experience in areas such as waste disposal mechanisms, assessment on ecological environment, surface and ground water monitoring and analysis, forestry management and more.	GreenCons, Liberia
Sanco Toejuea Lysander: Stakeholder Engagement Specialist Sanco is a Social Expert with more than 10 years of experience. He has a Master of Arts in Peace and Conflict Transformation from the University of Liberia (2013) and a Bachelor of Arts in Sociology and Anthropology from the University of Liberia 2003.	GreenCons, Liberia
Godwin Senagah: GreenCons Project Manager Godwin has more than 8 years of experience as an EIA consultant in Liberia. He is a Licensed & Certified Environmental Evaluator in Liberia by the Environmental Protection Agency. He has a M.Sc. in Environmental Science, Cuttington University School of Graduate & Professional Studies, Liberia, 2019.	GreenCons, Liberia
Conroy van der Riet: Project Manager Conroy has 13 years of experience in ESIA in sub-Saharan Africa, and direct work experience on wind farm and solar PV developments. He has an integral understanding of the IFC Performance Standards and EHS Guidelines.	SLR Consulting Africa, South Africa
Marco Da Cunha: Socio-economic and RAP specialist Marco has 14 years of experience in the field of Social Impact Assessments (SIAs) and Resettlement Action Plans (RAPs) for a range of industry sectors throughout sub-Saharan Africa. He has an integral understanding of the IFC Performance Standards and EHS Guidelines and has worked on a number of projects in Africa.	Nomad Consulting, South Africa
Jessica Hughes: Ecology Specialist Jessica has 25 years of experience in coordinating ecological studies to IFC performance standards, including baseline assessments, monitoring studies, Critical Habitat assessments and Biodiversity Management Plans.	SLR Consulting Africa, South Africa
Darius Nuah: EIA Generalist and Botanical Specialist Mr. Nuah has over 6 years of working experience. His last two years plus have been serving as a General Ecology for Green Consultancy Inc, and Independent Biodiversity consultant for Liberia Engineering Geo-Tech (LEG).	GreenCons, Liberia
Lorainmari den Boogert: Ecology Specialist Lorain has more than 10 years of experience as a botanist and aquatic specialist, specialising in ecological assessments, covering fauna, flora, wetland and aquatic ecosystems.	Iggdrasil Scientific Services, South Africa
Michelle Pretorius: Ecology Specialist Michelle has more than 10 years of experience as an environmental consultant, specialising in terrestrial and freshwater ecology and botanical assessments.	Iggdrasil Scientific Services, South Africa

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

An overview of the national environmental and social policies and legislation applicable to the project are provided in this chapter. Included are the relevant international treaties, conventions and good practice standards, such as the IFC Performance Standards.

2.1 POLICY FRAMEWORK

2.1.1 National Environmental Policy, 2003

The policy provides a systematic and logical framework by which to address environmental issues. Section 4.7 of the policy calls for an ESIA on all major developmental, socioeconomic and land use activities in any form that may have adverse effects/impacts on the environment to one degree or another.

2.1.2 National Energy Efficiency Action Plan of Liberia, 2004

The National Energy Efficiency Action Plan (NEEAP) sets out a number of policy measures for electricity and renewable energy. The main objectives of the NEEAP are:

- To implement efficiency measures that free-up 1,054 MW of power generation capacity by 2030. At an average of 53 MW per year.
- Phase out inefficient incandescent lamps by 2018.
- Reduce average losses in electricity distribution from the current levels of 28-40% to the world level of 10% by 2024.

The NEEAP also aim to implement the Sustainable Energy for all Initiative in order to guide and support efforts to achieve universal access to modern energy, rapidly increase energy efficiency, and expand the use of renewable energies.

2.1.3 National Energy Policy, 2007

In February 2007, the Government of Liberia, through the Ministry of Lands, Mines and Energy, with the support of the United States Agency for International Development (USAID), published the National Energy Policy (NEP).

The principal objective of the NEP is to ensure universal access to modern energy services in an affordable, sustainable and environmentally-friendly manner in order to foster the economic, political, and social development of Liberia. The NEP recognizes the fact that energy is essential towards the Poverty Reduction Strategy[1] and the achievement of the Millennium Development Goals[2].

The NEP assumes the implementation of proposed energy sector reforms founded on three essential features:

- Demonstrating the government's resolve for good governance and ensuring financial transparency in all sector transactions;
- Overcoming the significant obstacles to private sector investment in energy supply; and
- Creating the requisite institutional and legal framework and an independent regulatory regime.

In undertaking energy sector reform, the Government will also be addressing a key component of Liberia's commitment to the World Bank and other donors for debt relief under the program for Highly Indebted Poor Countries.

2.1.4 National Biodiversity Strategy and Action Plan, 2004

The National Biodiversity Strategy and Action Plan (NBSAP) aims to implement the United Nations (UN) Convention on Biological Diversity, of which Liberia is a member, on the national level.

2.1.5 National Forestry Policy and National Forest Management Strategy, 2007

The National Forestry Policy describes the main directions for the future of forestry development in Liberia, and updates earlier policies so they consider the new Forestry Reform Law[3].

---

[1] International Monetary Fund Poverty Reduction Strategy: Republic of Liberia, 2008

[2] World Health Organization Millennium Development Goals

[3] Act Adopting the National Forestry Reform Law of 2006

The National Forest Management Strategy summarizes the Forestry Development Authority's approach to managing the national forest endowment. It includes objectives, goals, and management actions in pursuit of the overall aim to "conserve and sustainably manage all forest areas so that they will continue to produce a complete range of goods and services for the benefit of all Liberians and contribute to poverty alleviation in the nation".

2.1.6 Land Rights Policy, 2013

The policy aims at addressing historic inequalities based on the principal that "practice has become the law and policy, rather than the law and policy guiding the practice". It defines Public Land, Government Land, Customary Land, and Private Land, as well as Protected Areas that will be conserved for the benefit of all Liberians.

For Public Land and Government Land, the Policy sets forth critical policy recommendations on how the Government transfers such land, and how the Government acquires land, especially through the exercise of eminent domain (i.e. forced acquisition).

With respect to the new category of Customary Land, there are several significant recommendations, including equal protection of Customary Land and Private Land, and that communities will self-define, be issued a deed, establish a legal entity, and strengthen their governance arrangements to make them fully representative and accountable. The Government of Liberia also undertakes to support communities in implementing these recommendations.

The policy recommendations are designed to ensure the Government of Liberia exercises eminent domain consistent with international best practices and in a manner that balances the Government's constitutional powers with the fundamental constitutional right of Private Land and Customary Land.

2.1.7 National Environmental and Occupational Health Policy

The National Environmental and Occupational Health Policy (NEOHP) was developed in 2007 to provide a framework for identifying policy needs and actions to improve occupational health and safety. It supplements the National Health Policy, which focuses on public health and health systems. The NEOHP identified the following key Environmental and occupational health needs:

- Environmental sanitation;
- Food Safety Services;
- Water Quality and Safety;
- Vector Control & Chemical Safety;
- Waste Management;
- Disaster Management;
- Health Promotion;
- Occupational Health Services;
- Port Health; and
- Pollution Control.

2.2 LEGAL FRAMEWORK

The section below provides an overview of the primary national law that applies, with a summary of applicability to the project provided in Table 1.

Table 1: The national legal framework and its applicability to the project

Law title	Applicability to the Project
Constitution of the Republic of Liberia, 1986	General protection of the environment and public participation relating to the project.

Law title	Applicability to the Project
Environmental Protection Agency Act, 2002	Establishment of the Environmental Protection Agency responsible for issuing an environmental impact assessment license for the project.
Act Adopting the Environmental Protection and Management Law of the Republic of Liberia, 2003	The project requires an application for an environmental impact assessment license. In terms of Annex I this project will primarily fall under Category 7: Energy Industry, and would trigger two activities under this category: • Production and distribution of electricity; and • Solar The act also provides requirements relating to periodic environmental audits, effluent, waste, pollution, protection of fauna and flora, water use and protection, biodiversity, etc. that will need to be adhered to by the project.
Liberia Land Commission Act, 2009	Establishes a framework for land rights reform. Land rights for the solar PV plant and transmission line route needs to be secured.
National Forestry Law, 2000	Makes provision for the management and conservation of forest resources. The project is to ensure avoidance of significant impacts on forest resources and wildlife.
National Wildlife Conservation and Protected Areas Management Act, 2014	Establishes requirements relating to biodiversity and protected areas. The project is to ensure avoidance of significant impacts on biodiversity and protected areas.
Decent Work Act, 2015	Establishes a regulatory framework for human rights, labour and occupational health and safety. The project will be required to adhere to these requirements during the construction and operational phases.

2.2.1 Constitution of Liberia

Article 7 of the Constitution of the Republic of Liberia, 1986 sets the fundamental basis for the constitutional, legislative, and institutional frameworks for the protection and management of the environment. It also encourages public participation in the protection and management of the environment and the natural resources in Liberia.

2.2.2 The Environmental Protection Agency Act

This Environmental Protection Agency Act, 2002 provides for the creation of the Environment Protection Agency (EPA). The establishment of the EPA marked a significant step forward in the protection and management of the environment of Liberia.

Section 5 of the Act designates the EPA as the principal Liberian authority for environmental management which shall co-ordinate, monitor, supervise, and consult with relevant stakeholders on all the activities for environmental protection and the sustainable use of natural resources. The EPA is mandated to carry out the following aspects of environmental protection and management in Liberia:

- Establish environmental criteria, guidelines, specifications, and standards for production processes and the sustainable use of natural resources for the health and welfare of the present generation, in order to prevent environmental degradation for the welfare of the future generations;
- Identify projects, activities, and programs for which environmental impact assessment must be conducted under this Law;
- Review and approve environmental impact statements and environmental impact assessments;
- Monitor and assess projects, programs, and policies including activities being carried out by relevant ministries and bodies to ensure that the environment is not degraded by such activities and that environmental management objectives are adhered to and adequate early warning and monitoring on impending environmental emergencies is given;
- Review sectoral environmental laws and regulations and recommend for amendments and to initiate proposals or the enactment of environmental legislations in accordance with this Act or any other Act;
- Encourage the use of appropriate environmentally sound technologies and renewable sources of energy and natural resources; and
- Function as the national clearinghouse for all activities relating to regional and international environment-related conventions, treaties and agreements, and as national liaison with the secretariat for all such regional and international instruments.

2.2.3 Act Adopting the Environmental Protection and Management Law of the Republic of Liberia

This Act adopts the Environmental Protection and Management Law, 2003 (EPML) which enables the EPA to protect the environment through the implementation of the Law. It arranges the rules, regulations, and procedures for the conduct of EIAs and establishes regulations for environmental quality standards, pollution control and licensing.

Section 6 of EPML requires an application for an environmental impact assessment license for the commencement of the projects and activities specified in Annex I of the Act and sets out the process to be followed for Project Briefs, Scoping process and Environmental Impact Statements.

In terms of Annex I of the Environmental Protection and Management Law of the Republic of Liberia (2003) this project will primarily fall under Category 7: Energy Industry, and would trigger two activities under this category:

- Production and distribution of electricity; and
- Solar.

The EPML requires that the EPA should ensure that projects comply with their environmental management plans through monitoring and allows the EPA to carry out periodic audits.

Section 58 of the EPML requires that a license must be obtained from the EPA for any type of effluent discharge into the sewage system, also in case of operation of a sewage system.

The Act also deals with aspects such as general duty of care, water resources protection, waste management and air emissions.

The EIA process in Liberia is presented in Figure 3. The main steps in the process are:

- Prepare an Application for the Environmental Impact License
- Prepare Notice of Intent (NOI)
- Submit Project Brief (allow 14 working days for EPA review and feedback)
- Conduct a scoping process
- Publish NOI in Media
- Prepare Terms of Reference (TOR)
- Conduct Meetings with EPA Environmental Committee and District Environmental Committees, as required

- Conduct stakeholder engagement including public meetings with potentially affected communities; and
- Submit Scoping Report to EPA
- Prepare Environmental Review
- Obtain EPA Approval of TOR and Environmental Review
- Prepare Environmental Impact Study and Report (included in ESIA)
- Prepare Environmental Impact Statement (EIS) (included in ESIA)
- Develop Comprehensive Environmental Mitigation Plan and Implementation Strategy (included in ESIA)
- Agency Review of ESIA (within 3 months)
- Public Consultation on ESIA (within first 30 days of 3 months)
- Public Hearings (EPA to decide whether to hold these)
- Liberia Line Ministries Comment on ESIA
- Review by EPA Environmental Assessment Committee
- Approval or Rejection by EPA (within 3 months of receiving ESIA).

After the submission of an application for an environmental impact assessment license, the project proponent is to publish a notice of intent that states the information that may be necessary to allow the stakeholders or any interested party to identify their interest in the proposed project or activity. This information must include the nature of the project, its related activities, its timeframe and its site of operation and the area that may be impacted.

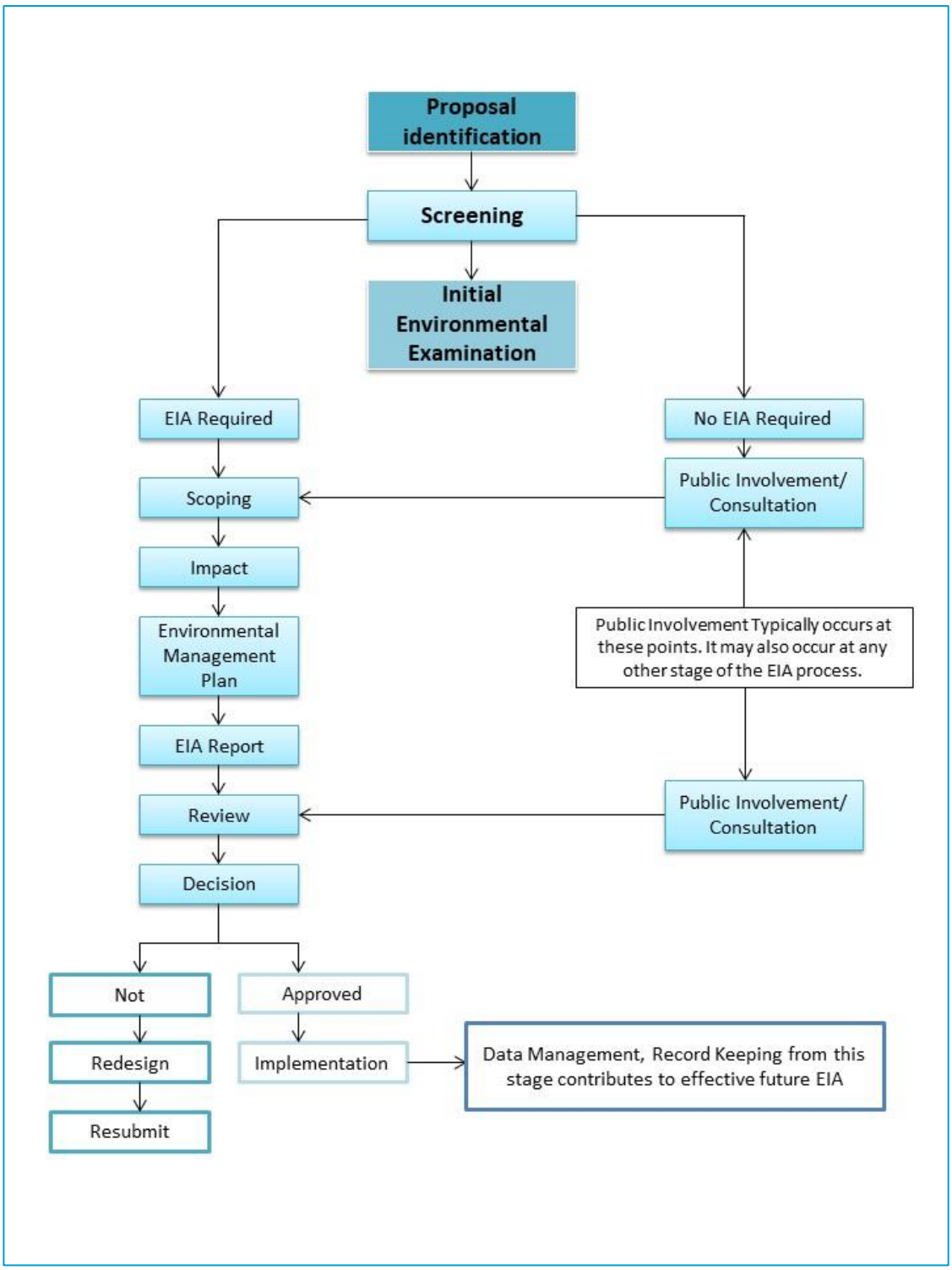
Before preparing the ESIA, the project proponent is required to conduct public consultations with the potentially affected stakeholders. This procedure is called the scoping process which aims to inform the stakeholders about the project's details, its potential impacts on the physical, biological and socio-economic environments, and the mitigation measures that can be taken in order to minimize these impacts. It also aims to get the stakeholders' input on the various related issues. The scoping process is also a guiding process and assists in identifying the impacts, mitigation measures and alternatives.

The scoping process consists of publishing the project's details in the affected district's media, holding public meetings to consult directly with the affected communities and stakeholders, and incorporating the views of these stakeholders in the scoping report which is submitted to the EPA.

On the completion of the ESIA report, the public is invited again to participate in the ESIA review through public consultation meetings. The public's views on the ESIA are taken into consideration by the EPA when deciding on approving or rejecting the project.

In some cases, the EPA may decide to hold a public hearing about the project in order to strengthen the public participation, if this was lacking.

Figure 3: EIA process in Liberia



2.2.4 Liberia Land Commission Act

The objective of the Liberia Land Commission Act, 2009 is to propose, advocate and coordinate reforms of land policy, laws and programs in Liberia. It does not have adjuratory or implementation role. The goal of the commission is "to develop comprehensive national land tenure and land use system that will provide equitable access to land and security of tenure so as to facilitate inclusive sustained growth and development, ensure peace and security and provide sustainable management of the environment".

2.2.5 National Forestry Law and the National New Forestry Reform Law

The National Forestry Law, 2000 makes provision for the management and conservation of forest resources of Liberia, defines ownership rights and other rights in forests, provides for the protection of the environment and wildlife in forests, regulates the trade in forest products and provides for various other matters relative to forestry and wildlife

This National New Forestry Reform Law, 2006 amends the National Forestry Law, 2000 and allows for the creation of the Forestry Development Authority (FDA). The administration of this Act provides for the FDA to exercise power under the law to ensure sustainable management of the Republic's forestland, conservation of the forest resources, and protection of the environment. It also has provisions for sustainable economic development with the participation of and for the benefit of all Liberians to contribute to poverty alleviation in the country.

2.2.6 National Wildlife Conservation and Protected Areas Management Act

The National Wildlife Conservation and Protected Areas Management Act, 2014 updates the 1988 law on wildlife and national parks. It includes a number of important provisions relating to biodiversity and protected areas.

2.2.7 The Decent Work Act

The purpose of the Decent Work Act, 2015 is to

- Promote the attainment of decent work in Liberia, by establishing a regulatory environment;
- Ensure respect for, and the protection and fulfilment of fundamental rights at work;
- Give effect to obligations incurred by Liberia as a member state of the International Labour Organization;
- Establish transparent and accountable institutions and procedures of labour market governance;
- Contribute to the enhancement of the human capabilities of all who work in Liberia; and
- Promote economic development and growth.

Part IV of the Act deals with Occupational Safety and Heath, while the rest of the Act deals with employment and labour requirements.

2.3 INSTITUTIONAL FRAMEWORK

The Environmental Protection Agency (EPA) is the regulatory Institution of the Government of Liberia for the sustainable management of the environment and its natural resources.

Government ministries, departments and local authorities work on behalf of the public to ensure that ecological, cultural, social and economic issues are addressed in line with existing government policy and legislation. Their main responsibility is to ensure that the proposed project meets all the sectoral requirements for which the agency is mandated.

Institutions with a supervisory and monitoring role relevant to the Project are described in Table 2.

Table 2: Institutions with a supervisory and monitoring role relevant to the Project

Institution	Responsibility
Environmental Protection Agency (EPA)	The Liberia Environmental Protection Agency (EPA) is an autonomous statutory body, established under the Act creating the Environmental Protection Agency of the Republic of Liberia 2003 (GOL, 2003a), and hereafter referred to as the EPA Act, to address the country's environmental issues. The EPA became a fully functioning entity in 2006, with the appointment of a board of directors and establishment of a Policy Council.

Institution	Responsibility
	The EPA was established to: 'coordinate, monitor, supervise and consult with relevant stakeholders on all activities in the protection of the environment and sustainable use of natural resources.' As the lead national environmental agency it is charged with executive authority for all environmental activities and programs relating to environmental management in Liberia. The EPA also has a key responsibility for matters relating to the issuing of environmental impact assessment licenses and for compliance monitoring relating to environmental regulations and standards. The EPA is also responsible for issuing permits/license relating to water, effluent, waste and activities likely to pollute the environment in excess of any standards or guidelines issued under the EPML. The EPA also issues Environmental Restoration Orders requiring remediation (or prevention) of environmental harm.
County and District Environmental Committees	To decentralize environmental management, the Environmental Protection Agency Act authorizes the establishment of County and District Environmental Committees and directs the National Environmental Policy Council to provide guidelines for their establishment. Each County Committee is composed of county and district officials, traditional leaders, private citizens, and two local representatives to the national legislature. The Committee is staffed by a County Environment Officer, hired by the EPA, but responsible to the County Committee. The District Environment Committees are to be established by and report to the relevant County Environment Committee. They are charged with promoting environmental awareness and mobilizing the public to manage and monitor activities within the district to ensure that they do not have any significant impact on the environment. The District Committees are composed of district officials, mayors, chiefs, and private citizens and are staffed by a District Environment Officer hired by the EPA. In addition to assisting the County and District Committees in the fulfilment of their responsibilities, the County and District Environment Officers are responsible for compiling reports to the EPA, promoting environmental awareness, and conducting public hearings on environmental impact assessment in the County and the District. The EPA has established outstation offices in eight counties. The offices are staffed by Environmental Inspectors. Once the County Environment Committees are established, some of the Inspectors may be reassigned as County Environment Officers.
Ministry of Land, Mines and Energy	The Ministry of Lands, Mines and Energy has the statutory responsibility for the development of mineral, water and energy resources in Liberia. It oversees land surveys in all parts of the country and coordinates, administers and regulates the use of public and private lands in Liberia, including mineral resources through granting of operation licenses as well as regulating beach sand mining. It also works in combination with the Ministry of Agriculture and the University of Liberia to conduct training and research on land rehabilitation. Energy provision is administered through the same Ministry by the National Energy Committee, while water resources are the responsibility of the National Hydrological Service.
Ministry of Agriculture	The Ministry of Agriculture regulates forestry (as related to plant quarantine, agro-forestry and food crop related plantations), fishery and agriculture sectors and has specific responsibilities for soil conservation. It plans, executes, administers, manages and supervises agriculture programs and provides extension services, trains local farmers in improved cultural practices, and supplies farm inputs to enhance food security.
Forestry Development Authority	The Forestry Development Authority (FDA), established in 1976, was historically the government agency with primary responsibility for environmental management in Liberia. Now an autonomous body, and mandated by the National Forestry Reform Law of 2006, the FDA has responsibility for the protection, management and conservation of government-owned forests and wildlife on a sustainable basis. It manages commercial, conservation and community usage of Liberia's forests. It provides long- and middle- range planning in the forestry sector as well as preparing forestry policy, law and administration. It exercises control of the commercial use of state-owned forests through the granting of concessions, supervises adherence to forest legislation and concession agreements, calculates and determines

Institution	Responsibility
	forestry fees, evaluates investment proposals, executes reforestation and forest research and training and monitors activities of timber companies. The 2006 law revised the institutional framework of the FDA and created a Department of Conservation which is made up of the Division of National Parks and the Division of Wildlife with the responsibility for development and management of protected areas and wildlife respectively.
Ministry of Planning and Economic Affairs	The Ministry of Planning and Economic Affairs (MPEA) is responsible for intersectoral coordination for the development of policies, plans and programs for the economic, financial, social, cultural and physical development of Liberia. In fulfilling its various duties, it serves as the direct link between implementing Ministries/Agencies, NGOs, private voluntary organizations, and the international community. Coordination occurs at the national, sectoral and regional planning levels and also involves the implementation of crosscutting initiatives
Rural and Renewable Energy Agency	The Rural and Renewable Energy Agency (RREA) was established in January 2010 to facilitate and accelerate the economic transformation of rural Liberia by promoting the commercial development and supply of modern energy products and services to rural areas through the private sector and community initiatives with an emphasis, but not necessarily exclusive reliance, on locally available renewable resources
Liberia Electricity Corporation	The Liberia Electricity Corporation was created in 1973 to generate, transmit, distribute, and sell electricity throughout the country at economically reasonable rates.
Other Relevant Governmental Institutions	Other governmental institutions with environment-related responsibilities include the Ministry of Education, Ministry of Public Works, Ministry of Health and Social Welfare, Ministry of Foreign Affairs, and the Liberia Water and Sewer Corporation.

2.4 INTERNATIONAL AGREEMENTS AND CONVENTIONS

Liberia is a party to several international and regional conventions related to the environment and natural resources management which influence the country's policies and legislation.

The environmental treaties and conventions most relevant to the project are set out in Table 3.

Table 3: International treaties and conventions of relevance to the Project

Name of Convention (Date of ratification)	**Description**	**Aspects related to the Project**
Ramsar Convention on Wetlands of International Importance (ratified 2003)	The Convention is relevant to management of wetland systems so that the human uses of these areas are undertaken in such a way as to retain their natural capital for future generations. To encourage and support countries to develop and implement national policy and legislative frameworks, education and awareness raising programs, as well as inventory, research and training projects.	The project will aim to mitigate impacts on wetland systems and will implement the necessary procedures to protect wetland systems.
Convention on Biological Diversity (ratified 2000)	The Convention is relevant in that land clearing activities have potential to cause loss of habitat and associated biodiversity and habitat disturbance. In addition, the IFC Performance Standard 6 (Biodiversity Conservation and Sustainable Natural Resource Management) reflects the objectives of the Convention to conserve biological diversity and	The project will be executed sustainably in such a way as to conserve natural aquatic, woodland and wildlife habitat as far as possible and minimize disturbance to the site ecosystem.

Name of Convention (Date of ratification)	Description	Aspects related to the Project
	promote use of renewable natural resources in a sustainable manner.	
United Nations Framework Convention on Climate Change (ratified 2002)	The Convention is relevant as the clearing of land for the Project has the potential to contribute to climate change since loss of vegetation deprives the earth of the carbon sink which help mitigate global warming.	The Project will ensure a conservative approach to vegetation clearing so as to limit loss of vegetation.
African Convention on the Conservation of Nature and Natural Resources (ratified 1978)	This convention aims at enhancing environmental protection, to foster the convention and sustainable use of natural resources and to harmonies and coordinate policies in these fields.	This convention is relevant to the planning, construction and operation phases of the proposed development.
UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage (ratified 2002)	This convention provides for protection of intangible cultural heritage.	The project will implement the necessary procedures to protect cultural and natural heritage.
Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) (ratified 1981)	This is an international agreement between governments to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	The project with implement the necessary procedures for the protection of the biodiversity in the surrounding area of the Project.
International Covenant on Economic, Social and Cultural Rights (ratified 2004)	This commits Liberia to work toward the granting of economic, social, and cultural rights to individuals, including labour rights and rights to health, education, and an adequate standard of living. ICESCR is part of the International Bill of Human Rights, along with the Universal Declaration of Human Rights (UDHR) and the International Covenant on Civil and Political Rights (ICCPR).	The project will implement the necessary procedures to ensure that there is no infringement on economic, social, and cultural rights.
Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (ratified 2007)	This provides a framework to combat all forms of discrimination against women through appropriate legislative, institutional and other measures.	The project will implement measures in line with this protocol to avoid discrimination against women.
African Charter on Human and Peoples' Right (not ratified yet, but signed 1998)	The charter sets standards and establishes the groundwork for the promotion and protection of human rights in Africa.	The project will implement measures in line with this charter to ensure human rights are not infringed.

In addition, Liberia is a signatory to various **International Labour Organisation (ILO) Conventions** which are relevant to working conditions and regulation on site during construction and operation of the Project. These include[4]:

- C029 - Forced Labour Convention, 1930
- C105 - Abolition of Forced Labour Convention, 1957

[4] Source: http://www.ilo.org/dyn/normlex/en/f?p=1000:11200:0::NO:11200:P11200_COUNTRY_ID:102742

- C182 - Worst Forms of Child Labour Convention, 1999
- C111 - Discrimination (Employment and Occupation) Convention, 1958

2.5 EQUATOR PRINCIPLES

The Equator Principles are a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and are primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. Equator Principle Financial Institutions (EPFIs) commit to implementing the Equator Principles in their internal environmental and social policies, procedures and standards for financing projects and will not provide Project Finance or Project-Related Corporate Loans to projects where the client will not, or is unable to, comply with the Equator Principles.

In order to facilitate potential access to funding for project development potential borrowing organisations need to consider the Equator Principles and environmental and social risk management as part of the ESIA process.

There are 10 principles as shown below, and these require that Projects conduct an ESIA process in compliance with the IFC Performance Standards on Environmental and Social Sustainability.

1. Review and categorisation
2. Social and environmental assessment
3. Applicable environmental and social standards
4. Environmental and Social Management System and Equator Principles Action Plan
5. Stakeholder Engagement
6. Grievance mechanism
7. Independent review
8. Covenants
9. Independent monitoring and reporting
10. Reporting and Transparency

2.6 IFC PERFORMANCE STANDARDS ON ENVIRONMENTAL AND SOCIAL SUSTAINABILITY (2012)

The IFC Performance Standards (IFC PS) define a client's roles and responsibilities for managing their projects and the requirements for receiving and retaining the IFC support or the support from institutions that subscribe to the Equator Principles. The IFC applies the PSs to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing of projects in the member countries eligible for financing. There are eight Performance Standards

Table 4: IFC Performance Standards and their applicability to the Project

IFC Performance Standard	Applicability to this project
PS1: Assessment and Management of Environmental and Social Risks and Impacts PS1 establishes the importance of (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.	Yes
PS2: Labour and Working Conditions PS2 asks that companies treat their workers fairly, provide safe and healthy working conditions, avoid the use of child or forced labour, and identify risks in their primary supply chain.	Yes
PS3: Resource Efficiency and Pollution Preventions PS3 guides companies to integrate practices and technologies that promote energy efficiency, use resources—including energy and water—sustainably, and reduce greenhouse gas emissions.	Yes
PS4: Community, Health, Safety and Security	Yes

IFC Performance Standard	Applicability to this project
PS4 helps companies adopt responsible practices to reduce such risks including emergency preparedness and response, security force management, and design safety measures.	
PS5: Land Acquisition and Involuntary Resettlement PS5 advises companies to avoid involuntary resettlement wherever possible and to minimize its impact on those displaced through mitigation measures such as fair compensation and improvements to and living conditions. Active community engagement throughout the process is essential.	Yes
PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources PS6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and managing living natural resources adequately are fundamental to sustainable development.	Yes
PS7: Indigenous Peoples PS7 seeks to ensure that business activities minimize negative impacts, foster respect for human rights, dignity and culture of indigenous populations, and promote development benefits in culturally appropriate ways. Informed consultation and participation with IPs throughout the project process is a core requirement and may include Free, Prior and Informed Consent under certain circumstances.	No
PS8: Cultural Heritage PS8 aims to guide companies in protecting cultural heritage from adverse impacts of project activities and supporting its preservation. It also promotes the equitable sharing of benefits from the use of cultural heritage.	Yes

Based on the ESIA the project has limited adverse environmental or social risks and impacts that are few in number, generally site-specific, largely reversible, and can be readily addressed through mitigation measure. It is therefore considered to be a Category B project in terms of the IFC Environmental and Social Categorization.

3. DESCRIPTION OF THE PROJECT

3.1 LOCATION OF THE PROPOSED PROJECT

Gigawatt Global (GWG) is proposing to develop a 20 megawatt (MW) solar photovoltaic (PV) plant, to be located on the Crawford Farm in the Montserrado County of Liberia, approximately 4 km south east of the Mount Coffee Hydropower Plant (MCHPP) and approximately 25 km north of Monrovia (see Figure 4 below).

GWG signed an amended Memorandum of Understating (MoU) with the Chairman of Liberian Electric Corporation (LEC) in December 2017 and the Power Purchase Agreement is likely to be valid for 25 years. The MoU states that land will be facilitated by the Government of Liberia for GWG to build the project. Since the land has yet to be allocated, GWG has chosen to secure private land, and has signed a private land lease options agreement in January 2019 for 85 acres (~ 34 hectares) of land on the Crawford Farm. The title deed can be found under Appendix A.

The nearest established community is Crozierville, located 2 km south east of the solar PV site. Photos of the project site and surrounds are presented in Appendix B, and an aerial view based on drone footage and some site photos are presented in Figure 5. The project site boundary and some of the surrounding features is presented in Figure 6. The coordinates of the solar PV site boundary are included in Table 5.

Table 5: Coordinates for the solar PV site boundary

Project Site Boundary Points	Coordinates
A	10°38'54.886"W; 6°27'52.818"N
B	10°38'42.551"W; 6°27'41.254"N
C	10°38'34.585"W; 6°27'39.027"N
D	10°38'28.417"W; 6°27'43.738"N
E	10°38'39.981"W; 6°27'19.410"N
F	10°38'45.378"W; 6°27'19.325"N

The project will also involve the construction of a medium voltage (± 66 kV) transmission line from the solar PV plant to the Mount Coffee substation. In this regard two options have been considered. Transmission Line (TL) Route Option 01 follows the Crozierville-White Plains road that runs directly south of the solar PV site for approximately 3km, and then heads north next to the MCHPP-Monrovia road for 4 km to the Mount Coffee Substation. TL Route Option 02 follows the existing CLSG transmission line servitude (that crosses the farm and the northern section of the solar PV site) to the Mount Coffee Substation (see Figure 7). The preferred alternative is TL Route Option 02. The coordinates of TL Route Option 01 are included in Table 6, while the coordinates of TL Route Option 02 are included in Table 7.

Table 6: Coordinates for the TL Route Option 01

TL Route Option 01 Points	Coordinates
K	10°38'48.205"W; 6°27'19.325"N
L	10°38'49.404"W; 6°27'19.068"N
M	10°38'51.46"W; 6°27'18.211"N
N	10°38'57.028"W; 6°27'15.898"N
O	10°39'3.196"W; 6°27'15.384"N
P	10°39'3.196"W; 6°27'15.384"N

TL Route Option 01 Points	Coordinates
Q	10°39'19.985"W; 6°27'19.582"N
R	10°39'25.724"W; 6°27'20.096"N
S	10°39'30.264"W; 6°27'21.466"N
T	10°39'39.173"W; 6°27'30.375"N
U	10°39'46.283"W; 6°27'31.917"N
V	10°39'50.994"W; 6°27'33.03"N
W	10°40'1.188"W; 6°27'41.768"N
X	10°40'6.156"W; 6°27'51.019"N
Y	10°39'58.618"W; 6°28'5.581"N
Z	10°39'45.341"W; 6°28'22.799"N
AA	10°39'30.607"W; 6°28'40.274"N
BB	10°39'27.951"W; 6°28'51.41"N
CC	10°39'26.838"W; 6°29'12.482"N
DD	10°39'22.212"W; 6°29'18.307"N
EE	10°39'9.363"W; 6°29'24.047"N
FF	10°39'8.506"W; 6°29'31.927"N
GG	10°39'7.479"W; 6°29'35.525"N
HH	10°39'10.991"W; 6°29'38.095"N

Table 7: Coordinates for the TL Route Option 02

TL Route Option 012Points	Coordinates
P1	10°38'55.093"W 6°27'51.455"N
P2	10°38'59.452"W 6°27'55.64"N
P3	10°39'4.683"W 6°27'59.824"N
P4	10°39'9.565"W 6°28'5.055"N
P5	10°39'12.354"W 6°28'7.496"N
P6	10°39'18.283"W 6°28'12.727"N
P7	10°39'18.283"W 6°28'18.829"N
P8	10°39'18.631"W 6°28'25.455"N
P9	10°39'19.503"W 6°28'32.604"N
P10	10°39'19.503"W 6°28'37.311"N
P11	10°39'19.154"W 6°28'42.193"N
P12	10°39'18.631"W 6°28'45.68"N
P13	10°39'17.585"W 6°28'50.388"N
P14	10°39'16.365"W 6°28'57.014"N
P15	10°39'14.621"W 6°29'3.465"N

TL Route Option 012Points	Coordinates
P16	10°39'12.529"W 6°29'10.09"N
P17	10°39'13.401"W 6°29'18.808"N
P18	10°39'16.365"W 6°29'24.737"N
P19	10°39'14.795"W 6°29'28.224"N
P20	10°39'11.831"W 6°29'34.849"N
P21	10°39'10.611"W 6°29'38.336"N

Figure 4: Solar PV project site location

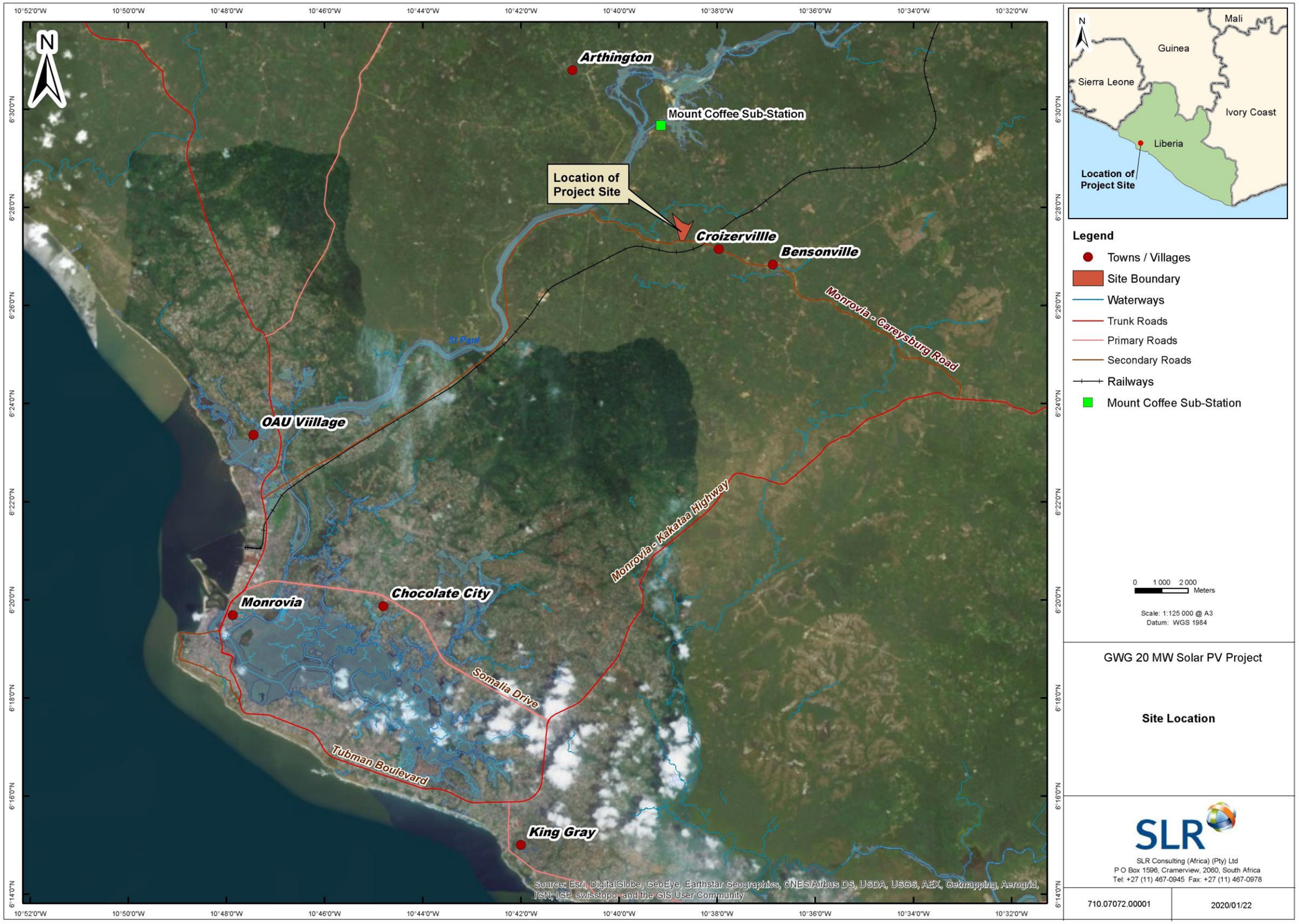


Figure 5: Aerial view (drone footage dated March 2019) and some photos (dated February 2020) of the solar PV site

Figure 6: Solar PV Project Boundary and some of the surrounding features

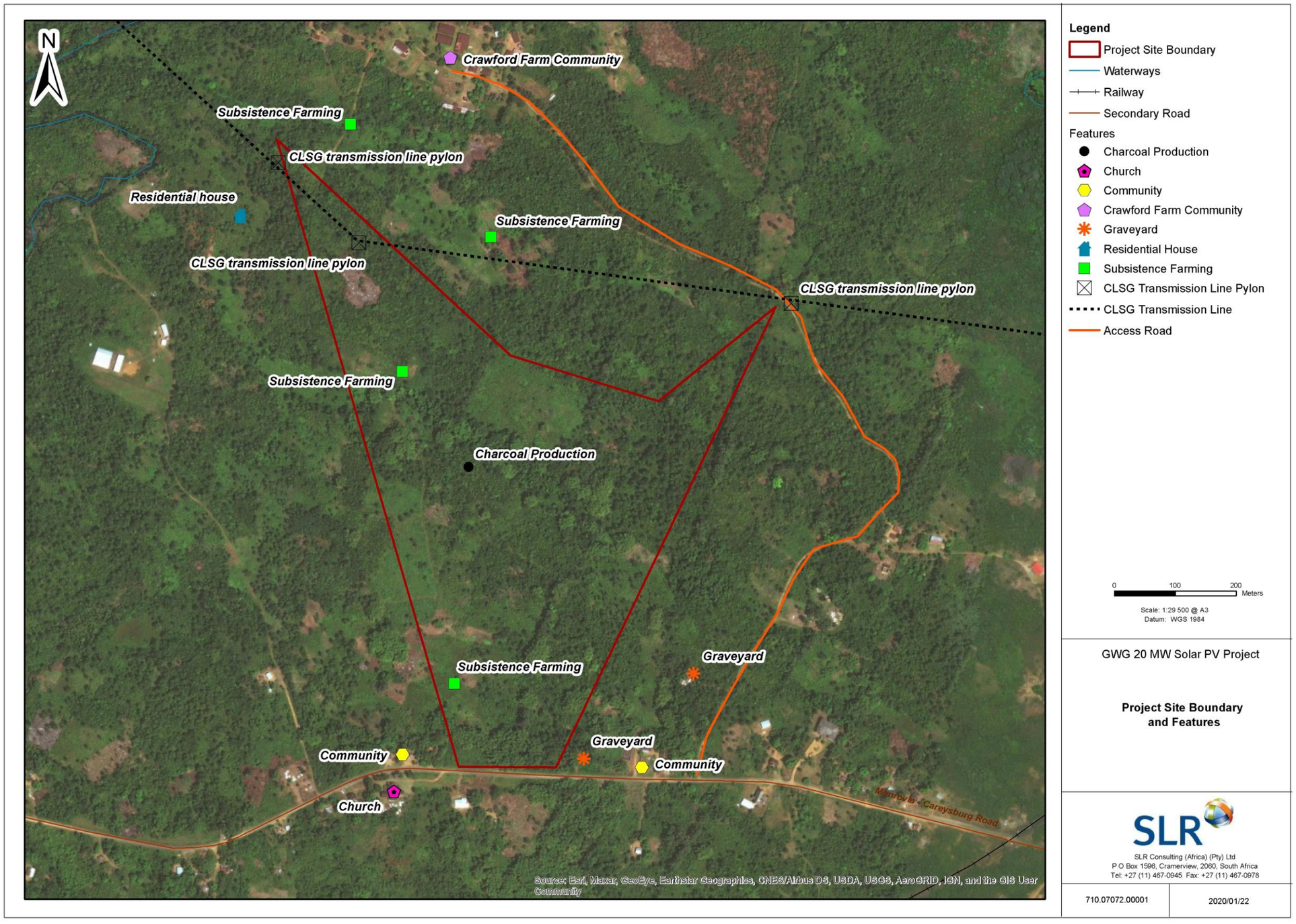
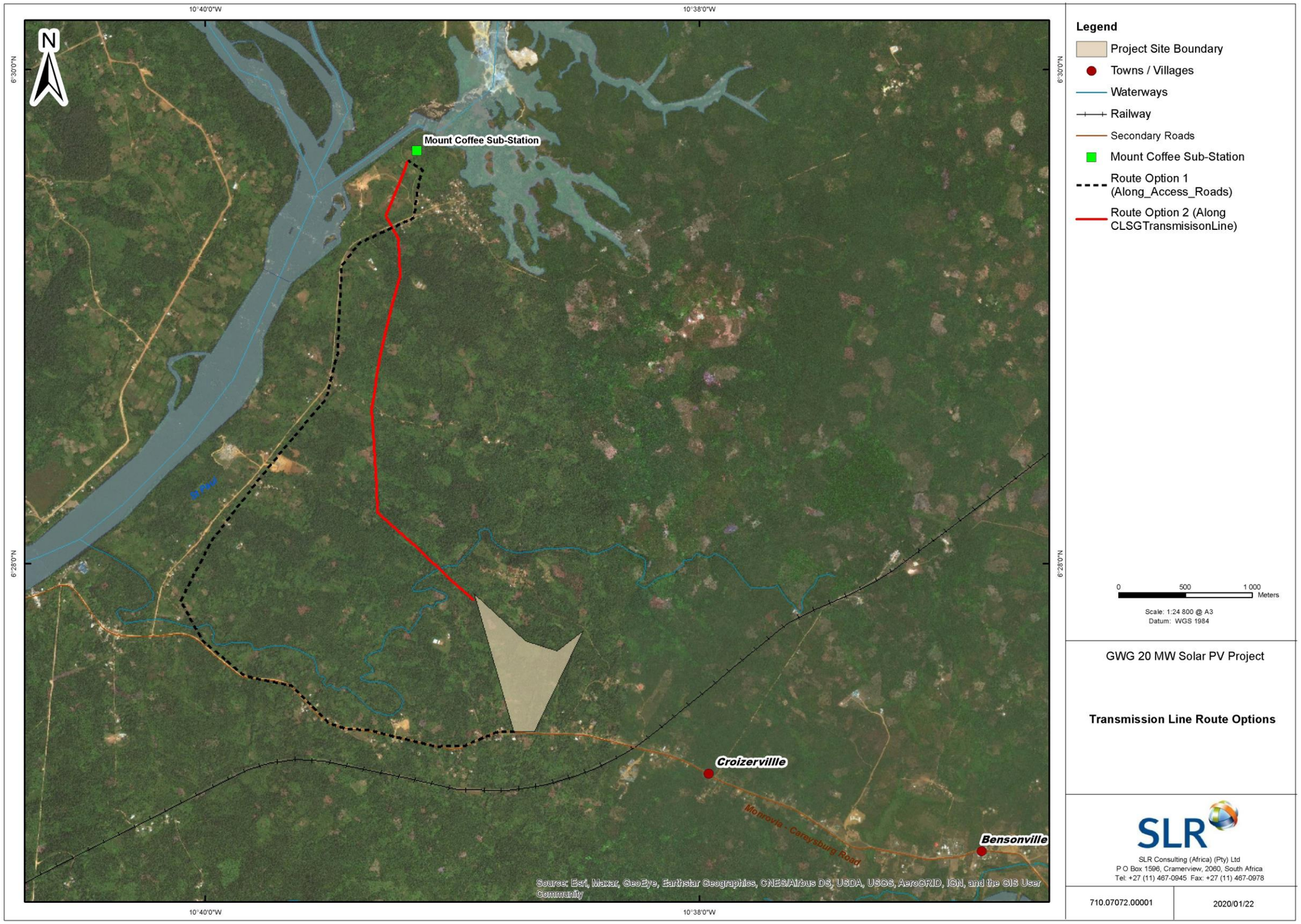


Figure 7: Transmission line route options

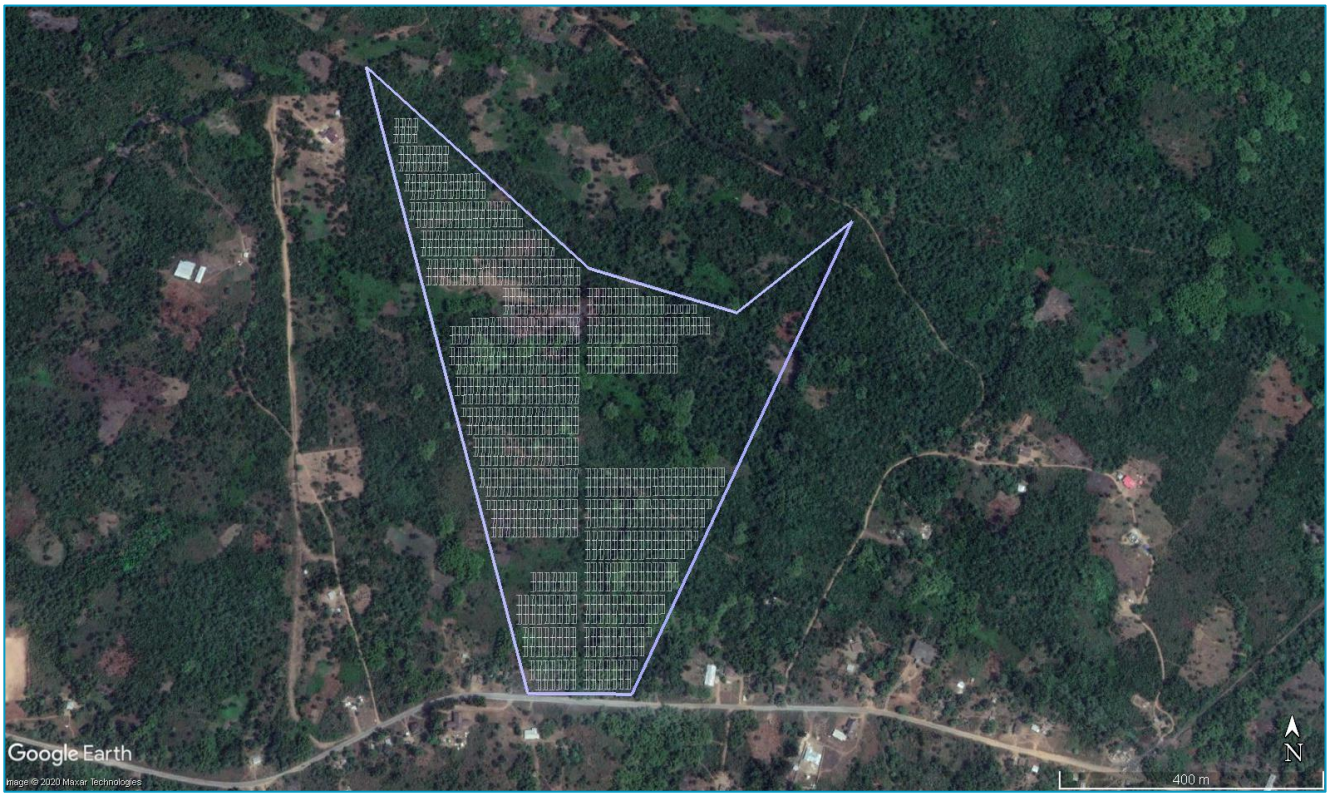


3.2 PROJECT LAYOUT

GWG is considering a fixed tilt system as the most appropriate PV system for the project. The layout of the solar PV plant within the project site boundary is shown in Figure 8.

The conceptual technical specifications are summarised Table 8 and the conceptual layout design summary is presented in Table 9.

Figure 8: Solar PV plant layout



An example of a solar PV plant layout for a plant built by Gigawatt Global in Rwanda is shown in Figure 9. A typical solar PV plant design is present in Figure 10.

Figure 9: Typical layout of a solar PV plant

3.3 PROJECT DESIGN AND COMPONENTS

In general, solar energy systems produce energy by converting photons “solar radiation” into electrons which then flow as electricity or heat. The proposed project will use photovoltaic (PV) solar technology to generate electricity. Solar PV technology usually consists of the following main components:

PV cell: The PV cell is the device that generates electricity when exposed to solar radiation. The absorbed solar energy excites the electrons inside the PV cell and produces electrical energy. All PV cells produce Direct Current (DC). There are three main types of solar cells:

- Monocrystalline – made from a single silicon crystal;
- Polycrystalline — made from multiple silicon crystals; and
- Thin film — common material used for thin film modules are Cadmium Telluride (CdTe), Copper Indium Gallium Selenide (CIGS), Copper Indium Selenide (CIS) and Amorphous Silicon (a-Si).

It is understood that it is proposed to make use of Thin Film (CdTe) type PV cells on fixed axis for this project.

PV module: The PV module is the set of interconnected PV cells encapsulated between a transparent front (usually glass) and a backing support material of either laminate or glass then mounted in an aluminium frame, or frameless with durable tempered glass. The modules will appear dark blue or black and will be mounted in an aluminium frame or laminated between durable glass sheets. The modules are designed to absorb the solar radiation and hence are not susceptible to reflection or glinting. Newer modules can also absorb irradiation reflected off the ground via the back of the panel if the back of the panel is glass. This type of module technology is referred to as bi-facial modules which are produced by a number of panel suppliers and can be produced in either monocrystalline or polycrystalline form.

Mounting structures: Multiple PV modules are bolted onto mounting structures. The mounting structures are either steel or aluminium sections extending between 1 and 3 m into the ground depending upon the ground conditions. Approximately 20 to 40 modules are usually fitted per frame. The structure supporting the panels can be between 50 cm and 3 m off the ground.

PV array: The PV array is the complete power generating plant consisting of multiple PV modules wired in series and in parallel. The PV modules are connected by Direct Current (DC) cables to combiner boxes mounted underneath the PV module mounting structures. The power generated by many PV module strings is combined in the combiner box and transmitted via DC cables to an inverter and transformer enclosure.

Inverters: The inverter converts the Direct Current (DC) to Alternating Current (AC) before being directed to the transformers. There could be between 20 and 150 inverter stations on site varying in size depending on the technology used.

Transformer: The transformers transform the low voltage AC from the inverter to medium voltage before being directed into the electric supply grid to match the grid voltage.

Delivery substation and switching station: The delivery station (or substation) receives all power from the inverters via underground cables and provides protection and control equipment required to safely manage the plant and to ensure grid code compliance regulations. The delivery station will consist of at least one small building, outdoor electrical plant/equipment and the transformers. It is prosed to construct a 66kV PV delivery substation and 66 kV switching station on the project site.

Warehouse, offices and control building**:** A small building containing space for spares, office seating, welfare facilities and computer control equipment may be required, and is typically located near the delivery station.

Access tracks and fencing: The project will most likely include stone or gravel tracks throughout the site and between panel rows to permit access for maintenance vehicles and personnel. Vegetation (such as grass) may be permitted to grow throughout the site but will be kept low or will be trimmed off on a regular basis if the plant relies on the reflected irradiance to be collected from the underside in the event bi-facial modules are utilised. A security fence and security cameras will surround the site. The existing access roads via a district road is expected to be used as the primary access to the site. This access road may need to be upgraded/maintained/resurfaced/graded to permit heavy goods vehicles to pass safely. In addition, a shoulder may need to be maintained as a footpath to allow safe passage without the need for people to walk on the road.

Transmission lines: Power will be evacuated from the solar PV site via a medium voltage (± 66 kV) overhead transmission line from the site to the Mount Coffee substation. An easement permit from LEC will be required. The intention is for GWG to construct the transmission line and then to hand over ownership, and therefore operations and maintenance, to the LEC.

Transmission line pylons: If the transmission line is not linked to the existing CLSG transmission line then monopole towers are preferred to lattice towers because they have a smaller footprint. For the connection starting and terminal/end towers, terminal steel 3-pole structures are proposed to be used at PV on-site switching station and MCHPP substation respectively. For the intermediate structures (where the line is relatively straight), single monopole pylon steel structures are proposed to be used. For the strain structures (where the line deviates from 0° with a large angle), guyed monopole steel structures are proposed to be used. The height of the pylons would typically be been 10 – 12 metres high, with minimum line clearance from the ground of 5.5 metres. Construction of the above proposed tower structures will require an estimated 8 m^2 of temporary construction work area at each tower location. The permanent footprint of each tower will be approximately 6 m^2 each tower location (for the connection towers and deviation towers only).

Figure 10: A typical solar PV plant

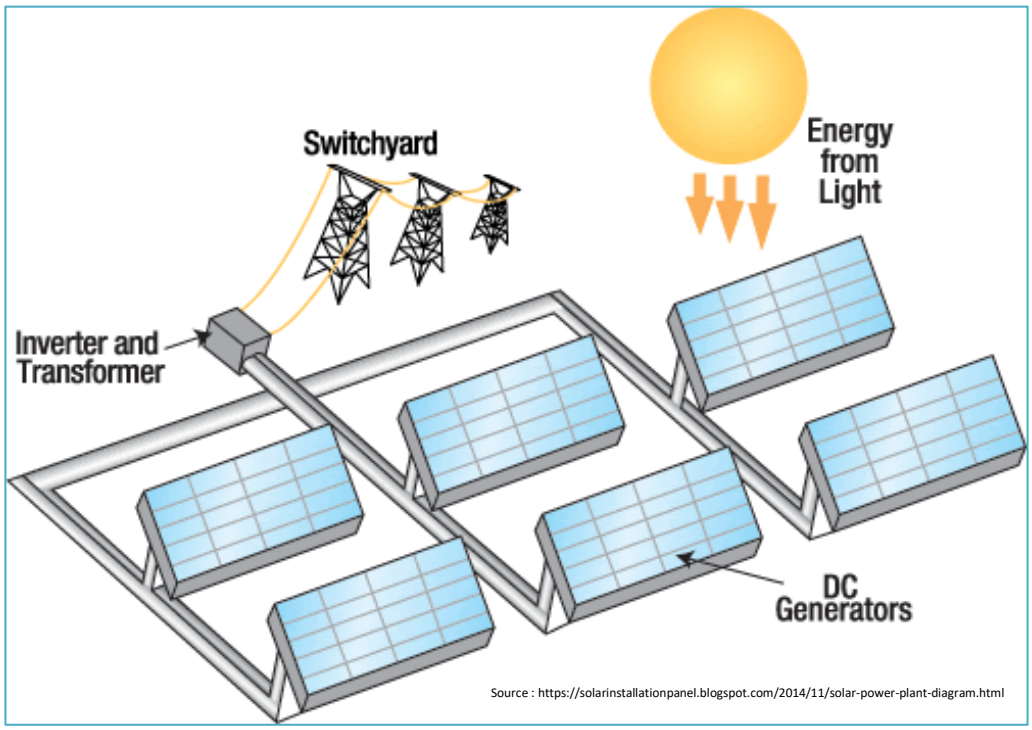


Table 8: Plant Design Technical Specifications

Parameter	Value
Plant Equipment	
PV Module type	First Solar 445Wp FS-6445
Inverters	190 kVA Huawei SUN2000-105TL-H1 String Inverter
Nominal power ratio[17]	1.30
Plant Layout	
Azimuth	-90°, 90° (East/West layout)

Parameter	Value
Tilt angle	15°
Inter-row pitch distance	12.3 m
Module orientation	4 x landscape

Table 9: Conceptual Layout Design Summary

Site	Values
Number of PV modules	58,440
Installed DC Capacity (MWp)	26.005
Installed AC Capacity (MWac)	19.95
Construction Area (ha)	19.9

3.4 AIR AND NOISE EMISSIONS

Air emissions: Temporary air emissions will occur during the construction phase due to the use of construction machinery, the clearing of vegetation and transportation of equipment and materials all of which may result in wind-blown dust. If required, dust suppression will be undertaken using water bowsers to damp down the surface and/or spreading woodchips as mulch. Little to no air emissions from the Project are anticipated during the operational phase allowing vegetation to grow back between the panels; management of on-site vehicle speed, and vegetation and soil landscaping.

Noise emissions: The key temporary noise sources during the construction phase will be from the mobile machinery, vehicles, workers and plant construction activities including high speed ramming using percussion hammers. In order to meet project time frames, construction activities are expected to be required afterhours (during night time) and on weekends. The operation of the solar PV plant is not expected to generate significant noise additional to that generated from the surrounding activities.

3.5 WASTES AND WASTEWATER

Non-hazardous and hazardous wastes: There will be waste generated across the lifecycle of the Project. During **construction**, wastes will comprise of spoil from excavations, general domestic waste including sanitary and food waste, office waste, packaging material (wooden pallets, plastic and cable drums) and concrete. Petrol and diesel will be used during the construction period for vehicles to transport goods and personnel, generators and heavy construction equipment.

During **operation**, waste materials may include waste from maintenance works, broken or cracked PV units, office waste and effluent from the site office and control room. Broken panels will be stored in their used crates in the lay down area and will be returned to the manufacturer.

Hazardous materials used on site during **operations** will include fuels, oils, lubricants, cleaning products, battery materials and specialised gases (for use in switchgear etc.). Minimal waste is expected to be generated during the operations phase. For certain types or transformers or backup generators, oil that needs to be replaced will be recycled, if possible, or safely stored and removed from the site and correctly disposed of.

Water management during the construction phase will be the responsibility of the EPC Contractor and the GWG will have overall oversight to verify that the collection, transport, handling and disposal of these wastes is being

undertaken in a suitable manner. Figure 11 provides examples of on-site waste management that will be implemented during the construction phase based on previous best practice at other project sites. Solar panels broken during construction will stored (on-site or rented locate off-site) and shipped out after construction to a recycling location appropriate for Liberia. Panels that a malfunctioning during operation will also be stored (on-site or rented locate off-site) until the volume is feasible to send abroad or recycled/disposed of locally.

Waste during decommissioning will be similar to that produced during the construction phase; this includes wooden and plastic packaging, cable off cuts, disused solar PV panels, metal frames, and office and domestic waste. All solid wastes generated (hazardous and non- hazardous) will be disposed of through contracting an approved waste handling company for the disposal at appropriately licenced landfill site/s.

Figure 11: Examples of on-site waste

Waste recycling of plastics

Waste recycling of plastics

Covered trucks transporting waste

Bunded fuel storage

Source: Barry Wieser Letsatsi

Wastewater: Wastewater includes any water affected in quality by construction-related activities and human influence and will include sewage, water used for washing purposes (e.g. equipment, staff etc.), drainage over potentially contaminated areas (e.g. concrete batching/ mixing areas and equipment storing areas).

Measures will be implemented to manage all wastewater generated during the construction period. Sewage will be stored on site in mobile or underground sanitary storage facilities which will be emptied by a licensed contractor and disposed of at a licensed facility on a regular basis or will be treated through a septic tank reviver (STR) or conservancy tank with a component of anaerobic digestion. There are some wetland features on the project site which will need to be taken into consideration (e.g. locating sanitary storage facilities, workshops, wash bays, etc. 100 m away from wetland features).

3.6 TRAFFIC

There will be some traffic during the construction phase for the delivery of the solar plant materials, machinery and labour. It is anticipated that the bulk of the equipment will be stored in Monrovia. It is expected that there will be approximately 350 trips by 5 trucks in total over the construction period, averaging approximately 3-4

trucks per day. However, peak trucking will take place around delivery of module equipment and quarry aggregate.

It is anticipated at this stage that access for delivery of construction materials and components will be from the west (from the Freeport of Monrovia along United Nations Drive) with regards to equipment needed at the Mount Coffee Substation and the transmission line. Access to the project site along this route (from the Freeport of Monrovia along United Nations Drive) is not possible as the bridge that was located on the access road approximately 2 km west of the project site has collapsed.

An alternative route is to access the project site from the east, via Bensonville. The MCHPP study indicated that during investigations associated with the construction of the hydropower plant, the bridges on the road from Bensonville were considered to be unsuitable for construction traffic. The equipment expected for this solar PV project will not be as heavy as the equipment for the MCHPP, however the routes and stability of the bridges will be evaluated to verify that the maximum load is not exceeded.

The traffic will diminish post-construction and there will be only a small number of vehicles travelling to and from the site during operations for maintenance purposes. Traffic management measures will be implemented to control construction and operational traffic

3.7 WATER AND ELECTRICITY

Water Requirement: Approximately 250 m^3 will be required during construction for the following uses:

- Drinking;
- Ablution facilities;
- Access track construction;
- Dust control;
- Fire-fighting reserve;
- Cleaning of facilities (floor mopping etc.); and
- Foundations delivery station, facilities and transformer.

During operation water will be required for the following purposes:

- Potable water for drinking;
- Water reserve for firefighting;
- Water for cleaning PV panels;
- Ablution facilities.

It is expected that there will be no more than 6 people on site simultaneously during operation, except when the panels are cleaned semi-annually. Water requirements will be sourced from existing licensed boreholes on the site as part of the lease agreement with the landowner.

The PV panels will be cleaned using dry brush techniques where possible. Water cleaning will be used under certain situations, where only water cleaning will remove the surface contaminants. In the rainy season, water requirements are expected to reduce as regular rains reduce the need for panel cleaning. Dust suppression binding agents may be used on access roads to reduce the frequency of road wetting and thereby minimise water requirements for this purpose. A summary of estimated water requirements is contained in Table 10.

Table 10: Water requirements during operation of the solar PV plant

Type of water use	Volumes required
Drinking water	Approximately 4 litre/person/day potable water will be required for drinking and : 0.5 a litre/person/day for the ablution facilities.
Fire fighting	Approximately 40 m^3 litres will be required to be held in reserve for fire-fighting reserve. This will be done using rainwater ('JoJo') tanks which will be filled once off.
Panel cleaning	Approximately 2 to 5 m^3 of water will be required per MW installed over the site for one full clean of the panels and it expected that the Project will require 2 cleans per annum (if washing is not required during the rainy season). This translates to 80-200 m^3/year

Electricity use: During construction, auxiliary power will be required largely for on-site offices and welfare facilities and would likely be supplied from an on-site power generator.

During operations the project will require power for inverter operation, offices, stores, security systems and welfare facilities. During the period when the project is generating power (i.e. sunlight hours), the project will use self-generated power (solar rooftop). During the night, the project will draw power from a battery storage system or on-site power generator (in emergency events).

3.8 EMPLOYMENT OPPORTUNITIES

The final number of people to be employed is likely to be up to 200 people during peak construction activities, with an estimated 100 unskilled and semi-skilled jobs likely to be available. However, the number of people employed at one time may vary as different contracts and subcontracts are completed on-site. Fewer staff will be required during the operations and maintenance phase, with potential employment numbers being up to 20 people of which approximately 6 people will be on-site simultaneously.

Recruitment will be undertaken in collaboration with local authorities and local agencies and in compliance with Liberian laws. GWG will put in place measures to ensure no employee or job applicant is discriminated against on the basis of his or her race, gender, marital status, nationality, age, religion or sexual orientation.

The EPC contractor will be required to comply with local labour, occupational health and safety laws (e.g. the Decent Works Act, 2015, International Labour Organisation (ILO) Conventions, World Bank EHS Guidelines and any relevant international best practice standards.

3.9 PROJECT PHASES

The project will be carried out in the following phases:

- Development/ planning phase;
- Site preparation;
- Construction phase;
- Operational phase; and
- Decommissioning phase.

These phases are described in more detail below.

3.9.1 Development/planning phase

During the ongoing planning phase GWG will undertake further assessment of the key technical parameters required for the construction and operation of a solar PV power plant and associated transmission line. This will include further investigation of the following:

- Grid code requirements and connections;
- Liberian power requirements and political support;
- Solar resource through installation of a solar measuring device in a cleared area of 20x20 m on the site;
- Geotechnical ground investigations; and
- Topographical investigations.

These investigations will confirm the requirements, time schedules and expectations of all the relevant stakeholders.

3.9.2 Site preparation phase

Site preparation would be initiated following issuance of an Environmental License and achieving Financial Close (i.e. confirmation of project funding). This phase would include the clearance of vegetation by bulldozer to remove roots, treatment against regrowth, levelling of the site and preliminary earthworks.

Thereafter the site will be marked out, a construction compound set up, safety and security fencing installed around the solar PV plant and associated buildings, and the access road upgraded and site access tracks constructed. Site clearance will be limited to the area required for the final configuration of the solar modules and associated electrical infrastructure, and supporting infrastructure, which is estimated at 25 ha in total.

3.9.3 Construction phase

Construction activities

The construction phase will be initiated following the completion of site preparation activities. The construction phase will include the following activities:

- Excavation of cable trenches;
- Ramming, screwing or drilling of the mounting structure frames;
- Installation of the modules onto the frames;
- Installation of measuring equipment;
- Laying of cables between the string inverters and delivery station;
- Construction of site substation foundations and installation of site substation plant and equipment;
- Construction of office and welfare facilities;
- Testing and commissioning;
- Removal of equipment and demobilisation of construction team; and
- Construction of the 66 kV transmission line.

Where possible; materials, plant and equipment, will be sourced from local suppliers. The bulk of the specialist PV equipment (modules, inverters, protection equipment etc.) will be imported from China, Europe or the USA and will be shipped to the port in Monrovia.

Construction schedule and work hours

The construction phase is estimated to take approximately 8 to 10 months to complete. Construction will be required during day time periods (and possibly during weekends) to meet the project timelines. No construction

work is anticipated to take place during the night time periods. The majority of noise generating works will occur during the first half of the construction period, for the following activities in particular:

- Site clearing via bulldozer and manual labour;
- Deliveries of equipment and materials;
- Predrilling of shallow piles;
- Piling of shallow piles;
- Clearing for roads; and
- Foundation digging for substations and central inverters.

Where possible, the contractor will prioritise to schedule noisy activities as far as possible from nearby homesteads and will inform nearby residents when any noisy night time activities need to take place.

3.9.4 Operational phase

The solar PV power plant will be operated during daylight hours, 7 days a week basis with 24-hour monitoring remotely from an operations centre (service provider location). On site, there will be 24 hours security and potentially after hours maintenance and repairs from time to time during operations.

Operational activities will comprise of the following:

- Regular cleaning of the modules by trained local personnel using a combination of brushes, water and air;
- Vegetation management for under and around the modules to allow maintenance and operation at full capacity;
- Maintenance of all components including modules, mounting structures, inverters, transformer and delivery station plant and equipment;
- Office management and maintenance of the welfare facilities;
- Supervision of the electricity production; and
- Site security monitoring.

3.9.5 Decommissioning phase

The proposed Project is expected to operate for at least 25 years. Once the plant reaches the end of its life, PV modules may continue to operate as their expected life time is 30 years; they may alternatively be refurbished or replaced to continue operations or the facility may be closed and decommissioned. If decommissioned, all components will be removed and the site rehabilitated. Where possible, all materials will be recycled, otherwise they will be disposed of in accordance with local regulations and international best practice in place at that time. Waste management requirements are addressed in the ESMP.

4. PROJECT ALTERNATIVES

4.1 MITIGATION HIERARCHY

Implementing the mitigation hierarchy is crucial when considering alternative sites and alternative infrastructure layouts.

The mitigation hierarchy is defined as:

- **Avoidance**: measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity.
- **Minimisation**: measures taken to reduce the duration, intensity and / or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible.
- **Rehabilitation/restoration**: measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/ or minimised.
- **Offset:** measures taken to compensate for any residual significant adverse impacts that cannot be avoided, minimised and / or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity[5]. Offsets can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, protecting areas where there is imminent or projected loss of biodiversity.

The mitigation hierarchy was applied to the project as summarised in Table 11 below.

Table 11: Project implementation of the mitigation hierarchy

Mitigation hierarchy	Action
Avoidance:	**Solar PV site alternatives:** The initial search for appropriate land parcels for the development of a solar PV plant included environmental and social criteria such as land ownership, land use, protected areas and biodiversity. Sites with high biodiversity, sensitive features, within protected areas and under community land ownership were screened out. The site selected is located on private title land (Crawford farm), previously used for agriculture, and with no Critical Habitat as defined by the IFC Performance Standards. **Transmission Line Route alternatives:** Two transmission line route options were considered. It was decided to follow the existing CLSG transmission line route as it has been cleared (TL Route Option 2) as this avoids the need for further clearance of vegetation and the need for physical resettlement as would have been required for the alternative route (TL Route Option 1).
Minimisation:	**Site layout alternatives:** Once the Crawford farm site was selected as the preferred site, detailed surveys were undertaken to confirm the use of the land for livelihoods by adjacent communities, the presence of cultural heritage sites, and to confirm the status of the habitats on site. The site was found to comprise mostly what can be characterised as Modified Habitat that due to past agricultural activities (rubber plantation, piggery and grazing) and current subsistence land uses (including palm oil production, planting of fruit trees, crop cultivation in wetland areas, fire wood collection and charcoal production). Some of the sensitive features identified on the

[5] In terms of IFC PS6, no net loss is typically required for significant adverse impacts on natural habitat, while net gain is required for impacts on Critical Habitat

Mitigation hierarchy	Action
	site included an area of "Young Bush" in the north-eastern part of the site and three wetland features located within the site boundary These sensitive features were mapped and communicated to GWG for including into the design of the layout of the solar PV plant. The layout was revised to avoid these sensitive features.
Rehabilitation/ restoration:	The solar PV site is ± 32 ha. While the footprint of the solar PV plant – estimated at 25 ha or 78 % of the site - will result in the total clearance of all vegetation, some areas affected by construction activities will be rehabilitated. The avoidance of the "Young Bush" and wetland features in the layout could allow for improvements in biodiversity and ecological condition over time by limiting agriculture and further wood harvesting in these areas.
Offset:	No biodiversity offset is required as the project will not have significant adverse impacts on biodiversity. As indicated above, the study has recommended that the "Young Bush" and wetland features on the solar PV site should be avoided.

4.2 IDENTIFICATION OF ALTERNATIVES

During the planning phase of the Project a number of alternatives were considered. Alternatives considered include the following:

- Site alternatives;
- Technology alternatives;
- Site layout alternatives;
- Transmission line route alternatives; and
- No-Go alternative.

Throughout the assessment of these alternatives the following criteria were used:

- Environmental - including biodiversity, fauna and flora, and habitat;
- Social and community - including land ownership, land use and proximity to communities;
- Financial – including life cycle costs balanced against initial capital expenditure and operational costs; and
- Technical – considering whether the options are viable if they can be efficiently implemented, maintained and operated.

4.3 ANALYSIS OF ALTERNATIVES

4.3.1 Site alternatives

GWG undertook a site selection exercise based on the following criteria: solar irradiance, existence of transmission lines and substations, land availability and ownership, land use, environmentally sensitive features and existing infrastructure. Three possible sites were considered for the development of the project. These included (1) a site near the Monrovia-Roberts International Airport, (2) a site in a commercial zone near Monrovia and (3) the Crawford Farm site near Crozierville. The criteria used are discussed in more detail below:

- **Availability of solar irradiance** based on the Global Horizontal Irradiation (GHI), which is the most commonly used method for estimating the energy production from solar PV projects. In the Global Incoming Radiation map for Liberia, the GHI varies from 1600 kWh/m^2 to 1900 kWh/m^2.
- **Grid connection:** GWG identified corridors for development through identifying feasible connection types to existing network infrastructure. Additionally, maximum distances were calculated for the nearest infrastructure connection based on an estimate of grid connection costs. Generally speaking, the Project could accommodate costs of up to a maximum of 15% of the total Project costs for connection costs; any higher and the Project would not be feasible. This typically translates into a connection distances less than 10km to ensure a competitively priced project.
- **Size of the site:** GWG looked for site locations that have large continuous areas as it is technically challenging to engineer a solar PV plant which is fragmented by roads, railway lines or other existing barriers.
- **Land use and ownership:** GWG opted to select areas which were free from residential dwellings that would result in physical displacement. Privately owned land was therefore preferable in order to minimise the social impacts.
- **Environmental issues:** It was also important to select an area that is free from environmentally sensitive receptors (such as forests) which were also considered as part of the initial screening.
- **Existing infrastructure:** Site selection also ensured that the potential project avoided major infrastructure which may obstruct the development or where the project may impact on existing infrastructure such as existing telecommunications networks and airports. Existing roads for access was preferable.

On completion of the alternative analysis, the Crawford Farm site, located on privately owned land, was selected as the preferred site. The site was close to the existing CLSG transmission line and substation located at MCHPP. The site is generally degraded due to historic and current land use activities (including farming) and no threatened or restricted range plant or animal species where identified on the site. Sensitive vegetation and wetland are avoided in the proposed layout (see Section 4.3.3 below). All other technical factors such as solar irradiation, grid capacity, size and proximity to other infrastructure were considered preferable for this site.

4.3.2 Technology alternatives

Solar PV technology is relatively mature and has already achieved a considerable level of market share. However, their output is not very stable in continuously changing weather and depends on the sun spectrum.

Traditional photovoltaic modules use semiconductors to generate electrical power by converting solar radiation into electricity. PV modules come in many forms, including crystalline silicon modules and thin-film modules based upon amorphous silicon, cadmium telluride and copper indium gallium selenide. Silicon modules and thin-film modules were considered by GWG. Bifacial monocrystalline silicon modules have efficiencies of 18-20%, while next generation thin-film modules have efficiencies of 17-18%, depending upon the technology. Efficiency rates are being improved year on year by major manufactures and higher efficiency panels are being introduced every year. Silicon panels are more sensitive to heat than thin film panels and less able to work optimally in a humid environment.

The photovoltaic solar panel is the most commonly used solar technology to generate electricity. The advantages and disadvantages of solar PV power plants are highlighted below:

Advantages:

- Solar PV provides clean, renewable energy;
- The technology can be utilised nearly everywhere;
- Solar PV is well suited for distributed generation;

- Little or no moving parts required;
- Solar PV does not generate noise or pollution when operating;
- Due to the large scale production, the cost of solar PV technology has been steadily decreasing over the last 10-15 years, making it one of the cheapest forms of new generation globally; and
- Solar PV plants require minimal maintenance.

Disadvantages:

- Solar PV plants require an inverter to produce AC current;
- The technology requires storage or grid connection for continuous use;

There are two alternative types of mounting systems that can be used for solar PV arrays, these are described below.

Fixed Mounted PV System

In a fixed mounted PV system, PV panels are installed at a pre-determined angle from which they will not move during the lifetime of the plant's operation. Misalignment of the angle of PV panels has been shown to marginally affect the efficiency of energy collection. There are further advantages which are gained from fixed mounted systems, including:

- The maintenance and installation costs of a fixed mounted PV system are lower than that of a 'tracking' system which is mechanically more complex given that these PV mountings include moving parts.
- Fixed mounted PV systems are an established technology with a proven track record in terms of reliable functioning. In addition replacement parts are able to be sourced more economically and with greater ease than with alternative systems.
- Fixed mounted systems are robustly designed and able to withstand greater exposure to winds than tracking systems.

Tracking System

There are various tracking systems. In a dual axis tracking system solar PV panels are fixed to mountings which track the suns movement on two axes. A 'single axis tracker' will track the sun from east to west, while a dual axis tracker will in addition be equipped to account for the seasonal waning of the sun. These systems utilise moving parts and technology including solar irradiation sensors to optimise the exposure of PV panels to sunlight. A single axis tracker is considered to increase a solar park's energy output by approximately 10-20% depending on location. In Liberia, where most of the solar radiation is diffuse due to high humidity the advantage of a tracking system is very limited.

Preferred technology

Having assessed the available technology alternatives, the preferred alternative is the use of solar PV with thin-film (CdTe) modules mounted upon a fixed axis (with string inverters).

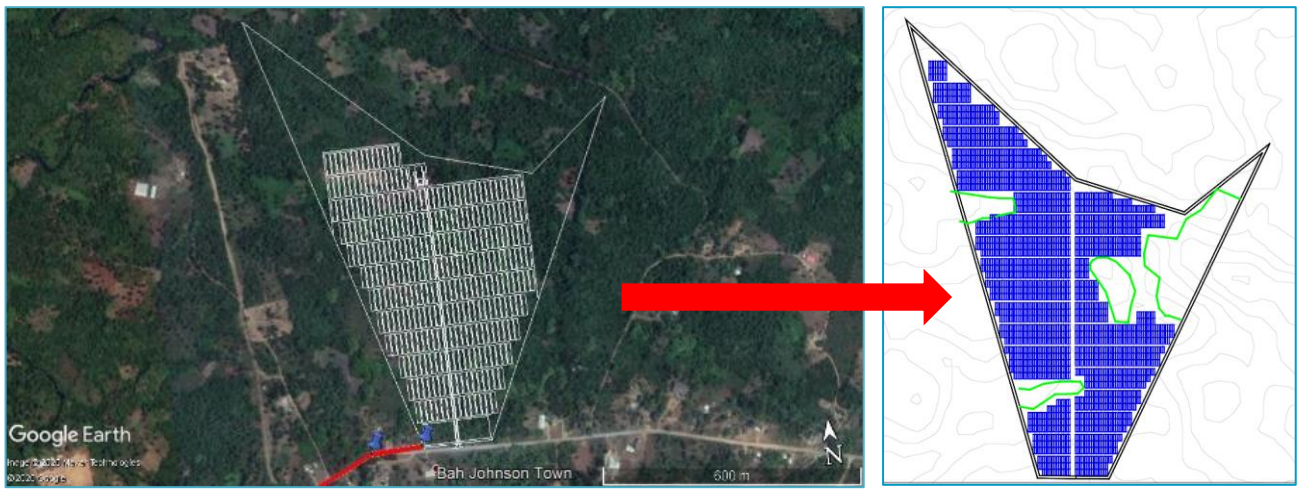
4.3.3 Site layout alternatives

Once the Crawford Farm site was selected as the preferred site, environmental and social constraints on the site were identified through field visits by social and biodiversity specialists. These sensitive features were mapped and communicated to GWG for including into the design of the layout of the solar PV plant. Some of the sensitive features identified on the site included:

- an area of "Young Bush" in the north eastern part of the site; and
- wetland features within the site boundary.

These features are indicated in Figure 34. The site layout was adjusted to accommodate these sensitive features, thereby avoiding and minimising impacts on the remaining natural habitat (see Figure 12 and Figure 37).

Figure 12: Site layout alternatives showing the original layout with the revised based on site sensitivities



4.3.4 Transmission line route and design alternatives

Two transmission line route alternatives were considered. Transmission Line (TL) Route Option 01 follows the Crozierville-White Plains road that runs directly south of the solar PV site for approximately 3km, and then heads north next to the MCHPP-Monrovia road for 4 km to the Mount Coffee Substation. TL Route Option 02 follows the existing CLSG transmission line servitude (that crosses the farm and the northern section of the solar PV site) to the Mount Coffee Substation (see Figure 7). Information gathered during the field visits was used to undertake a comparative route assessment of the two alternative routes. Various environmental and social aspects were used to assess each of the routes against each other and to identify a preferred route. The detailed comparative assessment is provided in Section 14. Based on the comparative assessment using various environmental and social aspects, TL Route Option 02 was identified as the preferred route.

Power will be evacuated from the solar PV site via a medium voltage (± 66 kV) overhead transmission line from the site to the MCHPP substation. Should there be a need to construct the transmission line as per TL Route Option 2, the intention is for GWG to construct the transmission line and then to hand over the ownership of it, and therefore operations and maintenance, to the Liberian Electric Corporation (LEC).

4.3.5 No-go alternative

The GWG project is responding to shortages in supply of electricity in Liberia. During the dry season in Liberia the Mount Coffee Hydropower Plant (MCHPP) (which supplies ±30% of Liberia's electricity) runs below its maximum production capacity leading to a shortage in the national electricity supply. The ongoing expansion of the national grid and the resulting new private and public off-takers are driving the need for additional electricity. GWG's solar PV project is responding to this need. As a result, GWG signed an amended Memorandum of Understating (MoU) with the LEC in December 2017.

This project is also in line with Liberia's National Energy Efficiency Action Plan (NEEAP) and the National Energy Policy (NEP) as it is an expansion in the use for renewable energy and a private sector investment in energy supply.

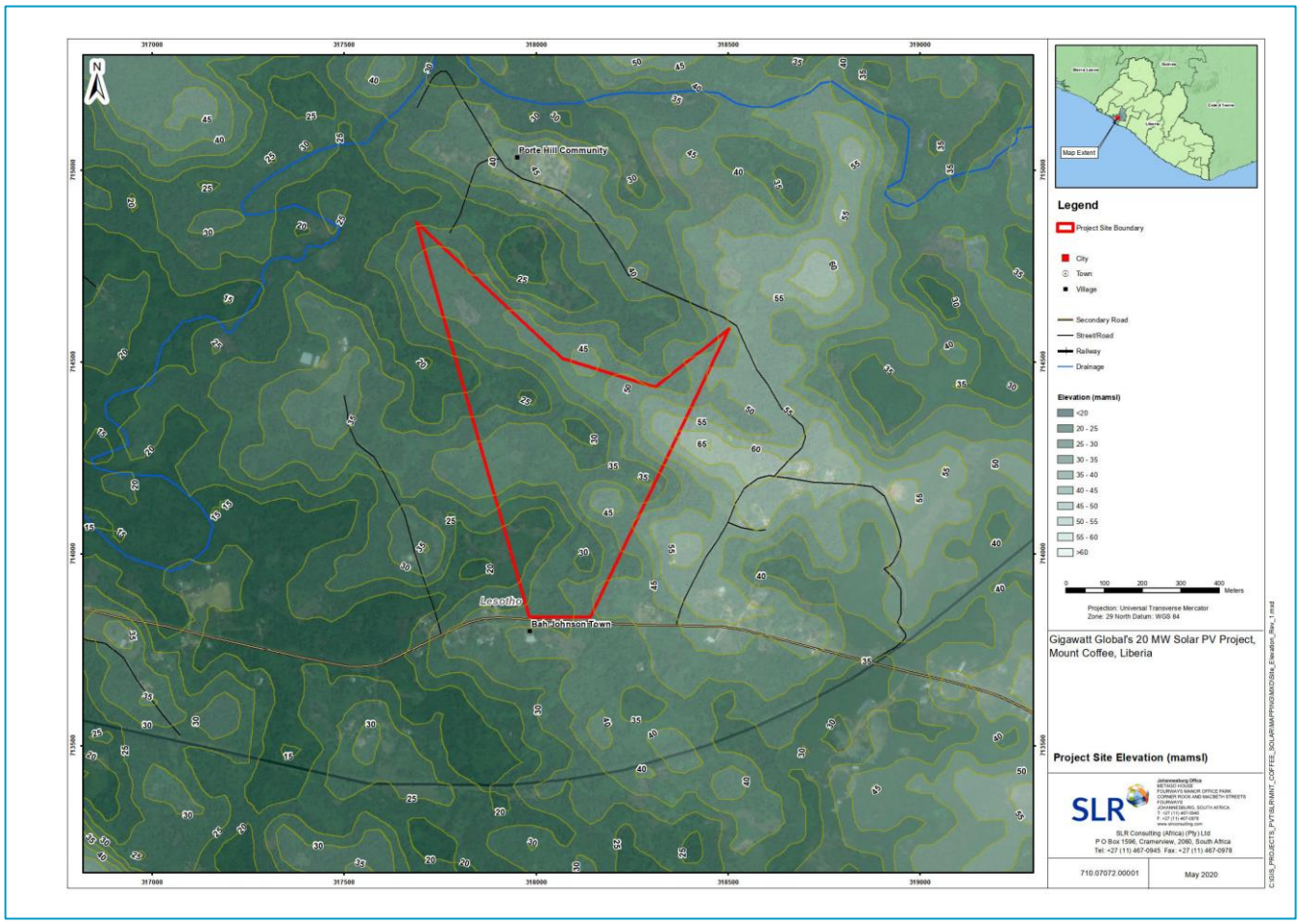
While none of the negative impacts of the project would be realised, none of the possible socio-economic benefits, which potentially outweigh the negative impacts, will be realised either. Apart from this, the "No-Go" alternative for this project would mean that the vision for NEEAP and NEP would not be able to be realised. In view of the above the "No-Go" alternative is not recommended.

5. DESCRIPTION OF THE BASELINE ENVIRONMENT

5.1 TOPOGRAPHY

The solar PV site is located on an undulating landform creating ridges and valleys running from a south easterly to north westerly direction across the site. The higher lying areas are located towards the east, and as such most of the valleys drain towards the west (Figure 13). There are two valleys located in the southern and northern sections of the solar PV site. The elevation varies between 22 meters above sea level (masl) in the south west to 60 masl in the north east. Various areas on the site contain slopes of between 15 (or 8.5°) and 20% (or 11.5°). The topography is similar along the two TL routes with undulating valleys and hills varying between 25 masl and 55 masl.

Figure 13: Topography of the project site



5.2 SURFACE HYDROLOGY AND DRAINAGE

The surface profile of the project area is generally slightly undulating but gently dipping towards the west, as part of the Saint Paul River watershed. Most of the surface water flows towards the Dayunn Creek and Queen Creek, found approximately 300 m west of the solar PV site.

Three wetlands fall within the proposed footprint of the solar PV site (A to C in Figure 15 below) and one falls on the boundary near the north-eastern corner (D in Figure 15 below). The wetlands are similar in scale, all at approximately half a hectare, providing a total area of approximately 2.2ha or 7% of the total project area (refer to Table 12 below). Site photos of the wetland areas are presented in Figure 14.

Figure 14: Photos of the wetland areas located on the solar PV site

The Shuttle Radar Topography Mission (SRTM, 2000) 30 m elevation model reveals rises of between 5 and 10 m between the wetlands that divide them into three distinct drainage systems (see Figure 16 below).

Wetlands A and B fall within a single valley bottom divided from Wetlands C and D by small ridgelines or rises. The general fall within the valley bottom is in a north-westerly direction from Wetland B to Wetland A. A Google Earth elevation profile along the approximate valley bottom indicates a small rise on the scale of approximately one meter between the two wetlands (see Figure 17). Therefore, although Wetland B is an isolated depression

and is not connected to Wetland A by surface or near-surface (wetland) flow, it is most likely connected by interflow. Wetland A appears, from aerial imagery, to extend westwards from the site boundary before turning northwards taking the form of a longitudinal wetland feature that follows the valley bottom. No channels are visible from aerial imagery and Wetland A is therefore most likely an Unchanneled Valley Bottom Wetland.

Wetland C falls within a separate drainage system that drains westward out of the solar PV site into a blind depressional area. According to both the SRTM 30 elevation model and the Google Earth elevation profile (see Figure 18), the wetland begins approximately 5 m higher at the eastern extreme than the lower parts of the depression such that the first 60 m of the wetland lies on approximately a 1:12 slope. This portion of the wetland is therefore likely a hillslope seep which flows into an isolated depression.

Wetland D falls just outside the solar PV site within a minor valley bottom that falls toward the northwest and is isolated from the other wetlands. According to the Google Earth elevation profile along the approximate floor of the valley bottom (Figure 19) the wetland falls within an almost flat portion of the valley which likely explains the formation of wetland conditions and diffuse flows. Wetland D may therefore be classified as an Isolated Bench Flat Wetland, but it is likely linked to wetlands further down the valley to the north by subsurface flow.

Table 12: Wetland areas identified on the solar PV project site

PV Wetlands	GPS Coordinates	Width	Area
Wetland A	06.46102 N; 010.64675 W	15	0.63114ha
Wetland B	06.45919N; 010.64443 W	20	0.7108ha
Wetland C	06.45719N; 010.64610 W	100	0.4314ha
Wetland D	06.46135N; 010.64361 W	26	0.4714ha
Total Area			2.24474ha

The wetland areas support characteristic aquatic fauna and flora, and there are examples in several taxonomic groups of specialised species that are associated with stream-side habitat, including plants and birds. They also provide ecosystem services likely including the following:

- Water supply for household and agriculture use;
- Direct provision of food due to agriculture within the wetlands;
- Streamflow regulation – reducing the likelihood of flooding while increasing base flow within rivers, streams and other wetlands downslope;
- Provision of biodiversity by supplying niche habitats;
- Uptake of nitrates and phosphates from agricultural areas and sewage; and
- Trapping of sediments from bare sand agricultural and residential areas upslope.

They are unlikely to provide fish as they are seasonal in nature and seldom provide suitable open water habitat. They are also unlikely to provide toxicant removal services as pesticides are unlikely to be used in the rural catchment.

Figure 15: Wetlands within the solar PV site

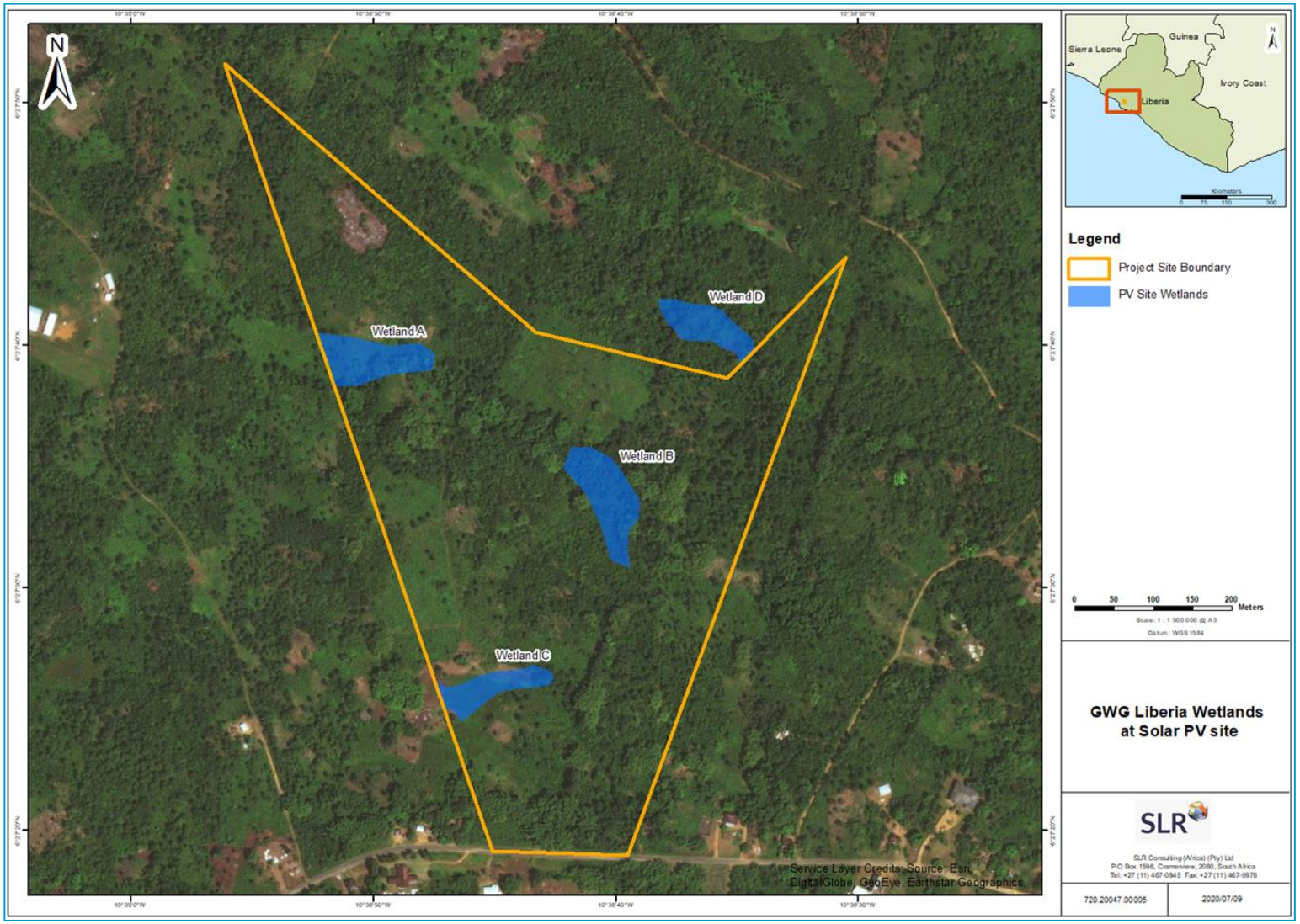


Figure 16: SRTM 30 digital elevation model with approximate drainage lines within minor valley bottoms indicated for the solar PV site

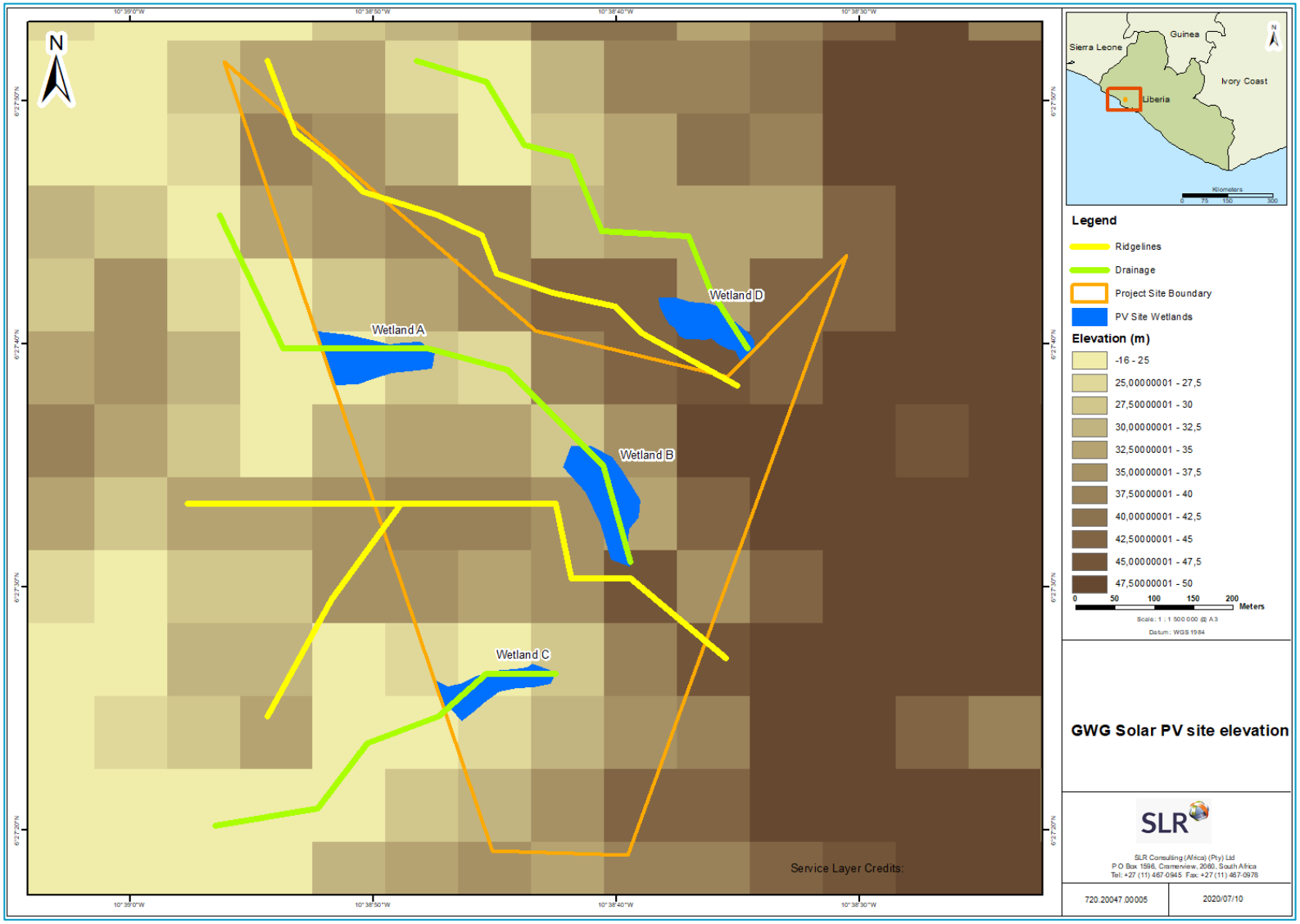


Figure 17: Elevation Profile along the white line with the slight rise between the two wetlands indicated by the red arrow on the map and the vertical line on the profile.

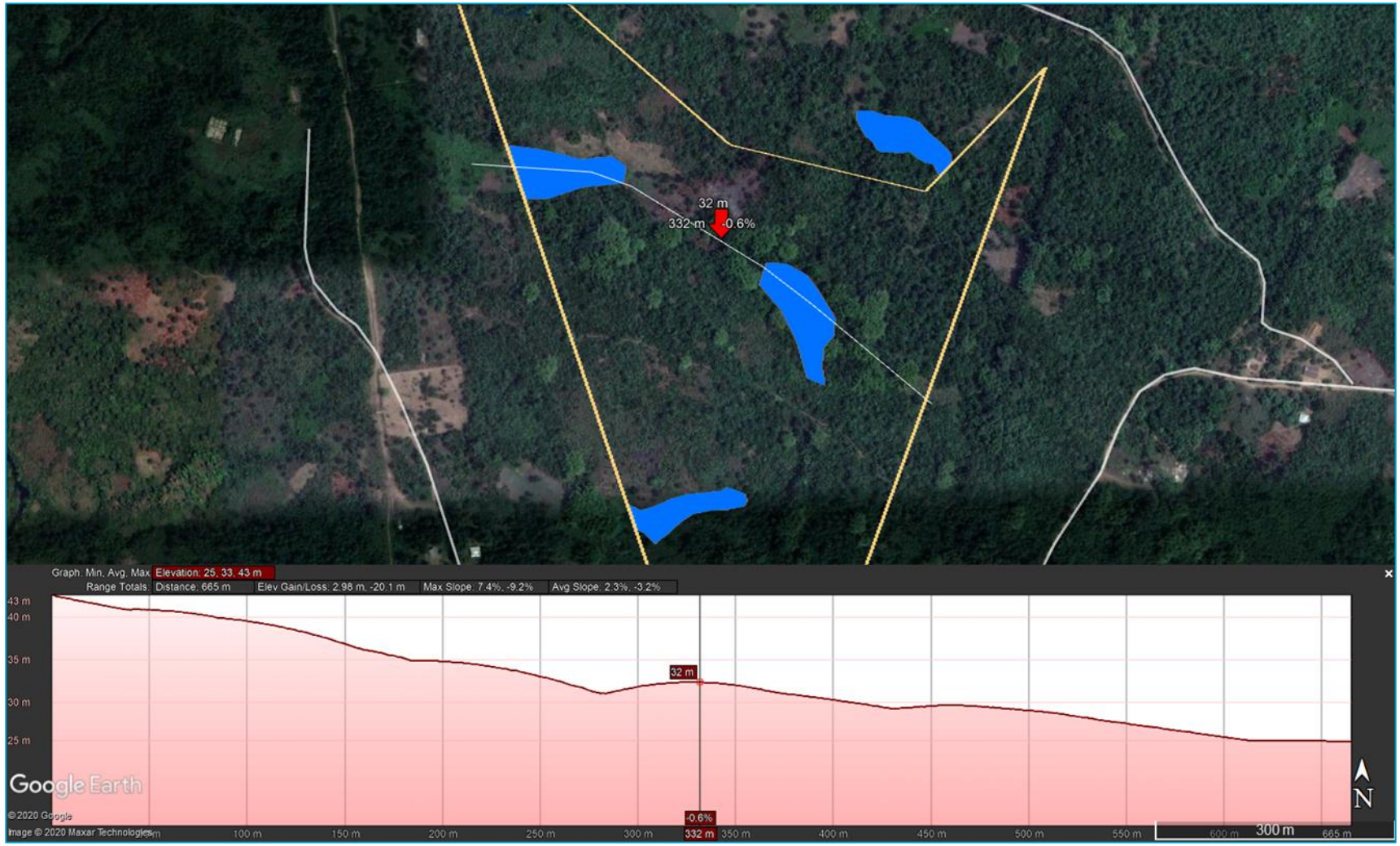


Figure 18: Elevation profile through Wetland C and the blind depressional area it drains into

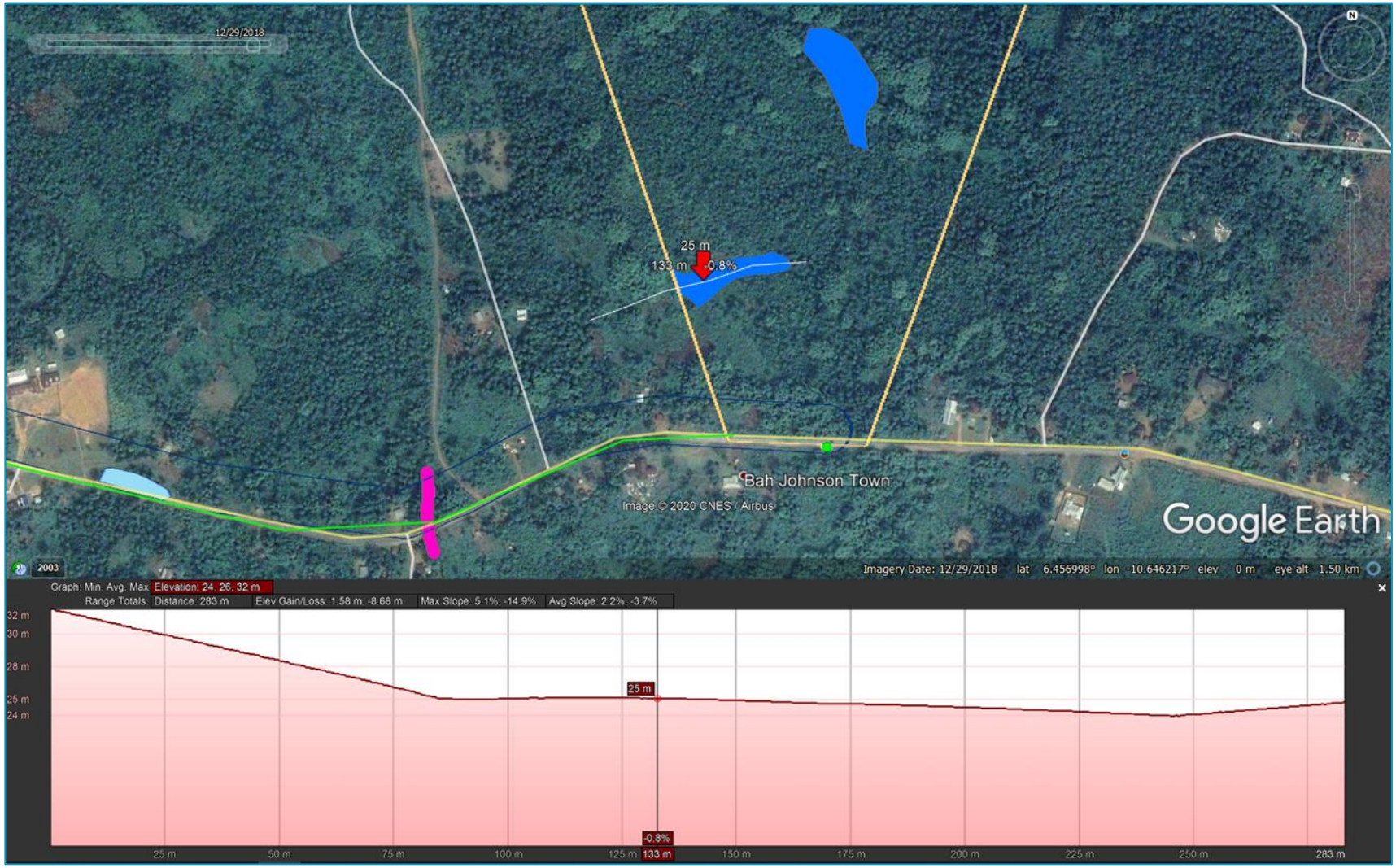
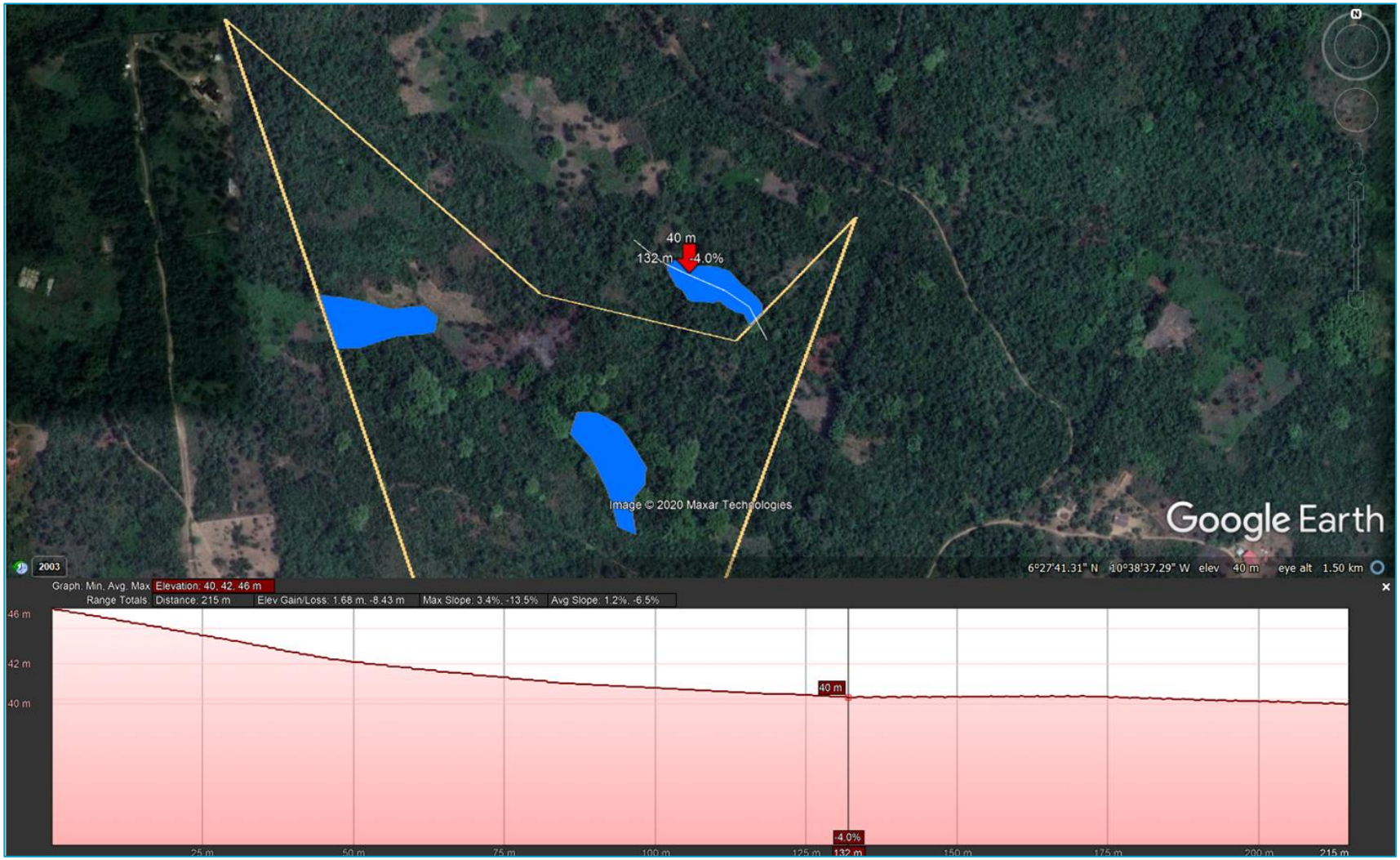


Figure 19: Elevation profile through Wetland D



TL Route Option 01 traverses four creeks and four wetlands, while TL Route Option 02 traverses one wetland and one creek (see Figure 20).

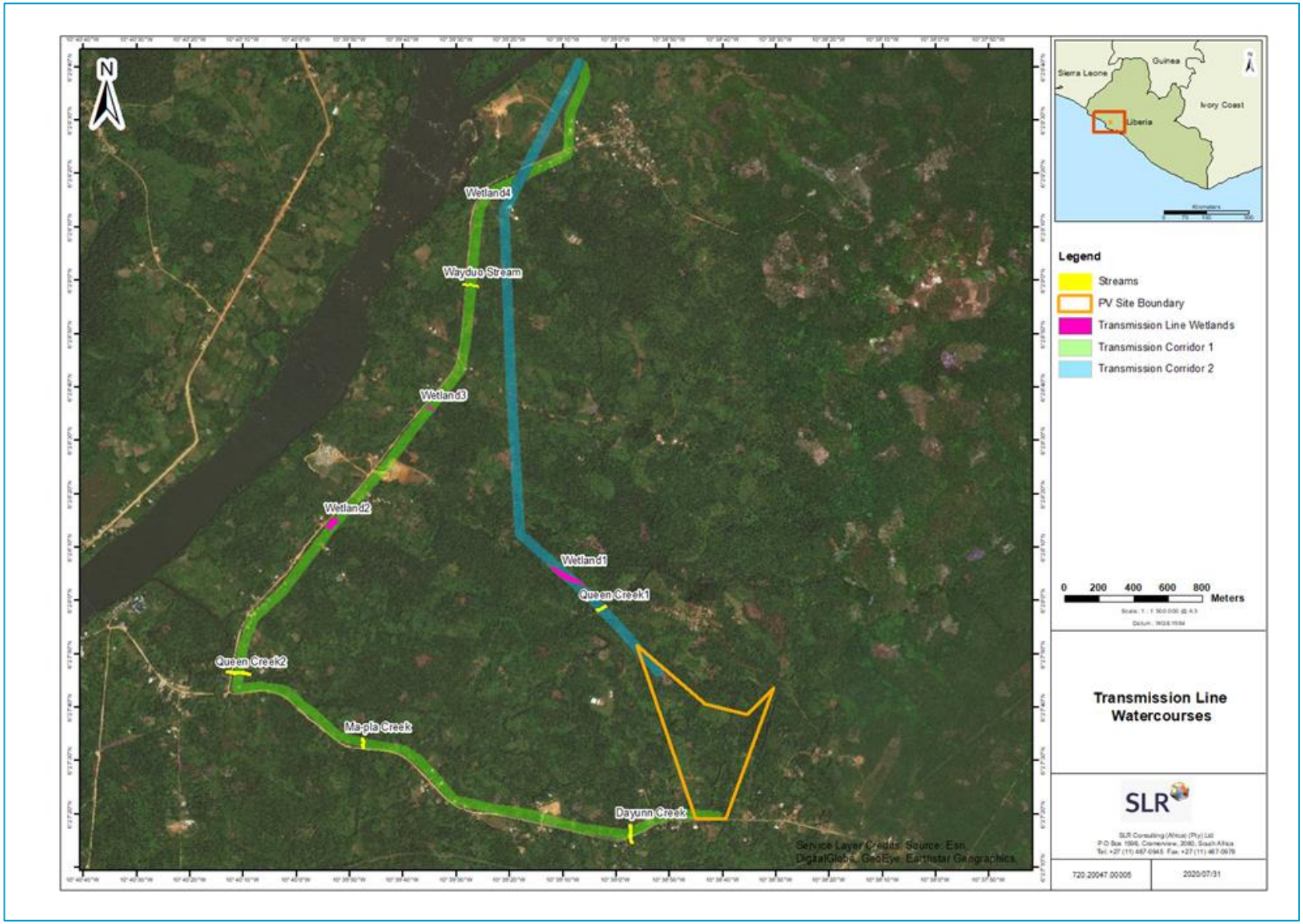
The wetland area within TL Route Option 02 is however much larger than those of TL Route Option 01 and covers an area of 0.630 ha compared to a total area of 0.541 ha in total for all three TL Route Option 01 wetlands. The smaller TL Route Option 01 wetlands are however less likely to be impacted by transmission infrastructure since wetlands #2 and #4 only encroach partially on the corridor and pylons may be installed adjacent to the wetland with little or no direct impact. The remaining wetland #3 presents an obstacle of only 16m in width that may fall between pylons in which case impact may be minimal.

Wetland #1 located within TL Route Option 02 lies diagonally across the route and presents approximately a 105m wide obstacle.

The small creeks and streams exhibit channels clearly visible on satellite imagery, with equally small catchments indicated by the digital elevation model. Both Dayunn and Ma-pla creeks drain towards the larger and longer Queen Creek, which empties into the St. Paul's River approximately 600 m to the west of TL Route Option 01, while the Wayduo Stream appears to drain westwards directly toward the St. Paul's River.

In terms of the Ollis *et al.* (2013) classification system for watercourses, the creeks and streams may be classified drainage lines, although portions of the creeks and streams appear as though they may be channelled valley bottom wetlands. All of the wetlands appear to be Unchanneled Valley Bottom Wetlands.

Figure 20: Streams, wetlands and creeks along on the Transmission Line Routes



5.3 CLIMATE AND CLIMATE CHANGE

5.3.1 Climate of the Project Area

The climate of Liberia is determined by the equatorial position and the distribution of low and high-pressure belts along the African continent and the Atlantic Ocean.

Generally, temperature remains warm throughout the country with little change between seasons. The average temperature over the country ranges from 27°C to 32°C during the day and from 21°C to 24°C at night.

The highest temperature occurs between January and March and the lowest temperature occurs between August and September, but in general there is little variation.

The dry season runs from November till April and a rainy season from May/June till October. Average monthly rainfall for the Monrovia area ranges from 0 to 50 mm in the dry season (during December/January) to 900 mm in the wet season (peaking during June/July). The onset of the rainy season can vary from year to year. Rainfall events exceeding 100 to 150 mm per day can occur regularly during the wet season, leading to localised flash floods. According to the feasibility study conducted by Wood[6] the project site can be expected to experience typical annual rainfall in the range of 2 500 to 3 500 mm.

Wind speeds in the Monrovia area range between 6 to 10 km/h peaking in August, with the dominant wind directions being south-west (during the wet season) and north (during the dry season).

The Harmattan trade wind coming from the Sahara Desert occur in Liberia during December to March (see Figure 21 below). The dust for the Sahara associated with the Harmattan trade wind can significantly affect the potential for solar production during this time.

The Global Horizontal Irradiation (GHI) is the most commonly used method for estimating the energy production from solar PV projects. In the Global Incoming Radiation map for Liberia, the GHI varies from 1600 kWh/m^2 to 1900 kWh/m^2 (Figure 22).

Figure 21: Example of dust levels in Monrovia due to Harmattan trade wind[7]

[6] Feasibility Study: 20MW Solar Photovoltaic Project near Mount Coffee, Liberia, 19/803692/O/R/001, Wood Group UK Limited

[7] https://sitesofliberia.wordpress.com/2012/02/08/monrovia-february-8-2012/

Figure 22: PV potential map (Global Solar Atlas)

5.3.2 Climate Change and Project Risks

Variability in climate is an increasing threat to the sustainable development of the country with droughts and floods occurring more frequently than in the past. This has impacted the country's food and water security and has had a major impact the livelihoods of people in rural communities. The Liberia economy is highly dependent on the country's natural resources, including its reliance on river flow (such as the St Paul River) for hydropower generation, and which has diminished in recent years due to poor rainfall. Reduced power generation impacts other core sectors such as mining, agriculture, construction, manufacturing, tourism and transport. These factors and trends highlight the importance of alternative renewable energy projects such as solar PV to aid in the supply of electricity during dry periods, especially as it is not dependent on water from rivers, and thereby supports the development of a climate resilient energy mix for Liberia. By contributing to Liberia's power supply, solar PV can support and expand the economy, alleviate poverty and help reduce the country's high reliance on wood resources for household energy supply. In this regard, PV plants can aid in the supply of electricity during these

dry periods as solar energy is not dependant on water from rivers for energy supply. This offers an opportunity for a climate resilient energy supply to the national grid.

Parameters of climate change which could influence the project are (i) rainfall (influencing surface runoff patterns, water supply, and flooding risks), and (ii) temperature (influencing solar radiation) and particulate matter in the air (from the Sahara or from pollution.

According to a study on potential impact of climate change on solar resource in Africa for photovoltaic energy[8] the annual mean solar potential is expected to decrease on average by 4% over most of the continent by the end of the century as a direct result of decrease in solar radiation and increase in air surface temperature. While the expected decrease may affect the sizing of the numerous solar projects planned in Africa for the next decades, this study suggests that it does not endanger their viability. Liberia falls within the Sahel area of the study. This study concludes that solar potential is expected to increase on average by +4% over the Sahel while decrease by more than 8% over the Horn of Africa); however, large uncertainties are associated with the study.

In Liberia weeks of heavy rain are punctuated by short but intense dry seasons.

According to a study on climate change over West Africa[9] the trends in seasonal (May-September) mean temperature and precipitation over West Africa for the period ranging from 1983 through 2010. The whole of West Africa, including Liberia, has recorded a warming of between 0.3 and 1 °C in recent decades. For the precipitation there is a significant increasing trend of about 0.2 - 1.0 mm/day per decade occurs along the Sahel band. Seasonal precipitation accumulations over the Sahel have recovered since the last few decades, but do not reach the levels of the period preceding the drought episodes of the 1970s and 1980s.

5.4 GEOLOGY AND SOILS

The Monrovia Quadrangle is within the Guinean Shield of West Africa which includes parts of the Liberian and Pan-African age provinces. Geological investigations in Liberia have shown that nearly all of the terrain is underlain by Precambrian crystalline metamorphic rocks which form part of the West African Guinea Shield. The rocks forming this crystalline shield are a series of granite, gneiss, and schist beds which have resulted from metamorphism by tectonic forces acting on a regional scale. The structural features of the rocks in this region are uniform over relatively large areas. Gneissic structure and schistosity dip at high angles in most places and are often vertical.

The project location is described on the United States Geologic Survey (USGS) geological map of the region as a Pre-Cambrian leucocratic, medium to coarse grained, commonly banded biotite-bearing granite to quartz diorite gneiss (Figure 23). The gneiss forms a wide northwest to southeast belt in which the project site is situated.

Due to the tropical weathering of the gneiss, this has decomposed to form a thick laterite and saprolite soil cover, which supported dense vegetation and rain forests over most of Liberia.

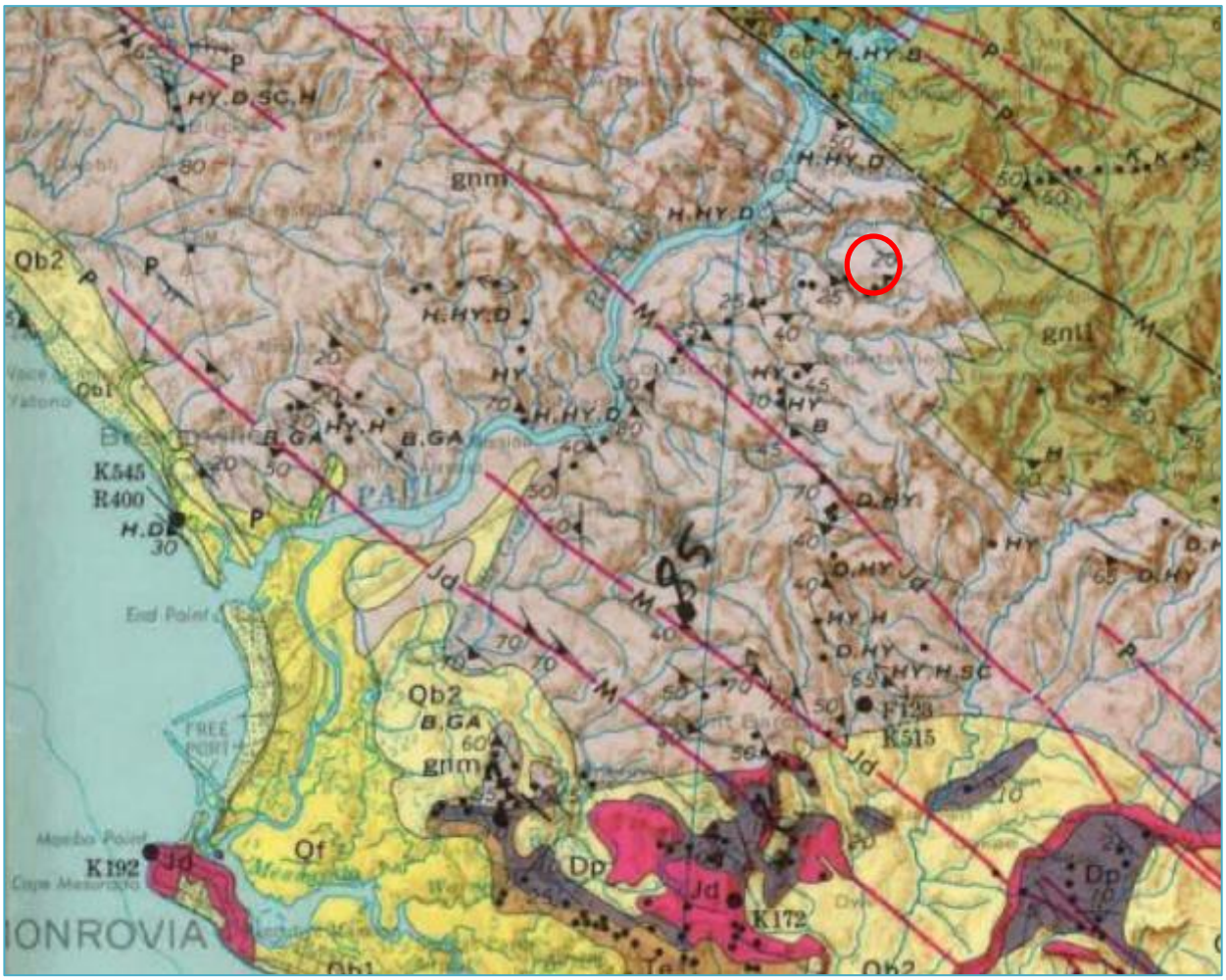
The solar PV site showed less weathered, relatively hard boulders of gneiss emerging from the gradually eroding matrix of more weathered lateritic saprolite.

From an engineering perspective, these materials tend to be porous but with low percolation rates. They can become quite plastic when saturated. Foundation conditions can vary from firm on areas of less weathered rocks (usually on the raised interfluves), to relatively weak in the more weathered depressional areas.

According to the UN Earthquake Risk of Africa: Modified Mercilli Scale map (2007) Liberia does not fall within any of the earthquake intensity zones. According to the Global Seismic Hazard Map (OpenQuake Map Viewer) the value of the 10% probability of being exceeded in 50 years for the project site is very low (0.0173816).

[8] Potential impact of climate change on solar resource in Africa for photovoltaic energy: Analyses from CORDEX-AFRICA climate experiments, Bithcet, A. *et al*, 2019.
[9] Climate Change over West Africa: Recent Trends and Future Projections, Sulla, M.B. *et al*, 2016

Figure 23: Extract from Geological Map of the Monrovia Quadrangle, Liberia (Thorman, 1977, USGS)



5.5 ECOLOGICAL RESOURCES

5.5.1 Terrestrial Ecology

The desktop assessment of the terrestrial ecological setting within which the solar PV site is located included a broad assessment of global areas of conservation importance applicable to the project area, mapping units of African vegetation as defined by White (1983), as well as a search for threatened floral species which may occur within or in proximity to the project area based on historical records captured in the Global Biodiversity Information Facility (GBIF) database.

The study area is located in the Afrotropical Biogeographic Realm and within the Tropical and Subtropical Moist Broadleaf Forests Biome, or terrestrial Major Habitat Type (MHT) (*sensu* Dasmann, 1974; Udvardy, 1975). This biome occurs in extensive, discontinuous patches around the equator and between the tropics, within areas with a low variability in annual temperature and an annual rainfall of more than 2 000 mm. Forests in the Tropical and Subtropical Moist Broadleaf Forests Biome are dominated by semi-evergreen and evergreen deciduous tree species, that contribute towards this biome having the highest level of species diversity of all terrestrial MHTs (WWF, 2020). Habitats within this biome are fragile and easily transformed through unsuitable land management practices such as excessive burning, overgrazing, ploughing and unsustainable hunting practices (WWF, 2020).

The study area is further located within the Guineo-Congolian Bioclimatic Region, which comprises the Upper Guinean Forests and the Lower Guinean Forests. These forest regions are separated from one another by the

Dahomey Gap that extends across Benin, Togo and Ghana, a region of forest-savanna mosaic too dry to support forest vegetation (CILSS, 2016) (Figure 24).

The applicable Global Biodiversity Hotspot, as defined by as defined by Mittermeier *et al*. (2004), is the Guinean Forests of West Africa, also referred to as the Guinean Forests Hotspot (Figure 24). In order to qualify as one of the currently defined 36 biodiversity hotspots, an area must meet the following criteria:

- It must contain a minimum of 1 500 endemic vascular plant species; and
- It must have lost a minimum of 70% of its primary indigenous vegetation (IUCN, 2015).

The Guinean Forests Hotspot provide habitat for over 9 000 vascular plant species, of which around 20% are thought to be endemic. The hotspot is also important in terms of mammal, bird, reptile, amphibian, fish and butterfly diversity, endemism and conservation (IUCN, 2015), and is considered a global conservation priority. Key threats to the hotspot differ between countries, but in general include agriculture and related pollution, bushmeat hunting and the wildlife trade, logging, overfishing, extraction of oil, gas and minerals, production of fuelwood and charcoal and climate change, particularly within low-lying areas that are vulnerable to sea level rise.

The study area is located Guineo-Congolian Regional Centre of Endemism (White, 1983) (Figure 24). Within this Centre of Endemism, more than 80% of the more than 8,000 known floral species are endemic. Most of the Guineo-Congolian Region previously comprised well-drained areas covered with rain forest, while hydromorphic soils supported swamp forest. Little undisturbed rain forest remains, with this vegetation mostly replaced by secondary forest, in various stages of regrowth, and secondary grasslands. In areas where soils are not suited for trees, small patches of edaphic grassland occur. Upland areas and rocky places provide habitat for stunted forest, bushland and thicket vegetation (White, 1983).

Figure 24: Regional biodiversity

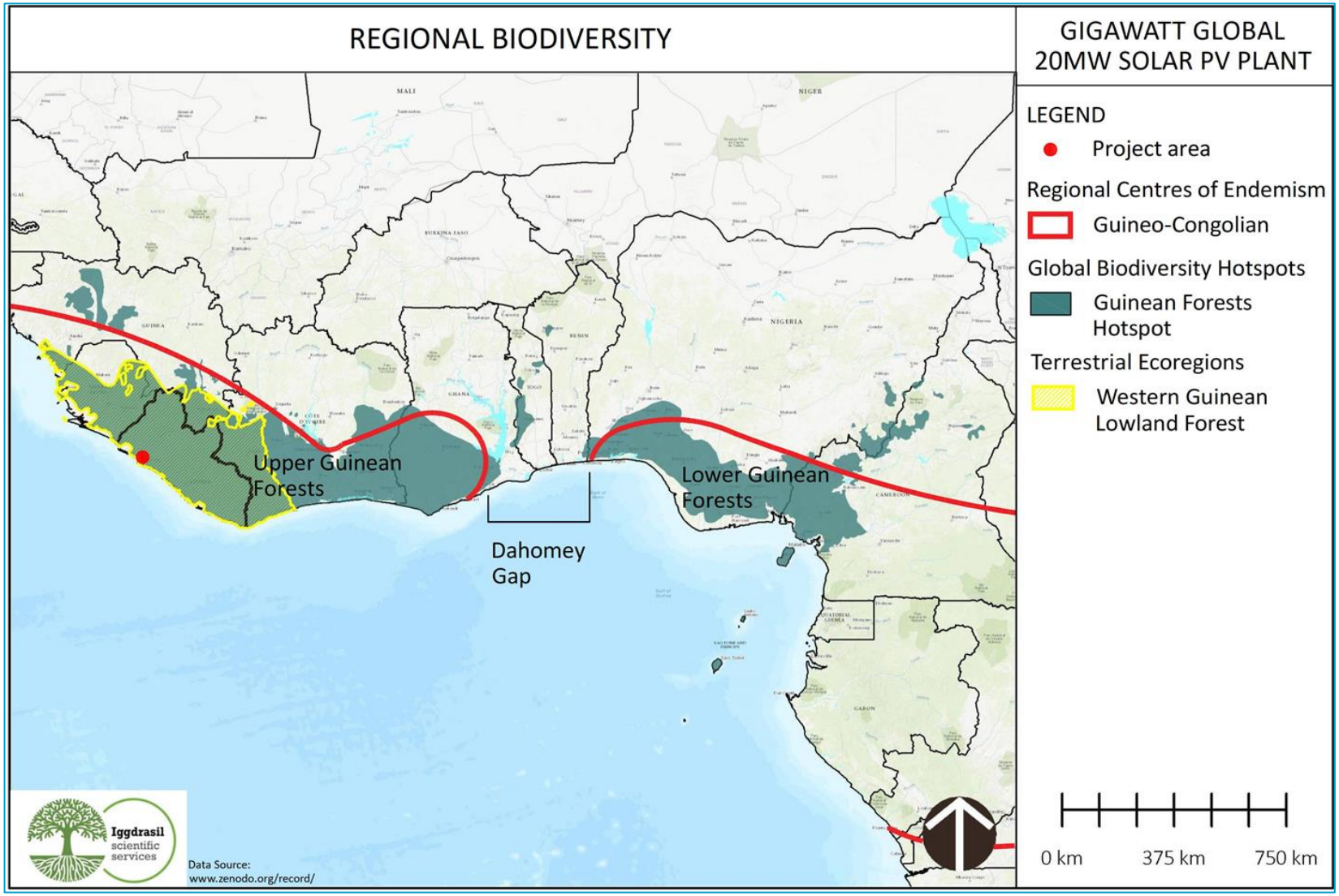
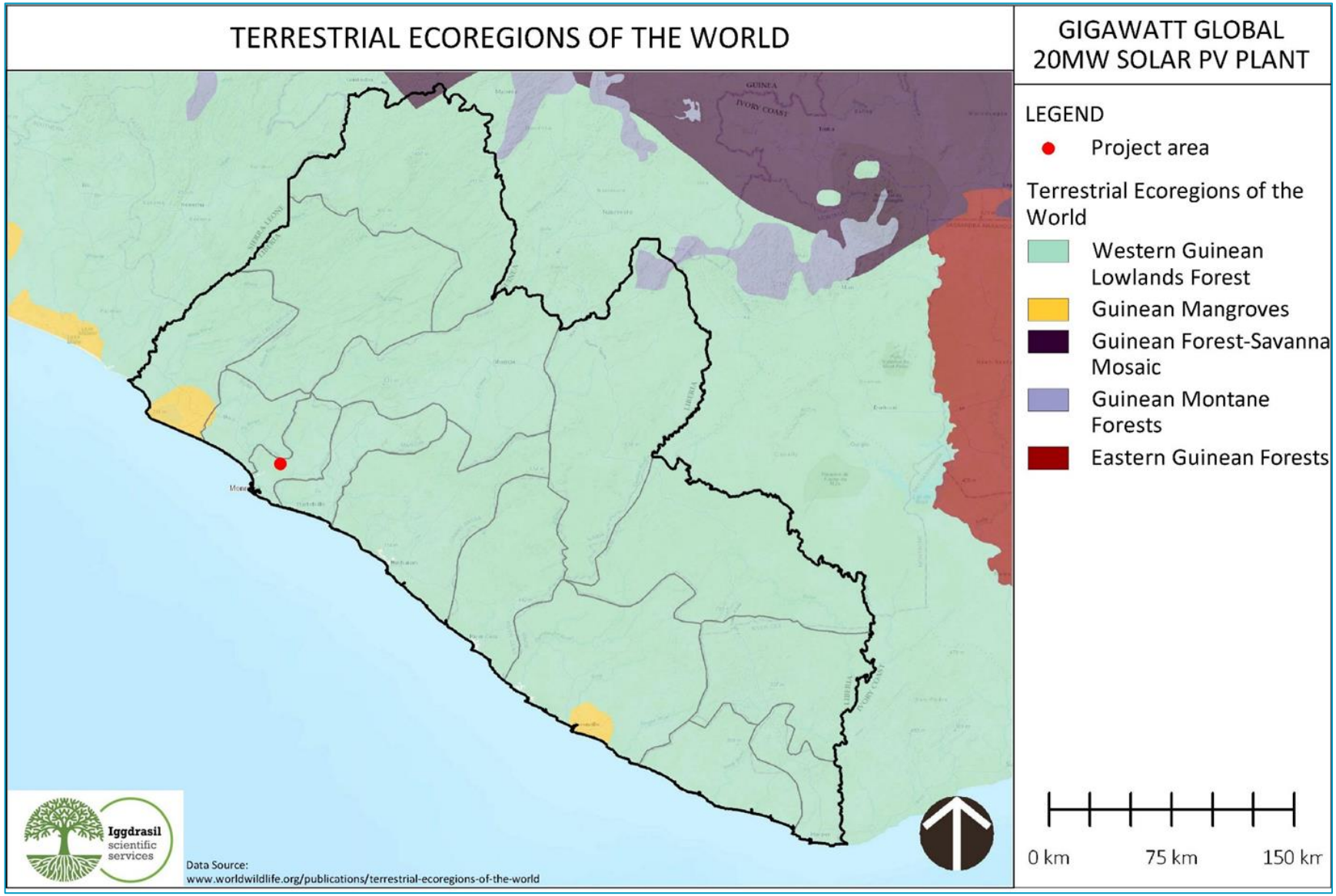


Figure 25: Terrestrial ecoregions



Within the Tropical and Subtropical Moist Broadleaf Forests biome, the project area is located within the Western Guinean Lowland Forest terrestrial ecoregion (Olson *et al*., 2001) (Figure 25). Terrestrial ecoregions were developed in response to the need for global conservation planning and prioritising and can be considered a biogeographic regionalisation of global terrestrial biodiversity through delineating relatively large units of land that share distinct assemblages of terrestrial floral and faunal species and communities reliant on similar environmental and climatic conditions (WWF, 2020).

Terrestrial ecoregions serve as a basis for defining the "WWF Global 200", a list of 238 terrestrial, freshwater and marine ecoregions that are in need of conservation prioritisation due to their distinctive, rare or exceptional biodiversity features and high level of irreplaceability (Olsen & Dinerstein, 2003). The conservation status of ecoregions can be classified as critical or endangered (CE), vulnerable (V), or relatively stable or intact (RS). The Western Guinean Lowland Forest terrestrial ecoregion, also referred to as the Guinean Moist Forest terrestrial ecoregion, is included in this list. This ecoregion and has a CE conservation status and has been classified as Globally Outstanding (IUCN, 2015) due to high species richness and endemism.

Similar to the larger Guinean Forests Hotspot which encompasses the Western Guinean Lowland Forest terrestrial ecoregion, a high level of endemism and biodiversity exist, particularly in terms of plant species, mammals and herpetofauna, and a high number of threatened species occur (IUCN, 2015).

Canopy trees are generally at least 30m in height, with some individuals reaching heights of up to 60m. Species diversity is generally low per hectare, and the tree composition is homogeneous over long distances, with prominent species including species such as *Calpocalyx aubrevillei, Dialium* spp., *Heritiera utilis, Lophira alata* and *Sacoglottis gabonensis*, with some dominance either by *Gilbertiodendron preusii, Parinari excelsa* or *Tetraberlinia tubmaniana* (Mayers et al. 1992). Local plant associations do however occur, and historical levels of exploitation also influenced species distribution and composition (WWF, 2020).

The ecoregion faces similar threats to habitat as that of the Guinean Forests hotspot, and the vegetation has been severely impacted by humans over a long period of time, especially due to the importance of the region for key global commodities such as rubber, cocoa and oil palm (IUCN, 2015). Prior to human disturbances, the majority of Liberia would have been covered with high forest vegetation, with other vegetation types such as natural savanna and poorly drained swamps occurring in limited areas (Voorhoeve, 1965). Currently little primary forest, i.e. forest that has not been disturbed by humans, remain, and the closed canopy forest has been significantly altered from its unimpacted condition, with the vast majority of Liberian high forests being old secondary forests (Voorhoeve, 1965). Other remaining forest fragments are grouped into moist evergreen and moist semi-deciduous forests, which may contain swamp or riparian forests (WWF, 2020). The current dominant vegetation type in the region is degraded secondary forest growth develops after slash-and-burn agriculture takes place (WWF, 2020). Figure 26 below illustrates the loss of dense and degraded forest to agriculture. Figure 27 illustrates the extent of forest cover in Liberia as of 1992 (Mayers *et al*. 1992). It is evident form these two maps that the project area is located within a region where significant loss of forest vegetation has occurred.

Figure 26: Change in Upper Guinean Forest extent from 1975 to 2013 (IUCN, 2015)

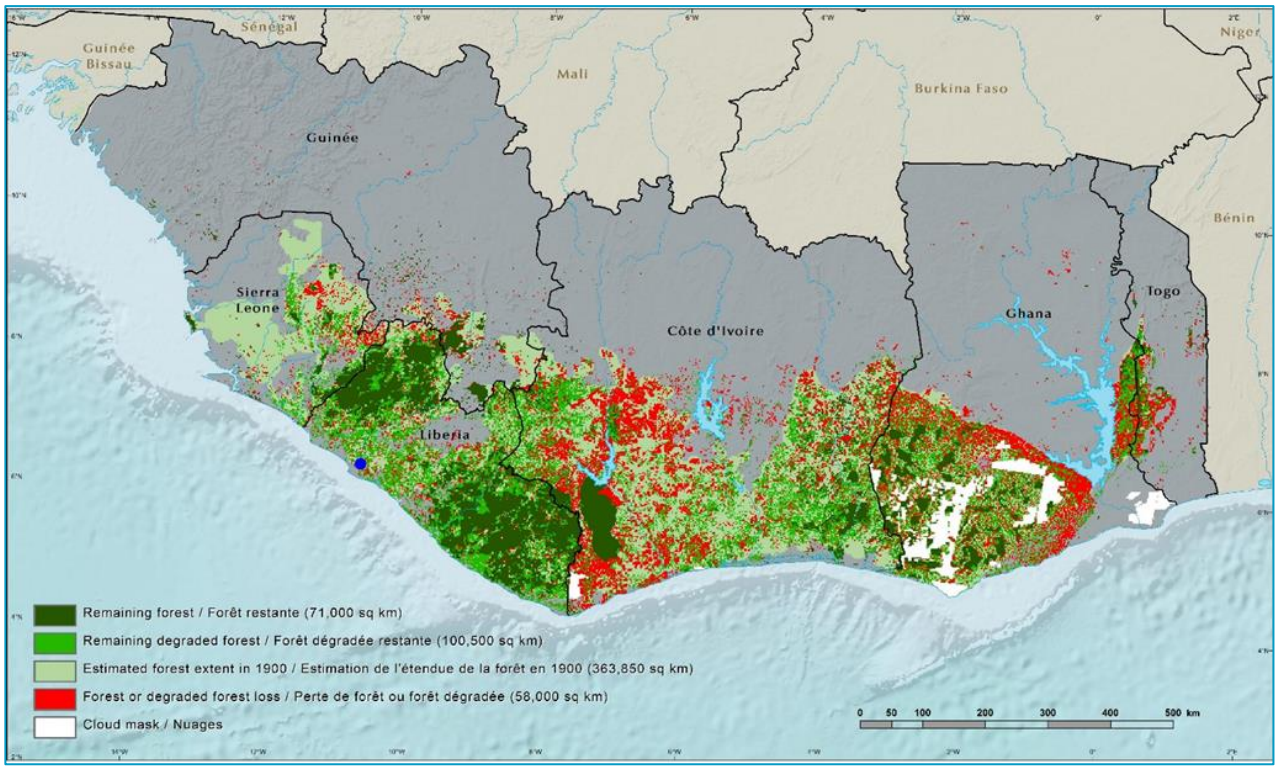
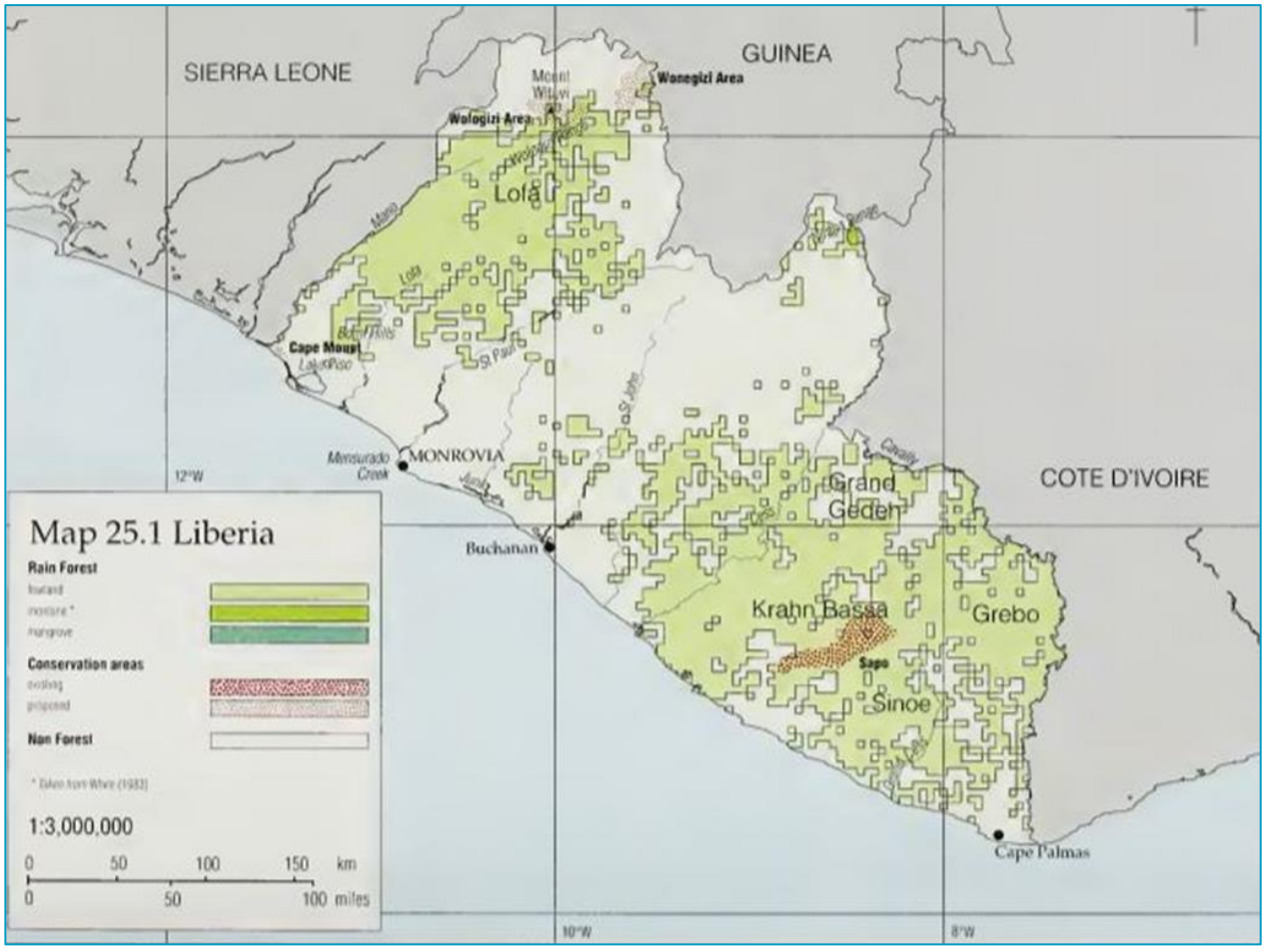


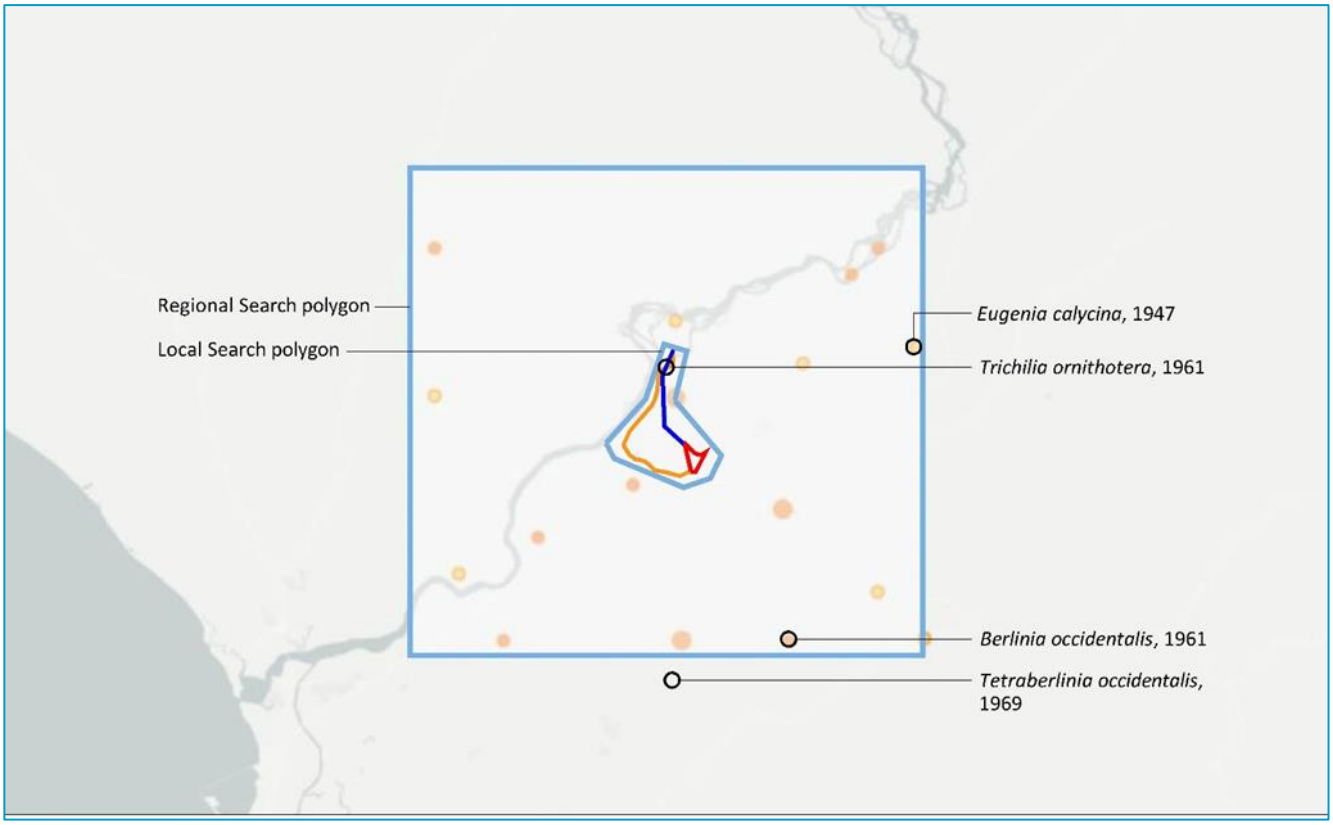
Figure 27: Remaining extent of forest cover in Liberia as of 1992 (Mayers et al., 1992)



The GBIF database contains information collated from various data sources, including direct human observations, material samples, herbarium collections and preserved specimens, published literature, and verified records from citizen science databases such as iNaturalist, amongst others.

Two polygons were used to obtain floral species data from the GBIF, the regional search covers an area of 20 km x 20 km around the project area, while the local search included only the immediate project area, as illustrated in Figure 28 below. It is important to note that many of the GBIF records date back to the 1940s and the species may have since been lost in their natural habitat due to ongoing disturbance and land use changes. The historical records indicated below are not necessarily accurately geo-referenced and are also single specimen representative of what is or was likely a larger population of the same species. Furthermore, not all species within the region have been sampled historically, and the available data only serve as a representation of the historical or current local floral biodiversity.

Figure 28: Extent of regional and local GBIF database searches



A total of 252 plant species are shown to occur (either historically or currently) within the region of the project area on the GBIF database, while the local search yielded a total of 47 species. Based on the results obtained from the GBIF database, the threatened floral species indicated in the Table 13 below were recorded within the polygons assessed.

Table 13: Plant species of conservation concern historically known from the region

Species	Common name	Conservation status (IUCN)	Habitat notes
Fabaceae			
Berlinia occidentalis	English red oak	Vulnerable	The species occurs in wet lowland evergreen forest along stream banks and swamps (Hawthorne & Jongkind, 2006).

Species	Common name	Conservation status (IUCN)	Habitat notes
			The species is under threat due to the general loss of its habitat, as a result of extensive commercial forestry activities and mining (IUCN, 2020). Three historical records, dated 1964, 1966 and 1969 are indicated to the southeast of the project area, at distances of approximately 6km, 10km and 5.5km, respectively.
Tetraberlinia tubmaniana	African Pine	Vulnerable	The species is endemic to Liberia, and is restricted to ultra-wet, evergreen forests (Hawthorne & Jongkind, 2006) and occurs at high densities in a number of forest reserves. The species is at risk due to continuing decline in area, extent and/or quality of habitat (IUCN, 2020). One historical record for the species from 1971 exists approximately 10km to the south of the project area (just outside the regional search polygon). The species is however targeted for timber, and it is unlikely to have persisted at this location due to ongoing habitat degradation in the area.
Maliaceae			
Trichilia ornithothera	Uwahgon; djawohi	Vulnerable	This species occurs in wet evergreen forest, especially along forest edges around swampy areas (IUCN, 2020). The species occurs from Guinea and Sierra Leone to Ghana (Hawthorne & Jongkind, 2006), but is mostly known from Ivory Coast and Ghana. The species is currently threatened by habitat loss (IUCN, 2020). One historical record, dated 1961, exists for the species within the local polygon search area, approximately 600m east of TL Route 2. GPS locality is 6.4833 N 10.65 W. The habitat requirements of wet evergreen forest of this species are not available along the TL Route servitudes, and this species is unlikely to have persisted in the area
Myrtaceae			
Eugenia calycina (=E. liberiana)	-	Endangered	This is a lowland species growing in forest or savanna vegetation, usually very close to the sea (IUCN, 2020; Hawthorne & Jongkind, 2006). The species is threatened by development, agricultural expansion and logging. One historical record for the species exists for 1947, located approximately 9km to the northeast of the project area. This location is not shown by IUCN (2020) to be extant (resident) or extant (possible).

Four threatened tree species are indicated by GBIF to have historically occurred in the vicinity of the project area. These records are all older than 60 years and considering the current and ongoing rate of habitat loss and degradation and ongoing disturbances within the project area, it is unlikely that these species would have persisted in the area over time. The species included in Table 13 have furthermore not been recorded within the project area during the 2020 field surveys undertaken by GreenCons. Little to no suitable, unimpacted forest habitat for these species is available within the project area. It should however be noted that a possibility for these species to occur within the project area, cannot be excluded.

5.5.2 Vegetation

The study area is located in Mapping Unit 11A (Mosaic of Guineo-Congolian rain forest and secondary grassland) according to the vegetation map of Africa developed by White (1983) (Figure 31)

White (1983) describes the Guineo-Congolian rain forests as relatively floristically diverse over large areas, at least 30 m tall, with most species being woody (see Figure 29). The Fabaceae plant family is prominent in these rain forests, but represented by comparatively few species, with Tertaberlinia spp. being the only species growing in pure stands. *Brachystegia leonensis*, *Cynometra ananta*, *Copaifera salikounda, Gilbertiodendron preussii, Monopetalanthus compactus* and *Tetraberlinia tubmaniana* occur in Liberian forest areas with other important species including members of the Fabaceae such as *Berlinia occidentalis, Gilbertiodendron bilineatum, G. splendidum* and *Stachyothyrsus stapfiana*, and *Coula edulis, Gluema ivorensis, Oldfieldia africana* and *Soyauxia grandifolia* among other tree families, the shrub *Diospyros chevalieri*, and several sedges of the genus *Mapania*.

Figure 29: An example of intact primary rain forest (Zeller, 2020)

Much of the rain forest within the region, as briefly describe above has been lost, altered or fragmented through cultivation and fire, and have since been replaced by secondary grassland. These grasslands usually occur in mosaic patterns together with small, severely degraded patches of the original forest, and small patches of secondary thicket and secondary forest (White, 1983). Secondary grasslands are typically at least 2m tall and may include fire-resistant stunted trees of varying density (see Figure 30). Where fire is excluded, secondary or young forests develop. Although secondary grasslands have a diverse species composition, these species tend to be widespread. Typical grass species encountered include *Andropogon gayanus,A. schirensis, A. tectorum, Pennisetum unisetum, Brachiaria brizantha, Ctenium newtonii, Hyparrhenia diplandra, H. familiaris, H. nyassae, H. rufa, H. subpiumosa, Imperata cylindrica, Loudetia arundinacea, L. phragmitoides, L. simplex, Monocymbium ceresiiforme, Panicum phragmitoides, Pennisetum purpureum* and *Schizachyrium sanguineum (semiberbe).* Common shrubs and fire-trimmed trees include *Annona senegalensis, Borassus aethiopum, Bridelia ferruginea, Burkea africana, Combretum collinum, Crossopteryx febrifuga, Cussonia arborea, Dichrostachys cinerea, Entada abyssinica, Hymenocardia acida, Maytenus senegalensis, Nauclea latifolia, Parinari curatellifolia, Piliostigma thonningii, Psorospermum febrifugum, Securidaca longepedunculata, Stereospermum kunthianum, Strychnos madagascariensis, S. spinosa, Syzygium guineense, Vitex doniana* and *V. madiensis* (White, 1983).

Figure 30: Example of secondary grassland forest mosaic

The study area is located within the Upper Guinean Forest, of which the largest part (up to 50%) in West Africa is located in Liberia. Of the remaining forests, however, less than 5% is primary forest (where no significant disturbance from human activity have taken place), while the remainder comprises mostly indigenous, regenerated forests, also known as young or secondary forests, where impacts from human activity are clearly visible (CILSS, 2016). The remaining Upper Guinean rain forest is an important hotspot of global biodiversity, with the forest flora being the richest in West Africa (CILSS, 2016).

In terms of the expected species list as per GBIF the total number of possible expected species present within the region surrounding the project area includes a total of 252 species, and a possible of 47 plant species within the immediate vicinity of the solar PV site and TL Route Options. The field survey recorded 52 plant species within the PV plant and the transmission lines, fourteen (14) of which are listed as expected species based on GBIF data. None of the plants identified are indicated as threatened in terms of the IUCN Red List (2020). Several plants identified have medicinal properties (± 31 species).

A list of plant species (including medicinal uses) occurring on the solar PV site and along the two TL routes is presented in Table 14. Majority of the plant species rerecorded for TL Route Option 02 are located on the edges of the cleared right of way.

Based on the information gathered during the community meetings medicine is obtained from clinics and hospitals in the area, rather than relying on medicinal plants.

Figure 31: Vegetation map of Africa

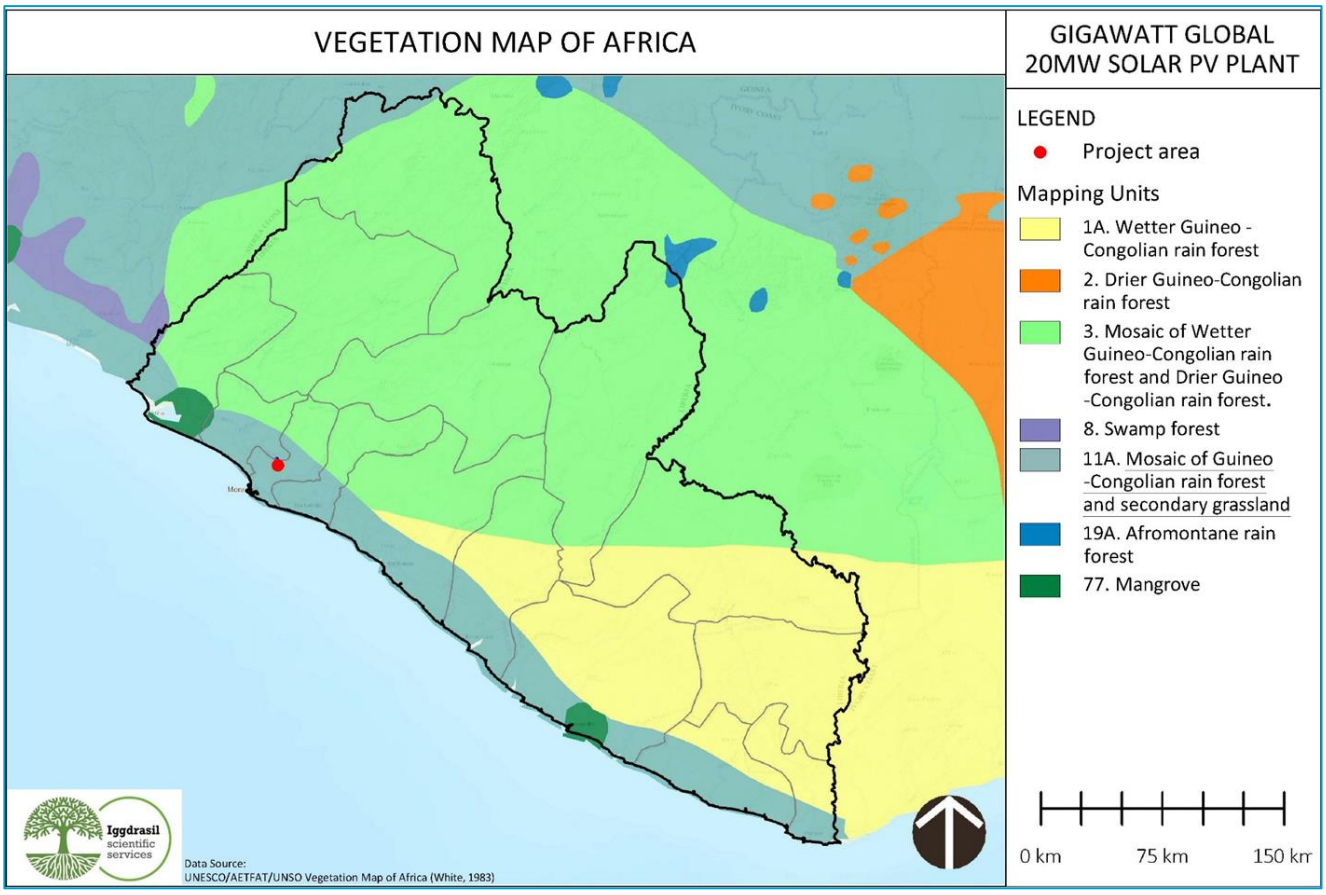


Table 14: Plant species occurring on the solar PV site and along the TL routes

Scientific Name	Common Name	Solar PV Site	TL Route Option 01	TL Route Option 02	IUCN Status	Species of special concern (SSC)	Medicinal value
Aframomum melegueta	Grains of Paradise	X	-	X	DD	-	Stomach, heart, measles, infection
Ageratum conyzoides	Billy goat weed	X	X	X	-	-	Snakebites, bleeding
Alchornea cordifolia	-	X		X	LC	-	Cough, bone ache, wounds, body pain, eye
Alectra sessiliflora	-	X	X	X	-	-	-
Alstonia boonei	Emien	X	-	X	LC	-	Yellow fever
Anadelphia leptocoma	-	X	X	X	LC	-	-
Anthocleista nobilis	Cabbage Tree	X	-	X	LC	-	Strong purgative and diuretic, diabetes, hypertension
Anthonotha macrophylla	-	X	-	-	LC	-	Sores, headache, worms, breast milk
Bambusa vulgaris	Reeves / Common Bamboo	X	X	-	LC	-	Stems are used for rheumatism, shoots are used to treat abscesses and malaria, ease fever, heart problems
Bussea occidentalis	Samanta	X	X	X	LC	-	Barks is diuretic. Treatment for kidney and liver problems.
Senna siamea	Pheasantwood	X	X	X	LC	-	Worms and prevent convulsions in children
Ceiba pentandra	Fromager	X	-	-	LC	-	Diuretic herb that lowers fevers, relaxes spasms and controls bleeding
Chromolaena odorata	-	X	X	X	-	-	Treat skin wounds
Clappertonia ficifolia	Bolo	X	-	X	-	-	-

Scientific Name	Common Name	Solar PV Site	TL Route Option 01	TL Route Option 02	IUCN Status	Species of special concern (SSC)	Medicinal value
Cocos nucifera	Coconut	X	X	X	NE	-	-
Costus dubius	-	X	X	X	-	-	Swollen testicles
Ctenium newtoni	-	X	-	X	LC	-	-
Cyclosorus aridus,	-	X	X	X	-	-	-
Cyclosorus striatus	-	X	X	-	-	-	-
Cyperus difformis.	-	X	X	-	NE	-	-
Elaeis guineensis	African Oil Palm	X	X	X	LC	-	-
Ficus sur	Broom Cluster Fig	X	-	-	LC	-	Latex is used for treating wounds, eye problems, toothache, pain, respiratory problems and gonorrea etc.,
Fuirena umbellata,	Yefen	X	X	X	LC	-	-
Futumia elastica	Mutundu/Futumi	X		X	LC	-	Snake bites, infections, stomach
Hallea ciliate	Abura	X	-	-	-	-	-
Harungana madagascariensis	-	X	X	X	LC	-	Menstruation ,urine, stomach and pancreas disorders
Hevea brasiliensis	Rubber	X	-	X	LC	-	-
Ipomoea asarifolia	-	X	X	X	-	-	Cough
Leersia oryzoides	-	X	X	X	LC	-	-
Macaranga heterophylla	-	X	-	X	LC	-	Cough, snakebites, prurgative and gonorrhoea

Scientific Name	Common Name	Solar PV Site	TL Route Option 01	TL Route Option 02	IUCN Status	Species of special concern (SSC)	Medicinal value
Macaranga hurifolia	-	X	-	-	-	-	Stomach
Managifera indica	Plum	X	X	X	NE	-	-
Manniophyton fulvum	-	X	-	-	-	-	Snake, pregnancy, infection
Mimosa pudica	Sensitive Plant	X	-	-	LC	-	Stomach, for babies
Musanga cecropioides	African corkwood	X	X	-	LC	-	Fever, cough, worm, toothache, snakebite
Myrianthus libericus	-	X	-	-	LC	-	Body, pregnancy, stomach aches
Nymphaea micrantha	-	X	X	X	LC	-	-
Panicum laxum,	-	X	X	X	-	-	-
Parinari excelsa	Songue	X	-	-	LC	-	Stomach, heart
Parkia bicolor	Parkia/ African Locust Bean	X	-	-	LC	-	Heart, headache
Cyperus lanceolatus	-	X	X	X	LC	-	-
Rauvolfia vomitoria	-	X	X	X	LC	-	Fever, malaria, convulsions
Sabicea harleyae	-	X	-	X	-	-	-
Sagittaria latifolia	-	X	-	X	LC	-	-
Scadoxus multiflorus	-	X	X	X	-	-	Heart
Scleria spp	Soft grass	X	X	X	LC	-	Afterbirth infection
Sherbournia calycina	-	X	X	X	-	-	Coughs

Scientific Name	Common Name	Solar PV Site	TL Route Option 01	TL Route Option 02	IUCN Status	Species of special concern (SSC)	Medicinal value
Solanum torvum	Pea Eggplant	X	X	X	NE	-	Children stomach, cods, skin wounds etc,
Spathodea campanelata	African tuliptree	X	-	X	NE	-	-
Spigeliaan thelmia	-	X	X	X	-	-	-
Tetracera affinis	-	X	X	X		-	Stomach, menstruation, bleeding nose, sore throat
DD: Data Deficient; EN: Endangered; LC: Least Concern; NE: Not Evaluated; NT: Near Threatened; VU: Vulnerable							

General vegetation: Solar PV Site

The natural vegetation and habitats on the project site have been impacted on as a result of past and current land used activities. This includes rubber tree plantations, use of slash-and-burn techniques for land clearance for farming, hunting/trapping and commercial exploitation such as charcoal production and fuelwood (see Figure 32). There is a small area of young secondary forest type vegetation (referred to as "Young Bush") in the north eastern part of the site that could support small mammal species (see Figure 33). No major examples of primary forests have been identified, but remnants of such forest are indicated by the presence of certain species recorded in the surveys. No Species of Conservation Concern (SCCs) were identified within the solar PV site boundary.

Figure 32: Examples of land use impacts on the natural vegetation and habitats

Figure 33: Example of young secondary forest type vegetation.

Typically, the stands of pioneering species found on the solar PV site include *Anthocleista, Smeathmannia, Anthonotha, Craterispermum,* and *Harungana* species that normally do not produce crowns of substantial shade cover. Grasses are the most common plants observed, especially *Scleria spp*. They are followed by *Bambusa vulgaris, Eleusine indica* and *Rottboellia cochinchinensis* grasses. A period of farming rotation may be of three to four years, and the most common introduced species on site is Oil Palm (*Elaeis guineensis*).

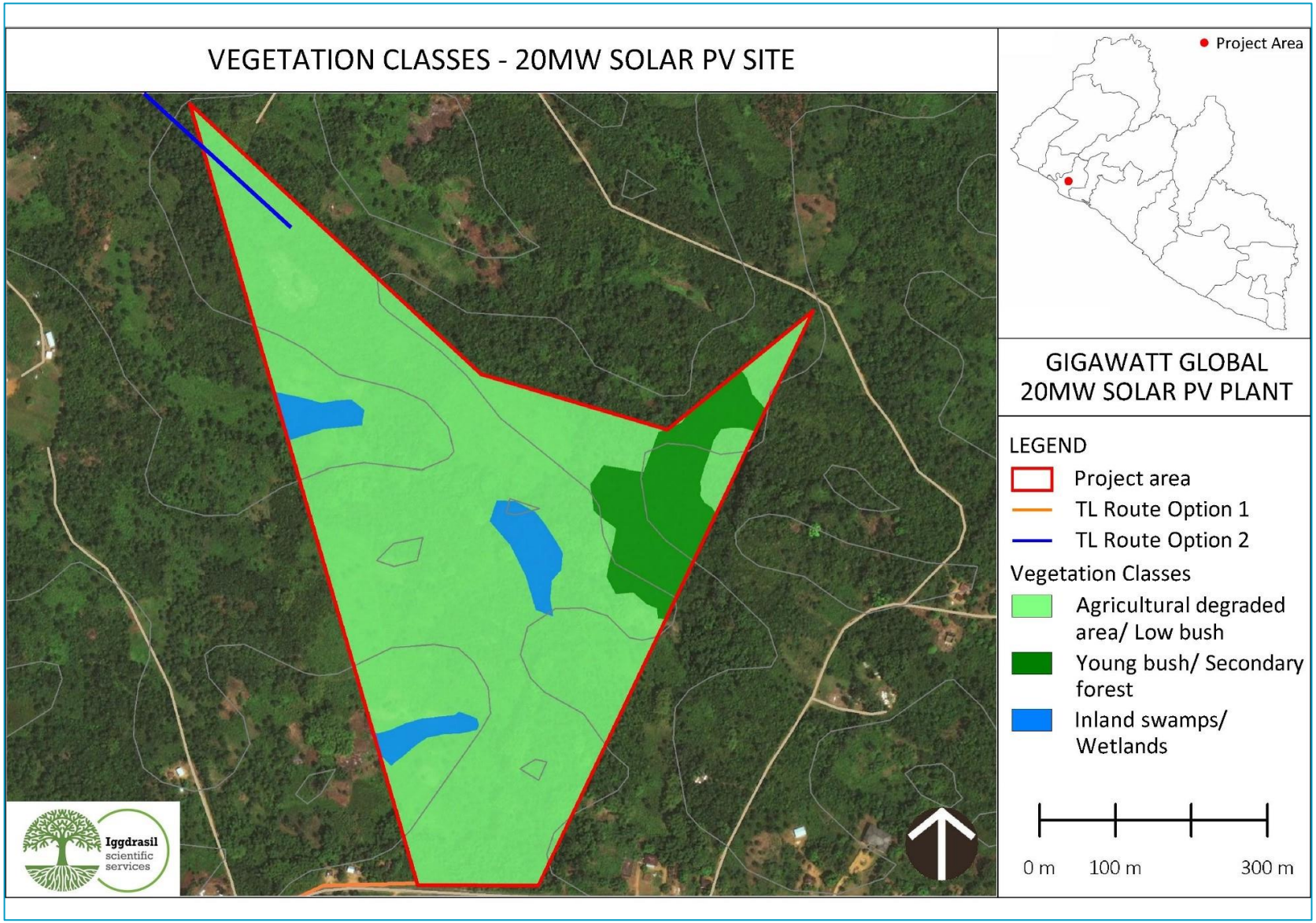
The vegetation and habitat units that were identified on the solar PV site are described in Table 15 below and presented in Figure 34.

Table 15: The main vegetation habitat units present on the solar PV site

Vegetation Class	Description	Habitat Classification in terms of IFC
Agricultural Degraded Areas/Low Bush	These types of vegetation consist mainly of shrubs and grasses providing ± 95% ground cover. This vegetation type occurs across majority of the project area and along the edges of roads specifically. Primary species include both indigenous and invasive species, both of which have ruderal strategies. The species include the *Scleriaflexuosa*, *Panicum laxum*, *Fuirena umbellata*, *C. difformis, Pycreus lanceolatus* and *Spigeliaan thelmia*. This vegetation class constitutes approximately 85% of the solar PV site (or 27.5 ha)	Modified Habitat: Historically used for rubber plantation and farming (including clearing land for grazing), and currently used for subsistence agriculture (including palm oil production, planting of fruit trees, crop cultivation, fire wood collection and charcoal production), resulting in significant modification and fragmentation of habitats. 
Wetlands	The project area is characterized by intermittent wetlands occurring in low-lying areas close to the (Dayunn, Ma-pla, Queen and Wayduo Creeks). The wetlands are water-logged or muddy, even during the dry season. These areas contain fern species which include *Nymphaea micrantha, Limnio phytonanolense, Ipomoea asarifola, Alectra sessiliflora* and *Cyclosorus aridus*. This vegetation class constitutes approximately 5% of the solar PV site (or 1.5 ha).	Modified Habitat/Degraded Natural Habitat: Historically impacted by land-use activities and currently used extensively for planting of crops (mainly sugar cane and maize)

Vegetation Class	Description	Habitat Classification in terms of IFC
		
"Young Bush"	Contextually, this type of vegetation contains many forest species which grow exceptionally quickly. Majority of the tree species found are rudemental with *Parkiabicolor, Uapacaguinensis, Harungana madagascariensis, Ceiba pentandra, Alstonia boonei* dominating and other species typical of a Primary Forest starting to grow (i.e. (secondary forest type vegetation). This vegetation class constitutes approximately 10% of the solar PV site (or 3 ha).	Natural Habitat: This vegetation unit contains viable assemblages of plant species of native origin, and past human activity has not essentially modified it. 

Figure 34: Vegetation units of the solar PV site



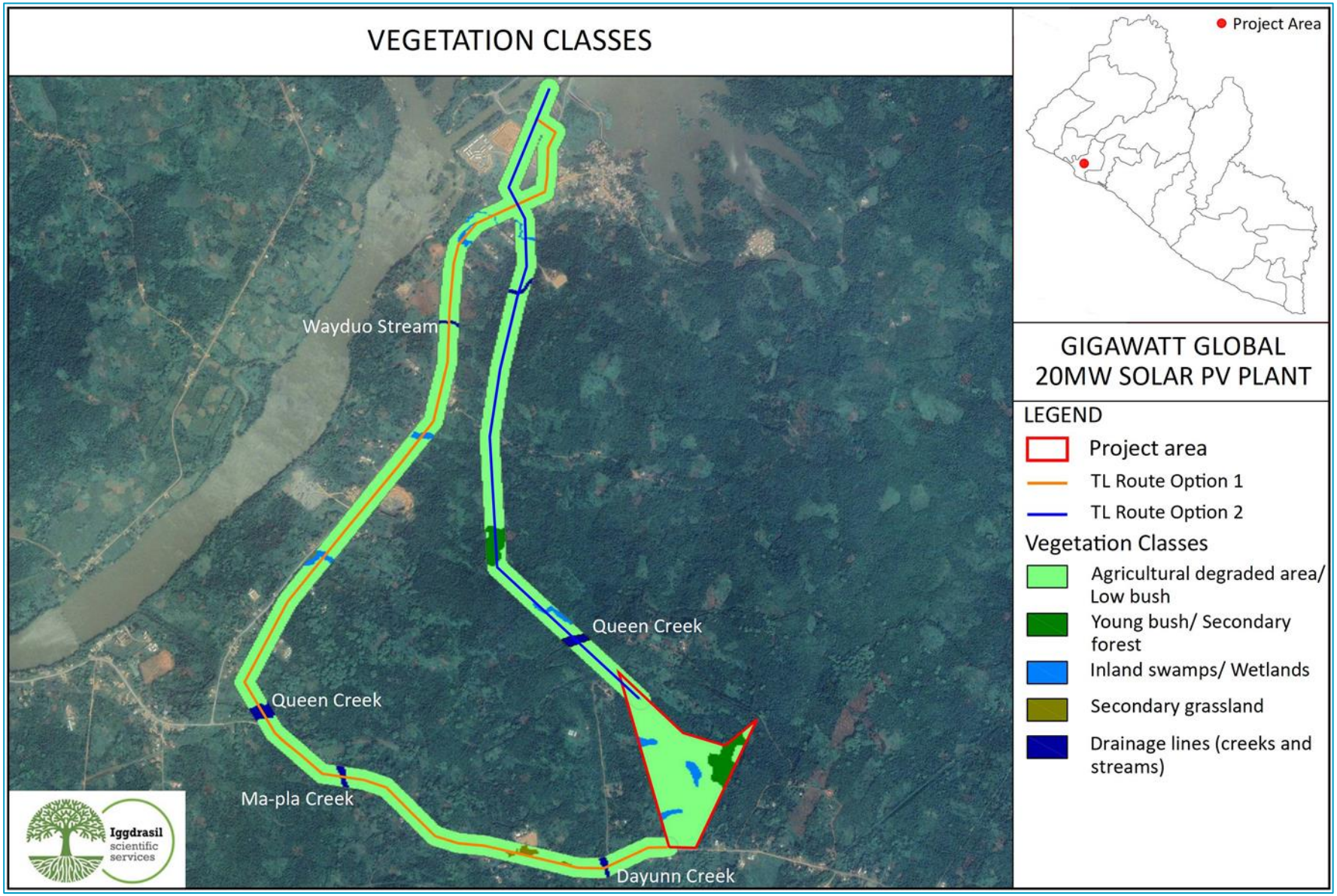
General vegetation: Transmission Line Corridors

The vegetation is intact for large parts along TL Route Option 01, while the vegetation has been cleared along the TL Route Option 02 due to the Côte d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG) transmission line already being constructed (Figure 35). The vegetation TL Route Option 01 largely comprises of patches of "Young Bush", Agricultural Degraded Areas, wetlands and grassy areas. Farms along this the route consisted mostly of rubber trees and food crops (e.g. rice, corn and cassava). Small patches of young secondary forests long this route consist mainly of *Acacia spp., Raffia spp., Uapaca spp., Pterocarpus santalinoides* and *Elaeis guineensis*.

Figure 35: Vegetation along TL Route Option 01 (right) and TL Route Option 02 (left)

The vegetation classes associated with the transmission line alternatives include creeks (Queen, Ma-pla, Dayunn) and streams (Wayduo), inland wetlands/ swamps, agricultural degraded/ low bush vegetation, and secondary grassland vegetation, with the majority of both transmission line routes traversing agricultural degraded/ low bush areas (see Figure 36).

Figure 36: Vegetation units along the TL Route Options



Plant Species of Conservation Concern

A species list of Species of Conservation Concern (SSC) is provided in Table 16 below. None of these species where encountered on the solar PV site or along the two TL routes.

Table 16: Plant species of Conservation Concern in Liberia

Scientific name	Common name	IUCN status	Habitat type
Amanoa bracteosa	-	Vulnerable	Terrestrial - Forests
Amanoa strobilacea	-	Vulnerable	Swampy areas within lowland evergreen rainforest,
Anopyxis klaineana	-	Vulnerable	Forests
Englerodendron vignei	-	Vulnerable	Forests
Berlinia occidentalis.	-	Vulnerable	Forests
Brachystephanus jaundensis subsp. *nimbae*	-	Vulnerable	Terrestrial Forests
Copaifera salikounda	Etimoe	Vulnerable	Forests
Cordia platythyrsa	West African Cordia	Vulnerable	Forests including secondary formations
Cryptosepalum tetraphyllum	-	Vulnerable	Wet evergreen forests and along rivers
Dactyladenia dinklagei	-	Vulnerable	Wet evergreen forest.
Didelotia idae	-	Near Threatened	Wet evergreen and swampy forest
Drypetes afzelii	-	Vulnerable	Wet evergreen forest habitat, mostly along rivers.
Entandrophragma angolense	-	Vulnerable	Forests
Entandrophragma utile	-	Vulnerable	Evergreen Forests
Sterculia oblonga	Yellow Sterculia	Vulnerable	Rain forests
Garcinia kola	-	Vulnerable	Evergreen forest
Gilbertiodendron bilineatum	-	Vulnerable	Along rivers of wet evergreen forests
Guarea cedrata	Light Bossé	Vulnerable	Moist evergreen forest and drier areas of moist evergreen forests
Leplaea thompsonii	Black Guarea	Vulnerable	Hilly moist evergreen forest
Guibourtia ehie	Black Hyedua	Vulnerable	Several forest types

Scientific name	Common name	IUCN status	Habitat type
Mitragyna ledermannii	-	Vulnerable	Restricted to swampy areas, rivers, and also coastal regions within forests
Haplormosia monophylla	-	Vulnerable	Lowland swamp forest
Heritiera utilis	-	Vulnerable	Evergreen forests
Homaliums mythei	-	Vulnerable	Moist forest
Khaya anthotheca	East African Mahogany	Vulnerable	Evergreen forest
Khaya ivorensis	African Mahogany	Vulnerable	Undisturbed evergreen forest
Ledermanniel laaloides	-	Vulnerable	Aquatic herb grows on rocks, submerged in fast flowing water
Loesenera kalantha	-	Vulnerable	Lowland forests and wet forest areas
Lophira alata	Azobe	Vulnerable	Wet evergreen forest
Lovoa trichilioides	African Walnut	Least Concern	Evergreen, deciduous forests and rainforests
Milicia regia	Iroko	Vulnerable	Lower altitude rainforests and cultivated areas
Millettia warneckei	-	Vulnerable	Dry forests
Monocyclanthus vignei	-	Vulnerable	Wet evergreen forest.
Monopetalanthus compactus	-	Vulnerable	
Nauclea diderrichii	-	Vulnerable	Lowland evergreen forest,
Neolemonniera clitandrifolia	-	Vulnerable	
Neostenanthera hamata	-	Least Concern	Humid lowland forests.
Nesogordonia papaverifera	-	Vulnerable	Savanna which has been replaced by forests
Ouratea amplectens	-	Vulnerable	Wet evergreen forest.
Phyllanthus profusus	-	Vulnerable	Wet evergreen forest
Piptostigma fugax	-	Least Concern	Primary and secondary rainforests
Placodiscus pseudostipularis	-	Endangered	Coastal forest. Wet evergreen or riverine forest in the Upper Guinea
Terminalia ivorensis	Black Afara	Vulnerable	Remaining forest areas and along roadsides

Scientific name	Common name	IUCN status	Habitat type
Tetraberlinia tubmaniana	-	Vulnerable	Lowland forest
Tieghemell aheckelii	Cherry Mahogany	Endangered	Wet evergreen rainforest
Trichoscypha bijuga	-	Near Threatened	Lowland rain forest
Trichoscypha cavalliensis	-	Vulnerable	wet evergreen forest
Trichoscypha mannii	-	Vulnerable	Lowland rain forest
Uvariodendron occidentale	-	Vulnerable	Dry forests.

Alien invasive species

Some invasive species were observed on the solar PV site and along the two TL routes (especially along TL Route Option 02 which was cleared for the CLSG line construction). Invasive species such as palm (*Elaeis guineensis*) and bamboo (*Bambusa vulgaris*) covers large areas of the site. *Lantana camara*, indigenous to the American tropics, is widespread around Africa and can form dense thickets. *Chromolaena ordorata* is a fast-growing perennial shrub, native to South America and Central America. It has been introduced into the tropical regions of Asia, Africa and the Pacific, where it is an invasive weed. Also known as Siam weed, it forms dense stands that prevent the establishment of other plant species. Perennial invasive species (*Ipomoea parasitica, Ricinus communis* var. *communis*) were observed within the irrigated sugarcane fields.

Vegetation Sensitivity

No areas of primary vegetation were identified within the project area or along either of the proposed TL Route Options. The vegetation sensitivity on the solar PV site is presented in Figure 37 and the vegetation sensitivity along the TL Route Options is presented in Figure 38. It is important to note that the "Young Bush" vegetation was identified as being secondary in nature (i.e. woody species that re-established after disturbances have taken place). No threatened plant species or plants of national or international conservation concern were identified. Although the GBIF assessment has indicated four tree species that have historically occurred within the region, it is unlikely that these species will have persisted in the area, due to the considerable amount of habitat degradation that has taken place. Should such species be present, they are most likely to occur in the "Young Bush"/ secondary vegetation. Medicinal plants were identified during the field survey.

In terms of ecosystem services, inland wetlands do provide numerous ecosystem services. If any threatened plant species or other plants of conservation concern are present within the project area it is expected that it would be in wetlands, creeks and streams, as well as the "Young Bush" vegetation types.

The inland wetlands as well as the "Young Bush" areas were assigned a medium sensitivity whilst the remainder of the project area was assigned a low sensitivity as it was identified as degraded agricultural areas and associated low bush.

Creeks and streams along the transmission lines were assigned a high sensitivity, due to the additional ecosystem services they offer as well as the habitat of the IUCN listed threatened species often occurring in forests along creeks and streams as well as the supportive role in maintaining ecological integrity of the St Paul River KBA. Based on the current proposed transmission line layouts, TL Route Option 02 crosses only one (1) area of high sensitivity whilst TL Route Option 01 crosses four (4) areas of high sensitivity (Figure 37). TL Route Option 02 has been cleared and altered due to the presence of existing transmission lines and the CLSG transmission line corridor. Due to the shorter distance (4 km, as opposed to the 7 km length of TL Route Option 01) as well as the largely degraded state of TL Route Option 02, this is the preferred alternative in terms of vegetation sensitivity.

Figure 37: Vegetation sensitivity map and solar PV plant layout

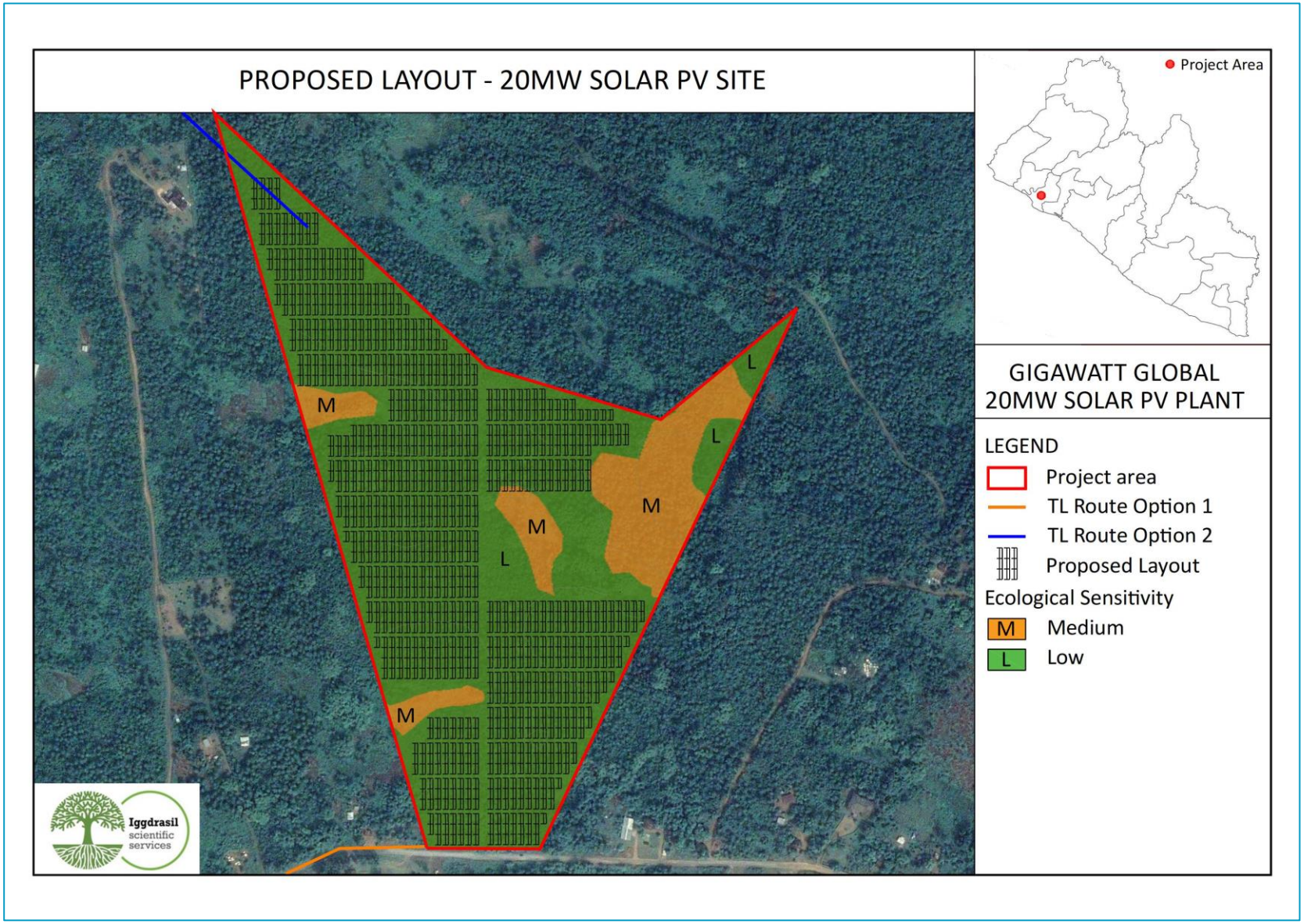
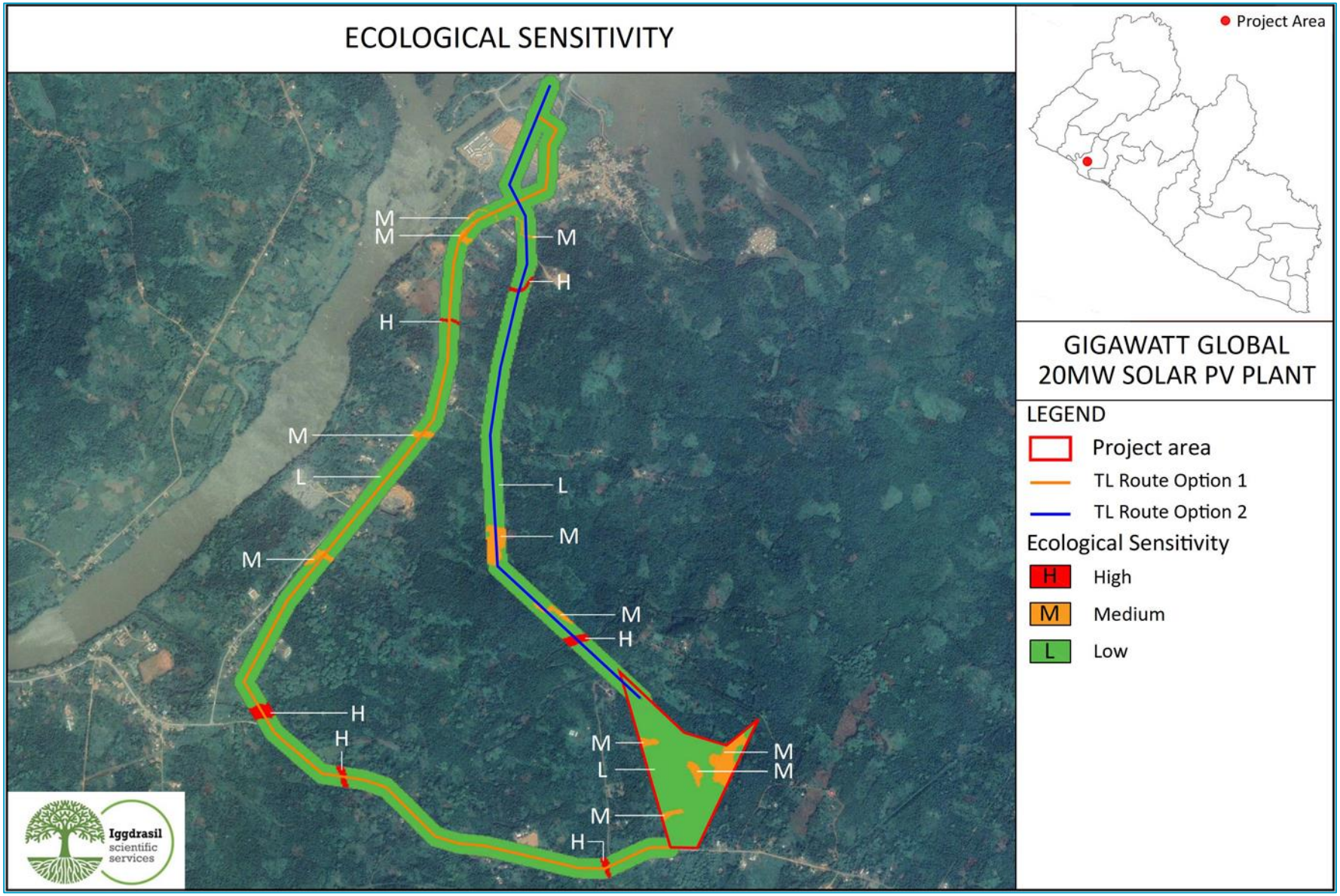


Figure 38: Vegetation sensitivity map along the TL Route Options



5.5.3 Fauna

Mammals

Solar PV Site

During the baseline investigations undertaken during March-April 2020 a total of 11 species were observed (Table 17). All of the observed species were rated as Least Concerned (LC) according to the IUCN Red List.

Table 17: Mammal species observed - Solar PV Site

Scientific name	Common name	IUCN Status
Cricetomys emini	Giant rat	LC
Thryonomys swinderianus	Greater cane rat	LC
Cricetomys gambianus	Gambian pouched rat	LC
Crocidura jouvenetae	Jouvenet shrew	LC
Crocidura obscurior	West African pigmy shrew	LC
Crocidura olivieri	Olivier's shrew	LC
Crocidura theresa	Theresa shrew	LC
Crocidura poensisschweizeri	Fraser Musk shrew	LC
Grammomys poensis	Shining thicket rat	LC
Mus minutoides	African pygmy mouse	LC
Colomys gosling	African wading rat	LC

Transmission Line Corridors

There were 8 species of mammals that were observed along TL Route Option 01, while 5 species were observed along TL Route Option 02 (Table 18). The most abundant species in both corridors are *Thryonomys swinderianus* (greater cane rat) and *Crocidura poensisschweizeri* (Fraser Musk Shrew). All of the observed species were rated as Least Concerned (LC) according to the IUCN Red List.

Table 18: Mammal species observed - Transmission Line Corridors

Scientific name	Common name	TL Route Option 01	TL Route Option 02	IUCN Status
Cricetomys emini	Giant rat	✓	-	LC
Thryonomys swinderianus	Greater Cane rat	✓	✓	LC
Cricetomys gambianus	Gambian pouched rat	✓	✓	LC
Crocidura jouvenetae	Jouvenet shrew	✓	-	LC
Crocidura obscurior	West African pigmy shrew	✓	✓	LC
Crocidura olivieri	Olivier's shrew	✓	-	LC
Crocidura poensisschweizeri	Fraser Musk shrew	✓	✓	LC
Grammomys poensis	Shining thicket rat	✓	-	LC
Mus minutoides	African pygmy mouse	-	✓	LC

Birds

Solar PV Site

Birds expected to inhabit the site are species adapted to live in secondary forests, agriculture habitats, and near rural residences. Previous reports indicate that the Red-eye dove (*Streptopelia semitorquata)* as the most abundant species in the project area. Further species frequently found include Senegal coucal (*Centropus senegalensis*), village weaver (*Ploceus cucullatus*), common bulbul (*Pycnonotus barbatus*), and orange cheek waxbill (*Estrilda melpoda*).

The survey encountered 10 species at the solar PV site (Table 19). The Swamp Palm Bulbul **(***Thescelocichla leucopleura),* Village Weaver (*Ploceus cucullatus)*, Laughing Dove (*Spilopelia senegalensis)* were most frequent. Among the birds of prey only the African Harrier Hawk *(Polyboroides typus)* was recorded. All of the observed species were rated as Least Concerned (LC) according to the IUCN Red List.

Table 19: Bird species observed - Solar PV Site

Scientific name	Common name	IUCN Status
Polyboroides typus	African Harrier Hawk	LC
Streptopelia semitorquata	Red-eyed Dove	LC
Merops albicollis	White-throated Bee-eater	LC
Eurillas gracilis	Little Grey Greenbul	LC
Thescelocichla leucopleura	Swamp Palm Bulbul	LC
Cisticola lateralis	Whistling Cisticola	LC
Ploceus aurantius	Orange Weaver	LC
Ploceus cucullatus	Village Weaver	LC
Lonchura cucullata	Bronze Mannikin	LC
Spilopelia senegalensis	Laughing Dove	LC

Transmission Line Corridors

The survey encountered 17 bird species along TL Route Option 01, and 7 species along TL Route Option 02 (Table 20). The most abundant species in both corridors were the Common Bulbul (*Pycnonotu sbarbatus*), and Swamp Palm Bulbul (*Thescelocichla leucopleura*). All of the observed species were rated as Least Concerned (LC) according to the IUCN Red List.

Table 20: Bird species observed - Transmission Line Corridors

Scientific name	Common name	TL Route Option 01	TL Route Option 02	IUCN Status
Polyboroides typus	African Harrier Hawk	✓	-	LC
Turtur afer	Blue-spotted Wood Dove	✓	✓	LC
Streptopelia semitorquata	Red-eyed Dove	✓	✓	LC
Centropus senegalensis	Senegal Coucal	✓	-	LC
Merops albicollis	White-throated Bee-eater	-	✓	LC
Pogoniulus scolopaceus	Speckled Tinkerbird	✓	-	LC
Andropadus virens	Little Greenbul	✓	✓	LC
Eurillas gracilis	Little Grey Greenbul	✓	-	LC

Scientific name	Common name	TL Route Option 01	TL Route Option 02	IUCN Status
Stelgidillas gracilirostris	Slender-billed Greenbul	✓	-	LC
Thescelocichla leucopleura	Swamp Palm Bulbul	✓	✓	LC
Pycnonotus barbatus	Common Bulbul	✓	-	LC
Ploceus aurantius	Orange Weaver	✓	-	LC
Ploceus cucullatus	Village Weaver	✓	✓	LC
Lanius collaris	Common Fiscal	✓	-	LC
Nectarinia olivacea	Olive Sunbird	✓	-	-
Cinnyris venustus	Variable Sunbird	✓	-	LC
Lonchura cucullata	Bronze Mannikin	✓	-	-
Spilopelia senegalensis	Laughing Dove	✓	✓	LC

Reptiles

Solar PV Site

There were 4 species of reptiles observed within the site. All of the observed species were rated as Least Concerned (LC) according to the IUCN Red List and include the West African Rainbow/Red Headed Rock Agama (*Agama agama*), Speckle-lipped skink (*Trachylepis maculilabris*), White-lipped skink (*Trachylepis albilabris*) and Western Green Mamba (*Dendroaspis viridis*).

Transmission Line Corridors

Only the West African Rainbow/Red Headed Rock Agama (*Agama agama*) was noted along both Transmission Line Corridors.

Amphibians

Solar PV Site

Only the broad-banded grassland frog (*Ptychadena bibroni*) was observed within the site. This species is rated as Least Concerned (LC) according to the IUCN Red List.

Transmission Line Corridors

There were 3 species of amphibians that were observed along TL Route Option 01, while only one species was observed along TL Route Option 02. For TL Route Option 01 this includes the African common toad (*Sclerophrys regularis*), broad-banded grassland frog (*Ptychadena bibroni*) and the Ogowe river frog (*Phrynobatrachus ogoensis*). All of the observed species were rated as Least Concerned (LC) according to the IUCN Red List.

Fish

Solar PV Site

A total of 8 fish species were reported by local community members to be present within the creeks that run north and west of the of the solar PV site. The species were rated as LC and Data Deficient (DD) according to the IUCN Red List (see Table 21).

Table 21: Fish species reported - Solar PV Site

Scientific name	Common name	IUCN Status
Heterobranchus longifilis	Black catfish (Vundu)	LC
Hemichromis fasciatus	Banded Jewelfish	LC
Tilapia zillii	Redbelly tilapia	LC
Hemichromis bimaculatus	Jewlfish	LC
Epiplatys spp	Panchax	LC
Chrysichthys johnelsi	-	LC
Ctenopoma spp	-	DD
Barbus spp	-	DD

Transmission Line Corridors

A total of 10 fish species were reported by local community members to be present in the streams along both of the Transmission Line corridors (and also the same types of species for each of the corridors). The species were rated as LC and DD according to the IUCN Red List (see Table 22).

Table 22: Fish species reported - Transmission Line Corridors

Scientific name	Common name	TL Route Option 01	TL Route Option 02	IUCN Status
Heterobranchus longifilis	Black catfish (Vundu)	✓	✓	LC
Papyrocramus afer	Reticulated knifefish	✓	✓	LC
Hemichromis fasciatus	Banded Jewelfish	✓	✓	LC
Tilapia zillii	Redbelly tilapia	✓	✓	LC
Hemichromis bimaculatus	Jewlfish	✓	✓	LC
Hepsetus odoe	African pike characin	✓	✓	LC
Epiplatys spp	Panchax	✓	✓	LC
Chrysichthys johnelsi	-	✓	✓	LC
Ctenopoma spp	-	✓	✓	DD
Barbus spp	-	✓	✓	DD

5.5.4 Protected and Conservation Areas

The solar PV site and transmission line corridors are not located close to any protected area. A summary of protected and conservation areas is presented in Table 23.

Table 23: Summary of Protected Areas

Level of significance	Information or Source	Significance specific to the study area	Figure
International	United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Sites	Liberia has no designated UNESCO World Heritage Sites, however two Tentative World Heritage Sites have been identified: Mount Nimba Strict Reserve (extension) (2017), located approximately 300 km from the project area in the northeast of Liberia. This site has been selected based on Natural Criteria; and Providence Island (2017), an island located within the Mesurado River in Liberia's capital city, Monrovia, 22km southwest of the project area. This site has been selected based on Cultural Criteria (UNESCO, 2017). Due to the distance of these sites from the project area, they are unlikely to be impacted. The proposed project will furthermore not impact the cultural significance of Providence Island.	Figure 39
	Endemic Bird Areas (EBAs) and Important Bird Areas (IBAs)	Most of Liberia is located within the Upper Guinea Forests EBA. The Upper Guinea forest originally covered most of Liberia and surrounding countries, although up to 77% this area has since been deforested as a result of logging, agriculture and mining, with the remaining forests undergoing degradation and fragmentation at a rapid pace for the same reasons. It is expected that most forests outside of protected areas and forest reserves will be lost within the next 25 years (Birdlife International, 2020a). All the endemic bird species within this EBA have restricted ranges (BirdLife International, 2020a). The project area is located on the boundary of the Upper Guinea Forests EBA, with the northern portions of the transmission line routes located within this EBA. Liberia has nine areas that are designated IBAs (BirdLife International, 2020b), with none located in close proximity to the project area. The closest IBA to the project area is the Lake Piso (Cape Mount) IBA, situated approximately 60 km to the west. Due to the distance of these sites from the project area, they are unlikely to be impacted.	Figure 40
	Key Biodiversity Areas (KBAs) and Alliance for Zero Extinction (AZEs) Sites	Key Biodiversity Areas (KBAs) are defined as sites that contribute significantly to the global persistence of biodiversity in terrestrial, freshwater and marine ecosystems. Global KBAs are selected based on eleven criteria within five categories which include threatened biodiversity,	Figure 40

Level of significance	Information or Source	Significance specific to the study area	Figure
		geographically restricted biodiversity, ecological integrity, biological processes and irreplaceability (IUCN, 2016). Twenty terrestrial KBAs have been identified within Liberia, none of which are located in close proximity to the project area. The closest terrestrial KBA to the project area is the Lake Piso (Cape Mount) KBA, situated approximately 60 km to the west (Birdlife International, 2020c). Four freshwater KBAs have been identified in Liberia, of which three are associated with the St. Paul River located immediately to the west of the project area, namely the Upper, Middle and Lower reaches of the St. Paul River. The project area is located within the Lower reaches of St. Paul River freshwater KBA (Birdlife International, 2020c). Alliance for Zero Extinction sites are sites selected for their importance in preventing global extinctions and which have threatened species restricted to a single location globally (AZE, 2018). All AZE sites are also designated KBAs. One AZE site occurs in Liberia, namely Weeni Creek and Associated Hydrobasin. This site has been designated as an AZE site specifically for the protection of *Liberonautes grandbassa* (Grandbassa River Crab), a threatened crustacean species. This site is located 100km southeast of the project area. The proposed project is unlikely to impact on the functioning and conservation value of terrestrial KBAs and AZEs, due to the distance of these sites from the project area. The project area is however located within the Lower reaches of St. Paul river freshwater KBA, and the proposed project may therefore impact on this conservation feature.	

Level of significance	Information or Source	Significance specific to the study area	Figure
	RAMSAR Wetlands	There are five wetlands in Liberia that have been identified as RAMSAR Wetlands of International Importance in terms of the RAMSAR Convention, 1996. None of Liberia's RAMSAR site are located in the immediate vicinity of the project area, with the closest RAMSAR sites being the Mesurado Wetlands, located 25km southwest of the project area and the Marshall Wetlands, located 47km to the southeast. The Mesurado Wetlands are of importance for the protection of three mangrove species (*Rhizophora harrisonii, R. mangle and Avicennia africana*) and several bird and crocodile species, as well as for ecosystem services such as sediment trapping and stabilisation of the shoreline. The site is at risk from fuelwood collection, dumping, unregulated fishing and pollution (RSIS, 2006). The Marshall Wetlands are of importance for ecosystem services provision such as flood control, sediment trapping and groundwater recharge, protection of secondary forest and woodland habitats as well as mangroves, fish populations and wildlife (RSIS, 2006). Due to the distance of these sites from the project area, they are unlikely to be impacted.	Figure 39
National	National Protected Areas	Liberia has four formally protected areas: • Sapo National Park; • Gola Forest National Park; • Lake Piso Multiple Sustainable Use Reserve; and • East Nimba Nature Reserve. None of the above protected areas are located in close proximity to the project area. The closest one to the project area is the Lake Piso Multiple Sustainable Use Reserve, situated approximately 60km to the west. In addition to the above, ten other areas are proposed protected areas, with the closest proposed protected areas being the Margibi Mangrove National Park located 25km to the southeast and the proposed Bong Mountain 56km to the northeast of the project area. Liberia also has a number of forest reserves (national forests), none of which are in close proximity to the project area. The management of protected areas and reserves is currently poor or non-existent.	Figure 39

Figure 39: Designated and proposed Protected Areas, including Forest Reserves, tentative UNECSO World Heritage Sites and RAMSAR Wetlands

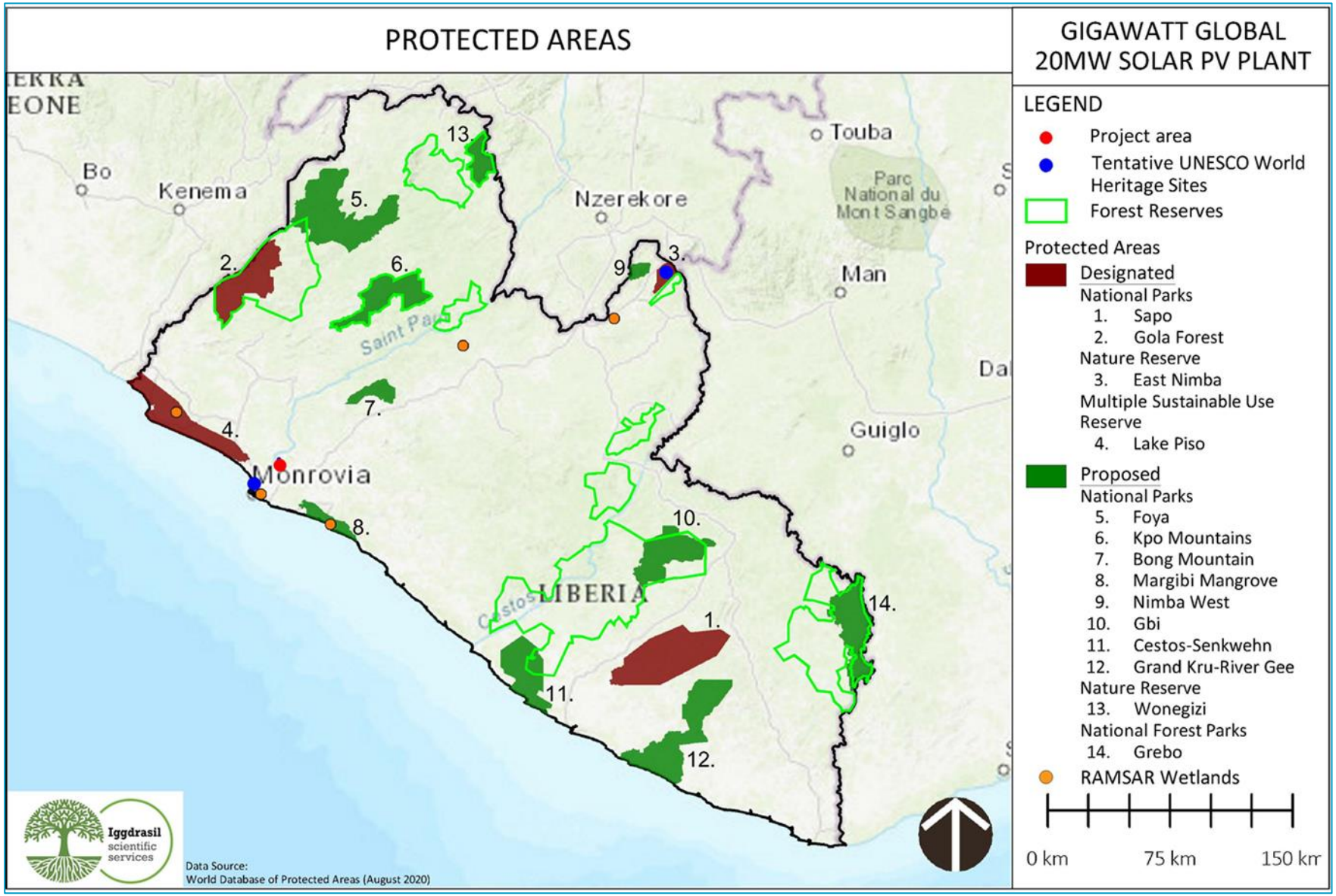
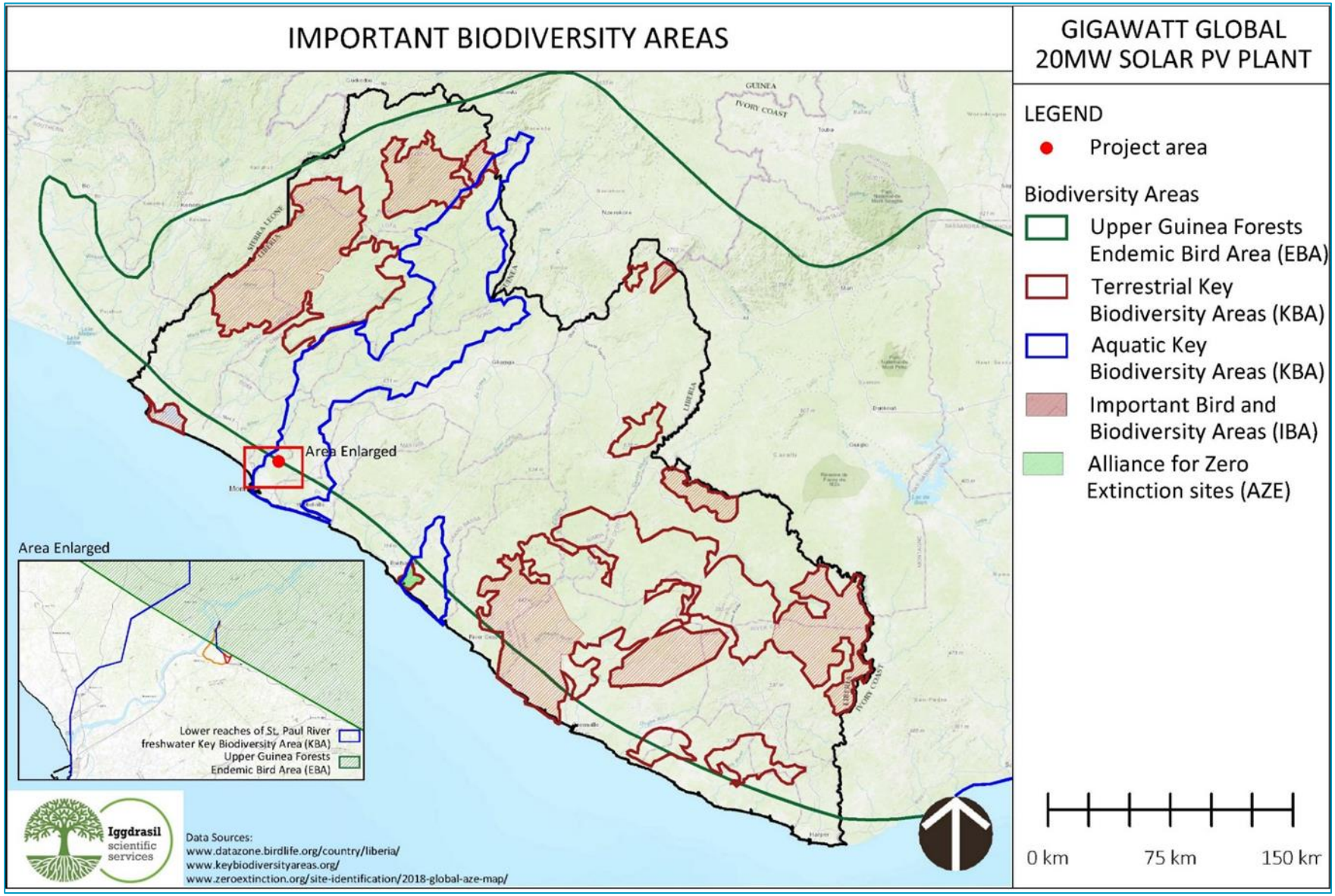


Figure 40: Important Biodiversity Areas, including ESAs, IBAs, KBAs and AZEs



5.5.5 Habitat Status Assessment

Modified Habitat is defined as "areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition.

Natural Habitat is defined as 'areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

Critical Habitats are areas with high biodiversity value, including

- habitat of significant importance to Critically endangered and/or endangered species;
- habitat of significant importance to endemic and/or restricted-range species;
- habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- highly threatened and/or unique ecosystems; and/or
- areas associated with key evolutionary processes.

Based on the above, the solar PV site and both of the transmission line corridors could be considered as Modified Habitat due to human-induced alteration, except for a small portion in the north eastern part of the solar PV site which is considered to be Natural Habitat (as it contain viable assemblages of plant species of native origin and past human activity has not essentially modified it).

The solar PV site was historically used as a rubber plantation, and later converted to a piggery farm (including clearing land for grazing) followed by subsistence agriculture (including palm oil production, planting of fruit trees, crop cultivation in wetland areas, fire wood collection and charcoal production), resulting in significant modification and fragmentation of habitats.

TL Route Option 01 exhibits similar habitats to the solar PV site due to similar impacts, and 4km of the 7km for this route has been cleared of vegetation for the existing transmission lines running between the MCHPP and Monrovia. There are various housing structures and subsistence farms along this route.

TL Route Option 02 has been cleared entirely of vegetation for the CLSG transmission line. Some area along this route is used for crop cultivation, grazing and charcoal production.

No Critical Habitat triggers have been confirmed to occur on the solar PV site or transmission line corridors, as summarized in Table 24.

Although not located within an area that can be defined as critical habitat, the proposed project is located within a freshwater KBA, namely the Lower reaches of St. Paul River freshwater KBA (Birdlife International, 2020c), which is defined as an internationally recognised in terms of Performance Standard 6 (IFC 2012).

Table 24: High Level Critical Habitat Assessment

IFC criterion	Rationale
Criterion 1. Critically Endangered and Endangered Species	Not triggered – No critically endangered or endangered species of flora or fauna has been confirmed or likely to occur on the site.
Criterion 2. Endemic and Restricted Range Species	Not triggered – No endemic or restricted range species of flora or fauna confirmed or likely to occur on the site. Some plant species could be endemic to Liberia or the region but are not considered to have restricted ranges.
Criterion 3. Migratory and Congregatory Species	Not triggered – No migratory or congregatory species occur on the Project Site or are likely to be impacted by project infrastructure (e.g. transmission lines).

IFC criterion	Rationale
Criterion 4. Highly Threatened and / or Unique Ecosystems	Not triggered – The "Low Bush" is a widespread habitat type that is resilient to disturbance, and recovers after fire, cultivation or exploitation if left alone.
Criterion 5. Key Evolutionary Processes	Not triggered – The site was previously used as a rubber plantation and agriculture. Invasive species such as palm (*Elaeis guineensis*) and bamboo (*Bambusa vulgaris*) covers large areas of the site, and no unique populations of fauna or flora were noted.

Implications for the Project

IFC PS6 Clause 14 requires that:

The client will not significantly convert or degrade natural habitats unless all of the following are demonstrated:

- *No other viable alternatives within the region exist for development of the project on modified habitat;*
- *Consultation has established the view of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation, and*
- *Any conversion or degradation is mitigated according to the mitigation hierarchy.*

In terms of the above, "significant" conversion or degradation is: i) the elimination or severe diminution of the integrity of a habitat caused by a major and/or long-term change in land or water use or ii) a modification that substantially minimises the habitat's ability to maintain viable populations of native species.

Clause 15 states:

In areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity where feasible. Appropriate actions include:

- *Avoiding impacts on biodiversity through the identification and protection of set-asides;*
- *Implementing measures to minimise habitat fragmentation, such as biological corridors;*
- *Restoring habitats during operations and / or after operations; and*
- *Implementing biodiversity offsets.*

Note: no net loss is defined as the point at which project-related impacts on biodiversity are balanced by measures taken to avoid and minimise the project's impacts, to undertake on site restoration, and finally to offset significant residual impacts, if any, on an appropriate geographic scale.

The solar PV layout has been adjusted to avoid the only remaining "Natural Habitat" in the north eastern part of the solar PV site, as well as the three wetland areas located within the solar PV site. Therefore impacts have been avoided and these areas shall be demarcated as no-go areas.

5.5.6 Aquatic Ecosystems

The extent of Liberia's surface area, including the project area, falls within the Tropical and Subtropical Coastal Rivers freshwater biome or Major Habitat Type (MHT). MHTs represent freshwater ecoregions that have similar biological, chemical and physical characteristics, and can roughly be equated to biomes in terrestrial ecology. These freshwater ecoregions are characterised by riverine ecosystems, with numerous small to medium-sized basins draining towards the ocean, as opposed to single large rivers with extensive floodplains. There are few floodplains in the region, but small lakes, coastal lagoons and other wetlands may be present, and swamps and mangrove forest often occur near river mouths (WWF/TNC 2019).

At a smaller scale, the project area is located within the Southern Upper Guinea freshwater ecoregion, which comprises the coastal basins from Liberia, southwards towards western Ivory Coast. Major river within the ecoregion include the Mano, Lofa, St. John, Cestos, Cavally and St. Paul Rivers, with the St. Paul River located approximately 2.5 km to the north-west of the proposed solar PV site at its closest point, and running roughly parallel to TL Route Option 01 at an average distance of around 500 m. The St. Paul River originates in south-eastern Guinea and enters the ocean at Monrovia. Queen Creek is located approximately 300 m west of the solar PV site at its closest point.

Stream and rivers within the Southern Upper Guinea freshwater ecoregion are relatively short, partly torrential and known to support a high percentage (up to one fifth) of endemic freshwater fish species due, in part, to long term geographical isolation (Hugueny & Lévêque, 1994). Several rare mammal species and endemic amphibian species occur in the ecoregion (IUCN, 2015). The Upper Guinea Rivers and Streams ecoregion is included as a WWF Global 200 freshwater ecoregion, and the freshwater features are classified as Bioregionally Outstanding. Threats to the ecoregion include pressures associated with agriculture, timber and fuel wood extraction, hunting and mining (IUCN, 2015).

5.6 AIR QUALITY AND NOISE

5.6.1 Air Quality

The project is located in an area that is rural in character. As such the levels of gaseous pollution should be relatively low, and the sources of air emission in the immediate area are limited. Sources of emissions at the solar PV site and along the TL routes include:

- Gaseous and dust emissions from vehicle traffic along the roads (which are largely unpaved);
- Smoke emissions from agricultural activities (e.g. slash and burn), charcoal manufacturing, cooking and burning of domestic waste; and
- Dust from the Harmattan trade wind coming from the Sahara Desert (especially during December to March).

The air quality in and around Monrovia is generally poor as a result the high use if diesel generators, burning of waste and emission from vehicles (often using sub-grade fuel purchased on the side of the road due to the recurring fuel shortages in the country). This could affect the air quality at the site as its located only 20 km north east of Monrovia.

5.6.2 Noise

Anthropogenic noise sources in the project vicinity and along the transmission line corridors include wood chopping, subsistence farming activities, social gatherings (e.g. church gatherings) as well as motorcycles and vehicles moving along the roads. Noise levels along the last 4km of TL Route Option 02 is expected to be higher due to the increased concentration of housing structures, industrial operations and the fact that it runs along the MCHPP – Monrovia road where there is an increased level of traffic.

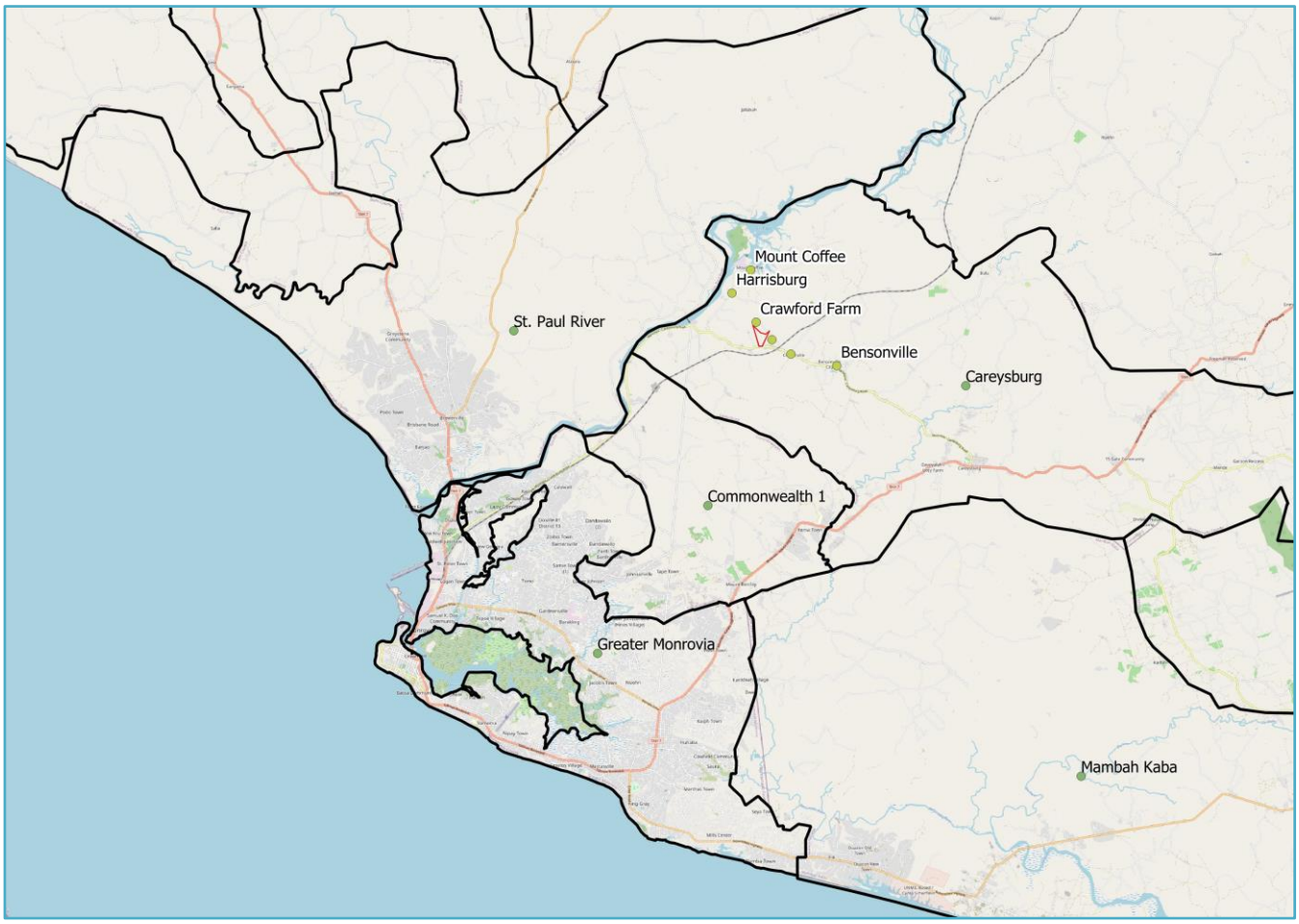
5.7 SOCIO-ECONOMIC PROFILE

5.7.1 Administrative Structure

The solar PV site is located in the Careysburg District of the Montserrado County of Liberia. The Districts are placed under the administration of the district commissioner that is further supported by a range of functionaries. The district is further divided into clans (or local political units) which is loosely associated with the traditional administrative structures. The Clan is headed by a traditional Paramount Chief (in the case of an agglomeration of multiple chiefdoms) or by a Town or Village Chief.

At the local level, the major settlements located in proximity to the project site include Bensonville (approx. 4 kilometres east), Crozierville (approx. 1 kilometre east), Harrisburg (approx. 2 kilometres north-west) and Mount Coffee (approx. 4 kilometres north) (see Figure 41). Bensonville functions at the administrative centre of Careysburg District.

Figure 41: Administrative Districts and Key Settlements



5.7.2 Land use and land tenure

Solar PV Site

The solar PV site is located on a derelict commercial farm that supported rubber-tree plantations, as well as piggery and poultry operations prior to the civil war. The farm has not been in operational since the second civil war that ended in 2003 (except for subsistence farming taking place). The commercial farm remains under private tenure as secured via formal title by the landowner.

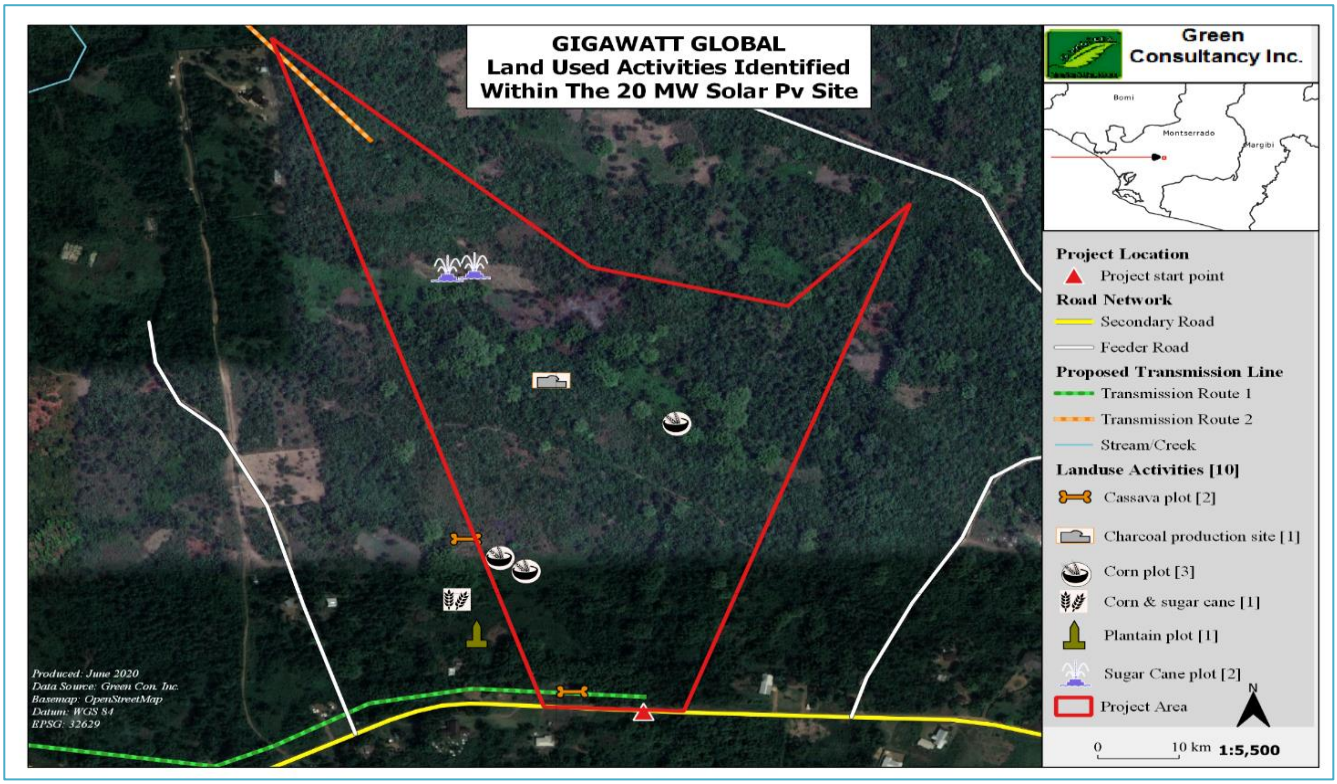
As the commercial operations have ceased the site has largely been allowed to reinstate back to natural vegetation, and the majority of the site is now classified as degraded agricultural land (See Section 5.5

concerning ecological characteristics). There is minimal active use of the site, which includes small-scale farmplots and seasonal gardens plots (see Figure 42), as well as charcoal production and natural resource harvesting.

It is estimated that 7% (2.5 hectares) of the solar PV site supports small-scale farming of predominately Cassava, Maize or Plantain on elevated areas, while Sugar Cane is grown along the ephemeral streams that cross the site (see Figure 43 and Figure 44). The area under cultivation is expected to variable for each season as local households practice shifting cultivation, but the presence of secondary forest suggests that there is no systemic clearing of local vegetation for farming.

The majority small-scale farming found on the solar PV site is undertaken by the residents of Crawford Farm. These residents are ex-employees of the commercial farm and who have largely remained resident in the farm housing after commercial operations ceased around 2003. The farm housing remains on the commercial farm; however they are outside of the solar PV site boundary.

Figure 42: Key Land-Uses in the Project Site



It was confirmed by the landowner, that the residents of Crawford Farm have been granted permission to occupy the farm housing. Given their long-term residency at the farm, this group of people can be broadly considered to be permanent occupants, with strong historical connections with the farm but without formal title. In essence, the residents of Crawford Farm are land and home tenants with long-term occupancy rights granted by the landowner.

In addition to the occupancy rights to farm housing, the residents of Crawford Farm have also been granted permission by the current landowner to use the land within the solar PV site. This permission is not based on a formal tenancy agreement, but rather is a long-term informal agreement or understanding between the landowner and local residents. As with housing, the residents of Crawford Farm may be considered to be long-term land tenants with permission to use the land by the landowners, but do not have any claim of ownership (via formal title or customary right) to the land.

As there are no clearly defined property boundaries, it is also expected that neighbouring households (including households that form part of Crozierville and Porte Hill) may also enter into the solar PV site to undertake small-scale farming. Field investigations suggest that the level of intrusion into the solar PV site

is very limited and is largely comprised of small-scale maize farming as well as harvesting of productive trees found along the southern boundary.

Figure 43: Small-Scale Cassava Farmland Located Within the Project Site

Figure 44: Sugar Cane Farmplots Located on Project Site Ephemeral Streams

Transmission Line Corridors

TL Route Option 01 is comprised of cleared land secondary forest, limited farmland and isolated farmsteads or small hamlets (see Figure 45). Most households will however be located along main and secondary access roads. Small-farming is the primary livelihood of such households and farmplots are interspersed throughout the proposed transmission line routes (see Figure 46).

TL Route Option 02 is comprised of cleared land for the CLSG wayleave (see Figure 47).

The proposed transmission lines (irrespective of the route alternatives) terminates at the Mount Coffee Sub-Station located at Mount Coffee approximately 4 kilometres north-west of the Project site. Mount Coffee is an established town with a concentration of households and commercial businesses focussed on the Mount Coffee hydropower plant.

The proposed transmission lines (including the two major alternatives) are likely to cross over multiple types of land ownership or tenure. Assuming that the transmission line is located in the existing Côte d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG) transmission line wayleave, then the route would be limited to state-owned land under a wayleave agreement. The transmission line that follows the local road network would likely cross multiple land tenure types including (1) private land under private tenure, (2) private land under customary tenure, (3) informal land tenants with or without permission from the landowners, or (4) state or public land.

Figure 45: Road-Side Household Found Along TL Route Option 01

Figure 46: Road-Side Small-Scale Farmland Found Along TL Route Option 01

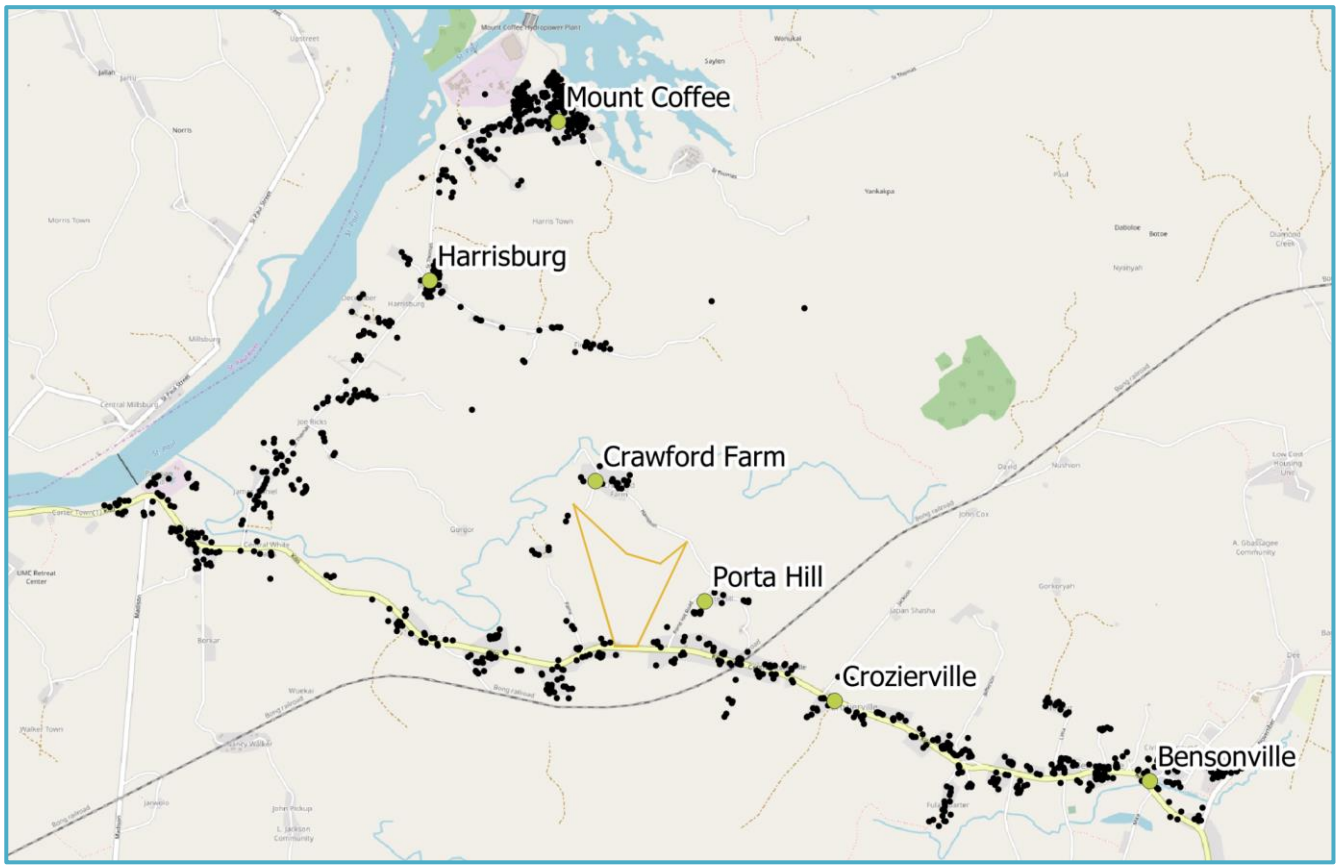
Figure 47: Existing CLSG Transmission Line and Wayleave (TL Route Option 02)

5.7.3 Settlement patterns

The settlement patterns surrounding the solar PV site and the transmission line routes comprises of rural villages interspersed with small hamlets and isolated farmsteads. All three types of settlements extend along existing main and secondary access roads.

There are three key townships (Crozierville, Harrisburg and Mount Coffee) in proximity to the solar PV site and the transmission line (see Figure 48). Crozierville does not have a defined central area, rather the village is comprised of an estimated 120 households extending along 2-kilometres of the local Kilo Main Road (see Figure 50).

Figure 48: Settlements and Households in Relation to the Project Site and Transmission Lines



Harrisburg and Mount Coffee are established townships located approximately 3.5 and 4 kilometres north-west of the solar PV site (see Figure 49). The two townships support a concentration of households and commercial businesses focussed on the Mount Coffee hydropower dam. The transmission line routes will both pass through this town and surrounding villages and terminate at the Mount Coffee Sub-Station.

In addition, the district is dotted with multiple small hamlets (or small clusters of farming households) that are often of insufficient size to be classified as a village and often support closely linked families or relations. Examples of such hamlets near the solar PV site include households residing in Porta Hill and Crawford Farm (see Figure 51).

The district also supports isolated and individual farmsteads that are located along existing primary roads and secondary access roads. These farmsteads act as connectors or filaments between the various villages and hamlets and are often subsumed into the nearest villages. The general spatial distribution of these farmsteads in relation to the Project site and the transmission line routes is depicted in Figure 48 above.

Figure 49: Image of Mount Coffee Town

Figure 50: Image of Crozierville

Figure 51: Image of Crawford Farm / Hamlet

5.7.4 Population profile

The solar PV site is located in the Careysburg District. Population statistics show that Careysburg District supported 29,712 persons during Census 2008 and an estimated[10] 33,349 persons in 2014 (Table 25). Further projections of population growth results in an estimated population of 39,074 persons in 2020.

Table 25: District Population Profile

Administrative Level	Projected Population 2014				Projected Population 2020			
	Males	Females	Total	HHs	Males	Females	Total	HHs
Bensonville City	2 250	2 162	4 412	865	2 534	2 435	4 969	897
Careysburg City	5 966	5 848	11 814	2 316	6 719	6 586	13 304	2 401
Crozierville Township	1 377	1 228	2 605	511	1 551	1 383	2 934	530
Harrisburg	847	804	1 651	324	954	905	1 859	336
Kingsville Township	5 812	5 800	11 612	2 277	6 545	6 532	13 077	2 360
White Plains Township	638	617	1 255	246	718	695	1 413	255
Careysburg District	**16 890**	**16 459**	**33 349**	**6 539**	**19 021**	**18 536**	**37 556**	**6 778**

Adapted From: (Liberia Institute of Statistics and Geo-Information Services, n.d.)

The population statistics further estimate that the district supports a total of 6,539 households in 2014, with a growth rate of only 0.6% per annum since Census 2008 (Liberia Institute of Statistics and Geo-Information Services, n.d.). This is lower than the national population growth rate of 2.0% per annum and suggests that existing households are absorbing this growth rather than the establishment of new households.

These above findings are supported by the average size of the households in the district. Population statistics (Liberia Institute of Statistics and Geo-Information Services, n.d.) show that the average household size at the time of Census 2008 was 4.7 persons. This has increased to a projected 5.1 persons per household in 2014 and further increased to a project 5.5 persons per household in 2020.

Local households are made up of the *nuclear family* – or the father (who is often the household head), mother and 2 to 3 children, while some households will also support grandparents and grand-children. As such, a single-family retaining use of a single homestead is by far the most common form of household in the area.

The 2014 population show a near equal gender ratio of 1.02 males to 1.00 females suggesting that the local population is largely stable and there is no appreciable gender bias in terms of immigration and emigration movement from the district.

The population density of the Careysburg District is estimated to be 114 persons per kilometre squared in 2020. In contrast the Greater Monrovia supports a population of 1,089,686 person in 2014 and an average population density of 5,588 persons per kilometres squared. This reflects a clear divide between the rural Careysburg District and the largely urbanised Monrovia.

The spatial distribution of the district population and household is not even (as discussed in Section 5.7.3). The two nearest settlements to the Project site (Harrisburg and Crozierville) supports 4,256 persons in 2014 or only 12% of the total district population. The great proportion of the district population are resident in Careysburg City and Kingsville Township. These district centres are located 12 kilometres and 20 kilometres east of the Project site, respectively.

---

[10] *The latest available statistics is the Census 2008 and the 2014 population projections provided by the Liberia Institute of Statistics and Geo-Information Service is based on a population growth rate of 2.0% per annum.*

5.7.5 Language

Liberia supports more than two dozen local languages as well as several vernaculars and dialect, however English remains the only official language as well as various simpler forms of Liberian English (Liberia Institute of Statistics and Geo-Information Services, 2014). With respect to the Montserrado County, the ethno-linguistic make-up is highly diverse due to the migration of different groups to the capital over time. However, the County is predominately made up of Kpelle (21% of county population) and Bassa speakers (52% of county population). The solar PV site is located in rural Montserrado which is predominately comprised of the Kpelle speaking ethnic group (approx. 40% of the population) followed by a mixture of Gola, Bassa, Grebo, Mano, Kru and Lorma-speaking ethnic groups.

It can be expected that communication with local communities will need to be a mixture of simpler forms of Liberian English as well as Kpelle as the primary two languages. It can also be reasonable assumed that minority languages can be accommodated by these languages as local households would have largely assumed one of the two languages to allow them to communicate with their neighbours.

5.7.6 Education and employment

Educational achievement remains a key challenge in Liberia in general, and is largely due to the education system being unstable since the civil war (Liberia Institute of Statistics and Geo-Information Services, 2014). However, the Government of Liberia has expanded education significantly and adopted a free primary education policy in all government schools. In essence, primary school (consisting of the first six years of school) is free, while junior high school and senior high school (consisting of three years each) is paid education.

In addition, the Government of Liberia has sought to promote better access for girls to primary school education as part of the National Girls' Education Policy of 2006. This covers a national programme aimed at activities to recruit and train more female teachers, provide counselling for girls and life skills education in schools, increase the availability of scholarships for girls and strengthen health systems in schools. The policy requires that government establish partnerships with international organisations in promoting girl's education

Education achievement rates in the Montserrado County (Liberia Institute of Statistics and Geo-Information Services, 2014) as shown in Table 26 show that the majority of females and males have either no education (25% of the surveyed county population) or achieve little more than partial basic primary education (27% of the surveyed country population).

Table 26: Education Profile

Cat.	No Edu.	Some Prim.	Complete Prim.	Some Sec.	Complete Sec.	More than Sec.	Med. Years Complete
Montserrado County							
Female	30.3	30.3	2.0	23.9	7.7	5.9	3.0
Male	21.2	24.0	2.3	23.8	15.8	12.9	5.9
Total	**25.8**	**27.2**	**2.2**	**23.9**	**11.8**	**9.4**	**4.5**
National							
Urban	30.5	28.3	2.0	24.3	11.0	7.8	4.1
Rural	53.0	28.6	1.8	12.3	3.6	0.6	0.2

Adapted from: (Liberia Institute of Statistics and Geo-Information Services, 2014)

Primary school completion rates are estimated at 39.5% for females and 54.2% of males (Table 26), showing that there remains prioritisation of male children over female children. In most cases, children

that have completed primary school are enrolled into secondary school. This suggests that households that are able to support their children through primary school have sufficient resources to allow for their continued education.

The statistics provided in Table 26 must however be read with caution as the Montserrado County support both urban and rural communities (including Monrovia). There are often major differences in education levels between urban and rural areas, as reflected in Table 26. Rural populations often have much reduced access to secondary schools or do no assign the same value to continued education as urban populations. This results in maximum education rates generally capping off at primary school in rural areas, while persons without any education is much higher in rural areas (53%) when compared to urban populations (30%).

With respect to employment rates, the Montserrado County supported 326,000 employed persons in 2010 or 46% labour force participation of economically active people (persons aged between 15 and 64 years and are deemed economically active) (Liberia Institute of Statistics and Geo-Information Services, 2011).

The majority of employment is however comprised of elementary positions (17% of employed county population) and the service sector (43% of employed county population), while technical or skills employment makes up the remaining 41% of employment. The majority (60%) of all employment falls into the informal sector suggesting that elementary and service trade is mostly undertaken on informal conditions and is not linked to formal employment (Liberia Institute of Statistics and Geo-Information Services, 2011)..

The labour force survey does not divide the Montserrado County labour statistics by the urban and rural divide and therefore the statistics must be read with caution. Urban areas (such as Monrovia) will support far greater rates of employment in the services sector via informal employment (27% of employment) or self-employment (58% of employment). In contrast, employment in rural areas is comprised mostly of self-employment in the informal small-scale farming sector (64%) and contributing family worker (16% of employment). Only 27% and 17% of urban and rural employment falls under the formal sector (Liberia Institute of Statistics and Geo-Information Services, 2011).

In practice, the communities surrounding the Project site will reflect the rural employment profile where formal employment will be very restricted and likely only found at the Mount Coffee Hydropower Project. Self-employment and casual labour in the informal small-scale farming sector will dominate and therefore is the economic foundation in the area.

5.7.7 Livelihoods

Local households surrounding the solar PV site have a limited range of livelihoods that are undertaken to meet household food needs or to generate an income. Interviews with local communities indicate that small-scale farming, market gardens and tree crops function as the economic foundation of local households while livestock rearing is of marginal value. Natural resources harvesting, including charcoal production, is an important secondary livelihood. Wage-based income is negligible given the lack for employment opportunities in the surrounding areas.

Small-Scale Farming

Small-scale farming is of critical importance for local households. While often termed *subsistence farming* this is not fully correct, as such farming is undertaken to secure household food needs first, and any surplus crops are traded for cash income.

The proportion of crop produce allocated to household food or trade will be highly variable between households and will be dictated by the size of farmplots, annual crop yields and the size of the family. However, broadly speaking 60% of crop produce is used for household food while the remaining 40% is traded for cash income (Liberia Institute of Statistics & Geo-Information Services, 2016).

A key determinant of crop yields is the size of farmland available to local households. The average field holdings at the county level is estimated to be 1 farmplot per household with the average size of each field being 0.7 hectares (Liberia Institute of Statistics & Geo-Information Services, 2017). This is half of the

national average of 1.6 hectares of land cultivate by households, which suggests that farming is far more restricted in the Montserrado county.

No similar statistics can be found for the Careysburg District, however interviews and desktop mapping suggest that local households are similarly restricted in terms of the overall field sizes. This is attributed to claims that large tracts of land in the district are under private tenure. Local households largely respect private land and will only farm the land when permission is granted by the landowner.

The solar PV site is located in a defunct private commercial farm while neighbouring landowners are also under private tenure. As such little farming is undertaken around the solar PV site without explicit permission by the landowners.

The primary annual crop farmed by households in the district is mostly cassava, and smaller amounts of maize, plantain, sugarcane, and mixed vegetables (including cucumber, peppers, pumpkins, eggplant etc.). This largely reflects the same crop diversity farmed in the Montserrado County (Liberia Institute of Statistics & Geo-Information Services, 2017) however there is less rice cultivation in the district.

The primary crops are closely linked to the seasonal rains and location of farmland. Cassava is predominately farmed on elevated land (i.e. dryland) during the rainfall season, while vegetables and sugarcane is farmed along local ephemeral streams during the dry season. The general characteristics of the two forms of cultivation is detailed below, while a broad annual cropping calendar depicted in Table 27.

1. **Wet-Season / Dryland Farmland:** This type of farmland entails the placing of farmplots on slightly elevated land away from local streams and may even extend up into the local hills. This is to avoid the waterlogging of soils and damage to the annual crops. These farmplots comprise the major landholdings of local households and is normally comprised of cassava, with some maize and plantain.

Table 27: Broad Cropping Calendar

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dryland Crops												
Land Preparation			■									
Planting			■	■								
Tending				■	■	■	■	■	■	■		
Harvesting										■	■	■
Fallow	■	■										
Market / Vegetable Gardens												
Land Preparation										■		
Planting										■	■	■
Tending											■	■
Harvesting	■	■										■
Fallow			■	■	■	■	■	■	■			
Rainfall Seasons												
High / Wet Season						■	■	■	■	■		
Medium					■						■	
Low / Dry Season	■	■	■	■								■

Dryland farming, irrespective of the crop, is undertaken at a very specific season. Land preparation and planting is undertaken between March and April and coincides with the seasonal rains. All crops are rainfed with some hand irrigation undertaken by local households. Interviews suggests that multiple types of the dominant cassava crop are cultivated however most require seven months to mature. Harvesting is undertaken between October to December but may extend into January. The solar PV site supports very limitation Cassava production (see Figure 52); however, it is commonly found throughout the local communities.

There is only a short two-month period where the land remains fallow (January and February). Interviews indicate that rotation farming is not undertaken, whereas shifting cultivation is more common. The latter practice is however restricted by private landholding in the district. This suggests that farmland may be under pressure from over-use.

Interviews with local communities suggest that the income generated from the sale of annual crops is essential to support the second form of cultivation (market gardens) and the income is used to secure seed and labour. This suggests that the two forms of cultivation are fundamentally interlinked.

2. **Market/Vegetables Gardens:** These gardens are restricted to local rivers, streams, and drainage lines (or any drainage feature that sustains water during the dry season). The gardens are normally very small (on average 40 metres squared) relative to the dryland farmplots.

   The gardens are predominately used to grow high-value and water-hungry vegetables (including maize, sugarcane, cucumber, peppers, and other mixed vegetables). The solar PV site support sugar cane and maize that are restricted to the two streams that extend through the site (see Figure 53)

   The cropping season for market gardens is almost an inverse of the dryland crops. The gardens are not farmed during the rainfall season as the streams are usually flooded or water-logged. Land preparation and planting is undertaken in around October, and in parallel with the harvest of the dryland crops. The harvesting of the crops, depending on crop type, occurs in December while a second harvest is possible in February.

   Interviews with local communities suggest that the income generated from the sale of vegetables is reinvested into the following seasons cassava crops. This forms a cyclic farming approach where the two forms of cultivation are used to support each other.

Figure 52: Small-scale cassava farmland located within the solar PV site

Figure 53: Market gardens located on solar PV site along the ephemeral streams

The two cropping seasons also permit a clear distribution of labour. Preparation for vegetables gardens occurs parallel or immediately after the harvesting of the dryland crops and when household labour is readily available. The harvesting of any garden crops occurs before the need to prepare the dryland farmplots for the next season.

Both dryland and market gardens are farmed using manual labour and basic farming implements (hoes, machetes, and axes). Labour is primarily sourced from within the household, however interviews suggest that income from crops are used to hire local labour to assist with the clearing and preparation of farmland each year.

Interviews with local communities indicate that both Cassava, Maize, Sugarcane, and mixed vegetables as well as traditional alcohol made from sugarcane are traded for cash income. This is however usually limited to any surpluses in crop produce after household food needs are secured. Broadly speaking 60% of crop produce is used for household food while the remaining 40% is traded for cash income (Liberia Institute of Statistics & Geo-Information Services, 2016).

Trade is undertaken at local markets, while interviews suggest that most buyers are actually bulk buyers from Monrovia rather than neighbouring households. This is expected as there is likely to be substantial demand for cassava and vegetables in the city, and the relative proximity of the district to Monrovia allows bulk buying by non-local buyers. The presence of such bulk buyers is likely to be an important source of cash income into local communities.

Analysis of latest available crop yields and market value for Cassava for the Montserrado County suggest that local households are able to generate an average of 6 metric tonnes of cassava per hectare (Ministry of Agriculture, 2009). Given that local households have access to an average of 0.7 hectares of land, the annual total yield per household is estimated to be 4.2 metric tonnes. In general, 60% of Cassava produce (2.5 tonnes) is allocated to household food while the remaining 1.6 tonnes is traded for cash income. This excludes losses to pests and rot which may result in losses around between 10-20% of the annual crop yields.

National market value for Cassava is estimated to be 1,300 Liberian Dollars (LD$) for a 50-kilogram bag in the Montserrado County as of 2017 (Liberia Institute of Statistics of Geo-Information Services, 2020) while there are upward pressures of cassava prices to around LD$ 1,600, prices are highly variable year-on-year (Ministry of Agriculture, 2019). Broadly, local households can be expected to earn an estimated income of between LD$ 41,600 – 51,200 per annum, or between USD 210 – 250 per annum from their crop harvests. This equates to a daily earning of USD 0.6 per day over one year/household.

Tree Crops

Tree crops function as an important but secondary livelihood for local households and includes palm oil production. While palm oil is considered to be important as a cash source nationally, interviews with local communities suggest that it is secondary to crop cultivation as the latter is a priority for securing household food. This is reflected in that only an estimated 4.0% of households undertake palm oil farming in the larger Montserrado County (Liberia Institute of Statistics and Geo-Information Services , 2017).

Palm oil production is undertaken by a limited number of households on a quasi-commercial basis and requires the establishment of either small orchards of palm or retaining large numbers of wild palm on available land. There is no evidence of palm orchards within the solar PV site, however there is substantive presence of isolated palm trees throughout the site. There are palm orchards located north of the solar PV site and just north of the Crawford Farm housing. Palm orchards will be privately owned, while isolated trees will be communally harvested by local households.

It is likely that local households will retain limited number of fruiting trees in or near the homestead. In most cases, these trees are simply used to provide supplementary fruit (e.g. bananas) for household consumption and is not linked to small-scale commercial growing or trade.

Livestock Farming

Interviews with local communities indicate that most households do own livestock, and the rearing of livestock will be secondary livelihood to annual crop farming. Local livestock holdings are restricted to limited number of small livestock (i.e. goats and chickens) that is used for household consumption and limited trade. Small livestock are normally allowed to forage around the household, and there is little evidence of cattle or communal grazing at the soar PV site or along the transmission line routes.

Businesses and Trade

The most common form of small-scale trade will be in the sale of farm produce including cassava and vegetables. Trade is undertaken at local markets and target bulk buyers from Monrovia rather than neighbouring households. This is expected as there is likely to be substantial demand for cassava and vegetables in the city, and the relative proximity of the district to Monrovia reduces transport costs.

Road-side stalls are also common along local main roads, and a range of products may be sold including locally-produced charcoal, crop produce and basic household goods. These stalls are usually informal secondary structures located on homesteads that sits directly against the road, as shown in Figure 54.

Figure 54: Road-Side Trade Stall

Natural Resource Harvesting

Local households will harvest a range of natural resources from the open bush, and this will primarily comprise of firewood collection, tree cutting for charcoal production, harvesting of palm nuts. In addition, local ephemeral streams may be used to harvest natural building materials including clays and sands for brick production, and bamboo, grasses and reeds which are used for constructing local residential structures. Based on the information gathered during the community meetings medicine is obtained from clinics and hospitals in the area, rather than relying on medicinal plants.

The solar PV site does not support any resident households, and that there is limited accessed permitted to the site by the landowner, which reduces the rate of natural resource harvesting. However, there are several households that are resident in proximity to the site (including residents of Crawford Farm and isolated farmsteads) that enter the site to harvest natural materials. The most visible being bamboo collection (see Figure 55) and charcoal production (see Figure 56).

Figure 55: Bamboo Collection

Figure 56: Charcoal Production

The proposed transmission lines routes follow existing wayleaves or along the local access roads, and both will support transformed vegetation related to clearing of the wayleave and human development along the access roads. Natural resource harvesting in the wayleave may also include charcoal production, palm nut collection, firewood collection and harvesting of natural building materials.

5.7.8 Housing and living conditions

Local households support between 1 to 3 structures which generally comprise of a main house, secondary structures (including additional bedrooms, kitchens) while pit latrines, storage sheds and stalls may also be found.

The building materials and quality of the main residential structure (or the main house) is highly variable for households located surrounding the project site. Some local structures are constructed of brick or concrete blocks with roofing made of either tiles, corrugated iron, or local grasses. However, it more common to see the main residential structure constructed of mud and sticks or mud-brick with corrugated or grass roofing.

There are no district-level statistics on the local housing profile, however the national level statistics functions as a useful proxy and likely reflects local housing trends (see Table 28) . Overall it is expected that the largely rural district will support mostly mud and stick and mud-brick structures; while a smaller proportion will be constructed of concrete / cement bricks with iron sheet roofing (examples are depicted in Figure 57.

Table 28: National Housing Profile

Building Material	Percent of Main Residential Structures		
	Urban	Rural	Total
Mud and Sticks	18.3	68.8	45.2
Mud Bricks	25.4	17.1	21.0
Zinc / Iron / Tin	6.3	9.2	7.9
Stone / Clay Bricks	8.4	0.8	4.4
Concrete / Cement Blocks	40.5	3.8	20.9
Other Material	1.0	0.4	0.7

Adapted From: (Liberia Institute of Statistics & Geo-Information Services, 2016)

Figure 57: Examples of Residential Housing Found Around the Project Site

Interviews with local communities indicate that basic service provision is very constrained in the district and again this likely follows national trends in terms of the level and quality of access to basic services in rural area. The following broad trends where noted:

- **Access to Water:** Households in towns or villages within the district predominately access water from private or public boreholes that may be connected to hand-pumps or public stand-pipes respectively. Isolated households outside of the villages will access water from hand-dug wells or more commonly water from local rivers, lakes, or creeks. Piped water is largely non-existent in the district.

  With respect to the solar PV site, there is a manual hand-pump connected to a borehole which is used by the Crawford Farm residents. There are also two ephemeral streams traverse the site and they are used by local households for domestic needs (drinking, cooking, and washing). This includes resident of Crawford Farm as well as households surrounding the Project site.

- **Access to Sanitation:** Access to formal sanitation is largely non-existent in the district. Interviews suggest that most households use the open bush while some households will have access to unimproved pit latrines located at their households. This follows national trends where 72% of rural households in Liberia do not have access to sanitation and rely on the open bush (Liberia Institute of Statistics and Geo-Information Services, 2014).

- **Waste Disposal:** Access to formal waste collection and disposal is largely non-existent for local households, and interviews indicate that domestic waste is generally dumped in the bush or in private pits at the homestead.

- **Access to Fuels:** Interviews indicate that few households have access to electricity and few local villages have public lighting. Again, this reflects national trends where only 1.4% of rural households have access to electricity (Liberia Institute of Statistics and Geo-Information Services, 2014).

  Fuel for cooking comprises mostly of harvested wood from the open bush surrounding local households, while a smaller proportion of households also use charcoal. Charcoal production occurs at the solar PV site and within the district; however interviews suggest that the majority of charcoal is traded at local markets to bulk buyers that resell charcoal in Monrovia. This is expected as wood fuel is scarce in urban areas, and there is a strong dependency on charcoal produced in surrounding rural areas.

  Given that it is substantial, and largely free, wood resources around local households, there is little incentive for them to spend money or time producing charcoal for domestic use. Rather, local charcoal production is a secondary income source for local households that is driven by demand from Monrovia.

5.7.9 Accessibility and mobility

The solar PV site does not contain any public access roads, however there are several roads that extend around the site. The only form of access within the site are foot-paths used mostly be residents of Crawford Farm or local households to access their farms. The limited number of neighbouring households and the presence of few footpaths suggests that utilisation of these paths is limited.

The surrounding primary and secondary access roads are however important for the accessibility and mobility of local households, notably for the hamlets and isolated households located off the main roads. This is reflected in that most settlements and households are located along existing roads, while there are few that are located off these roads.

There is a primary tarred road (Kilo Road) that forms the southern boundary of the solar PV site (Figure 58) and will likely form the primary entry point for the project and provide the needed road connection

to Monrovia. There are also two secondary roads (Porta Hill Road, Hamilton Road, Paine Road) which are located outside the Project site and comprise of gravel access roads in differing states of repair (see Figure 59).

The transmission lines route(s) will follow either an existing wayleave or run parallel to the existing main tarred road (including Kilo Road and St. Thomas Road) to the Mount Coffee Sub-Station. The existing wayleave uses local secondary access road and internal maintenance roads, which support limited vehicle traffic but some pedestrian traffic. Thomas road supports substantial commercial and public traffic as well as pedestrian traffic (see Figure 60).

Figure 58: Kilo Road (Southern Project Site Boundary)

Figure 59: Secondary Gravel Road (Accessing Crawford Farm)

Figure 60: St Thomas Road (Outside Harrisburg, the final approach to MCHPP from Monrovia)

5.7.10 Community and public services

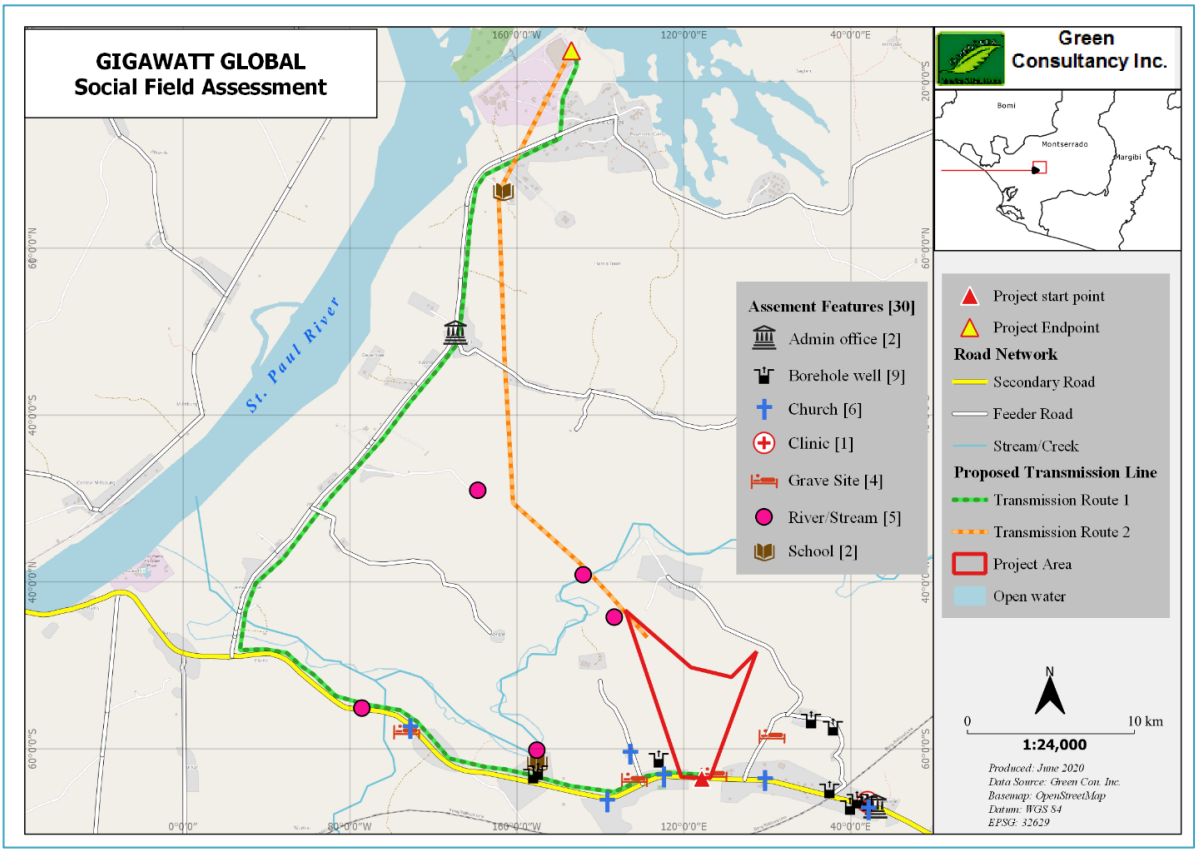
The solar PV site does not support any community or public services, however some resources are found within proximity of the site (see Figure 61). Such resources are however limited to churches, grave-sites, and boreholes located adjacent or within 1 kilometre of the site perimeter. The proposed transmission lines also cross over or near administration offices and a school. However, most public services are found in neighbouring communities (including Crozierville, Harrisburg, Bensonville and Mount Coffee). While the project will not directly impact them, it may rely on such services during the construction phase and its operational life.

At approximately 12%, Liberia has one of the lowest electricity access rates in the world. In the capital city of Monrovia, less than 20% of the population has access to electricity. By 2030, the Government of Liberia aims to meet an anticipated peak demand of 300 MW and serve 1 million customers, connecting 70% of the population in Monrovia and providing access to 35% of the rest of Liberia[11]. Less than 2% of rural population having access to electricity[12].

[11] https://www.usaid.gov/powerafrica/liberia

[12] https://esmap.org/node/57270

Figure 61: Location of Public or Community Resources



5.7.11 Vulnerable People

Vulnerable People is a term given to individuals, households, or groups of people that may be disproportionately affected by the proposed project activities based on their gender, ethnicity, age, physical or mental disability, economic disadvantage, or social status within their community. For the purposes of this study, vulnerable people are likely to include:

1. **Elderly Households with Limited Support:** Elderly headed households (older than 65 years of age) or where the household is comprised of elderly, who have no or marginal support from economically active (able adults) family members. However, some caution is needed, as some households may be headed by an elderly patriarch or matriarch with substantive support of able adult sons and daughters.

2. **Female-headed or Female-Only Households:** While the rights for women are protected under law in Liberia, local customary rights (notably those linked to land) may undermine those rights, while the lack of able adult males often limits household productivity and income. However, some caution is needed, as some households headed by women are not automatically vulnerable as they may be headed by a matriarch with substantive support of able adult sons and daughters.

   More broadly, the rights of women and girls in Liberia remain deeply challenging. This stems from a range of issues, but specifically the predominance of restricted access to education, poor access to maternal health, female genital mutilation, child-marriages, and high divorce rates. In addition, women's right to land is tenuous and may often be undermined where there is no male head and no clear line of inheritance from father to son. Land ownership is entirely patriarchal, and where the head as passed to females, may be evicted from their home or land by the male's clan or extended family.

Liberia has an overall poor gender equality with a Gender Inequality Index (which looks at gender equality in three dimensions – reproductive health, empowerment, and economic activity) of 0.651 and placing it in 155 out of 162 countries in the 2018 Human Development index (United Nations Developement Programme, 2019).

3. **Child-Headed Households:** The vulnerable group covers cases where the household head is below the age of 18 and has no or marginal support from an economically active (adult) family member.

4. **Persons with Disabilities or Long-Term Illnesses:** Households where one or more household members are defined as disabled (including physical, mental, and long-term illness) are potentially vulnerable.

5. **Landless:** Agriculture is the primary livelihood strategy adopted by local households. Therefore, households without claim to land are potentially vulnerable as their ability to generate food and income is undermined. Interviews suggest that often landless households are headed by females, as their rights to land may be undermined or entirely removed once their husband has passed away or divorced.

6. **Ethnic Minorities:** The 2009 Census classifies Liberians into seventeen well-defined major ethnic groups and a number of other Liberian and African tribes. The groups that make up the majority of the national population include the Kpelle (20%), Bassa (13%), Grebo (10%) as well as the Gio, Mano and Kru (7% for each group) followed by smaller proportions of Lorma, Kissi, Gola, Vai, Krahn, Mandingo, Gbandi, Mende, Sapo, Belle, Dey and Other minor ethnic groups (Liberia Institute of Statistics and Geo-Information Services, 2011). Americo-Liberians who are descendants of freed slaves that arrived in Liberia early in 1821 make up an estimated 5% of the population.

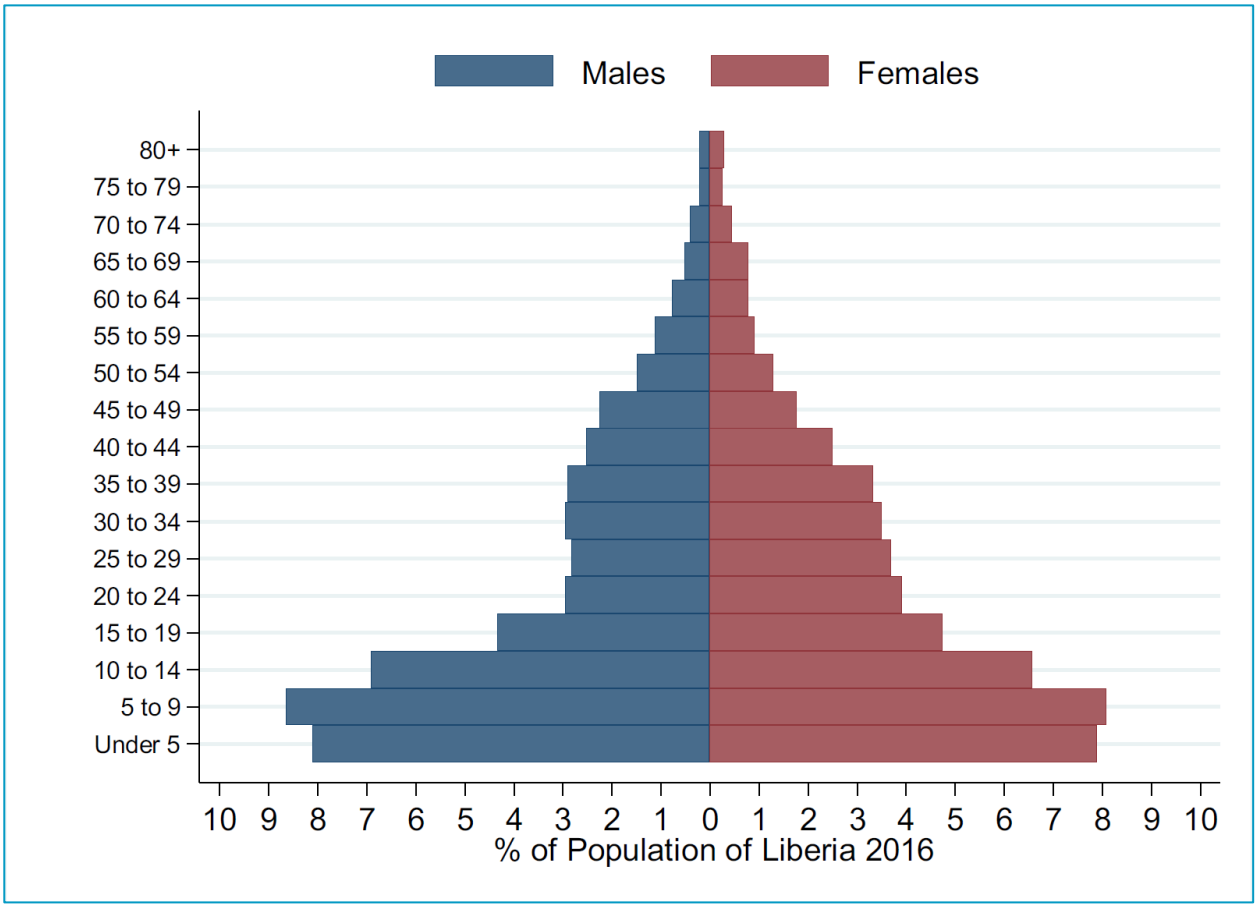
   The solar PV site is located in rural Montserrado which is predominately comprised of the Kpelle majority ethnic group (approx. 40% of the population) followed by a mixture of Gola, Bassa, Grebo, Mano, Kru and Lorma ethnic groups. In general relationships between ethnic groups is considered to be good (PeacebuildingData, 2020), however past conflicts have at time been closely linked to religious-ethnic divisions. This includes long-standing divide between the descendants of indigenous Liberians and the descendants of resettled slaves and free-born African Americans (Minority Rights , 2020). There has also been, albeit localised to certain regions such as the Nimba Country, ongoing conflict between differing ethnic and religious groups related to grievances on land disputes, dispossession and perceived state harassment (Minority Rights , 2020).

5.7.12 Gender

At a national level Liberia's population is estimated to be just over 4.2 million people in 2016. Of these, 48.9% are males and 51.1% are females, which results in a gender ratio of males to females of 95.6 (Liberia Institute of Statistics & Geo-Information Services, 2017). Montserrado County support 32% of the total national population and gender ratio of males to females of 90.3, and female outnumber males by nearly 5%. (Liberia Institute of Statistics & Geo-Information Services, 2017)

The typical age analysis for males and female for Liberia is presented in Figure 62 below. It shows that the majority of females are aged below 14 years of age and comprise nearly 63% of all females in the country. The dominance of young girls has several ramifications with respect to marriage and education as detailed further below.

Figure 62: Population Pyramid (Liberia Institute of Statistics & Geo-Information Services, 2016)



National estimates (Liberia Institute of Statistics & Geo-Information Services, 2017) indicate that 35% of all households are headed by females in 2013, and it is unlikely that this percentage has significantly shifted over the last 7 years. The percentage does vary with urban household having a relatively larger percent of female headed households (~38%) compared to their rural counterparts (~30%). There is no similar statistics for the Careysburg District, however, estimates for the larger Montserrado County (Liberia Institute of Statistics & Geo-Information Services, 2017) indicates that 28% of households are headed by females. Given that the Careysburg District is largely rural in nature, it can be assumed that approximately 30% of all local household will be female headed.

Access to electricity is highly constrained in Liberia, with 82.3% of all national households having no access to electricity in their homes (Liberia Institute of Statistics & Geo-Information Services, 2017), although this increases to nearly 96% of households in rural areas. Similar statistics can be expected for the largely rural Careysburg District where most households (~96%) will not have access to any formal electrical connections, barring limited connections in the local towns. It is also very unlikely that there will be significant variation in level of access between male and female headed households.

Defining employment / unemployment rates in Liberia can be complex, with the formal unemployment rate defined as 2.81% for 2019 (Liberia Institute of Statistics of Geo-Information Services, 2020) however such a rate is misleading as it ignores informal or unsecure (i.e. casual or self-employment) that dominated in Liberia. While outright unemployment is low, informal, or unsecure employment rates are very high at around 80%, which mean formal employment likely constitutes 20% of all employment opportunities. Informal employment is further skewed between males (69%) and females (91%) showing that females are far more likely to work informally.

There remains limited recent information on the employment in the energy sector, with the latest information being the 2010 Labour Force Survey (Liberia Institute of Statistics and Geo-Information Services, 2011). Based on the findings of this survey, the national energy sector provided formal employment to 2,000 males mostly in urban areas, and less than 500 similar opportunities for females in 2010.

In general, women and young girls face several challenges in Liberia, with respect to their rights, living arrangements, education, and wellbeing. Priority public policy areas of concern (National Population Commission, 2018) include force (child) marriage and female genital mutilation (FGM), however women are likely to continue to face systemic discrimination at the home, limited rights to land and ownership, as well as opportunities for employment. This is based on entrenched cultural and traditional mind-sets, lack of gender rights knowledge, lack of economic empowerment, and limited legislative safeguards framework.

Indicators of such challenges include low female literacy rates (54% of female are literate compared to 77% of males), low enrolment rates in primary school (51% of females are enrolled in school compared to 75% of males), high rates of FGM (39% of females aged between 15 and 49 years of age) and limited access to maternal care.

With respect to the Project itself, local communities are likely to reflect a similar gender (in)equality situation that is found throughout the rural communities of the Montserrado County. This includes limited educational achievement (mostly primary school), limited artisanal or professional skills to fill in needed Project worker positions, lack or limited proper representation at local council or village committees. The presence of the project is however unlikely to negatively impact or worsen the gender (in)equality situation.

5.7.13 Human Rights Context

The Constitution of Liberia (1986) recognises fundamental human rights and freedoms, and the Constitution make specific provision for such rights under Chapter 3. In addition, Liberia has signed and ratified several United National international human rights treaties (as summarised in Table 29).

Table 29: International Human Right Treaties

Treaty	Signed	Ratified
Con. on Torture & Other Cruel Inhuman or Degrading Treatment or Punishment		22 Sep 04
Optional Protocol of the Convention against Torture		22 Sep 04
Int. Covenant on Civil and Political Rights	18 Apr 67	22 Sep 04
Int. Covenant on the abolition of the death penalty		16 Sep 05
Convention for the Protection of All Persons from Enforced Disappearance		
Convention on the Elimination of All Forms of Discrimination against Women		17 Jul 84
Int. Convention on the Elimination of All Forms of Racial Discrimination		05 Nov 76
Int. Covenant on Economic, Social and Cultural Rights	18 Apr 67	22 Sep 04
Int. Convention on the Protection of the Rights of All Migrant Workers	22 Sep 04	
Convention on the Rights of the Child	26 Apr 90	04 Jun 93
Convention on the involvement of children in armed conflict	22 Sep 04	
Convention on the sale of children child prostitution and child pornography	22 Sep 04	
Convention on the Rights of Persons with Disabilities	30 Mar 07	26 Jul 12

Sourced From: (United Nations Human Right Council, 2020)

However, the United Nations Human Right Council recognises that the “process of post conflict recovery” in Liberia has been ongoing for over a decade. Despite significant progress made Liberia faces serious human rights challenges many of which stem from historical social divides, discrimination and impunity” (United Nations Human Right Council, 2020).

A national review of human rights (United Nationals Human Rights Council, 2015) indicate that Liberia is generally on a positive trajectory in terms of human rights and shown sustained peace since the civil war which ended in 2003. In this period, Liberia has established a number of laws and institutions (notably the National Commission on Human Rights) to address human rights.

Never-the-less the review notes that there remain several challenges including "*endemic corruption and a culture of impunity; high illiteracy and unemployment rates; low professional development; a lack of awareness of human rights among the society at large; the continued existence of dual justice systems and discriminatory laws and practices; a lack of public trust in the judiciary and law enforcement, often leading to mob violence; residual delays in domesticating regional and international human rights norms; inadequate human and financial resources to fully implement crucial human rights initiatives; and a still-fragile security situation*" (United Nationals Human Rights Council, 2015).

5.7.14 Risk of unexploded ordinances

In September 2003, UNMAS conducted an assessment mission to Liberia and found no credible reports of mine use during the conflict from 1999 to August 2003, but indicated there might be some areas still affected from previous conflicts. Subsequently, UNICEF conducted a landmine and UXO risk assessment in Liberia in April and May 2004, and concluded that mines and UXO are not a major problem in the country. Systematic humanitarian mine clearance or mine risk education has been carried out in Liberia. The *Landmine Monitor* has identified no reports of landmine casualties in Liberia since 2000.

5.8 CULTURAL HERITAGE

5.8.1 Solar PV Site

No graveyard sites were located within the site boundary; however, two graveyard sites were found (see Figure 63), located to the south west, and outside the solar PV site boundary (see Figure 6). The Crawford Farm community also indicated during the interviews that none of the forest areas on site are used as sacred sites.

Figure 63: Images of the graveyard sites located near the solar PV site

5.8.2 Transmission Line Corridors

Two graveyard sites were identified within the TL Route Option 01 corridor while one graveyard sites was identified within 1 km of the TL Route Option 02 corridor (see Figure 64).

Figure 64: Images of graveyard sites along the transmission line routes

The two graveyard sites that were identified within the TL Route Option 01 corridor were located in between Crozierville and Cotton Tree Community, while the other site was a much smaller site located at Kpelle Town (Figure 65).

The graveyard site identified outside of the TL Route Option 02 corridor is located between Port Town and Joseph Risk Community. (Figure 65)

Figure 65: Map showing the location of gravesites along the transmission line routes

6. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT – SOLAR PV PLANT

The environmental and social impacts of the proposed solar PV plant on the affected environment are assessed in this chapter. The impacts have been assessed according to the impact assessment methodology provided in Appendix D. Both positive and negative impacts are assessed for the construction, operation and decommissioning phases of the project. Mitigation measures for negative impacts and enhancement measures for positive impacts are described as the basis for evaluating residual impact significance. These, together with monitoring measures for construction and operation, have been incorporated in the Environmental and Social Management Plan (ESMP) in Appendix E.

A number of environmental and social impacts were screened prior to the assessment phase. These impacts are described below. Based on an understanding of the environmental and social sensitivity of the solar PV site and the impacts of the construction and operation of a typical solar PV plant, several impacts were screened out of the impact assessment and standard mitigation measures included in the ESMP. In some cases the impacts for the construction and operation phases of the Project are similar and are therefore assessed together. Decommissioning phase impacts and cumulative impacts are assessed separately.

6.1 BIO-PHYSICAL IMPACTS

6.1.1 Air emissions

Background and Baseline Conditions

The solar PV site is located 20 km north east of Monrovia, a regional urban centre that supports a range of medium and heavy industries, private and public services as well as established and growing urban residential areas. Ambient air quality is degraded due to the following:

- Gaseous and dust emissions from vehicle traffic along the roads (which are largely unpaved);
- Smoke emissions from agricultural activities (e.g. slash and burn), charcoal manufacturing, cooking and burning of domestic waste; and
- Dust from the Harmattan trade wind coming from the Sahara Desert (especially during December to March).
- Emissions from Monrovia due to the high use if diesel generators, burning of waste and emission from vehicles (often using sub-grade fuel purchased on the side of the road due to the recurring fuel shortages in the country).

The solar PV site itself supports little active utilisation or activities that release air emissions, with the exception of vegetation clearing for agriculture, wood harvesting and charcoal production. There are no households or *in situ* sensitive receptors however there are households within 300 m of the site boundary to the north, south-east, south and west. This includes three small communities (including the Crawford farm community), a church and two private dwellings.

Impact Assessment

Construction and operational activities may lead to a range of air emissions that are a risk to community health and safety. Such activities will include those listed below:

1. **Vegetation Clearing During Construction:** The establishment of the solar PV plant will require bulldozer clearing of approximately 25 ha of trees and bush for the solar PV development. There are no households on the solar PV site, but the dust generated may affect the receptors located within 300 m of the site boundary and construction workers will be impacted by occupational dust exposure.
2. **Construction Traffic (Inside the solar PV site):** Movement of construction traffic to and from, and within the solar PV site will be required. The movement of traffic will exacerbate fugitive dust generated from areas that are cleared of vegetation as noted above.

3. **Construction Traffic (Outside the solar PV site):** Construction materials will be transported by truck on existing public roads leading from Monrovia; with the route still to be determined. There are sections along the Crozierville-White Plains road and the MCHPP-Monrovia road that is unpaved. These roads support both industrial and commuter traffic and any construction traffic will likely cumulatively add to existing fugitive dust emissions along the unpaved sections. Minimal traffic is expected during the operational phase.
4. **Dust Management During Operations:** Maintenance of vegetation will be required so as to not interfere with the operations of the solar panels. It is proposed to maintain vegetation (grass) in the rows between the solar which will reduce dust.

In terms of the total air emissions generated by the project, it is probable that any significant impact will be limited to fugitive dust during the construction phase, and the key receptors will be the three small communities, church and two private dwellings located 300 m of the site boundary and the households located along the main access roads. As summarised in Table 30, the significance of air emissions impacts are ***medium*** during construction, but this may be reduced to ***low*** if dust suppression measures are effectively implemented or if the site clearing will take place during parts of the rainy season.

Air emissions during the operational phase are likely to be of ***very low*** significance (see Table 30). Solar power generation does not generate emissions and any emissions will likely be focussed on fugitive dust from untreated access roads, cleared areas and areas without vegetative cover. Again, there are no households present within the solar PV site, so impacts are limited to occupational exposure by staff and potential exposure by the receptors close to the site boundary as referred to above.

Table 30: Impact Assessment of Air Emissions (Solar PV plant)

Type of Impact	Negative Impact			
Impact Criteria	Construction		Operations	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Low	Very Low	Very Low
Geographic Extent	Local	Local	Local	Local
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Probable	Probable	Probable
Consequence	Medium	Low	Very Low	Very Low
Significance	Medium	Low	Very Low	Very Low

Recommendations and Mitigation Measures

The following recommendations and mitigations measures are proposed to reduce air emissions impacts.

- The Proponent will adopt suitable measures to manage fugitive dust from vegetation clearing during the construction phase. This will include a programme of dust management that limits both occupational and community exposure to dust.
- The Proponent will adopt measures to control the generation of fugitive dust from construction traffic including limiting construction vehicles speeds to the 20 km/hr on-site. An appropriate speed must be adopted along the unpaved areas on the access roads to the site to ensure limited dust generation.
- The Proponent will ensure that fugitive dust emissions will be actively managed during the operational life of the project.

- Establish an external grievance mechanism throughout the construction and operation phases to address any community complaints regarding dust and noise.

6.1.2 Noise emissions

Background and Baseline Conditions

Anthropogenic noise sources in the project vicinity and along the transmission line corridors include wood chopping, subsistence farming activities, social gatherings (e.g. church gatherings) as well as motorcycles and vehicles moving along the roads. There are no appreciable sources of noise within and surrounding the solar PV site.

Sensitive receptors, with respect to noise generated within the solar PV site, are largely limited to the three small communities, church and two private dwellings located 300 m of the site boundary. Other sensitive receptors include households along the main access roads between Monrovia and the site that will be used during construction and operations.

Impact Assessment

The construction activities may lead to a range of noise emissions that may pose a risk to community health and safety. These include:

1. **General Construction Noise:** Site clearing, construction and installation of equipment will involve the use of heavy construction equipment including bulldozers, front end loaders and tipper trucks. Construction noise will be generated at active work areas during day time and weekend periods.
2. **High speed ramming for solar PV foundation installation:** The project will require the ramming of foundational piles. This is likely to take approximately 3 months after the site is cleared.
3. **Movement of Construction Traffic (Inside the solar PV site):** The project will require the movement of construction traffic within the site. This will include the access point on the Crozierville-White Plains road passing the site to the south and vehicular movement throughout the site, which will generate noise for the duration of the construction phase.
4. **Movement of Construction Traffic (Outside the solar PV site):** The project will likely use the MCHPP-Monrovia road and Crozierville-White Plains road as the main transport route for the TL construction, while the Crozierville-Bensonville road will most likely be used as the main transport route to and from the solar PV site. The existing road supports pedestrian, commuter and commercial traffic. The introduction of project-related construction traffic will have a cumulative impact on noise along the access road, and adjacent residential communities.
5. **Operational Noise:** Operation of the solar PV plant is unlikely to generate significant noise and depending on the final siting of operational infrastructure (e.g. transformers) to the nearest receptors. The plant will not operate at night and should therefore not produce any noise at that time.

The Project will generate noise during the construction phase, but this will be limited the daytime hours.

The three small communities, church and private dwellings located 300 m of the site boundary will be most exposed to construction noise generated, especially when construction activities are required in close proximity.

The impact of construction noise on nearby receptors is expected to be largely of high intensity but given that it is of local extent, short duration and definite likelihood, the pre-mitigation significance is ***medium*** and can be mitigated to reduce the impact to ***low***, as summarised in Table 31. There are no operational activities that generate significant noise (besides some operational traffic) and any noise will be contained within the solar PV site. The impact on the ambient noise levels during the operational phase is considered to be ***very low***, and therefore no specific mitigation measures are warranted.

Table 31: Impact Assessment of Noise Emissions (Solar PV plant)

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	High	Medium	Very Low	Very Low
Geographic Extent	Local	Local	Local	Local
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Definite	Probable	Probable	Probable
Consequence	Low	Low	Very Low	Very Low
Significance	Medium	Low	Very Low	Very Low

Recommendations and Mitigation Measures

The following recommendations and mitigations measures are proposed to reduce noise emissions impacts during construction.

- Avoid or limit noisy construction activities outside of daytime hours. If night time work is required the CLO should inform nearby residents 24 hours in advance of undertaking the required noisy activities.
- Noisy work sites close to the receptors should be avoided.
- Construction vehicles and plant will be serviced according to manufacturer's specifications, and maintenance records must be kept up to date and presented for inspection as required.
- Noisy work around the southern portions of the site on Sundays should be avoid as far as possible due to the close proximity of the church.

6.2 ECOLOGICAL IMPACTS

In terms of ecological impacts, the following aspects have been assessed in further detail below:

- Habitat loss, fragmentation and increase in edge effects;
- Loss of biota;
- Increased sedimentation of wetlands and creeks;
- Alteration of flow regimes to inland wetland and creeks;
- Alteration of water quality; and
- Alien Invasive Species infestation.

6.2.1 Habitat loss, fragmentation and increased edge effects

Background and Baseline Conditions

The solar PV site is characterised by degradation and past disturbance, with no areas of significant biodiversity noted. "Young Bush" vegetation has been identified within the project area; however, these areas comprise secondary vegetation that re-emerges after disturbances. Although considered to be moderately sensitive, these areas have already experienced past disturbance and edge effects and are not considered representative of vegetation in an undisturbed or natural state. The solar PV site is located

on a derelict commercial farm that supported rubber-tree plantations, as well as piggery and poultry operations prior to the civil war. The farm has not been in operational since the second civil war that ended in 2003, except for subsistence farming taking place. Habitats within the project area are fragmented with harvesting of trees for firewood and charcoal production purposes, shifting cultivation, and unregulated hunting taking place.

Assessment of Impacts

The development footprint for the proposed PV plant is situated in areas comprising largely modified vegetation of low sensitivity. Therefore, no further fragmentation of habitat is expected to take place. Some habitat loss is expected however, the layout of the solar PV plant has been revised to exclude the three wetland areas and "young bush" vegetation identified. Such habitat impacts are largely limited to the degraded agricultural areas. When habitat fragmentation occurs, the perimeter of a habitat increases, creating new borders and increasing edge effects. Additionally, fragmentation breaks habitat continuity, reducing reproductive success, genetic exchange and, therefore, reducing genetic diversity in species.

Given the total footprint of the solar PV plant is approximately 25 ha the impact extent is rated as local within which the habitat loss is permanent and of a medium to low intensity. Given the small size of the habitat loss and the low ecological sensitivity of the vegetation, the impact is assessed as having an overall ***medium*** consequence. Given that the likelihood of this impact is ***definite*** the post-mitigation impact significance is ***low.***

Project operation will entail general site maintenance to keep vegetation under and around the solar PV panels low and prevent tree regrowth in order to maximise the amount of solar radiation reaching the panels. Once the site has been cleared during construction and the solar PV plant established, other operational impacts on terrestrial habitats include potential edge effects around the plant on vegetation and fauna due to reflection of heat and glare from the panels and disturbance from activities of operational staff on site.

The potential operational impacts on habitat loss, fragmentation and increased edge effects are considered of local extent, long-term duration and of low intensity resulting in an overall ***low*** consequence, which together with the ***probable*** likelihood results in a pre-mitigation impact significance of **low**. Additional mitigation measures are summarised below which will reduce the potential post-mitigation impact significance to ***very low.***

Table 32: Assessment of Impacts on habitat loss, fragmentation and increased edge effects (Solar PV plant)

Type of Impact	Negative Impact			
Impact Criteria	Construction		Operations	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Low	Medium	Low
Geographic Extent	Local	Local	Local	Local
Duration	Long-Term	Long-Term	Long-Term	Long-Term
Probability	Definite	Definite	Probable	Possible
Consequence	Medium	Medium	Medium	Low
Significance	Low	Low	Low	Very Low

Recommendations and Mitigation Measures

The following recommendation and mitigation measures apply:

- No activities are to take place in the wetland areas or "Young Bush" areas (i.e. historically disturbed areas indicated as having low sensitivity should be used for the proposed development). Peg out and demarcate these areas as no-go areas before commencing with site clearing activities.
- The solar PV site shall be fenced off at the start of construction.
- Upgrade and use existing roads where possible. Where possible a ring road system should be implemented as the rounded shape of roads will decrease potential edge effect. Existing roads which will not be used for the proposed development should be removed/de-compacted and allowed to revegetate naturally.
- Revegetate any temporary roads as soon as possible after use. Additionally, width of roads should be kept to a minimum.
- Loss of riparian vegetation associated with streams and creeks should be avoided
- Monitor for any emerging Alien Invasive Species and ensure that these are rapidly removed. Care should be taken when using chemical sprays. Preferably use them well away from the wetlands and "Young Bush" areas. Ensure that if herbicide has to be used they are specific to the targeted Alien Invasive Species and not a broad spectrum herbicide. If this is unavoidable, take notice of wind direction to prevent drift and be aware that chemicals could runoff or leach through the soil into the habitat and cause extensive damage.
- Herbicides: use of herbicides for plant maintenance should be avoided but if essential only environmentally approved brands that comply with Liberian legal requirements and relevant international conventions should be used. Persistent Organic Pollutants (POPs) and Pesticides as listed by UNEP will not be allowed.
- No open fires shall be allowed on site, unless in safe areas specially demarcated for that purpose.
- Harvesting of plants and hunting of animals will not be allowed within the wetland areas or young bush areas.
- Indigenous grasses could be removed from development footprint areas as sods but planted in temporary flower beds, should be watered if required, while stored until such time that it could be used for rehabilitation.
- Run-off control measures on either side of roads must be constructed to allow for small terrestrial animals to cross. Ditches/trenches should have slopes of less than 45° rather than vertical sides.
- Plan for placement of material stockpiles (topsoil and subsoil and excavated rock) within the areas designated as low sensitivity. Do not leave the soil or rock mounds in place after construction, but rather spread these out over the area of low sensitivity after construction.
- Where areas not targeted for development are inadvertently impacted and/or damaged, clear any material dumped and rehabilitate the site as soon as possible, by levelling, ripping compaction and allowing to revegetate. Where excessive damage has occurred to the inland wetlands, creeks bed, stream banks or riparian zones, this must be rehabilitated immediately under the guidance of an aquatic specialist.
- Alien vegetation management: ongoing monitoring will be required during operation to ensure the site is kept free of alien invasive species and any species are removed on a regular basis (before flowering or seeding occurs);
- Monitoring of restoration success: areas which have been restored or rehabilitated should be checked regularly to monitor natural plant regrowth and presence of erosion.

6.2.2 Impacts on biota

Background and Baseline Conditions

The habitat of the solar PV site has been significantly altered due to historic and current land use activities. Majority of the site is located in degraded agricultural land, and the wetland areas are used extensively for subsistence agriculture. None of the mammal, bird, reptile, amphibian or fish species identified were of conservation concern.

The solar PV site is located 25 km from the closest national park (Margibi Mangrove National Park) and RAMSAR site (Mesurado Wetlands), and more than 60 km from the nearest Important Bird Area and terrestrial Key Biodiversity Area.

Assessment of Impact

Destruction of the moderately sensitive areas will reduce habitat and buffer areas and expose more sensitive areas to potential edge effects, which will ultimately reduce habitat quality. Any impacts to habitat will affect overall ecological drivers, ecological processes, and ecosystem function as well as overall biodiversity. Most of the plant species situated within the development footprint are secondary species, and therefore the impact on vegetation is not expected to be significant. Sedimentation, changes in hydrological regime, alteration in water quality and changes in turbidity could negatively affect aquatic species.

The developer has already designed the layout of the solar PV plant to minimise the requirement to infill the wetland areas and "Young Bush".

For the construction phase and after mitigation the predicted impact on biota is of local extent, long-term duration, low intensity with overall low consequence, which together with its probable likelihood results in an overall impact significance of ***low***.

For the operational phase and after mitigation the predicted impact on biota is of local extent, long-term duration, low intensity with overall low consequence, which together with its possible likelihood results in an overall impact significance of ***very low.***

Table 33: Assessment of Impacts on biota (Solar PV plant)

Type of Impact	Negative and Direct Impact			
Impact Criteria	Construction		Operation	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Low	Medium	Low
Geographic Extent	Local	Local	Local	Local
Duration	Long term	Long term	Long term	Long term
Consequence	Low	Low	Low	Low
Probability	Probable	Possible	Probable	Possible
Significance	Low	Low	Low	Very Low

Recommendations and Mitigation Measures

- No activities are to take place in the wetland areas or "Young Bush" areas.
- Harvesting of plants and hunting of animals will not be allowed. If any protected or endangered plant species are encountered during site clearing they must be relocated to suitable habitats.

- Avoid unnecessary drainage line crossings and design site drainage and stormwater runoff to minimise risk of contaminated water entering the stream course or aquatic features (e.g. seasonal pans).
- Conduct clearing and construction activities during the drier months of the year if possible.
- Ensure chemical storage and use complies with standard good practice and be stored in an enclosed restricted access area (to prevent human re-use) and disposed of at an approved waste facility or by approved waste service providers. Hazardous chemicals, including fuels, should be stored in a bunded and fenced area located at least 150 m from the seasonal drainage line or other surface depressions or pans.
- Conduct site inspections to check for oil spills and leaks on soil surface and water bodies (if any form in the wet season) and implement remediation as required.
- Vehicle maintenance shall be done on an impermeable surface to prevent soil and water contamination.

6.2.3 Impacts on aquatic ecology

Background and Baseline Conditions

The site does fall within an aquatic KBA; however, the Dayunn and Queen Creeks are located approximately 300 m west of the solar PV site, and the St. Paul River is located approximately 2.5 km to the north-west. The streams and creeks identified are all located outside the solar PV site boundary and are unlikely to be directly impacted upon in a significant way.

Three wetlands fall within the proposed footprint of the solar PV site and one falls on the boundary near the north-eastern corner. The wetlands are similar in scale, all at approximately half a hectare, providing a total area of approximately 2.2ha or 7% of the total project area. A small rise is located between Wetland A and Wetland B, indicating that is not connected to Wetland A by surface or near-surface (wetland) flow, it is most likely connected by interflow. These wetland areas have been used for subsistence agriculture, but do support specialised species that are associated with stream-side habitat, including plants and birds. They also provide a range of ecosystem services.

The groundwater level is close to the surface (within 2m) along the low-lying valleys.

Impact Assessment

The wetland areas have been excluded from the solar PV plant footprint. There are however some activities in the areas surrounding the wetlands during the construction and operation that may impact on these aquatic systems, including the groundwater.

During the construction phase the clearing of natural vegetation and the stripping of topsoil and erosion could result in the increased runoff of sediment from the site into the wetland areas, which could also lead to sedimentation of the nearby creeks.

During operations the new infrastructure is likely to increase peak run-off rates and concentrate flow paths, thereby changing water quantity in the wetlands (and nearby creeks during high rainfall periods). Hardened infrastructure including solar panels, roads and buildings tend to increase runoff and storm peak flow which may lead to wetland erosion downslope. It may also increase storm peak flows in the Dayunn and Queen Creeks thereby increasing flooding risk downstream.

Apart from a requirement to store diesel and other hydrocarbons on site for construction and operation, the project involves limited hazardous chemicals and risk of pollution from these are minimal if good industry practice is implemented.

Clearing of natural vegetation reduces surface roughness and infiltration which in combination also increase runoff and storm peak flows. Clearing of crops would have a similar but lesser impact. Soil compaction by use of heavy construction vehicles results in similar impact.

Sewage infrastructure installed for PV site staff could leak over time which may lead to elevated nutrient loads in downslope wetlands.

Concrete leaches hydroxyl ions which may increase wetland pH, particularly in acidic wetlands.

For the construction phase and after mitigation the predicted impact on aquatic ecology are of local extent, short-term duration, low intensity with overall ***low*** consequence, which together with its ***probable*** likelihood results in an overall impact significance of ***low***.

For the operational phase and after mitigation the predicted impact on aquatic ecology are of local extent, long-term duration, low intensity with overall ***low*** consequence, which together with its ***possible*** likelihood results in an overall impact significance of ***very low***.

Table 34: : Assessment of Impacts on streams, wetlands and creeks (Solar PV plant)

Type of Impact	Negative and Direct Impact			
Impact Criteria	Construction		Operation	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	High	Low	Medium	Low
Geographic Extent	Regional	Local	Local	Local
Duration	Short term	Short term	Long term	Long term
Consequence	Medium	Low	Medium	Low
Probability	Probable	Probable	Probable	Possible
Significance	Medium	Low	Low	Very Low

Recommendations and Mitigation Measures

- No activities are to take place in the wetland areas. Peg out and demarcate these areas as no-go areas before commencing with site clearing activities.
- If wetland areas are disturbed they must be revegetated with locally indigenous vegetation.
- Concrete mixing must occur on impermeable surface and more than 50m away from any wetland area or drainage lines. If ready-mix is available, it would be preferable to use rather than mixing concrete on-site.
- Provision must be made for adequate sanitation facilities located at least 150 m away from the wetland areas and drainage lines. Toilets and general plumbing will be regularly checked for leaks which will be attended to immediately.
- Ensure the necessary spill kits are available on site. All hydrocarbons spills on bare ground will be cleared immediately. This will include the lifting of the contaminated soil for bio-remediation or disposal to a hazardous waste facility.
- Develop soil and storm water management plan for the entire surface area of the solar PV plant that will prevent concentrated runoff into the wetland areas, including the use of diversion trenches, berms, flow control dams, silt traps etc. Run-off from the developed areas need to be redistributed evenly over large areas well away and outside of the wetlands through appropriate modelling and design.
- Cut-off drains should be located in such a way that the zone of influence (the area affected by the drain – these drains divert surface and subsurface flow in a certain direction, and lead to drawdown over a wide area) is well away from the wetland areas. The area of influence should

be determined by a hydrogeologist. The construction of surface stormwater drainage systems during the construction phase must be done in a manner that would protect the quality and quantity of the downstream aquatic systems.

- Where applicable, the use of swales, which could then be grassed for the operational phase, is recommended as the swales would attenuate run-off water. Stormwater outflows should not enter directly into a wetland or drainage line or their buffer zones. The velocity and quality of water that may reach wetland and drainage line buffer zones should be the same or similar as the predevelopment scenario through using siltation and erosion control structures.
- Abstraction of water from wetlands areas must not be allowed for any purpose.
- Repair all erosion damage as soon as possible.
- Avoid impeding the natural drainage the wetland systems in order to prevent ponding and subsequent loss of biota.
- Ensure chemical storage and use complies with standard good practice and be stored in an enclosed restricted access area (to prevent human re-use) and disposed of at an approved waste facility or by approved waste service providers. Hazardous chemicals, including fuels, should be stored in a bunded and fenced area located at least 150 m from the seasonal drainage line or other surface depressions or pans.
- Conduct site inspections to check for oil spills and leaks on soil surface and water bodies and implement remediation as required.
- Maintenance on vehicles/diesel powered equipment will be conducted off-site or within a designated, paved and bunded area.

6.2.4 Alien invasive species impacts

Background and Baseline Conditions

Some invasive species were observed in scatter patches on the solar PV site. *Lantana camara*, *Chromolaena ordorata, Elaeis guineensis* and *Bambusa vulgaris*, *Ipomoea parasitica* and *Ricinus communis* were observed within the solar PV site.

Impact Assessment

Disturbance to soil and vegetation during construction is likely to create opportunities for the establishment of alien invasive species. Alien invasive species can outcompete natural vegetation, decreasing indigenous species abundance and diversity. If allowed to seed before control measures are implemented, alien plans can easily colonise and impact on vegetation communities on site and in the surrounding areas. Alien invasive pants could also be distributed through vehicles leaving the site.

In terms of alien fauna several urbanised alien faunal species are already present in the greater area. If food and food waste is not managed appropriately it could attract additional alien faunal species or individuals to site.

If equipment and/or fill material from other areas is imported during the construction and operational phases there is a high risk that alien invasive plants may be introduced and could spread into adjacent areas where they may replace indigenous vegetation and/or reduce grazing potential for wild animals and cattle.

For the construction phase and after mitigation the predicted impacts as a result on alien invasive species are of local extent, short-term duration, low intensity with overall ***low*** consequence, which together with its ***probable*** likelihood results in an overall impact significance of ***low.***

For the operational phase and after mitigation the predicted impacts as a result on alien invasive species are of local extent, long-term duration, low intensity with overall ***low*** consequence, which together with its ***possible*** likelihood results in an overall impact significance of ***very low***.

Table 35: Alien invasive species impacts (Solar PV plant)

Type of Impact	Negative and Direct Impact			
Impact Criteria	**Construction**		**Operation**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	High	Low	Medium	Low
Geographic Extent	Regional	Local	Regional	Local
Duration	Short term	Short term	Long term	Long term
Consequence	Medium	Low	Medium	Low
Probability	Probable	Probable	Probable	Possible
Significance	Medium	Low	Low	Very Low

Recommendations and Mitigation Measures

- All alien invasive species seedlings and saplings must be removed as they become evident for the duration of construction.
- Staff at the plant must be educated and made aware of alien vegetation that could be present and that must be eradicated.
- Sourcing of fill material: any requirement for fill material to create a level platform for site development should be sourced from weed free areas to minimise the risk of spreading alien invasive species and to reduce the ongoing maintenance requirements.
- All construction vehicles and equipment, as well as construction material should be free of plant material when leaving the site to avoid contamination of road reserves. Therefore, all equipment and vehicles should be thoroughly cleaned prior to leaving the site.
- On-site alien invasive plant monitoring and control (removal and disposal).
- Alien vegetation management: ongoing monitoring will be required during operation to ensure the site is kept free of alien invasive species and any species are removed on a regular basis (before flowering or seeding occurs)

6.3 SOCIAL IMPACTS

6.3.1 Physical and Economic Displacement

Background and Baseline Conditions

The solar PV site does not support any form of formal or informal occupants. Households are found to the north of the site covering residents of Crawford Farm that have been granted occupancy rights to the farm buildings by the landowner. Housing is also found along the main access road on the southern boundary of the site. Physical displacement and resettlement of any households will not be required.

The solar PV site supports limited small-scale farming and natural resource harvesting. It is estimated that 7% (2.5 hectares) of the Project site supports small-scale farming of predominately Cassava, Maize or Plantain on elevated areas, while Sugar Cane is grown along the ephemeral streams and wetland areas. The majority small-scale farming found on the solar PV site is undertaken by the residents of Crawford Farm, with permission of the landowner.

As there are no clearly defined property boundaries, it is also expected that neighbouring households (including households that form part of Crozierville and Porte Hill) may also enter into the solar PV site to undertake small-scale farming. Barring residents of Crawford Farm, it is unlikely that prior permission is sought by households before entering the property.

It is expected that the establishment of the solar PV plant will result in the restriction of access to the site as well as the clearing on local vegetation. This will result in the direct loss of small-scale farmplots as well as restriction of access to the solar PV site by local households. Some economic displacement is therefore expected.

Impact Assessment

The solar PV plant establishment will not require the resettlement of any households, therefore no impact is expected in terms of physical displacement. However, it is expected that the solar PV site establishment will result in economic displacement related to the clearing of vegetation within the site and the need to ensure the solar PV plant is secured with perimeter fencing. This will exclude neighbouring households from farming or collecting natural resources within the solar PV site.

The impact of such losses is deemed to be of a ***medium negative*** significance as this will reduce the ability of local households (notably households resident at Crawford Farm) to generate crops that are critical in securing household food needs as well as generating income. The overall impact is however reduced as the solar PV site is located on private property and utilisation is low. Only an estimated 7% of the site is used for farming (likely by household resident at Crawford Farm) and natural resource harvesting is largely intermittent and informal in nature. Excluding the “young bush” and wetland areas along the western boundary will be considered during the layout final design.

The impacts related to economic displacement can be readily mitigated via the adoption of a suitable compensation and livelihoods restoration process. The effective adoption of such mitigation will probably reduce to impacts to a ***very low*** significance.

Table 36: Impact Assessment of Displacement (Solar PV plant)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Zero to Very Low	-	-

Type of Impact	Negative			
Geographic Extent	Local	Local	-	-
Duration	Permanent	Short-Term	-	-
Probability	Definite	Probable	-	-
Consequence	Medium	Very low	-	-
Significance	Medium	Very low	-	-

Recommendations and Mitigation Measures

The following recommendation and mitigation measures apply:

- Prepare a suitable Livelihoods Restoration Plan (LRP) consistent with national law and international good practice (specifically the IFC Performance Standard 5 on Land Acquisition and Involuntary Resettlement, 2012) to compensate for the loss of small-farming undertaken in the Project site, as well as pay special attention to affected vulnerable households (female headed households, elderly headed households, landless-households etc).
- The LRP will address the fair, full and prior compensation for all existing small-scale farmplots as well as investigate the provision for in-kind replacement farmland outside the solar PV site.
- The LRP will provide measures that allows for continued harvesting of natural resources from the solar PV site (prior to site clearing).

6.3.2 Loss of Access to Natural Resources

Background and Baseline Conditions

The solar PV site is located on private land which supported rubber-tree plantations, as well as piggery and poultry operations prior to the civil war. However, the site has converted to mostly Low Bush once commercial farming activities ceased.

There is evidence of natural resource harvesting occurring within the solar PV site. The most visible being firewood collection, tree cutting for charcoal production, and harvesting of palm nuts. It is also likely that the local streams and wetlands will be used to harvest natural building materials including clays and sands for brick production, bamboo, grasses, and reeds.

As there are no clearly defined property boundaries, it is very likely that neighbouring households (including households that form part of Crawford Farm, Crozierville and Porte Hill) enter into the site to undertake natural resource harvesting. Barring residents of Crawford Farm, it is unlikely that prior permission is sought by households before entering the property.

As the land is private there tends to be limited egress into the site by local households. There is little evidence of over-harvesting of natural resources which is also likely attributed to the relatively low density of households immediately around the site and that the surrounding areas all support open bush.

Impact Assessment

The solar PV plant establishment will result in the restriction of access to the site as well as the clearing of local vegetation. This will result in the direct restriction of access to natural resources for local household, as well as the loss of such resources from the permanent clearing of vegetation.

The utilisation of natural resources is however considered to be low and there remains sufficient open bush surrounding the solar PV site to allow the continue harvesting of natural resources at alternative locations. The overall impact, prior to the adoption of mitigation measures, is considered to be of **low negative** significance. There is little opportunity for the conservation of natural resources within the solar PV site while it is probable that the site will include secure boundary fencing. The adoption of mitigation

measures may offset some of the losses incurred by local households but the impact will remain as of ***low negative*** significance.

Table 37: Impact Assessment of Restrictions to Natural Resources (Solar PV plant)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Low	Low	-	-
Geographic Extent	Local	Local	-	-
Duration	Permanent	Permanent	-	-
Probability	Definite	Probable	-	-
Consequence	Low	Low	-	-
Significance	Low	Low	-	-

Recommendations and Mitigation Measures

The following recommendation and mitigation measures apply:

- Establish a Corporate Social Responsibility plan (CSR) that will support investment into community services, facilities as well as livelihoods of neighbouring households.
- Ensure that local households will be permitted to collect cleared trees, bamboo or other economically valuable materials during vegetation clearing that will occur during the construction phase.
- Biomass removed from the project site during site clearing should be made available for the local community to use as building material, fire wood or to refine and sell.

6.3.3 Community Facilities, Access, and Mobility

Background and Baseline Conditions

The solar PV site does not support any community facilities, services, infrastructure in any form, barring limited footpaths used by residents of Crawford Farm and neighbouring households. Most public services are found in neighbouring communities (including Crozierville, Harrisburg, Bensonville and Mount Coffee) with an average distance of 4 km of the site. While the solar PV plant will not directly impact them, it may rely on such services during the construction phase and its operational life.

The solar PV site is flanked by existing primary tarred roads (Monrovia – Careysburg Road) and secondary gravel access roads that are used by members of the public to access their homes, farmplots as well as connecting households and hamlets with local villages. There are also several churches and informal graveyards and boreholes located adjacent or within 1 kilometre of the solar PV site perimeter.

Impact Assessment

The solar PV plant establishment will not directly result in the loss of community or public facilities, services, or infrastructure. It will utilise local access roads including the tarred and gravel roads surrounding the site during construction and operations. Increased traffic may result in the increased degradation of the gravel roads in particular, as well as pose a safety risk to local commercial, public, and pedestrian traffic. It is also expected that the solar PV plant establishment will to some extent utilise local

public facilities located at the neighbouring towns (including Crozierville, Harrisburg, Bensonville and Mount Coffee) during construction and its operational life. However, the expected impact is considered to be of ***low negative*** significance while this can readily be mitigated to a ***very low negative*** significance.

Table 38: Impact Assessment of the Impact on Community Facilities and Access (Solar PV plant)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Low	Low	Zero to Very Low
Geographic Extent	Regional	Regional	Regional	Regional
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Probable	Probable	Probable	Probable
Consequence	Low	Very Low	Medium	Very Low
Significance	Low	Very Low	Medium	Very Low

Recommendations and Mitigation Measures

The following recommendation and mitigation measures apply:

- Avoid the overuse or degradation of local public facilities and roads during the **construction phase**, by adopting the following mitigation measures:
    - Prioritise to use of the Monrovia-Careysburg tarred road during construction where feasible for the powerline and substation and minimise the use of the gravel roads surrounding the solar PV site. Where the gravel roads are regularly used by construction traffic, endeavour to maintain the gravel roads in good working condition.
    - Avoid the use of local public facilities, services and infrastructures, and the construction contractor will establish their own internal infrastructure (water, sanitation etc.) or establish agreements with suitable private service providers (emergency response, health, sanitation etc.). In the event where a Project activity or equipment causes an emergency or incident with any member of the public or local communities, the Project will ensure that their emergency response plans will cater and support any affected person.
    - Establish suitable traffic safety measures or traffic management plans that address (1) road usage and maintenance, (2) continued public access to roads during construction and (3) public commuter and pedestrian traffic safety.
- Avoid the overuse or degradation of local public facilities and roads during the **operational phase**, by adopting the following mitigation measures:
    - Do not acquire any existing public roads, nor seek to obtain any exclusive access rights to any gravel roads surrounding the Project site.
    - Explore supporting the local road authorities in terms of ongoing maintenance of existing gravel roads near the site.

- Avoid the use of local public facilities, services, and infrastructures, and establish their own internal infrastructure (water, sanitation etc.) or establishment agreements with suitable private service providers (emergency response, health, sanitation etc.).
- Establish reasonable traffic safety measures to safeguard both Project traffic, as well as commercial and public traffic, with specific focus given to pedestrian traffic.

6.3.4 Community Development, Local Employment and Local Content

Background and Baseline Conditions

Broadly speaking, the Montserrado County supports only a 46% labour force participation of economically active people. Most labour is concentrated in urban Monrovia and is comprised mostly of elementary and service sector positions in the informal sector.

Communities located around the solar PV site are largely dependent on small-scale farming as their primary livelihood and source of income. Employment is therefore mostly comprised of self-employment in the informal small-scale farming sector (64% of employment) and contributing family worker (16% of employment). Only 17% of rural employment falls under the formal sector, and opportunities is expected to be negligible with the exception for formal and contract labour at the Mount Coffee Hydropower Project.

The lack of any real employment opportunities around the solar PV site, generally limits the ability of local people to invest in the development of their households. As such, local household largely dependent on government or NGO support for the development of local community facilities, services, and infrastructure. There is negligible private development in the area around the solar PV site that supports any form of community development.

The establishment of the solar PV project is expected to promote national and local development via several avenues. It will foster development indirectly via the provision of 20 Megawatt (MW) of power into the national grid, while more directly injecting substantial investment capital into the national economy, to finance the design, procurement and construction of the solar plant.

In addition, the construction phase is expected to require a peak of 200 workers with an average of 100 workers throughout the construction period of 9 months. The workers will include international and national skilled workers as well as elementary positions for local people. The operational phase will require approximately 20 full-time skilled and semi-skilled workers (as local staff for long-term operations, maintenance, and security). The project is focused on giving preference for employment to the communities surrounding the site and the transmission line if the required skill level is available, and there is a requirement to have at least 30% of women employed during construction. The presence of workers at the site also enables local farmers to sell their produce and products to the workers, who have a cash income.

Impact Assessment

The establishment of the solar PV project is expected to result in benefits with respect to local community development, employment, as well as increased local business opportunities. Such benefits will be gained indirectly via improvements in national electricity supply, as well as direct benefits related to national capital investment. Most of the benefits would like to accrue at the regional level and are considered to be of ***low positive*** significance. Greater active investment in local development (with focus on communities around the solar PV site) may however increases such benefits to ***medium positive*** significance . These benefits would apply for both the construction and operational phase.

Table 39: Impact Assessment on Community Development, Local Employment and Local Content Benefits (Solar PV plant)

Type of Impact	Positive Benefit	
Project Phase	Construction	Operations

Type of Impact	Positive Benefit			
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	High	Zero to Very Low	Low
Geographic Extent	Regional	Regional	Regional	Regional
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Probable	Probable	Probable	Probable
Consequence	Low Benefits	Medium Benefits	Very Low Benefits	Medium Benefits
Significance	Low Benefits	Medium Benefits	Very Low Benefits	Medium Benefits

Recommendations and Mitigation Measures

The following recommendations are provided to maximise local community benefits:

- Establish a Corporate Social Responsibility (CSR) project that will provide annualised funds for the investment with a focus on energy and sustainability in local community development projects, for the duration of construction and operational of the solar PV project (a minimum of 20 years).
- Establish suitable Human Resources and Recruitment Procedures that establish rules for local recruitment and preferential employment. These procedures will be issued to the construction contractor for adoption with the own internal recruitment procedures during the construction phase. The procedures will also apply to the operational workforce.
- Establish suitable local content procedures as part of their overall procurement system. The procedures will be issued to the construction contractor for adoption with the own internal procurement procedures during the construction phase. The procedures will also apply to local procurement of materials and services during the operational life of the solar PV project.
- For the purposes of the CSR, as well as local recruitment and procurement, the terms local shall be defined by multiple levels, and priority will be given to household and community in the order below:
    - Priority Level 1 – Households immediately surrounding the Project site and final transmission line, with specific focus on residents of Crawford Farm.
    - Priority Level 2 – Communities nearest to the Project site and final transmission line, covering Crozierville, Bensonville, Harrisburg, and Mount Coffee.
    - Priority Level 3 – Persons and businesses based in Monrovia, and thereafter nationally.

6.3.5 Landscape and visual amenity

Background and Baseline Conditions

The solar PV site is located on an undulating landform creating ridges and valleys running from a south easterly to north westerly direction across the site. The higher lying areas are located towards the east, and such most of the valleys drain towards the west. The elevation varies between 22 meters masl in the south west to 60 masl in the north east.

The landscape is comprised mostly of degraded agricultural areas, and invasive species such as palm (*Elaeis guineensis*) and bamboo (*Bambusa vulgaris*) covers large areas of the site. Limited natural vegetation remains on the solar PV site and surrounds.

The settlement patterns surrounding the solar PV site and the transmission line routes comprises of rural villages interspersed with small hamlets and isolated farmsteads. All three types of settlements extend along existing main and secondary access roads.

Impact Assessment

The potential impact of the project is associated with how it conforms with the local landscape as well as its visual footprint. The solar PV plant will definitely alter the local landscape from natural to industrial; however, the topography should screen sections of the solar PV plant if viewed from the south or the north due to the undulating topography and ridges running from a south easterly to north westerly direction across the site (i.e. infrastructure along the top of the ridge lines will be more visible than infrastructure located in the low-lying areas). Extensive vegetation cover should remain around the site boundary, between the site and the surrounding visual receptors, except for the southern end of the site that runs along the access road for approximately 200 m. A large portion (50%) of the eastern site boundary has been excluded from the layout, and remaining vegetation would therefore enhance natural visual screening.

The solar PV plant will result in some visual intrusion and disruption related to vegetation clearing as well as the light reflectivity from the solar module surfaces through the construction and operational phases. The proposed solar modules would be between 1 and 4 m above ground level and are unlikely to be highly visible from the surrounding low-lying areas.

The anticipated impacts on landscape characteristics, visual intrusion and changes in visual amenity is considered to be of ***Low*** significance after mitigation.

Table 40: Impacts on landscape and visual amenity

Type of Impact	Negative and Direct Impact			
Impact Criteria	**Construction**		**Operation**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Medium	Low	Medium	Low
Geographic Extent	Local	Local	Local	Local
Duration	Long Term	Long Term	Long Term	Long Term
Consequence	Medium	Low	Medium	Low
Probability	Definite	Definite	Definite	Definite
Significance	Medium	Low	Medium	Low

Recommendations and Mitigation Measures

- Avoid development in the “Young Bush” area located in the north eastern portion of the solar PV site.
- To reduce the visual impact of the Project on road users and nearby residents, a vegetated buffer or screen of vegetation along the perimeter is recommended where technically feasible without restricting solar radiation and project performance.

6.3.6 Cultural Heritage

Background and Baseline Conditions

No graveyard sites were identified within the solar PV site boundaries. Two graveyard sites are located to the south west, outside the solar PV site boundary. The Crawford Farm community also indicated during the interviews that none of the forest areas on site are used as sacred sites.

Impact Assessment

Both graveyard sites are located within 150 meters of the solar PV site boundary; however, the solar PV plant is not expected to extend beyond the site boundary, and will likely be fenced off at the start of construction, thereby preventing uncontrolled access to the surrounding areas. The overall significance after mitigation is consider insignificant.

Table 41: Impact Assessment on Cultural Heritage (Solar PV plant)

Type of Impact	Positive Benefit			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Very Low	-	-
Geographic Extent	Local	Local	-	-
Duration	Permanent	Medium Term	-	-
Probability	Probable	Possible	-	-
Consequence	Medium	Very Low	-	-
Significance	Medium	Insignificant	-	-

Recommendations and Mitigation Measures

The following mitigation measures apply to avoid and minimize impacts in cultural heritage:

- The site must be fenced off at the start of construction.
- The two graveyard sites shall be demarcated as no-go areas and all project staff (including contractors) shall be made aware of this.
- A Chance Find Procedure will be developed and implemented to address any potential finds of cultural heritage value during the construction phase.
- If an archaeological site/archaeological finds or potential fossil finds are discovered during any construction activity, the work is to be halted and the National Heritage Conservation Commission (NHCC) must be notified.
- Any human burials unearthed should be immediately reported to the National Heritage Conservation Commission (NHCC).

7. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT – TRANSMISSION LINE ROUTES

7.1 BIOPHYSICAL IMPACTS

7.1.1 Air Emissions

Background and Baseline Conditions

The transmission line route options extend through areas that are exposed to a range of air emissions including: (1) air and odour emission from small scale industries, (2) general emissions from Monrovia and communities located along the routes, (3) vegetation and waste burning (4) fugitive dust from cleared land and (5) fugitive dust from the MCHPP-Monrovia road. Local ambient air quality is considered degraded.

Impact Assessment

Air emissions related to the development of the transmission lines is considered limited to fugitive dust during the construction phase and emissions from construction vehicles. Emissions from vehicles is likely to be negligible. Fugitive dust will be generated where vegetation is cleared, the movement of construction traffic and along any newly construction access roads. If vegetation is allowed to regrow along the transmission line right-of-way and access roads, dust during the operational phase will be negligible.

TL Route Option 02 does not extend in direct proximity to any established settlements or villages. However, there are various settlement located along TL Route Option 01, and crosses over extensive small-scale farm plots. Exposure to fugitive dust is therefore limited to: (1) settlements (for TL Route Option 01 only), (2) farmers present in the area during the farming season, (3) vehicle and pedestrian traffic utilising local access roads, and (4) the construction work force.

The impacts associated with dust will be similar for both transmission line options and are therefore not assessed separately.

The impact from dust emissions is anticipated to be ***very low*** significance and limited during construction as well as during operation if no mitigation measures are established. The adoption of standard measures of dust control as well as the adoption of mitigation measure noted below will reduce to overall significance of the impact to ***insignificant*** levels.

Table 42: Impact Assessment of Air Emissions (TL Route Options 01 and 02)

Type of Impact	Negative Impact			
Impact Criteria	Construction		Operations	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Low	Low	Very Low
Geographic Extent	Local	Local	Local	Local
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Probable	Possible	Possible	Possible
Consequence	Very Low	Very Low	Low	Very Low
Significance	Very Low	Insignificant	Very Low	Insignificant

Recommendations and Mitigation Measures

- Adopt suitable measures to manage fugitive dust generated during the construction of the transmission line. This will include a programme of dust management that limits both occupational and community exposure to dust.
- Ensure that fugitive dust emissions will be managed during the operational life of the transmission line. This should include the rehabilitation of cleared areas (if any) (notably the transmission line right-of-way) once construction has concluded and the ongoing maintenance of these areas, unless the land is allocated to local people to continue small-scale farming.

7.1.2 Noise emissions

Background and Baseline Conditions

Anthropogenic noise sources along the transmission line corridors include wood chopping, subsistence farming activities, social gatherings (e.g. church gatherings) as well as motorcycles and vehicles moving along the roads. The number of appreciable sources of noise along TL Route Option 01 is much higher than with TL Route Option 02, due to the fact that TL Route Option 01 largely follows existing roads, whereas TL Route Option 02 cuts across a rural/agricultural landscape with a small number of secondary access roads along the way.

Sensitive receptors, with respect to noise generated is also much higher along TL Route Option 01 due to the number of communities located along this route. Due to the rural/agricultural landscape along TL Route Option 02 there is a low number of communities located along this route.

Impact Assessment

The key temporary noise sources during the construction phase will be from the construction machinery, vehicles, workers and transmission line construction activities. Construction activities is expected to be limited to normal day-time hours and on weekends.

Very low noise levels are expected during the operational phase, and source will mainly be from the transmission line itself, substations/transformers and noises generated during maintenance activities (which are expected to be minimal).

As noted above the sensitive receptors, with respect to noise generated is much higher along TL Route Option 01 due to the number of communities located along this route. After mitigation the predicted noise impacts for TL Route Option 01 are of local extent, short-term duration, medium intensity with overall ***low*** consequence, which together with its ***definite*** likelihood results in an overall impact significance of ***low.***

Table 43: Impact Assessment of Noise Emissions (TL Route Options 01)

Type of Impact	Negative Impact			
Impact Criteria	Construction		Operations	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	High	Medium	Low	Low
Geographic Extent	Local	Local	Local	Local
Duration	Short Term	Short Term	Long Term	Long Term
Probability	Definite	Definite	Definite	Definite
Consequence	Medium	Low	Low	Low

Type of Impact	Negative Impact			
Significance	Medium	Low	Low	Low

After mitigation the predicted noise impacts for TL Route Option 02 are of local extent, short-term duration, low intensity with overall ***low*** consequence, which together with its ***possible*** likelihood results in an overall impact significance of ***very low***.

Table 44: Impact Assessment of Noise Emissions (TL Route Options 02)

Type of Impact	Negative Impact			
Impact Criteria	**Construction**		**Operations**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Intensity/Severity	Medium	Low	Very Low	Very Low
Geographic Extent	Local	Local	Local	Local
Duration	Short Term	Short Term	Long Term	Long Term
Probability	Probable	Possible	Possible	Possible
Consequence	Low	Low	Very Low	Very Low
Significance	Low	Very Low	Insignificant	Insignificant

Recommendations and Mitigation Measures

- Avoid or limit noisy construction activities outside of daytime hours. If night time work is required the CLO should inform nearby residents 24 hours in advance of undertaking the required noisy activities.
- Construction vehicles and plant will be serviced according to manufacturer's specifications, and maintenance records must be kept up to date and presented for inspection as required.

7.2 ECOLOGICAL IMPACTS

7.2.1 Habitat loss, fragmentation and increased edge effects

Background and Baseline Conditions

No areas of primary vegetation were identified within the project area or along either of the proposed TL Route Options. The vegetation is intact for large parts along TL Route Option 01, while the vegetation has been cleared along the TL Route Option 02 due to the CLSG transmission line already being constructed. The vegetation TL Route Option 01 largely comprises of patches of "Young Bush", Agricultural Degraded Areas, wetlands and grassy areas. Farms along this the route consisted mostly of rubber trees and food crops (e.g. rice, corn and cassava). Based on the current proposed transmission line layouts, TL Route Option 02 crosses only one (1) area of high sensitivity whilst TL Route Option 01 crosses four (4) areas of high sensitivity. As noted above, TL Route Option 02 has been cleared and altered due to the presence of existing transmission lines and the CLSG transmission line corridor. Due to the shorter distance (4 km, as opposed to the 7 km length of TL Route Option 01) as well as the largely degraded state of TL Route Option 02, this is the preferred alternative in terms of vegetation sensitivity.

The transmission line corridors are not located close to any protected areas

The inland wetlands do provide numerous ecosystem services. If any threatened plant species or other plants of conservation concern are present within the project area it is expected that it would be in wetlands, creeks and streams, as well as the "Young Bush" vegetation types. TL Route Option 01 traverses 4 creeks and 3 wetlands, while TL Route Option 02 traverses one wetland and one creek.

Assessment of Impacts

Some habitat loss is expected along TL Route Option 01, but habitat impacts are largely limited to the degraded agricultural areas. As the route for the CLSG transmission line has already been cleared no further fragmentation of habitat is expected to take place along TL Route Option 02. The transmission line needs to be 32 m from the existing CSLG line, so there may be some limited sections of vegetation that may need to be cleared along the edge of the current CLSG wayleave to avoid disruption by falling trees.

TL Route Option 01 crosses four (4) areas of high sensitivity whereas TL Route Option 02 crosses only one (1) area of high sensitivity. Similarly, TL Route Option 01 traverses 4 creeks and 3 wetlands, while TL Route Option 02 traverses one wetland and one creek.

Construction of the above proposed tower structures will require an estimated 8 m^2 of temporary construction work area at each tower location. The permanent footprint of each tower will be approximately 6 m^2 (for the connection towers and deviation towers only, as the other towers are monopole structures).

During the construction phase heavy machinery and other vehicles may need to cross creeks, stream or wetland areas. While this practice should be avoided wherever possible, it may be necessary where drainage lines cross the full extent of the transmission line corridors. In areas where there are numerous drainage lines present this may result in heavy machinery entering and traversing inland wetlands, creeks and streams as they manoeuvre. This may destabilise consolidated sediments resulting in erosion and downstream sedimentation. It could also result in compaction of soil and destruction of riparian vegetation; these riparian zones provide important ecological functions and must be conserved wherever possible. Where roads or other infrastructure intersect drainage lines, vegetation will need to be cut or removed.

After mitigation the predicted impacts on habitat loss, fragmentation and increased edge effects for TL Route Option 01 are of local extent, long-term duration, medium intensity with overall ***medium*** consequence, which together with its ***probable*** likelihood results in an overall impact significance of ***medium.***

Table 45: Assessment of Impacts on habitat loss, fragmentation and increased edge effects (TL Route Option 01)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	High	Medium	-	-
Geographic Extent	Local	Local	-	-
Duration	Long Term	Long Term	-	-
Probability	Definite	Probable	-	-
Consequence	High	Medium	-	-
Significance	High	Medium	-	-

After mitigation the predicted impacts on habitat loss, fragmentation and increased edge effects for TL Route Option 02 are of local extent, long-term duration, very low intensity with overall ***very low*** consequence, which together with its ***improbable*** likelihood results in an overall impact significance of ***insignificant.***

Table 46: Assessment of Impacts on habitat loss, fragmentation and increased edge effects (TL Route Option 02)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Low	Very Low	-	-
Geographic Extent	Local	Local	-	-
Duration	Long Term	Long Term	-	-
Probability	Possible	Improbable	-	-
Consequence	Low	Very Low	-	-
Significance	Very Low	Insignificant	-	-

Recommendations and Mitigation Measures

- Locate transmission line pylon outside of high sensitivity areas along the route.
- Ensure construction vehicle and equipment are well maintained and not leaking any hydrocarbons.
- Minimise construction footprints within creeks and wetlands by demarcating vehicle access routes and clearing the minimum required servitude width.
- Loss of riparian vegetation associated with streams and creeks should be avoided.
- Restoration / rehabilitation: All construction disturbed areas not required for infrastructure, including access tracks that are not required for maintenance, should be graded to near natural contours, scarified to decompact soils and allowed to recover naturally.
- Revegetate any temporary roads as soon as possible after use. Additionally, the number and width of roads should be kept to a minimum.
- Monitor for any emerging Alien Invasive Species and ensure that these are rapidly removed. Care should be taken when using chemical sprays. Preferably use them well away from the wetlands and “Young Bush” areas. Ensure that if herbicide has to be used they are specific to the targeted Alien Invasive Species and not a broad spectrum herbicide. If this is unavoidable, take notice of wind direction to prevent drift and be aware that chemicals could runoff or leach through the soil into the habitat and cause extensive damage.
- Herbicides: use of herbicides for plant maintenance should be avoided but if essential only environmentally approved brands that comply with Liberian legal requirements and relevant international conventions should be used. Persistent Organic Pollutants (POPs) and Pesticides as listed by UNEP will not be allowed.
- No fires are allowed along the TL constriction corridor.

- Harvesting of plants and hunting of animals be will not be allowed.
- Construction in and around wetlands and creeks should be limited to the dry season as far as possible.
- Plan for placement of material stockpiles (topsoil and subsoil and excavated rock) within the areas designated as low sensitivity. Do not leave the soil or rock mounds in place after construction, but rather spread these out over the area of low sensitivity after construction.
- Where areas not targeted for development are inadvertently impacted and/or damaged, clear any material dumped and rehabilitate the site as soon as possible, by levelling, ripping compaction and allowing to revegetate. Where excessive damage has occurred to the inland wetlands, creeks bed, stream banks or riparian zones, this must be rehabilitated immediately under the guidance of an aquatic specialist.
- Monitoring of restoration success: areas which have been impacted should be checked regularly to monitor natural plant regrowth and presence of erosion.

7.2.2 Impacts on biota

Background and Baseline Conditions

The project area is located Guineo-Congolian Regional Centre of Endemism; however, Little undisturbed rain forest remains, with this vegetation mostly replaced by secondary forest, in various stages of regrowth, and secondary grasslands. In areas where soils are not suited for trees, small patches of edaphic grassland occur. This presents the general vegetation along TL Route Option 01. TL Route Option 02 has already been cleared for the CLSG transmissions line.

None of the mammal, bird, reptile, amphibian or fish species identified along both of the TL Route Options were of conservation concern. However, the project area is located within the Lower reaches of St. Paul River freshwater KBA. The project is also located on the boundary of the Upper Guinea Forests EBA, with the northern portions of the transmission line routes (2-3 km) located within this EBA.

TL Route Option 01 crosses four (4) areas of high sensitivity whereas TL Route Option 02 crosses only one (1) area of high sensitivity. Similarly, TL Route Option 01 traverses 4 creeks and 3 wetlands, while TL Route Option 02 traverses one wetland and one creek.

Assessment of Impacts

Transmission line construction for TL Route Option 01 would entail land clearance and site preparation access roads and for pylon footings. The land along Route Option 02 has been cleared already. Destruction of the moderately sensitive areas will reduce habitat and buffer areas and expose more sensitive areas to potential edge effects, which will ultimately reduce habitat quality. Any impacts to habitat will affect overall ecological drivers, ecological processes, and ecosystem function as well as overall biodiversity. Most of the plant species situated within the development footprint are secondary species, and therefore the impact on vegetation is not expected to be significant. Sedimentation, changes in hydrological regime, alteration in water quality and changes in turbidity could negatively affect aquatic species.

Once the transmission line, access roads and pylons have been constructed, the expected additional impacts on biota during operation includes the risk of alien invasive plant spread (especially if new construction material was imported from infested areas), risk of fires (due to broken lines/faulty equipment) and bird collisions (particularly where the transmission line crosses over stream, creeks and wetlands).

Transmission lines pose collision and electrocution risks to birds, particularly larger birds with a long wing span (such as cranes) which are less manoeuvrable and cannot change direction quickly or birds which may perch or nest on the transmission line cross bars (typically raptors). The risk of electrocution by perching birds on pylons is elevated when the live electrical components are located above the lateral cross bar and closer than 1.2 m which enables wing tips of a bird to touch both conductors resulting in electrocution. This can be avoided by suspending the live components below the crossbar so that birds can safely perch. The survey encountered 17 bird species along TL Route Option 01, and 7 species along

TL Route Option 02. The most abundant species in both corridors were the Common Bulbul (*Pycnonotu sbarbatus*), and Swamp Palm Bulbul (*Thescelocichla leucopleura*). Among the birds of prey only the African Harrier Hawk *(Polyboroides typus)* was recorded. All of the observed species were rated as Least Concerned (LC) according to the IUCN Red List. However, in mitigation of this risk, there is already an extensive network of transmission lines in the area (ranging from 33kV to 225kV), particularly along the northern parts of the transmission line routes. The height of the pylons would typically be been 10 – 12 metres high, with minimum line clearance from the ground of 5.5 metres.

During the construction phase and after mitigation the predicted impacts on biota for TL Route Option 01 are of local extent, short-term duration, low intensity with overall ***low*** consequence, which together with its ***probable*** likelihood results in an overall impact significance of ***very low.***

During the operational phase and after mitigation the predicted impacts on biota for TL Route Option 01 are of local extent, long-term duration, very low intensity with overall ***very low*** consequence, which together with its ***possible*** likelihood results in an overall impact significance of ***insignificant.***

Table 47: Assessment of Impacts on biota (TL Route Option 01)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Low	Medium	Very Low
Geographic Extent	Local	Local	Local	Local
Duration	Short-term	Short-term	Long-term	Long-term
Probability	Probable	Probable	Possible	Possible
Consequence	Low	Very Low	Medium	Very Low
Significance	Low	Very Low	Low	Insignificant

During the construction phase and after mitigation the predicted impacts on biota for TL Route Option 02 are of local extent, short-term duration, very low intensity with overall ***very low*** consequence, which together with its ***improbable*** likelihood results in an overall impact significance of ***insignificant.***

During the operational phase and after mitigation the predicted impacts on biota for TL Route Option 02 are of local extent, long-term duration, very low intensity with overall ***very low*** consequence, which together with its ***improbable*** likelihood results in an overall impact significance of ***insignificant.***

Table 48: Assessment of Impacts on biota (TL Route Option 02)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Low	Very Low	Very Low	Very Low
Geographic Extent	Local	Local	Local	Local

Type of Impact	Negative			
Duration	Short Term	Short Term	Long Term	Long Term
Probability	Possible	Improbable	Possible	Improbable
Consequence	Low	Very Low	Very Low	Very Low
Significance	Very Low	Insignificant	Insignificant	Insignificant

Recommendations and Mitigation Measures

- Transmission line configuration should be designed to minimise electrocution risks to birds perching on the pylon structures by implementing the following types of measures where practically possible:
  - Configure the insulators and conductors in such a way that birds landing, perching or taking off cannot connect them by keeping as many elements as possible under the cross-arm; and
  - Insulate all the live elements of the structure sufficiently to ensure that birds cannot connect exposed, live elements.
- Bird diverters: Consideration could be given to installing bird diverters on the line, particularly where the line crosses streams, creeks and wetlands.
- Mitigation measures prescribed in Section 7.2.2. also applies.

7.2.3 Impacts on aquatic ecology

Background and Baseline Conditions

None of fish species identified along both of the TL Route Options were of conservation concern. However, the project area is located within the Lower reaches of St. Paul River freshwater KBA. The creeks and streams may be classified drainage lines, although portions of the creeks and streams appear as though they may be channelled valley bottom wetlands. All of the wetlands appear to be Unchanneled Valley Bottom Wetlands.

TL Route Option 01 traverses 4 creeks and 3 wetlands, while TL Route Option 02 traverses one wetland and one creek.

The wetland area within TL Route Option 02 is however much larger than those of TL Route Option 01, and covers an area of 0.630 ha compared to a total area of 0.541 ha in total for all three TL Route Option 01 wetlands. The smaller TL Route Option 01 wetlands are however less likely to be impacted by transmission infrastructure since wetlands #2 and #4 only encroach partially on the corridor and pylons may be installed adjacent to the wetland little or no direct impact. The remaining wetland #3 presents an obstacle of only 16m in width that may fall between pylons in which case impact may be minimal.

Wetland #1 located within TL Route Option 02 lies diagonally across the route and presents approximately a 105 m wide obstacle. The distance between the proposed pylons range from 100 m to 275 m. Based on the current deign none of the pylons will be placed within this wetland (nor within the Queen Creek).

Assessment of Impacts

Transmission line construction for TL Route Option 01 would entail land clearance and site preparation access roads and for pylon footings. The land along Route Option 02 has been cleared already.

During the construction phase the clearing of natural vegetation and the stripping of topsoil will result in the increased runoff of sediment from construction areas into wetlands, streams and creeks (relevant to TL Route Option 01 only). In addition, possible contaminants can be released by construction vehicles and equipment, including hydrocarbons (fuel and oil from vehicles) or cement/concrete waste. In addition,

solid waste such as plastic litter could be dispersed by construction workers. Erosion could result in increased suspended sediment loads in the creeks and wetlands.

Once the transmission line, access roads and pylons have been constructed, the only additional impacts include the risk of alien invasive plant spread (especially if new construction material was imported from infested areas) and release of hydrocarbons during maintenance/repair activities.

During the construction phase and after mitigation the predicted impacts on aquatic ecology for TL Route Option 01 are of local extent, short-term duration, low intensity with overall ***very low*** consequence, which together with its ***probable*** likelihood results in an overall impact significance of ***very low.***

During the operational phase and after mitigation the predicted impacts on aquatic ecology for TL Route Option 01 are of local extent, long-term duration, very low intensity with overall ***very low*** consequence, which together with its ***possible*** likelihood results in an overall impact significance of ***insignificant.***

Table 49: Assessment of Impacts on aquatic ecology (TL Route Option 01)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Low	Low	Very Low
Geographic Extent	Local	Local	Local	Local
Duration	Short-term	Short-term	Long-term	Long-term
Probability	Probable	Probable	Possible	Possible
Consequence	Low	Very Low	Low	Very Low
Significance	Low	Very Low	Very Low	Insignificant

During the construction phase and after mitigation the predicted impacts on aquatic ecology for TL Route Option 02 are of local extent, short-term duration, very low intensity with overall ***very low*** consequence, which together with its ***improbable*** likelihood results in an overall impact significance of ***insignificant.***

During the operational phase and after mitigation the predicted impacts on aquatic ecology for TL Route Option 02 are of local extent, long-term duration, very low intensity with overall ***very low*** consequence, which together with its ***improbable*** likelihood results in an overall impact significance of ***insignificant.***

Table 50: Assessment of Impacts on aquatic ecology (TL Route Option 02)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Low	Very Low	Very Low	Very Low
Geographic Extent	Local	Local	Local	Local

Type of Impact	Negative			
Duration	Short Term	Short Term	Long Term	Long Term
Probability	Possible	Improbable	Possible	Improbable
Consequence	Low	Very Low	Very Low	Very Low
Significance	Very Low	Insignificant	Insignificant	Insignificant

Recommendations and Mitigation Measures

- Locate transmission line pylon outside of wetlands and creeks along the route.
- Where vehicle access and work within a wetland or creek is unavoidable demarcate the access, route using temporary markers. Limit disturbance along edges, monitor edges for any emerging alien invasive species and ensure that these are rapidly removed.
- Herbicides shall not be used within 50m of wetland and creeks (i.e. only manual clearing is allowed). The use of herbicides for plant maintenance should be avoided but if essential only environmentally approved brands that comply with Liberian legal requirements and relevant international conventions should be used. Persistent Organic Pollutants (POPs) and Pesticides as listed by UNEP will not be allowed.
- Disturbed wetland areas must be revegetated with locally indigenous vegetation wherever possible.
- Cement and concrete should be mixed within a mixing tray and/or ready mix should be utilised. Cement should not be mixed within 50 m of the wetland areas.
- Provision must be made for adequate sanitation facilities located at least 150 m away from the wetland areas.
- Ensure chemical storage and use complies with standard good practice and be stored in an enclosed restricted access area (to prevent human re-use) and disposed of at an approved waste facility or by approved waste service providers. Hazardous chemicals, including fuels, should be stored in a bunded and fenced area located at least 150 m from the seasonal drainage line or other surface depressions or pans.
- Repairs to vehicles/diesel powered equipment will be conducted off-site
- Ensure the necessary spill kits are available on site. All hydrocarbons spills on bare ground will be cleared immediately. This will include the lifting of the contaminated soil for bio-remediation or disposal to a hazardous waste facility.
- Abstraction of water from wetlands and creeks must not be allowed for any purpose.
- Bathing and washing of equipment in creeks must not be allowed.
- Repair all erosion damage as soon as possible.
- Avoid impeding drainage of the wetland systems to prevent ponding and subsequent loss of biota.
- Avoid impeding the flow of the creeks.

7.2.4 Alien invasive species impacts

Background and Baseline Conditions

Some invasive species were observed along both of the TL routes (especially along TL Route Option 02 which was cleared for the CLSG line construction). *Lantana camara*, indigenous to the American tropics, is widespread around Africa and can form dense thickets. *Chromolaena ordorata* is a fast-growing

perennial shrub, native to South America and Central America. It has been introduced into the tropical regions of Asia, Africa and the Pacific, where it is an invasive weed. Also known as Siam weed, it forms dense stands that prevent the establishment of other plant species. Perennial invasive species (*Ipomoea parasitica, Ricinus communis* var. *communis*) were observed.

Assessment of Impacts

Disturbance to soil and vegetation during construction is likely to create opportunities for the establishment of alien invasive species. Alien invasive species can outcompete natural vegetation, decreasing indigenous species abundance and diversity. If allowed to seed before control measures are implemented, alien plans can easily colonise and impact on vegetation communities along the TL corridor and in the surrounding areas. Alien invasive pants could also be distributed through vehicles entering the site, or moving from invested areas within the corridor to the uninvested areas.

Following construction, if equipment and/or fill material from other areas is imported there is a high risk that alien invasive plants may be introduced and could spread into adjacent areas where they may replace indigenous vegetation and/or reduce grazing potential for wild animals and cattle.

The impacts associated with alien invasive species will be similar for both transmission line options and are therefore not assessed separately

During the construction phase and after mitigation the predicted impacts associated with alien invasive species are of local extent, short-term duration, medium intensity with overall ***very low*** consequence, which together with its ***probable*** likelihood results in an overall impact significance of ***very low.***

During the operational phase and after mitigation the predicted impacts associated with alien invasive species are of local extent, long-term duration, very low intensity with overall ***very low*** consequence, which together with its ***possible*** likelihood results in an overall impact significance of ***insignificant.***

Table 51: Assessment of alien invasive species impacts (TL Route Options 01 and 02)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	High	Medium	Low	Very Low
Geographic Extent	Regional	Local	Local	Local
Duration	Short-term	Short-term	Long-term	Long-term
Probability	Probable	Probable	Possible	Possible
Consequence	Medium	Very Low	Low	Very Low
Significance	Medium	Very Low	Very Low	Insignificant

Recommendations and Mitigation Measures

- All Alien Invasive Species seedlings and saplings must be removed as they become evident for the duration of construction.
- Herbicides shall not be used within 50m of wetland and creeks (i.e. only manual clearing is allowed). The use of herbicides for plant maintenance should be avoided but if essential only environmentally approved brands that comply with Liberian legal requirements and relevant

international conventions should be used. Persistent Organic Pollutants (POPs) and Pesticides as listed by UNEP will not be allowed.

- Construction staff must be educated and made aware of alien vegetation that could be present and that must be eradicated.
- Sourcing of fill material: any requirement for fill material to create a level platform for site development should be sourced from weed free areas to minimise the risk of spreading alien invasive species and to reduce the ongoing maintenance requirements.
- On-site alien invasive plant monitoring and control (removal and disposal).
- Alien vegetation management: ongoing monitoring will be required during operation to ensure the site is kept free of alien invasive species and any species are removed on a regular basis (before flowering or seeding occurs);
- Clearing of vegetation should be limited to the development footprint areas.
- Access roads should be planned in areas that have already been disturbed or transformed to limit additional fragmentation within the landscape and additional loss of vegetative cover.
- All construction vehicles and equipment, as well as construction material should be free of plant material when leaving the site to avoid contamination of road reserves. Therefore, all equipment and vehicles should be thoroughly cleaned prior to leaving the site.

7.3 SOCIAL IMPACTS

7.3.1 Physical and Economic Displacement

Background and Baseline Conditions

The establishment of the transmission line may result in physical and economic displacement related to the need to relocate all housing and small-scale farmland from the transmission line wayleave (right-of-way). Two route options are considered in this ESIA, and both routes will require a wayleave width of 60 metres (or 30 metres each side of the transmission line route centreline) as depicted in Figure 36.

TL Route Option 1 (Alternative Route) extends for approximately 7.5 kilometres parallel to the existing main access road (including the Monrovia-Careysburg Road and St. Thomas Road). Assuming that all structures would need to relocate from the transmission line wayleave, TL Route Option 1 would result in the displacement of ±105 separate structures held by an estimated 63 households. Small portions of road-side small-scale farmland would also be displaced.

TL Route Option 2 (Preferred Route) extends for approximately 4.2 kilometres and would run parallel to the existing CLSG Transmission Line. This allows the solar PV plant to utilise the existing CLSG transmission line wayleave, which has already been cleared of any structure and land-rights. This negates the need to establish a new transmission wayleave or the need to widen the existing CLSG transmission line wayleave. At the time of the preparation of this report, the Proponent has initiated discussion with the relevant authorities and LEC to place the transmission line in accordance with TL Route Option 02 and the final agreement remained pending.

Assuming that TL Route Option 2 follows the existing CLSG Transmission Line corridor and does not require the amendment of the existing wayleave, then potential need for physical and economic displacement is substantially reduced. No structures would need to be relocated which negates any physical displacement impacts. It is however expected that small-scale farming continues to some extent in the existing wayleave.

Impact Assessment

TL Route Option 1 (Alternative Route) will result in substantial physical and economic displacement, and the impact would be considered to be of ***high negative*** significance if no suitable mitigation measures are established. Consistent with national law and international good practice, the Proponent would need to

approach the Government of Liberia to commence a compulsory land acquisition process for all property in the wayleave and provide fair, full, and prior compensation. This compensation process would be supported by a Resettlement Action Plan (RAP). Assuming the effective planning and implementation of the RAP, the impacts related to displacement along Route Option 1 may be reduced to a ***low negative*** significance .

Table 52: Impact Assessment of Displacement (TL Route Option 01)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	High	Medium	-	-
Geographic Extent	Local	Local	-	-
Duration	Permanent	Medium-Term	-	-
Probability	Definite	Probable	-	-
Consequence	High	Low	-	-
Significance	High	Low	-	-

TL Route Option 2 (Preferred Route) will not likely require physical displacement but may disrupt any active small-scale farming that may found in the existing CLSG Transmission Line wayleave. The impact of the loss of the farmland is however considered to be of ***low negative*** significance as there is limited active farming in the wayleave. Where such active farming is found, the adoption of the mitigation measures presented below will further reduce the impact to ***very low negative*** significance .

Table 53: Impact Assessment of Displacement (TL Route Option 02)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Zero to Very Low	-	-
Geographic Extent	Local	Local	-	-
Duration	Permanent	Short-Term	-	-
Probability	Probable	Probable	-	-
Consequence	Low	Very Low	-	-
Significance	Low	Very Low	-	-

Recommendations and Mitigation Measures

TL Route Option 2 is deemed to be the preferred route as it results in substantially less physical and economic displacement when compared to TL Route Option 1. The adoption of Route Option 1 would result in material project impacts and costs related to resettlement and compensation and should be avoided to the maximum extent possible.

- The following additional recommendation and mitigation measures apply with respect to Route Option 1:
    - Prepare a Resettlement Action Plan (RAP) to address both physical and economic displacement. The RAP will be prepared consistent with national law and international good practice (specifically the IFC Performance Standard 5 on Land Acquisition and Involuntary Resettlement, 2012).
- The following additional recommendation and mitigation measures apply with respect to Route Option 2:
    - Undertake a Social Due Diligence of the CLSG Transmission Line to determine past land acquisition, compensation, and resettlement activities, as well as existing land use restrictions in the CLSG Transmission Line wayleave.
    - Where active farming is found in the CLSG Transmission Line easement, the Proponent will attempt to avoid any disruption to the maximum extent possible related to any construction activities in the wayleave.
    - Where the disruption of active small-scale farming cannot be avoided, the Proponent will be required to prepare a Livelihoods Restoration Plan (LRP) consistent with national law and international good practice (specifically the IFC Performance Standard 5 on Land Acquisition and Involuntary Resettlement, 2012).

7.3.2 Loss of Access to Natural Resources

Background and Baseline Conditions

The establishment of the transmission lines may result in the clearing of vegetation within the required wayleaves (right-of-way), particularly along TL Route Option 01. Two route options are considered in this ESIA, and both routes will require a wayleave width of 60 metres (or 30 metres each side of the transmission line route centreline).

TL Route Option 1 (Alternative Route) extends for approximately 7.5 kilometres parallel to the existing main access road (including the Monrovia-Careysburg Road and St. Thomas Road). Much of the wayleave will comprised of highly degraded Low Bush related to housing development, small-scale farming, and extensive clearing along the road. Natural resources are likely limited to remnant productive trees used for firewood, charcoal production, palm nut and bamboo collection. In addition, the local wetlands function as important seasonal sites for growing water-dependant crops such as vegetables and sugarcane.

TL Route Option 2 (Preferred Route) extends for approximately 4.2 kilometres and would run parallel to the existing CLSG Transmission Line at a distance of 32 m. This connection allows the Project to utilise the existing CLSG Transmission Line wayleave, which has already been cleared of any natural vegetation as part of the construction and ongoing maintenance of the wayleave. This results in much of the habitats already being heavily modified, barring local streams and wetlands found within the wayleave.

Impact Assessment

The development of TL Route Option 1 (Alternative Route) would require the establishment and clearing of a new transmission wayleave. The clearing of vegetation would result in the loss of natural resources that are readily available along the existing roads that the transmission line follows. Such losses would include privately owned or communal economically productive trees (such as fruit, rubber and palm) as well as the possible loss of streams and wetlands used for seasonal gardens.

The loss of natural resources within the TL Route Option 1 wayleave would be considered to be of ***medium negative*** consequence, specifically with respect to the loss of privately owned economic productive tress and seasonal gardens. The impact is however reduced as the wayleave requirement is estimated to be only 60 metres in width and there remains substantial open bush outside of the wayleave that is available to local households. The adoption of suitable mitigation measures may reduce the impact to a ***low negative*** significance.

Table 54: Impact Assessment of the Loss of Natural Resources (TL Route Option 01)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Medium	Low	-	-
Geographic Extent	Local	Local	-	-
Duration	Permanent	Permanent	-	-
Probability	Definite	Probable	-	-
Consequence	Medium	Low	-	-
Significance	Medium	Low	-	-

Assuming that TL Route Option 2 connects to existing CLSG Transmission Line and does not require the amendment of the existing wayleave, then the further clearing of local habitats is unlikely. As such the potential for the loss of natural resources that are used by local households is largely mitigated and the impact is considered to be of ***very low negative*** significance. The establishment of the transmission line in the existing wayleave is the primary mitigation measure in avoiding higher impacts and the impact will remain as a ***very low negative*** significance.

Table 55: Impact Assessment of the Loss of Natural Resources (TL Route Option 02)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Zero to Very Low	Zero to Very Low	-	-
Geographic Extent	Local	Local	-	-
Duration	Permanent	Permanent	-	-
Probability	High	High	-	-
Consequence	Very Low	Very Low	-	-
Significance	Very Low	Very Low	-	-

Recommendations and Mitigation Measures

TL Route Option 2 is deemed to be the preferred route as it results in substantially less losses of natural resources utilised by local households. The adoption of Route Option 1 would result in losses notably with respect to privately owned and communal economically productive trees and potentially the losses of wetlands used for seasonal garden plots.

- The following additional recommendation and mitigation measures apply with respect to TL Route Option 1:
    - Prepare a Resettlement Action Plan (RAP) to will make provision for the compensation and in-kind replacement of all cleared privately owned economically productive trees and seasonal garden plots held by local households. The RAP will be prepared consistent with national law and international good practice (specifically the IFC Performance Standard 5 on Land Acquisition and Involuntary Resettlement, 2012).
    - Ensure that local households will be permitted to collect cleared trees, bamboo or other economically valuable materials during vegetation clearing that will occur during the construction phase.
    - Establish land-use restrictions in the operational wayleave of the transmission line. Where possible the land-use restrictions will permit local households to access the wayleave to undertake small-scale farming of annual crops, while retaining full restrictions in terms of any new trees or buildings.
    - Where possible, appoint local households to undertake regular vegetation clearing of the wayleave as part of the transmission line operational maintenance requirements.
- With respect to TL Route Option 2 utilising the existing CLSG Transmission Line corridor is the primary mitigation measure in avoiding higher impacts and no additional mitigation measures are needed.

7.3.3 Community Facilities, Access, and Mobility

Background and Baseline Conditions

The establishment of the transmission lines may result in the loss of community facilities or infrastructure where they are located in the proposed 60 metre wayleave (right-of-way). The extent of the disruption will however vary depending on the final route option as well as the location of any existing community facilities or infrastructure.

TL Route Option 1 (Alternative Route) extends for approximately 7.5 kilometres parallel to the existing main access road (including the Monrovia-Careysburg Road and St. Thomas Road). The road will be used to support construction and operational traffic as well as allowing access into the wayleave but continued public use of the road will remain unaffected. However, the wayleave extends through at least two informal graveyards, two churches, one public school, the Mount Coffee clinic, and several shops in Mount Coffee Town. Depending on the restrictions within the wayleave, these public services may need to be relocated.

Route Option 2 (Preferred Route) extends for approximately 4.2 kilometres and would be adjacent to the existing CLSG Transmission Line. This allows the Project to utilise the existing CLSG Transmission Line wayleave, which is already cleared of any public facilities, services, or infrastructure. There is no known infrastructure that is noticeable in the existing CLSG Transmission wayleave.

Impact Assessment

The establishment of TL Route Option 1 (Alternative Route) would result in the partial disruption or full relocation of public facilities from the wayleave, including churches, informal graveyards, schools, and clinics. Without any mitigation measures the impact would be deemed to be of ***very high negative***

significance, while the adoption of a suitable relocation programme (supported by a Resettlement Action Plan) can reduce the impact to a ***medium negative*** significance .

Table 56: Impact Assessment of the Impact on Community Facilities and Access (TL Route Option 01)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	High	Low	-	-
Geographic Extent	Regional	Regional	-	-
Duration	Permanent	Permanent	-	-
Probability	Definite	Probable	-	-
Consequence	Very High	Medium	-	-
Significance	Very High	Medium	-	-

Assuming that TL Route Option 2 (Preferred Route) does not require the amendment or significant widening of the existing wayleave, then the route option is not expected to result in any impact on local public facilities, services, or infrastructure. The impact is deemed to be ***insignificant*** and no mitigation measures are required.

Table 57: Impact Assessment of the Impact on Community Facilities and Access (TL Route Option 02)

Type of Impact	Negative			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Zero to Very Low	Zero to Very Low	-	-
Geographic Extent	Regional	Regional	-	-
Duration	Permanent	Permanent	-	-
Probability	Improbable	Improbable	-	-
Consequence	Very Low	Very Low	-	-
Significance	Insignificant	Insignificant	-	-

Recommendations and Mitigation Measures

TL Route Option 2 (Preferred Route) is deemed to be the preferred route as it does not result in the disruption or loss of any known public facilities, services or infrastructure, and does not require the amendment or significant widening of the existing wayleave.

The adoption of TL Route Option 1 would result in material project impacts and costs related to resettlement and compensation and should be avoided to the maximum extent possible. Where Route 1 is selected, the Proponent will prepare a Resettlement Action Plan (RAP) to address the partial loss or full relocated of all affected public facilities. The RAP will be prepared consistent with national law and international good practice (specifically the IFC Performance Standard 5 on Land Acquisition and Involuntary Resettlement, 2012).

Route Option 2 as the preferred route does not impact on any known public facilities, services, or infrastructure therefor no mitigation measures are recommended.

7.3.4 Community Development, Local Employment and Local Content

Background and Baseline Conditions

Broadly speaking, the Montserrado County supports only a 46% labour force participation of economically active people. Most labour is concentrated in urban Monrovia and is comprised mostly of elementary and service sector positions in the informal sector.

Communities located along the TL routes are largely dependent on small-scale farming as their primary livelihood and source of income. Employment is therefore mostly comprised of self-employment in the informal small-scale farming sector (64% of employment) and contributing family worker (16% of employment). Only 17% of rural employment falls under the formal sector, and opportunities is expected to be negligible with the exception for formal and contract labour at the Mount Coffee Hydropower Project.

The lack of any real employment opportunities along the TL routes, generally limits the ability of local people to invest in the development of their households. As such, local household largely dependent on government or NGO support for the development of local community facilities, services, and infrastructure. There is negligible private development in the area around the solar PV site that supports any form of community development.

Impact Assessment

The establishment of the solar PV project (collectively including the solar PV plant and the transmission line) is expected to result in benefits with respect to local community development, employment, as well as increased local business opportunities. Such benefits will be gained indirectly via improvements in national electricity supply, as well as direct benefits related to national capital investment.

TL Route Option 1 (Alternative Route) extends for approximately 7.5 kilometres parallel to the existing main access road and would be a new transmission line constructed by the Proponent (and handed over to the LEC for the operational phase). As a new line, it is expected that there will be substantive labour demand covering engineering design and construction, land acquisition and clearing, resettlement etc.

Most of the benefits associated with the labour demand on TL Route Option 1 would like to accrue at the regional level (notably with respect to employment of specialists from Monrovia or international companies) and are considered to be of ***low positive*** significance (see Table 58). Greater active investment in local development (with focus on communities around the solar PV site) may however increases such benefits to ***medium positive*** significance (see Table 58). These benefits would apply for the construction phase only, and low positive benefits are expected during the operation phase and related to limited labour needs for ongoing maintenance on the transmission line and vegetation clearing of the wayleave.

Table 58: Impact Assessment on Development, Local Employment and Content Benefits (TL Route Option 01)

Type of Impact	Positive Benefit			
Project Phase	Construction		Operations	
Impact Criteria	Without	With	Without	With

Type of Impact	Positive Benefit			
	Mitigation	Mitigation	Mitigation	Mitigation
Intensity/Severity	Medium	High	Zero to Very Low	Low
Geographic Extent	Regional	Regional	Regional	Regional
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Probable	Probable	Probable	Probable
Consequence	Low Benefits	Medium Benefits	Very Low Benefits	Low Benefits
Significance	Low Benefits	Medium Benefits	Very Low Benefits	Low Benefits

TL Route Option 2 (Preferred Route) extends for approximately 4.2 kilometres and would utilise the existing CLSG Transmission Line corridor, which has already been cleared. This substantially reduces the development requirements for this route and will have a lower labour demand compared to TL Route Option 1. It is expected that this route option would result in **insignificant positive benefits** (see Table 59) for both the construction and operational phase.

Table 59: Impact Assessment on Development, Local Employment and Content Benefits (TL Route Option 02)

Type of Impact	Positive Benefit			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Zero to Very Low	Zero to Very Low	Zero to Very Low	Zero to Very Low
Geographic Extent	Regional	Regional	Regional	Regional
Duration	Short-Term	Short-Term	Long-Term	Long-Term
Probability	Possible	Possible	Possible	Possible
Consequence	Very Low Benefits	Very Low Benefits	Very Low Benefits	Very Low Benefits
Significance	Insignificant Benefits	Insignificant Benefits	Insignificant Benefits	Insignificant Benefits

Recommendations and Mitigation Measures

The following recommendations are provided to maximise local community benefits:

- Establish suitable Human Resources and Recruitment Procedures that establish rules for local recruitment and preferential employment. These procedures will be issued to the construction contractor for adoption with the own internal recruitment procedures during the construction phase.

- Establish suitable local content procedures as part of their overall procurement system. The procedures will be issued to the construction contractor for adoption with the own internal procurement procedures during the construction phase.
- For local recruitment and procurement, the terms local shall be defined by multiple levels, and priority will be given to household and community in the order below:
    - Priority Level 1 – Households immediately surrounding the Project site and final transmission line, with specific focus on residents of Crawford Farm.
    - Priority Level 2 – Communities nearest to the Project site and final transmission line, covering Crozierville, Bensonville, Harrisburg, and Mount Coffee.
    - Priority Level 3 – Persons and businesses based in Monrovia, and thereafter nationally.

7.3.5 Cultural Heritage

Background and Baseline Conditions

Two graveyard sites were identified within the TL Route Option 01 corridor while one graveyard sites was identified within 1 km of the TL Route Option 02 corridor.

Impact Assessment

Even tough TL Route Option 01 corridor runs over two graveyard site it is not anticipated to be significantly impacted upon, as long as the pylons are located outside of these graveyard sites. There is however a safety risk associated with broken lines and the use of excavators on the graveyard sites if there are overhead lines present (and the potential indirect result of fires which pose a community safety risk if an accident/break occurs).

Some maintenance is expected to be undertaken as part of the operational phase where the activities will be similar to the construction phase, but significantly smaller in scale over much shorter periods.

During the construction phase and after mitigation the predicted impacts on cultural heritage for TL Route Option 01 are of local extent, short-term duration, low intensity with overall ***very low*** consequence, which together with its ***possible*** likelihood results in an overall impact significance of ***insignificant.***

During the operational phase and after mitigation the predicted impacts on cultural heritage for TL Route Option 01 are of local extent, short-term duration, very low intensity with overall ***very low*** consequence, which together with its ***improbable*** likelihood results in an overall impact significance of ***insignificant.***

Table 60: Impact Assessment on Cultural Heritage - TL Route Option 01

Type of Impact	Positive Benefit			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	High	Low	Low	Very Low
Geographic Extent	Local	Local	Local	Local
Duration	Permanent	Short term	Short term	Short term
Probability	Probable	Possible	Possible	Improbable
Consequence	High	Very Low	Very Low	Very Low
Significance	High	Insignificant	Insignificant	Insignificant

The graveyard site close to TL Route 02 is not expected to be impacted upon due the distance from the existing CLSG right of way, and the fact that no further vegetation clearance will be required.

During the construction phase and after mitigation the predicted impacts on cultural heritage for TL Route Option 02 are of local extent, short-term duration, very low intensity with overall ***very low*** consequence, which together with its ***improbable*** likelihood results in an overall impact significance of ***insignificant.***

During the operational phase and after mitigation the predicted impacts on cultural heritage for TL Route Option 02 are of local extent, short-term duration, very low intensity with overall ***very low*** consequence, which together with its ***improbable*** likelihood results in an overall impact significance of ***insignificant.***

Table 61: Impact Assessment on Cultural Heritage - TL Route Option 02

Type of Impact	Positive Benefit			
Project Phase	Construction		Operations	
Impact Criteria	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Intensity/Severity	Low	Very Low	Low	Very Low
Geographic Extent	Local	Local	Local	Local
Duration	Permanent	Short term	Short term	Short term
Probability	Possible	Improbable	Possible	Improbable
Consequence	Low	Very Low	Very Low	Very Low
Significance	Very Low	Insignificant	Insignificant	Insignificant

Recommendations and Mitigation Measures

The following mitigation measures apply to avoid and minimize impacts in cultural heritage:

- TL Route Option 02 should be implemented as the preferred alternative.
- The pylons shall be placed outside of graveyard sites.
- The graveyard sites shall be demarcated as no-go areas and all project staff (including contractors) shall be made aware of this.
- Communities located near the TL route shall be made aware of what to do in the event of discovering a broken powerline and in the event of a fire.
- Safety signage shall be placed on pylons near communities, farming areas and graveyard sites warning of the dangers associated with high-lift/excavation work under powerlines as well as provide emergency contact details.
- A Chance Find Procedure will be developed and implemented to address any potential finds of cultural heritage value during the construction phase.
- If an archaeological site/archaeological finds or potential fossil finds are discovered during any construction activity, the work is to be halted and the National Heritage Conservation Commission (NHCC) must be notified.
- Any human burials unearthed should be immediately reported to the National Heritage Conservation Commission (NHCC).

8. DECOMISSIONING PHASE IMPACTS

The impacts during the decommissioning phase for both the solar PV plant and the transmission line will be similar as during the construction phase where none are considered to result in impacts of high significance. A detailed ESMP will be compiled for the decommissioning phase prior to decommissioning the plant, and more details are included in the ESMP (Appendix E). The framework for a decommissioning plan is outlined in Section 13.

Once the solar PV plant reaches its end of life, there are two options. The first includes refurbishing or replacing the PV modules to allow the project to continue generating electricity. The second option is to decommission the facility. The latter options will involve all components of the solar PV plant being removed and the site being rehabilitated. Where possible materials will be recycled, alternatively they will be disposed of according to both local and international waste management practices.

9. CUMULATIVE IMPACTS

From a cumulative impact perspective, there is some uncertainty about specific future developments in and around the project site, with only some road rehabilitation projects identified around the Crozierville area in the Montserrado County Development agenda (2008-2012).

The solar PV site is rural in nature and no other existing industries or developments were noted in the Crozierville area. The only known infrastructure development in the area is the CLSG transmission line that runs directly north of the solar PV site.

There are however various existing transmission lines along the last 4km of the 7km TL Route Option 01 corridor (i.e. between White Plains and the MCHPP). It is unlikely that an additional transmission line along this area will result in significant additional negative cumulative impacts.

If not properly managed, alien invasive plant species will out-compete indigenous flora and reduce overall indigenous biodiversity in the area. Not attempting to control or preventing the worsening of alien invasive infestation will cause a decline in indigenous species. Altered population dynamics, such as displacement of natural indigenous species by alien invasive species, can impact on natural community structures, impacting further on ecological interactions, ecological services and natural food-chains.

10. STAKEHOLDER ENGAGEMENT

10.1 INITIAL STAKEHOLDER ENGAGEMENT PROCESS

The stakeholder engagement process followed during the compilation of the ESIA Report and the issues raised is summarised in Table 62 while supporting information (e.g. stakeholder engagement reports, attendance registers, Notice of Intent, etc) is contained in Appendix C.

Stakeholders involved in the engagement process and a summary of issues raised is presented in Table 63.

Table 62: Summary of stakeholder engagement process

Date	Activity
29 January 2020	Letter and Background Information Document (BID) compiled and distributed to key stakeholders in January 2020. (Appendix C). The BID contained information about the project, including the project description, what authorisation is required, the key E&S issues for consideration, and an invitation to register or comment (with contact details).

Date	Activity
18 February 2020	Stakeholder engagement meetings held with Crozierville Farm Community and Harrisburg community. The main purpose of these meetings was to share information about the proposed project and to gather socio-economic data. Minutes of meetings Appendix C
19 February 2020	Stakeholder engagement meeting held with Crawford farm community. The main purpose of the meeting was to share information about the proposed project and to gather socio-economic data as well as to record potential concerns. Minutes of meeting Appendix C
02 September 2020	A Notice of Intent (NOI) was published in the local media. The NOI served to inform the general public and stakeholder of the project, invited them to provide views, comments, recommendations or concerns, and provided the contact details (physical, telephone and email) for submitting views, comments, recommendations or concerns. Appendix C

Table 63: List of stakeholders consulted to date and summary of issues raised

Organisation	Name	Position	Summary of issues raised
Liberia Land Authority (LLA)	Cllr. Kula L. Jackson	Commissioner, Land, Policy, and Planning	LLA should be involved in the process.
Liberia Land Authority (LLA)	Mr. Romeo Clark	Director of Internal Audit Division	The compensation process should be transparent to avoid confusion.
Ministry of Public Works	Hon. James J. Reynolds	Assistant Minister for Planning and Programming	The finalized design should be sent to the ministry for site verification.
Ministry of Mines & Energy	Hon. Gesler E. Murray	Minister	The project site should be properly mapped to capture all areas including the affected areas.
Ministry of Mines & Energy	Hon. Emmanuel O. Shannon	Deputy Minister for Operation	
Liberia Electricity Corporation	Mr. Ballah Y. Kezelee	Community Liaison Officer	The team should capture all Project Affected People (PAPs) and property holders within the project area and identified the legal owner to avoid conflict.
Liberia Electricity Corporation	Mr. B. Baccus Robert	HSE Manager	
Liberia Electricity Corporation	Mr. Abraham L. B	Environmental Officer	
Ministry of Agriculture	Mr. James T. Moore	Director, Marketing Department	There should be a plan to support sustainable farming for locals.
Ministry of Agriculture	Mr. Stephen N. Teeneh	Marketing Officer	
Environmental Protection Agency	Mr. Kawasu M. Toure	Assistant Manager, Environmental Social Impacts Assessment Unit	The consultants should work in line with all relevant environmental guidelines and ensure that mitigation measures are put in place for all impacts relating to the project.
Environmental Protection Agency	John Kpakolo Jallah Jr	Manager, Department of Compliance & Enforcement	The agency should be part of all the activities regarding the project and profiling of the PAPs.
Liberia Refugee Repatriation Resettlement Commission	Hon. Alphanso Wallace	Deputy Executive Director for Operation	
National Public Health Institute of Liberia	Dr. Amos Gborie	Director of Environmental and Occupational Health	The entity should be involved during the enumeration exercise. Affected graves should be properly relocated (if affected). The Traditional Council of Liberia should be involved with the relocation of graves if traditional rituals are to be performed before removal of those graves.

Organisation	Name	Position	Summary of issues raised
			Water quality should be properly monitored during the project operation.
Rural and Renewable Energy Agency of Liberia	Mr. David Wiles	Environmentalist	Upon the completion of the project, electricity facilities should serve the inhabitants within the project environment as well as citizens of rural Montserrado county.
Crozierville Township Leadership	Ruth L. James	Commissioner	The commissioner appreciated the project and its sponsor.
Crozierville Township Leadership	G. Matthew Siaker	Township Development Chairman	Locals within the area should be given first preference as it relates to employment. Upon completion, the project should serve the township.
The Elder Council - Crozierville	Philip Gblayah Jonathan M. Kennedy Rufus Gbanjah	N/A	The Elder council should form part of the decision-making process regarding the recruitment of locals during the construction phase.
Women Leadership - Crozierville	Konah Yah	N/A	Women should be provided with small scale businesses to enhance their livelihood, and they should be prioritized regarding employment opportunities.
Youth Leadership - Crozierville	Randolph S. Diggs	Youth chairman	Youth within the township should be given preference considering the project site is to be situated in Crozierville.
Antoinette Tubman Public School - Crozierville	Peter S. Harris	VPI and Teaching Staff	The institution is understaffed. Most children within the township are not in school due to financial and domestic problems. Upon the completion of the project, electricity facilities should be installed to enhance the learning environment for the project inhabitants.
Crozierville Reproductive and Maternity Center	Christopher M. Nyaquoi	Kaikee Padmore Registrar	Health workers within the area indicated a lack of drugs and lack of staff at the facility as the current major challenges they are faced with. The health workers appreciated the project as it will augment the electricity issues within the township.
Porte School	Gladys M. Porte	Principal	Lack of finance for parents to send their kids to school is the major issue the institution is faced with.

Organisation	Name	Position	Summary of issues raised
			The project should help improve the learning environment by providing electricity.
Religious Council/Leadership	Mot. Fatu Bemah	N/A	The inhabitants within the project area should be given preference for employment upon the completion of the project.
Weeks Compound, Adjacent Crawford farm	Angelique Weeks	N/A	The consultant should work in line with the EPA environmental guidelines and ensure that mitigation measures are adequate for all predicted impacts.
White Plain Township Leadership	Urias W .Brooks (John B. Bannie) Otis Brown	Commissioner Chief of Elders (Youth Chairman)	The project is necessary as it will boost the power supply. However, locals within the area should be given first preference as it relates to employment. The project should also serve the inhabitants of white plain upon completion.
Harrisburg Township Leadership	Viola B. Garway	Commissioner	The project is necessary. Locals within the area should be given preference relative to employment opportunities. Upon completion of the project, the affected Townships should have access to the electricity.
Harrisburg Township Leadership	Romeo D. Bass	Township Clerk	
Harrisburg Township Leadership	Thomas D. Cooke	Gen. Town Chief	
Crawford Farm Community	Jeremiah Knuckles	N/A	Expressed optimism and questioned as to whether assistance will be provided during the implementation of the project.
Crawford Farm Community	Esther Flomo	N/A	Appreciated the team for the interview and she hoped for assistance to enhance their livelihood.
Crawford Farm Community	Rose Ketteh	N/A	The project should assist them by enhancing their practice of their livelihood activities.
Crawford Farm Community	David Daweh	N/A	Noted that he hoped that he will have an opportunity for employment when the project commences.
Crawford Farm Community	Esther Kaipah	N/A	stressed that life on the farm is often in poor condition and they hope that the project will augment their living condition.

10.2 STAKEHOLDER ENGAGEMENT DURING THE ESIA PROCESS

On the completion of the Draft ESIA report, the public is invited again to participate in the ESIA review through public consultation meetings arranged by the EPA. The public's views on the ESIA are taken into consideration by the EPA when deciding on approving or rejecting the project.

In terms of the Environmental Protection and Management Law, 2003 (EPML) the EPA will need to publish a notice inviting the comments from the public allowing a period of 30 days (or more at the discretion of the EPA) to receive such comments. This notice must state the particulars of the project.

In some cases, the EPA may decide to hold a public hearing about the project in order to strengthen the public participation. According to the EPML this public hearing should be attended by the EPA, the Line Ministry representatives and relevant County Environmental Offices. This hearing must be held at a venue which is convenient to the persons who are likely to be specifically affected by the project. If the EPA decides to conduct a public hearing then the date and venue will need to be published.

The issues raised by stakeholders during the EPA process and responses will be presented in a detailed Comments and Response Report.

10.3 OPPORTUNITIES FOR FUTURE STAKEHOLDER ENGAGEMENT

A full time Community Liaison Officer (CLO) will be employed who will be responsible for disseminating information and coordinating community communications through the course of the project. An external Grievance Mechanism will need to be developed and implemented to enable community members and other stakeholders to raise issues of concern. This will serve to receive and facilitate resolution of affected communities' concerns and grievances about the client's E&S performance.

The Proponent will inform the affected communities about the external Grievance Mechanism in the course of the stakeholder engagement process. The external Grievance Mechanism must include detailed procedures around recording, tracking and closing out of grievances received. The EPC contractor is responsible for adhering to and implementing the external Grievance Mechanism.

11. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

A detailed Environmental and Social Management Plan (ESMP) is included in Appendix E. This document was prepared by Gigawatt Global, and SLR incorporated the mitigation measures as contained in this report into the ESMP.

The ESMP provides a framework for the implementation of environmental and social management measures identified in the ESIA and is based on best practice principles which require that every reasonable effort is made to reduce, and prevent negative impacts while enhancing the benefits.

The project will be implemented in line with the ESMP. As the Project Owners, GWG will have overall responsibility, authority and accountability for environmental and social issues associated with the project. The ESMP outlines the key steps to be taken by all project personnel and their contractors, to effectively manage the environmental and social impacts and risks associated with the construction and operation of the project. All personnel engaged on the project are required to fully comply with the requirements of the ESMP in order to limit the potential for unacceptable environmental and/or social impacts or regulatory non-compliance.

12. ENVIRONMENTAL AND SOCIAL MONITORING PLAN

Monitoring will be conducted during construction and operational activities to verify compliance and to evaluate the effectiveness of the mitigation measures. Monitoring requirements have been set out in the monitoring plans as contained in the ESMP.

13. DECOMMISSIONING AND CLOSURE PLAN

The key objective of the Decommissioning and Closure Plan is to return the disturbed areas on the project site back to an acceptable state. In general, the solar PV site includes areas of disturbed agricultural land, one small area of “Young Bush” and three wetland areas. The rehabilitation programme will attempt to restore the area to an acceptable standard.

The overall closure objectives for the solar PV site are:

- Minimise the visual impact of the solar PV site and rehabilitate areas by carefully shaping the site to blend with the surrounding landscape and by using indigenous vegetation from the area for rehabilitation.
- Ensure that the plant communities which establish within the rehabilitated areas comprise of indigenous vegetation only.
- Ensure that all areas are stable and rehabilitated to prevent erosion or dust creation.
- Ensure that the area is safe for the intended end land use with the removal of the project infrastructure.

At the end of the life of the solar PV plant, the following decommissioning and rehabilitation activities will take place:

- Shut down and disconnect the solar PV plant from the transmission line connection;
- Disconnect all services;
- Dismantle all solar PV panels and dispose of them in accordance with waste management requirements;
- Dismantle solar PV stands, send PV stands for scrap metal reclamation;

- Dismantle / demolish buildings;
- Concreate foundations will be ripped;
- Rubble will be removed and disposed of at a suitably licensed facility;
- Removal of fencing;
- Compacted and disturbed areas on the project footprint will be ripped, sloped and shaped;
- Disturbed areas will be sloped to enhance natural run-off patterns;
- Seeding of the project footprint will be undertaken using indigenous seed mix;
- Monitoring and ongoing management of the vegetation establishment at site for a period of time to be determined after rehabilitation.

14. SUMMARY AND CONCLUSION

The aim of the ESIA process is to provide sufficient information to allow the EPA to make an informed decision with regards to allowing the proposal solar PV plant and associated transmission lines to proceed. The ESIA provides this information and has been compiled in alignment with national legislation and the IFC Performance Standards.

The impacts of the construction and operation of the solar PV plant are summarised in Table 64. The impacts of the construction and operation of the transmission line are summarised in Table 65.

Neither the solar PV site nor the preferred transmission line route includes any Critical Habitat as defined by the IFC. The solar PV site is located on private land owned by a single land owner, who is not actively farming the land , however the site does support some informal livelihood activities. Transmission line Route Option 02 (Preferred Route) will not likely require physical displacement but might disrupt some active small-scale farming identified in the existing CLSG Transmission Line wayleave. It is likely that the local communities will be able to be appropriately compensated through implementing mitigations that is aligned with IFC Performance Standard 5.

Occupational health and safety issues for the workforce during both the construction and operational phases of the project are of concern due to the potential unfamiliarity of the local workforce with international good practice procedures. However, this can easily be mitigation through appropriate training and implementation of health and safety management system throughout the construction and operational phase of the project.

The benefits of job creation and opportunities for local suppliers cannot be overstated. This combined with a well-structured Corporate Social Responsibility plan will result in increased benefits to the surrounding local communities.

The assessment of the construction and operation of the solar PV plant shows there are no impacts, as a result of the solar PV plant, that are assessed to be of medium significance or higher after mitigation; all range from low to insignificant. For the alterative transmission line route (TL Route Option 01) the aspects relating to (1) Habitat loss, fragmentation and edge effects, and (2) Community Facilities, Access, and Mobility are rated to be medium after mitigation, whereas these two aspects are rated as insignificant for the preferred transmission line route (TL Route Option 02). The rest of the aspects associated with the transmission line routes range from low to insignificant.

It is concluded that, if mitigation and monitoring measures contained in the Environmental and Social Management Plan (ESMP) (Appendix E) are implemented and the developer commits to enhancing community benefits through creation of local jobs, use of local suppliers and development of a robust Corporate Social Responsibility plan for the community, the benefits of the solar PV plant and associated transmission line will outweigh the negative impacts.

Table 64: Summary of impacts of the solar PV plant

Environmental component	Impact during construction & operation phase of the **Solar PV plant**	**CONSTRUCTION PHASE** Significance without mitigation		**OPERATIONAL PHASE** Significance with mitigation	
		Without mitigation	With mitigation	Without mitigation	With mitigation
Biophysical Impacts	Impact of air emissions	Medium	**Low**	Very Low	**Very Low**
	Impact of noise emissions	Medium	**Low**	Very Low	**Very Low**
Ecological Impacts	Habitat loss, fragmentation and edge effects	Low	**Low**	Low	**Very Low**
	Impacts on biota	Low	**Low**	Low	**Very Low**
	Impact on aquatic ecology	Medium	**Low**	Low	**Very Low**
	Alien invasive species impacts	Medium	**Low**	Low	**Very Low**
Socio-economic Impacts	Physical and Economic Displacement	Medium	**Very low**	-	-
	Loss of Access to Natural Resources	Low	**Low**	-	-
	Community Facilities, Access, and Mobility	Low	**Very Low**	Medium	**Very Low**
	Community Development, Local Employment and Local Content	Low Benefits	**Medium Benefits**	Very Low Benefits	**Medium Benefits**
	Landscape and visual amenity	Medium	**Low**	Medium	**Low**
	Cultural Heritage	Medium	**Insignificant**	-	-

Table 65: Summary of impacts of the Transmission Lines

Environmental component	Impact during construction & operation phase of the **Transmission Line**	TL Route Option 01				TL Route Option 02			
		CONSTRUCTION PHASE Significance without mitigation		OPERATIONAL PHASE Significance with mitigation		CONSTRUCTION PHASE Significance without mitigation		OPERATIONAL PHASE Significance with mitigation	
		Without mitigation	**With mitigation**	Without mitigation	**With mitigation**	Without mitigation	**With mitigation**	Without mitigation	**With mitigation**
Biophysical Impacts	Impact of air emissions	Very Low	**Insignificant**	Very Low	**Insignificant**	Very Low	**Insignificant**	Very Low	**Insignificant**
	Impact of noise emissions	Medium	**Low**	Low	**Low**	Low	**Very Low**	Insignificant	**Insignificant**
Ecological Impacts	Habitat loss, fragmentation and edge effects	High	**Medium**	-	-	Very Low	**Insignificant**	-	-
	Impacts on biota	Low	**Very Low**	Low	**Insignificant**	Very Low	**Insignificant**	Insignificant	**Insignificant**
	Impact on aquatic ecology	Low	**Very Low**	Very Low	**Insignificant**	Very Low	**Insignificant**	Insignificant	**Insignificant**
	Alien invasive species impacts	Medium	**Very Low**	Very Low	**Insignificant**	Medium	**Very Low**	Very Low	**Insignificant**
Socio-economic Impacts	Physical and Economic Displacement	High	**Low**	-	-	Low	**Very Low**	-	-
	Loss of Access to Natural Resources	Medium	**Low**	-	-	Very Low	**Very Low**	-	-
	Community Facilities, Access, and Mobility	Very High	**Medium**	-	-	Insignificant	**Insignificant**	-	-
	Community Development, Local Employment and Local Content	Low Benefits	**Medium Benefits**	Very Low Benefits	**Low Benefits**	Insignificant Benefits	**Insignificant Benefits**	Insignificant Benefits	**Insignificant Benefits**
	Cultural Heritage	High	**Insignificant**	Insignificant	**Insignificant**	Very Low	**Insignificant**	Insignificant	**Insignificant**

APPENDIX A: COPY OF TITLE DEED

APPENDIX B: SITE PHOTOS

APPENDIX C: STAKEHOLDER ENGAGEMENT

C1: Minutes of Community Meetings

C2: Attendance Registers of Community Meetings

C3: Notice of Intent

APPENDIX D: SLR IMPACT ASSESSMENT METHODOLOGY

APPENDIX E: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Conroy van der Riet
(Main Report Author)

Conroy van der Riet
(Project Manager)

Stuart Heather-Clark
(Reviewer)

AFRICAN OFFICES

South Africa

CAPE TOWN
T: +27 21 461 1118

JOHANNESBURG
T: +27 11 467 0945

Namibia

WINDHOEK
T: + 264 61 231 287