Environmental and Social Impact Assessment (ESIA) for developing a 200 MWac PV Power Plant Project in Jordan

Draft Report

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Abbreviations

AJ	Arabtech Jardaneh
dBA	A-Weighted Decibels
EIA	Environmental Impact Assessment
EPRP	Emergency Preparedness and Response
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental Social Management Plan
GoJ	Government of Jordan
GHG	Green House Gas
IFC	International Finance Corporation
IPP	Independent Power Project
JMD	Jordan Meteorological Department
MoEnv	Ministry of Environment
MEMR	Ministry of Energy and Mineral Resources
MW	Megawatt
NEPCO	National Electric Power Company
OHS	Occupational Health & Safety
PS	Performance Standard
PV	Photovoltaic
DoA	Department of Antiquities
PEA	Preliminary Environment Assessment
ToR	Terms of Reference
WWTP	Wastewater Treatment Plant

1 EXECUTIVE SUMMARY

1.1 Introduction

Baynouna for solar energy intends to develop a 200MWac grid connected Photovoltaic project within Muwaqqar area in Amman. The project has been approved by all authorities of concern including Ministry of Energy and Mineral Resources (MEMR).

The project will help to decrease the country's dependency on traditional forms of energy by increasing the availability and use of solar energy. The generated electricity will be injected into the national grid, to support the country in meeting its renewable energy target of 10% by 2020.

Arabtech Jardaneh (AJ) was appointed by Baynouna to prepare the Comprehensive Environment Impact Assessment (ESIA) Study for the project activities during the three phases of the project construction, operation and decommissioning. The ESIA will be prepared in accordance with the requirements of the Jordanian Environmental Impact Assessment (EIA) Regulation no. 37 of 2005, and the International Finance Corporation (IFC) Performance Standards (PSs), in addition to both EBRD Performance Requirements (PRs) and Equator Banks Principles in order to support the application for an environmental permit from the Ministry of Environment (MoEnv).

1.2 Project Description

The Project is to be located approximately 30 kilometres (km) southeast of Amman in Tilal Al-Rukban area in Muwaqqar district and approximately 25 km northeast of the Queen Alia International Airport.

The project area will occupy 6000 dunums (i.e. 6 km^2). The site is characterised with hard soil and an approximate elevation of 800 - 840 meters above sea level. The Site is flat, yet can have a topography with varying heights due to a large number of valleys (wadis) runing across the Site in some areas.

The total installed capacity of the Project will be 247.6 MWp DC and 230.3 MVA AC at 40ÁC. Such capacity will be installed to export 200 MW AC power to the NEPCO grid.

1.2.1 Project Components

PV Modules

The PV module to be used for the project will be either crystalline silicon based technology or thin film based technology or mixture of both technologies module. The DC capacity of single module foreseen for this Project varies depending upon the final selection of the technology mixture.

Mounting Structure

The mounting structure is a metal supporting structure on which PV modules are mounted. In this project, modules will be installed on single axis tracker which tracks the position of Sun during the day in order to maximize the energy output from the plant.

Inverter and Inverter Station

Several PV modules are combined in series to form string and the strings are grouped in combiner box. The group of strings are then fed into the inverter. Inverter converter electrical energy from DC to AC. Each inverter station foreseen for the project in indicative design mainly includes 2*inverters, LV/MV transformer, switchgear and electrical connection. In the indicative design of the project, a total of 49 inverter stations are considered. The LV/MV transformer included in inverter station steps up voltage up to 33 KV.

Substation

The several inverters are then connected to the grid via substation. Substation includes MV/HV Power Transformers, MV Switchgears, electrical protections and connections. The output voltage from Inverter station i.e. 33 kV will be further stepped into 132 kV through power transformers installed in then substation. The output from the substation will then be fed into the NEPCO grid.

Control Room

The project performance, meteorological parameters and control on output according to NEPCO requirements will be made through SCADA system installed in control room. This building also includes office areas during construction and operation of the Project.

Cablings and other equipment

The project will have different DC, AC (LV and MV), communication and network cables. Communication and network cables are used in SCADA system to monitor the plant, meteorological data and communicate with grid operator. Other equipment includes, combiner box, meteorological equipment, security system components (camera, fences) etc. The project will have storage facility to store spare parts required for the Project during operation and maintenance period.

Civil Works

Civil works of the project will consist of the following:

Site Levelling or Grading

Foundation for Mounting Structure

Access road and Internal Roads

Underground cable trenches

Civil Work for Drainage System

Foundation of Inverter Stations, control room, storage facility

Civil work for Substation

Civil Work for Security System

Any other civil works required for the Project

Construction period is expected to be of 12-20 months. It will employ approximately 300 people during the peak of construction period. During operational period that will extend for 20 years, approximately 30 people will be working full time to operate and maintain the PV plant.

During construction, workers will likely be accommodated in the nearest accommodation facilities to the site (possibly in Amman and surrounding) and will be provided with means of transportation to the site. However worker accommodation options are still being explored. If the project opted to include worker accommodation facilities on site, these shall be established in accordance with the specifications of the International Labour Organisation (ILO) standards and guidance published by EBRD and IFC and shall adhere to all measures needed to prevent potential occupational hazards on site.

The most likely activities during the complete development and operation of the Project can be divided in to following main three phases,

- **Planning and Design Phase**: Typical activities includes finalization of Project permits, approval, project partners, designs etc.
- **Construction and Commissioning Phase:** Typical activities include

  Transportation of all project components to the site

  Civil, mechanical and electrical construction/installation of project according to design

  Interconnection to the grid

  Commissioning of the project: mechanical, electrical and performance tests.

- **Operation Phase:** Typical activities include

  Minimum 20 years of operation and maintenance of the plant.

  Corrective maintenance in case of defect or failure of components.

1.3 Legislative Framework

The Competent Authority approving EIA Studies in Jordan is the Ministry of Environment, who is responsible for the evaluation of the environmental impacts of the project and the issue of associated permits and licenses.

According to the Environmental Protection Law No. (52)/ year 2006, the EIA study should be done before the project is initiated and sent to the Ministry of Environment where it will be reviewed.

Regulation No. (37) / year 2005 sets out the process for conducting an EIA study and the items to be included in the Study, procedure for obtaining an environmental clearance.

If the Impact assessment is approved, the project will get the license and start construction and operation while adhering to the environmental mitigation and management systems specified and approved in the study. Any deviation from those guidelines would render the project to violations.

In addition to local requiremnts, AJ is committed to deliver this ESIA in acceordance with the International Finance Corporation (IFC) Performance Standards (PSs), in addition to both EBRD Performance Requirements (PRs) and Equator Principles in order to support the application for an environmental permit from the Ministry of Environment (MoEnv).

1.4 Baseline Conditions

1.4.1 Physical Environment

Meteorology and Climate

The project area belongs to the Arid Mediterranean-cool Zone. The initial meteorological characteristics have been obtained based on the data averages for the years (2011- 2015) recorded in Ghabawi weather station. The data averages show that the average maximum temperature is 24.6 ÁC; the average minimum temperature is 11.8 ÁC; average mean temperature is 18.2 ÁC; average mean humidity is 59.4 %; average annual rainfall amount is 87.5 mm; average mean wind speed is 8.01 knot.

Air Quality

Mass concentrations of PM10 & PM2.5 were simultaneously measured during January 30-February 6, 2017. The daily concentrations of PM10 ranged between 30.910 µg/m3 and 57.893 µg/m3 with no exceedance to the Jordanian standards limit of 120 µg/m3. On the other hand, the daily concentrations of the PM2.5 were between 8.194 µg/m3 and 13.095 µg/m3; therefore, no exceedances were observed to PM2.5 daily limit stated in the Jordanian standards.

Noise Levels

Spot noise monitoring was carried out at proposed construction location for this project in order to determine the ambient baseline sound level profile. Monitoring was undertaken using data logging Sound Level Meter Model Extech HD600 (Hand Held Type II noise meter).

The measurements were carried out during day time while the wind speed was at moderate speeds. Vehicles movement considered as the main noise emission sources at noise monitoring location.

Noise measurements were recorded at two spots on 26-12-2016. Results have shown that the maximum measurement at spot 1 is (64.9dBA), the minimum is (44.7dBA) and the average is (50.8dBA). For spot 2 maximum measurement was found to be (52.6dBA), (38.2dBA) as minimum and (43.2dBA) as average.

As can be seen from these data, LAavg is within the allowed limits, the maximum levels recorded whereas a vehicle passed the nearby road, however these maximum levels are not exceeding the allowable limits at the monitoring location.

Physiography and Soil

The project area falls in a transitional region between the Mountainous Region and the Eastern Desert Region; this region is called Steppe Topographical Region.

A topographic survey was conducted for the project area on June 2016. The results of this survey have shown that the project area is considerably moderate sloppy in most parts and more gentle slopes in some parts of the project area.

Project area falls in land region 11 which is Jordan Highland Plateaue. The major soil types present in this land region are transitional xerochreptic subgroups of calciorthids and camborthids.

Geomorphology and Geology

The project area belongs to the B4 and B3,B2/A7 formations, which fall within the Tertiary and Cretaceous systems including the Paleocene and Upper Cretaceous. In terms of sedimentary rocks these formations consist of chalk, chert, limestone and mart. Limestone and chert layers are prolific aquifers in much Jordan.

Tectonic Settings

The project site lies within the light magnitude of Richter's scale. Therefore, if an earthquake was induced in that area, it is anticipated that the intensity will fall between the 4.0 to 4.9 magnitudes according to Richter's scale. The light magnitude is often felt with rattling and shaking noises, but usually causes no significant damages.

Surface water

The project area is located within Azraq basin. Azraq Basin is an extensive inland drainage system lying in the steppe and desert to the east of Amman. The basin covers over 12,710 km^2 which is not entirely in Jordan; stretching from the lava peaks of Jebel Druze in southern Syria to the Wadi Sirhan in northern Saudi Arabia. A hydrological study was conducted for the project area during June 2016, which studied the storm water based on the existing topographic condition, the study is discussed in details under the baseline section.

Groundwater

The project area is located between Amman-Zarqa and Azraq groundwater basins – within groundwater characteristics leaning more towards the Amman-Zarqa Basin. The project area falls within Muwaqqar formation / Chalk-Marl Unit (B3) which spreads in many parts of the kingdom.

Since the Muwaqqar formation is an aquitard, as a result there is no groundwater in the area; since this aquitard, consists of a thick sequence of chalk and marl which forms a groundwater barrier in the eastern limit of the basin along the Qihati fault Ministry of Water and Irrigation, Water resource policy support, Groundwater management component, Outline Hydrogeology of the Amman-Zarqa Basin, May, 2000. (Outline Hydrogeology of the Amman-Zarqa Basin, 2000).

1.4.2 Biological Environment

Flora

Biogeographic Zones

The project site exists Mediterranean biogeographic zone which is restricted to the highlands of Jordan extending from Irbid in the north to Ras Al-Naqab in the south. This region comprises the most fertile part of Jordan and presents the best climate for the forest ecosystem.

Ecosystem

The proposed project area is represented in one major Ecosystem; Scrap and Highland Ecosystem. This ecosystem consists of escarpments and mountains, hills and undulating plateaus, which extend mainly from Irbid in the north to Ras Al Naqab in the south, and, from Rift Valley region in the west to the Badia in the east.

Vegetation Types

The project area is characterized by two vegetation types due to its location at a transitional margin between two vegetation types namely; Steppe Vegetation and Mediterranean Non-Forest Vegetation.

The proposed site for the project has a very poor vegetation cover that was due to natural causes where the distribution of the vegetation is restricted to the very shallow depressions and wadis. Also due to the existing and past use of the site for seasonal cultivation to produce livestock fodder.

Fauna

Mammals

The mammals of the project area are almost representing most of the mammals of that found in the two zoogeographic zones represented at the project area; Mediterranean Zoogeographic Zone and Saharo – Sindian Zone. Mediterranean Zoogeographic Zone is a distinct sub region within the Palearctic region (European Origin). It includes mountain areas that extend from the north of Jordan till Al Naqab Mountains in the south. As for Saharo – Sindian Zone it is located to the east of the mountain ranges, extending from south of Jordan to northeast of the country in Mafraq area.

Birds

The proposed project area for the project is not located at one of the birds' migration fly ways but close to the west of the raptors and eastern desert fly way for migratory birds. Soaring birds' sensitivity tool has been used on 1, 2, 5 and 10 km. Results shown as APPENDIX C.

Due to the deterioration and the absence of the natural vegetation at the proposed site for the project, the faunal diversity recorded at the site is also very minimal. No species of reptiles were recorded due to the winter season during the survey, two species of mammals and five species of birds where recorded at the proposed site of the project and the surrounding area within 500 meter from the proposed sites borders.

1.4.3 Socio-Economic Conditions

Population

The project site is located in Telal Al Rukban area, belonging to Muwaqqar District which falls in Amman Governorate. The Population of Muwaqqar District is 84,370. The number of males for the same year is estimated at 45,590 while females are estimated at 38,880. The project area and its direct surroundings is void of any populations. The nearest populated are to the project is Maghayer Mhanna village with a population of 2,963.

Project Support to Jordanian Government in Hosting Refugees

As of March 2016, there are approximately 636,000 Syrians (6.7 % of Jordan's population) formally registered by UNHCR although the Jordanian government considers a more realistic number to be 1.27 million Syrians. According to government statistics residential consumption rose by 9.44% from 2011 to 2012, compared to just 5.9% between 2010 and 2011.

An average of 57 % of refugee's income goes on accommodation. Spending on liquefied petroleum gas (LPG) for cooking and heating in winter, and electricity for heating water are significant expenses.

The government foresees additional power demand in cities and towns to be approximately 225 MW, with capital investment to meet this additional demand estimated at US$ 337.5 million.[1] In order to cover these additional needs the Government of Jordan (GoJ) sees that instead of developing new import-dependent power capacities, the suggestion is to meet extra loads through energy efficient and renewable energy solutions.

Land Use

The land use of the project area falls within the bare soils. During the site visits conducted to the project area, some signs of land ploughing have been observed within the project area and outside surroundings as well, mainly near the wadi routes. Although no residential dwellings or settlements have been observed on site since the project land terrain is characterized by wadis, thus making it difficult for settlements to reside there, especially during the winter season due to cold climate conditions and potential flooding from wadis, such ploughing activity can be a result of locals/herders ploughing the land for livestock fodder purposes on seasonal basis.

Infrastructure and Utilities

The Site is easily accessible through Muwaqqar area in the south or through the road leading to the conventional power plant north west of the Site. A paved road runs along the western side providing access. The project is 4.5 km away from the conventional electricity power plant, so during construction phase the project can get its electricity supply from the plant. As for water supply; a cow farm which served by water is located 3 km away from the site, this means there will be no problems serving the project area with water.

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[1] 6Ministry of Planning and International Cooperation (MOPIC), Impact of Hosting Syrian Refugees, October 2013

1.5 Archaeological and Cultural Heritage Resources

An Archaeological survey was carried out by the Department of Antiquities (DoA). Two archeological sites were found; the first is the remains of a small Burj Amouni, where the area was used as a cemetery by Bedouins, no pottery remains were found. The second site ;220m away from the first; also consists of the remains of a Burj Amouni, same as the first site; no pottery remains were found. It is worth mentioning that both sites were sabotaged by treasures and archeology opportunistic seekers.

1.6 Stakeholder Identification

Stakeholders should play a vital role in providing advice to the project management, therefore, in compliance with local ESIA regulations, and international standards, i.e. IFC/World Bank, stakeholder engagement has been an ongoing process throughout the ESIA process in order to ensure transparency with all stakeholders that may be affected by, or have influence on the project.

The stakeholder engagement activities carried out during this ESIA are as follows:

- Identification of project stakeholders and all parties affected or related to this project
- Conducting a scoping session and documenting its results in a Scoping Session report as part of the Final ToR.
- Conducting site visits to meet with community representatives.

The details of the above mentioned activities are further elaborated in the ESIA report.

1.7 Identification of Environmental and Socio-economic Aspects and Receptors

A definition of environmental aspects adopted for this ESIA is namely that defined by ISO 14001:2004 Environmental Management Systems - Specification with Guidance for Use. An environmental aspect is denoted where an activity has the potential to interact with the environment. A socio-economic aspect can be considered to occur when an activity has the potential to interact with the social or economic environments within or at the vicinity of a specific project area.

In order to identify environmental and socio-economic aspects for this project, project activities, which may affect environmental and socio-economic receptors, require identification. This has been achieved through:

- Project-related studies and documentation;
- Consultation with project proponent i.e. Developer (Baynouna);
- Consultation with MoEnv during the Scoping Session and ToR in addition to relevant stakeholders.

Environmental and Socio-economic receptors in relation to this Project have been identified which include receptors within: Physical Environment, Biological Environment and Socio-economic Environment. In addition, the possible interaction between the environmental aspects and receptors relevant to this project have been also identified and presented. This includes the main project activities/environmental & socio-economic aspects and the potential environmental impacts associated with each activity related to the Project. The impacts are mainly generated from construction, operation and decommissioning activities.

1.8 Analysis of Proposed Project Alternatives

After examining all alternatives such as the 'project' versus 'no project' alternative and energy sources alternatives, it was found that going forward with the project is considered the best possible option as opposed to 'No Project' since the proposed project is considered a green and environmental solution for energy generation in Jordan as the solar energy considered as renewable clean technology with no emissions as well as the global and local trend for energy generation. Moreover, solar energy has less impact than the conventional energy resources. Also, GHG emissions from PV systems has been found to be about 40 g CO2eq/kwh compared to 1000 g CO2eq/kwh for traditional coal fired electric power plants; making solar PV projects more environmentally viable.

Other project technologies have been compared with respect to this project which is the use of tracking or non-tracking PV modules. For this project it is found that it is more efficient to use tracking PV modules. The full discussion is provided in the ESIA report, section 8.3.

Main arguments of site selection have been also discussed under this chapter. Proximity to grid connection location, land ownership, land use and distance to residential areas were the deciding factors of site selection.

1.9 Impact Assessment

An identification and assessment of environmental, socio-economic and health & safety issues potentially arising from the Project have been undertaken, and mitigation measures were proposed aiming to reduce the potential impacts that may result from the Project.

Details of impact assessment and impact significance are provided in Section 9 of this ESIA. In addition, an Environmental and Social Management Plan have been developed to ensure that potential impacts are sufficiently monitored and mitigation measures are implemented.

A brief summary of the key potential impacts and their corresponding mitigation measures and monitoring requirements are presented in the Tables below.

1.10 Environmental and Social Management Plan

Table 1: Environmental and Social Management Plan during Construction Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Physical Environment							
Air Quality	Dust generation due to construction activities	• Setting an appropriate site speed limit to reduce dust generation from vehicles travelling over unmade surfaces. • During construction dust generated on unpaved roadways and work areas should be controlled by the application of water on an "as needs" basis. • Unnecessary handling of dusty materials will be avoided such as minimising drop heights when loaders dump soils into trucks. • Train workers to handle construction materials and debris during construction to reduce fugitive emissions. • Cover trucks when transferring fine and dusty materials outside the project location.	Visual monitoring of dust emissions during earthworks and construction activities	Daily	Corrective actions for all significant dust generation issues Contractor shall prepare and submit a report to Baynouna in case of compliants	No visible dust plumes originating from construction site.	EPC Contractor
	Exhaust emissions due to operation of construction plant and machinery	• Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. • Not running engines for longer than is necessary.	Visual monitoring of exhaust emissions during earthworks and construction activities	Daily	N/A	Regular vehicle maintenance records	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Noise	Increased noise levels due to constrcution & machinery	• The contractor shall use heavy equipment, machinery, and fuels in compliance with national regulations. The contractor shall perform regular maintenance on all equipment, vehicle and machinery to prevent noise emissions. • The contractor shall limit idling of engines when not in use to reduce its contribution to noise emissions.	Noise measurements to be undertaken during construction activities, at the site in order to demonstrate compliance with the National environmental noise guidelines using a portable noise meter.	One month after start up and every quarter after that., and after receiving any complaints from workers or third parties.	Corrective actions reporting to Baynouna in case of any exceedance	Compliance with MoEnv and National guideline limits for environmental noise at sensitive receptors:	EPC Contractor
Soil	Soil contamination	• A spill prevention and response plan shall be prepared by the contractor in order to control any inadvertent leakage or spillage. • Spill response measures shall be implemented (as necessary) to contain and clean up any contaminated soil. • Construction of bunds around relevant work and storage areas. Bunds in areas of hazardous chemical storage (including temporary storage) should be lined to contain accidental spillage and minimize the potential for migration to the underlying soil. • Any spilled chemical shall be immediately collected and disposed of in accordance with Spill Prevention and Response Plan and Material Saftery Data Sheets (MSDS).	Visual Inspection of storage area, and machinery through conducting regular audits of on-site activities and incident reporting forms. All site workers to be trained on spill response procedures.	Weekly	All unplanned incidents/ accidents and Corrective actions.	Number of spills or incidents to be recorded during on-site audits. Training records of personnel trained in spill response procedures must be filed	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Contractor shall ensure that a spill kit and adequate PPE is available at the site for emergency cleanup activities in case of chemical/oil spillage.					
	Soil disrtubance	• To control soil erosion, surface run-off should be collected from all paved working areas into retention ditches to restrict concentration of flows	Visual Inspection of any temporary soil storage and run-off controls	Weekly	Corrective actions reporting	Regular inspection reports	EPC Contractor
Visual Amenity	Visual impacts from construction activities such as materials lay down, excavation, backfilling	• The contractor shall ensure general cleanliness and good housekeeping practice at the project site at all times. • Prohibit the disposal of solid waste ino the surrounding land during construction activities. All inert material surpluses shall be managed within the limit of the project Site.	Visual inspection of general housekeeping and cleanliness at site in addition to waste management on site.	Daily	Inspection reports	Good housekeeping practices and tidiness of work areas within the project site.	EPC Contractor
Waste Generation	Hazards presented by improper management and handling of hazardous and non-hazardous waste during construction.	• The contractor shall segregate storage for different types of wastes, such as hazardous, non-hazardous recyclable construction material, plastic, paper, etc. to facilitate proper disposal. • The contractor shall provide a separate storage area for hazardous materials. The hazardous materials/products must be labeled with proper identification of its hazardous properties. • Chemical waste shall be stored in accordance with the provisions of Material Safety Data Sheets (MSDS). The contractor shall keep MSDS onsite. • Contractor shall provide trash bins within each construction site so as to prevent littering in the project area and surrounding areas.	Visual monitoring of site cleanliness and proper storage and handling of hazardous waste and sewage. Inspect that segregated waste disposal or storage areas are clearly marked.	Daily	Contractor shall prepare and submit monthly waste report to Baynouna.	Compliance with waste management procedures. Current and complete records of regular waste pickup	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• The contractor shall establish regular intervals for waste collection and disposal as per contractor's waste management procedures. • The sanitary and organic wastes shall be collected in a septic tank to be installed on site and disposed off regularly.				and disposal.	
Water Resources	Potential surface water runoff / potential flood risks.	To minimize risks from high rainfall and potential flooding the following measures have been proposed as per the surface hydrology study conducted for the project area: • As preliminary vision some of the streams need channelization with grouted riprap lining, especially at lower elevations of the project area as mentioned in **Table 36**. • For maintenance purposes and to serve the site in all weather conditions, it is recommended to define the wadi banks by means of creating depression within the flooding plain in order to guide the flood to run in a well-defined path. • Pipe or box culverts may be required to be constructed under the access road to the project and under any of the internal roads, if the wadis cross these roads, in order to transfer the flood waters from one side to the other side safely. • Wadis 5 and 11 require full protection for the parts located within the project area as shown in **Table 36**.	Visual inspection of drainage features during the rainy season	Daily during rainy seasons	Inspection reports and Incident reports to Baynouna in case of flood from high precipitation events.	No flooding caused by the construction and operations	EPC Contractor in collaboration with Baynouna

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• If any internal road to cross the channel at any location, it should cross over Box/ Pipe culvert having the size that able to discharge the coming flood from upstream drainage channel. • The design and layout of photovoltaic arrays of the project should be protected by providing PVC sleeves at each channel or road crossing with photovoltaic arrays. • Follow-up with the Ministry of Water and Irrigation (if needed).					
Biological Environment							
Terrestrial Ecology	Potential disturbance to flora	• Prohibit removal of existing natural plant if not necessary for construction. • Prohibit workers from cutting natural plants in the surrounding area for fire. • Prohibit machinery from using surrounding area of the proposed site as parking or maintenance area for machinery.	Visual inspection within project site.	All throughout construction	Periodic report to Baynouna on EHS performance	N/A	EPC Contractor
	Potential Disturbance to fauna	• Prohibit workers from hunting, killing animals as well as destroying ground nests for birds inside the proposed site and the surrounding area. • Replace any found ground nests inside the proposed site in coordination with Ministry of Environment and the Royal Society for Conservation of Nature (RSCN) • Report any killing accidents for wild life to the Ministry of Environment and RSCN.	Coordination with RSCN when needed.	All throughout construction	Periodic report to Baynouna on EHS performance	N/A	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Decrease the construction activity to the minimal during night time to decrease potential disturbance.					
Health and Safety							
Health and Safety risks	Potential of exposure to safety events such as tripping, working at height activities, fire from hot works, smoking, failure in electrical installations, mobile plant and vehicles, and electrical shocks	• Presence and compliance with Environmental, Health & Safety (EHS) related policies and procedures on site. • Allocate specific personnel responsible for health & Safety management on site. • Adequate and appropriate training of all workers of the contractor's EHS policies and procedures before they are permitted to undertake a task. • All construction equipment used for the execution of the project works shall be fit for purpose and carry valid inspection certificates and insurance requirements. • Risk assessment shall be prepared and communicated prior to commencement of work for all types of work activities on site. • Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. • Signpost any slippery areas, ensure proper footwear with a good grip is worn for personnel working within slippery areas.	Visual inspection by user before each activity Maintain proper housekeeping for the project site Routine Facilities' and site Inspection Inspection of Equipment and tools used during	Prior to activity Continuously Monthly Prior to work activity	Contrctors shall prepare and submit monthly H&S report to Baynouna	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency Fatal Accident Rate Number of safety training performed Number of non-	EPC Contractor and Baynouna

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• As far as reasonably practical, use cordless tools that may not need to use cables. Where cables for temporary lighting or mains-powered tools will be used, all cables shall be run through designated corridors. • Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. • Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards; • Arrest a fall with equipment to minimise the distance and consequences of a fall, e.g. safety nets, where work at height cannot be avoided or the fall prevented. • Carry out fire risk assessment for the construction areas, identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. • Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. • Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. • Establish and communicate emergency preparedness response plan (EPRP) with all parties, the EPRP to consider such things as	working at height activities Fire Emergency Response Drills Inspection for fire extinguishers, testing for fire detection system, and other fire fighting equipment. Maintenance for fire extinguishers, testing for fire detection system, and other fire fighting equipment. Monitor work areas and activities to identify fire and explosions hazards. Preventive maintenance and patrol inspections	Semi-annually Monthly Continuously Based on Fire risk assessment Monthly		conformance events. Reports. Training records of workers on EHS policies and procedures	

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan. • Ensure all plant machines and vehicles are regularly inspected, serviced and maintained; ensure all staff assigned is trained and competent to operate plant machines and vehicles. • Ensure all routes are suitable and wide enough for the vehicles, routes should be planned by minimising bends/junctions, steep gradients and the need for reversing, clearly designate areas for pedestrian walkways and crossing points. • Ensure clear signages are in place, such as Warning of speed limits, obstructions, allowable widths/heights...etc. • Electrical equipment must be safe and properly maintained; works shall not be carried out on live systems. • Only competent authorised persons shall carry out maintenance on electrical equipment, adequate Personal Protective Equipment (PPE) for electrical works must be provided to all personnel involved in the tasks. • Lock-Out / Tag-Out (LOTO) system shall be implemented during any electrical works.	for all vehicles and mobile plant Vehicles and mobile plants inspection	Pre-use			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Adequate number of staff and first aiders shall be on site in accordance with Jordanian Labour Law requirements. • First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. • Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills.					
	Exposure to health events during construction activities such as manual handling, electrical shocks and burns, hand-arm vibration, temporary or permanent hearing loss, heat stress, and dermatitis	• Adequate and appropriate training of all workers of the contractor's EHS policies and procedures before they are permitted to undertake a task. • Ensure that operations, which involve manual handling, are eliminated so far as reasonably practicable, provide mechanical aids such as forklifts, trolleys, cranes, hoists etc. • Ensure all equipment are suitable for jobs (safety, size, power, efficiency, ergonomics, cost, user acceptability etc), provide the lowest vibration tools that are suitable and can do the works. • Ensure all tools and other work equipment are serviced and maintained in accordance with maintenance schedules and manufacturer's instructions. • Regular noise exposure assessments and noise level surveys of noisy areas, processes and	Monitor the health of workers Monitor work areas and operations to identify noise hazards. Inspection for use hear protection equipment Fit Testing	Continuously Monthly Prior Use	Contrctors shall prepare and submit monthly H&S report to Baynouna	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency Fatal Accident Rate Medical Treatment Case(MTC) No. Restricted Work Day	EPC Contractor and Baynouna

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		equipment shall be carried out in order to form basis for remedial actions when necessary. • As far as reasonably practical, all steps to reduce noise exposure levels of employees by means other than that of personal protective equipment shall be taken, such as reducing exposure times, enclosures, silencers, machine covers…etc. • Provide suitable and effective hearing protection to employees working in high noise levels. • Designate and clearly mark hearing protection zones, which may include particular areas, operations or pieces of equipment. All personnel entering these zones shall be required to wear hearing protection inside these areas. • Awareness training sessions should be established and provided to all personnel involved during the construction phase in order to highlight the heat related illnesses of working in hot conditions such as heat cramps, heat exhaustion, heat stroke, dehydration. • Ensure adequate quantities of drinking water are available at different locations within the site, • Ensure proper planning of works to consider the time of peak temperatures during the day, provide rest brakes during the peak times. • Provision of sun shades at different locations within the site.	Maintenance & Care for Hear protection equipment.	Prior to employment Monthly		Cases (RWDC) HSE Training Hours Number of non-conformance events.	

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Eliminate the risk of exposure whenever possible, provide proper PPE wherever necessary and to ensure that there are satisfactory washing and changing facilities. • Ensure that all workers exposed to a risk are aware of the possible dangers. They should be given thorough training in how to protect themselves and there should be effective supervision to ensure that the correct methods are being used.					
Socio-economics							
Traffic	Additional traffic load due to transport of equipment and materials to and from the site through the surrounding road network	• The contractor to ensure that all trucks and vehicles accessing the facility are operated by licensed operators. • Pedestrians Safety: All project vehicles and trucks shall comply with the proposed speed limits • Ensure adequate maintenance and inspection of vehicles • Presence of flagman at the entrance and exit of the project site in order to control vehciles and truck movement. • Every employee working on the project site shall make sure that all needed signs and preventive measures are implemented when starting any activity. • Number of traffic signs, their characteristics and distance among them will be placed according to local legal requirements and an on-site HSE	Maintain open dialogue with Electric power plant facility since the project site is easily accessible through Muwaqqar area in the south or through the road leading to the electric power plant north west of the site. Monitor vehicle movement to and from the Project area.	Continuously	All incidents to be investigated and reported to Baynouna.	No complains or concerns from traditional users of the area's roads routes are received during the construction activities. No incidents or accidents (collisions) are recorded	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		assessment that will conducted prior to any construction activity starts. • Signs shall always be in good conditions and be visible to every road user. • Vehicle transit across any restricted area and/or limited to working activities is prohibited. • Vehicle repairmen and/or maintenance activities are not allowed within the project area. They shall only be carried out within the especially dedicated areas.					
Local communities	Potential implications of local community groups.	• Preparation of a community grievance mechanism and a Stakeholder Engagement Plan (SEP) prior to construction in complicance with IFC guidelines. • Undertake appropriate assessment (recommended during spring season) to confirm the use of the site in terms of seasonal cultivation for producing livestock fodder and identification of such intermittent land users / project affected persons. It is advised to conduct this assessment prior to construction. • Appoint a Community Liaison Officer (CLO) whose responsibility shall include the management of all community related matters for the project. The CLO role shall also be relfected in the SEP.	Ensure to establish specific monitoring procedure for stakeholder consultation and records of grievances where needed.	Throughout the project phases	To Baynouna management	Compliance with IFC guidelines and implementation of community grievance mechanism and SEP. Number of grievances and time taken to resolve them.	Baynouna

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	Community Health, Safety and Security	• Appoint a Community Liaison Officer (CLO) whose responsibility shall include the management of all community related matters for the project. The CLO role shall also be relfected in the SEP. • Implementation of approproate security management on site.	Ensure project area is secure and access is well monitored throughout all project phases.	Throughout the project phases	To Baynouna management	Compliance with IFC guidelines and implementation of community grievance mechanism and SEP. Number of grievances and time taken to resolve them.	EPC Contractor during Construction and Baynouna during operation.
Worker Community	Labor and Working Conditions	• The Contractor shall take all reasonable steps to ensure that all national legislation on labour and health and safety, the requirements of IFC Performance Standard 2 (Labour and Working Conditions), the World Bank General EHS Guidelines, relevant Standards and Procedures as developed and implemented by Baynouna, and any other relevant standards identified by IFC are complied with. • The Contractor shall provide a Grievance Mechanism for all workers and employees. The Contractor will ensure that all workers are informed	Ensure that systems are in place to monitor compliance with labor and health and safety standards. Appointment of a manager on site to be responsible for ensuring that labor and health and	Regularly through project phases	To Baynouna management	Compliance with IFC guidelines and implementation of worker grievance mechanism. Number of grievances reported by workers/emp	EPC Contractor during Construction and Baynouna during operation.

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		about the Grievance Mechanism and that information about the mechanism is posted in relevant areas of the project site. • The Contractor ensure that hiring, recruitment and training plans satisfy the requirements of the provisions of PS2, and the HR procedures are well tailored to comply with local Jordanian Laws, IFC requirements and Baynouna's HR policy and procedures. • The Contractor shall ensure that a safe and healthy working environment is provided for all workers on site and that good international practice on occupational health and safety is followed in line with policies developed by the Contractor. • The Contractor shall not under any circumstance employ workers under the minimum age for employment, as defined in national legislation. Children under the age of 18 will not be employed in hazardous work and a risk assessment will be carried out in respect of any work carried out by such employees. • The Contractor shall ensure that there shall be no use of forced or compulsory labor. • If workers accommodation will be established on site, it is essential to ensure that the camp is established in accordance with the specifications of the International Labour Organisation (ILO) standards and guidance published by EBRD and	safety legislation is complied with, and for monitoring supplier and sub-contractor performance. This shall be conducted through Internal audits and/or inspections to monitor compliance.			loyees and time taken to resolve them.	

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		IFC. Also is is reocmmended to implement an induction program for all workers' resident in the camp to be aware of their rights, and safety measures.					
Archaeological Resources & Cultural Heritage							
Archaeology & Cultural Resources	Only potential concern can be impacts on possible unseen archaeological sites/remains (chance finds)	Based on the Archaeological Survey report docuncted for the project (**APPENDIX D**). Two main recommendations are proposed: 1) Adherence to the project area allocated for the project and not exceed it; and 2) Impementation of Chance Find procedures as per the Jordanian Antiquities Law. This is described as follows: - Construction works shall be ceased if any historical/ culturally sensitive or archaeological sites / remains are chance found during construction activities. - If any known sites were found during construction and may potentially be threatened by construction, the area with the newly discovered remains/sites shall be fenced and the DoA shall be notified immediately and invited for consultations and assessment of the finding and agreement must be reached with the DoA in order to	- Minimum of one site inspection immediately after chance find. - Informing personnel present on site of chance find procedures in case any archaeological or cultural resources were encountered	One site inspection after chance find	To Department of Antiquities (DoA) in case of chance finds.	N/A	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		minimize damages to the sites. It shall also be the Contractor's responsibility to notify the supervisor of the Cultural resources Management Office of the DoA are encountered in any area during construction and also specifications set in Article 15 of the Antiquities Law No. 21 (1988). • The DoA will assess the discovered remains and may carry out an emergency salvage excavation (i.e. archaeological excavation conducted during the construction phase, which should be conducted only when an archaeological site is accidently found (chance found)). • The available short time for salvage excavations cannot be considered an authorization to destroy the discovered remains or site. Each site must be given proper consideration and analysis before its destruction. • Construction work shall be resumed within the newly discovered area only after archaeological experts from DoA and official authorities are consulted and appropriate mitigation measures are implemented, however construction activities can continue at other parts of the site after coordination with DoA.					

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Baynouna shall employ specialized personnel to oversee and supervise the implementation of mitigation measures.					

Table 2: Environmental and Social Management Plan during Operation Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Physical Environment							
Soil	Potential spillage of stored oil and chemicals	• Implementation of proper housekeeping practices on site at all times. • Specific procedures shall be developed for the removal of waste or spilled fuel, oil and contaminated soil at approved disposal facilities. • Proper storage for chemicals and fuel within confined areas on site and adopting proper safety measures when handling those chemicals to prevent their leakage and infiltration into the soil.	Inspect the presence of any disturbed areas in and around the project site for erosion Visual inspection of oil storage tanks, waste storage area and fuel storage area for spills and leaks	Post rainfall event Weekly	To developer's top management	Maintain readily available records of all workers training on spill response procedures.	EPC Contractor during warranty preiod ; and O&M Contractor during Operation Phase
Visual Amenity	Potential glare from PV panels	The used technology has Anti- Reflective coating that significantly reduce the refelectivity of the PV Panels as elaborated under section 9.2.1.5 – Visual Amenity during Operation Phase.	N/A	N/A	N/A	N/A	EPC Contractor during warranty preiod ; and O&M Contractor during

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
							Operation Phase
Waste Management	Potential disrcharge from WWTP.	• Project developer will construct a small scale wastewater treatment plant (WWTP) to treat domestic wastewater and liquid effluent generated from site activities, toilets and sanitation facilities during operation phase, treatment plant iffluents shall meet relative Jordanian Standards.	• Monitoring the wastewater effluent quality to comply the Jordanian standard. • Frequent Sampling of influents and the iffluents of the treatmant plant.	Regularly	To developer's top management	Complinance with relevant Jordanian Standards (JS 893:2006) Reclaimed Domestic Wastewater	O&M Contractor during Operation Phase
	Handling of Broken PV Panels	• The developer will be committed to develpp a process to safely remove the broken modules in accordance with best industry practice & coordination with MoEnv.	• Constant inspection of PV modules.				
Terrestrial Ecology							
Terrestrial Ecology	Potential disturbance and harm to birds	• Minimize human and vehicular contact with faunal species present on site. • Any ground nests found on site shall be translocated outside the project boundary.	Visual inspection within project site.	Weekly	To Banouna management	No reported harm to any faunal species.	EPC Contractor during warranty

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site. • Apply manual plant removal if needed.					preiod ; and O&M Contractor during Operation Phase
Health and Safety							
Safety risks	Potential of exposure to safety events during operation activities such as slipping and tripping, working at height activities, and fire	• Adopt specific Occupational Health & Safety policies to be complied with during operation. • Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. • Ensure all works and storage areas are tidy, all material deliveries shall be planned to minimize accumulated materials at project site. • Signpost any slippery areas, provide proper footwear during working within slippery areas. • Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. • Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards.	Inspection of equipment and tools used during working at height activities Maintain proper housekeeping for the project site Facilities and site inspection.	Prior to work commencement Continuously Monthly Based on fire Assessmnet	Prepare regular report to developer's top management	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency Number of safety training performed Number of non-conformance events..	EPC Contractor during warranty preiod ; and O&M Contractor during Operation Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Carry out fire risk assessment during operation to identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. • Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. • Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. • Establish and communicate emergency preparedess and response plan with all parties, the EPRP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan. • Adequate first aiders shall be on site in accordance with Jordanian Labour Law requirements. • First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site.	Monitor work areas and activities to identify fire hazards. Fire emergency response drills Maintenance check for fire extinguishers, testing for fire detection system, and other fire fighting equipment.	Semi-annually Monthly			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills.					
Socio-economics							
Traffic	Potential minimal increase of traffic load	Implementation of a regulated entrance and exit into the facility.	Monitoring of access roads around site Record complaints received from locals or authorities.	Daily	All incidents reported to the proper authority and to Baynouna's Management.	Number of complaints from road users. Number of traffic incidents due to vehicle movement.	EPC Contractor during warranty preiod ; and O&M Contractor during Operation Phase

1.11 Cumulative Impacts Assessment

It is appropriate for developers to conduct a cumulative impact assessment as part of the risks and impact identification process when multiple projects occur in, or are planned for within the same geographic area.

Currently there are no existing utility scale solar and wind power plant projects in close proximity to the project site. Ma'an solar projects (currently operational), Mafraq solar projects (in the process of commencing construction) and some other projects in Aqaba and Irbid are considered the projects of concern in this cumulative impact assessment. The mentioned projects are located far away from the project area, Ma'an being approximately 195 km away, and Mafraq 53 km away, while Aqaba is more than 250 km away. Therefore; these facilities are sufficiently distanced from the project area such that their development is not anticipated to add very insignificantly to the potential direct impacts of the Project.

A planned solar PV plant that will be constructed and is set to be situated around 2 km away from Al Manakher electric power plant (IPP4), meaning that it will be located 12 km north-west of the project area. This planned project will be considered the nearest to the Baynouna project area when in operation. The existence of this solar PV project 12 km away from the project site is also not considered to cause any significant cumulative impacts.

Future projects may be planned after the NEPCO green corridor which is a multi-component programme that aims to enhance the capacity of the electricity transmission network in the south of Jordan. The green corridor is expected to be operational by end of 2018 / beginning of 2019. Therefore, at this point in time there is difficulty in terms of making assertions as to future developments in the renewable energy sector since there is no official announcement yet.

1.12 Decommissioning

The solar power plant facility is considered a large scale long-term investment that will contribute to economic benefits to the country through provision of power supply, designed in accordance with best practice, taking into account all relevant national and internal codes and legislation.

The design life of the facility will cover the period of 20 years, and will be renewed upon mutual consent between project stakeholders.

No impacts with high significance are anticipated to take place during decommissioning of the project since all facilities will be removed. Solar power plant will be decommissioned and its components disconnected, and PV panels will be dismantled and sent for recycling. Special consideration to be taken into account when handling and recycling thin-film (CdTe) modules; recycling the modules at the end of their useful life completely resolves any environmental concerns

The study has taken into account the impacts discussed in **section 9** in case the project is to be dismantled which is expected to involve rehabilitation, upgrading and modernization of the facility, with a possible expansion (retrofitting and addition of new technology).

Therefore, to avoid repetition, please refer to **Table 1** for detailed mitigation measures that overlap with decommissioning as well.

2 INTRODUCTION

Baynouna Solar Energy PSC (the ''Project Company'') – which is owned Abu Dhabi Future Energy Company PJSC – Masdar, intends to develop a 200MWac grid connected Photovoltaic project within Muwaqqar area in Amman. The project has been approved by all authorities of concern including Ministry of Energy and Mineral Resources (MEMR).

The project developer or / Baynouna (used interchangeably throughout this ESIA report) aims to develop the solar energy project using PV technology to generate electricity in Jordan. The project will help to decrease the country's dependency on traditional forms of energy by increasing the availability and use of solar energy. The generated electricity will be injected into the national grid, to support the country in meeting its renewable energy target of 10% by 2020.

MEMR and the National Electric Power Company (NEPCO) have successful track record with independent power projects (IPPs) that include top international power developers with active projects in Jordan.

Arabtech Jardaneh (AJ) was appointed by Baynouna to prepare the Comprehensive Environment Impact Assessment (ESIA) Study for the project activities during the three phases of the project construction, operation and decommissioning. The ESIA will be prepared in accordance with the requirements of the Jordanian Environmental Impact Assessment (EIA) Regulation no. 37 of 2005, and the International Finance Corporation (IFC) Performance Standards (PSs), in addition to both EBRD Performance Requirements (PRs) and Equator Banks Principles in order to support the application for an environmental permit from the Ministry of Environment (MoEnv).

The Comprehensive ESIA study will be used to support the application for an environmental permit from the MoEnv in line with the Jordanian Environmental Impact Assessment "EIA" Regulations 37/2005.

In accordance with MoEnv's requirements, the ESIA assignment will consist of the following phases:

- Preparation of Preliminary ToR (*completed*);
- Attend and document scoping session with stakeholders (*completed*);
- Finalize and submit ToR following input from MoEnv along with Scoping Report (*Completed*);
- Perform ESIA study and prepare ESIA report - including the Environmental & Social Management Plan (ESMP) - (*subject of this document*);
- Finalize and submit ESIA study following input from MoEnv and obtain the environmental permit.

2.1 ESIA Objectives

AJ team is providing a Comprehensive ESIA study for developing 200 MWac PV solar power plant will be located within Muwaqqar district and will be as part of Telal Al Rukban land area.

This ESIA assignment aims to:

- Identify and assess the potentially significant existing and future environmental and social impacts resulting from project activities during the three phases of the project;
- Determine the measures needed to prevent and/or minimize potential environmental and social impacts, and identify mitigation measures and opportunities for the project;
- Ensure that the project is socially and environmentally sustainable;
- Respect the rights of affected workers/personnel on site and communities;
- Ensure that the project is designed and operated in compliance with IFC Performance Standards (PSs) and other lenders requirements (where applicable) and applicable local and national regulatory requirements and good international practice, and
- Support the application for environmental approval from the Ministry of Environment (MoEnv.) in line with the Environmental Impact Assessment (“EIA”) Regulation No. 37 for year 2005.

2.2 The Proponent

Baynouna Solar Energy PSC (the ‘’Project Company’’) – which is owned Abu Dhabi Future Energy Company PJSC – Masdar is the Proponent for the proposed Solar Power Plant Project. The contact details for the proponent’s primary contacts are provided below:

Eng. Basel Dahleh
Project Manager / Clean Energy
P.O. Box 54115, Abu Dhabi
United Arab Emirates (U.A.E)
Telephone: +971 2 653 2012
Fax: +971 2 653 2002
Email: bdahleh@masdar.ae

2.3 The Consultant

Arabtech Jardaneh (AJ) has prepared this Comprehensive ESIA report on behalf of the project proponent in accordance with the MoEnv guidelines and IFC requirements. The primary contact for AJ is:

Jihad Abu Jamous
Director of Operations
Infrastructure and Environment
P.O. Box 9532
Amman 11191, Jordan
Telephone: +962 6 586 1074
Fax: +962 6 586 1075
E-mail: Jihad_Abujamous@AJ-Group.com

2.4 Preliminary ESIA Reporting

This Draft ESIA report has been prepared in compliance with the requirements stated in the Jordanian EIA Regulation no. (37) For the year 2005, and includes the following:

Executive Summary	Summary (in **English and Arabic)** of the project, main findings and recommendations
Introduction	Overview and purpose of the project and scope of the ESIA
Review of Legislation and Standards	Details of the applicable legislation and regulations and other standards in Jordan with potential implications to the project
Project Description	A clear and concise description of different activities over the life of the project. The description should be sufficient to allow the risks and impacts to be identified, described and evaluated
Environmental &Social Baseline	Assessment of the baseline conditions against which the impacts of the project can be assessed
Assessment of Impacts	Assessment of the impacts of the project (and methodology used), which shall include a listing, description, assessment (including quantification of impact), and discussion of the possible negative and positive impacts of the project on the environment and social fabric, including socio-economic context – in addition to consideration of cumulative impacts.
Stakeholder Identification and Engagement	Summary of the stakeholder engagement process which will identifies the related and parties and stakeholders influencing the project and details how the project will communicate, inform and discuss the substantive issues with all interested and effected parties
Analysis of Alternatives	A comparison of the project alternatives considered and their anticipated potential impacts
Mitigation and Monitoring measures	Recommendations for mitigation measures to minimize the identified impacts and any ongoing monitoring requirements
Environmental & Social Management Plan	Details of specific activities to be carried out during different phases of the project and project activities to ensure the identified mitigation measures are implemented

3 PROJECT DESCRIPTION

3.1 Project Review

The Project is to be located approximately 30 kilometres (km) southeast of Amman in Al-Muwaqqar district and approximately 25 km northeast of the Queen Alia International Airport as shown in **Figure 1** below. Nearest port is Tel Aviv Marina, in Israel, at around 140 km. Nearest port in Jordan is Aqaba, at approximately 350 km. The Site is easily accessible through Muwaqqar area in the south or through the road leading to the conventional power plant north west of the Site. A paved road runs along the western side providing access (the "**Site**").

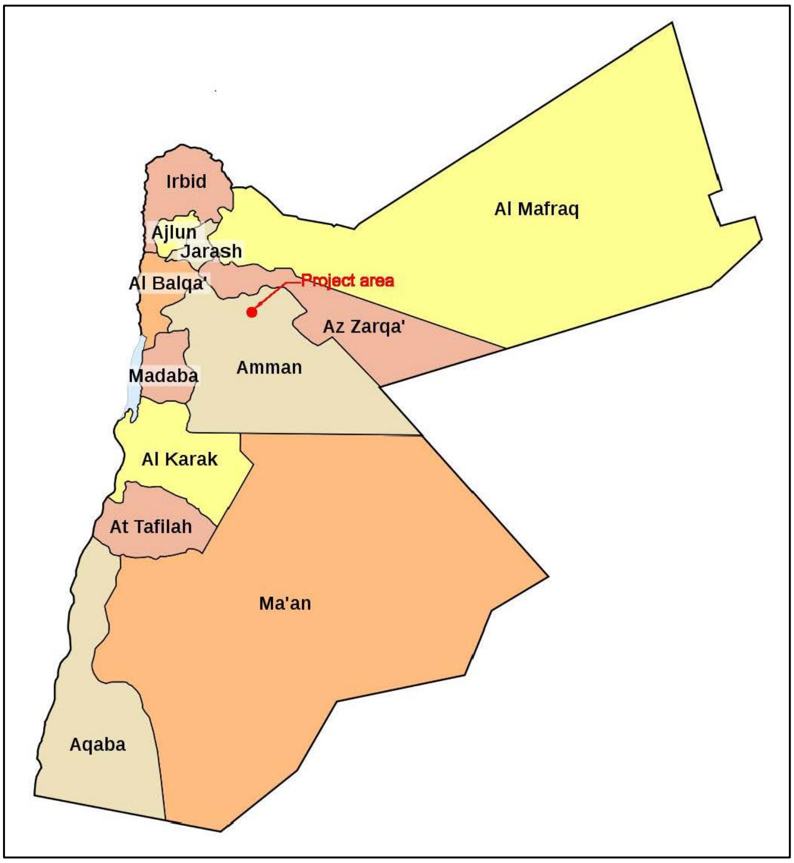


Figure 1: Project location relative to Jordan

The project area will occupy 6000 dunums (i.e. 6 km^2). The site is characterised with hard soil and an approximate elevation of 800 - 840 meters above sea level. The Site is flat, yet can have a topography with varying heights due to a large number of valleys (wadis) runing across the Site in some areas.

You can see the exact location of the site in **Figure 2** below. **Table 3** shows the coordinates of the substation and the site in general.

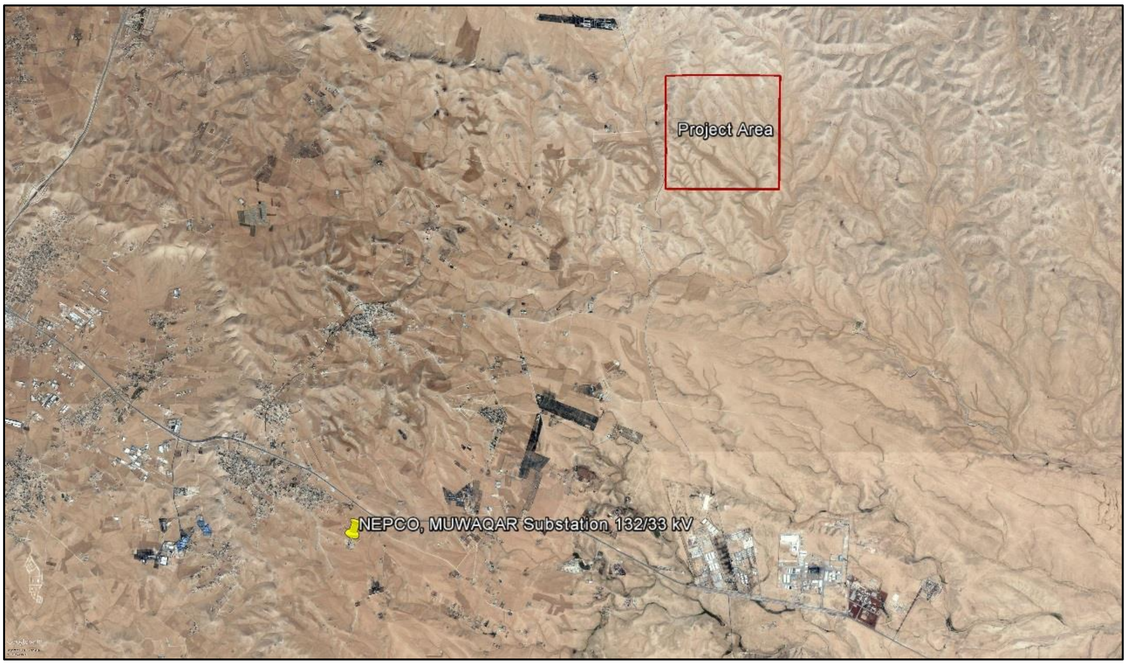


Figure 2: Project Location

Table 3: Project Area and Substation Coordinates

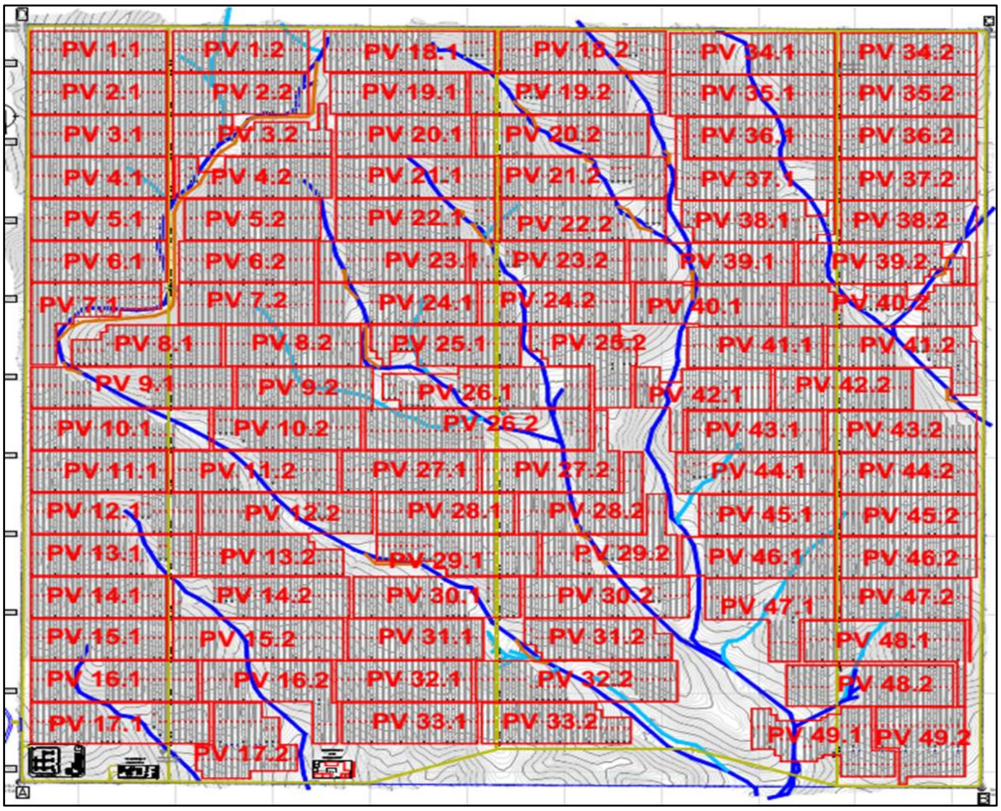
Coordinates in Decimal Degrees of the Site	Latitude	Longitude
A	31.865817Á	36.200163Á
B	31.865817Á	36.226324Á
C	31.887619Á	36.226324Á
D	31.887619Á	36.200163Á
Coordinates in Decimal Degrees of the Existing Substation	**Latitude**	**Longitude**
NEPCO, Muwaqqar Substation 132/33 KV	31.796632Á	36.127708Á

The total installed capacity of the Project will be 247.6 MWp DC and 230.3 MVA AC at 40ÁC. Such capacity will be installed to export 200 MW AC power to the NEPCO grid. The Project consists of following as main equipment:

- PV Module;
- Mounting structure;
- Inverter and Inverter Station;
- Substation;
- Control Room; and
- Cablings and other equipment

PV (Photovoltaic) converts the solar energy incident on its surface into electrical energy, through the photo-electric effect. A PV module is mainly made up of PV cell (mainly semiconductor), front cover (glass), back sheet material, electrical connections and supporting frame. The electrical energy generation from commercially available PV module is direct current (DC), which is then converted into alternating current (AC) with the use of inverter. To feed the generated electricity from PV modules into the grid, the voltage output from plant need to match with grid that the plant will be connected to.

The indicative Layout for the Project is shown below. The final layout, to be constructed depends upon the final design of the Project, which will be prepared after the selection of EPC Contractor.


PV 1.1
PV 1.2
PV 18.1
PV 18.2
PV 34.1
PV 34.2
PV 2.1
PV 2.2
PV 19.1
PV 19.2
PV 35.1
PV 35.2
PV 3.1
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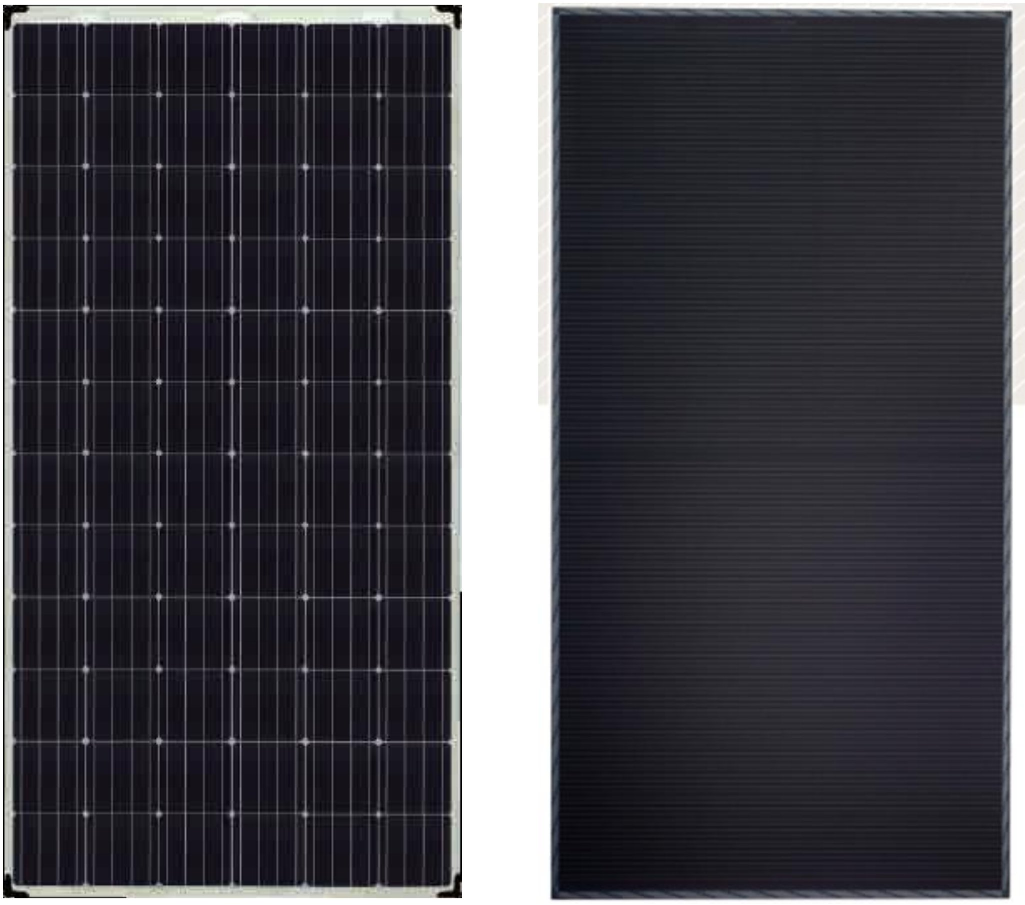
PV 16.1
PV 16.2
PV 32.1
PV 32.2
PV 48.2
PV 17.1
PV 33.1
PV 33.2
PV 49.1
PV 49.2
PV 17.2

Figure 3: Indicative Layout of the Project

3.2 Project Components

3.2.1 PV Modules

The PV module (**Figure 4**) to be used for the Project will be either crystalline silicon based technology or thin film based technology or mixture of both technologies module. The DC capacity of single module foreseen for this Project varies depending upon the final selection of the technology mixture. The output power of module is rated at standard test condition, a common reference measurement in PV industry. PV Modules are mounted on mounting structure.

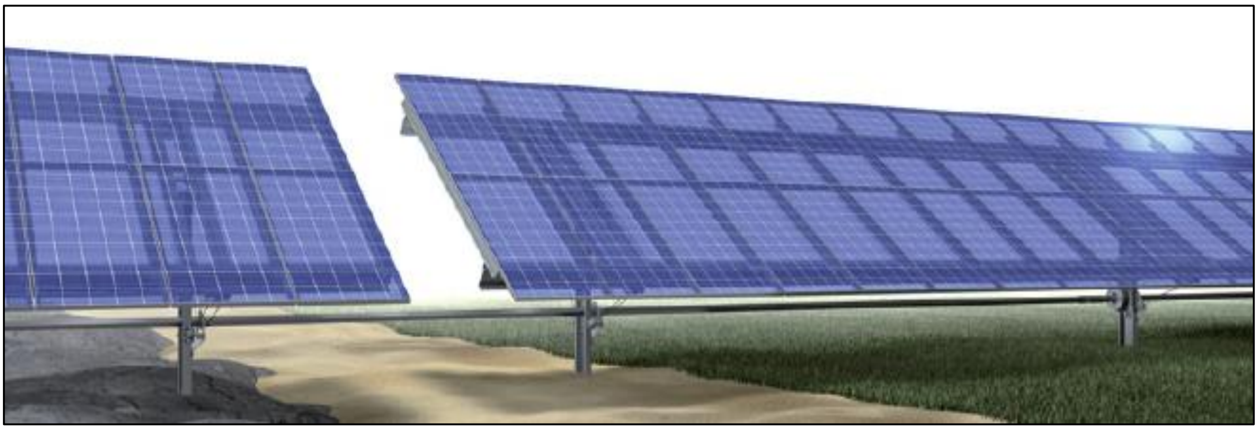


(Source: JA Solar and First Solar)

Figure 4: PV Module

3.2.2 Mounting Structures

The mounting structure is a metal supporting structure on which PV modules are mounted as shown in **Figure 5** below. With respect to this project, modules will be installed on single axis tracker which tracks the position of Sun during the day in order to maximize the energy output from the plant.

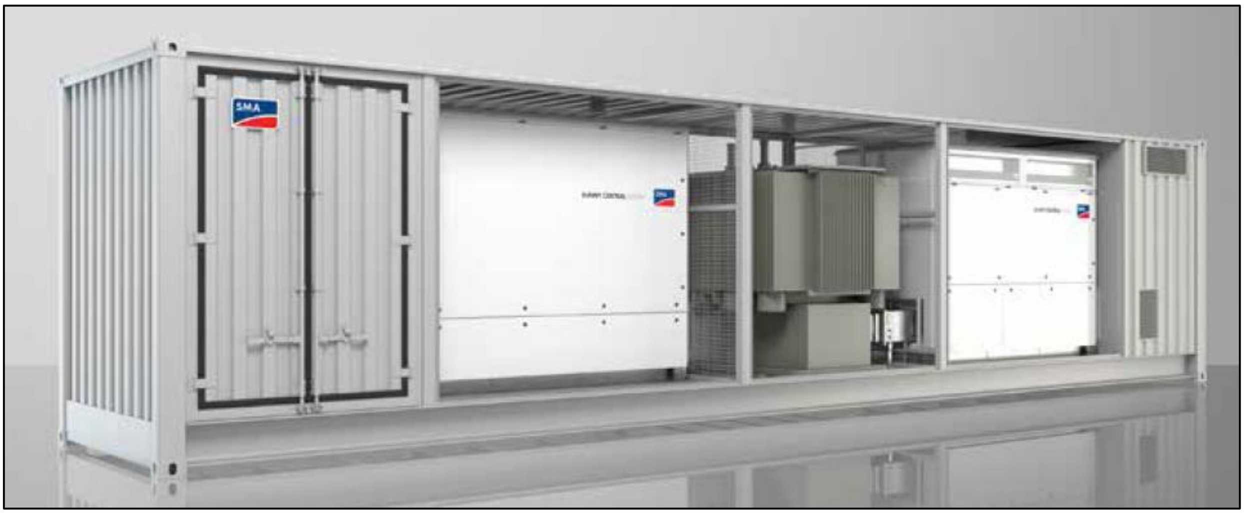


(Source: Ideematec)

Figure 5: Mounting Structure Example

3.2.3 Inverter and Inverter Station

Several PV modules are combined in series to form string and the strings are grouped in combiner box. The group of strings are then fed into the inverter. Inverter converter electrical energy from DC to AC. Generally, inverters are housed in an inverter station. Each inverter station foreseen for the project in indicative design mainly includes 2*inverters, LV/MV transformer, switchgear and electrical connection. In the indicative design of the project, a total of 49 inverter stations are considered. The LV/MV transformer included in inverter station steps up voltage up to 33 KV. The final number of inverter stations depends upon the final selection of inverter type and design. An example of an inverter station is shown below.



Source: SMA

Figure 6: Inverter Station Example

3.2.4 Substation

The several inverters are then connected to the grid via substation. Substation includes MV/HV Power Transformers, MV Switchgears, electrical protections and connections. The output voltage from Inverter station i.e. 33 kV will be further stepped into 132 kV through power transformers installed in then substation. The output from the substation will then be fed into the NEPCO grid.

3.2.5 Control Room

The project performance, meteorological parameters and control on output according to NEPCO requirements will be made through SCADA system installed in control room. This building also includes office areas during construction and operation of the Project.

3.2.6 Cabling and Other Equipment

The project will have different DC, AC (LV and MV), communication and network cables. DC cables are used for the connection from PV module to the Inverter. AC cables are used to connect output of inverter to the project grid connection. Communication and network cables are used in SCADA system to monitor the plant, meteorological data and communicate with grid operator. The cable type and size varies depending upon the design and connection interfaces. Other equipment includes, combiner box, meteorological equipment, security system components (camera, fences) etc. The project will have storage facility to store spare parts required for the Project during operation and maintenance period.

3.3 Monitoring and Control System

Minimum 20 years of operation and maintenance of the plant are anticipated after the commissioning of the project which includes several scheduled preventive maintenance such as PV module cleaning; physical inception of project components and site conditions; structural integration check, cabling and connection checks, plant performance measurements and so on.

The O&M Contractor will be responsible for the complete operation and maintenance of the Project. The on-site staff organization during operation and maintenance depends on the O&M contractor to be selected on later phase of the Project. However, the following staff can be expected:

- O&M Manager
- Operators and Controller
- Engineers
- Technicians
- Labors
- Specialists

Most likely the Panel will be cleaned using water. PV modules will be cleaned on a regular basis to minimize the losses in energy production due to dust on panel. Cleaning frequency depends upon the level on soiling during operation phase. Cleaning will be done once a loss in performance is observed. In current estimation, 4 cleanings per year is considered. The water required for each cleaning cycle is estimated as 2,000 m3 i.e. 22m3 per day. Therefore the total water required only for panel cleaning will be approximately 22m3 per day for 20 years of operational period.

The water required for the cleaning is most likely to be sourced from nearest water supply city/municipality.

3.4 Civil Works and Security

The level of civil works required for PV project are very minimum when compared with similar nature of conventional power projects. The civil works required for the project include land clearing, levelling, excavations etc. The major civil works foreseen for the project are followings:

- Site Levelling or Grading
- Foundation for Mounting Structure
- Access road and Internal Roads
- Underground cable trenches
- Civil Work for Drainage System

- Foundation of Inverter Stations, control room, storage facility
- Civil work for Substation
- Civil Work for Security System
- Any other civil works required for the Project

3.4.1 Site Levelling or Grading

The project may require site leveling or grading in some areas as the site is not completely flat. The major component for the Project (mainly mounting structure) is selected in such a way that effort on site leveling or grading is minimized. The tracker type selected for the Project suits the installation on site topography. Therefore, very minimum or no site grading is expected for the Project during installation of mounting structure.

3.4.2 Foundation for Mounting Structure

Rammed or Pile foundation are estimated at this phase for the Project. Depending upon the final EPC Contractor's design the type of foundation required will be detailed.

3.4.3 Access road and Internal Roads

The site is located to very close to existing unnamed road (south – west corner of the site). The access to the site will be provided by constructing approximately 8 m wide road connecting site with existing unnamed road. The length of such access road is estimated less than 50 m and will support 40 t vehicles at speed of < 5 kmh, mainly during construction.

Similarly, internal roads will be built within Project site to provide access mainly to substation, inverter stations. Such internal roads provide access to project components during operation and maintenance of the Project. Internal road will have a width approximately 4-6 m. The detail design determines the final specification on road details.

3.4.4 Underground cable Trenches

Cables within the site, mainly MV AC cables and communication cables will be guided for their respective connected via underground trenches. The depth and width of the trenches depends upon the type of cable, number of cables within the trench etc., hence will be determined during detailed design.

3.4.5 Civil Work for Drainage System

The site contains existing wadis and water channels. The Project layout is designed in such a way that the disturbance on existing flow of the stream is zero to minimum. In some area, the project may require diversion of existing stream and in some area, the proper grouting may be required in order to guide the water flow in existing stream line and to avoid the risk of water flowing inside the plant, especially during rainy season. The detail civil work will be done according to the recommendation from hydrological study conducted for the Project.

3.4.6 Foundation of Inverter Station, Control Room and Storage Facility

The project requires some civil work for the foundation of inverter station, control room and storage facility. This may include land clearing, levelling, excavations etc. The civil work for foundation can be considered as minimum because

Each inverter cabin will not have foundation more than approx. 20 m * 5 m

Control room will not have foundation more than approx. 50 m * 20m

Storage facility foundation not more than approximately 50 m * 30 m

3.4.7 Civil Work for substation, Security System and others

The project will also require civil works for substation, security system (installation of fences). This may include land clearing, levelling, excavations etc.

The security on site will be managed with the installation of standard meshed Fences around the site boundaries, CCTV cameras around the site boundaries, flood lights within the site. The camera will be monitored through SCADA system in control room. Security camera and fences will also be considered during construction phase of the Project.

During the execution of the Works, Contractor shall keep the Site free from all unnecessary obstruction, and shall store or dispose of any Contractor's Equipment or surplus materials. Contractor shall clear away and remove from the Site any wreckage, rubbish and Temporary Works which are no longer required. All the recyclable portions of the discharge material will be evacuated through proper systems to ensure they are recycled in accordance with local law requirements.

3.5 Workforce

The number of peak construction personnel during construction phase and operation phase is hard to estimate at this phase. This is also highly dependent upon the approach that will be considered by the EPC contractor.

As an estimate, the peak number of personnel on site during construction can range up to 300. However such numbers are not expected for all time during construction phase. Peak construction can be expected 10-12 months for the Project. These Personnel includes engineers, specialists, project partner and representatives, suppliers as well as unskilled construction workers.

During operation, peak number of personnel on site can be in a range up to 40 considering the size of the Project. The average number of personnel during operation and maintenance can be between 20 and 30 for 20 years of operation period. These include skilled labor: such as operators, electrical and mechanical technicians, and unskilled labor such as module cleaner, security personnel etc.

During construction, workers will likely be accommodated in the nearest accommodation facilities to the site (possibly in Amman and surrounding) and will be provided with means of transportation to the site. However worker accommodation options are still being explored. If the project opted to include worker accommodation facilities on site, these shall be established in accordance with the specifications of the International Labour Organisation (ILO) standards and guidance published by EBRD and IFC and shall adhere to all measures needed to prevent potential occupational hazards on site.

Labor camps on site will be installed temporarily according to the Good Utility Practice, kitchen with catering facilities, common recreational space, offices for the Contractor as necessary, workshop facilities, lay down areas, safety gear for the Contractor and Project Company i.e. Baynouna.

3.6 Implementation Schedule

Overview of Project Phases:

The most likely activities during the complete development and operation of the Project can be divided in to following main three phases,

Planning and Design Phase: Typical activities includes:

- finalization of Project permits, approval, project partners, designs etc.

- **Construction and Commissioning Phase**: Typical activities include:

  - Transportation of all project components to the site
  - Civil, mechanical and electrical construction/installation of project according to design
  - Interconnection to the grid
  - Commissioning of the project: mechanical, electrical and performance tests.

- **Operation Phase:** Typical activities include:

  - Minimum 20 years of operation and maintenance of the plant after the commissioning of the project which includes several scheduled preventive maintenance such as PV module cleaning; physical inception of project components and site conditions; structural integration check, cabling and connection checks, plant performance measurements and so on

  - Corrective maintenance in case of defect or failure of components.

The **Table 4** below summarizes the expected Project Implementation Schedule:

Table 4: Project Implementation Schedule

Milestone	Expected Start Date	Expected Period
Construction Phase	Fourth Quarter 2017	12-20 months depending upon EPC contractor's capability

Milestone	Expected Start Date	Expected Period
Interconnection	Second Quarter 2019	
Commissioning	Second Quarter 2019	1-3 months
Operation	-	Minimum 20 years after the commissioning

4 REGULATORY FRAMEWORK

This section outlines regulations relevant to the natural environment of the Hashemite Kingdom of Jordan and describes relevant international conventions and treaties signed and ratified by Jordan and incorporated into the national law.

Specifically, the legislative framework presented in this section is relevant to the solar power plant project.

4.1 Relevant Environmental-Related Institutions

A selection of the main Ministries, Institutions and Authorities that are directly related to environmental issues are as follows:

4.1.1 Ministry of Environment

The Jordanian Ministry of Environment (MoEnv.) is the principal environmental institution in Jordan and responsible for the evaluation of the environmental impacts of the project and issue of associated project licenses and clearance.

MoEnv was established in 2003, and its mission is maintaining and improving Jordan's environmental quality through sustaining and conserving the environmental resources thus contributing to sustainable development. MoEnv develops environmental policies that are implemented and enforced throughout the Kingdom, moreover, it is dedicated towards ensuring that legislation is enforced; raising public awareness, inspection and monitoring, encouraging co-operating with national, regional and international bodies.

The Ministry of Environment has the legal strength of the environmental law that provides the Ministry with the tool to perform their duties. The Environmental Protection Law was one of the temporary laws issued in 2003, and was officially endorsed by the Jordanian Parliament in 2006 and issued as the Law No. 52 for the Year 2006.

The law considers the Ministry of Environment to be the competent authority for the protection of environment in the Kingdom, and the official and national authorities shall be bound to implement the instructions and resolutions issued under the provisions of this law which give the Ministry all the judicial powers it requires for implementing the law.

Law No. 52 provides the Ministry with the legal power to inspect any facility, and according to the findings of the audit, gives the Ministry the right to order a facility shutdown until the proper mitigation and control measures are implemented and the environmental violation eliminated. This inspection system was further strengthened with the establishment of the Environmental Police in 2007 where the police are now acting as an implementation tool and a full-fledged partner in the implementation of the environmental law.

The Environmental Protection Law has also introduced a system of an environmental "pre-emptive" assessment of all economic and developmental projects to be established in Jordan. This process is known as the Environmental Impact Assessment (EIA) where any developmental or economic project should carry out a detailed assessment of the expected environmental impacts potentially arising from the implementation of the project, and how these impacts can be mitigated through remedial action at the technical, legislative and public levels.

According to the Environmental Protection Law, the EIA study should be done before the project is initiated and sent to the Ministry of Environment where it will be reviewed. Please refer to EIA Regulation No. (37) / year 2005 classifies projects into three categories according to their environmental impacts:

- **Category 1:** Projects that require comprehensive EIA
- **Category 2:** Projects that require PEA
- **Category 3:** Projects that don't require an EIA

This regulation sets out the process for conducting an EIA study and the items to be included in the Study, procedure for obtaining an environmental clearance. In addition, it lists the projects that require a full EIA or a preliminary EIA. Any project which may pose potentially significant impacts on the environment must have a full EIA carried out and will be classified as a Category 1 Project according to the EIA regulation, the study must be conducted prior to obtaining environmental clearance from MoEnv for construction and operation activities. This will apply to this project.

Baynounah, the Proponent, is responsible for submitting the EIA study to MoEnv. upon an agreement with AJ (the EIA Consultant) who will be conducting an EIA Study for the project in compliance with all Jordanian legislation mentioned in the following sections, in addition to all regional and international laws and regulations (if applicable).

If the impact assessment is approved, the project will get the license and start its activities while adhering to the environmental mitigation and management systems specified and approved in the study. Any deviation from those guidelines would render the project to violations.

4.1.2 EIA Regulation in Jordan

According to the Jordanian EIA Regulation no (37) / Year 2005, this project is classified as Category (1), i.e. it needs a comprehensive EIA study. In accordance with Article (9), the Project Developer, i.e. Baynouna submitted preliminary Terms of Reference (ToR) for the ESIA Study prior to holding the scoping session, MoEnv shall call the project owner and any concerned individual or representative of a public or private party that may be potentially affected by the project to participate in investigating the preliminary ToR to identify the Significant Impacts of the project on the environment. As a result, this has been carried out through the Scoping Session which was held on Thursday, January 26th 2017. Baynouna and its ESIA Consultant (AJ) provided all the available information on the project and its surrounding environment and social conditions to all concerned entities within an appropriate time prior to the date of the Scoping Session.

After the Scoping Session, AJ submitted a summary of the scoping session's discussions and deliberations as well as a list of the parties/stakeholders who attended, and the key issues of concern/comments that were raised during the session (scoping session report – provided as

APPENDIX A of this ESIA report), which was then attached to the Final ESIA Terms of Reference (ToR) and submitted to MoEnv. The Final ToR was reviewed by the technical committee at the MoEnv which will make recommendations to the project developer (if deemed necessary). If the Minister approves the Final ToR of the project ESIA, the project developer shall advise the consultant team to prepare the draft of the ESIA document. For this project, the Final ToR and Scoping Report were approved by the MoEnv on February 15th 2017 via an official approval letter (Ref. No.4/7/1420).

Relevant to this project and upon submission of the Draft ESIA, the MoEnv's technical committee will be responsible for review. If the document fulfils the requirements of this regulation, then the ESIA will be considered the final document.

If the committee decides that the Draft ESIA does not fully cover the requirements, it shall require Baynouna and its Consultant (AJ) to provide any additional information needed to complete its analysis of the draft.

The decision related to the ESIA study shall be announced to the public in the manner that MoEnv deems appropriate. When the ESIA approval letter is issued, the project is considered to have obtained environmental clearance.

4.2 Other Relevant Ministries and Governmental Entities

4.2.1 Ministry of Energy and Mineral Resources (MEMR)

MEMR was established in 1984 and entrusted with administering and organizing the energy sector in a way that achieves the national objectives. the responsibilities of the Ministry were amended to include the comprehensive planning process of the sector, and setting the general plans and ensuring their implementation in a way that achieves the general objectives of the energy sector, the most important of which is providing energy, in its various forms, for the development process, organizing its affairs, exchanging electric power with neighboring countries, and attracting international capital for investment in this field, especially the generation of electric power, the production of oil derivatives, transportation of oil and gas, and utilizing local energy sources.

The Natural Resources Authority (NRA) was established in 1965. In 1968 law number 12 was ratified to regulate tasks, responsibilities and management of NRA. NRA was formed then, from many Directorates amongst are Mining, Geology, Water and Irrigation. Since 1985, MEMR was assigned as the President of NRA. Water and Irrigation Directorates were transferred to form an essential component of MWI.

However, based on recent restructuring, law No. (17) For the year (2014) relating to the restructuring of institutions and governmental organizations, is the legal successor for the NRA was formed, which is the Energy and Minerals Regulatory Commission (EMRC) –the EMRC is also the legal successor for Electricity Regulatory Commission (ERC) and the Jordan Nuclear Regulatory Commission (JNRC).

The main strategic objectives of the ministry are to ensure energy efficient practices in all sectors, promote energy efficiency projects, development and efficient exploitation of local energy sources such as renewable energy.

4.2.2 Ministry of Agriculture (MoA)

The Ministry of Agriculture (MoA) is responsible for managing public rangelands and forests, protecting soil, pasture-land and flora, provision of agricultural loans, support farmers, the granting of permits for import and export of agricultural products of plant, animal and veterinary medicines and vaccines, and live birds, the establishment and renewal of licenses for companies, factories, shops, galleries, nurseries and agricultural farms and olive presses, provide training for farmers, protecting and managing wildlife, issuing fishing and hunting licenses and regulations. Some wildlife protection and permitting tasks are the responsibility of the Royal Society for the Conservation of Nature (RSCN).

4.2.3 Ministry of Water and Irrigation (MWI) / Water Authority of Jordan (WAJ)

These organizations work collectively in order to determine the national water policies and regulations in order to protect water from contamination. In addition, the ministry is responsible for water protection and monitoring studying irrigation patterns and sewerage. Moreover, groundwater, aquifer management and abstraction monitoring and licensing are the responsibility of WAJ.

Generally, WAJ is responsible for the public water supply and wastewater services, as well as for the overall water resources planning and monitoring, while JVA is responsible for management and protection of water and land resources, including their supporting infrastructure.

4.2.4 Ministry of Health (MoH)

The Ministry of Health undertakes all health affairs in the Kingdom, and its tasks and duties include: maintaining public health by offering preventive treatment and health control services; organizing and supervising health services offered by the public and private sectors; providing health insurance for the public within available means; establishing and controlling the management of health educational and training institutes and centers according to relevant provisions of the legislations enacted; and working, in coordination with concerned parties, to raise public health standards.

In terms of this project, the Ministry of Health will have a supervisory and monitoring role through enforcing all applicable legislation to ensure Baynouna’s compliance with all relevant aspects and provisions of the General Health Law, no. 47 for the year 2008 (in particular chapters 8 to 10 and 13). In summary, the ministry’s roles will include but not limited to the following:

- Chapter 8, Drinking Water: Monitoring of drinking water quality and its sources to prevent any potential contamination;

- Chapter 9, Chemicals: Monitoring and supervising of chemicals imported into the country, handling methods and chemicals used in industries, through screening chemical types and categorizing them into a list with permitted chemicals and prohibited types depending on the degree of hazard. Chemicals used in industries are to abide by the list of permitted chemicals proposed by the Ministry to ensure public health protection.

- Chapter 10, Health Hazards: Compliance with the Instruction No. (1) Foryear 2011 for the prevention of occupational hazards related to health hazards resulting from labour housing units' onsite to avoid any health hazards to workers or others such as, dust, odor, and noise and ensure proper disposal of generated wastes and wastewater.
- Chapter 13, Trade and Industries: the Ministry will ensure compliance with the Trade, Industry and Occupational Safety Law No. (16) For the year 1953. This can be done through inspections in order to prevent any potential health or occupational hazards.

4.2.5 Ministry of Municipal Affairs

The Ministry is taking up the supervisory role over the activities of the Municipalities and the Joint Services Councils (JSC) operating in all over the Kingdom with a total of (93) Municipalities and (22) JSCs. The main duties are: to provide the various facilities to the municipalities to enable them to perform their functions and support them in improving the services efficiency; oversee, coach and monitor the financial, administrative and organizational performance of the municipalities; enhance the institutional capabilities of the sector; manage the financial transactions and arrange with the relevant parties to provide the necessary funding for the programs and projects; set, develop and implement the legislative, administrative, financial and institutional framework that are effective for the Municipal operations; prepare the regional, organizational and detailed construction plans for the municipalities; monitor and control the implementation of the regulations, policies and instructions of the municipalities and joint services councils and draw up the regulatory bills of the municipal affairs sector and review and supervise the infrastructure projects of the municipal councils and develop the designs, technical specifications and tender documents in addition to sustaining and developing the inhabited clusters that have no municipal councils.

4.2.6 Ministry of Public Works and Housing

The Ministry of Public Works and Housing aims to develop a network of public roads in the kingdom, linking towns, villages and communities and sites of industrial production, agricultural and tourist areas and archaeological sites; and to link the Kingdom and neighboring countries and sustain this network and keep it in a good technical level.

The Ministry is also working on upgrading the quality of the roads and the promotion of safety requirements in addition to keeping abreast of the latest updates and techniques of modern roads and lighting.

4.2.7 Ministry of Transport

The Ministry assumes the following responsibilities under the Transport Law No. (89) / year 2003 and authorizations needed in order to carry out its mission such as: devising the general policy for transport and overseeing its implementation in coordination and cooperation with all related parties; regulating and monitoring the road freight transport sector and its services; issuance of necessary permits for individuals and companies operating in the sector;

regulating and monitoring the freight transport by rail sector and its services, as well as issuance of necessary permits for operating in the sector and many other responsibilities.

4.2.8 Jordan Standards and Meteorology Organisation (JSMO)

JSMO plays a proactive role in protecting the interests, health and safety of citizens and environment and enhancing the competitiveness of Jordanian products in the national, regional and international markets in keeping with the national goals and contributing to achieving them within the defined priorities. JISM prepares, approves, revises, amends and monitors the implementation of standards and technical regulations with regard to all services and products (with the exception of pharmaceutical and food products, medicines, veterinary medicines, serums and vaccines).

The main objectives of JSMO are:

- Adoption of a national system for standardization and metrology based on accepted international practices.
- Keeping pace with scientific and technical developments in the fields of standards, metrology, conformity assessment and laboratory accreditation.
- Ensuring the health and safety of the Jordan's citizenry and protection of the environment by making sure that products are in compliance with the technical regulations adopted by the Organization for the purpose.
- Raising the quality of local products through the adoption of appropriate Jordanian Standards in order to enhance their competitiveness in the local and international markets and thus support the national economy.

4.2.9 Department of Antiquities (DoA)

DoA was established in 1928 as the official institutional authority mandated by law to be responsible for the protection, conservation and presentation of antiquities.

The two main policies are:

- For the protection of antiquities, conservation measures that do not require physical intervention to the remains are preferred as the first choice where possible.
- For the presentation of antiquities, including research, survey, excavation and site management.

4.2.10 Energy and Minerals Regulatory Commission (EMRC)

The EMRC is a governmental body that possess a legal personality with financial and administrative independence and is considered the legal successor of the Electricity Regulatory Commission (ERC) and the Jordan Nuclear Regulatory Commission (JNRC) and the Natural Resources Authority (NRA) in relation to its regulatory tasks according to law No. (17) for the year (2014) regarding the restructuring of institutions and governmental organizations.

4.2.11 National Electric Power Company (NEPCO)

NEPCO is the official successor to Jordan Electricity Authority (JEA) since 1999; NEPCO owns the electric transmission network and is responsible for construction, planning, development, operation, maintenance and management of the control systems, and the electric transmission and interconnection networks. The company also manages to purchase electricity from all available sources and sell them to distribution.

4.2.12 Ministry of Labor (MoL)

MoL has undertaken the responsibility of accomplishing the general objectives of labor and laborers affairs and issues in Jordan. To keep pace with social and economic development, the Labor Law No. (8) and its amendments for the year 1996 was issued and the administrative regulation No. (38) of the year 1994 was established, along with its amendments.

The tasks of the Ministry include:

- Organizing the labor sector, as well as updating labor legislation so as to meet the needs of the labor market in light of the social and economic developments within a framework that maintains the production parties rights, and contributes in encouraging the foreign investments.
- Contribution to the development of workforces through the Vocational and Technical Training and Educational Council.
- Collaboration in human resources and workforces development projects.
- Organizing the foreign labor in the Jordanian Labor Market.
- Maintain available job opportunities to employ Jordanian Labor.
- Building up labor market databases.
- Consolidating cooperation and partnership with the private sector.
- Consolidating regional and international cooperation and partnership.
- Consolidating partnership and cooperation with corporations concerned with preparing and developing Human Resources

4.3 Principal National Legislation

4.3.1 Laws

- Industry & handicraft law (No. 16, 1953)
- Management of Natural Resources Law (No. 12, 1968)

- Land Acquisition Law (No. 12, 1987)
- Water Authority Law (No. 18, 1988) and its amendments
- The Antiquities Law (No. 21, 1988) and its amendments (No. 23, 2004)
- Labour Law (No. 8, 1996) and its amendments
- Civil Defence Law (No. 18, 1999)
- Agricultural Law (No. 44, 2002)
- General Electricity Law (No.64, 2002)
- Transportation Law (No. 89, 2003) and its amendments
- The Environment Protection Law (No. 52, 2006)
- Municipalities Law, No. (14) of 2007
- The Free and Development Zones Law (No. 2, 2008)
- Public Health Law (No.47, 2008)
- Traffic Law (No. 49, 2008)
- Renewable Energy and Energy Efficiency Law (No. 13, 2012)
- Development Zones Law (No.2, 2008)

4.3.2 Regulations

- Regulations for Protection of Birds and Wildlife and rules covering their hunting (No. 113, 1973)
- Regulation of Protection and Safety from Industrial Tools and Machines and Worksites (No.43, 1998) – Issued by the virtue of the provisions of Paragraph (c) of Article (85) of the Labour Law No. (8) Of 1996 and its amendments.
- Regulation for the establishment of Occupational Health and Safety Committees & supervisors (No. 7, 1998), issued in accordance to Article (85) of the Jordanian Labour Law no.(8) / year 1996 and its amendments.
- Groundwater Control Regulation (No. 85, 2002), Issued pursuant to Articles 6 and 32 of Water Authority Law No. 18 for the year 1988.
- Regulation of Harmful and Hazardous Waste Management, Transfer & Handling (No. 24, 2005).
- Soil Protection Regulation (No. 25,2005)
- Regulation for the Protection of the Environment from Pollution in Emergency Situations (No. 26, 2005)

- Regulation of Solid Waste Management (No. 27, 2005)
- Air Protection Regulation (No. 28, 2005)
- The Environmental Impact Assessment Regulation (No. 37, 2005)
- Land use planning Regulation (No. 6, 2007)
- The Development Zones Law (No. 2, 2008) (Environmental Protection Regulation still unofficial).

4.3.3 Instructions

- Instructions for Disposal of Industrial and Commercial wastewater into the sewage network, issued in accordance with Water Authority Law No. 18 for year 1998 and Article No. 23 of the Sewage System Law No. 66 for the 1994.
- Instructions for the Management and Handling of Hazardous Waste of the year 2003.
- Instructions for Recycling and Handling of Consumed Oils of the year 2003.
- Instructions for the Limitation and Control of Noise for the year 2003.
- Instruction for Controlling the Use of Substances that Deplete the Ozone Layer for the year 2003, issued in accordance with Law No. (1) 2003 Articles 9-15; 'Law for the Protection of the Environment'.
- Instructions for the Selection of locations for Development Activities for 2007 issued in accordance with paragraph (d) of Article (4) of the Environmental Protection Law no. 52 for 2006.Instructions No. (1) for the year 2011 for the prevention of occupational hazards related to health hazards resulting from labour housing units onsite, issued in accordance to article (49) of the temporary Public health law No. (49) For the year 2008.

4.3.4 Standards

- Standard for lighting levels in work environment (No. 524/1987)
- Standard for heat levels allowed to be exposed to in work environment (No. 525/1987)
- Standard for maximum allowable limits of air pollutants emitted from the stationary sources (No. 1189/1998)
- Standards for Motor Emissions (JS 1052/1998)
- Standards for Motor Vehicle Emissions – Diesel Engines (JS 1053/1998)
- Standards for Motor Vehicles (Noise Levels) (JS 1059/1998)
- Standards for reclaimed domestic wastewater (No. 893/2006)
- Ambient Air Quality Standard (No. 1140/2006)

- Standards for industrial reclaimed wastewater (No. 202/2007)
- Drinking Water (No.286/2008) Standards.

4.4 Regional and International Agreements and Protocols

The Kingdom of Jordan has signed and ratified (that is, placed into national law) the following international protocols and agreements relevant to this project (dates of entry into force noted in parentheses):

- International Plant Protection Convention (24/4/1970);
- Convention Concerning the Protection of the World Cultural and Natural Heritage (17/12/1975);
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (10/5/1077);
- Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) (14/3/1979);
- Protocol to amend the Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR Convention) (1/10/1986);
- Amendment to the Convention of International Trade in Endangered Species of Wild Fauna and Flora (art. XI) (13/4/1987);
- Protocol on Substances that Deplete the Ozone Layer (30/8/1989);
- Convention for the Protection of the Ozone Layer (31/8/1989);
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (5/5/1992);
- Convention on Biological Diversity (10/2/1994);
- Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer (10/2/1994);
- Framework Convention on Climate Change (21/3/1994);
- Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer (28/9/1995);
- International Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (26/12/1996).
- Constitution of the Food and Agriculture Organization of the United Nations (23/1/1951)

4.5 Specific Relevant Standards and Guidelines

All projects within Jordan depend on the specific project design requirements and applicable agreements with environmental permitting authorities. Specific requirements relating to the following are provided below:

- Ambient air quality;
- Air emission limits from stationary sources;
- Ambient noise;
- Soil and Groundwater Quality; and
- Waste Management.

4.5.1 Ambient Air Quality

Ambient air quality limits recommended by the Ambient Air Quality Jordanian Standards (JS No. 1140/2006) and the World Health Organization WHO guidelines are summarized and presented in **Table 5** below:

Table 5: Ambient Air Quality Standards

Air Pollutant	JS No. 1140/2006			WHO Guidelines (Õg/m^3)
	Average Time	Maximum Allowable Concentration in the Ambient Air	Number of Allowed Exceedences	
Sulphur Dioxide (SO_2)	1 Hour	0.3 mg/kg	3 times within a given month in one year	--
	24 Hour	0.14 mg/kg	Once a year	125 (IT 1) 50 (IT 2)
	1 Year	0.04 mg/kg	--	--
Carbon Monoxide (CO)	1 Hour	26 mg/kg	3 times within a given month in one year	--
	8 Hour	9 mg/kg	3 times within a given month in one year	--
Nitrogen Dioxide (NO_2)	1 Hour	0.21 mg/kg	3 times within a given month in one year	200

Air Pollutant	**JS No. 1140/2006**			**WHO Guidelines (Õg/m^3)**
	Average Time	**Maximum Allowable Concentration in the Ambient Air**	**Number of Allowed Exceedences**	
	24 Hour	0.08 mg/kg	3 times within a given month in one year	--
	1 Year	0.05 mg/kg	--	40
Total Suspended Particles (TSP)	24 Hour	260 Õg/m^3	3 times within a given month in one year	--
	1 Year	75 Õg/m^3	--	--
PM_{10}	24 Hour	120 Õg/m^3	3 times within a given month in one year	150 (IT 1)
	1 Year	70 Õg/m^3	--	70 (IT 1)
$PM_{2.5}$	24 Hour	65 Õg/m^3	3 times within a given month in one year	75 (IT 1)
	1 Year	15 Õg/m^3	--	35 (IT 1)
H_2S	1 Hour	0.03 mg/kg	3 times within a given month in one year	--
	24 Hour	0.01 mg/kg	3 times within a given month in one year	--

IT: Interim Target of the WHO.

Occupational Safety and Health Administration (OSHA) are considered applicable to this project. The Air Quality Guidelines for BTEX as provided by the above mentioned organizations are summarized in **Table 6** below.

Table 6: BTEX Standards

Parameter	**Occupational Exposure Limits**		
	WHO AQG	**NIOSH**	**OSHA**
Benzene	11 unit risk	0.319mg/m3 (TWA) 3.19 mg/m3 (ST)	3.19 mg/m3 (TWA) 15.95 mg/m3 (ST)
Toluene	0.26mg/m3 (week) 1mg/m3 (30 min)	375mg/m3 (TWA) 560mg/m3 (ST)	188 mg/m3 (TWA) 1875 mg/m3 (ST)

Ethyl benzene	22 mg/m3 (yr)	435mg/m3 (TWA) 545mg/m3 (ST)	435 mg/m3 (TWA)
Xylenes	4.8mg/m3 (24 hrs) 0.870mg/m3 (yr)	435mg/m3 (TWA) 655mg/m3 (ST)	435mg/m3 (TWA)

Note:
TWA – time weighted average (8 hours)
ST – short term exposure (15mins)

4.5.2 Ambient Noise Limits

Article (4) of the Standards for the prevention and elimination of noise (2003) indicated that all projects and noise producing facilities should comply with International Noise Standards (No. 2204) and related amendments for issues related to measurement of noise and other associated technical issues.

Article (5) of the same standards established a list of activities is prohibited by law. Those relevant to the proposed Project are:

- All construction activities utilizing noise producing plants and equipment (e.g. rigs, mixers and vibrators) must cease between 8:00 pm and 6:00 am, unless a permit is granted by the MoEnv;
- Work activities within light industrial areas with residential dwellings are prohibited to continue between 9:00 pm and 6:00 am (summer) and between 8:00 am and 7:00 am (winter).

Article (6) of the noise standard specifies the maximum allowable noise level (dBA) for specific times and areas. The maximum allowable noise levels applicable to this project are detailed in **Table 7** below.

Table 7: Maximum Allowable Noise Limits

Area	Allowable Limits for Noise Levels (dBA)	
	Day	Night
Residential areas within cities	60	50
Residential areas within suburbs	55	45
Residential areas within villages	50	40
Residential areas with commercial activities, services, light handcrafts, and city centre	65	55
Industrial areas (Heavy Industry)	75	65
Places of education, worship, treatment and hospitals	45	35

4.5.3 Occupational Noise

The Instructions for the protection of workers and institutions from occupational hazards/risks issued by the virtue of Article (79) of the Labor Law no.8 of 1996 discuss the provision of workers with necessary personal protective equipment, rest areas and other facilities in addition to lifting limits and other occupational health and safety considerations. Furthermore, Article (16) mentions that each company or establishment must ensure to prevent or minimize noise generation so as to prevent any occupational risk on workers, which should not exceed the intensity mentioned below:

Table 8: Acceptable Noise Exposure

Noise Intensity (dBA)	Acceptable exposure during that day (in Hours)
80	16
85	8
90	4
95	2
100	1
105	1/2
110	1/4
115	1/8

As for Intermittent noise in the form of strong quick strikes can be calculated as per the below:

Table 9: Daily Acceptable Noise Exposure

Noise Intensity (dBA)	Number of times acceptable per day
140	100
130	1,000
120	10,000

4.5.4 Soil and Groundwater Quality

Soil

The Soil Protection Regulation No. 25 for the year 2005 states the requirements to protect soils and prevent its contamination through proper management and monitoring.

Groundwater

The general rules of the Groundwater Control Regulation No (85) of 2002, issued pursuant to Articles 6 and 32 of Water Authority Law No. 18 of 1988 are that “the groundwater is state-owned and subject to its control. It is not permissible to pump out or utilize underground water without obtaining a license issued according to the provisions of the law. The purpose usage and the quantities of pumped-out water and any other conditions should be identified in the license”. Owning land does not include water ownership that is stored underground. The license is required for drilling wells; in addition, supervision from the authority is required, plus a pumping test before utilization. “Anyone who is granted a license to extract groundwater shall be committed not to cause water pollution or depletion and to strictly comply with the conditions of the license".

The regulation also covers licensing rules and fees as well as water prices, pollution control, and requirements from private well owners.

4.5.5 Waste Management

Hazardous Waste Management

Regulation of Harmful and Hazardous Waste Management, Transfer & Handling No. 24, 2005:

This regulation focuses mainly on setting the general procedures for hazardous waste producers in terms of storing, handling, collection and disposal procedures for hazardous waste and empty hazardous waste containers, including emergency plans, precautions and setting general procedures before transferring to those who are responsible for transporting this type of waste.

The regulation also deals with special conditions for owners or managers of the specified site for storing, treating and disposing of hazardous waste in terms of receiving and registering the waste, ensuring the implementation of safe procedures in order to prevent fire and other accidents, since there are special restrictions for safety and health of the employees in the site.

Solid Waste Management

Regulation of Solid Waste Management No. 27 for the year 2005:

The objective of the Regulation is to ensure the management of solid waste in a way that maintains environment protection and public health.

It lists details, responsibilities and tasks to be undertaken including observing and collecting operations, transportation of wastes, permitting, supervising, scheduling, archiving and outlining the responsibilities and tasks for the Ministry of Municipalities. In addition, it sets the duties to be fulfilled by the Ministry in cooperation with the related bodies. These duties include picking up the waste, defining stipulations of storage, collecting, sorting, recycling, treating, and training and awareness programs, in addition to dealing with compliance, offences, punishments and fines.

Handling of Oils

Instructions for Recycling and Handling of Consumed Oils for the year 2003:

The instructions provide definitions of consumed oils as oils refined from raw petrol or industrial oils that have been used, and which as a result are transferred into polluted waste together with chemicals or physical pollutants and which should be disposed of or treated or recycled. Examples are machine oils, engines oils, hydraulic oils, energy transfer and movement oils, heat exchange or any other oils that are used for lubrication. Other definitions are given for underground tanks used as storage tanks to store and treat oil, oil containers and oil collecting licensed stations.

The instructions state implemented measures for oil producers, parties that transport oil, collecting stations, treatment units, oil combustors, and all directly or indirectly related parties in the stages of oil use and recycling.

Definitions of general requirements are also included such as:

- Prohibition of discharge of oil into sewage networks or septic tanks or surface and ground water resources or the environment
- All parties mentioned in Article 3 must obtain a license from the MoEnv.
- Oil mixing with solid domestic waste and disposal into the municipal dumping sites for domestic waste is prohibited
- Oil use for energy production is prohibited in food producing institutions
- Use of raw oil for energy production is prohibited in institutions, factories or houses unless an approval is given
- Mixing of oils with hazardous waste and chemicals is prohibited

In addition, general conditions for oil producers, oil collection stations and oil carriers are set and the general conditions for oil carriers include having an identification number (license), submitting of full information about the company with the license request, transferring the oil into a licensed collection station only. Other articles list the conditions for oil recycling and treatment units.

4.6 IFC Environmental and Social Standards

The International Finance Corporation (IFC) Performance Standards (PS), Environmental, Health and Safety Guidelines and Practice Notes, provide guidelines on conducting environmental, social and health assessments and address a variety of issues for different types of projects and sectors. These performance standards and guidelines will be taken into account during the preparation process of the Preliminary EIA.

- **PS 1:** Assessment and Management of Environmental and Social Risks and Impacts;
- **PS 2:** Labor and Working Conditions;
- **PS 3:** Resource Efficiency and Pollution Prevention;
- **PS 4:** Community Health, Safety, and Security;
- **PS 5:** Land Acquisition and Involuntary Resettlement;
- **PS 6:** Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- **PS 7:** Indigenous Peoples;
- **PS 8:** Cultural Heritage;

In addition to the above performance standards, other relevant IFC guidelines and practice notes relevant to the project issues will be reviewed simultaneously, and will be considered for the proposed project where applicable. These include but are not limited to the following:

- General Environmental, Health and Safety (EHS) Guidelines;
- Practice Note on addressing grievances from project-affected communities (guidance for projects and companies on designing grievance mechanisms);
- Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets;
- To maintain compliance with international standards such as the EBRD and IFC throughout the project phases, the project will be committed to implement an Independent Environmental and Social (E&S) Auditing Protocol to review the current operational performance of the company's existing operations i.e. the PV power plant project. For this project, the audit shall be conducted during the **construction phase** and the **operation phase**, usually by an independent third party consultant.

  The audit protocol will help facilitate the identification of any risks and hazards throughout the project construction and operation phases and propose remedial action with a timeframe to ensure that risks are eliminated/reduced. The protocol also aims to ensure that the project Environmental and Social Action Plan (ESAP) is updated accordingly. The E&S auditing protocol has been prepared as part of the ESMS documentation specific for this project.

4.7 EBRD Environmental and Social Policy

The EBRD is committed to promoting ''environmentally sound and sustainable development'' in its investment and technical cooperation activities. The Environmental and Social Policy (ESP) outlines how the Bank will address the environmental and social impacts of its projects by:

- Defining the respective roles and responsibilities of the EBRD and the Clients designing, implementing and operating projects in line with the ESP and the Performance Requirements (PRs);
- Setting a strategic goal to promote projects with high environmental and social benefits;
- Mainstreaming environmental and social sustainability considerations into all its activities.

EBRD has adopted a comprehensive set of PRs that projects are expected to meet. The Bank expects its clients to manage the environmental and social issues associated with the projects to meet the PRs over a reasonable period of time.

The EBRD PRs that are relevant to this project, and which AJ team will consider during the Preliminary ESIA process are listed below:

- **PR1 –** Assessment and Management of Environmental and Social Impacts and Issues;

- **PR2 –** Labour and Working Conditions;
- **PR3 –** Resource Efficiency, Pollution Prevention and Control;
- **PR4 –** Health and Safety;
- **PR5 –** Land Acquisition, Involuntary Resettlement and Economic Displacement;
- **PR6 –** Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- **PR7 –** Indigenous Peoples;
- **PR8 –** Cultural Heritage;
- **PR10 –** Informational Disclosure and Stakeholder Engagement

4.8 Equator Principles

These principles were primarily intended to provide a minimum standard for due diligence by commercial banks. The principles were set based on the International Finance Corporation Performance Standards on social and environmental sustainability and on the World Bank Group’s Environmental, Health, and Safety Guidelines. These principles will be taken into account during the preparation process of the ESIA.

- **Principle 1:** Review and Categorization
- **Principle 2:** Social and Environmental Assessment.
- **Principle 3:** Applicable Social and Environmental Standards.
- **Principle 4:** Action Plan and Management System.
- **Principle 5:** Stakeholder Engagement.
- **Principle 6:** Grievance Mechanism.
- **Principle 7:** Independent Review.
- **Principle 8:** Covenants.
- **Principle 9:** Independent Monitoring and Review.
- **Principle 10:** Reporting and Transparency.

5 BASELINE CONDITIONS

Following is an overview of the findings of the data collection and literature review work. A listing of the data obtained and reports reviewed is presented in the section below, and the overview of the physical, biological, socio-economic and archaeological baseline conditions is described below:

5.1 Data Sources and Literature Reviews

All available information sources have been reviewed and relevant information extracted, analyzed and presented in the context of this study. A detailed references list of reports and documents reviewed for information is presented in **Section 12– References** of this report. A literature review together with a field survey of the project area and its surroundings has been conducted in order to summarize the most up to date data needed for preparation of the project description, the environmental baseline as well as documents of a more technical nature to better understand the potential impacts and to propose mitigation measures of the project's activities.

Information has been collected from various sources, to the extent possible. Some sources include relevant government institutions such as the Jordanian Department of Statistics (DoS), Jordan Meteorological Department (JMD), MEMR, and DoA.

Some of the major topics reviewed as part of the Literature Review included:

- Hydrological, Hydrogeological and Water Resources Studies;
- Ecological Studies and Reports on the Flora and Fauna;
- Archaeology; and
- Geology of the Area

5.2 Physical Environment

5.2.1 Meteorology and Climate

Jordan's climate varies from Mediterranean in the west, to desert in the east and south, but the land is generally arid. The proximity of the Mediterranean Sea is the major influence on Jordan's climate, although continental air masses and elevation also modify it. The prevailing winds throughout the country are westerly to north-westerly, but spells of hot, dry, dusty winds blowing from the southeast off the Arabian Peninsula frequently occur providing the country with its most uncomfortable weather (especially during the khamsin Wind[2] period April-May).

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[2] The Khamsin is an oppressive, hot, dry and dusty south or south-east wind occurring in N. Africa, around the E Mediterranean and the Arabian Peninsula intermittently in late winter and early summer, but most frequently between April and June. (Source: http://www.weatheronline.co.uk/reports/wind/The-Khamsin.htm).

The country's climate is a result of both its geographical location in the Eastern Mediterranean region and its relief, which ranges from 416 m below sea level at the Dead Sea shoreline to 1800 m above sea level in the Southern Highlands (GTZ, Water Resources in Jordan, 2004).

Jordan is vulnerable to the potential impacts of climate change, since ecosystems and water resources are affected by changes in the hydrological cycle (MoEnv, Environmental Profile of Jordan, 2006).

A map showing the bioclimatic zones of Jordan is presented in **Figure 7**. The Figure indicates that the project area belongs to the Arid Mediterranean-Cool Zone.

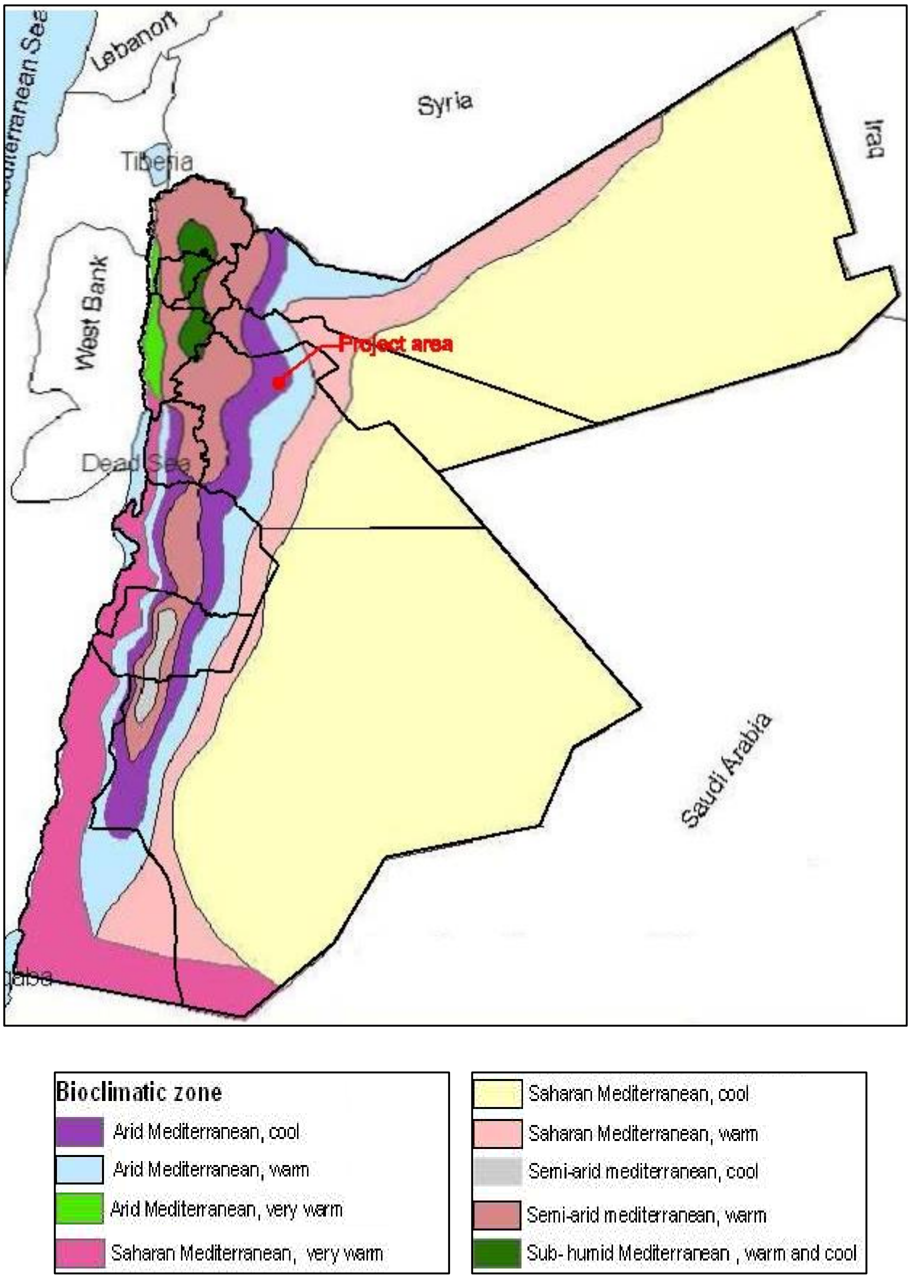

Mediterranean Sea
Lebanon
Syria
Iraq
Tiberia
West Bank
Project area
Dead Sea
Saudi Arabia
Aqaba
Bioclimatic zone
Arid Mediterranean, cool
Arid Mediterranean, warm
Arid Mediterranean, very warm
Saharan Mediterranean, very warm
Saharan Mediterranean, cool
Saharan Mediterranean, warm
Semi-arid mediterranean, cool
Semi-arid mediterranean, warm
Sub-humid Mediterranean , warm and cool

Figure 7: Bioclimatic Zones of Jordan

The initial meteorological characteristics have been obtained based on the data averages for the years (2011 to 2015) recorded in Ghabawi weather station – which is the nearest weather station to the project area - located around 14km north of the project area. **Figure 8** below illustrates the location of the weather station. The raw data has been provided by Jordanian Department of Meteorology.

Table 10 below summarizes the average annual temperature, rainfall, and wind speed readings, over the period of year (2011-2015) as registered in Ghabawi weather station.

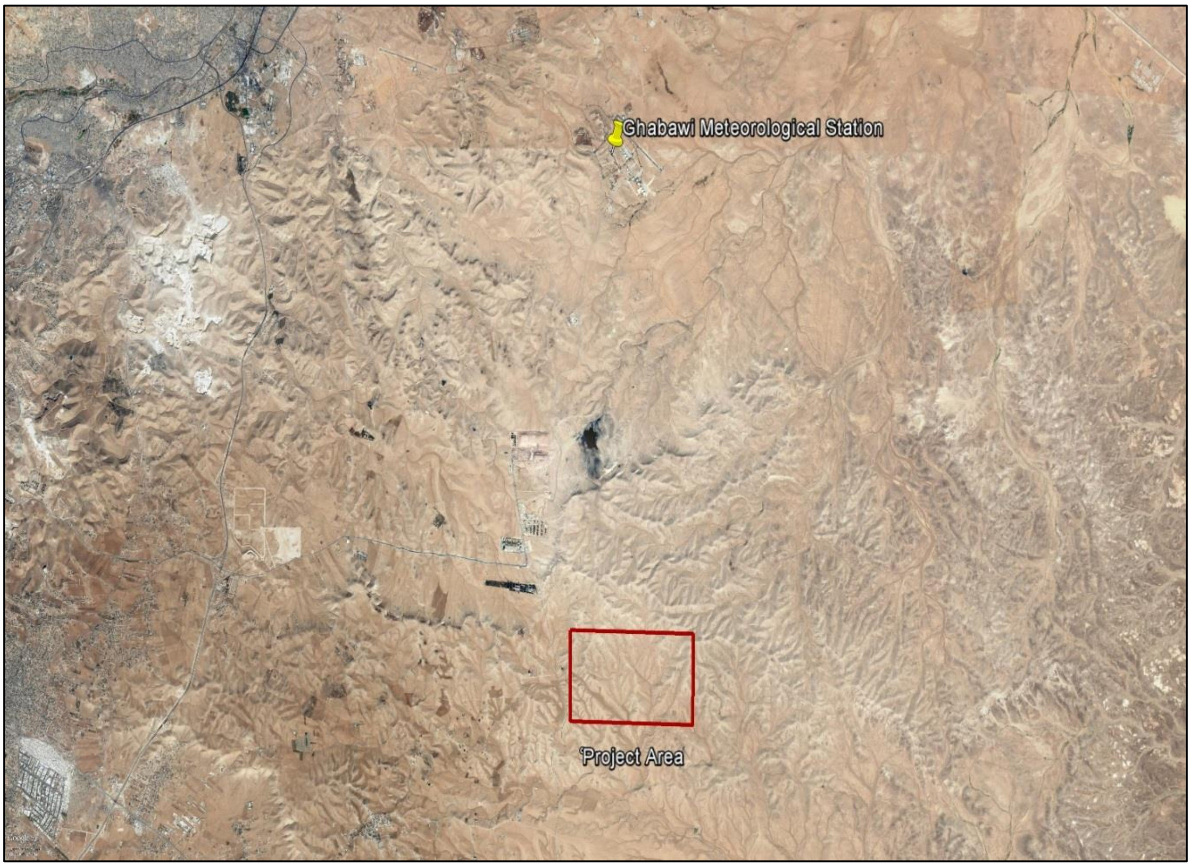


Figure 8: Ghabawi Weather Station Location with respect to Project Area

Table 10: Main Meteorological Parameters at Ghabawi Weather Station

Parameter	Ghabawi Weather Station
Ave. Max Temp (ÜC)	24.6
Ave. Min Temp (ÜC)	11.8
Ave. Mean Temp (ÜC)	18.2
Ave. Annual Rainfall Amount (mm)	87.5
Ave. Mean Humidity (%)	59.4
Ave. Mean Wind speed (Knot)	8.01

Source: Jordanian Department of Meteorology

All parameters mentioned above are calculated based on the data for five years period (2011 to 2015); the following Figures show part of averages records.

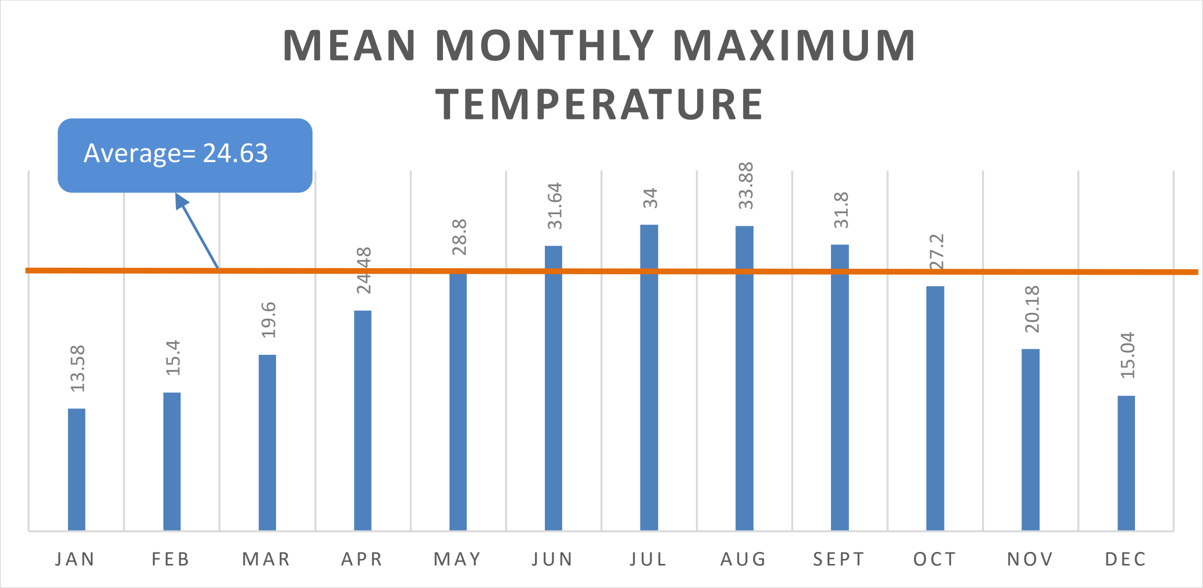


Figure 9: Mean Monthly Maximum Temperature

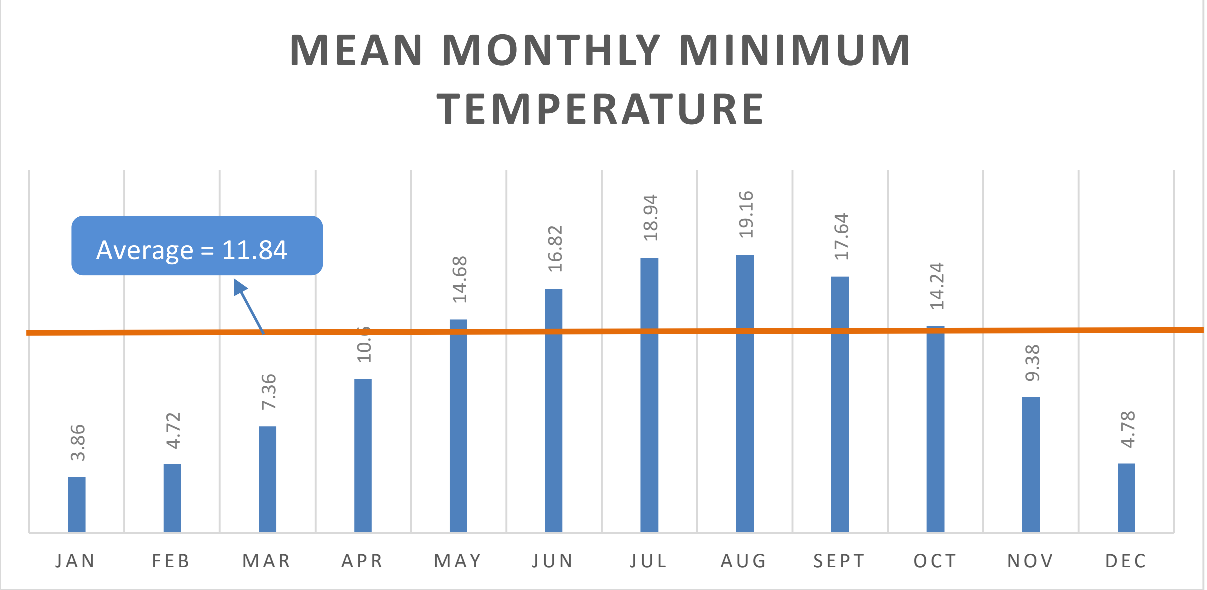


Figure 10: Mean Monthly Minimum Temperature

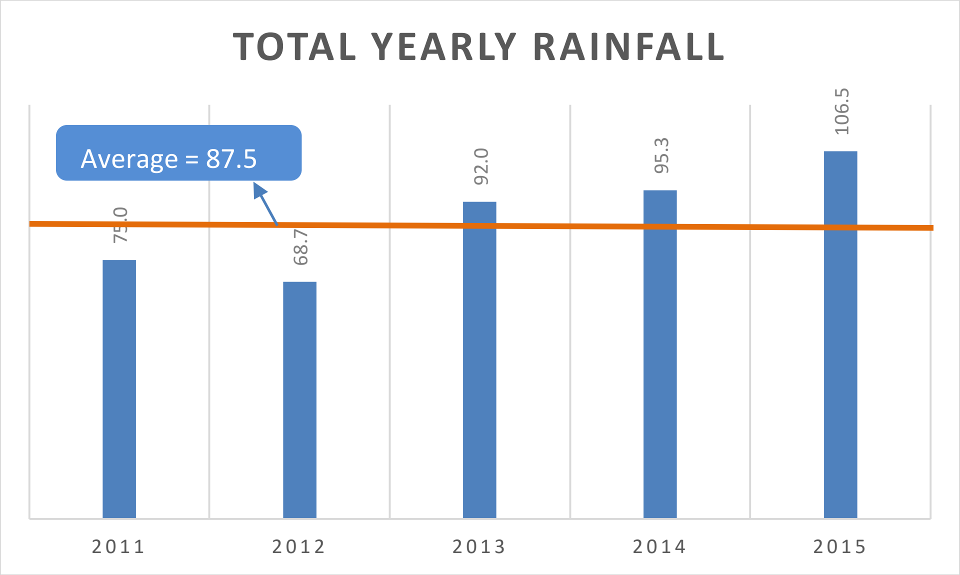


Figure 11: Total Yearly Rainfall

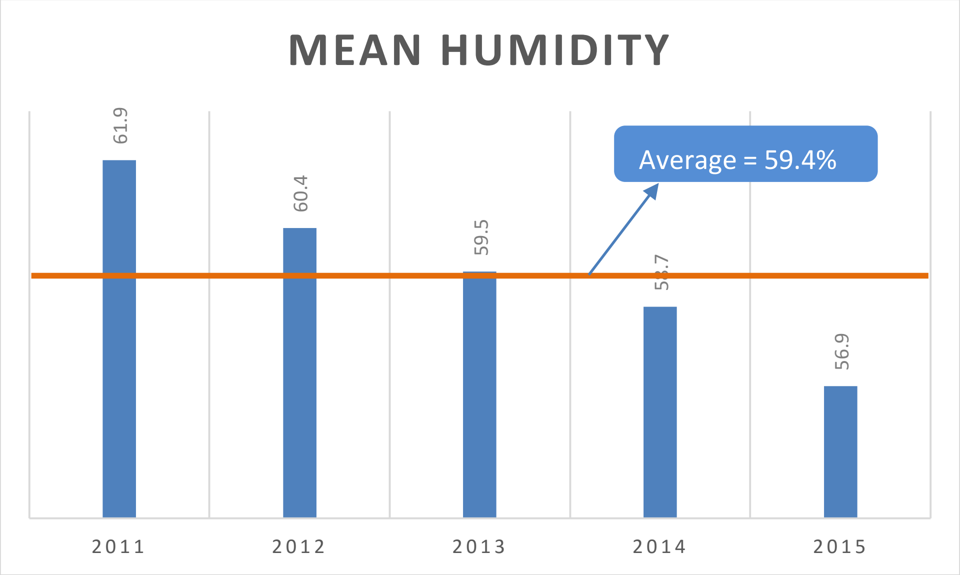
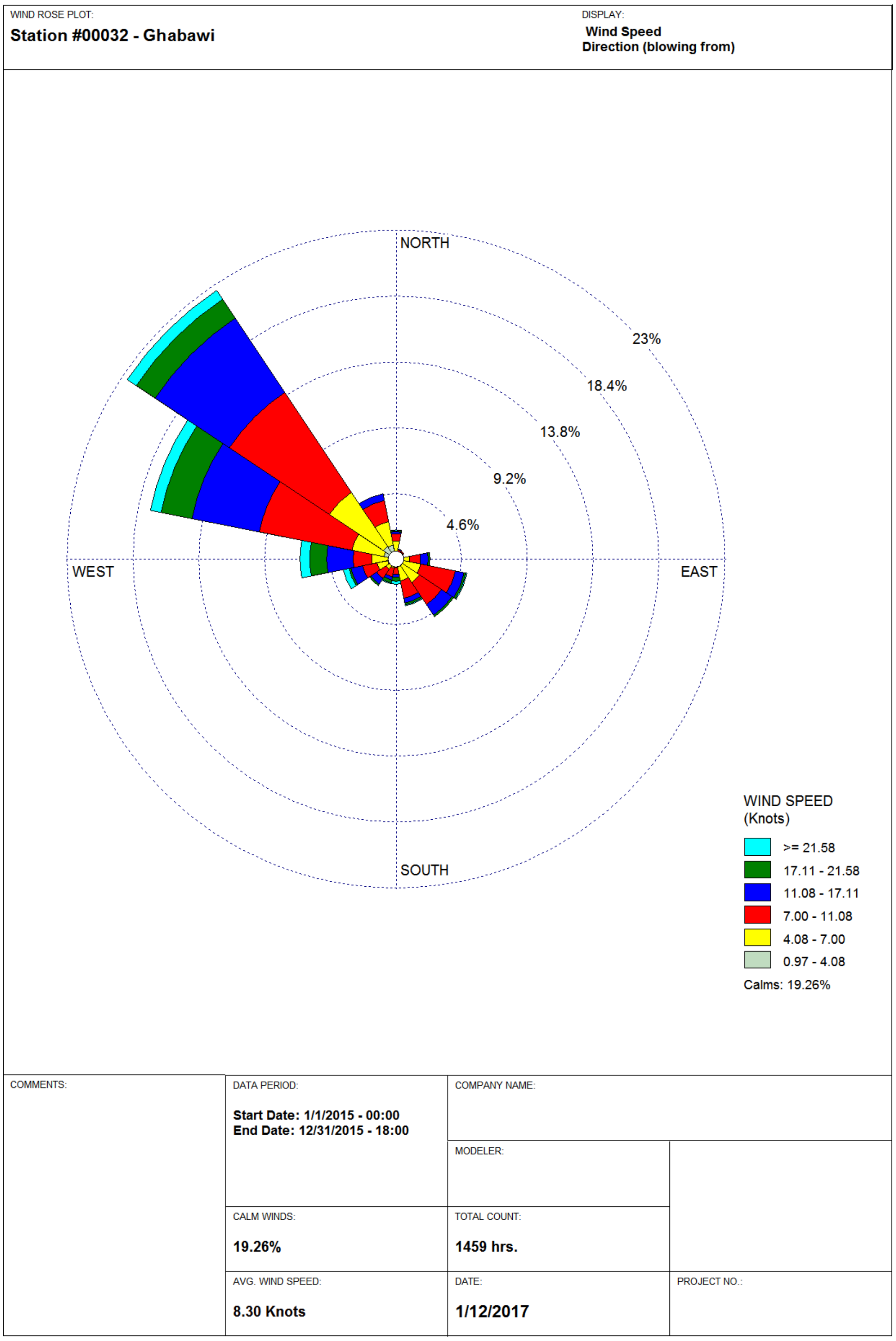


Figure 12: Mean Humidity



WIND ROSE PLOT:
Station #00032 - Ghabawi

DISPLAY:
Wind Speed
Direction (blowing from)

COMMENTS:

DATA PERIOD:
Start Date: 1/1/2015 - 00:00
End Date: 12/31/2015 - 18:00

COMPANY NAME:

MODELER:

CALM WINDS:
19.26%

TOTAL COUNT:
1459 hrs.

AVG. WIND SPEED:
8.30 Knots

DATE:
1/12/2017

PROJECT NO.:

Source: Jordanian Department of Meteorology

Figure 13: Wind Rose of the Project Area

5.2.2 Air Quality

The main aim of the baseline assessment of air quality is to determine whether there will be potential changes of specific parameters and pollutants adversely affecting ambient air quality. The anticipated emissions resulting from project activities will be limited to those resulting from the construction machineries and or vehicles during construction phase. Those emissions will be mainly to CO, CO_2 and PM_{10}, and they are likely to disperse rapidly leaving no noticeable change to the ambient air quality within the project area.

Meanwhile, the weather conditions are impactful and increase the concentration of the **PM_{10} and $PM_{2.5}$.**

The air pollution concentration vary spatially and temporally causing the air pollution pattern to change with different locations and time due to changes in meteorological and topographical condition. Air pollutants can be natural or may be the result of various anthropogenic activities like industrial, vehicles and waste emissions.

An air quality monitoring activity was conducted at the project site during January 30 - February 6, 2017 by an accredited laboratory by the Jordanian Accreditation System (JAAS) – Test - 080 and ISO 17025 Certified - Hima Laboratory for Environmental Testing, for both PM_{10} and $PM_{2.5.}$

Objectives:

The general objectives of the air quality monitoring practice are:

- To assess the ambient concentrations of selected air pollutants in the immediate vicinity of the identified project site.
- To determine if the Jordanian Ambient Air Quality Standards (JS 1140/2006) were violated or exceeded at the project site
- To establish ambient air quality baseline data within the project site.
- To ensure that possible adverse impacts are identified and avoided or minimized.

Methodology:

- The Jordanian standard for the ambient air quality (JS 1140/2006) include strict and clear guidelines and methods that were followed when monitoring for ambient air quality criteria pollutants. The methodology used to monitor particulate matters (PM2.5 and PM10) in ambient air is discussed below.

  The Dust monitor automatically measures and records airborne particulate concentration levels in terms of mass concentration (in milligrams or micrograms per cubic meter) using the principle of beta ray attenuation. Beta rays (electrons with energies in the 0.01 to 0.1 MeV range) are attenuated according to an approximate exponential function of particulate mass when they pass through deposits on a filter tape. Filter tape samplers measure the attenuation through unexposed and exposed segments of tape. The blank-corrected attenuation readings are converted to mass concentrations.

  A known volume of air is drawn through a size-selective inlet, which can be configured to measure $PM_{2.5}$ or PM_{10} and deposited onto the auto-advancing filter tape. The combined measurement of mass and air volume are used to obtain the mass concentration readings. Supplied with user-selectable data logging options, concentrations can be reported in actual or standard conditions.

  Instrument

The thermos Scientific Model 5014i Continuous Ambient Particulate Monitor continuously measures the mass concentration of suspended and refined particulates ($PM_{2.5}$ and PM_{10}) using beta attenuation technology.

The main key features of this analyzer are:

- USEPA approved PM_{10} (EQPM – 1102 – 150) and $PM_{2.5}$ (EQPM – 0609 – 183) (Ref. https://www3.epa.gov/ttn/amtic/criteria.html);
- Provides real-time hourly and daily averages;
- Filter tape that advances in a continuous pattern instead of a stepwise pattern; and
- Contains important alerts to ensure safe operation and prevent equipment damage.

Site Selection

The sampling site; located in the coordinates (31Á52'47.24"N, 36Á12'6.94"E); **Figure 14** below illustrates the monitoring location that was carried out during January 30 - February 6, 2017.

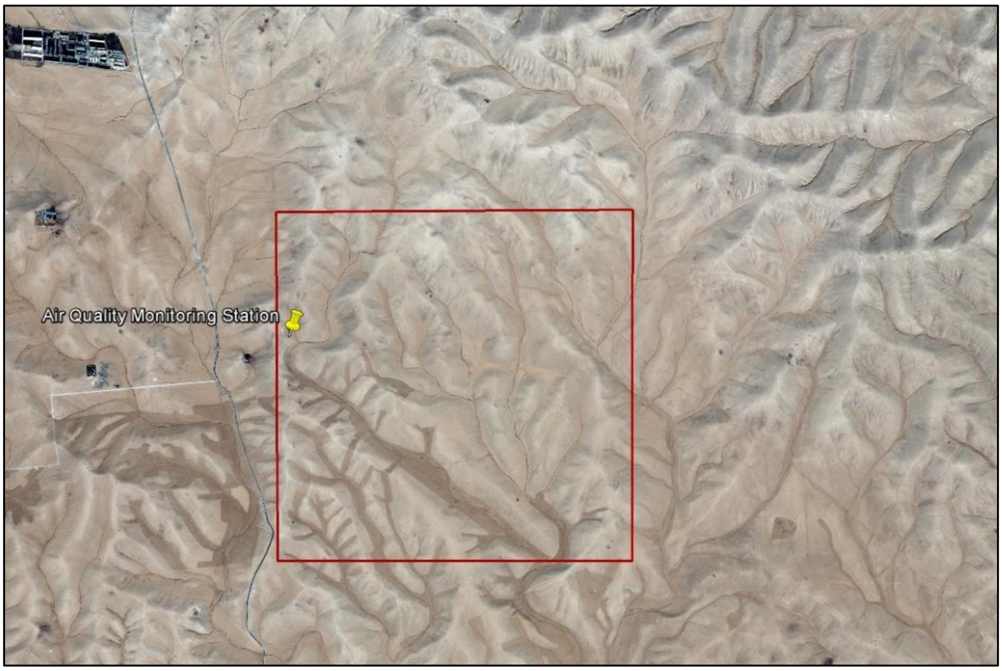


Figure 14: Air Quality Monitoring Location

The monitoring site should be representative of the surrounding area. As a minimum, the following guidelines were met during site selection of the monitoring site:

- The flow around the inlet sampling probe should be unrestricted without any obstructions affecting the air flow in the vicinity of the sampler;

- The inlet sampling point should be between 2.0 m (the breathing zone) and 4.0 m above the ground level;

- The inlet probe should be positioned away from the near vicinity of sources to avoid drifting air pollution plumes; and

- The samplers exhaust outlet should be positioned so that recirculation of exhaust air to the sample inlet is avoided.

Basic siting criteria for the placement of ambient air samplers are documented in (Table 1) as stated in 40 CFR 58, Appendix E (Available at https://www.law.cornell.edu/cfr/text/40/appendix-E_to_part_58).

Table 11: Minimum siting requirements

Scale	Height above ground level (m)	Distance from (m)		
		Supporting structures[1]	Trees	Roads[2]
Micro	2 – 7	> 2	> 10	2 – 10
Middle	2 – 7	> 2	> 10	10 – 80
Large or neighbourhood	2 – 15	> 2	> 10	80 - 150

[1] horizontal distance

[2] Spacing from roads varies with traffic

Existing Environment

Wind speed is of key importance in a dispersion of air pollutants; pollutant concentrations are inversely related to wind speed. Thus, concentrations will be greatest under very calm conditions and low wind speeds when movement of air is restricted.

The WRPLOT View Version (7.0.0) by Lakes Environmental Software was used to display the wind rose and wind direction frequency in the period of monitoring. Hourly wind data was recorded for the monitoring period and reformatted in a SCRAM format to be processed by the software.

A wind rose plots (Figures 1 and 2) showed that the prevailing winds blow from the northwest much of the time and comprise about 45% of all hourly wind directions. The maximum velocity range recorded was (8.8 – 11.1 m/s), and stayed 1.0% of the total time and the frequency of calm conditions is 0 %, while the highest frequency was 35.4% for the ranges (2.1 – 3.6) m/s and (3.6 – 5.7) m/s.

Wind speeds up to and including 1 knot (0.51444 m/s) are considered to be calm. Calm winds (wind speed 00) are not shown on the wind rose plots because they have no direction.

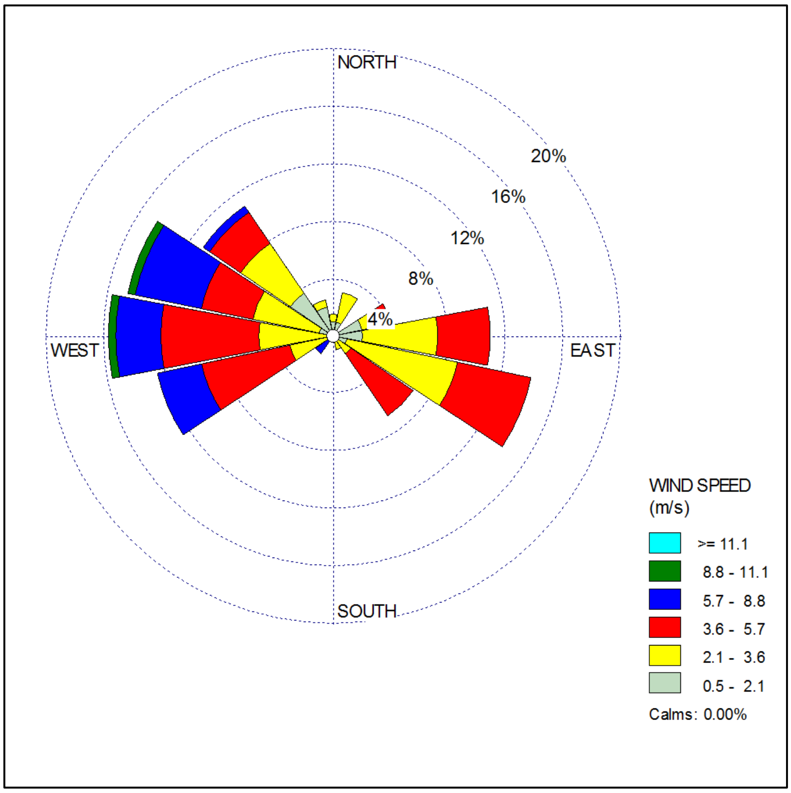


Figure 15: Wind rose plot for monitoring period

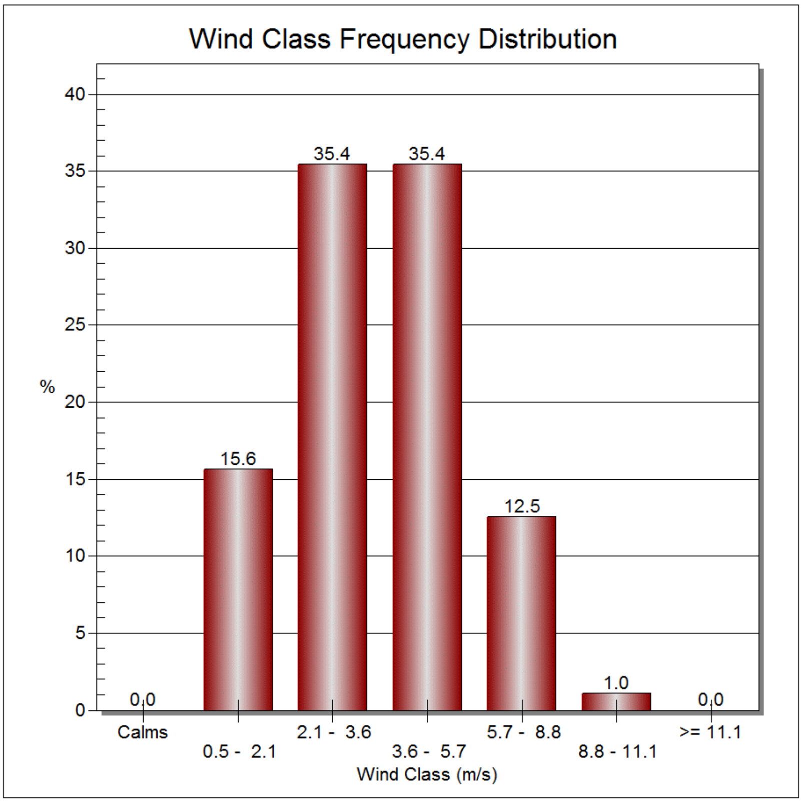


Figure 16: The wind class frequency distribution

Environmental Legislation

Air quality significant criteria are assessed on the basis of compliance with the appropriate standards or limit values. The ambient air quality standards are defined as the levels of air quality protect the public health and public welfare from any unknown anticipated adverse effects. The Jordanian standard for ambient air quality JS1140/2006 is shown below.

Table 12: JS1140/2006 Ambient Air Quality Standards for Particulate Matters

Pollutant	JS 1140/2006		Max. Allowable Exceedances	
	24-hour	Annual	24-hour	Annual
PM$_{2.5}$	65 Õg/mį	15 Õg/mį	3 times a year	None
PM$_{10}$	120 Õg/mį	70 Õg/mį	3 times a	None

The ambient air quality monitoring results are shown below and the hourly raw data and graphs are provided in **APPENDIX B.**

Main Findings

As shown in **Table 13** below the currently proposed region has no significant air emission sources and the existing levels of Particulate Matters (PM2.5 & PM10) are well below the national standard JS1140/2006.

The daily concentrations of PM$_{10}$ ranged between 30.910 µg/m^3 and 57.893 µg/m^3 with no exceedance to the Jordanian standards limit of 120 µg/m^3. On the other hand, the daily concentrations of the PM$_{2.5}$ were between 8.194 µg/m3 and 13.095 µg/m^3; therefore, no exceedances were observed to PM$_{2.5}$ daily limit stated in the Jordanian standards

Table 13: Daily average ambient monitoring of PM10 & PM2.5 at the project monitoring location, January 30 to February 6 2017

Date / Time	**Result (Õg/m^3)**		**Legal Limits (Õg/mį)**		**Test Method**
	[N] PM$_{2.5}$	**[N] PM$_{10}$**	**PM$_{2.5}$**	**PM$_{10}$**	
30/01/2017	11.240	57.560	65	120	JS 1140-2006
31/01/2017	11.600	57.893			
01/02/2017	8.782	40.127			
02/02/2017	12.104	38.624			
03/02/2017	12.082	30.910			
04/02/2017	8.194	32.777			
05/02/2017	12.557	51.890			
06/02/2017	13.095	55.301			
Monitoring Location Coordinates within project site (31Á52'47.24"N, 36Á12'6.94"E)					

[N] Test out of scope of accreditation

The test results relate only to the items tested

5.2.3 Noise Levels

Spot noise monitoring was carried out at the project location on December 26th 2016 in order to determine the ambient baseline sound level profile. Monitoring was undertaken using data logging Sound Level Meter Model Extech HD600 (Hand Held Type II noise meter).

5.2.3.1 Methodology

The noise meter was hand-held and positioned such that the microphone, equipped with a windshield, was pointing opposite to wind direction. The noise meter was set to automatically record a range of noise related parameters over a period less than 10minutes, Values were then calculated for L_{Aeq}, LA_{max}, LA_{min} (i.e. the average, maximum and minimum A-weighted Sound Pressure Level of the residual noise in dBA) for the monitoring period.

5.2.3.2 Allowable limits

- Allowable noise limits are governed by the Jordanian instructions for elimination of noise for the year 2003, which defines the maximum allowed noise limits for the different land-use types during day time and night time as listed in **Table 7** These limits are applicable for ambient noise outside workplace, for noise limits within workplace; instructions issued by Ministry of Labor are adopted.
- The project area is considered as an industrial area; therefore, the measured noise level will be compared with limits set for Industrial areas.

5.2.3.3 Measured Noise Level

A short-term noise monitoring program was conducted at the project area, which aims at determining the existing noise level at the proposed project site in order to assess the expected impacts of the project activities on the surrounding area during construction and operation phases. Two central monitoring locations were chosen as illustrated in **Figure 17.**

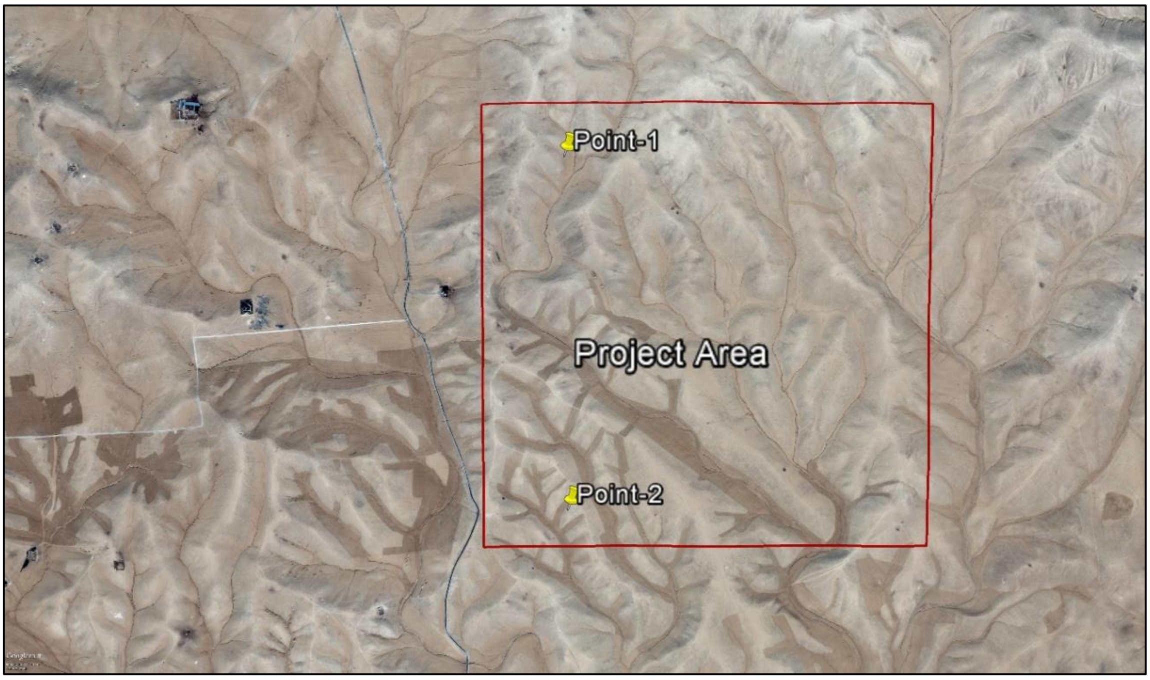


Figure 17: Noise Monitoring Location

The results of noise level monitoring are shown in **Figure 18** and **Figure 19** below. The measurements were carried out during day time while the wind speed was light. Nearby road vehicles movement is considered as the main noise emission sources at noise monitoring location. As can be seen from these data, LA_{avg} is within the allowable limits, the maximum levels recorded whereas a vehicle passed into the road, however these maximum levels are not exceeding the allowable limits at the monitoring location.

Any additional noise generated from the Project construction activities need to be taken into account and appropriate mitigation of adverse health impacts applied, such as wearing protective ear muffs or plugs by workers during construction and operation. These will be discussed in further detail in the impact assessment and mitigation section.

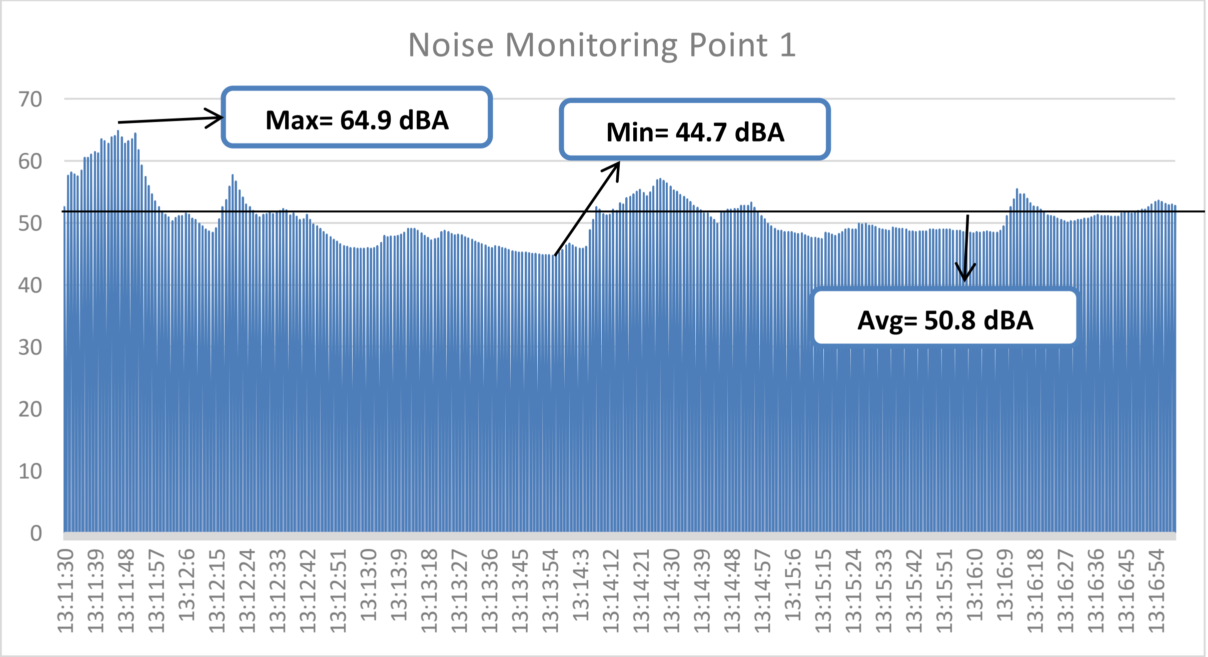


Figure 18: Results of Noise Monitoring Point 1

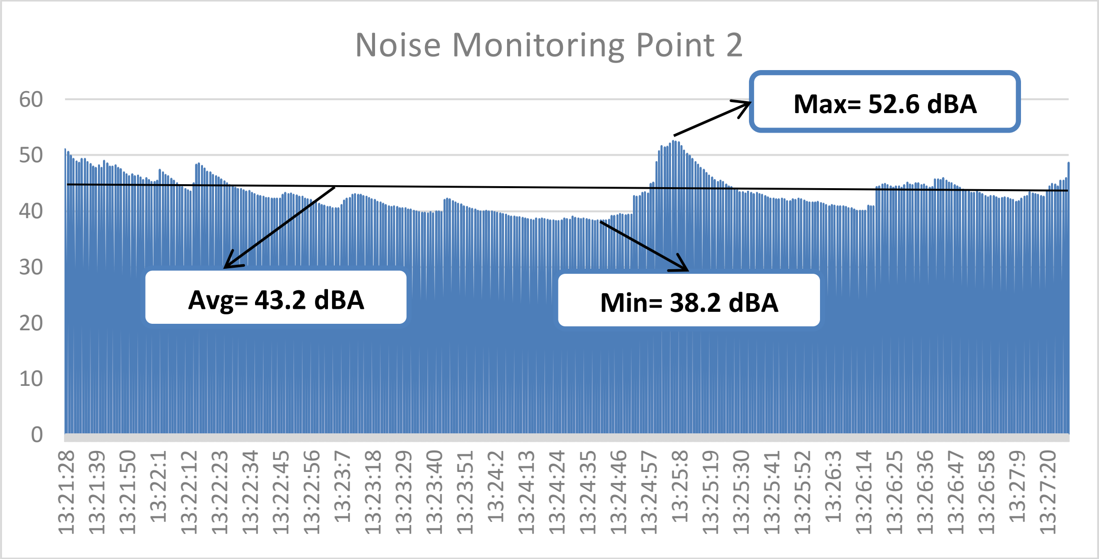


Figure 19: Results of Noise Monitoring Point 2

5.2.4 Topography and Soil

Jordan is located about 80 km east of the Mediterranean Sea, bounded by Syria to the north, Saudi Arabia and the Gulf of Aqaba to the south (which is Jordan's only outlet to the sea), Iraq to the east and Palestine to the west. The area of landmass is approximately 88,778 km^2, while the area of water bodies is approximately 482 km^2 which includes the Dead Sea and the Gulf of Aqaba. Topography, morphology and soil are interrelated physical characteristics which are described in the following paragraphs (MoEnv, 2006).

Jordan is divided into three main topographic regions. These three regions, from east to west, are:

- **The Jordan Rift Valley:** A fault that extends from Lake Tiberias in the north to the Gulf of Aqaba in the south. The Jordan Valley, the Dead Sea and Wadi Araba are located in this zone (MoEnv, 2006).
- **The Mountainous Region:** forms the eastern boundary of the Rift Valley and extends from Lake Tiberias to the Gulf of Aqaba. Mountains in this zone have elevations ranging from 1,200 to 1,500 meters above sea level. The region has a relatively mild climate with winter rains. The higher elevations receive occasional winter snows. Average annual precipitation in the zone varies from 600 mm in the north, to 100 - 300 mm in the south. Ninety percent of Jordan's population live in this zone (MoEnv, 2006).
- **The Eastern Desert** (also known as the Badia) lies east of the Mountainous Region and covers 80 percent of the land area of Jordan. This region is characterized by a dry, hot climate. Most of the zone is flat or hilly, but in the south lays the two highest mountains in Jordan, namely Rum Mountain (1,753 m) and Umm ad Dami (1,854 m) (MoEnv, 2006).

As shown in **Figure 20,** the project area falls in a transitional region between the Mountainous Region and the Eastern Desert Region. This region is called Steppe Topographical Region, forming the Eastern boundary of The Mountainous Region and extending from the eastern boundary of Irbid to the Eastern boundary of Aqaba. The region is characterized with gentle slopes in most parts and hilly in others.

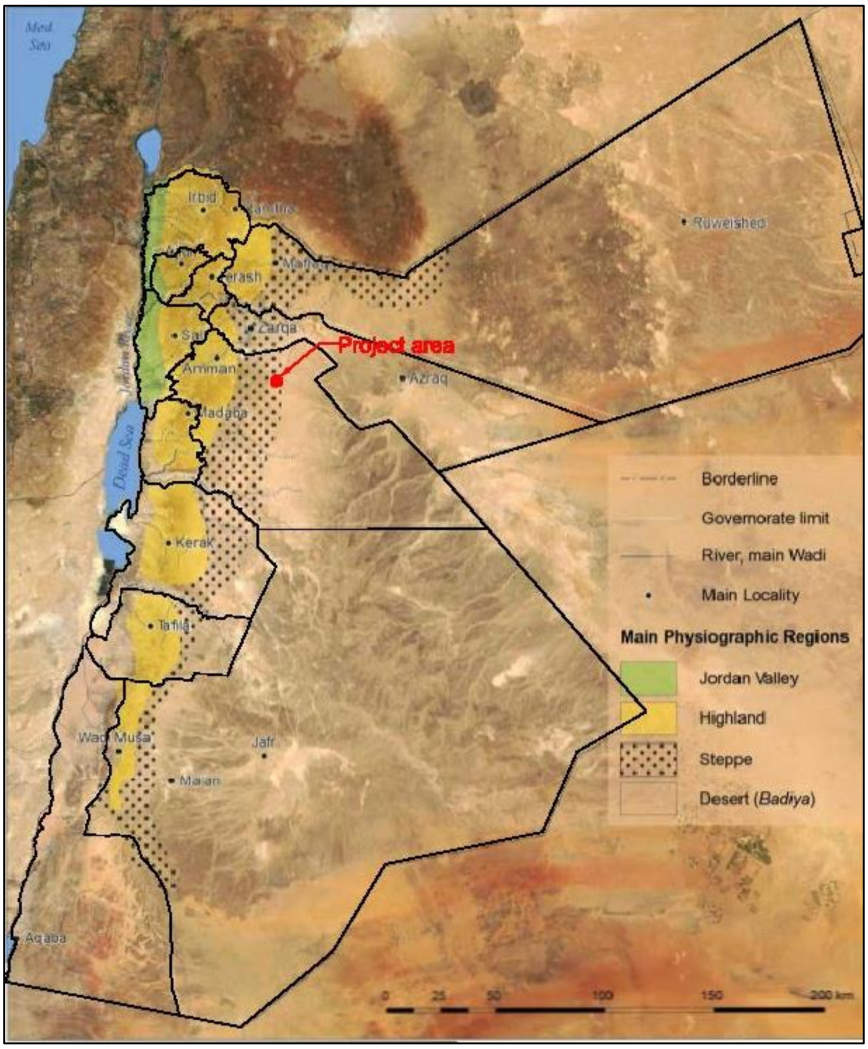

Med. Sea
Irbid
Ramtha
Mafraq
Jerash
Zarqa
Salt
Amman
Project area
Azraq
Ruweished
Madaba
Jordan River
Dead Sea
Kerak
Tafila
Wadi Musa
Jafr
Maan
Aqaba
Borderline
Governorate limit
River, main Wadi
Main Locality
Main Physiographic Regions
Jordan Valley
Highland
Steppe
Desert (Badiya)
0
25
50
100
150
200 km

Figure 20: Physiographic Regions in Jordan

A topographic survey was conducted for the project area on June 2016. The results of this survey have shown that the project area is considerably moderately sloped in most parts and more gentle slopes in some parts of the project area as shown in **Figure 21** below.

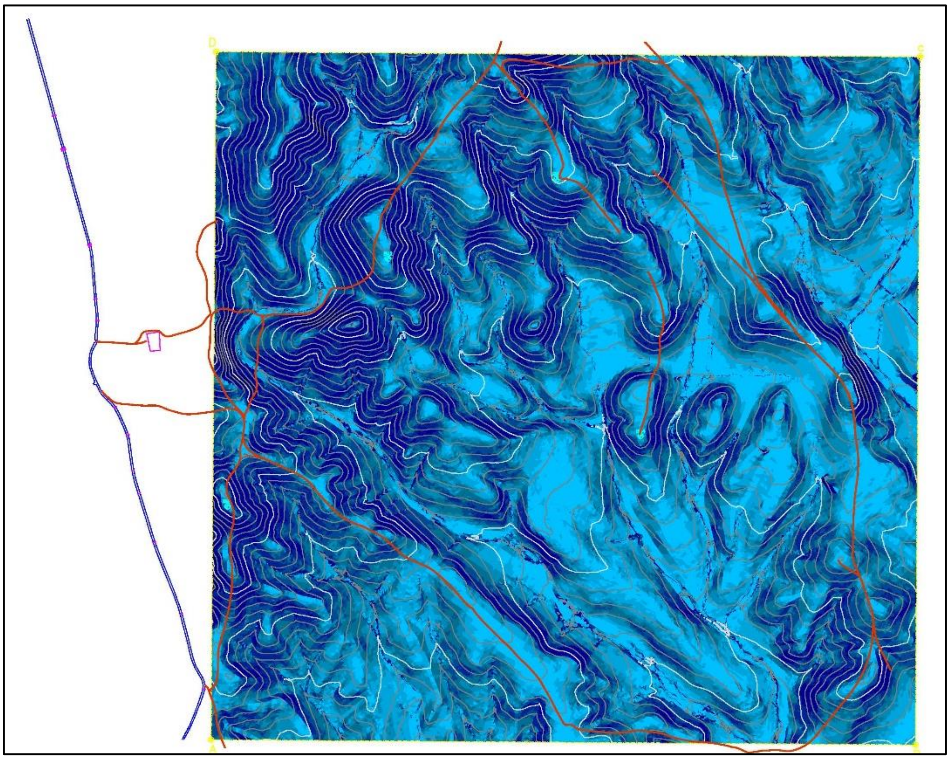
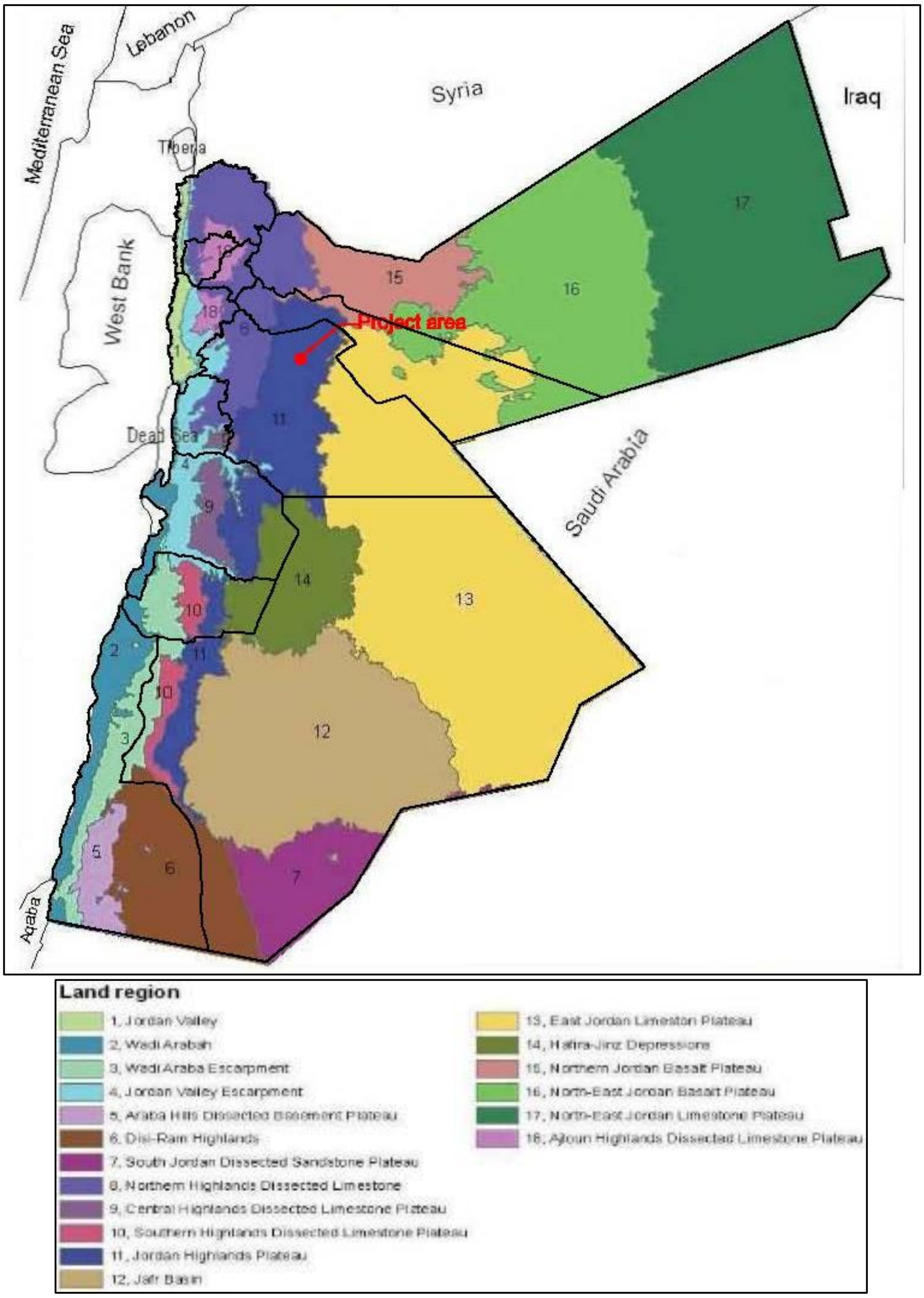


Figure 21: Project Area Topographic Map

Furthermore, Jordan is split into 18 land regions as shown in **Figure 22** below, where each land region is characterized by altitude, physiography, dominant soil type, vegetation and land use; the Project area falls in land region no. 11 which is Jordan Highland Plateau. The major soil types are transitional xerochreptic subgroups of calciorthids and camborthids. (Jordan soils and land management, 2006).

- Camborthids Group: Camborthids are Aridisols that have an ochric epipedon and a cambic subsurface horizon. Most Camborthids are deep and found on flat or gentle darker than the topsoil. These soils have much less calcium carbonate content than the calciorthids. The extent of these soils in Jordan is very limited compared to other Aridisols, where crusting due to high silt content is one of the characteristics of these soils.
- Calciorthids Group: These are Aridisols with an ochric epipedon and subsurface calcic horizon. They contain high amounts of lime in the subsoil and in the parent material. Sometimes the calcic horizon becomes indurate, decreasing the rootability of the soil. These soils are distributed in the steppe region where rainfall is very low.


Mediterranean Sea
Lebanon
Syria
Iraq
Tiberia
West Bank
Dead Sea
Saudi Arabia
Aqaba
Project area
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Land region
1, Jordan Valley
2, Wadi Arabah
3, Wadi Araba Escarpment
4, Jordan Valley Escarpment
5, Araba Hills Dissected Basement Plateau
6, Disi-Ram Highlands
7, South Jordan Dissected Sandstone Plateau
8, Northern Highlands Dissected Limestone
9, Central Highlands Dissected Limestone Plateau
10, Southern Highlands Dissected Limestone Plateau
11, Jordan Highlands Plateau
12, Jafr Basin
13, East Jordan Limeston Plateau
14, Hafira-Jinz Depressions
15, Northern Jordan Basalt Plateau
16, North-East Jordan Basalt Plateau
17, North-East Jordan Limestone Plateau
18, Ajloun Highlands Dissected Limestone Plateau

Source: Jordan soils and land management, 2006

Figure 22: Land Regions Distribution in Jordan

Soils in the study area are highly calcareous and the predominant land use is open grazing rain-fed cultivation such as barley. Wild species of barley, vetch, onion and Aegilops can be found in Amman Airport agriculture.

As a result, the dominant soils in the project area are calcareous clay with some chalk whitish brown to red soils with some rocks and hand dug holes located in the higher elevations as presented in **Figure 23** and **Figure 24** respectively. **Figure 25** and **Figure 26** presents thick soils at both sides of the stream scoured by flood waters.

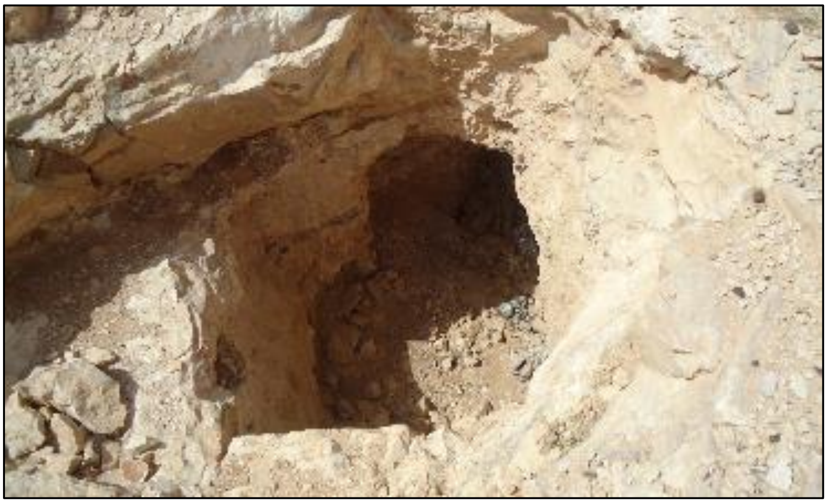


Figure 23: Dominant Soil and Rocks in Higher Elevations of the Project Area

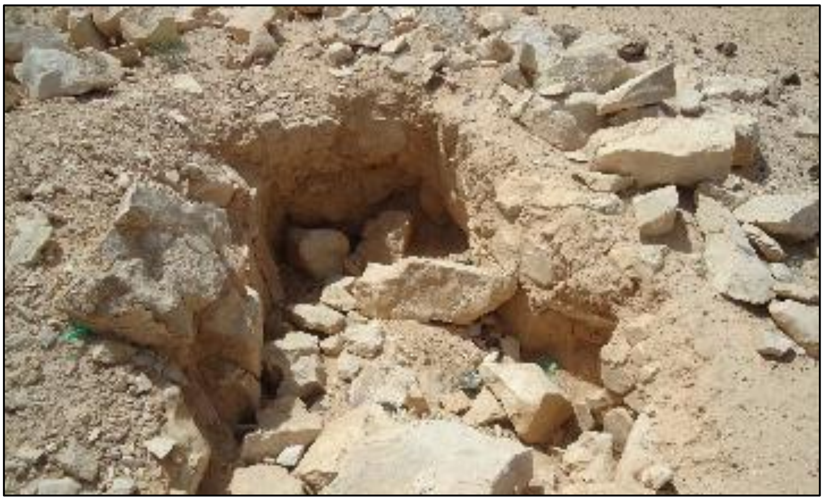


Figure 24: Hand Dug Holes in Higher Elevations of the Project Area

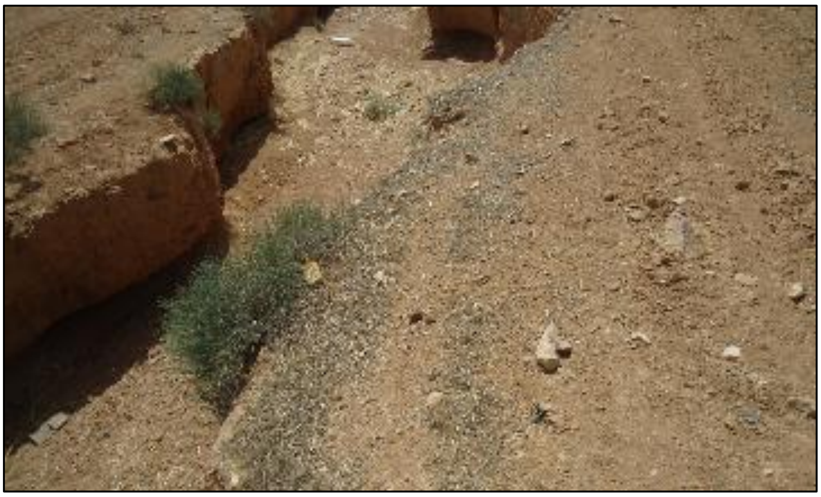


Figure 25: Thicker Soil in Lower Elevations of the Project Area (Wadi Sides)

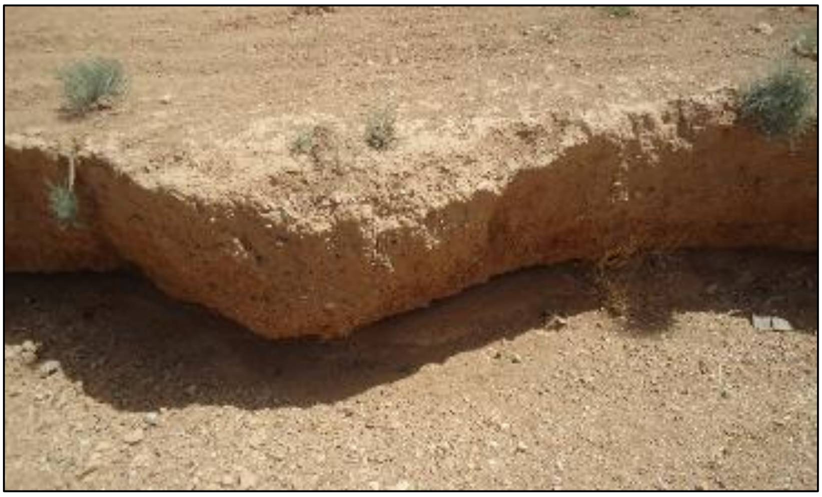


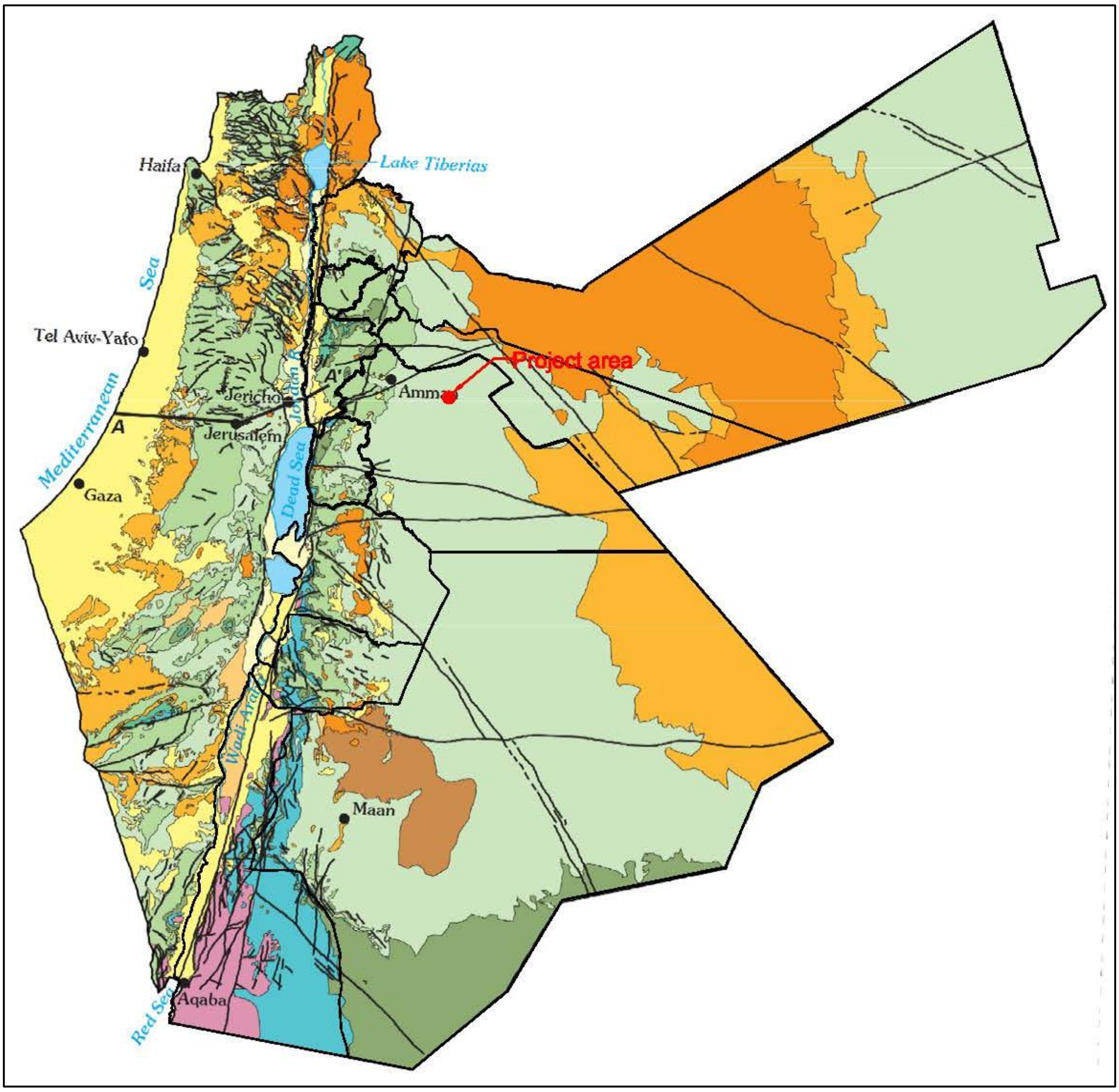
Figure 26: Thicker Soil in Lower Elevations of the Project Area (Wadi Sides)

5.2.5 Geomorphology and Geology

Jordan occupies the north-west part of the Arabian plate where most of the country is located within the stable shelf part of the plate (Petroleum and Oil shale Directorate, NRA, 2006). The geology in Jordan includes basalt, sandstone, limestone, chalk, marl and chert and various other Pleistocene and Holocene deposits of alluvial and Aeolian deposits.

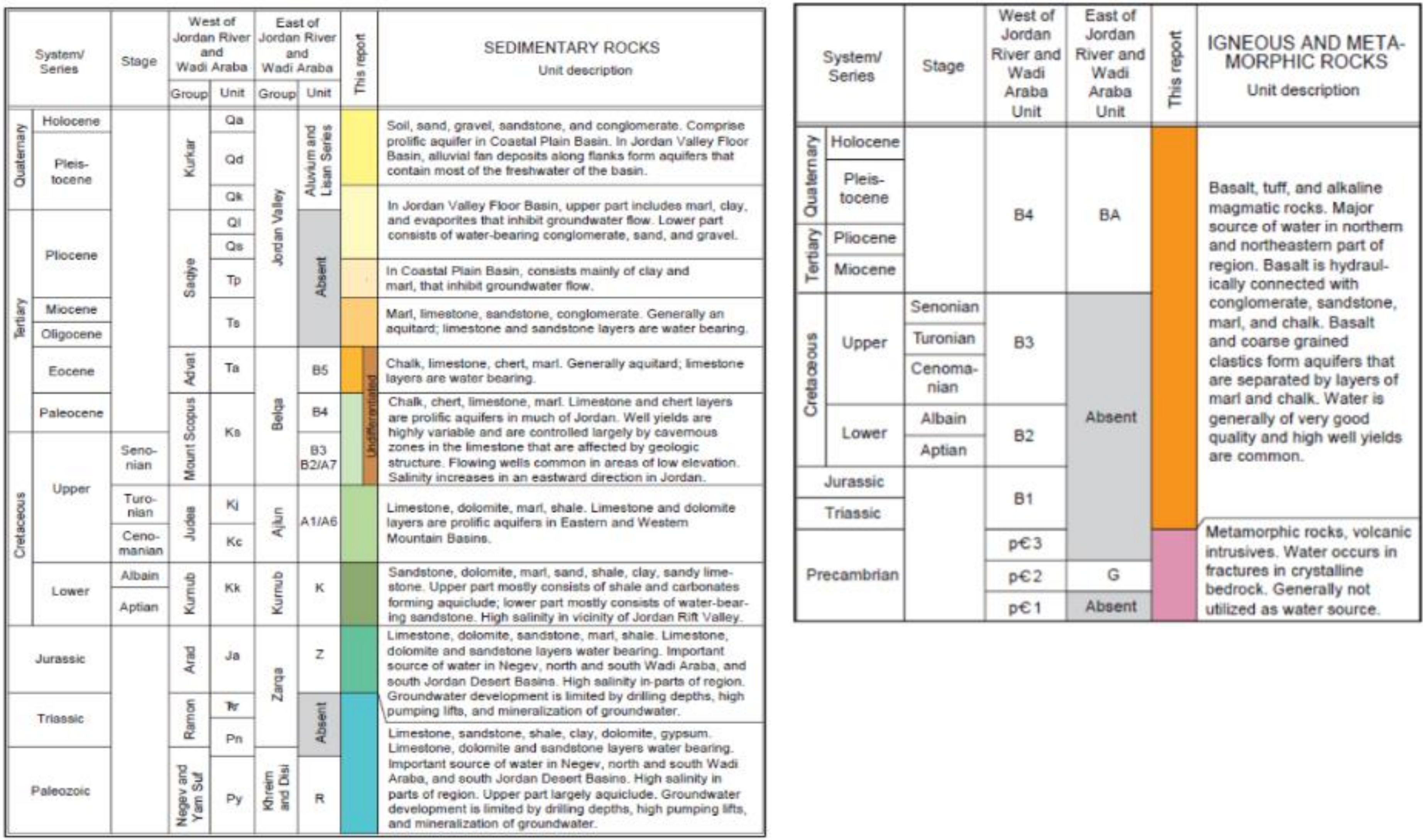
The oldest rocks in Jordan are Precambrian in age and crop out around Aqaba and Wadi Arabah. Magnificent outcrops of the Palaeozoic sandstone in southern Jordan are present along the eastern shoulder of Wadi Arabah until the north-east tip of the Dead Sea.

The geologic map presented below shows the differing geologic features, landforms and hydrologic conditions from one part of the country to another. The detailed legend of the geologic map is also shown in **Figure 27** explaining the rock units, their age, lithology and water bearing properties.


Haifa
Lake Tiberias
Sea
Tel Aviv-Yafo
Mediterranean
A
A'
Jericho
Jerusalem
Jordan R.
Dead Sea
Amman
Project area
Gaza
Wadi Araba
Maan
Aqaba
Red Sea

Source: U.S Geological Survey, 1998

Figure 27: Geology of Jordan



System/ Series		Stage	West of Jordan River and Wadi Araba		East of Jordan River and Wadi Araba		This report	SEDIMENTARY ROCKS Unit description
			Group	Unit	Group	Unit		
Quaternary	Holocene		Kurkar	Qa	Jordan Valley	Aluvium and Lisan Series	🟨	Soil, sand, gravel, sandstone, and conglomerate. Comprise prolific aquifer in Coastal Plain Basin. In Jordan Valley Floor Basin, alluvial fan deposits along flanks form aquifers that contain most of the freshwater of the basin.
	Pleis-tocene			Qd				
				Qk			🟨	In Jordan Valley Floor Basin, upper part includes marl, clay, and evaporites that inhibit groundwater flow. Lower part consists of water-bearing conglomerate, sand, and gravel.
Tertiary	Pliocene		Saqiye	Ql		Absent		
				Qs				
				Tp			🟨	In Coastal Plain Basin, consists mainly of clay and marl, that inhibit groundwater flow.
	Miocene			Ts			🟧	Marl, limestone, sandstone, conglomerate. Generally an aquitard; limestone and sandstone layers are water bearing.
	Oligocene							
	Eocene		Advat	Ta	Belqa	B5	🟧 Undifferentiated	Chalk, limestone, chert, marl. Generally aquitard; limestone layers are water bearing.
	Paleocene		Mount Scopus	Ks		B4	🟩	Chalk, chert, limestone, marl. Limestone and chert layers are prolific aquifers in much of Jordan. Well yields are highly variable and are controlled largely by cavernous zones in the limestone that are affected by geologic structure. Flowing wells common in areas of low elevation. Salinity increases in an eastward direction in Jordan.
Cretaceous	Upper	Seno-nian				B3 B2/A7		
		Turo-nian	Judea	Kj	Ajlun	A1/A6	🟩	Limestone, dolomite, marl, shale. Limestone and dolomite layers are prolific aquifers in Eastern and Western Mountain Basins.
		Ceno-manian		Kc				
	Lower	Albain	Kurnub	Kk	Kurnub	K	🟩	Sandstone, dolomite, marl, sand, shale, clay, sandy limestone. Upper part mostly consists of shale and carbonates forming aquiclude; lower part mostly consists of water-bearing sandstone. High salinity in vicinity of Jordan Rift Valley.
		Aptian						
Jurassic			Arad	Ja	Zarqa	Z	🟩	Limestone, dolomite, sandstone, marl, shale. Limestone, dolomite and sandstone layers water bearing. Important source of water in Negev, north and south Wadi Araba, and south Jordan Desert Basins. High salinity in-parts of region. Groundwater development is limited by drilling depths, high pumping lifts, and mineralization of groundwater.
Triassic			Ramon	TR		Absent	🟦	Limestone, sandstone, shale, clay, dolomite, gypsum. Limestone, dolomite and sandstone layers water bearing. Important source of water in Negev, north and south Wadi Araba, and south Jordan Desert Basins. High salinity in parts of region. Upper part largely aquiclude. Groundwater development is limited by drilling depths, high pumping lifts, and mineralization of groundwater.
				Pn				
Paleozoic			Negev and Yam Suf	Py	Khreim and Disi	R		

System/ Series		Stage	West of Jordan River and Wadi Araba Unit	East of Jordan River and Wadi Araba Unit	This report	IGNEOUS AND METAMORPHIC ROCKS Unit description
Quaternary	Holocene		B4	BA	🟧	Basalt, tuff, and alkaline magmatic rocks. Major source of water in northern and northeastern part of region. Basalt is hydraulically connected with conglomerate, sandstone, marl, and chalk. Basalt and coarse grained clastics form aquifers that are separated by layers of marl and chalk. Water is generally of very good quality and high well yields are common.
	Pleis-tocene					
Tertiary	Pliocene					
	Miocene					
Cretaceous	Upper	Senonian	B3	Absent		
		Turonian				
		Cenoma-nian				
	Lower	Albain	B2			
		Aptian				
Jurassic			B1			
Triassic						
Precambrian			p€3		🟪	Metamorphic rocks, volcanic intrusives. Water occurs in fractures in crystalline bedrock. Generally not utilized as water source.
			p€2	G		
			p€1	Absent		

Figure 28: Generalized Geologic Units and Water-Bearing Properties

The project area belongs to the B4 and B3,B2/A7 formations, which fall within the Tertiary and Cretaceous systems including the Paleocene and Upper Cretaceous – [however it is expected that the project area has the characteristics of the B3 (Muwaqqar) formation]. In terms of sedimentary rocks these formations consist of chalk, chert, limestone and mart. Limestone and chert layers are prolific aquifers in much Jordan. (U.S Geological Survey, 1998).

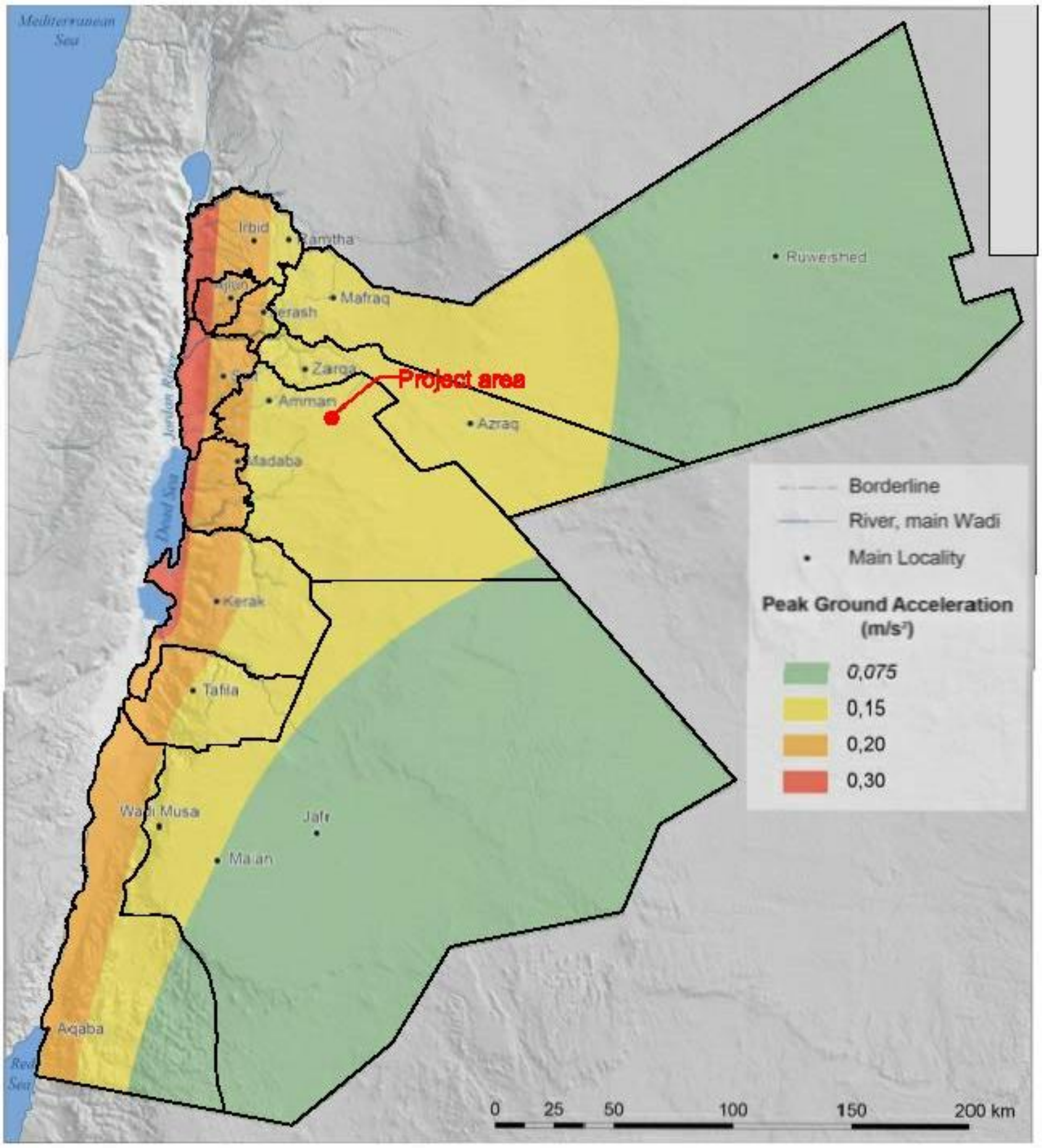
5.2.6 Tectonic Settings

The geological structure of Jordan shows the effect of several phases of deformation since the Cambrian period. The crustal movement that affected the country has resulted in gentle, regional tilting, uplift and subsidence and a combination of faulting and folding (Petroleum and Oil shale Directorate, NRA-2006).

Jordan occupies the northwest part of the Arabian plate where most of the country is located within the stable shelf part of the plate. The late Proterozoic (approximately between 2500 Ma to 542.0 Ñ 1.0 Ma) was characterized by Arabian Shield cratonization and island arcs accretions with basement sutures indicating east-west compressional forces (Petroleum and Oil shale Directorate, NRA-2006).

Overall, the rate of current seismic activity in Jordan, including the project area, is minor with many of the strong seismic events located along the axis of the Dead Sea Rift.

As shown in **Figure 29** the project site lies within the light magnitude of Richter's scale. Therefore, if an earthquake was induced in that area, it is anticipated that the intensity will fall between the 4.0 to 4.9 magnitudes according to Richter's scale. The light magnitude is often felt with rattling and shaking noises, but usually causes no significant damages (Richter Scale Explained, 2011).


Mediterranean Sea
Irbid
Ramtha
Ajlun
Jerash
Mafraq
Zarqa
Project area
Salt
Amman
Azraq
Ruweished
Jordan River
Madaba
Dead Sea
Kerak
Tafila
Wadi Musa
Jafr
Ma'an
Aqaba
Red Sea
Borderline
River, main Wadi
Main Locality
Peak Ground Acceleration (m/s²)
0,075
0,15
0,20
0,30
0
25
50
100
150
200 km

Source: Atlas of Jordan. 2014

Figure 29: Seismic Hazard Distribution Map of Jordan

5.2.7 Water Resources

Jordan is classified as a country with scarce water resources. The available water resources per capita are falling due to population growth and are anticipated to fall from less than 160 m¡/capita/year at present to about 90 m¡/capita/year by 2025, putting Jordan in the category of absolute water shortage. Due to the limited water resources in Jordan, the demands and uses of water are exceeding renewable water supply, as a result of major contributing factors, such as the unsustainable use of groundwater through overdrawing of highland aquifers which leads to the gradual depletion of groundwater resources (MoEnv, 2006).

The water uses in Jordan are divided in four main uses, in the following each use with the percentage of usage from the total affordable quantity of water resources:

- Irrigation , 70%,
- Municipal , 24%
- Industrial, 5%
- Touristic, 1%.

In terms of renewable water resources; groundwater, base flow and flood flow are considered conventional resources while treated wastewater, brackish and desalinated water are considered non-conventional resources. Highly variable seasonal rainfall is the main source of water in the Country. Significant amounts of rainfall (i.e. above 200 mm/a) are limited to the highlands in the north-western part presenting the long-term average of annual precipitation. Around 5% of rainwater infiltrates into the ground, thereby replenishing groundwater aquifers. The amount transformed into direct flow is slightly smaller. The largest share of over 90% of annual rainfall is lost to evapo-transpiration.

Besides the indigenous water resources the country's renewable water resources are replenished through regional watercourses and trans-boundary groundwater flow (GTZ, National Water Master Plan, 2004). Water desalination, on the other hand, could be considered a future source of water supply.

Below is a description of surface and groundwater hydrology, existing water pollution discharges, and receiving water quality for water resources related to location of the project.

5.2.7.1 Surface Water

Surface water basins in Jordan are depicted in **Figure 30.** According to this figure, the project area is located within Azraq basin.

Azraq Basin is an extensive inland drainage system lying in the steppe and desert to the east of Amman. The basin covers over 12,710 km^2 which is not entirely in Jordan; stretching from the lava peaks of Jebel Druze in southern Syria to the Wadi Sirhan in northern Saudi Arabia. This basin is situated between 250 to 400 E and 055 to 230 N (according to Palestine Grids). Azraq oases lies at its center and were formed around copious springs and an extensive playa lake which fills after winter storms (Climate Change Adaptation: a case study in Azraq Basin, Jordan, 2014)

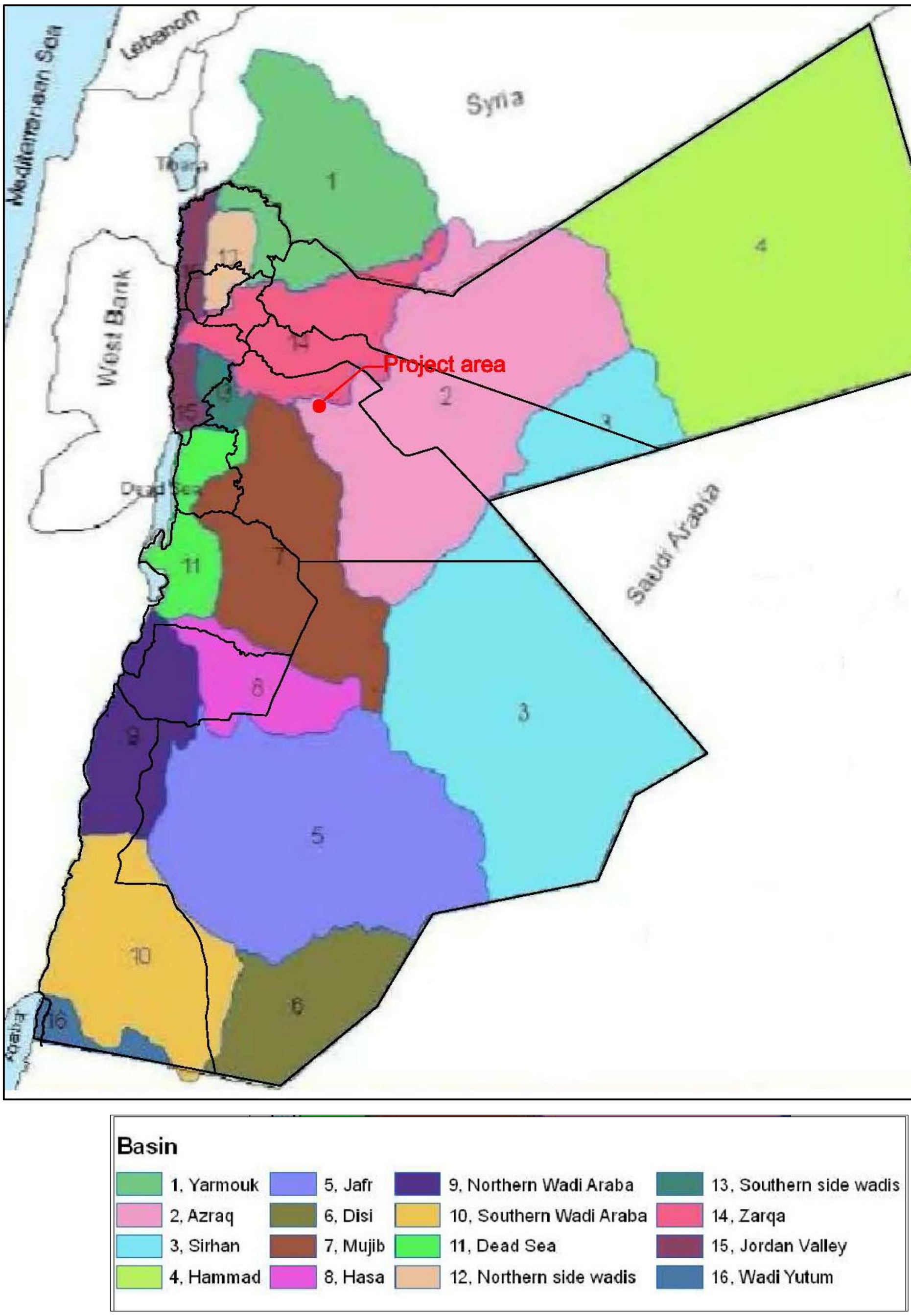

Mediterranean Sea
Lebanon
Syria
Iraq
West Bank
Dead Sea
Saudi Arabia
Project area
Aqaba
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Basin
1, Yarmouk
2, Azraq
3, Sirhan
4, Hammad
5, Jafr
6, Disi
7, Mujib
8, Hasa
9, Northern Wadi Araba
10, Southern Wadi Araba
11, Dead Sea
12, Northern side wadis
13, Southern side wadis
14, Zarqa
15, Jordan Valley
16, Wadi Yutum

Figure 30: Surface Water Basins Distribution in Jordan

A surface hydrology study was conducted for the project area during June 2016, which studied the storm water based on the existing topographic condition. The following are the study findings:

Catchment Characteristics

The study area is located in the South east of Amman; the Capital city of Jordan, with a distance of about 25km, and to the Northeast of Al Muwaqqar with a distance of about 11km. Most parts of the project are located in an almost flat to gentle sloppy area. The elevations of the wadis and the run-on area are from about 800 m to about 900 m above the sea level (ASL). The study area consists of a single plot with a total area of about 6 km^2.

The catchments of the wadis draining in the study area consist of 2 small wadis where the first is having an area of about 0.3 km^2 and the area of the second is about 1.9 km^2 as shown in **Figure 31**.

For the delineation of the catchment areas related to the drainage of the proposed hydraulic structures, actual survey of the contour intervals of 0.25 m. This information was found satisfactory to delineate the catchments.

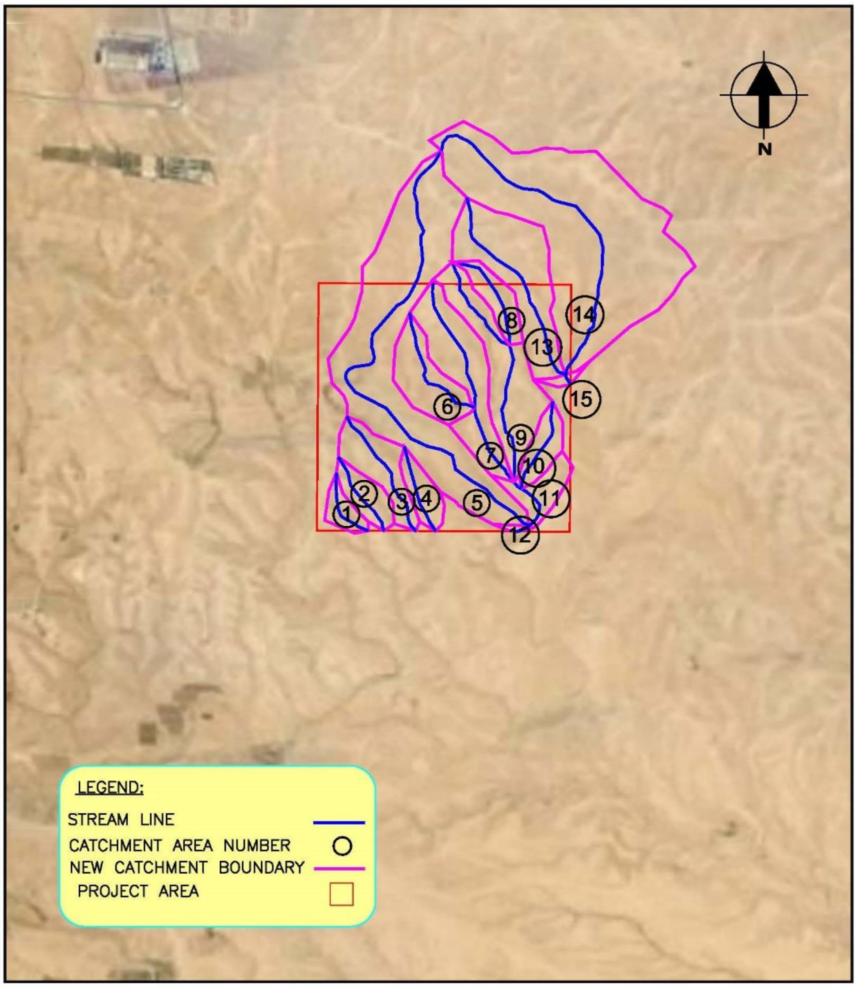


Figure 31: Catchments in the Study Area

Using the AutoCAD software, the areas of these catchments have been measured. The characteristics of the catchments will include the highest elevation (H1), lowest elevation (H2), longest wadi course and the general slope (S) of the catchment itself **Table 14** below shows the characteristics of catchments.

Table 14: Characteristics of Catchments

Area No.	Area (m^2)	Area (km^2)	ΔH	L (m)	L (km)	Slope %
1	34100.8	0.034	11.8	324.0	0.32	0.036
1-a	15776.1	0.016	8.0	175.4	0.18	0.046
2	206880.6	0.207	31.1	806.6	0.81	0.038
3	330053.4	0.330	32.0	1231.6	1.23	0.026

Area No.	Area (m^2)	Area (km^2)	ΔH	L (m)	L (km)	Slope %
4	120326.9	0.120	20.4	738.5	0.74	0.028
4-a	53383.7	0.053	11.3	438.4	0.44	0.026
4-b	26722.6	0.027	10.0	247.0	0.25	0.040
5	2169177.9	2.169	98.5	5077.4	5.08	0.019
6	482003.2	0.482	39.0	1413.2	1.41	0.028
7	1148976.1	1.149	53.7	2173.7	2.17	0.025
8	246812.4	0.247	46.8	1233.3	1.23	0.038
8-a	218936.4	0.219	46.8	1150.0	1.15	0.041
9	952330.5	0.952	64.5	2446.7	2.45	0.026
10	233203.8	0.233	22.3	1035.7	1.04	0.021
11	2574877.6	2.575	69.0	2971.5	2.97	0.023
12	4744055.5	4.744	69.8	3159.2	3.16	0.022
13	840388.2	0.840	76.0	2208.0	2.21	0.034
14	2623175.3	2.623	96.0	3478.5	3.48	0.028

Topography of the Catchment

The topography of the major catchment is characterized by considerably moderately sloped in all parts of the catchment and more gentle slopes in some parts of the project area. **Figure 32** shows the gentle terrain parts of the project area whilst **Figure 33** shows rough terrain parts of the project area.

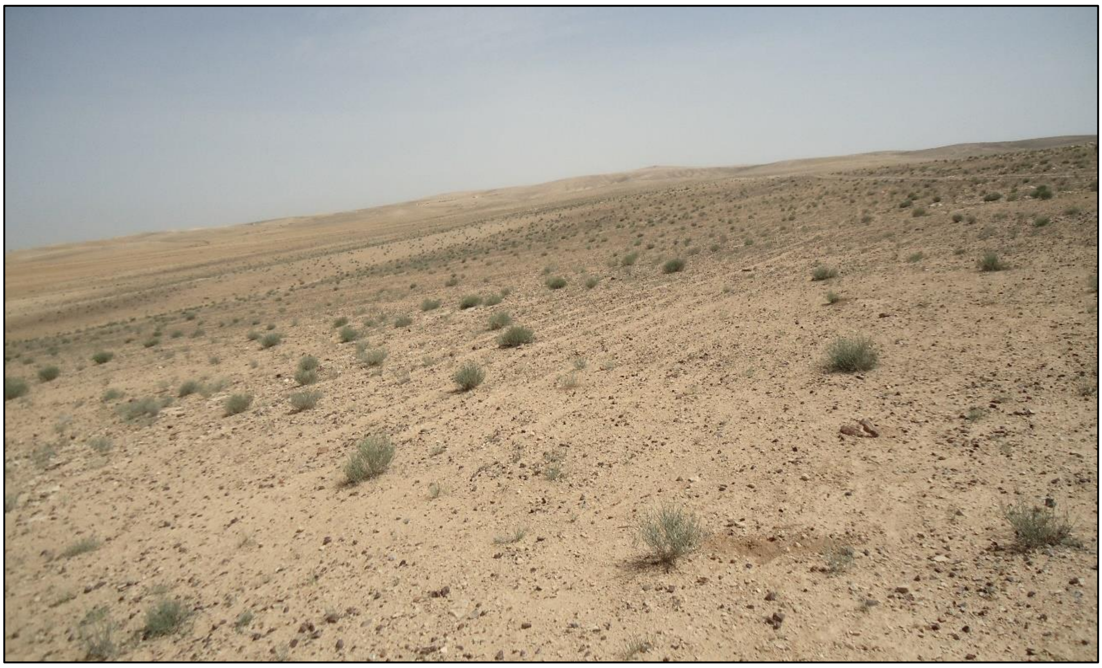


Figure 32: Gentle Terrain of the Project Area

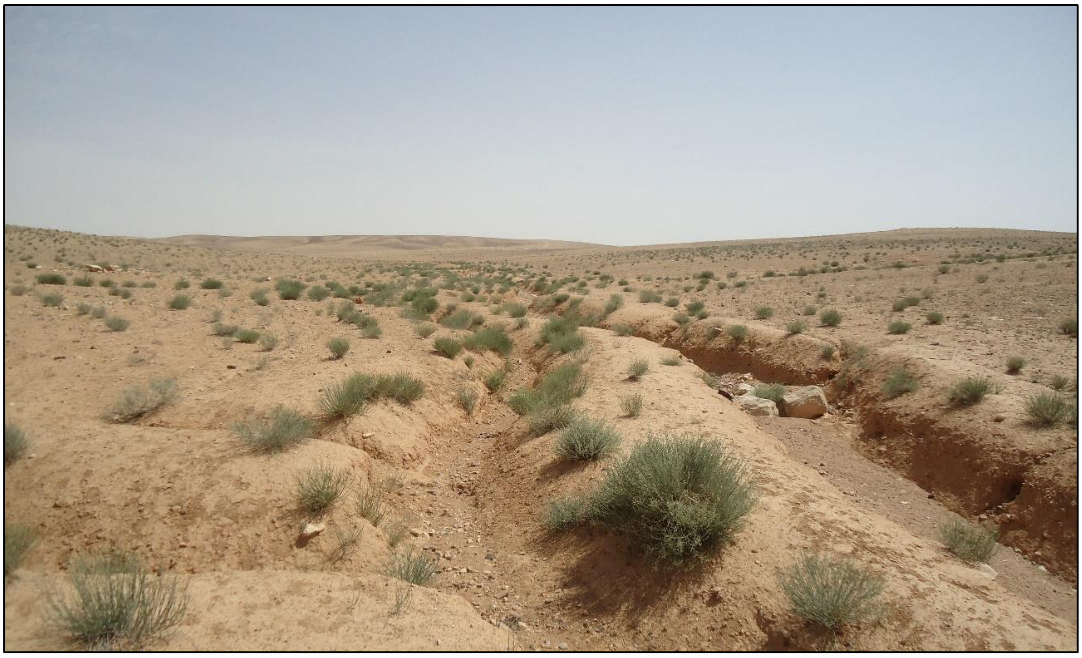


Figure 33: Rough Terrain of the Project Area

In order to carry out the hydraulic study, the IDF curves of Amman Airport, (the nearest rainfall station to the project area that having IDF curves) have been used to calculate the rain fall intensities for 2, 5, 10, 25 and 50 years' frequencies.

No streamflow observations are available in the concerned area. The flows of wadis crossing the project are to be computed, in order to calculate the optimum sizes of the flood protection and flow drainage elements.

The rational method was used for conducting the hydrological study for the project area, which is related to the area, slope, and time of concentration and the runoff coefficient of the basin.

To calculate the time of concentration, Kirpich's formula was used. The annual data series of the short duration precipitation for Amman Airport have been collected from the Ministry of Water and Irrigation as shown in **Table 15.** The statistical analysis of these short duration annual data series of precipitation are presented in **Table 16.**

Table 15: Annual Data Series of the Short Duration Precipitation at Amman Airport

No.	5 MIN	10 MIN	20 MIN	30 MIN	1 HR	2 HR	3 HR	6 HR	24 HR	Years
1	1.8	2.0	3.0	4.5	6.0	10.0	15.0	30.0	39.7	59
2	2.1	3.1	3.8	4.0	4.7	4.8	5.6	11.9	16.5	60
3	3.9	4.9	9.4	10.1	12.4	12.4	14.6	16.7	58.8	61
4	2.7	3.2	3.4	4.4	10.9	12.7	15.3	19.7	31.7	62
5	2.0	2.6	3.3	3.5	5.0	7.1	8.0	16.0	35.6	63
6	1.6	2.6	3.6	4.2	7.1	10.7	15.5	28.5	39.2	64
7	2.8	3.8	5.3	5.5	5.9	10.5	12.3	18.8	39.9	65
8	7.9	9.4	10.9	13.5	17.5	18.0	18.2	27.6	66.2	66

No.	5 MIN	10 MIN	20 MIN	30 MIN	1 HR	2 HR	3 HR	6 HR	24 HR	Years
9	2.7	4.5	6.4	6.4	7.0	12.7	15.3	23.1	60.9	67
10	3.2	3.6	4.5	5.4	7.9	8.5	8.6	11.8	40.9	68
11	4.7	8.2	9.4	10.5	11.2	11.5	12.9	19.5	66.1	69
12	2.2	4.1	4.2	4.2	5.5	7.0	8.1	10.3	23.0	70
13	3.4	4.2	6.8	8.3	9.7	15.1	20.0	30.5	66.1	71
14	2.6	3.1	5.0	5.0	7.2	12.9	14.1	14.1	23.7	72
15	4.9	5.8	6.2	6.6	7.4	11.2	14.3	14.6	39.5	73
16	2.5	4.0	4.5	4.7	8.0	11.8	13.0	25.0	72.0	74
17	2.1	2.9	5.7	8.0	11.5	19.0	25.0	37.5	46.5	75
18	2.5	3.0	3.4	4.7	8.3	12.2	19.7	23.0	34.8	76
19	2.9	3.4	3.6	4.4	7.0	11.1	17.5	27.2	33.0	77
20	1.7	2.5	3.5	4.4	6.0	9.5	11.8	19.6	31.9	78
21	7.6	10.5	15.6	19.1	21.1	21.4	23.6	44.0	92.8	79
22	2.9	3.4	4.2	5.5	7.5	10.7	11.5	21.8	73.6	80
23	1.8	2.7	4.2	4.3	6.4	9.6	11.5	12.2	20.4	81
24	4.6	7.0	11.0	12.2	12.9	14.6	15.0	15.0	31.3	82
25	3.3	4.1	5.4	7.1	10.0	14.8	19.0	28.7	57.2	83
26	1.7	2.3	3.6	4.4	6.7	10.7	14.3	18.1	27.6	84
27	2.4	2.7	3.4	4.3	6.8	11.0	15.7	20.6	52.8	85
28	4.6	4.7	4.7	5.0	6.2	11.0	14.3	18.3	45.1	86
29	6.1	8.5	14.0	15.4	17.8	18.1	18.1	18.1	27.9	87
30	2.6	3.2	4.0	5.2	7.5	13.0	18.4	29.0	62.1	88
31			4.6	7.2	8.0	8.6	9.4	12.2	25.2	89
32			2.8	3.0	4.6	7.0	8.2	12.0	18.8	90
33			6.8	6.8	6.8	7.0	8.4	9.0	13.8	91
34			1.4	2.0	4.0	7.6	9.8	17.2	30.6	92
35[3]										
36			1.6	3.2	3.4	5.0	6.4	9.2	9.6	94
37			5.0	5.0	5.0	5.8	5.8	6.2	6.4	95
38										
39			2.2	3.2	4.6	7.2	9.8	17.4	24.2	97
40										
41			2.6	3.4	4.2	4.8	5.8	7.2	13.4	99

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[3] Missing Data

Table 16: Statistical Analysis of Short Duration Annual Data series of Precipitation at Amman Airport

Water Year	Duration								
	5 min	**10 min**	**20 min**	**30 min**	**1 hr**	**2 hr**	**3 hr**	**6 hr**	**24 hr**
Mean	3.17	4.33	5.23	6.16	8.15	10.97	13.80	19.17	38.79
Median	2.70	3.50	4.20	5.00	7.05	11.00	14.30	18.10	34.80
Mode	1.80	3.10	3.40	4.40	6.00	12.70	14.30	12.20	66.10
Harm. Mean	2.22	3.62	3.67	4.75	6.87	9.39	11.82	15.45	27.21
Geo. Mean	2.75	3.92	4.42	5.37	7.43	10.22	12.87	17.31	33.19
St. Dev.	1.70	2.22	3.24	3.68	3.94	4.00	4.85	8.57	20.49
Skew Coef	1.37	1.55	1.63	1.88	1.70	0.51	0.10	0.76	0.61
Variat Coef	0.54	0.51	0.62	0.60	0.48	0.36	0.35	0.45	0.53
Count (yr)	31	30	39	39	38	39	39	39	39
reduced mean	0.5371	0.5362	0.543	0.543	0.543	0.543	0.543	0.543	0.543
reduced SD	1.1159	1.1124	1.1388	1.1388	1.1388	1.1388	1.1388	1.1388	1.139

The Gumbel's double exponential distribution has been applied to calculate the IDF information and draw the IDF curves as **Table 17** and **Figure 34.**

Table 17: Rainfall Intensity [mm/h], Duration [min.] & Frequency [year] at Amman Airport

Duration (min)	Return Period (yr)					
	2	**5**	**10**	**25**	**50**	**100**
5	34.87	55.58	69.30	86.62	99.48	112.23
10	23.97	37.51	46.48	57.81	66.21	74.55
20	14.17	23.86	30.27	38.37	44.39	50.35
30	11.18	18.50	23.34	29.46	34.01	38.51
60	7.54	11.46	14.06	17.34	19.78	22.20
120	5.17	7.16	8.48	10.14	11.38	12.60
180	4.35	5.96	7.02	8.37	9.36	10.35
360	2.97	4.40	5.34	6.53	7.41	8.28
1440	1.48	2.33	2.90	3.61	4.14	4.66

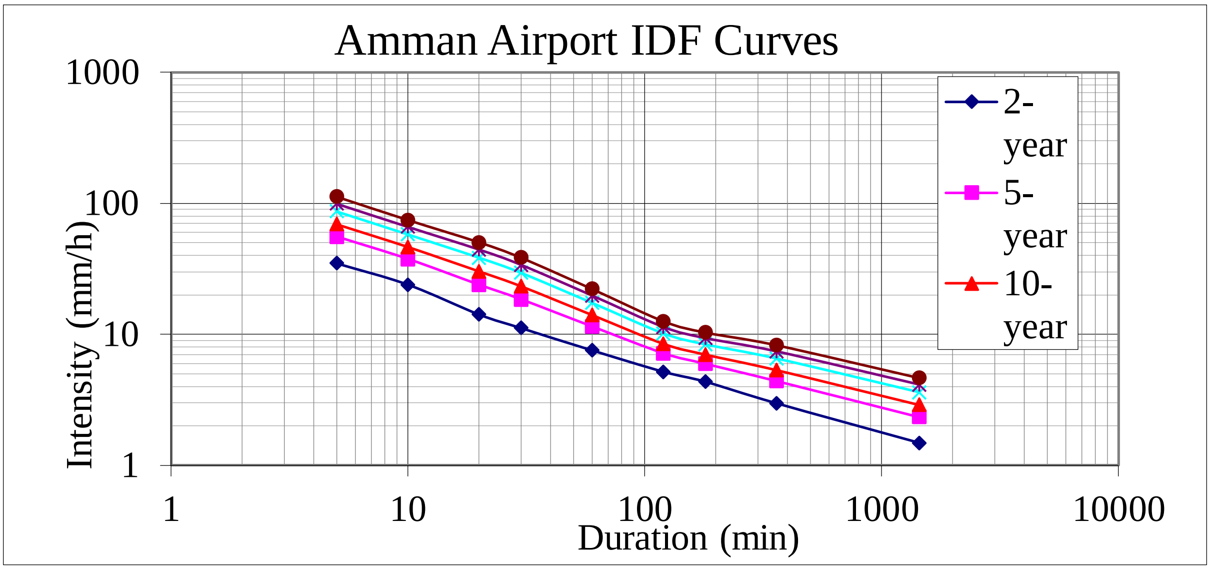

Figure 34: Rainfall Intensity, Duration & Frequency Curves at Amman Airport

Using **Table 17** and/or **Figure 34** the best fit trend line can be drawn for the rainfall intensities and find the equation and regression coefficient as they can be used in the derivation of the rainfall intensities relevant to any time of concentration.

In **Figure 35** the best fit distribution (power trend line) for the IDF curves of Amman Airport is presented.

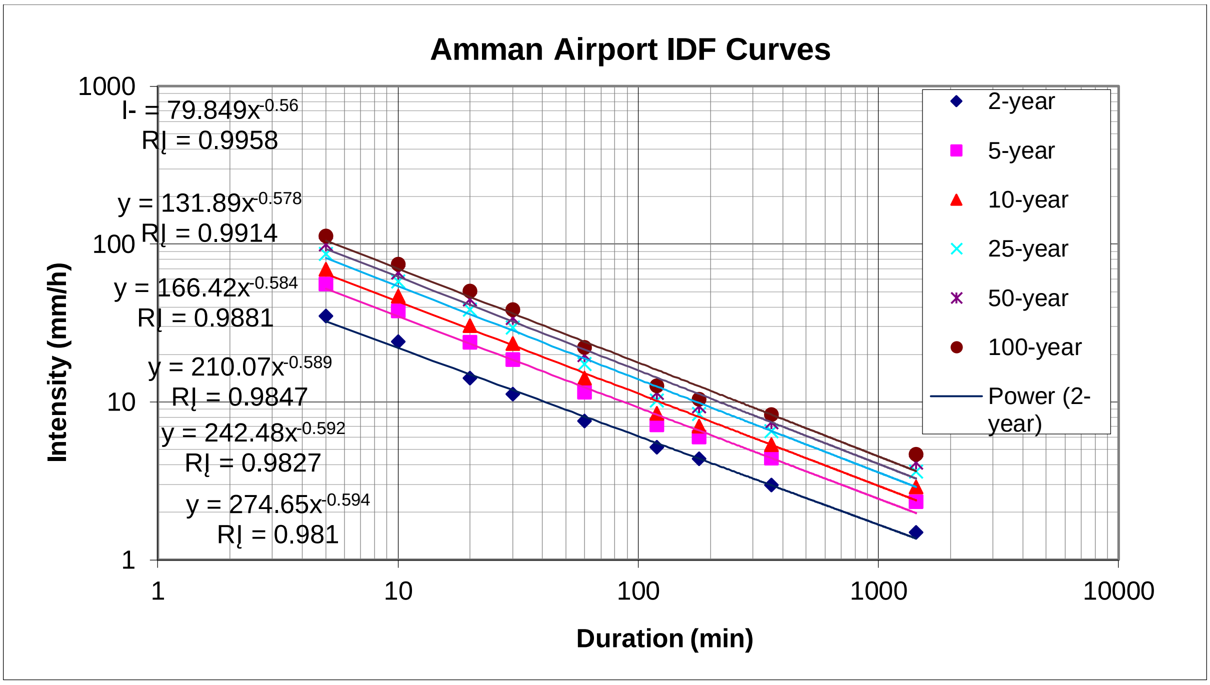

Figure 35: Best Fit Distribution (Power Trend Line) for the IDF Curves of Amman Airport

The hydrological calculation for the available catchment areas within the project has been computed, to provide cost effective design. For designing the storm water collecting system, the rainfall intensities and design floods have been computed for different standard return periods as shown in the following **Table 18** and **Table 19**.

Table 18: Rainfall Intensities related to Duration and Frequency

Area No.	Concentration Time Tc (min)	2-year	5-year	10-year	25-year	50-year
1	10.00	26.44	42.02	59.07	75.97	87.53
1-a	10.00	26.44	42.02	59.07	75.97	87.53
2	11.81	23.11	36.73	52.06	67.07	77.28
3	19.03	15.70	24.96	36.23	46.89	54.03
4	12.53	22.02	34.99	49.75	64.13	73.88
4-a	10.00	26.44	42.02	59.07	75.97	87.53
4-b	10.00	26.44	42.02	59.07	75.97	87.53
5	63.37	5.92	9.42	14.52	19.02	21.91
6	20.67	14.68	23.34	34.02	44.07	50.78
7	30.05	10.84	17.24	25.60	33.29	38.35
8	16.47	17.65	28.05	40.43	52.26	60.21
8-a	15.19	18.84	29.95	42.99	55.52	63.97
9	32.10	10.28	16.34	24.35	31.68	36.50
10	17.92	16.49	26.20	37.92	49.06	56.52
11	39.15	8.75	13.91	20.94	27.30	31.45
12	41.84	8.29	13.18	19.90	25.97	29.92
13	26.77	11.91	18.93	27.95	36.30	41.83
14	41.35	8.37	13.31	20.08	26.20	30.18
15	44.54	7.88	12.53	18.98	24.78	28.55

Table 19: Computed Design Floods Related Frequency

Area No.	Runoff Coefficient	2-year	5-year	10-year	25-year	50-year
1	0.35	0.088	0.139	0.196	0.252	0.290
1a	0.35	0.041	0.064	0.091	0.117	0.134
2	0.35	0.465	0.739	1.047	1.349	1.554
3	0.35	0.504	0.801	1.162	1.505	1.734
4	0.35	0.258	0.409	0.582	0.750	0.864
4a	0.35	0.137	0.218	0.307	0.394	0.454
4b	0.35	0.069	0.109	0.153	0.197	0.227
5	0.35	1.250	1.986	3.062	4.011	4.621
6	0.35	0.688	1.094	1.594	2.065	2.380
7	0.35	1.211	1.925	2.860	3.718	4.284
8	0.35	0.424	0.673	0.970	1.254	1.445
8a	0.35	0.401	0.637	0.915	1.182	1.362
9	0.35	0.952	1.513	2.254	2.933	3.379
10	0.35	0.374	0.594	0.860	1.112	1.281
11	0.35	2.191	3.482	5.241	6.833	7.873

Area No.	Runoff Coefficient	2-year	5-year	10-year	25-year	50-year
12	0.35	3.825	6.079	9.180	11.977[4]	13.799
13	0.35	0.973	1.547	2.284	2.966	3.417
14	0.35	2.135	3.394	5.122	6.681	7.698
15	0.35	2.792	4.438	6.722	8.776	10.111

Hydraulic Design

The hydrological study aims to provide the peak flood estimates that determine the required design discharge for the cross project drainage structures. It is necessary to estimate the flow that crosses the project in order to convey these flows safely across the project since the hydraulic design is an important aspect for such projects.

The selected hydraulic structure should be sufficient to transfer the floodwater from one side of the project to the other safely; proper hydraulic study was carried out to those locations. Some locations might need diversions to be added.

The hydraulic design is usually covering the sizing of the drainage structures needed for the project including:

- Channels of various sizes and types.
- Side ditches to drain small basins located near the project.
- Side protection for the project.

The return period of the design flood, sometimes referred to as the recurrence interval, is a measure of the event frequency and may be defined as the average length of time between events having the same volume and duration.

The following criteria influence the selection of a particular design frequency:

- Class of the project.
- Type of structure.
- Consequence of failure.
- Economic constraints.

The catchment characteristics (i.e., area, slope, topography, geology, shape.... etc.) that considerably affects the flood volume and velocity.

In general, the recommended return period criteria for the design flow of flood protection measures and diversion channels is between 25-year return period and 50-year.

For the design of diversion channels, wherever applicable, the Manning’s Equation is normally used.

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[4] Note: Wadi 12 is a combination between both 5 and 11 wadis that located downstream outside the project area.

In general, the site is almost gentle to moderate sloppy in some localities and almost flat in others allowing the water to spread over wide areas, and in this case, the flow is to be considered as sheet flow and has no damaging effect to any structure. In other localities the wadi streams are well defined and soil scouring exist that requires protection. Some of the streams need channelization with grouted riprap lining, especially at lower elevations of the project area. It is recommended to define the wadi banks by means of creating depression within the flooding plain in order to guide the flood to run in a well-defined path. Pipe or box culverts may be required to be constructed under the access road to the project and under any of the internal roads. Finally, wadis 5 and 11 require full protection for the parts located within the project area.

5.2.7.2 Groundwater

Groundwater is water that is stored underground in spaces of soil or rock. The water-bearing porous soil or rock strata yielding significant amounts of water to wells or springs are called ‘aquifers’. The groundwater aquifers in Jordan are classified into three main complexes:

- **The Deep Aquifer Complex**: This is formed from sandstone and is found as one unit in the south and two units in the north separated by thick limestone and marl layers.
- **The Middle Aquifer Complex** (the upper and middle cretaceous complex): This consists of limestone, dolomite, marl stone and chert beds.
- **The Shallow Aquifer Complex:** This is the mostly exploited and consists of two main systems; the basalt aquifer system and the sedimentary rocks and alluvial deposits of Tertiary and Quaternary ages system.

In Jordan, groundwater is recharged either by the seepage of a small percentage of total rainfall into the ground, or through groundwater inflow from Syria (referred to as “trans-boundary flow”, in which water resources are shared with another country). Other inflows are the result of return flows from irrigation, leaks from pipes, reservoirs, and wastewater treatment plants. Groundwater outflows are from abstraction by pumping wells, spring and base flow discharge (GTZ, NWMP-Water Resources in Jordan, 2004).

Twelve groundwater basins are identified having a total renewable annual supply “safe yield” of about 280 MCM. The distribution of the groundwater basins is shown in **Figure 37.**

As illustrated in **Figure 37** below, the project area is located between Amman-Zarqa and Azraq groundwater basins – within groundwater characteristics leaning more towards the Amman-Zarqa Basin.

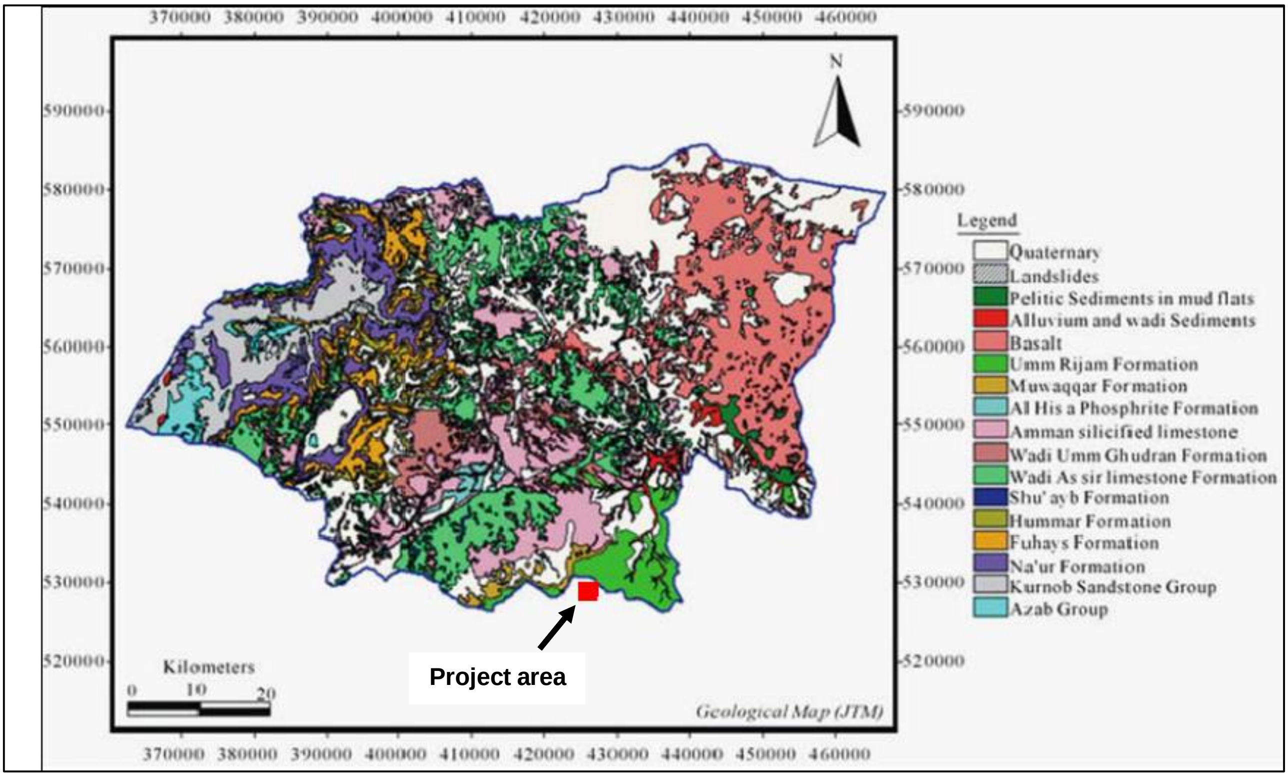
The Amman-Zarqa groundwater basin has a safe yield of 88 MCM per annum, Amman-Zarqa Basin is the critical renewable ground water basin in Jordan. While the Azraq Basin has an estimated safe yield of 24 MCM per annum. The Azraq basin suffered from over-pumping of the shallow aquifer across the years which resulted in a substantial depression on the groundwater level that exceeded 20 m (MoEnv, 2006).

The project area falls within Muwaqqar formation / Chalk-Marl Unit (B3) which spreads in many parts of the kingdom.

Since the Muwaqqar formation is an aquitard, as a result there is no groundwater in the area; since this aquitard, consists of a thick sequence of chalk and marl which forms a groundwater barrier in the eastern limit of the basin along the Qihati fault[5]. (Outline Hydrogeology of the Amman-Zarqa Basin, 2000).

This unit is partly bituminous and consists of chalky marl and marly limestone. In Some locations it contains thin beds of gypsum and concretions of chert. Although the thickness of this unit in some places (Yarmouk River and Wadi Shallala) is more than 300m, the average thickness is generally about 50m.

The Muwaqqar Formation (B3) is considered the only formation in this unit, and can be easily recognized. It consists of chalk, marl, chalky limestone and chert nodules. The recorded thickness of (B3) varies from place to place and generally ranges between 60 m and 320m (Masri, 1963[6]; McDonald and Partners, 1965[7]; and Wolfart, 1968[8]). The wide variation in thickness may be due to facies changes. Regardless of its thickness, this formation has very poor potential and is considered as an aquiclude.


370000 380000 390000 400000 410000 420000 430000 440000 450000 460000
590000
580000
570000
560000
550000
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530000
520000
N
Legend
Quaternary
Landslides
Pelitic Sediments in mud flats
Alluvium and wadi Sediments
Basalt
Umm Rijam Formation
Muwaqqar Formation
Al His a Phosphrite Formation
Amman silicified limestone
Wadi Umm Ghudran Formation
Wadi As sir limestone Formation
Shu' ayb Formation
Hummar Formation
Fuhays Formation
Na'ur Formation
Kurnob Sandstone Group
Azab Group
Kilometers
0 10 20
Project area
Geological Map (JTM)

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[5] Ministry of Water and Irrigation, Water resource policy support, Groundwater management component, Outline Hydrogeology of the Amman-Zarqa Basin, May, 2000

[6] Masri, M.R., 1963. The geology of the Amman-Zerqa area: Central Water Authority, Amman.

[7] McDonald, Sir m., and Partners in Cooperation with Hunting Geological Survey Ltd., 1965. East Bank Water Resources: Central Water Authority, Jordan, Six Volumes.

[8] Wolfart, R., 1968. Stratigraphisch-Fauna des ober-Ordovizium, (Caradoc-Ashgill) und unter-Silurs (unter-Llandovery) von Sudjordanien: Geol. jb., v. 85, Hannover,p. 517-564.

Figure 36: Geological Map of Amman-Zarqa Basin[9]

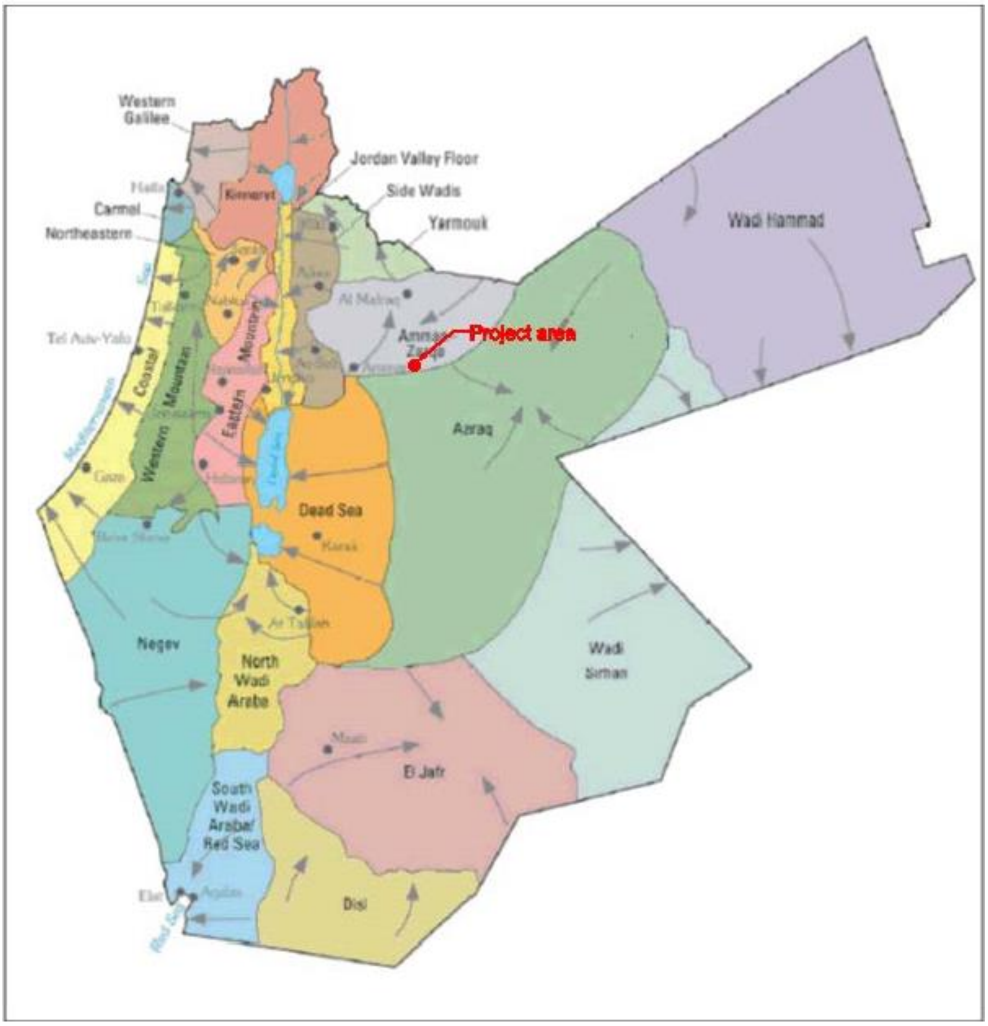
Western Galilee
Haifa
Carmel
Northeastern
Jordan Valley Floor
Side Wadis
Yarmouk
Kinneret
Wadi Hammad
Al Mafraq
Amman Zarqa
Project area
Tel Aviv-Yafo
Coastal
Western Mountain
Eastern Mountain
Mediterranean
Gaza
Azraq
Dead Sea
Karak
Negev
North Wadi Arabe
At Tafilah
Wadi Sirhan
Maan
El Jafr
South Wadi Araba/ Red Sea
Elat
Aqaba
Red Sea
Disi

Figure 37: Groundwater Basins in Jordan

5.3 Biological Environment

The biological environment baseline has been collected based on literature review, and site visits to the project area and its surroundings. As well as the experience of AJ ESIA team in the biodiversity of the project area. The findings are presented in the sections below:

5.3.1 Study Methodology

In order to meet the objectives and scope of this study, different methods were used to assess the existing biological environment aspects at the project area and to evaluate the expected impacts on these aspects.

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[9] http://file.scirp.org/Html/5-8101905/ded2841b-a865-45d3-bb8b-d63aab68409a.jpg

Methods included the following:

Literature Survey: In this part, the survey team collected and reviewed the available data about the biological environment in the project area. Data collection was achieved through:

- Library search for the available reference on the biodiversity or any related biological aspects.
- References from institutions that are working in this field of specialty such as, Ministry of Environment (MoEnv), Royal Society for Conservation of Nature (RSCN) and University scientists and specialists.

Field Work Survey: This survey was completed and updated the literately collected data. Different techniques were used in the field to assess the biological environment as the following:

- **Line Transects:** This technique was used to study most of the biological aspects of environment as the following:
  - Flora: Line Transects was commonly used to study changes in vegetation along a physical environmental gradient. Also it was used to estimate overall density of cover values of species in a single type of vegetation, which also can be correlated to various physical environmental factors such as salinity, humidity, soil composition, topography etc.

    The project area has been divided into equal plots each of 0.5 km X 0.5 km, and from those grids that are located within the major wadies in the area, 6 plots were randomly selected to perform 3 transects each of 1 km length at these plots. The figure below shows the selected plots for line transects.

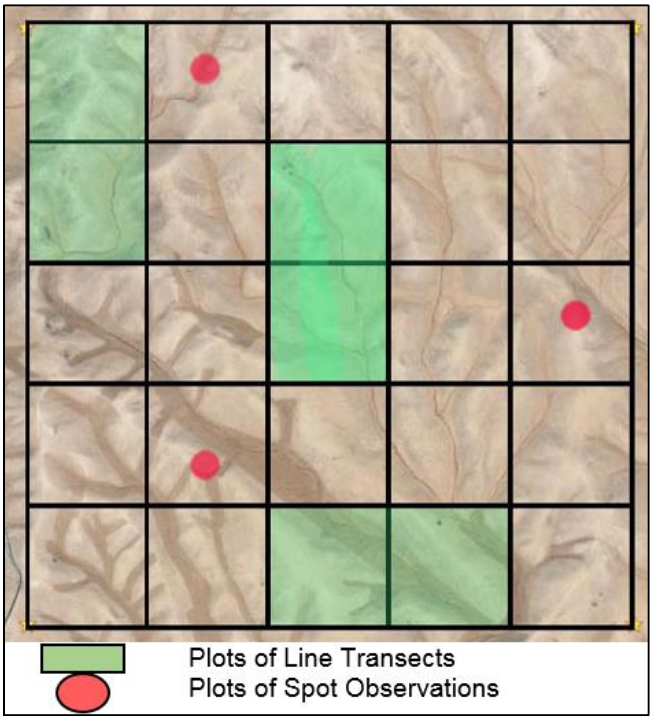

Figure 38: Sampling Plots within Project Area

- Fauna: In this technique, researchers walked the project area in a systematic way that enabled them to cover the whole area. This technique was applied for different target groups of fauna as follows:

- Birds: line transects were effective method to study birds of extensive open habitats in both terrestrial and wetland habitats. This method was used to identify counting density along various environmental gradients.

- Mammals: line transect technique was applied for both large and small mammals, and for large reptiles. It was the easiest and direct method for counting mammals and or recording them through a gradient of various environmental factors. It depends mainly on recording their singes like foot pints, spoors and body remnants.

- **Spot Observation Technique:** this method was applicable for birds, which was implemented ornithologist to define a fixed location to record the number and species of birds cross that spot within the possible observation range using binoculars to identify birds' species.

5.3.2 Flora

5.3.2.1 Biogeographic Zones

Mediterranean Biogeographic Zone

The project site exists in this biogeographic zone which is restricted to the highlands of Jordan extending from Irbid in the north to Ras Al-Naqab in the south. The altitude ranges from 700-1750 m above sea level. The rainfall ranges from 300-600 mm. The minimal annual temperature ranges from 5-10°C and the mean maximum annual temperature from 15-25°C. Soil type is dominated by the red Mediterranean soil (Terra Rosa) and the yellow Mediterranean soil (Rendzina). This region comprises the most fertile part of Jordan and presents the best climate for the forest ecosystem. **Figure 39** below shows the collation of the project within this biogeographic zone.

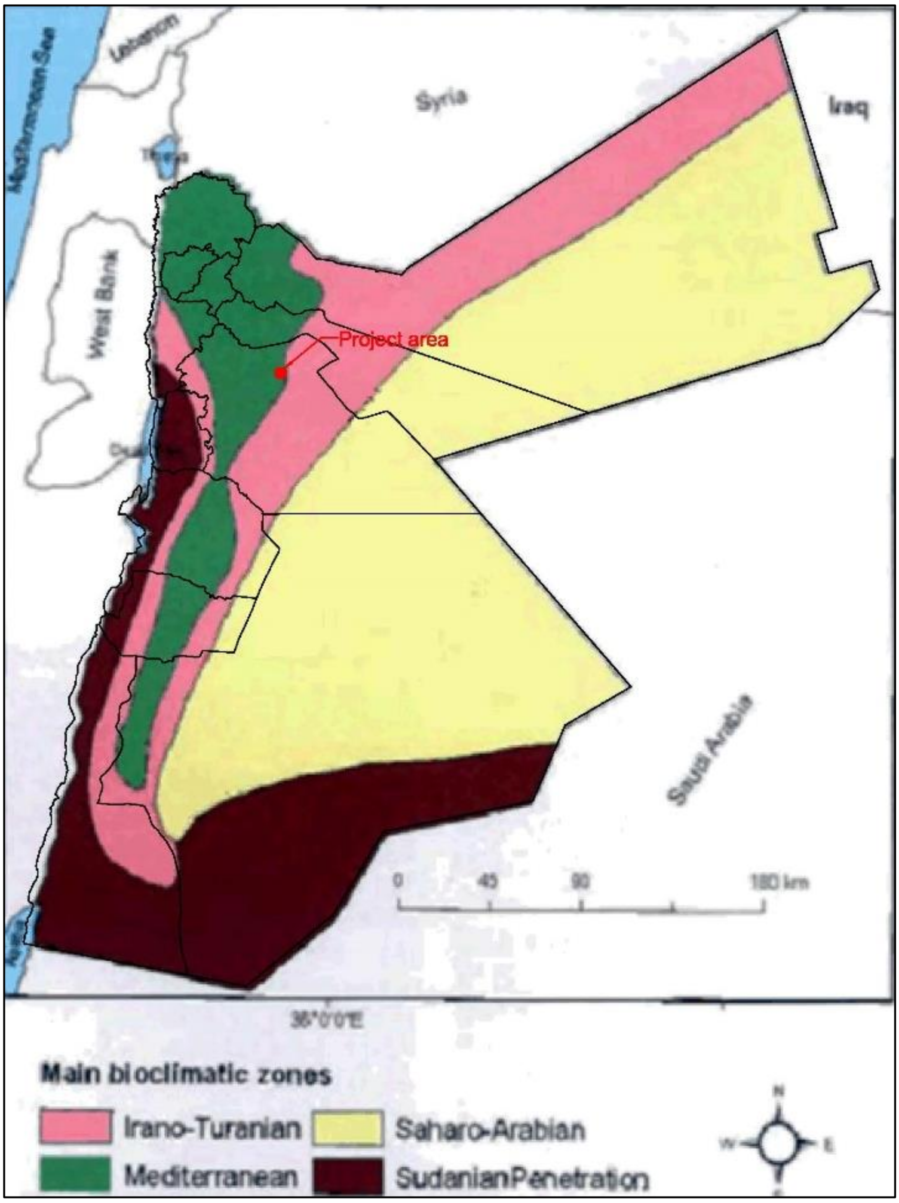
Mediterranean Sea
Lebanon
Syria
Iraq
West Bank
Dead Sea
Project area
Saudi Arabia
0
45
90
180 km
36°0'0"E
Main bioclimatic zones
Irano-Turanian
Saharo-Arabian
Mediterranean
Sudanian Penetration
N
W
E

Figure 39: Project Area within Mediterranean Biogeographic Zone

5.3.2.2 Ecosystems

The proposed project area is represented in one major Ecosystem; Scrap and Highland Ecosystem. This ecosystem consists of escarpments and mountains, hills and undulating plateaus, which extend mainly from Irbid in the north to Ras Al Naqab in the south, and, from Rift Valley region in the west to the Badia in the east. The mountains in the southern part of this zone are higher on average, and some range between 1200 m and 1600 m high.

Mediterranean woodland of pine and oak, with juniper and cypress more locally is believed to have originally covered large tracts of the Jordanian highlands, but the human and climatic factors resulted in high deforestation and replacement of natural vegetation by secondary species.

The largest remaining areas of natural woodland occur in the highlands between Amman and North of Jordan, and are dominated by *Pinus halepensis* above 700 m, whilst mixed evergreen/deciduous oak woodland of *Quercus calliprinos* and *Q. ithaburensis* dominate at lower elevations where the original pine-dominated woodland has been degraded. Cultivation of rain fed wheat widespread on the plateau between Madaba and Irbid, and olive groves cover a large part of the northwestern mountains above 700m. More than 80% of Jordan's cities and villages occur within this zone.

5.3.2.3 Vegetation Types

The project area is characterized by two vegetation types due to its location at a transitional margin between two vegetation types as shown at **Figure 40** below, these types are the following:

Steppe Vegetation

This vegetation is confined to the Irano – Turanian biogeographic zone and may intrude either into the Mediterranean as in the project area or the Saharo- Arabian zone. The composition of this vegetation varies according to the soil and climatic differences depending on its location with respect to the Mediterranean zone. For example, the steppe vegetation in the Northern Ghor which links with the Northern mountains is dominated by *Retama raetam, Ziziphus lotus, Z. nummularia*, and *Ferula communis* with almost no *Artemizia herba-alba*, while the steppe vegetation in the North, East and South Mediterranean borders shows other elements like *Pistacia atlantica, Anabasis syriaca* and *Artemisia herba –alba* which are not found in the western steppes. This might be due to the fact that the western steppes are more affected by the tropical conditions and vegetation in the Rift Valley, while the Eastern steppes are more affected by the Sahara conditions and vegetation.

Therefore, variation in the vegetation composition are recognized, a fact that led to distinguish distinct sub- divisions of the major type. However, since it is very difficult to make a clear distinction between the different types it would be more advisable not to sub divide this type of vegetation.

The common features of this type of vegetation are the presence of shrubs and bushes and the absence of tree vegetation. This vegetation type forms a strip surrounding the Mediterranean region. The common species in this type are:

Retama raetam
Noaea mucronata
Asphodelus aestivus
Ferula communis
Salsola spp.
Crocus moabiticus
Artemisia herba-alba
Ziziphus lotus
Urgiea maritime
Hammada spp.
Astragalus spinosus
Pistacia atlantica
Ziziphus nimmularia
Anabasis syriaca
Gypsophila Arabica
Tamarix spp.

Table 20: Conservation Important Species

Family	Species	Importance
Caryophyllaceae	*Paronychia argentea*	Used in traditional medicine for the treatment of kidney stones. / under pressure
Chenopodiaceae	*Salsola vermiculata*	Palatable for livestock

Family	Species	Importance
Compositae	*Achillea fragrantissima*	Used in traditional medicine for the treatment of stomach ache and digestive disorders./ under pressure
	Artemisia herba alba	Used in traditional medicine for the treatment of stomach ache and digestive disorders./ under pressure and palatable for livestock
	Ifloga spicata	Palatable for livestock
Cucurbitaceae	*Citrullus colocynthis*	Used in traditional medicine for the treatment of Arthroides.
Graminae	*Poa sinaica*	Palatable for livestock
	Stipa capensis	Palatable for livestock
Labiatae	*Teucrium polium*	Used in traditional medicine for the treatment of stomach ache./ under pressure
Liliaceae	*Urginea maritime*	Used in recent medicines for the treatment of heart disorders.

Mediterranean Non-Forest Vegetation

The Mediterranean zone, which is not covered by forests, contains some shrubs and bushes. Such zone is often referred to as Garigue and Batha Mediterranean vegetation. The leading species of this vegetation are *Rhamnus palaestinus*, *calycotome villosa*, *Sarcopoterium spinosum* and *Cistus spp*. in the North and *Artemisia herba-alba* will be associated with others in the South.

The Mediterranean non-forest vegetation is treated as degraded forest. Therefore, some scientists believe that if this vegetation is protected, steps toward forest climax will be observed until the final stage is reached.

It is found in the entire Mediterranean zone except the forestlands and the cultivated lands. Common species in this vegetation type are:

Rhamnus palaestinus
Sarcopoterium spinosum
Teucrium polium
Artemisia herba-alba
Eryngium glomeratum
Asphodelus aestivus

Capparis spinosa
Dactylis glomerata
Varthemia iphionoides
Ballota undulata
Thymus capitatus
Calycotome villosa

Echinops spp.
Horedeum bulbosum
Ononis natrix
poa bulbosa
Noaea mucronata
Asparagus aphyllus

Table 21: Conservation Important Species:

Family	Species	Importance
Araceae	*Biarum angustatum*	Common but start to decrease. Sensitive to plowing
Compositae	*Scorzonera papposa*	Common/ recently under pressure as roots collected and edible
	Achillea falcate	Used in traditional medicine for the treatment of stomach ache./ under pressure
	Varthemia iphionoides	Used in traditional medicine for different digestive disorders.
	Phagnalon rupestre	Used in traditional medicine (Burning) for all joints pains.
Cruciferae	*Allysum iranicum*	Restricted to Ras al Naqab area
Graminae	*Poa bulbosa*	Palatable for livestock
Leguminosae	*Ononis natrix*	Palatable for livestock
	Onobrychis crista-galli	Palatable for livestock
Liliaceae	*Allium truncatum*	Recently under pressure as bulbs collected and edible
Malvaceae	*Malva parviflora*	Leaves collected and edible
Rhamnaceae	*Rhamnus palaestinus*	Decreasing/ cut for fire wood

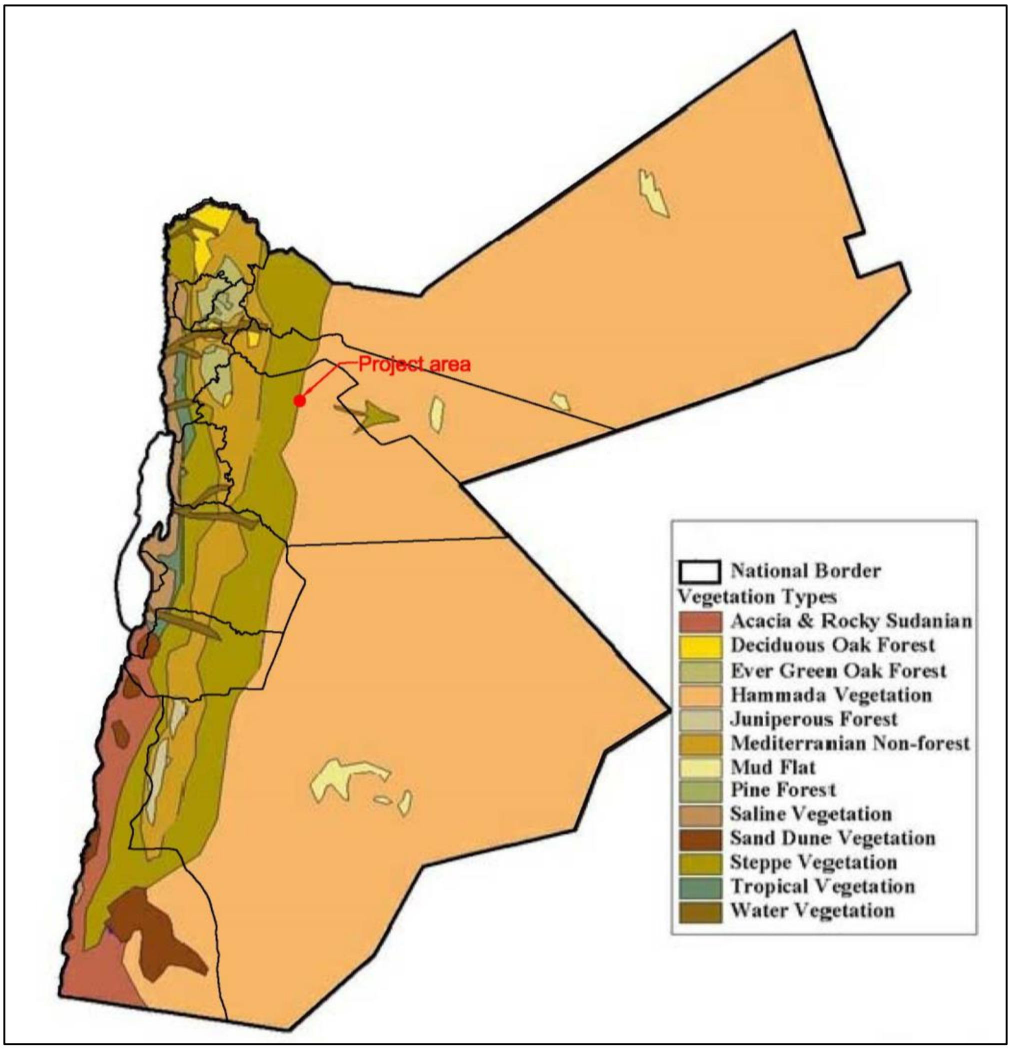
Project area
National Border
Vegetation Types
Acacia & Rocky Sudanian
Deciduous Oak Forest
Ever Green Oak Forest
Hammada Vegetation
Juniperous Forest
Mediterranian Non-forest
Mud Flat
Pine Forest
Saline Vegetation
Sand Dune Vegetation
Steppe Vegetation
Tropical Vegetation
Water Vegetation

Figure 40: Vegetation Types Represented at the Project area

5.3.3 Fauna

5.3.3.1 Mammals

The mammals of the project area are almost representing most of the mammals of that found in the two zoogeographic zones represented at the project area. These zoogeographic zones are:

Mediterranean Zoogeographic Zone

This is a distinct sub region within the Palearctic region (European Origin). It includes mountain areas that extend from the north of Jordan till Al Naqab Mountains in the south. In the project area, mammals that belong to this zone exist in Al Naqab Mountain in the south and in the southern of Amman, to the east and to the west of the Desert highway.

Table 22: Important Mammals found in this Zoogeographic Zone

Family	Scientific Name	Common Name	Status
Erinaceidae	*Erinaceus concolor*	Common Hedgehog	Insufficient data

Family	Scientific Name	Common Name	Status
	Hemiechinus auritus	Long-eared Hedgehog	Insufficient data
Soricidae	*Corcidura suaveolens*	Lesser white-toothed shrew	Vulnerable
Canidae	*Canis aureus*	Golden jackal	Vulnerable
	Canis lupus	Grey Wolf	Nationally Threatened
Felidae	*Felis caracal*	Caracal	Nationally Endangered
	Felis silvestris	Wild Cat	Vulnerable
Herpestidae	*Hepestes ichneumen*	Egyptian mongoose	Vulnerable
Hyaenidae	*Hyaena*	Striped hyena	Nationally Threatened
Mustelidae	*Martes foina*	Rock Marten	Nationally Threatened
	Meles	Common Badger	Nationally Threatened
	Vormela peregusna	Marbled Polecat	Vulnerable
Procaviidae	*Procavia capensis*	Hyrax	Nationally Threatened
Spalacidae	*Spalax leucodon*	Mole Rat	Vulnerable
Hystricidae	*Hystrix indica*	Indian crested porcupine	Vulnerable

Saharo – Sindian Zone (also referred to as the Saharo-Arabian and Irano-Turanian phytogeographic region by Zohary 1973).

This zone is located to the east of the mountain ranges, extending from south of Jordan to northeast of the country in Mafraq area. It is another sub region within the Palearctic and includes the Sahara Desert, The Arabian Desert. The majority of the project’s mammals are belonging to this zone. Examples of the Sahro-Sindian mammals are:

Table 23: Important Mammals found in this Zoogeographic Zone

Family	Scientific Name	Common Name	Status
Erinaceidae	*Paraechinus aethiopicus*	Desert Hedgehog	Insufficient data
	Hemiechinus auritus	Long-eared Hedgehog	Insufficient data
Soricidae	*Corcidura suaveolens*	Lesser white-toothed shrew	Vulnerable
Canidae	*Canis aureus*	Golden jackal	Vulnerable
	Canis lupus	Grey Wolf	Nationally Threatened
	Vulpes cana	Blanford’s fox	Nationally Endangered
	Vulpes rueppelli	Sand Fox	Nationally Endangered
Felidae	*Felis caracal*	Caracal	Nationally Endangered
	Felis silvestris	Wild Cat	Vulnerable

Family	Scientific Name	Common Name	Status
	Felis margarita	Sand Cat	On the verge of Extinction
Hyaenidae	*Hyaena*	Striped hyena	Nationally Threatened
Mustelidae	*Vormela peregusna*	Marbled Polecat	Vulnerable
	Mellivora capensis	Honey Badger	Nationally Threatened
Procaviidae	*Procavia capensis*	Hyrax	Nationally Threatened
Bovidae	*Capra ibex*	Nubian Ibex	Nationally Endangered
Hystricidae	*Hystrix indica*	Indian crested porcupine	Vulnerable

5.3.3.2 Birds

Jordan has a wide diversity of bird habitat types due to its varied topography and climate and its biogeographical location. More than 363 bird species have been recorded in Jordan, of which more than 141 species are breeding birds and this number might increase with the continuous research – the important breeding birds are provided in the table below. Jordan lies on the main route of bird’s migration between Africa, Asia and Europe. Millions of birds are migrating over Jordan each year, among which the majority of the Jordanian avifauna is belonging. The huge number of migrant birds that visit Jordan twice a year has made the country of a great importance for the global avifauna. The important migrant species are provided in the table below.

The project area is not located at one of the birds’ migration fly ways but close to the west of the raptors and eastern desert fly way for migratory birds. It is also not located within an Important Bird Area (IBA) the nearest IBA is Qa Khanna at 21 km from the project boundary while Al Shaumari IBA which is 33 km away from the project site as illustrated in **Figure 41** below. In addition the nearest Rangeland Reserve to the project location is Wadi Al Butum which is 12 km away from the project site as shown below. Al Shumari Protected area is located at 54km distance to the north east of the project area.

Birdlife International Soaring Birds Sensitivity Mapping Tool has been applied to the project site with assumptions of 1km, 2km, 5km and 10km buffer around the project area. All assumptions have shown a sensitivity of 0 of these habitats for soaring birds which are mainly the large migratory birds including raptors. Results of the tool application are presented at **APPENDIX C.**

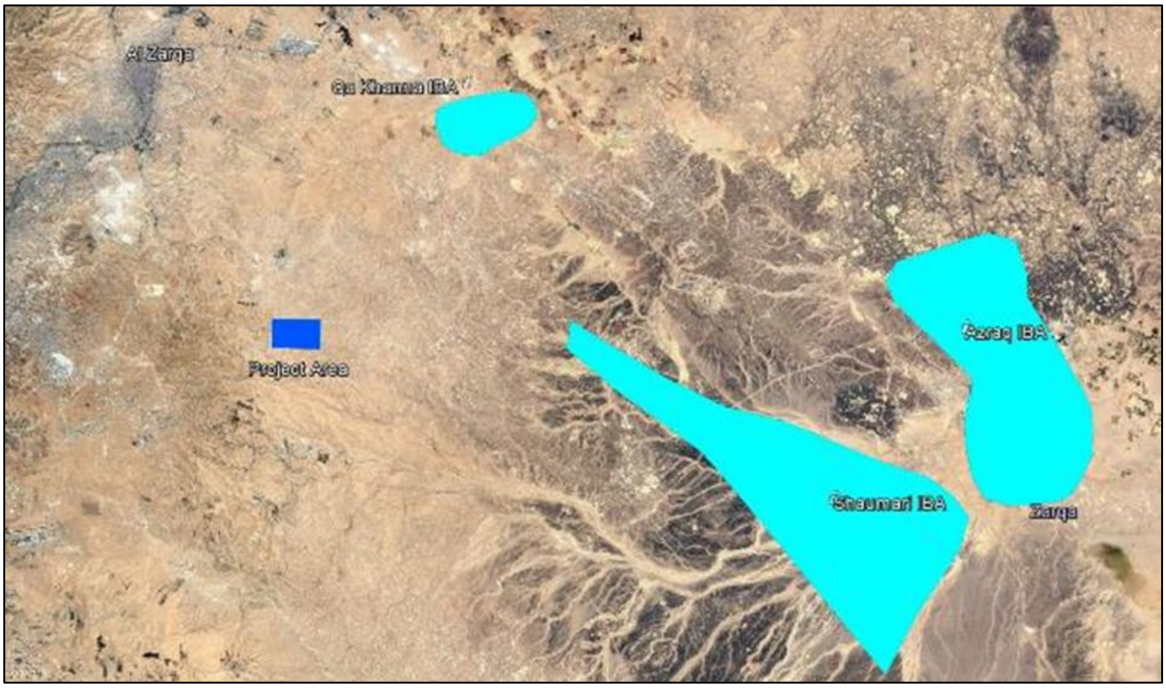
Al Zarqa
Qa Khanna IBA
Project Area
Azraq IBA
Shaumari IBA
Zarqa

Figure 41: The Nearest IBA to the Project Area

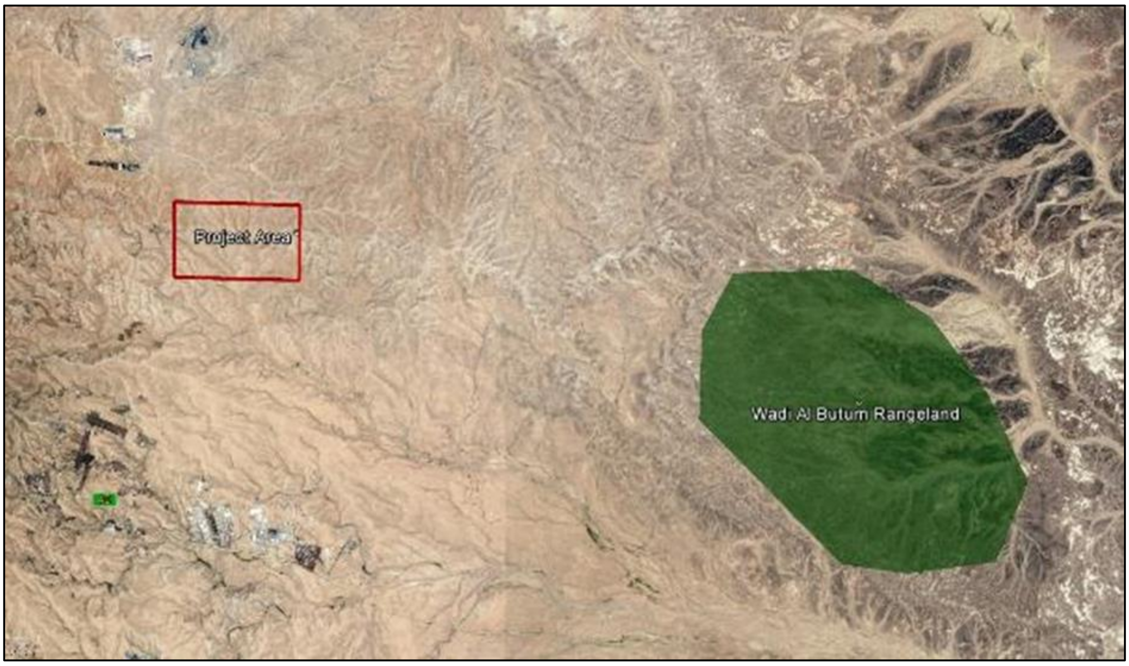
Project Area
Wadi Al Butum Rangeland

Figure 42: The Nearest Rangeland Reserve to the Project Area

Table 24: Important Breeding Birds

Family	Scientific Name	Common Name	Status
Anatidae	*Marmaronetta angustirostris*	Marbled Duck	Globally Threatened
Falconidae	*Falco naumanni*	Lesser Kestrel	Globally Threatened
Otididae	*Chamydotis undulata*	Houbara Bustard	Globally Threatened
Accipitridae	*Aegypius monachus*	Black Vulture	Globally Threatened

Family	Scientific Name	Common Name	Status
Strigidae	*Ketupa zeylonensis*	Brown Fish Owl	Globally Threatened
Phasianidae	*Francolinus*	Black Francolin	Regionally Threatened
Accipitridae	*Gypaetus barbatus*	Lammergeier	Regionally Threatened
Accipitridae	*Torgos tracheliotus*	Lappet-faced Vulture	Regionally Threatened
Passeridae	*Passer moabiticus*	Dead Sea Sparrow	Restricted to Middle East
Fringillidae	*Serinus syriacus*	Syrian Serin	Restricted to Middle East
Fringillidae	*Corpodacus synoicus*	Sinai Rosefinch	Nationally Threatened
Paridae	*Parus caeruleus*	Blue Tit	Nationally Threatened

Table 25: Important Migrant Species

Family	Scientific Name	Common Name	Status
Ardidae	*Botaurus stellaris 1*	Great Bittern	Globally Threatened
Accipitridae	*Aquila heliaca*	Imperial Eagle	Globally Threatened
Rallidae	*Crex*	Corn Crake	Globally Threatened
Accipitridae	*Buteo*	Buzzard	Significant Proportion of the World Population
Accipitridae	*Pernis apivorus*	Honey Buzzard	Significant Proportion of the World Population
Accipitridae	*Aquila nipalensis*	Steppe Eagle	Significant Proportion of the World Population
Accipitridae	*Accipiter brevipes*	Levant Sparrowhawk	Significant Proportion of the World Population

5.3.4 Baseline Results

According to the baseline strategy the following parts and areas along the proposed project’s corridor were sampled by the study team, the baseline results are presented as the following:

5.3.4.1 Flora

The proposed site for the project has a very poor vegetation cover that was due to natural causes where the distribution of the vegetation is restricted to the very shallow depressions and wadis as shown at **Figure 43** and **Figure 44** below. Also due to the existing and past use of the site for seasonal cultivation to produce livestock fodder. However, remnants of the natural vegetation cover were recorded in the proposed site and the surrounding area which of common species and ecologically considered a sign for a high degradation levels in the projects area habitats.

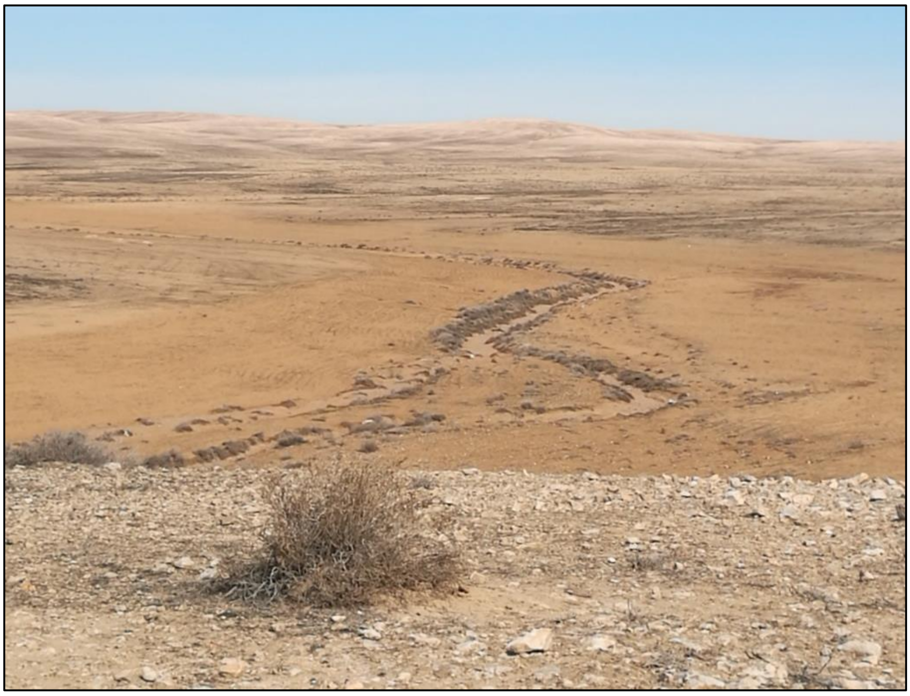

Figure 43: Very Low Vegetation Cover with Project Area

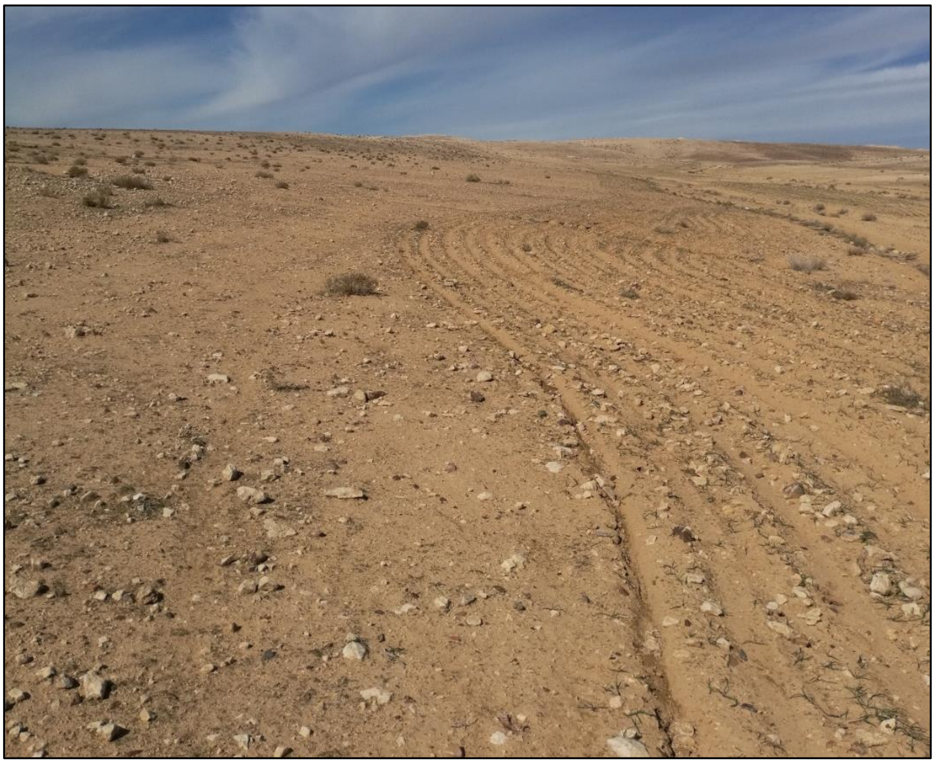

Figure 44: Plough for Seasonal Livestock Fodder Cultivation at Project Area

Only two species of natural plan found in the proposed site of the project that are representing the two vegetation types found at the project surrounding area. These one plant species is of not conservation importance since it is common at its vegetation type.

Recorded Plant Species

Rhamnus palaestinus: This plant is considered decreasing in the country since it used for making fire in some nomad communities, but at the site it was removed in the past to prepare land for existing landfill management.

Anabasis syriaca: common and do not have any conservation value.

5.3.4.2 Fauna

Due to the deterioration and the absence of the natural vegetation at the proposed site for the project, the faunal diversity recorded at the site is also very minimal. No species of reptiles were recorded due to the winter season during the survey, two species of mammals and five species of birds where recorded at the proposed site of the project and the surrounding area within 500 meter from the proposed sites borders.

It is believed that previous and current cultivation of the proposed site of the PV power plant has removed the suitable micro habitats for the fauna species that have small home ranges like reptiles and rodents. However, the area is still considered part of a larger ecosystem that surround the proposed site that can support such species in spite that the agriculture activity inside the project area and at the surrounding area but the small depression wadis can play the role of safe corridors for wildlife. Hunting signs were observed at site, **Figure 45** below shows empty hunting bullets observed at site For that the expected impact of the project during construction is very minimal, while during operation it's expected to have miner impacts on birds during migration seasons if not proper mitigation measures placed and properly considered.

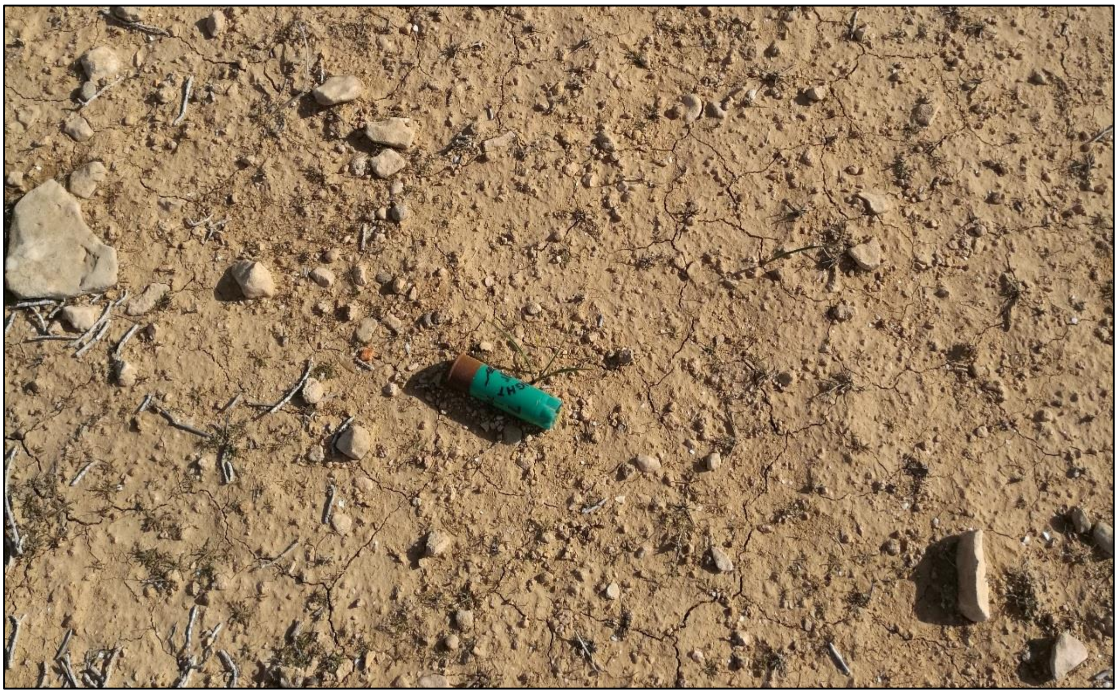

Figure 45: Empty Hunting Bullet at Site

The recorded fauna species and their conservation are the following:

Mammals

Canis Vulpes; Red Fox:
This species has been recorded through observation at project area, the study team has observed as well several dens at site that have foxes footprints.

Gerbillus gerbillus; **Lesser Egyptian Gerbil:**
This species has been recorded during the baseline survey through the borrows records and the scats, this species has no conservation status where it is considered of Least Concern according to IUCN Red Data List of 2008. This species is found throughout the desert and semi-desert regions.

Vulpes vulpes; Red Fox:
One of the most common large mammals in Jordan, which found in most of the Jordanian habitats and ecosystems. This species recorded at the project proposed site is through observation and foot prints and scats. The conservation status of this species in Jordan is not well defined due to the insufficient data about this species, however it is more common in the eastern parts of Jordan where the open desert considered a suitable habitat for the Red Fox.

Birds

Ammomanes deserti; Desert Lark:
This species has been recorded at the proposed site for the project by direct observation. It is one of the most common birds which found at different desert habitats. It has no important conservation value.

Eremophila bilopha; Temminck's horned lark:
One of the most common bird in the semi-desert and arid regions of Jordan. Its nest is on the ground, with two to four eggs being laid. Its food is seeds supplemented with insects in the breeding season. It has been recorded at the proposed site of the project by direct observation. The conservation status of this bird of Jordan is common and is not threatened.

Alauda arvensis; Eurasian skylark:

A very common and resident bird that found in mainly at the arid regions, and those contain cultivated lands. It has been recorded at site through direct observation.

Galerida cristata; Crested Lark:

It is a widespread arid and semi-arid habitats bird that even found at the transitional zones between the desert habitats and others. It has no conservation importance status and considered one of most common resident birds in Jordan. This species recorded by direct observation at the project site.

Buteo buteo vulpinus; Steppe Buzzard:

A common migratory raptor, it's found at a wide variety of habitats from woodlands to open and arid regions, also it is recorded at cultivated lands. It was recorded through a direct observation at the proposed site of the project. The conservation status of this species is common.

5.4 Socio – Economic Conditions

In general, Jordan is characterized by three major social environments, the urban life style, the rural life style, and Bedouin life style. The urban life style is represented by cities such as Amman, Mafraq, Irbid, etc. The rural life style is the dominant in the villages and small settlements scattered along the governorates where they rely on agricultural activities including seasonal cultivation of fodder for their livestock, and still the base and the governing reference for all social relations. Bedouin life style is mainly represented by nomads' movement on seasonal basis from one place to another in order to find proper water and feed resources for their livestock. The movement patterns rely on many different factors such as Water Resources, Biological Resources (Rangelands), Climate Conditions and Feed Resources (Cultivated Forage Lands).

This section gives an overview of the type and number of people who will be available within the project site and the surroundings, the surrounding land uses, existing infrastructure and utilities.

5.4.1 Population in the Vicinity of the Project Area

The project site is located Telal Al Rukban area, belonging mostly to Al Muwaqqar District which falls in Amman Governorate. The Population of Muwaqqar District is shown in **Table 26** below:

Table 26: Population of Muwaqqar

Area	Population
Muwaqqar District (total)	**84,370**
Muwaqqar Sub-district	47,753
Rajm Al Shami Sub-District	36,617

Source: Department of Statistics (DoS), Yearbook, 2015

The number of males in Muwaqqar district is estimated at 45,590 while females are estimated at 38,880. The project area and its direct surroundings is void of any populations. It is anticipated that the population that will be present within project premises is limited to project workers and employees. (DoS,2015)

The nearest populated are to the project is Maghayer Mhanna village with a population of 2,963. (DoS,2015)

As per DoS yearbook for 2015, the unemployment rate in Amman governorate is 11.5% of total the population, the rate of unemployment between males is 9.7% while the unemployment rate between females is much higher within Amman governorate which is 19.8%.

5.4.2 Project Support to Jordanian Government in Hosting Refugees

Energy Sector in Jordan

Jordan is one of the world's most energy insecure countries, importing about 97% of its energy needs. In terms of energy supply. Jordan has traditionally relied on natural gas imported from Egypt for 80% of its electricity. A series of disruptions to this flow have been experienced since 2011, with gas imports from Egypt declining by up to 70%. In response, Jordan shifted to crude oil imports from the Arab Gulf, with crude oil rising to 42% of energy imports in 2012. [10] As oil prices are much higher than natural gas, this has added about USD 2 billion per year to Jordan's energy import bill.[11] (Ministry of Planning, 2013)

In response to energy security concerns and Jordan's crippling subsidy bill, the country issued the Renewable Energy and Energy Efficiency Law (2012) focused on diversifying its energy mix and promoting renewable technologies. The government also endorsed major energy subsidy reforms, raising the prices of transport fuel and electricity. With rich renewable energy potential, the Ministry of Energy and Mineral Resources (MEMR) expects renewables to cover 10 % of their energy demand by 2020 – as of 2015. According to the National Energy Strategy for 2007–20, Jordan plans to develop some 600MW of wind projects and 600MW of solar generation by 2020. (Refugees and Energy Resilience in Jordan, 2016).

Situation Analysis

As of March 2016, there are approximately 636,000 Syrians (6.7 % of Jordan's population) formally registered by UNHCR although the Jordanian government considers a more realistic number to be 1.27 million Syrians (13.7 % of Jordan's population); which includes those who have chosen not to register with the UN and those who were living in Jordan before the war. Nearly 83 per cent of these refugees are living among host communities, outside of the designated refugee camps. (Refugees and Energy Resilience in Jordan, 2016)

The majority of Syrians in Jordan are poor, and their conditions have been worsening as the crisis continues. Around 70 % are living below the poverty line and as the years pass by many families have spent all their savings, sold their valuables or exhausted support from family members abroad. (Refugees and Energy Resilience in Jordan, 2016)

In recent years, Jordan has faced a serious convergence of energy related pressures, including disruptions of natural gas imports from Egypt and rising local demands due to a large influx of Syrian refugees. According to government statistics residential consumption rose by 9.44% from 2011 to 2012, compared to just 5.9% between 2010 and 2011. (Ministry of Planning, 2013) As per the latest statistics, electricity consumption in the northern governorates (those mostly affected by the Syria crisis) showed an additional increase of 2.3 per cent compared to other governorates in Jordan. (Jordan Response Plan for The Syria Crisis 2016-2018)

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[10] Department of Statistics, quoted http://english.nuqudy.com/Levant/Jordan%E2%80%99s_Energy_Cri-4547

[11] *See* http://www.reuters.com/article/2013/10/13/imf-jordan-idUSL1N0I208M20131013

An average of 57 % of refugee's income goes on accommodation. Spending on liquefied petroleum gas (LPG) for cooking and heating in winter, and electricity for heating water are significant expenses. There has been some assistance with heating costs and blankets for vulnerable families through the 'Cash Working Group' (now renamed the 'Basic Needs Sector Working Group') on the coordination committee (co-chaired by NRC and UNHCR). LPG is the only fuel derivative that remains subsidized by government and, according to the World Bank, Jordan has spent an additional USD 24.9 million on LPG due to the influx of refugees in 2012–14.[12] (Refugees and Energy Resilience in Jordan, 2016).

Response Plan as Announced by Ministry of Planning

The government foresees additional power demand in cities and towns to be approximately 225 MW, with capital investment to meet this additional demand estimated at US$ 337.5 million.[13] In order to cover these additional needs the Government of Jordan (GoJ) sees that instead of developing new import-dependent power capacities, the suggestion is to meet extra loads through energy efficient and renewable energy solutions, and increase awareness towards energy saving while building on existing capacities and initiatives. This approach empowers Jordan's capabilities to have a sustainable energy in the near future. (Jordan Response Plan for the Syria Crisis 2016-2018)

To accelerate and scale up efficient and effective responses to Jordan's growing energy demands in a sustainable manner that alleviates incremental demand pressures from the Syria crisis; within Jordan's broad strategy for transformational change in both energy supply and demand dynamics, two key objectives of relevance to Jordan's response to the Syria crisis are: (i) sustainable energy solutions including energy efficiency to meet rising residential energy demands in the short-term, and (ii) expand renewable energy solutions to meet the growing pressures for energy demand expansion in the medium-term. (Jordan Response Plan for the Syria Crisis 2016-2018)

5.4.3 Land Use

The land use of the project area falls within the bare soils; as shown in the figure below; which is considered an open rangeland.

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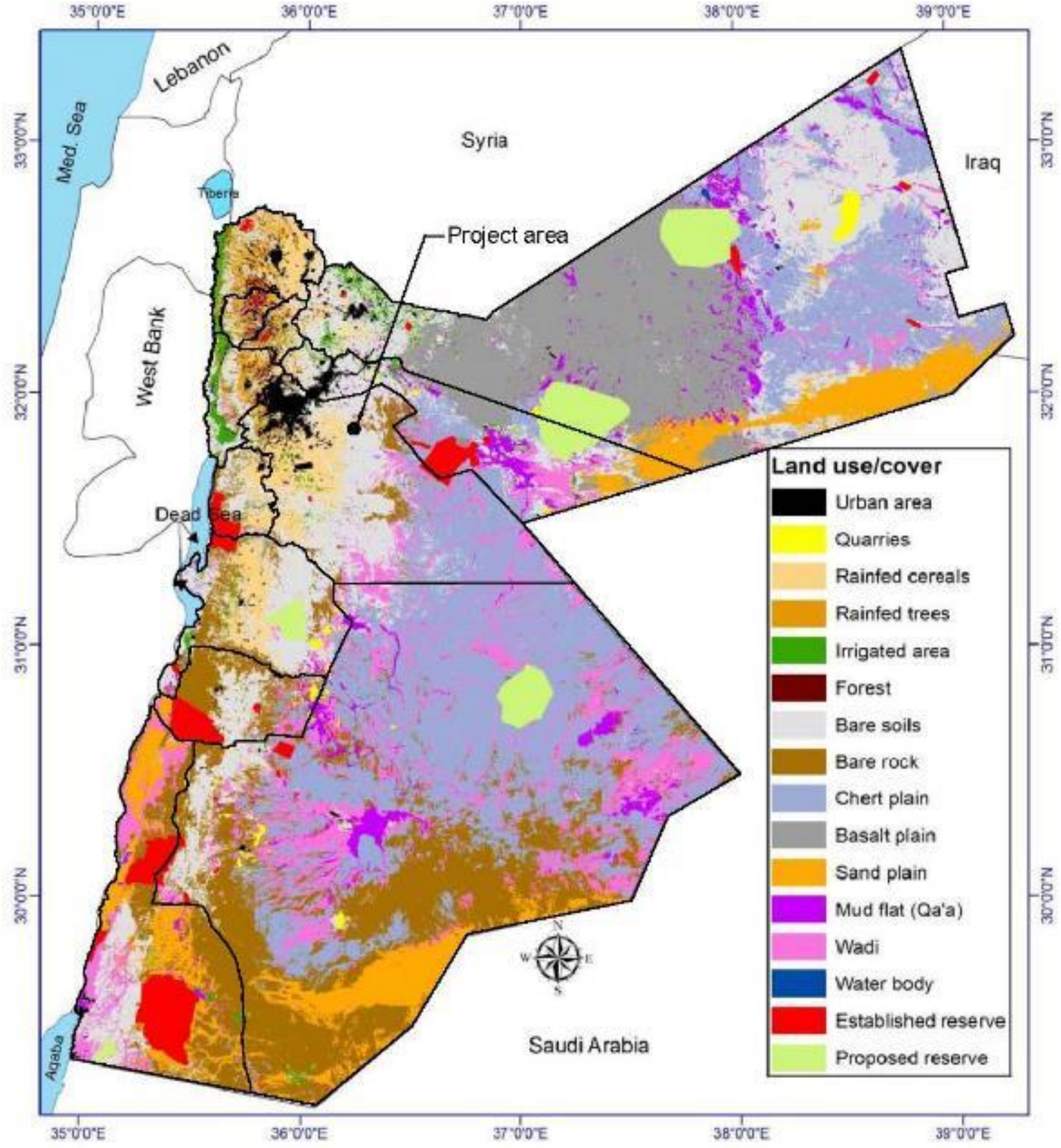
[12] World Bank (2013), *Jordan Economic Monitor, Moderate Economic Activity with Significant Downside Risk*, http://www.worldbank.org/content/dam/Worldbank/document/MNA/Jordan_Economic_Monitor_Fall_2013.pdf (accessed 7 May 2016).

[13] 6Ministry of Planning and International Cooperation (MOPIC), Impact of Hosting Syrian Refugees, October 2013


35°0'0"E
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39°0'0"E
33°0'0"N
32°0'0"N
31°0'0"N
30°0'0"N
Lebanon
Med. Sea
Syria
Iraq
Tiberia
Project area
West Bank
Dead Sea
Aqaba
Saudi Arabia
N
S
E
W
Land use/cover
Urban area
Quarries
Rainfed cereals
Rainfed trees
Irrigated area
Forest
Bare soils
Bare rock
Chert plain
Basalt plain
Sand plain
Mud flat (Qa'a)
Wadi
Water body
Established reserve
Proposed reserve

Figure 46: Land Use within Jordan

Other project area surroundings identified are located further away such as: closest communities, industrial & commercial activities, and private lands. These are illustrated below.

The distances for each from the boundary of project area are:

- Muwaqqar City is located ~12 km away
- Al-ghabawi landfill is located ~ 6.5 km away
- Al-maghayer village is located ~ 8.5 km away
- Electricity Power plant is located ~ 4.5 km away
- A farm is located ~ 3 km away
- Petroleum Products Terminal is located ~ 4.5 km away
- Fertilizer Workshop located ~ 200 m away to the west from the project boundary.

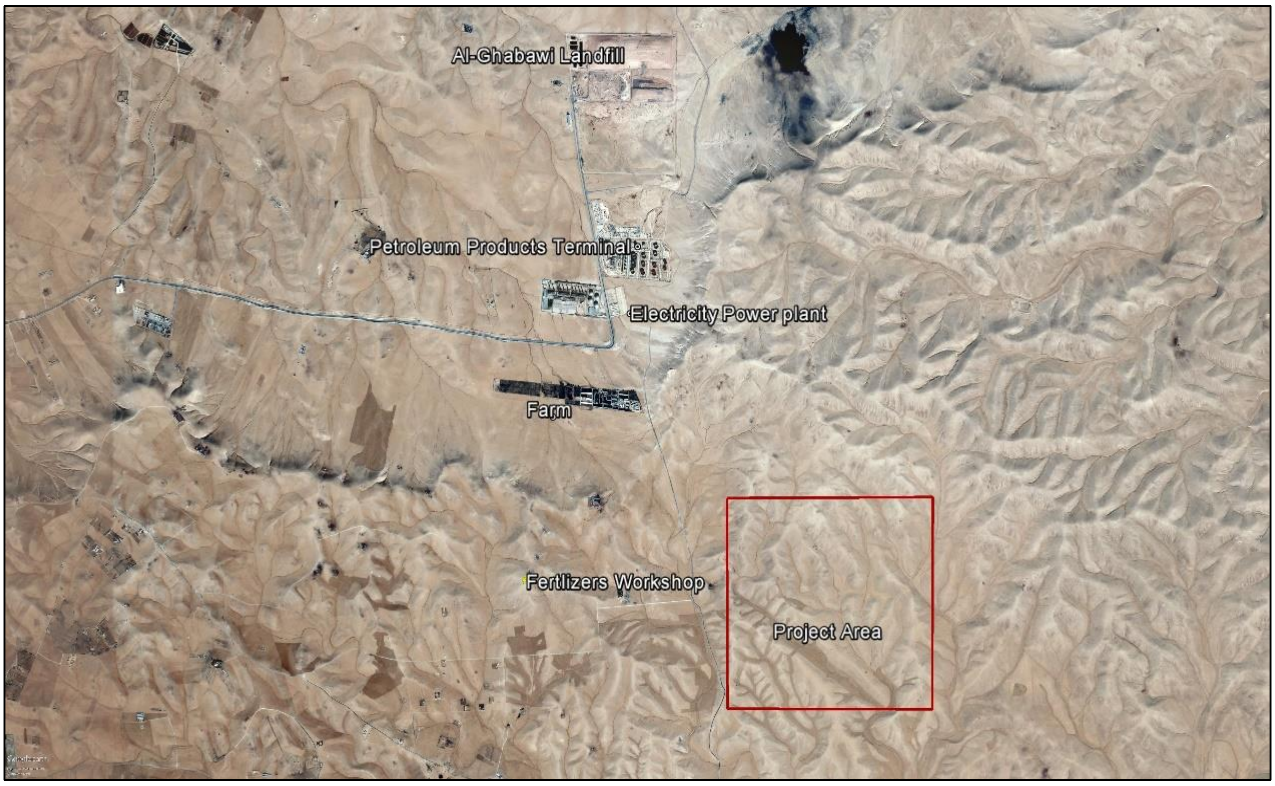

Figure 47: Other Project Area Surroundings

During the site visits conducted to the project area during winter season, some signs of land ploughing and cultivation have been observed within the project area and outside surroundings as well, mainly along the wadi routes as shown in **Figure 48** below. Although no residential dwellings or settlements are present on site and no identified use have been observed by the ESIA team during the site visits – given that the project land terrain is characterized by wadis, thus making it difficult for settlements to reside there, especially during the winter season due to cold climate conditions, topography of the land and potential flooding from wadis, such ploughing activity can be a result of herders or possibly locals from nearby villages or even nomads ploughing the land for the intermittent use possibly for seasonal cultivation to produce livestock fodder during spring season. It is worth mentioning also that ploughing evidence has been observed not only within the project area but within the nearby land surrounding the project area along wadi routes as well.

It is recommended to undertake further appropriate assessment prior to construction commences and during the spring season in order to verify the above information and identify the users.

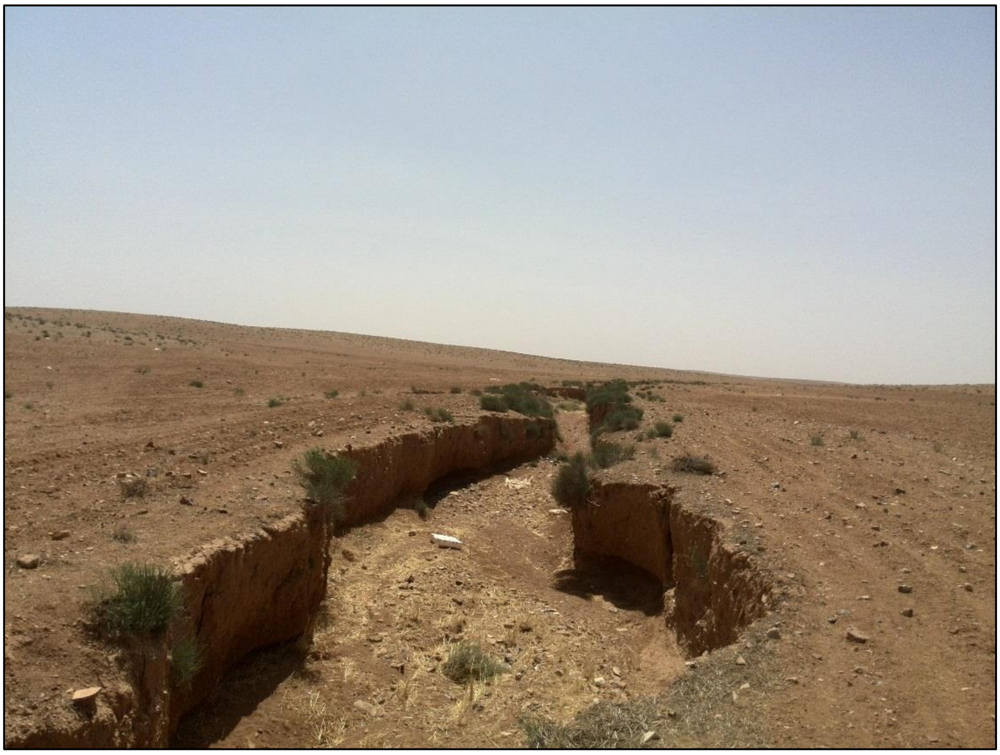

Figure 48: Observed land ploughing near Wadis

5.4.4 Infrastructure and Utilities

The Site is easily accessible through Muwaqqar area in the south or through the road leading to the conventional power plant north west of the Site. A paved road runs along the western side providing access; however this existing road is relatively narrow.

Currently, there is no electricity or water supply within the project area. As can be seen in **Figure 47** above; the project is 4.5 km away from the conventional electricity power plant (IPP3), so during construction phase the project can get its electricity supply from the plant. As for water supply; a cow farm which served by water is located 3 km away from the site, this means there will be no problems serving the project area with water.

5.5 Archaeological and Cultural Heritage Resources

As part of the geotechnical investigation conducted for this project – an Archaeological survey was carried out by the Department of Antiquities (DoA). To ease the process; the DoA have divided the area into 9 squares. Two archeological sites were found in one of the squares; the first (Site 1) is the remains of a small Burj Amouni, where the area was used as a cemetery by Bedouins, no pottery remains were found.

The second site (Site 2) is 220m away from Site 1; which also consists of the remains of a Burj Amouni, same as the first site; no pottery remains were found on the surface. **Figure 49** shows location of the two sites within the 6km^2 project area boundaries. Pictures of the two sites are shown in **Figure 50** and **Figure 51**. It is worth mentioning that both sites were sabotaged by opportunists seeking treasures and archeological remains. The survey did not identify any other archaeological remains; and its worth mentioning that the project area and its surroundings have undergone an archaeological survey during year 1996; however, no archaeological sites were found.

The Archaeological survey report consisted of two main recommendations which are:

- Adherence to the project area allocated for the project and not to exceed it; and
- Follow the chance finds protocol if any artifacts were found on site during construction works or any other civil works related to the project.

DoA issued a no objection letter which approves the construction of the project. The Archeological survey report together with the no objection letter included is presented in (**APPENDIX D**).

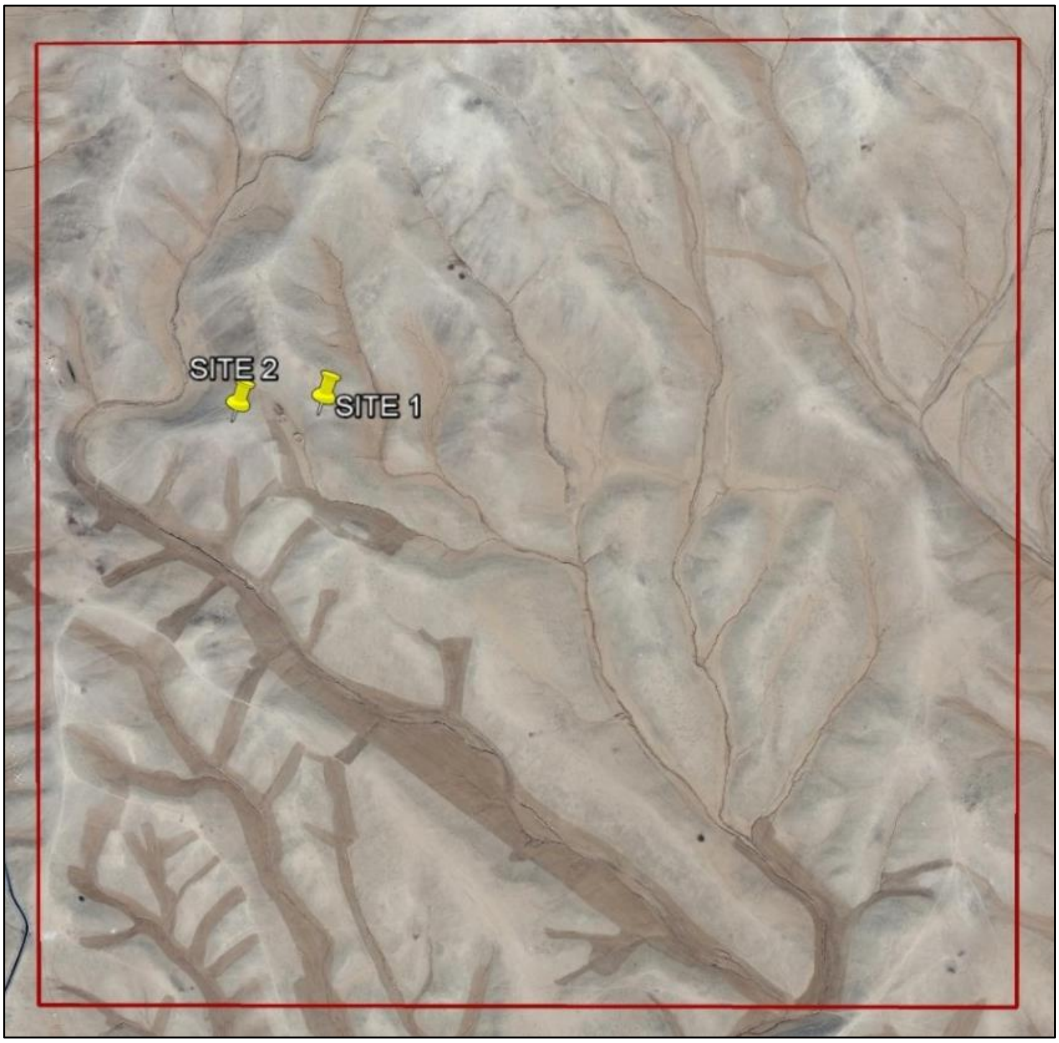

Figure 49: Archeological Sites within Project Area

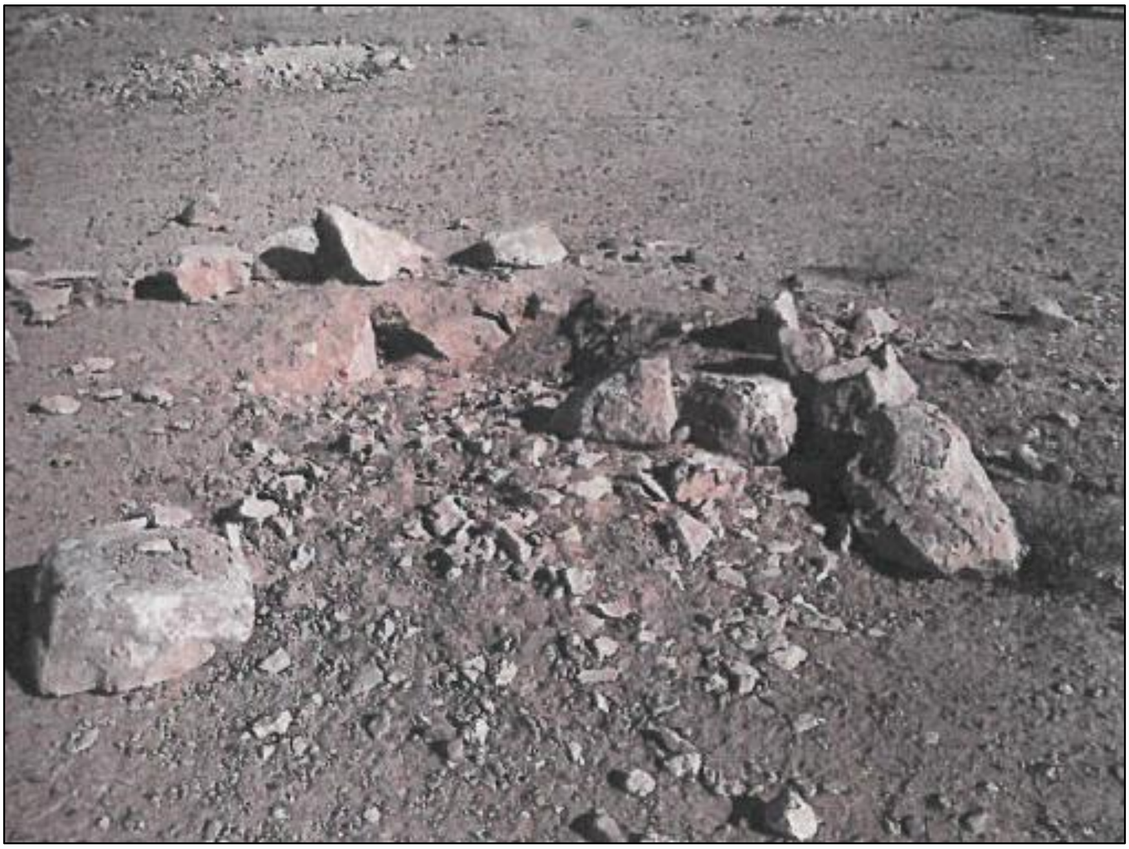

Figure 50: First Identified Site with Archeological Remains (Site 1)

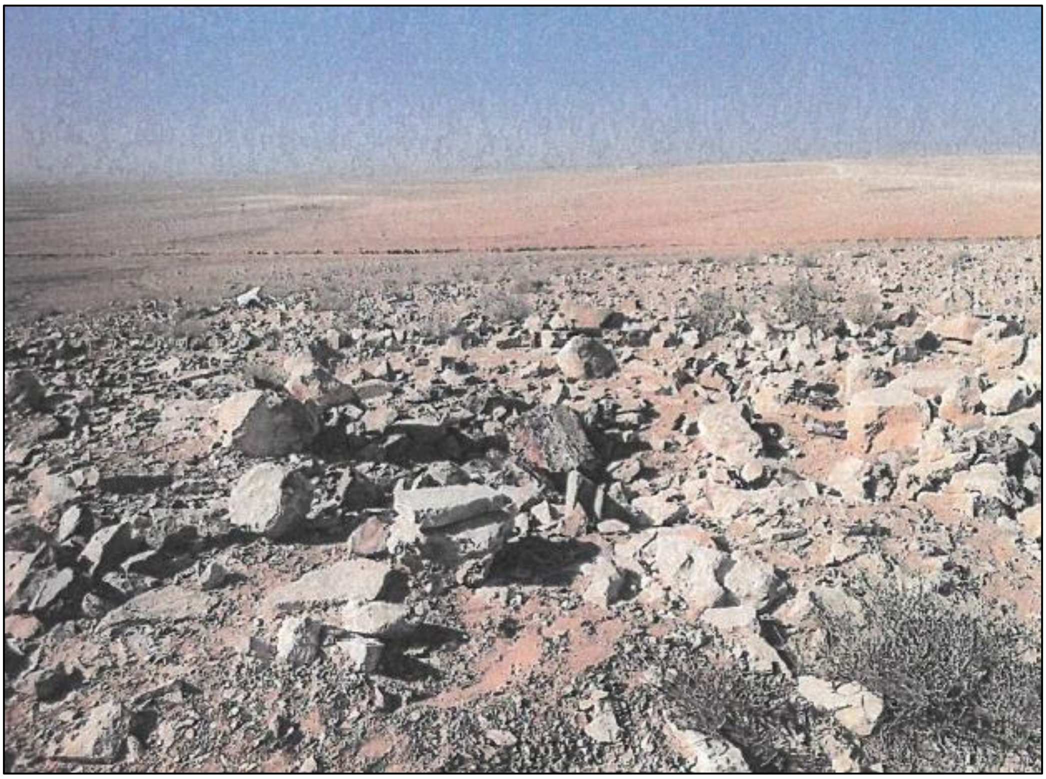

Figure 51: Second Identified Site with Archeological Remains (Site 2)

6 STAKEHOLDER IDENTIFICATION AND ENGAGEMENT

6.1 Introduction

Stakeholders are identified as any individual and/or group that could be affected by the proposed project activities and has interest in their outcome. According to this definition, the stakeholders may include property owners, business owners, central government and local officials, special interest groups, and non-government organization.

Stakeholders should play a vital role in providing advice to the project management, therefore, in compliance with local EIA regulations, and international standards, i.e. IFC, stakeholder engagement activity has been an ongoing process throughout the ESIA process.

The stakeholder engagement activities carried out during this ESIA are as follows:

- Identification of project stakeholders and all parties affected or related to this project
- Conducting a scoping session and documenting its results in a Scoping Session report as part of the Final ToR.
- Conducting site visits to meet with community representatives / relevant locals.

6.1.1 Identification of project stakeholders

As per the Stakeholder Engagement Plan (SEP) prepared for this project, project stakeholder groups have been identified and are presented in **Table 27** below.

Table 27: Identified Stakeholder Categories

Stakeholder Category	Stakeholders
Internal Stakeholders	
Employees	This includes relevant Baynouna female and male employees such as Managers, Engineers, Technical Staff, maintenance, secretaries, administrative personnel, etc.
Workers	Temporary and permanent workers at Project Company.
Operators	Operators responsible for the daily operation and maintenance of the PV plant.
Contractors / Sub-contractors	Contractors and sub-contractors working with Baynouna on this project.
External Stakeholders	
National Government	Ministry of Environment, Ministry of Energy and Mineral Resources, Ministry of Municipal Affairs, Ministry of Health, Ministry of Labour, Ministry of Transport, Ministry of Public Works and Housing, Ministry of Agriculture, Department of Antiquities, Jordan Standards and Metrology Organization,

Stakeholder Category	Stakeholders
	Energy & Minerals Regulatory Commission, Civil Aviation Regulatory Commission.
Local Government	Municipalities such as Muwaqqar Municipality
Community Members	Community leaders, employed men and women, herders and farmers, households' males and females, employed and unemployed labour force, youth and students.
Trade	Trade association groups, cooperatives, credit institutions, banks, businesses, business owners, tourism, agriculture, private health business, and public services companies
NGOs	This category includes local CBOs, local woman organizations, local cooperation societies, Farmers Society /association.
International Agencies	This includes international funding agencies that are funding projects in the area such as The International Finance Corporation (IFC).
Academic	Universities and Research Institutes.

6.1.2 Conducting a scoping session

The Ministry of Environment has sent invitations for all relevant stakeholders to attend the scoping session a week prior to the session's date. The list of stakeholders that attended the scoping session is presented in the Scoping Session report which is provided as **APPENDIX A.**

The main issues that were tackled during the session can be summarized as follows:

- The positive impact the project might hold for local community.
- Panels cleaning method and source of cleaning water;
- The project is considered as a green project.

The overall aim of the scoping session was to take into consideration all issues of concern raised by stakeholders throughout different phases of the project. Thus, the above mentioned issues were evaluated and assessed, where relevant, to ensure that the impacts are not significant and no harmful effects will be caused during and after the project.

6.1.3 Consultation of Community Representatives in Muwaqqar

In addition to conducting the scoping session a visit to Muwaqqar by the ESIA team was conducted on Thursday January 19th 2017. **Table 28** below consists of consulted parties during that visit. The ESIA team have reached the cow farm (Al-Haj Aliyan Farm) close to project area for consultation, but there was no collaboration and the team couldn't meet with anyone representing the farm.

Table 28: Consulted Stakeholders

No	Consulted Party	Name of Party Representative	Date of Meeting
1	Muwaqqar Municipality	Mr. Abdulkareem Al-Qaishish	17/1/2017
2	Al-Nuqairah Women's Association	Ms. Samia Al-Jbour	17/1/2017
3	Robou' Al-Ordon Workshop Fertilizers workshop	Mr. Marwan Abdulhamid Sandouqa	17/1/2017

- **Consultation with Muwaqqar Municipality**

AJ team have met Muwaqqar municipality representative Mr. Abdulkarim Al-Qaishish. Multiple topics have been discussed concerning the project. Muwaqqar municipality has shown acceptance to the project. Major topics discussed in this meeting were:

- The main effects this project might have on local community.
- Municipality's major demands and concerns about the project:
    - Much focus was payed to job opportunities, whether it's done by providing jobs or through the training of locals on works related to such projects.
    - The Municipality expects to keep local community involved during all project stages, and to keep constant consultation of them.
    - The Municipality asked if any support can be provided to help paying the electricity bill of the municipality building.

- **Consultation with Al-Nuqairah Women Association.**

The association showed full support of the project, for such projects decrease country's dependency on fossil fuels. The association expects the area to thrive economically due to the presence of all workers. Ms. Samia Al-Jbour the representative of the association has raised the workforce issue; she mentioned that local community has the potential to provide the project with much of the required workforce, she also emphasized on the importance of employing women for suitable positions.

- **Consultation with a local fertilizers workshop (Robou' Al-Ordon Workshop)**

The workshop is the closest facility to the project area (approximately 200 m away); hence, AJ team have seen that it is essential to be consulted. AJ team have met the owner of this workshop Mr. Marwan Abdulhamid Sandouqa. Mr. Marwan was very welcoming and supportive of the project and had no comments or concerns in its regard.

As part of the interview AJ team inquired about the observation of the ploughed land that was been witnessed across the wadi routes during the project site visit. Mr. Marwan mentioned that usually such lands are ploughed for forage cultivation during autumn season (mainly October / November) and then herders'/herd owners would come back during spring time (April / May) to feed their herds. However according to Mr. Sandouqa such activities occur in very minimal manner and have also been observed outside the project area and surroundings.

مصنع
شركة ربوع الاردن ذ.م.م
لصناعة المحسنات - أسمدة عضوية
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Figure 52: Photos from consultation activities

7 IDENTIFICATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC ASPECTS AND RECEPTORS

Project environment covering physical, biological, Socio-economic and Occupational Health & Safety (OHS) aspects are identified for all proposed activities which has the potential to:

- Interact with the environment (physical, biological, socio-economic & OHS); and
- Breach the conditions of relevant national and international standards and guidelines.

The identified receptors are presented in **Table 29** below.

Table 29: Identified Environmental and Socio-economic Receptors

Aspects/ Receptors	Details
1-Physical Environment	
Air Quality	The atmosphere at and around the Project Site.
Noise	The construction phase especially activity related to transportation and execution might have a potential impact upon.
Soil	The soils of the project area on which construction, operation and decommissioning activities will occur.
Hydrogeology	The hydrogeology (i.e., groundwater) in the area in and around where construction and operation activities will occur.
Hydrology	Storm water within the project area.
Landscape / Visual Impact /Topography	The geomorphologic land forms and terrain at the Project site.
2-Biological Environment	
Flora	Plant species that could potentially exist in the area in which the construction and operational activities will occur.
Fauna: (Birds, Reptiles and Mammals)	Fauna species that could potentially be affected by the project different activities in the area in which the construction and operational activities will occur.
3-Occupational Health and Safety	
Construction Team	Staff on project site which are subject to occupational hazards effects such as noise, dust, etc.
4-Socio-economic Environment	

Aspects/ Receptors	**Details**
Public Health & Safety – (PHS)	Land users nearby the project boundaries that could be subject to hazards/public health and safety effects potentially arising from the Project's activities.
Population	The project area is far from the populated areas. Hence, there is no population (people) utilising the project area.
Land Use & Land Ownership	The project area is owned by the Government of Jordan (GoJ) and has been leased by Baynouna for the project duration.
Workforce & Employment	New work opportunities are expected mainly construction phase and operation phase
Utilities and infrastructure	The utilities (e.g. power supply, water, telecommunications, sewage services) which will be provided for the project.
Transport & Traffic	Road transport systems of the area in which the Project activities are to occur during the construction phase, and minor during operation phase.
Archaeology / Cultural Property	Archaeological sites and artefacts that have cultural significance found within or in the vicinity of the Project area.

7.1 Interaction of Identified Aspects and Receptors

Based on the review of environmental aspects, project activities, and the project's environmental receptors, a summary of potential interactions between the environmental aspects and receptors relevant to this project were identified. This will allow for a preliminary assessment of the key environmental issues related to physical, biological, OHS and socio-economic receptors, or 'key issues' associated with the Project to be completed.

The interaction of aspects and receptors identified in the ESIA process are presented in **Table 30** below for all planned and unplanned activities in addition to take natural disasters into consideration:

Table 30: Environmental and Socio-Economic Aspect Matrix

Receptor / Activity		Physical						Biological			OHS	Socio-economic							Other
		Air Quality	Noise	Soil	Groundwater	Hydrology	Landscape / Topography	Flora (habitats)	Birds	Reptiles & Mammals		PHS	Population	Land Use	Workforce & Employment	Utilities & Infrastructure	Transport & Traffic	Cultural & Archaeology	Liability / Reputation
Planned Activities																			
Construction	Access road to site	●	●	●			●	●		●	●	●			●	●	●	●	●
	Accommodations	●	●	●			●	●		●	●		●		●	●	●		●
	Haulage	●	●	●		●		●	●	●	●	●			●	●	●		●
	Site survey	●	●					●							●		●		●
	Site soil Investigation	●	●	●	●	●		●			●				●			●	
	Clearing and grading	●	●	●		●	●	●	●	●	●	●			●	●		●	●
	Trenching & ditching	●	●	●			●	●		●	●	●			●	●		●	●
	Excavation & digging	●	●	●			●	●		●	●	●			●	●		●	●
	Earthworks & Civil works	●	●	●			●	●		●	●	●			●				●
	Mobilization/demobilization of labor & equipment	●	●	●		●	●	●	●	●	●	●			●	●	●		●
	Structures construction	●	●	●		●	●	●	●	●	●	●		●	●			●	●
	Waste generated from construction activities			●		●	●	●		●	●	●	●	●	●				●
	Wastewater generated by site workers			●		●	●	●		●	●	●	●	●	●	●			●

Receptor / Activity		Physical						Biological			OHS	Socio-economic							Other
		Air Quality	Noise	Soil	Groundwater	Hydrology	Landscape / Topography	Flora (habitats)	Birds	Reptiles & Mammals		PHS	Population	Land Use	Workforce & Employment	Utilities & Infrastructure	Transport & Traffic	Cultural & Archaeology	Liability / Reputation
Operation	Wastewater discharge			●		●	●	●	●	●	●	●	●		●	●			●
	Municipal solid waste handling	●		●		●	●	●	●	●	●	●	●	●	●				●
	Hazardous/chemical waste storage and disposal	●		●		●	●	●	●	●	●	●	●	●	●	●			●
	Chemical / oil storage	●		●		●		●	●	●	●	●	●		●				●
	Vehicles operation	●	●								●	●			●		●		●
	Maintenance activities	●	●	●		●	●	●		●	●	●			●	●	●		●
Decommissioning	Equipment Dismantling & disconnection of plant components		●	●			●	●		●	●	●	●		●		●		●
	Demolishing	●	●				●	●	●	●	●	●	●		●		●		●
	Fence Removal		●					●			●	●	●		●		●		●
	Excavation & backfilling	●	●	●		●	●	●	●	●	●	●	●		●	●	●		●
	Disposal		●	●			●				●				●	●			●
Unplanned Project Activities																			
Construction	Vehicle collision	●	●	●				●	●	●	●	●	●				●		●
	Spill of chemicals or liquid fuels	●		●		●	●	●	●	●	●	●	●						●
	Ignitions of flammable materials / accidental fires	●		●			●	●	●	●	●	●	●				●		●
Operation	Vehicle collision	●	●	●				●	●	●	●	●	●				●		●

Receptor / Activity		Physical						Biological			OHS	Socio-economic							Other
		Air Quality	Noise	Soil	Groundwater	Hydrology	Landscape / Topography	Flora (habitats)	Birds	Reptiles & Mammals		PHS	Population	Land Use	Workforce & Employment	Utilities & Infrastructure	Transport & Traffic	Cultural & Archaeology	Liability / Reputation
	Spill of chemicals or liquid fuels	●		●		●	●	●	●	●	●	●	●						●
	Ignitions of flammable materials / accidental fires	●		●			●	●	●	●	●	●	●				●		●
Natural Disasters																			
Construction	Earthquake “Seismic Activities”		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	
	Flooding			●		●	●	●	●	●		●	●	●		●	●		
Operation	Earthquake “Seismic Activities”		●	●	●		●	●	●	●		●	●	●	●	●	●	●	
	Flooding			●		●	●	●	●	●		●	●	●		●	●		

8 ANALYSIS OF PROPOSED PROJECT ALTERNATIVES

The analysis of project alternatives is one of the main tenets of environmental impact policy and procedures world-wide. A thorough, unbiased and transparent assessment of alternatives from an environmental, social, technical and economic standpoint is one of the most important contributions an ESIA can make to improve decision making.

The analysis for this project contains options/alternatives which are the “No Project” versus “Project” alternative in addition to other energy resources alternatives; however, the project location is selected by the developer.

By considering these alternatives prior to the commencement of Project activities, environmental and social project benefits can be maximized and potential challenges can be identified and addressed.

Table 31 below presents the symbols that denote the various levels of environmental impact to aid in the comparison of alternatives. Each symbol indicates an overall evaluation of the specified environmental component and social aspect.

Table 31: Evaluation Symbols for Levels of Environmental and Social Impact

Symbol	Description
X	Denotes potential for impact, which is not considered significant
S-	Denotes Potential Significant Adverse Impact
S+	Denotes Potential Significant Beneficial Impact
*	Denotes no change to the existing situation

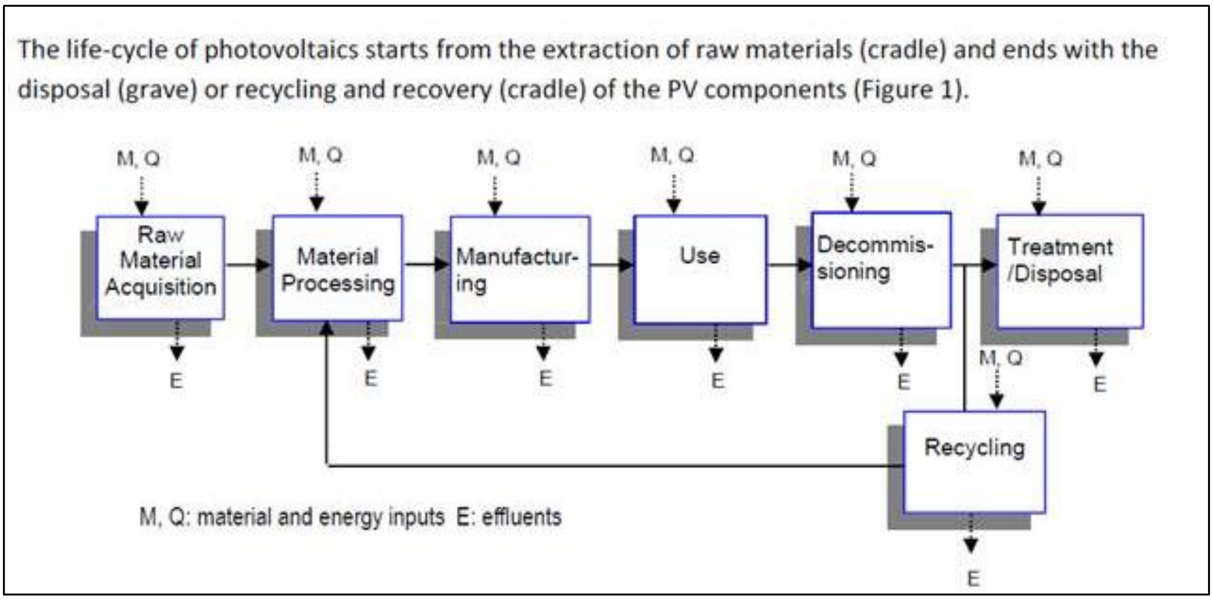
8.1 The ‘Project’ Vs. the ’No Project’ Alternative

The “No Project” option considers the alternative of not conducting the project at all. It is normally evaluated to assess the impacts if the project does not go ahead. This alternative is evaluated against the implementation of solar energy project as one of the renewable energy resources in Jordan.

Table 32 presents the results of the evaluation. Going forward with the proposed project alternative is considered the best possible option as opposed to ‘No Project’ since the proposed project is considered a green and environmental solution for Solar Power in Jordan as the solar energy considered as renewable clean technology with no emissions as well as the global and local trend for energy generation.

With respect to GHG emissions generated from solar PV projects compared to other conventional power generation projects such as traditional coal fired electric power plants. We notice that the implementation of solar PV projects is considered more environmentally sound as per the below analysis.

Life Cycle Assessments (LCA) and Green House Gas emission inventories are conducted to better understand a project's environmental burden from "cradle to grave' and also to aid in comparison between different energy technologies (for example, PV plant compared to traditional coal fired power plant). The LCA looks at the Green House Gas (GHG) emissions associated with every step of the PV project's lifecycle including the upstream (manufacturing) processes, operational processes during the life of the project and downstream processes including system decommissioning and disposal. This cradle-to-grave (and sometimes cradle-to-cradle when certain components are reused) approach is illustrated in the figure below generated by the International Energy Agency (IEA, 2011).



The life-cycle of photovoltaics starts from the extraction of raw materials (cradle) and ends with the disposal (grave) or recycling and recovery (cradle) of the PV components (Figure 1).

Figure 53: Material and energy inputs / outputs during the PV project lifecycle from cradle to grave (or cradle) (IEA.2011)

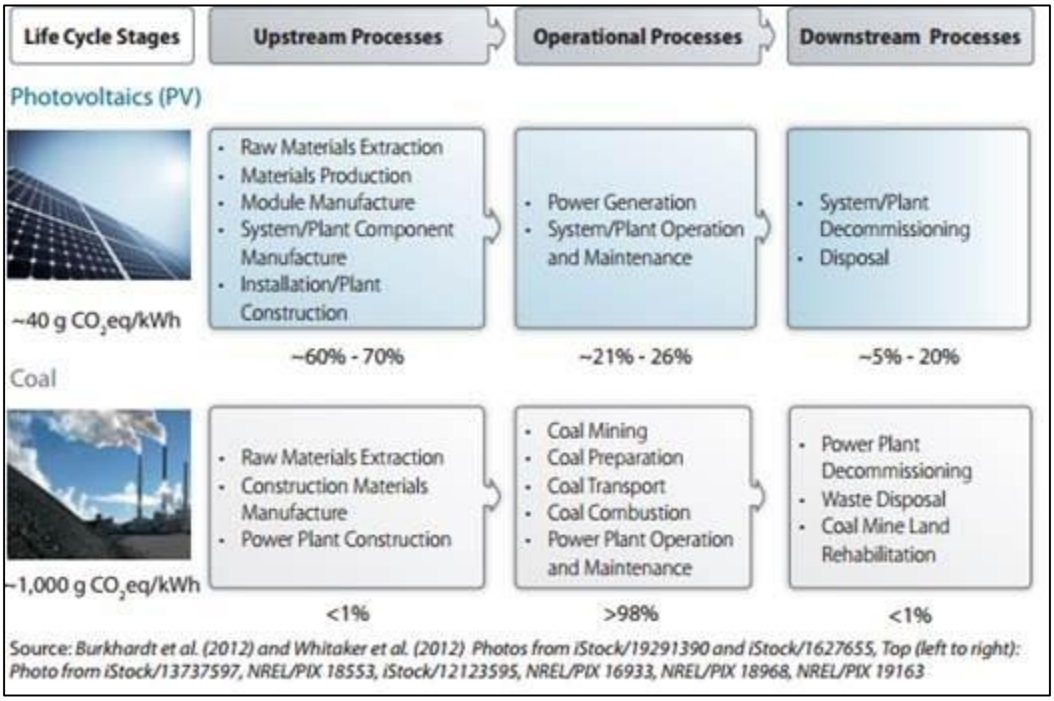
Based on a desktop review of relevant sources by renowned international organizations like the International Energy Agency (IEA, 2011) and the US based National Renewable Energy Laboratory (NREL, 2012), benchmarks for lifecycle GHG emissions for PV technology are presented in this section. In both cases, the lifecycle GHG emissions for PV projects have been generated based on the following information and assumptions:

- Analysis of the lifecycle emissions for the most widely used PV systems including Crystalline Silicone (c-Si) (both mono and multi-crystalline) and Thin Film (TF) (however for thin film there is less available robust data globally).
- The analysis includes all stages of the upstream process: material extraction, materiel production, module manufacture (input / output energy and materials during

manufacturing of cell, wafer, module, and balance-of-system), System/plant component manufacture, installation/plant construction.

- This is followed by GHG analysis duration operation activities which include power generation and system/plant operation and maintenance
- Finally, the LCA considers emissions during system/plant decommissioning, disposal and recycling –where applicable.
- The NREL has conducted a Harmonization Project (2012) based on the outcomes of hundreds of published LCA studies over the past 30 years, where the following parameters and assumptions were harmonized to provide accurate and transparent estimates for GHG emissions from PV systems. These are:
    - Solar Irradiation 1700-2400 kwh/m^2/yr.
    - System lifetime at 30 years
    - Crystalline Module Efficiency at 14% and 13.2% respectively for mono and multi-crystalline modules, respectively
    - Performance ratio of 0.8 for ground-mounted systems

Based on the above, the GHG emissions from PV systems has been found to be about **40 g CO_2eq/kwh** compared to 1000 g CO_2eq/kwh for traditional coal fired electric power plants as illustrated below.


Life Cycle Stages
Upstream Processes
Operational Processes
Downstream Processes
Photovoltaics (PV)
• Raw Materials Extraction
• Materials Production
• Module Manufacture
• System/Plant Component Manufacture
• Installation/Plant Construction
• Power Generation
• System/Plant Operation and Maintenance
• System/Plant Decommissioning
• Disposal
~40 g CO2eq/kWh
~60% - 70%
~21% - 26%
~5% - 20%
Coal
• Raw Materials Extraction
• Construction Materials Manufacture
• Power Plant Construction
• Coal Mining
• Coal Preparation
• Coal Transport
• Coal Combustion
• Power Plant Operation and Maintenance
• Power Plant Decommissioning
• Waste Disposal
• Coal Mine Land Rehabilitation
~1,000 g CO2eq/kWh
<1%
>98%
<1%

Source: *Burkhardt et al. (2012) and Whitaker et al. (2012) Photos from iStock/19291390 and iStock/1627655, Top (left to right): Photo from iStock/13737597, NREL/PIX 18553, iStock/12123595, NREL/PIX 16933, NREL/PIX 18968, NREL/PIX 19163*

Figure 54: Lifecycle GHG emissions for PV systems compared to coal fired electric power plants

It is important to note that most of the emissions associated with PV systems are attributed to the material and energy intensive upstream process including extraction and manufacturing. Operational emissions account for 20% of the PV system's lifecycle GHG emissions however this number could even be lower for a country like Jordan where the solar irradiation would be higher than the assumed 1700 kwh/m^2/yr., potentially reaching up to 2400 kwh/m^2/yr. in the project area near Muwaqqar within Amman Governorate as can be seen in the figure below.

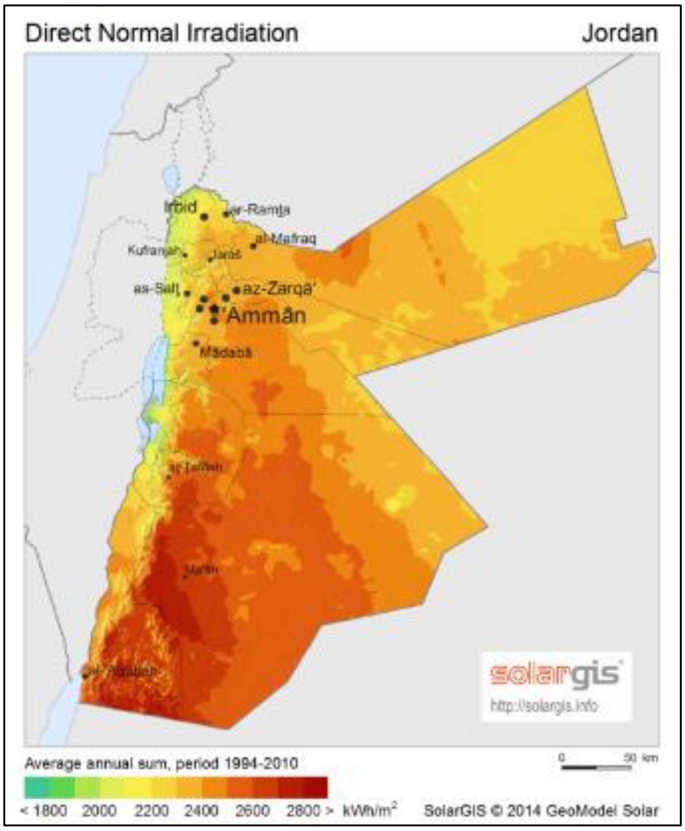

Direct Normal Irradiation
Jordan
Irbid
ar-Ramtha
al-Mafraq
Kufranjah
Jarash
as-Salt
az-Zarqa'
'Amman
Madaba
solargis
http://solargis.info
Average annual sum, period 1994-2010
0
50 km
< 1800 2000 2200 2400 2600 2800 > kWh/m²
SolarGIS © 2014 GeoModel Solar

Figure 55: Jordan solar irradiation map in (kwh/m2/yr.) (Source: solargis)

Similarly, the study prepared by the IEA (2011) reflects a similar but slightly lower range of GHG emissions for the key PV technologies at about 30 g CO_2eq/kwh, as illustrated below. However, the variation may be attributed to the fact that the figure below is based on roof-mounted PV systems where the BOS (Balance of System including module support, cabling and power conditioning) may differ for ground mounted PV, which is the case for our project. In addition, these studies do not specifically differentiate between the GHG LCA for tracking vs. non-tracking systems, where there may be a slightly higher operational GHG emissions for tracking systems as is the case for the project at hand.

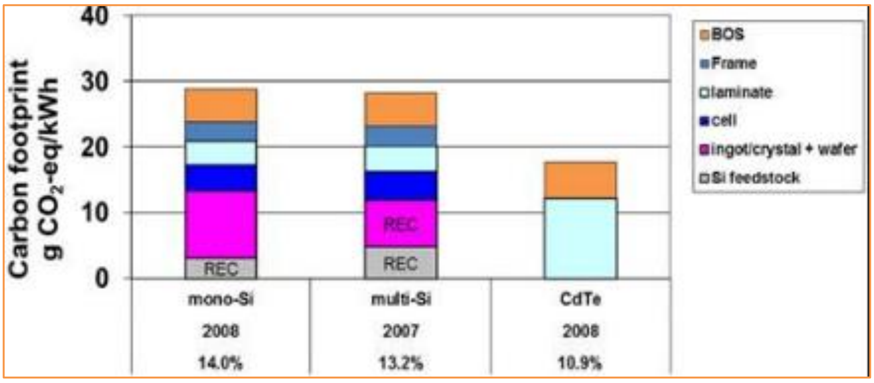
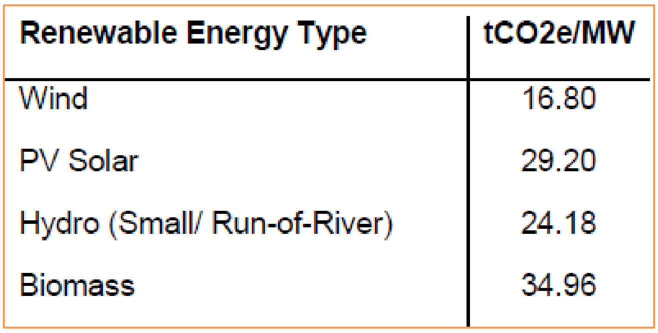


Figure 56: Carbon foot print of crystalline and thin-film roof mounted PV systems (IEA, 2011)

In addition, the IFC for its own investment purposes assumes the following conservative default emissions factors for the non-operational aspects of renewable energy projects which included GHG emissions during production, transportation, installation, disposal and leakage beyond the project boundary). These are summarized below:



Renewable Energy Type	tCO2e/MW
Wind	16.80
PV Solar	29.20
Hydro (Small/ Run-of-River)	24.18
Biomass	34.96

Figure 57: IFC Renewable Energy Emission Factors

Based on the above, for this 200 MW project, **5,840 ton equivalent of CO_2 (tCO_2e)/yr.** are expected from “other emissions” (as opposed to operational emissions) over the lifetime of the project (IFC, 2011).

Generally speaking, however, renewable energy systems including PV power plants are considered to be climate change mitigation projects in the sense that their deployment results in an overall reduction of GHG emissions, as they tend to replace more carbon-intensive technologies like the coal or heavy-fuel fired electric power plants. This is the case in Jordan where grid-connected PV systems result in offsetting electrical power that is otherwise produced by fuel powered electric power plant. The latest Carbon Emissions Estimation Tool (CEET) issued by the IFC in 2014 indicates the following emission factor for a kWh of electricity produced the grid in Jordan:

637.42 g CO_2eq/kwh, compared to the 40 g CO_2eq/kwh associated with the PV lifecycle GHG emission mentioned above roughly shows the reduction potential of such projects.

This mitigation dimension of PV projects is captured by parameters like the Energy Payback Time (EPBT), which is defined by the IEA as “the period for a renewable energy system to generate he same amount of energy (in terms of primary energy equivalent) that was used to produce the system itself”, which is captured by the following equation:

$$\text{Energy Payback Time (EPBT)} = (E_{mat}+E_{manuf}+E_{trans}+E_{inst}+E_{EOL}) \,/\, ((E_{agen}/\eta_G) - E_{aoper})$$

where,

E_{mat} : Primary energy demand to produce materials comprising PV system
E_{manuf} : Primary energy demand to manufacture PV system
E_{trans} : Primary energy demand to transport materials used during the life cycle

E_{inst} : Primary energy demand to install the system
E_{EOL} : Primary energy demand for end-of-life management
E_{agen} : Annual electricity generation
E_{aoper} : Annual energy demand for operation and maintenance in primary energy terms
η_G : Grid efficiency, the average primary energy to electricity conversion efficiency at the demand side

Applying the above equation to the common PV systems, the IEA study indicates an average EPBT of around 1.5 years for these projects.

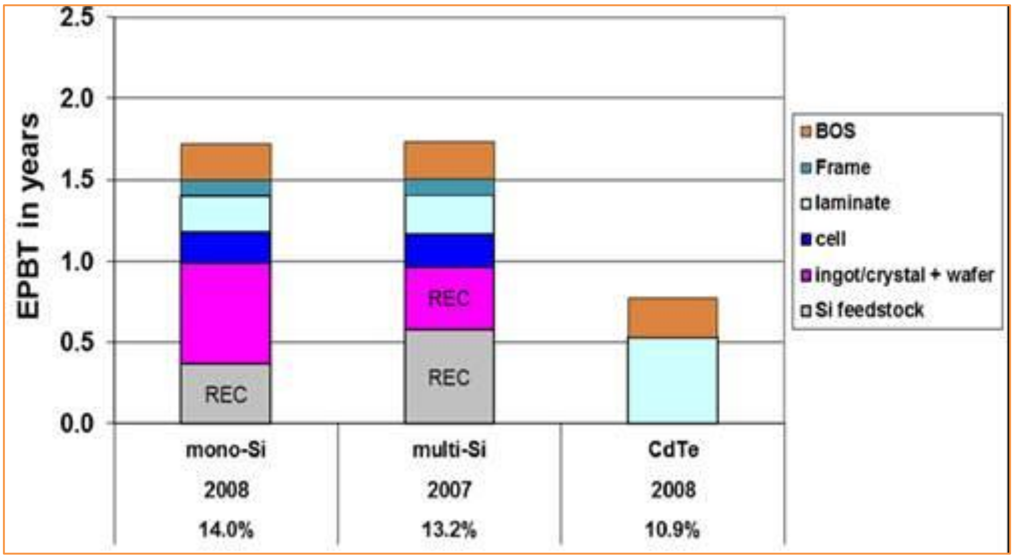


Figure 58: Energy payback time (EPBT) for PV technologies (Source: IEA, 2011)

Table 32: Comparison of overall environmental and socio-economic impacts for the project Vs. 'no project' alternative

Environmental Components	Project Options	
	Proposed Project	No-Project Alternative
Terrestrial Ecology	S-	*
Air Quality	*	*
Green House Gas (GHG) Emissions	S+	S-
Noise Generation	*	*
Wastewater Generation	S-	*
Waste Generation / Disposal	S-	*
Soil & Groundwater	*	*
Health & Safety	s-	*
Socio-economic Impacts	S+	x
Traffic Disturbance	x	*
Land Use	S+	s-
Archaeology / Cultural Property	x	*

Environmental Components	Project Options	
	Proposed Project	No-Project Alternative
Energy Production	S+	s-
Employment and Job Opportunity	S+	s-
Notes: X: Denotes potential for impact, which is not considered significant S-: Denotes Potential Significant Adverse Impact S+: Denotes Significant Beneficial Impact * : Denotes no change to the existing situation		

8.2 Site Selection Alternatives

The rationale for choosing the selected site is based on several factors:

- Close to the grid connection, which increases financial feasibility of the Project. The solar PV plant will be connected to NEPCO's existing 33/132kV Substation which falls within Muwaqqar district.

- Project is developed under direct agreement with government, hence the land is provided by the government; there is no conflict with the existing or planned land use of the site since it is government owned and the government decided to allocate such lands for this solar PV project.

- Distance to environmental and socio-economic receptors. The project area is empty of any official use and is located relatively far away from residential areas. It is also worth mentioning that the project area is surrounded by relatively nearby industrial facilities within the northern side such as Al Ghabawi Landfill, Petroleum Products Terminal, Electric Power Plant (IPP3), and a small fertilizer workshop close to the site boundary. In addition to the Manakher Electric Power Plant (IPP4) located to the west of the project area.

8.3 Project Technology Alternatives

8.3.1 Tracking Systems versus Fixed Systems

Baynouna's solar PV project will utilize single axis tracking systems for the PV modules where a single axis tracker follows the daily movements of the sun from east to west.

The tracking system improves the modules overall performance with respect to sunlight tracking, higher absorption of sunlight i.e. higher energy harvest since PV modules can capture more available sunlight, thus leading to high power production efficiency compared with fixed systems. This way the tracking system utilizes the available solar resource throughout the day in order to maximize energy production (kWh).

In the long-run utilizing tracking systems will minimize the dependency on more conventional power generation sources such as energy from fossil fuels; this is due to the efficiency and higher power production of tracking systems.

According to an article[14] discussing the difference between tracking and non-tracking; it is stated that the downside of a tracking system is the cost of the tracker, plus the cost of concrete, labor, and other structural components, in addition to operation and maintenance costs due to the potential for failure of motorized and electric components.

Also concerning the Solar Balance-of-System of tracking and non-tracking systems[15] is that for a tracker to be economically feasible, the increased energy harvest must exceed the added cost of installing and maintaining trackers over the lifetime of the system. An additional factor to consider in the decision to use trackers or fixed systems is land use; tracking systems tend to use additional land because they must be spaced out in order to avoid shading one another as they track the sun. This means that PV panels will be spaced farther apart, as a result increasing land use and land costs for the developer. On the other hand, tracking systems can require fewer modules compared to fixed systems. With regards to eco-efficiency[16] discussing how tracking systems can boost eco-efficiency **Figure 59** below illustrates a comparison of daily energy production curves with tracking versus fixed systems.

However, for the project area, and based on Jordan's solar irradiation map (**Figure 55**) above the solar irradiance in Al Muwaqqar area can reach up to 2400 kwh/m^2/yr., therefore tracking system proved to be an optimized solution between cost and performance of the Project; furthermore the tracking system considered in this Project has several track records and can be considered as robust technology. As a result, it is considered more efficient to install tracking systems in such location, which is adopted for this project.

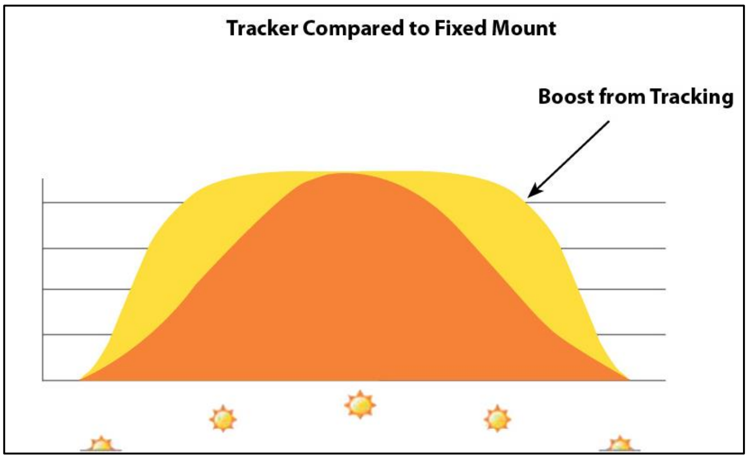


Figure 59: Daily power production for tracking vs. fixed systems

Balance of systems impacts for tracking systems are higher than fixed systems, however this is counteracted in the module's end of life stage. Also the lifecycle impacts from tracking systems is slightly lower (1% - 3%) than for fixed systems given that the improved energy yield that may result in a lower cost per kWh, thus being more eco-efficient i.e. creating more value with less lifecycle environmental impact which leads to improving improves the sustainability of PV systems, of course this depends on factors such as project design, site latitude, and diffuse light conditions. **Figure 60** below illustrates how the incremental energy generated from trackers is generally higher than that of fixed systems, with less environmental impact and less cost per kWh.

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[14] http://www.homepower.com/articles/solar-electricity/design-installation/track-or-not-track
[15] http://www.greentechmedia.com/articles/read/Solar-Balance-of-System-To-Track-or-Not-to-Track-Part-I
[16] http://www.solarindustrymag.com/issues/SI1311/FEAT_02_Tracking-Systems-Boost-Eco-Efficiency.html

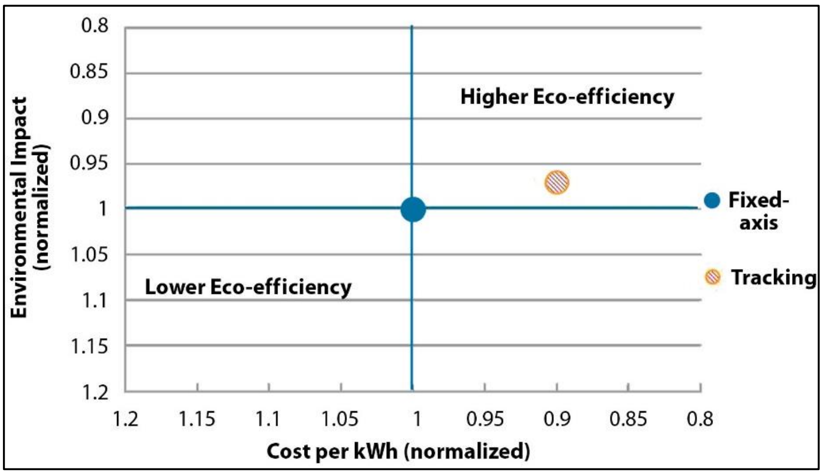


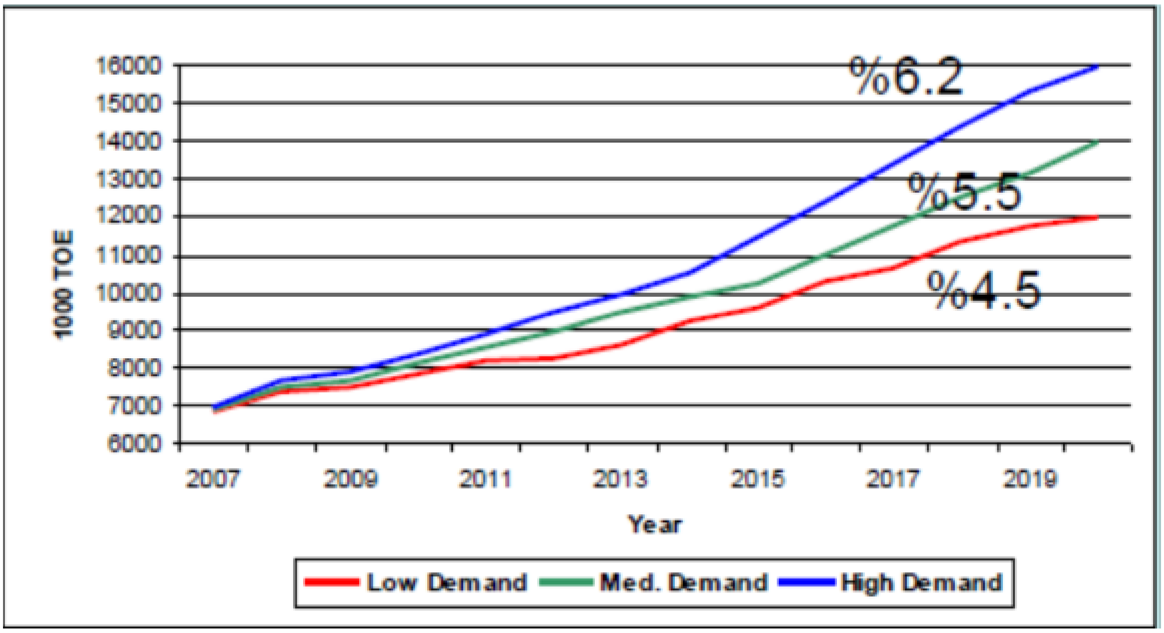
Figure 60: Tracking vs. fixed Systems

8.4 Electricity Sources Alternatives

The energy demand in Jordan and in the world increasing rapidly, then in order to face this increasing Jordan government has been issued in December 2007 ''Updated Master Strategy of Energy Sector in Jordan for the period (2007-2020)'' which entitled as Energy Strategy 2020, The energy strategy expected that the demand increasing according to two scenarios: high and low scenario related to the increasing growth rate. An update of the energy strategy has been recently amended to include the period between years 2015-2025.

Figure 61 presents the demand scenarios in collaborate with the growth rate, in the following the description of these scenarios.

- The demand for primary energy for the year 2007 about 7858 thousand Tonne of Oil Equivalent (TOE) for the high demand scenario and 17108 thousand TOE in the year 2020 i.e. an expected growth rate of 6.2% during the period (2007-2020);
- The demand for primary energy according to the low scenario in the year 2007 is about 7450 thousand TOE to raise in the year 2020 to 13057 thousand TOE at an annual growth rate of 4.5% for the period (2007-2020).



Source: Updated Master Strategy of Energy Sector in Jordan for the period 2007 - 2020

Figure 61: Energy demand increasing rates

According to the Ministry of Energy and Mineral Resources, the updated Energy strategy 2015 - 2025 is planning to increase the renewable energy as a clean technology for Solar Power to cover 9% of total demand by year 2015 as illustrated in **Figure 62** below, as well as increase the local energy resources share to 40% of the total demand by 2025.

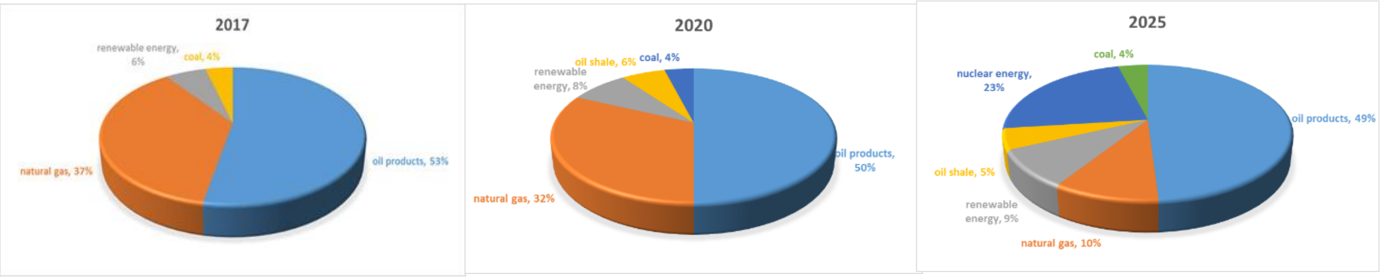


Figure 62: The Updated Energy Strategy 2015-2025 (MEMR)

As all above the demand increasing force the government to find additional energy resources and these resources could be conventional and renewable resources, so the using the solar energy is one of the preferable option with less impact than the conventional resources, furthermore, it is considered as green option for Jordan with high sunshine days and land availability, in the following the main reasons to use solar energy instead the conventional:

- Solar power is pollution-free during use;
- Production end-wastes and emissions are manageable using existing pollution controls;
- End-of-use recycling technologies are under development and policies are being produced that encourage recycling from producers;

- PV installations can operate for 100 years or even more [with little maintenance or intervention after their initial set-up;
- Grid-connected solar electricity can be used locally thus reducing transmission/distribution losses;
- Compared to fossil and nuclear energy sources, very little research money has been invested in the development of solar cells, so there is considerable room for improvement.

9 IMPACT ASSESSMENT

An impact assessment has been undertaken following the full characterization of the environmental, social and health baseline, and identification of all project aspects. The scope of the assessment covers all Project area and was undertaken in accordance with relevant MoEnv regulations and applicable local, national and international standards and guidelines.

9.1 Approach and Methodology

Initially, Project environmental, social and economic and health aspects were identified for the proposed activities. The activities were considered in terms of their potential to:

- Interact with the environment (physical, biological, socio-economic); and
- Breach the conditions of relevant national and international standards and guidelines or company policy.

The environmental, socio-economic and engineering information and data gathered, collated and reviewed during the baseline and aspect identification tasks were systematically developed to prepare matrices of key Project activities and environmental, social, health and economic receptors. This allowed for a preliminary assessment of the key environmental and socio-economic issues, or ‘key issues’ associated with the Project to be completed.

When assessing impacts the following were considered:

- Positive or negative impacts
- Impacts occurring directly or indirectly from Project activities
- Magnitude of impact
- Public health and safety risks
- Geographical extent of the effect
- Duration and frequency of the impact
- Sensitivities of the receiving environment over the entire project area
- Potential significance
- Residual impacts.

Figure 63 below illustrates the ESIA process adopted during the ESIA study phases.

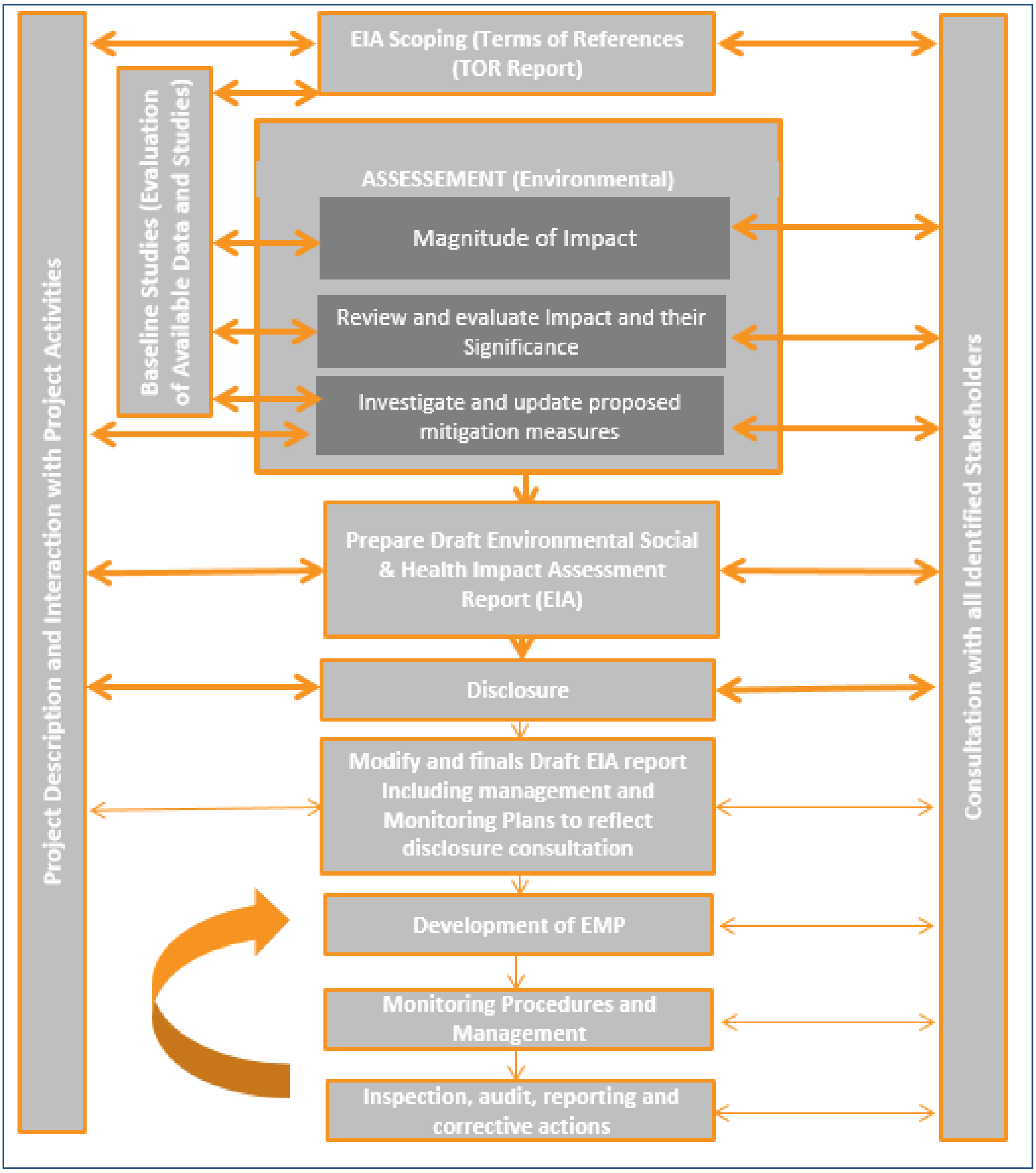

Project Description and Interaction with Project Activities
EIA Scoping (Terms of References (TOR Report)
Baseline Studies (Evaluation of Available Data and Studies)
ASSESSEMENT (Environmental)
Magnitude of Impact
Review and evaluate Impact and their Significance
Investigate and update proposed mitigation measures
Prepare Draft Environmental Social & Health Impact Assessment Report (EIA)
Disclosure
Modify and finals Draft EIA report Including management and Monitoring Plans to reflect disclosure consultation
Development of EMP
Monitoring Procedures and Management
Inspection, audit, reporting and corrective actions
Consultation with all Identified Stakeholders

Figure 63: ESIA Process

As part of the assessment, the potential cumulative effects were considered, taking into account other developments (if any) in the local area.

Once all of the project environmental and socioeconomic impacts have been assessed, the significance of the impacts was ranked by considering the following elements:

- **The consequence of identified events:** the resulting effect (positive or negative) of an activity's interaction with legal, natural and/or socioeconomic environments; and
- **Likelihood:** the likelihood that an activity will occur.

Agreed criteria were defined for each level of consequence and each level of likelihood and the significance of the impact associated with each identified aspect is the product of the consequence and likelihood. It should be noted that the assessment has been conducted by considering the mitigation measures normally designed into / included in the project.

The following sections briefly describe the consequence, likelihood, and significance criteria.

9.1.1 Consequence

To assign a level of consequence to each environmental and social impact, criteria are defined for environmental and socio-economic consequence or severity. Legal issues are embedded in both criteria sets. The consequence categories and their ranking are presented in **Table 33**.

Table 33: Consequence Categories and Rankings

Consequence	Ranking	Description
Catastrophic	5	Massive effect – Persistent severe environmental damage or severe nuisance extending over a large area. In terms of commercial or recreational use or nature conservation, a major economic loss for the Company. Constant, high exceedance of statutory or prescribed limits, high profile community outrage.
Severe	4	Major effect – Severe environmental damage. The Company is required to take extensive measures to restore polluted or damaged environment to its original state. Extended breaches of statutory or prescribed limits, and serious community concern and complaints.
Critical	3	Localised effect – Limited discharges of known toxicity, considerable community concern and/or complaints. Repeated breaches of statuary or prescribed limit. Affecting neighborhood. Spontaneous recovery of limited damage within one year.
Marginal	2	Minor effect – Contamination. Damage sufficiently large to damage the environment, some community concern raised. Single exceedance of statutory or prescribed criterion. No permanent effect on the environment.
Negligible	1	Slight effect – Local environmental damage. Within the fence and within systems. Negligible financial severity.
None	0	No impact
Positive	+	Beneficial impact – enhances the environment

It should be noted that it is often difficult to compare impacts consistently across different natural and socio-economic environments. When evaluating the environmental and socio-economic aspects, emphasis was placed on specific cause and effect relationships.

Scientific evidence as well as predictions based on observation of previous similar activities can and have been used in the impact assessment process. Where it has not been possible to fully quantify the effect that an activity may have on the environment or a component of the environment, or where there is a lack of scientific knowledge, qualitative judgment has been used. Such judgments is based on a full understanding of the project activities, and the team's knowledge of the environment, social structure and general health aspects of the region in which the project's activities will occur.

9.1.2 Likelihood

To assign likelihood to each activity, five categories are defined and ranked. The criteria for likelihood are shown in **Table 34**.

Table 34: Likelihood Categories and Rankings

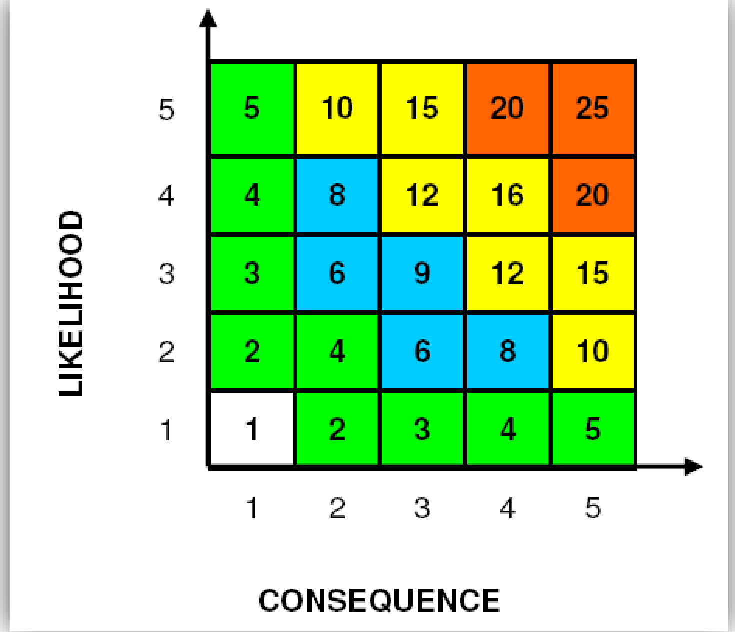
Category	Ranking	Definition
Certain	5	The activity will occur under normal operating conditions
Very Likely	4	The activity is very likely to occur under normal operational conditions
Likely	3	The activity is likely to occur at some time under normal operating conditions
Unlikely	2	The activity is unlikely to but may occur at some time under normal operating conditions
Very Unlikely	1	The activity is very unlikely to occur under normal operating conditions but may occur in exceptional circumstances

9.1.3 Significance

The significance of the impact is expressed as the product of the consequence and likelihood of occurrence of the activity, expressed as follows:

Significance = Consequence x Likelihood

Figure 64 Illustrates all possible product results for the five consequence and likelihood categories.



LIKELIHOOD					
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5

Figure 64: Product Results for Consequence & Likelihood Categories

Based on its consequence-likelihood score, each environmental aspect has been ranked into five categories by order of significance as illustrated in **Table 35**.

Table 35: Significance Categories

Ranking (Consequence X Likelihood)	Significance
>16	**Critical**
10-16	**High**
6-9	**Medium**
2-5	**Low**
<2	**Negligible**

To assist in determining and calculating the significance of an impact, impact assessment matrices has been developed based on the aspect identification exercise.

9.1.4 Residual Impact

Residual impacts are impacts that remain after mitigation measures, including those incorporated into the project's base case design in addition to those developed as part of the base design.

The residual impacts assessment identifies which project activities are likely to result in a semi-permanent to permanent change in the natural (i.e. physical, biological) and/or socio-economic environments. The significance of this change has also been assessed.

9.2 Potential Environmental and Social Impact Assessment

This section identifies and, where appropriate, quantifies the primary biophysical effects expected to result from construction, operation and retrofit/decommissioning of the PV Power Plant.

Every identified aspect was assessed in terms of its potential to cause an impact on natural and/or socio-economic receptors and was subsequently ranked in terms of consequence and likelihood, thus enabling the determination of the overall significance of the impact.

In general, PV power plants have recently proved to be sustainable and safe around the world, given that they do not cause the release of air pollutants or global warming emissions, and are considered economically viable.

This section will address the potential environmental and social impacts specific to this project.

The section is structured according to the main issues and effects resulting from the proposed project activities across the following project phases:

- **Construction Phase:** This involves all activities for the construction of the PV power plant.
- **Operation Phase:** This refers to the PV power plant operation processes.
- **Retrofit or Decommissioning Phase:** Following the operation phase, determination as to whether the facility can be retrofitted i.e. upgraded and addition of new technology will be determined. If retrofitting did not turn out to be feasible, then decommissioning activity will take place. Decommissioning activities are anticipated to be similar to construction; therefore, the potential impacts are anticipated to be relatively similar.

9.2.1 Physical Environment

9.2.1.1 Air Quality

Construction Phase

The main impacts associated with construction activities will be:

1) **Dust generation:** resulting from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy conditions. The contractor shall be committed to control emitted dust from such operations through the proposed dust emission control procedures described in the environmental and social management plan (ESMP) included in this report.

2) **Exhaust emissions:** Exhaust emissions of SO_2, NO_x, CO, CO_2, and PM_{10} will be attributed predominantly to the operation of the construction plant and road vehicles such as movement of trucks and vehicles during construction works. These emissions will be

limited to the project area and are anticipated to be generated in small concentrations and dispersed rapidly within the area leading to an impact of low significance. This means that these effects are localized and temporary which implies that any deterioration in air quality at project location is unlikely to be significant and is expected to be transient.

Based on the above, local degradation of the ambient air quality during construction is considered to be with a likelihood of **likely (3)** and **negligible (1)** Consequence with an overall **low (3)** Impact significance.

Operation Phase

No emissions are expected to be released during the operation phase, due to the fact that solar PV power plants do not release greenhouse gases or any toxic pollutants during their operation, as a result, no impacts on ambient air quality are anticipated during the operation phase.

It is worth mentioning that solar PV power plants have very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide during operations compared to fossil fuel power generation facilities, since solar power plants do not involve combustion processes. Therefore, this impact is considered **negligible (1).**

Decommissioning Phase

Similar to construction, the decommissioning phase is anticipated to generate dust and exhaust emissions. Decommissioning activities will involve site preparation, dismantling and disassembling of the components of the solar power plant facility, clearance of the site, and rehabilitation if needed.

Similarly, local degradation of air quality is expected on a limited and temporary level. As a result, the impact is considered **likely (3),** with a **negligible (1)** given the temporary nature of decommissioning, yielding an overall **low (3)** impact significance.

9.2.1.2 Green House Gas Emissions

Operation Phase

Based on the Project / ‘No’ Project alternatives (elaborated in Section 8.1) for this 200 MW project, **1460 ton equivalent of CO_2 (tCO_2e)/yr** are expected from “other emissions[17]” (as opposed to operational emissions) over the lifetime of the project (IFC, 2011).

Renewable energy systems including PV power plants are considered to be climate change mitigation projects in the sense that their deployment results in an overall reduction of GHG emissions, as they tend to replace more carbon-intensive technologies like the coal or heavy-fuel fired electric power plants. This is the case in Jordan where grid-connected PV systems result in offsetting electrical power that is otherwise produced by fuel powered electric power plant. The latest Carbon Emissions Estimation Tool (CEET) issued by the IFC in 2014 indicates that the emission factor for a kwh of electricity produced the grid in Jordan is **637.42 g CO_2eq/kwh**, compared to the 40 g CO_2eq/kwh associated with the PV lifecycle GHG emission which shows the reduction potential of such solar projects.

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[17] Other emissions are GHG emissions associated with the renewable energy climate related products upstream inputs, transport, installation, implementation, dismantling, and disposal as defined by the IFC (GHG accounting guidance note, Sept. 2011) which are partly related to Scope 3 emissions; also as mentioned in the above guidance note, ‘’For IFC investments where indirect GHG emissions are too difficult to estimate, certain conservative default emission factors for solar PV can be used’’.

Furthermore, to calculate the avoided emissions (offset) from the PV plant. Please see below:

200 mw (project capacity) x 1000 kw/mw = 200,000 kwp

200,000 kwp x 1560[18] kwh/kwp = 312,000,000 kwh/year

= (312,000,000 kWh x 637.4 gCO2/kw) / 1000,000 = (198,868.8 t CO2 eq) / 1,000

= 198.87 KT CO_2 eq (offset by the project per annum)

Therefore, the impact likelihood from GHG emissions is very unlikely (1), with a negligible (1) consequence, yielding an overall **negligible (<2)** impact significance.

9.2.1.3 Noise

Construction Phase

Construction activities for the PV power plant will contribute to noise impacts. There are several noise generating activities such as earthworks, haulage activities, excavation, backfilling, and installation of PV panels, and other equipment within the facility in addition to noise sources generated from machinery and equipment on site.

The closest communities/activities to the project area are shown in **Figure 47** of the baseline section above. And the closest community/village is 8.5 km away from the project site.

Hence, it can be considered that the only human receptors who could potentially be impacted by the noise are the employees working within the project site during assigned working hours,

During construction, workers will likely be accommodated in the nearest accommodation facilities to the site (possibly in Amman and surrounding) and labor camps with kitchen facilities and offices will most likely be present on site for daily use during working hours. However, there is a possibility for having worker accommodation facilities on site; if this is the case, the facilities shall be established in accordance with the specifications of the International Labour Organisation (ILO) standards and guidance published by EBRD and IFC; and workers will be working on site during the day within normal working hours and sleeping at night where all project activities and noisy operations will cease. Therefore, no noise impacts are expected during night time and the contractor shall be committed to adhere to such requirements.

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[18] Based on expert advice obtained from the National Energy Research Centre (NERC)/ Royal Scientific Society (RSS), the energy yield in Jordan is considered to be 130 kwh/kwp per month = 1560 kwh/kwp annually. This was calculated taking into account the following considerations:
- Average solar irradiation in the country taking into account all seasons
- Degradation factor of PV modules (average value)
- Temperature effects of the Jordanian climate on the PV modules
- Dust accumulation and its effect on the performance of the system

These increased noise levels on site is considered occupational noises that require occupational health and safety measures and shall comply with the occupational noise exposure limits outlined in Section 4.5.3. In addition to this, some reptiles and mammals, within the project area can potentially be driven away from the site due to the sound levels. Furthermore, the project area is considered to be in an industrial area given that it is surrounded by other industrial facilities / projects as shown in **Figure 47**. As a result, industrial noise limits apply to the project area, meaning that the maximum allowable limit during the day is 75 dBA and 65 dBA during the night.

However, these noise impacts are not considered to significantly harm animals nor cause impacts on a population level since they will be temporary.

Since the activities will occur under normal operating conditions and are expected to have only localized and temporary effects within the project area, the impact likelihood is **very likely (4)** with a **negligible (1)** consequence, thus the impact significance is **low (4**).

Operation Phase

The PV power plant as a facility is not considered to exhibit any significant noisy operations, although the facility's inverters and transformers may produce some sound, but this is not considered a serious issue, since they will not generate any noise. In addition, there will be no close by sensitive receptors such as worker accommodation or residential dwellings within the project site during the operation phase.

In addition, noise generated from inverters is only heard when distance is close (i.e. within 1-2 m, however, as distance increases, noise will be greatly reduced, not to mention that they do not generate noise during night time.

As a result, the impact is very unlikely (1), with a negligible (1) consequence, thus, the overall significance is **negligible (<2).** Therefore, no mitigation measures are needed.

Decommissioning Phase

The decommissioning activities of dismantling the PV power plant and removing the ancillary facilities are associated with potential increased noise levels.

However, as the only receptors will be the workers at the site and within the proposed facilities within the vicinity of the PV power plant, these increased noise levels are considered occupational noises that require occupational health and safety measures. For any potential receptors other than the workers, the impact likelihood is **likely (3),** with a **negligible (1)** consequence, thus it is of **low (3)** significance since it is considered to be temporary.

9.2.1.4 Soil

Construction Phase

Construction activities are not expected to result in significant soil loss; however excavation, leveling and other c may disturb the soil due to the minimal removal of top soil during the construction of office buildings and inverter building; however soil erosion triggered from such activities is considered minor. The top soil material will remain on site.

The other source of impact to soil is waste generation from construction material, accidental leakage of fuel, oil, or chemicals stored within a bunded area causing direct contamination to soil which may degrade lower layers of soil depending on the amount of spills.

Assuming that spill response plans shall be in place by the contractor, it is anticipated that impacts to soil resulting from these activities will be **likely (3),** with a **marginal (2)** consequence, yielding a **medium (6**) impact significance.

Operation Phase

Soil impacts during operation phase are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation. However, the impact is not considered significant given the spill response procedures and good site practice that is expected to be in place as a result, the magnitude of the spill is expected to be minimal during operation.

The proper implementation of spill response procedures, and proper storage and handling of any chemicals on site, will reduce the probability of the impact.

Therefore, this impact is **unlikely (2**), with a **marginal (2)** consequence, yielding an overall **low (2)** impact significance.

Decommissioning Phase

During the decommissioning phase, the decommissioning activities are anticipated to have an impact of medium significance to soil. This is due to possible accidental leakage of fuel, oil, or chemicals during dismantling activities. Therefore, proper environmental protection measures should be followed to prevent or control the occurrence of such incidences.

The impact likelihood is **likely (3),** with a **marginal (2**) consequence, the impact assessment is considered to be **medium (6).**

9.2.1.5 Visual Amenity

Construction Phase

The civil works and site preparation activities that are likely to take place during construction to install the project components such as the PV arrays, inverters, cables, buildings and other ancillary facilities are anticipated to include materials lay down, site levelling, excavation, trenching works for underground cables, drainage works, foundations for mounting structures, access roads and internal roads, backfilling, and spoil.

The above activities are expected to create temporary visual intrusion on the site and its surroundings. The visual environment during construction will include equipment and machinery and construction related vehicles such as trucks, compactors, excavators and loaders. However since the direct project vicinity already has poor vegetation cover and is empty of any official use; it does not encompass any sensitive receptors such as environmentally sensitive areas, natural reserves, important bird areas or residential dwellings - the visual intrusions will be limited to employees.

Hence, the visual effects of the construction will be of low significance within the project area.

The impact likelihood is **likely (3),** with a **negligible (1)** consequence, the impact assessment is considered to be **low (3).**

Operation Phase

The presence of a large area of PV panels is not expected to constitute a risk for glare since the Solar PV modules are designed to transmit the solar irradiation from glass to cell, which then converts the solar energy into electrical energy. High transmission of solar irradiation from glass to cell surface is desired to maximize the electrical energy production from the Project. Therefore, the reflection from solar module will be significantly lower than with traditional glass.

PV modules design include dark, light absorbing material (called cell) and covered with an anti-reflective coating (ARC) for glass surfaces which typically reduces the average reflectance from PV panels below 4%. ARC is common in PV modules and PV modules to be installed in the project will have Anti reflective coating.

The project will have single axis tracking technology on which PV modules will be mounted. The tracking system tracks the position from Sun from E-W throughout the day with maximum tracking range of +/-55Á This means, the PV module will be facing towards east in early morning and towards west during late evening.

The two closest airport runways to the project area are shown below; King Abdullah II Air Base is located along the northern side of the Project, approximately 13 km away the second airport – Amman Civil Airport (in Marka district) is located approximately 22 km away on north-west of the Project. Since the PV modules will be moving between East to West during the day, the effect of reflection in these direction (E-W) can be assumed higher than in other directions, although the reflectance from PV panels is already in low level. In this regard, effect in airport can be considered minimum.

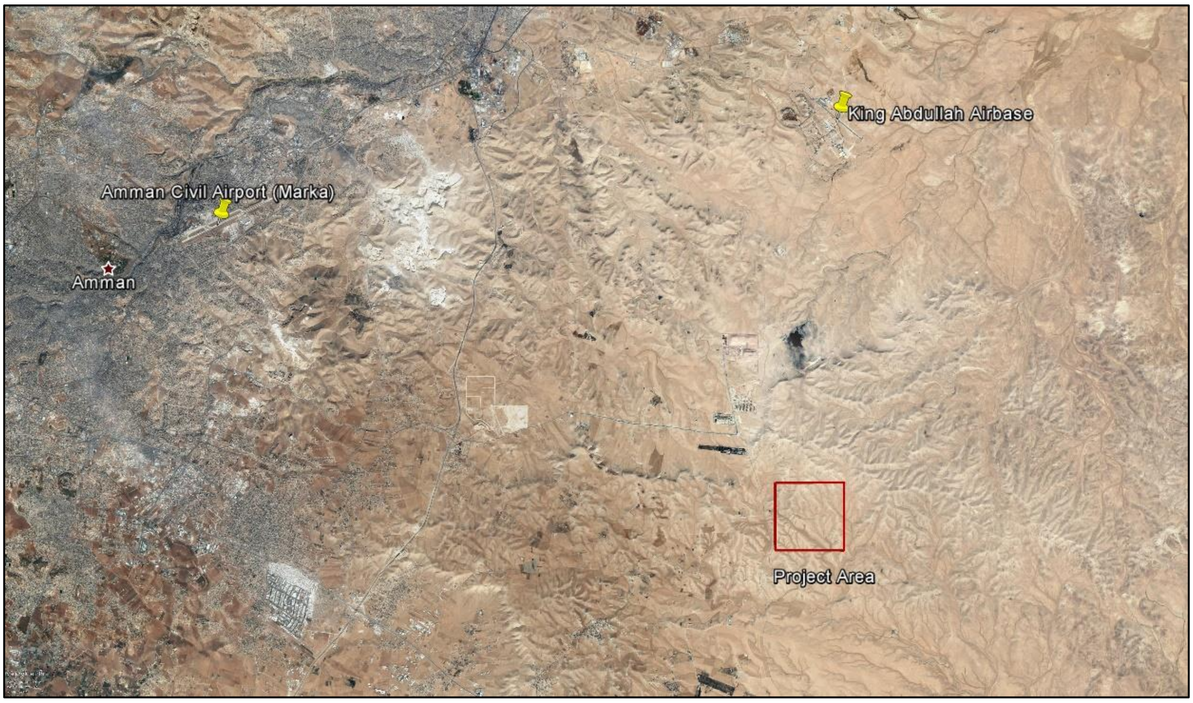

Figure 65: Project location with respect to nearest airport runways

To support the above analysis, a published report conducted by Spaven Consulting in 2011[19] provides an assessment of the potential impact of solar photovoltaic energy facilities located in off-airfield situations, and specifically considers PV technology on aviation on solar farms next to airports. The report explains that solar panels are not expected to have any significant glare impacts on nearby airports due to the following justifications:

- Solar panels are designed to absorb light, as a result only reflect a small amount of the sunlight that falls on them compared to most other everyday objects. Most notably, solar panels reflect significantly less light than flat water. This is illustrated in **Figure 66.**
- Panels are usually treated with anti-reflective (AR) coating which reduces the sun's reflection from PV panels. As a result, PV panels treated with this material (which is the case for the panels installed for this project) only reflect approximately less than 4% of the light. According to the report, glare from PV solar panels will only be reflecting some 2% of the light, the intensity of any glare will be less than the glare from direct sunlight as would be experienced when flying directly towards the low sun. The AR coating minimizes glare, traps more light, which gives the PV system a characteristic of being primarily absorptive, making them suitable to be installed at airports. Solar panels treated with AR coating reflect a lower percentage of light than smooth water.

Based on previous experience, specifically in the U.S.A, solar energy projects have operated adjacent to airports for more than 20 years. The airports located adjacent to such Solar PV facilities, especially in the southern and western states have not reported any distractions by glare. Furthermore, the Federal Aviation Administration (FAA) in the U.S.A published a guidance in November 2010 which listed eight solar power projects at / or adjacent to airports which have completed FAA assessments. In all of these cases, the FAA determined that a full review is not required, or reached a finding of ‘’no hazard’’.

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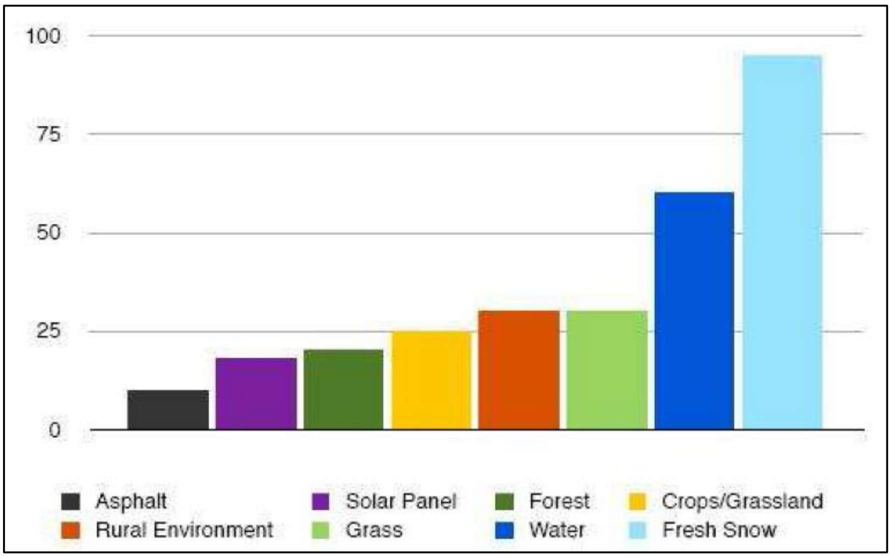
[19] http://www.solarchoice.net.au/blog/wp-content/uploads/Reflectivity-of-Solar-Electric-PV-Modules.pdf.pdf



Source: (Spaven Consulting, 2011)

Figure 66: Comparative Reflection Analysis of different material

For example, the Oakland International Airport in California (U.S.A) which has undergone full FAA analysis since an adjacent fixed PV facility is located directly under final approach for Oakland’s runway 33. The airport has been operational since 2007 and had no reports of glare from pilots or controllers in the control tower.

Another example is the Fresno Airport development in California (U.S.A) which is also located in the final approach area for one of the airport runways. The Planning Manager for Fresno Airport has confirmed that there have been no complaints from pilots or controllers and has written to the developers of another solar scheme in the USA stating that "reflectivity is not an issue for aviation".

Moreover, no nearby residential dwellings are present within the immediate vicinity of the project area, therefore it is expected that the project will have a negligible impact on the surrounding communities since the project is located relatively far away any permanent settlements and residential dwellings. As for birds, the visual disturbance is not expected given the fact the closest IBA (Qa Khanna IBA) is located are far from the project area (around 21 km away), and as a result, there is no migratory bird flyway over the project area.

The project area is not anticipated to cause visual impacts due to the PV system design and factors discussed above.

It is however essential to point out that the intensity of light reflected from a PV module surface depends on factors such as the amount of sunlight reaching the surface and will therefore vary based on, among others, geographic location, time of year, cloud cover, and PV module orientation.

Based on the above assessment, visual impacts from the PV power plant is considered **unlikely (2)** given that PV panels have minimal reflectivity, with a **marginal (2)** consequence, thus an overall impact significance of **low (4).**

Decommissioning Phase

During the dismantling of the PV power plant, removal of ancillary facilities, and the rehabilitation of the project area (if needed), visual intrusions will be likely but their consequence will be negligible due to fact that such impact would be temporary (over a short period). Moreover, the actual dismantling of the PV power plant will reduce or remove the visual impacts witnessed during the operation phase.

Therefore, the impact likelihood is **very unlikely (1)** given that there will be remediation procedures on site, with a **negligible (1)** consequence, yielding an overall **negligible (<2)** impact.

9.2.1.6 Waste Management

Construction Phase

Improper management of non-hazardous and hazardous waste generated during construction may lead to impacts on soil, water, visual environment, in addition to health and safety of workers.

Non-hazardous waste includes paper, wood, plastic, scrap metals, glass and mud. Hazardous waste includes absorbent material, batteries, tires, metal drums, empty chemical containers, waste oil from machinery lubricants, etc.

All waste generated at the construction site will segregated, handled, stored and managed as per Contractor's Waste Management procedures. Domestic wastewater generated at site will be collected in septic tanks. These shall be transported to the nearest approved municipal wastewater treatment facility, and solid waste shall be disposed of in a secured area for trash.

The impact likelihood is **likely (3)** and consequence is **marginal (2),** therefore, the impact significance is assessed as **medium (6).**

Operation Phase

Waste generated during operation phase will be limited to wastewater from maintenance and cleaning activities in addition to domestic waste (due to workers' domestic activities).

Also domestic wastewater and liquid effluent generated from site activities, toilets and sanitation facilities during operation phase, will be treated via a small scale Wastewater Treatment Plant (WWTP) which the project developer plans to construct. The treated effluent generated shall meet the Jordanian Standards if discharged.

Waste generation during the operation phase is considered part of daily operations, therefore, it is not considered to have any significant impacts to the environment or health of personnel working on site given that the number of personnel on site during operations will be around 20-30 persons. Broken/damaged and discarded PV modules shall be cleaned and contained through proper handling as per manufacturer's procedures and disposed at licensed dumping areas/landfills that can accommodate such material – as for thin film (CdTe) PV modules, although are not expected to pose any risk when in operation nor will they generate any cadmium (Cd) emissions. According to a published research '' CdTe modules are very well sealed and Cd cannot be released during normal operation'', ''If a collection and recycling program were established, all health concerns about CdTe and other end-of-life photovoltaic modules would be resolved fully''[20].

it is worth mentioning that the handling method will be based on a combination of expertise such as the recommendations of the Ministry of Environment, manufacturer requirements and the O&M team experience.

Therefore, the impact likelihood is assessed as **very unlikely (1),** with a **marginal (2)** consequence, yielding a **low (2)** impact significance.

Decommissioning Phase

Waste generated during decommissioning limited to non-hazardous and inert wastes such as scrap metals, paper, wood, plastic, given that the contractor will adhere to the set waste management procedures.

Similar to the construction phase, potential generation of hazardous waste includes absorbent material, batteries, tires, metal drums, empty chemical containers, waste oil from machinery lubricants, etc.

To avoid the generation of hazardous wastes from dismantling the PV power plant and disconnection of the plant components, it is recommended that these materials and components are evaluated to determine whether they are suitable to extend their life, or return them the manufacturer for recycling or to be reused in other facilities depending on their efficiency and feasibility. Also, any terms set in the Power Purchase Agreement relating to disposal mechanisms shall be adhered to.

Any discarded panels will be disposed at licensed dumping areas/landfills that can accommodate such materials; moreover, there will be coordination with the Ministry of Environment and the responsible municipality in matters relating to PV panels disposal since this process shall be handled with care where the project developer will be committed to safely remove the broken modules to avoid any potential adverse impacts.

If complete decommissioning is to occur – it will take place around 20 years from now or more, therefore more certainty with regards to disposal methods will be clarified by then depending of new available technologies and reuse/recycling options and other appropriate disposal facilities.

The impact of waste generation is considered **unlikely (2),** with a consequence of **marginal (2)** during to this temporary phase, given that specific waste management procedures will be implemented on site, yielding an overall impact significance of **low (4).**

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[20] https://www.bnl.gov/pv/files/pdf/art_164.pdf

9.2.1.7 Water Resources

Surface Water

All Phases

Based on the surface hydrological study conducted for the project area; the project site is almost gentle to moderately sloped in some localities and almost flat in others allowing the water to spread over wide areas, and in this case, the flow is to be considered as sheet flow and has no damaging effect to any structure. In other localities the wadi streams are well defined and soil scouring exist that requires protection.

Based on the Computed Design Floods Related Frequency – specifically for 25 years (**Table 36**) provided in the baseline section of this ESIA study, some wadis have a higher flood risk than others and require certain mitigations since they have higher potential for soil erosion in the case of heavy rainfall. All identified wadis during the hydrology study with their recommended drainage solution are provided in the below Table.

Table 36: Recommended Drainage Solutions and Protection

Area No.	25-year	Recommended Drainage Solutions
1	0.252	Surface Natural Drainage
1-a	0.117	Surface Natural Drainage
2	1.349	Downstream part to be protected
3	1.505	Downstream part to be protected
4	0.750	Downstream part to be protected
4-a	0.394	Surface Natural Drainage
4-b	0.197	Surface Natural Drainage
5	4.011	All the part that located inside the plot to be protected
6	2.065	Downstream part to be protected
7	3.718	Downstream part to be protected
8	1.254	Downstream part to be protected
8-a	1.182	Downstream part to be protected
9	2.933	Downstream part to be protected
10	1.112	Downstream part to be protected
11	6.833	All the part that located inside the plot to be protected
12	11.977[21]	Nothing to be done. It is located outside the plot.
13	2.966	Downstream part to be protected
14	6.681	Downstream part to be protected

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[21] Note: Wadi 12 is a combination between both 5 and 11 wadis that located downstream outside the project area.

Area No.	25-year	Recommended Drainage Solutions
15	8.776	All the part that located inside the plot to be protected

However, through the implementation of the suggested recommendations/mitigations discussed in the ESMP and the hydrology study, the impact will be greatly minimized. As a result, the impact is considered **unlikely (2)** with a **critical (3)** consequence, yielding a **medium (6)** impact significance.

Groundwater

All Phases

The project activities during three phases: construction, operation, and decommissioning are not expected to impact the ground water since it is not expected to have groundwater aquifers within the project area. This can be attributed to the wadis seen within the project site and as concluded in the baseline section - groundwater resources no groundwater expected to be found in the area.

Although the project area falls between the Amman-Zarqa and Azraq groundwater basins, but it falls within the Muwaqqar formation (B3) which is considered an aquitard, consisting of a thick sequence of chalk and marl which forms a groundwater barrier.

As a result, no groundwater contamination is expected from project activities.

The impact likelihood is assessed as **very unlikely (1),** with a **negligible (1)** consequence, yielding a **negligible (1)** impact significance.

9.2.1.8 Biological Environment

Construction Phase

The activities anticipated during the construction phase will include earthworks, excavations, grading, site leveling, asphalting, paving and the operation of construction machinery and equipment. However, according to the biological baseline description, the project area is considered to have poor vegetation cover and the faunal diversity recorded at the site is also very minimal; it was clear that the natural vegetation at the project site has been removed due to overgrazing. For that the expected impact on the natural flora of the proposed site for the power plant is negligible. Furthermore, cultivation of the project site and its surroundings has removed the suitable micro habitats for the fauna species that have small home ranges like reptiles and rodents. However, the area is still considered part of a larger ecosystem that surround the proposed site that can support such species in spite that the agriculture activity inside the project area and at the surrounding area but the small depression wadis can play the role of safe corridors for wildlife.

Birdlife International Soaring Birds Sensitivity Mapping Tool was applied to the project site with assumptions of 1km, 2km, 5km and 10km buffer around the project area. All assumptions have shown a sensitivity of zero of these habitats for soaring birds which are mainly the large migratory birds including raptors.

The proposed project area does not contain or surrounded by an important biodiversity habitat. The habitats of the area are highly fragmented and even deteriorated where vegetation cover is very low. Also the area has a sign of solid waste dumping that may occur illegally by the trucks that are assumed to transfer the waste into the nearby Al Ghabawi Landfill as shown below.

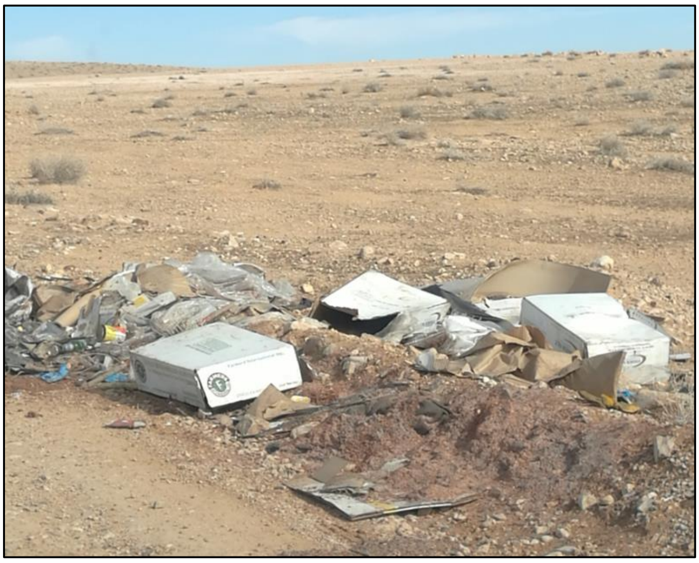

Figure 67: Solid Waste found within project area at the time of biological environment survey

As a result, it can be concluded that construction activities are not anticipated to pose any risks on the ecology of the vicinity of the project site. However, it may cause temporary disturbance to resident birds with ground nests due to noise, dust and particulate emissions, and possible illegal hunting by construction workers. Moreover, certain mammals species present within the project site may temporarily move to adjacent locations during construction activities, however are expected to return back as construction is completed.

Due to the absence of terrestrial habitats within the Project area, no significant impact terrestrial ecology is expected, therefore it is assessed as **unlikely (2),** with a **marginal (2)** consequence, therefore, the impact significance is **low (4).**

Operation Phase

As discussed above, and given that the project area falls within a degraded natural system and is poorly vegetated with minimal faunal diversity.

The anticipated impacts on terrestrial ecology is considered low, however, activities such as vehicular movement, may cause disturbance to resident birds and their ground nests.

However, this is considered minimal, as a result the impact likelihood is **unlikely (2)** with a **negligible (1)** consequence yielding **low (2)** impact significance.

Decommissioning Phase

The activities associated with decommissioning will involve dismantling of the PV power plant and removal of its facilities.

This is a temporary phase that could result in some additional noise and dust disturbances. These activities are not anticipated to harm any flora elements due to absence or scarcity of vegetative cover within and around project area, provided dust suppression measures and other procedures are followed. On the other hand, decommissioning activities may cause disturbance to bird species similar to what was discussed during construction.

The impact likelihood is **unlikely (2)** with a marginal **consequence (2),** thus the impact significance is considered to be **low (4).**

9.2.1.9 Health and Safety

Construction Phase

The construction activities include site preparation, infrastructure utilities installation, building structures. As a result, will be potential impacts on workers' health and safety due to exposure to risks through construction activities that lead to accidents causing injuries and death. The most frequent risks cause of accidental death and injury are:

Safety risks such as: tripping; falling due to working at heights; potential fire due to hot work, smoking, failure in electrical installations; electric shocks.

Health risks: Injuries such as: lifting, lowering, pushing, pulling and carrying; temporary or hearing loss which usually comes from noise generated from machinery used for excavation or piling work and from compressors and concrete mixers etc.; heat stress and working during high temperatures; dermatitis that can arise from contact with substances that cause dermatitis such as wet cement, asphalt, solvents used in paints, glues or other surface coatings…etc.

The Contractor will be committed to ensure all health and safety measures are in place to prevent accidents and\or reduce the consequences of nonconformance events – this is associated with the application of effective Environmental, Health and Safety (EHS) policies by the contractor. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety procedures through training, awareness and supervising in addition to the adherence to the Occupational, Health, and Safety & Environmental procedures and emergency response procedures on site and issuing relevant procedures for different types of work.

Moreover, the contactor shall provide all appropriate resources (Personal Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

It is worth noting that the Jordanian Labor Law No. 8 for the year 1996 and its amendments mentions that when an employee is stricken with one of the occupational diseases, disabilities or death due to working practices and a medical authority report is submitted stating the condition, the employer is then obliged to pay the compensation payment according to the law. Moreover, the provisions of the ‘General Safety Code of Construction Projects Implementation’, as part of the Jordanian National Building Law must be observed carefully by the assigned contractor, in addition to the fire protection code. The occurrence of occupational health and safety impacts such as death and serious injuries is considered irreversible and highly significant since human receptors are adversely affected.

Given the health and safety system and precautions that are expected to be applied by the contractor, the impact is considered to be **likely (3)** with a **critical (3)** consequence, yielding a **medium (9)** impact significance.

Operation Phase

During the operation phase, the risks will be quite limited due to nature of operation activities; the activities will be limited to guarding and on call and\or onsite technical support (Maintenance and cleaning). There will be potential impacts on personnel’ health and safety during operation phase due to exposure to risks such as: Slipping and tripping, falling during working at height, handling wastewater, Fire…etc. As a result, the impact is considered **unlikely (2)** with a **marginal (2)** consequence, yielding a **low (4)** impact significance.

Therefore, the project developer shall ensure all risks from operation activities to be assessed and to establish specific work procedures for tasks and developing Occupational, Health, Safety & Environmental (OHSE) procedures for the operation phase to prevent the incidence of health and safety risks and avoid non-conformance events.

Decommissioning Phase

The decommissioning activities will include equipment dismantling and possibly demolishing facilities at project site. As all project components will be recycled after decommissioning, the prospect risks from decommissioning phase will be limited to dismantling and demolishing activities including moving all recyclable components to their final destination. There will be potential impacts on workers’ health and safety due to exposure to risks through decommissioning activities as following:

Safety risks such as: tripping; falling due to working at heights; potential fire due to hot work, smoking, failure in electrical installations; electric shocks.

Health risks: Injuries such as: lifting, lowering, pushing, pulling and carrying; temporary or hearing loss which usually comes from noise generated from machinery used for excavation or piling work and from compressors and concrete mixers etc.; heat stress and working during high temperatures; dermatitis that can arise from contact with substances that cause dermatitis such as wet cement, asphalt, solvents used in paints, glues or other surface coatings…etc.

As a result, the impact likelihood is **likely** (**3**) with **marginal** (**2**) Consequence, as a result, the impact is found to be **medium** (**6**) significance.

Therefore, the operator under the supervision of the project developer i.e. Baynouna will be committed to ensure all health and safety measures are in place to prevent accidents and\or reduce the consequences of non-conformance events. The developer shall ensure all prospect risks during decommissioning phase are assessed and all prevention and mitigations measures are in place accordingly.

9.2.1.10 Socio-economics

Construction Phase

Employment Opportunities

Positive benefits of the project may arise from short-term job opportunities during construction which may range up to 300 jobs at peak. Peak construction is expected 10-12 months of the project. These personnel include engineers, specialists, project partner and representatives, suppliers as well as unskilled construction workers. The project developer will ensure that the majority of project’s workers shall be dedicated for Jordanian workforce, with prioritizing locals for these job opportunities, should their qualification match the needed requirements.

In terms of gender issues, the job opportunities during construction is mainly limited to men due to required physical efforts and other cultural considerations, therefore jobs available to local men can benefit women directly through support services such as a) renting homes; b) selling goods and products indirectly through benefiting from income from the job provided for the spouse or head of the household.

The impact is assessed as **positive (+);** however, will be short-time during the construction period. Maximizing the impact can be through selecting local staff as much as possible or sourcing goods and services from locals.

Traffic

During the Construction Phase traffic is expected to increase to a certain degree due to the nature of activities that will take place such as the transport of equipment and materials to and from the site through the surrounding road network. Additional traffic load will be evident at certain times during the day, especially if there are slow moving heavy vehicles transporting material to and from the site.

Vehicle traffic can cause congestion on road networks around and within the site and thereby leading to potential accidents.

The above potential traffic impacts can possibly occur during the duration of construction, especially during working hours. However, this is considered a short-term impact.

During construction, workers will likely reside in the nearest accommodation facilities to the site (possibly in Amman and surrounding) and labor camps with kitchen facilities and offices will most likely be present on site for daily use during working hours. As a result, it is anticipated that a number of vehicles (buses, cars) will be used to transport personnel to and from the project area. However, there is still a possibility for having worker accommodation facilities on site; if this is the case, daily transportation of workers to and from the site will be minimal. Furthermore, the workers will likely adhere to a special shift system under the direction of the EPC Contractor; and may not all be present on site at once. Such options are still being explored and the exact details will be determined once the EPC Contractor is appointed.

As for the material used for construction, a number of it will be imported to Jordan from abroad and will enter through Aqaba port, which will consequently be transported to the project site.

This impact is likely to happen but is not anticipated to cause any permanent effect on the receiving environment, also the number of vehicles provided during construction is not anticipated to case significant traffic impacts to the area.

This impact is likely to happen but is not anticipated to cause any permanent effect on the receiving environment. Hence, the impact is **likely (3),** with a **marginal (2)** consequence, as a result, the impact is found to be of **medium (6)** significance.

Potential Implications on Local Community Groups

The project area is a government owned land as previously discussed which is leased to the project developer i.e. Baynouna through a land lease agreement (LLA) to establish the solar PV plant. As mentioned in the baseline section, the study team observed signs of land ploughing during the site visits, mainly close to the wadi routes; this could be due to nomads, herders or locals from nearby communities utilizing the site intermittently for seasonal cultivation to produce livestock fodder; however, such observations have also been seen outside the project boundary within surroundings. In order to verify this, a further assessment is recommended to be undertaken prior to construction during the spring season.

The potential for impacts relating to IFC's PS5 with regards to Land Acquisition and Involuntary resettlement have been considered through the ESIA. This assessed the situation with regards to the two main categories:

Category 1: Physical Displacement

No physical displacement will occur within the project area because the project will be developed inside a government land that is currently empty of any official use or residential dwellings and this area has been designated to establish the solar PV project. In addition, Baynouna plans to install a fence around the project area prior to construction which will not affect the access or mobility of nearby local populations.

Category 2: Economic Displacement

As mentioned previously the ploughing observed on site along the wadi routes is expected to be for natural forage cultivation activity which is not considered as a permanent asset for the local community where other ploughing and cultivation occurs at areas surrounding the project.

The project area is government owned land which means there is no land ownership conflicts, as a result, the development of the project at the proposed location does not comprise any losses for the local community.

The area does not support the livelihoods of the surrounding communities in a structured and continuous manner and as per the interview with the nearby fertilizer workshop located outside the project boundary, the ESIA team were informed that some herd owners may plough the land during the autumn (October – November) season and come back in spring time (April – May) to feed their livestock however such activities are intermittent and very minimal, although they have an open access to pass through the area till now (however Baynouna aims to fence the site prior to construction) such activities are also practiced within the project area surroundings; therefore such herd owners have access to alternative alternative sites to use when they need to. This in turn will not cause loss of income sources of means on livelihood since there are no economic income obtained by them from the project land. Furthermore, consultation activities by the ESIA team during the scoping session and with the local stakeholders has raised no specific concerns over such issues.

Also, the closest community/village to the project area is Maghayer village and is relatively distant and located 8.5 km away; therefore, the project is not expected to cause any serious impacts to such communities. As a result, the impacts are considered **unlikely (2)** with a **negligible (1)** consequence, yielding a **low (2)** impact.

Community, Health, Safety and Security

The closest community/village to the project area is Maghayer village (~8.5 km away) and closest commercial activity is a fertilizer workshop located around 200 m away from project boundary. The project area is not expected to cause any serious impacts to such communities; given that Baynouna plans to fence the project are boundary even prior to construction activities commence, as a result the project site will eventually be secure and access will be controlled in the near future as a result any potential public risks during construction are expected to be avoided.

No direct community residents/locals/vulnerable groups are expected to be significantly affected by project activities. The nuisances that they may be exposed to on short-term basis during construction are traffic congestion at certain times, noise and dust and general disturbance.

In addition, the security on site will be managed with the installation of standard meshed Fences around the site boundaries, CCTV cameras around the site boundaries, flood lights within the site. The camera will be monitored through SCADA system in control room. Security camera and fences will also be considered during construction phase of the Project.

As for labor influx into the site, especially during construction, this is not expected to negatively impact the local communities given that the closest community/village is relatively distant, and communities may even benefit economically in terms in income generation if such workers decided to be accommodated in nearby areas. The construction phase is expected to provide opportunity for skill transfer and increased sales for local retail and service industries which will benefit the community.

The impact to community, health, safety and security is not expected therefore is considered **unlikely (2)** with a **marginal (2)** consequence, yielding a **low (4)** impact significance. Even for the project operation phase, such impact is not expected.

Labor and Working Conditions

Common activities during construction such as excavations, lifting, movement of heavy machinery, handling chemicals, etc. can introduce occupational health & safety risks to workers as mentioned under health and safety impacts above. Other risks are also associated with child labor and forced labor.

Effective systems in line with The IFC Performance Standard 2: Labor and Working Conditions, World Bank EHS guidelines and International Labor Organisation (ILO) requirements and good site practices in terms of site services and facilities shall be designed and implemented to manage such potential risks. Such systems include a set of Human Resources (HR) policies that will comply with Jordanian Labor Law and required international guidelines (i.e. IFC, ILO). The contractor shall also take reasonable steps to develop a workers' grievance mechanism to be implemented during construction to receive and follow up on worker grievances.

The construction phase shall be managed by the contractor and supervised by the project developer to ensure that such incidents do not take place – competent persons shall be appointed by the contractor on site to oversee all activities and carry out relevant audits and inspections. Such practice shall not be limited to direct contractor staff only, it shall also be applied other employment relationships such as workers engaged by third parties and the supply chain (vendors/suppliers) that the contractor deals with.

During construction, workers will likely be accommodated in the nearest accommodation facilities to the site (possibly in Amman and surrounding) and labor camps with kitchen facilities and offices will most likely be present on site for daily use during working hours. However, there is a possibility for having worker accommodation facilities on site; if this is the case, the facilities shall be established in accordance with the specifications of the International Labour Organisation (ILO) standards and guidance published by EBRD and IFC;

A grievance mechanism during the operation phase shall also be developed and will under the responsibility of the project developer and/or the operation and maintenance contractor.

The implementation of an effective system, development of relevant plans and contracting suppliers / sub-contractors that satisfy IFC requirements will reduce the risks of labor and working conditions throughout the project phases. As a result, the impact is considered **very unlikely (1)** with a **critical consequence (3)** – yielding an overall **low (3) impact significance.**

Operation Phase

Employment Opportunities

The long-term operation of the PV power plant will provide specialized employment and training for a small local workforce (up to 40 people) to be hired as part of the operation and maintenance contractor team. However, these opportunities are assumed to be limited in number and require people with certain technical qualifications. Also to manage local community expectations and to maximize this impact a Corporate Social Responsibility (CSR) plan will be developed and implemented by Baynouna to ensure a certain budget will be allocated for community development activities. The impact significance is assessed as **positive (+).**

Traffic

Impacts from traffic are not expected to occur during the operation phase due to the low number of personnel present within the project site. Therefore, increased traffic load is not considered a significant impact. As a result, the impact is **very unlikely (1),** with a **marginal (2)** consequence, yielding an overall **low (3)** impact significance.

Economy and Society

Solar projects in Jordan are expected to improve Jordan’s economy as more investors are attracted to the country to establish clean energy projects, this will consequently provide electricity and help serve more households and commercial establishments in Jordan for lower tariffs, thus satisfying the Energy Strategy of increasing the share of renewable energy mix by year 2025 which will in turn contribute to increase the portion of energy generation from local sources (up to 40%) within the total energy mix (MEMR, 2015).

The solar projects will also lead to upgrading the economic status of the local communities in addition to potential increase in land prices and improvement in welfare conditions in the long run. This project is anticipated to have benefits to society since it will contribute to skill transfer, and will provide a clean and pollution free energy, as a result, improved public health. Therefore, this impact is considered to be **Positive (+).**

Project Support to Jordanian Government in Hosting Refugees

According to the latest national census, the total population of Jordan is estimated around 9.5 million, including 6.6 million Jordanians. Of the total non-Jordanian population; 1.266 million are Syrians (this number was utilized since it is more realistic and reflecting the actual situation), constituting 46 % of non-Jordanians living in the Kingdom and 13.2 % of the overall population (Population & Housing Census, 2015).

The per capita electricity consumption in Jordan in 2015 was 2483 kWh, according to Energy 2016- Facts and figures from Ministry of Energy and Mineral Resources’. **Figure 68** below includes electricity consumption for household, industrial, transport, water pumping and other services. If per capita estimation is done only for residential sector, then per capita consumption in Jordan in 2015 becomes 1067.7 kWh. According to government statistics, average per capita energy intensity among Syrians living in cities and towns is 25% lower than that of the general population.[22] This makes final per capita electricity consumption for Syrian refugees 801 kWh.

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[22] Ministry of Planning and International Cooperation, *Impact of Hosting Syrian Refugees*, October 2013, Amman.

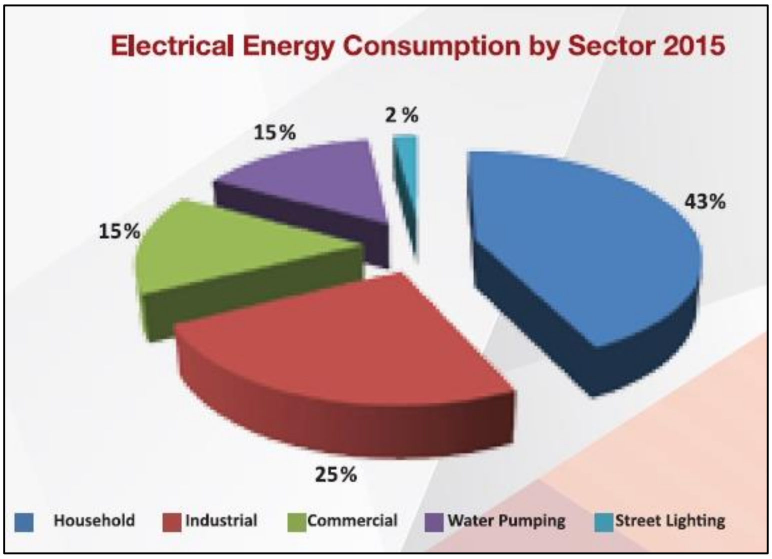

Figure 68: Electrical Energy Consumption by Sector 2015

Considering 1.266 million of refugees from Syria as of January 2017, the total residential electricity required will be 1,014 GWh, if the per capita electricity consumption is to be taken as the value calculated above. It is estimated for the project to generate 532.3 GWh as annual average for 20 years (first year in 560 GWh and in year 20 it is expected to reach 504 GWh (because the PV module degrades in the range up to 0.5% per year).

This makes the project's annual average generation approximately 3.3% of the total electricity consumption (16173 GWh in 2015). In this regard, the proposed project provides approximately 52.5% of total residential electricity (similar figure as above) required for Syrian Refugee in Jordan.

As a result, the project will help Jordan to meet the increasing energy demands arising from the presence of Syrians in towns and cities across Jordan (whether formally registered as refugees or not) in addition providing a clean and pollution free energy; especially that as part of the response options, the GoJ foresees a need to install additional power to meet such demands, given that the estimated levels of additional power needed to respond to the Syrian crisis (225 MW for cities and 46 MW for the Al-Za'atri Camp)[23].

Therefore, this impact is considered to be **Positive (+).**

Decommissioning

Employment Opportunities

Short-term job opportunities may be arise during decommissioning, however, this can negatively impact permanent personnel at the PV power plant since the facility will cease its operations, therefore permanent staff may lose their jobs.

Although this impact is **very unlikely (1)** given that fact that an upgrade is expected for the facility during its post – design life**,** however, the consequence is considered **critical (3)** to permanent personnel if the facility underwent decommissioning, yielding a **low (3)** impact significance.

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[23] Ministry of Planning and International Cooperation and the United Nations, Host Community Support Platform - Needs Assessment Review of the Impact of the Syrian Crisis on Jordan, November 2013.

Traffic

The anticipated impacts during decommissioning are similar to those for the construction phase, where the heavy machinery that transports disassembled parts of the project PV power plant facility might be of more significance than normal vehicles and pickups.

Proper management actions with adequate mitigations can reduce significantly such anticipated impacts.

The impact likelihood is **likely (3),** with a **marginal (2)** consequence, thus the significance of the impact is considered to be **Medium (6).**

9.2.1.11 Archaeology and Cultural Resources

Construction & Decommissioning Phases

Based on the archaeological survey performed by the Department of Antiquities (DoA) provided in **APPENDIX D**; it was identified that two sites fall within the project area as illustrated in the baseline section.

The survey determined that there are no significant archaeological and cultural heritage sites within the project area; as a result, an archaeological clearance letter has been issued also provided in **APPENDIX D.** As per the letter, the DoA has no objection to move forward and go ahead with the project; but if any archaeological remains were found during project implementation; site works must cease and the DoA must be informed of this in order to assess them.

Since the survey mentions that the project area and surroundings has been surveyed years ago (1996) it is not anticipated that undiscovered archaeological remains are present, the consequence of finding such remains will be minor if construction was coupled with effective monitoring during site activities and paying attention to the identified sites if such similar remains are found in addition to early coordination with the Jordanian Department of Antiquities – with respect to chance find procedures in accordance with the Jordanian Antiquities Law.

It is concluded that there is no anticipated impact from construction or decommissioning on these receptors; therefore, the impact assessment process for this receptor has yielded a low significance.

The chance find site impact likelihood is **very unlikely (1),** with a **Critical (3)** consequence if archaeological remains happen to be discovered, therefore, the overall impact assessment is considered to be **low (3).**

10 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The project developer i.e. Baynouna is committed to achieving and maintaining environmental standards, such that Jordanian environmental regulations and IFC performance standards are met, and potential adverse environmental impacts resulting from the project activities are minimized as practicably as possible. This will be achieved through appropriate project planning and methods of Project operation.

Implementation of on-going environmental monitoring programs will enable the assessment and modification, if required, of the Environmental Management program.

10.1 Objectives

This Environmental and Social Management Plan (ESMP) aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project.

The key objectives of the ESMP are summarized below:

- Minimizing any adverse environmental, social and health impacts resulting from the project activities;
- Conducting all project activities in accordance with relevant Jordanian Legislation and applicable IFC guidelines.
- Implementation of on-going environmental & Social monitoring program;
- Include an Environmental and Social Safeguards Program (ESSP) embedded in the ESMP to monitor the implementation of mitigation measures and propose relevant performance indicators.
- Periodic review of the Environmental & Social Management programs to allow for iterative improvement;
- Ensure that all stakeholder concerns are addressed.

Overall, this ESMP aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project as presented in **Table 37** and

Table 38**.**

10.2 Mitigation and Monitoring

Further to the impacts assessed in the previous chapter, this section presents more detailed mitigation measures and monitoring requirements (included in the following tables) that correspond to the impacts examined in the previous section, thus exploring them in more detail.

Mitigation measures aim to offset any negative impacts that may result from the project, and monitoring is the process of measuring the success of mitigation measures in order to assess their effectiveness. Reporting is the process of measuring actual performance or how well the mitigation measures have been implemented, including the format, timing and responsibility for reporting of the monitoring results.

Although the ESIA process did not reveal any high significant impacts (highest was found to be medium), this section provides measures that further reduce those impacts considered to be medium as well as those considered to be low.

Table 37: Environmental and Social Management Plan during Construction Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Physical Environment							
Air Quality	Dust generation due to construction activities	• Setting an appropriate site speed limit to reduce dust generation from vehicles travelling over unmade surfaces. • During construction dust generated on unpaved roadways and work areas should be controlled by the application of water on an "as needs" basis. • Unnecessary handling of dusty materials will be avoided such as minimising drop heights when loaders dump soils into trucks. • Train workers to handle construction materials and debris during construction to reduce fugitive emissions. • Cover trucks when transferring fine and dusty materials outside the project location.	Visual monitoring of dust emissions during earthworks and construction activities	Daily	Corrective actions for all significant dust generation issues Contractor shall prepare and submit a report to Baynouna in case of compliants	No visible dust plumes originating from construction site.	EPC Contractor
	Exhaust emissions due to operation of construction plant and machinery	• Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. • Not running engines for longer than is necessary.	Visual monitoring of exhaust emissions during earthworks and construction activities	Daily	N/A	Regular vehicle maintenance records	EPC Contractor
Noise	Increased noise levels due to	• The contractor shall use heavy equipment, machinery, and fuels in compliance with national regulations. The contractor shall perform regular	Noise measurements to be undertaken during construction activities, at the site	One month after start up and every quarter	Corrective actions reporting to Baynouna	Compliance with MoEnv and National guideline limits for	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	constrcution & machinery	maintenance on all equipment, vehicle and machinery to prevent noise emissions. • The contractor shall limit idling of engines when not in use to reduce its contribution to noise emissions.	in order to demonstrate compliance with the National environmental noise guidelines using a portable noise meter.	after that., and after receiving any complaints from workers or third parties.	in case of any exceedance	environmental noise at sensitive receptors:	
Soil	Soil contamination	• A spill prevention and response plan shall be prepared by the contractor in order to control any inadvertent leakage or spillage. • Spill response measures shall be implemented (as necessary) to contain and clean up any contaminated soil. • Construction of bunds around relevant work and storage areas. Bunds in areas of hazardous chemical storage (including temporary storage) should be lined to contain accidental spillage and minimize the potential for migration to the underlying soil. • Any spilled chemical shall be immediately collected and disposed of in accordance with Spill Prevention and Response Plan and Material Saftery Data Sheets (MSDS). • Contractor shall ensure that a spill kit and adequate PPE is available at the site for emergency cleanup activities in case of chemical/oil spillage.	Visual Inspection of storage area, and machinery through conducting regular audits of on-site activities and incident reporting forms. All site workers to be trained on spill response procedures.	Weekly	All unplanned incidents/ accidents and Corrective actions.	Number of spills or incidents to be recorded during on-site audits. Training records of personnel trained in spill response procedures must be filed	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	Soil disrtubance	• To control soil erosion, surface run-off should be collected from all paved working areas into retention ditches to restrict concentration of flows	Visual Inspection of any temporary soil storage and run-off controls	Weekly	Corrective actions reporting	Regular inspection reports	EPC Contractor
Visual Amenity	Visual impacts from construction activities such as materials lay down, excavation, backfilling	• The contractor shall ensure general cleanliness and good housekeeping practice at the project site at all times. • Prohibit the disposal of solid waste ino the surrounding land during construction activities. All inert material surpluses shall be managed within the limit of the project Site.	Visual inspection of general housekeeping and cleanliness at site in addition to waste management on site.	Daily	Inspection reports	Good housekeeping practices and tidiness of work areas within the project site.	EPC Contractor
Waste Generation	Hazards presented by improper management and handling of hazardous and non-hazardous waste during construction.	• The contractor shall segregate storage for different types of wastes, such as hazardous, non-hazardous recyclable construction material, plastic, paper, etc. to facilitate proper disposal. • The contractor shall provide a separate storage area for hazardous materials. The hazardous materials/products must be labeled with proper identification of its hazardous properties. • Chemical waste shall be stored in accordance with the provisions of Material Safety Data Sheets (MSDS). The contractor shall keep MSDS onsite. • Contractor shall provide trash bins within each construction site so as to prevent littering in the project area and surrounding areas. • The contractor shall establish regular intervals for waste collection and disposal as per contractor's waste management procedures.	Visual monitoring of site cleanliness and proper storage and handling of hazardous waste and sewage. Inspect that segregated waste disposal or storage areas are clearly marked.	Daily	Contractor shall prepare and submit monthly waste report to Baynouna.	Compliance with waste management procedures. Current and complete records of regular waste pickup and disposal.	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• The sanitary and organic wastes shall be collected in a septic tank to be installed on site and disposed off regularly.					
Water Resources	Potential surface water runoff / potential flood risks.	To minimize risks from high rainfall and potential flooding the following measures have been proposed as per the surface hydrology study conducted for the project area: • As preliminary vision some of the streams need channelization with grouted riprap lining, especially at lower elevations of the project area as mentioned in **Table 36**. • For maintenance purposes and to serve the site in all weather conditions, it is recommended to define the wadi banks by means of creating depression within the flooding plain in order to guide the flood to run in a well-defined path. • Pipe or box culverts may be required to be constructed under the access road to the project and under any of the internal roads, if the wadis cross these roads, in order to transfer the flood waters from one side to the other side safely. • Wadis 5 and 11 require full protection for the parts located within the project area as shown in **Table 36**. • If any internal road to cross the channel at any location, it should cross over Box/ Pipe culvert having the size that able to discharge the coming flood from upstream drainage channel.	Visual inspection of drainage features during the rainy season	Daily during rainy seasons	Inspection reports and Incident reports to Baynouna in case of flood from high precipitation events.	No flooding caused by the construction and operations	EPC Contractor in collaboration with Baynouna

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• The design and layout of photovoltaic arrays of the project should be protected by providing PVC sleeves at each channel or road crossing with photovoltaic arrays. • Follow-up with the Ministry of Water and Irrigation (if needed).					
Biological Environment							
Terrestrial Ecology	Potential disturbance to flora	• Prohibit removal of existing natural plant if not necessary for construction. • Prohibit workers from cutting natural plants in the surrounding area for fire. • Prohibit machinery from using surrounding area of the proposed site as parking or maintenance area for machinery.	Visual inspection within project site.	All throughout construction	Periodic report to Baynouna on EHS performance	N/A	EPC Contractor
	Potential Disturbance to fauna	• Prohibit workers from hunting, killing animals as well as destroying ground nests for birds inside the proposed site and the surrounding area. • Replace any found ground nests inside the proposed site in coordination with Ministry of Environment and the Royal Society for Conservation of Nature (RSCN) • Report any killing accidents for wild life to the Ministry of Environment and RSCN. • Decrease the construction activity to the minimal during night time to decrease potential disturbance.	Coordination with RSCN when needed.	All throughout construction	Periodic report to Baynouna on EHS performance	N/A	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Health and Safety							
Health and Safety risks	Potential of exposure to safety events such as tripping, working at height activities, fire from hot works, smoking, failure in electrical installations, mobile plant and vehicles, and electrical shocks	• Presence and compliance with Environmental, Health & Safety (EHS) related policies and procedures on site. • Allocate specific personnel responsible for health & Safety management on site. • Adequate and appropriate training of all workers of the contractor's EHS policies and procedures before they are permitted to undertake a task. • All construction equipment used for the execution of the project works shall be fit for purpose and carry valid inspection certificates and insurance requirements. • Risk assessment shall be prepared and communicated prior to commencement of work for all types of work activities on site. • Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. • Signpost any slippery areas, ensure proper footwear with a good grip is worn for personnel working within slippery areas. • As far as reasonably practical, use cordless tools that may not need to use cables. Where cables for temporary lighting or mains-powered tools will be used, all cables shall be run through designated corridors.	Visual inspection by user before each activity Maintain proper housekeeping for the project site Routine Facilities' and site Inspection Inspection of Equipment and tools used during working at height activities	Prior to activity Continuously Monthly Prior to work activity	Contrctors shall prepare and submit monthly H&S report to Baynouna	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency Fatal Accident Rate Number of safety training performed Number of non-conformance events. Reports.	EPC Contractor and Baynouna

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. • Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards; • Arrest a fall with equipment to minimise the distance and consequences of a fall, e.g. safety nets, where work at height cannot be avoided or the fall prevented. • Carry out fire risk assessment for the construction areas, identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. • Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. • Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. • Establish and communicate emergency preparedness response plan (EPRP) with all parties, the EPRP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan.	Fire Emergency Response Drills	Semi-annually		Training records of workers on EHS policies and procedures	
			Inspection for fire extinguishers, testing for fire detection system, and other fire fighting equipment.	Monthly			
			Maintenance for fire extinguishers, testing for fire detection system, and other fire fighting equipment.	Continuously			
			Monitor work areas and activities to identify fire and explosions hazards.	Based on Fire risk assessment			
			Preventive maintenance and patrol inspections for all vehicles and mobile plant	Monthly			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Ensure all plant machines and vehicles are regularly inspected, serviced and maintained; ensure all staff assigned is trained and competent to operate plant machines and vehicles. • Ensure all routes are suitable and wide enough for the vehicles, routes should be planned by minimising bends/junctions, steep gradients and the need for reversing, clearly designate areas for pedestrian walkways and crossing points. • Ensure clear signages are in place, such as Warning of speed limits, obstructions, allowable widths/heights...etc. • Electrical equipment must be safe and properly maintained; works shall not be carried out on live systems. • Only competent authorised persons shall carry out maintenance on electrical equipment, adequate Personal Protective Equipment (PPE) for electrical works must be provided to all personnel involved in the tasks. • Lock-Out / Tag-Out (LOTO) system shall be implemented during any electrical works. • Adequate number of staff and first aiders shall be on site in accordance with Jordanian Labour Law requirements. • First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex	Vehicles and mobile plants inspection	Pre-use			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		gloves, scissors, thermometer, etc. shall be made available by the contractor on site. • Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills.					
	Exposure to health events during construction activities such as manual handling, electrical shocks and burns, hand-arm vibration, temporary or permanent hearing loss, heat stress, and dermatitis	• Adequate and appropriate training of all workers of the contractor's EHS policies and procedures before they are permitted to undertake a task. • Ensure that operations, which involve manual handling, are eliminated so far as reasonably practicable, provide mechanical aids such as forklifts, trolleys, cranes, hoists etc. • Ensure all equipment are suitable for jobs (safety, size, power, efficiency, ergonomics, cost, user acceptability etc), provide the lowest vibration tools that are suitable and can do the works. • Ensure all tools and other work equipment are serviced and maintained in accordance with maintenance schedules and manufacturer's instructions. • Regular noise exposure assessments and noise level surveys of noisy areas, processes and equipment shall be carried out in order to form basis for remedial actions when necessary. • As far as reasonably practical, all steps to reduce noise exposure levels of employees by means other than that of personal protective equipment	Monitor the health of workers Monitor work areas and operations to identify noise hazards. Inspection for use hear protection equipment Fit Testing Maintenance & Care for Hear protection equipment.	Continuously Monthly Prior Use Prior to employment Monthly	Contrctors shall prepare and submit monthly H&S report to Baynouna	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency Fatal Accident Rate Medical Treatment Case(MTC) No. Restricted Work Day Cases (RWDC) HSE Training Hours	EPC Contractor and Baynouna

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		shall be taken, such as reducing exposure times, enclosures, silencers, machine covers…etc. • Provide suitable and effective hearing protection to employees working in high noise levels. • Designate and clearly mark hearing protection zones, which may include particular areas, operations or pieces of equipment. All personnel entering these zones shall be required to wear hearing protection inside these areas. • Awareness training sessions should be established and provided to all personnel involved during the construction phase in order to highlight the heat related illnesses of working in hot conditions such as heat cramps, heat exhaustion, heat stroke, dehydration. • Ensure adequate quantities of drinking water are available at different locations within the site, • Ensure proper planning of works to consider the time of peak temperatures during the day, provide rest brakes during the peak times. • Provision of sun shades at different locations within the site. • Eliminate the risk of exposure whenever possible, provide proper PPE wherever necessary and to ensure that there are satisfactory washing and changing facilities. • Ensure that all workers exposed to a risk are aware of the possible dangers. They should be given				Number of non-conformance events.	

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		thorough training in how to protect themselves and there should be effective supervision to ensure that the correct methods are being used.					
Socio-economics							
Traffic	Additional traffic load due to transport of equipment and materials to and from the site through the surrounding road network	• The contractor to ensure that all trucks and vehicles accessing the facility are operated by licensed operators. • Pedestrians Safety: All project vehicles and trucks shall comply with the proposed speed limits • Ensure adequate maintenance and inspection of vehicles • Presence of flagman at the entrance and exit of the project site in order to control vehciles and truck movement. • Every employee working on the project site shall make sure that all needed signs and preventive measures are implemented when starting any activity. • Number of traffic signs, their characteristics and distance among them will be placed according to local legal requirements and an on-site HSE assessment that will conducted prior to any construction activity starts. • Signs shall always be in good conditions and be visible to every road user. • Vehicle transit across any restricted area and/or limited to working activities is prohibited.	Maintain open dialogue with Electric power plant facility since the project site is easily accessible through Muwaqqar area in the south or through the road leading to the electric power plant north west of the site. Monitor vehicle movement to and from the Project area.	Continuously	All incidents to be investigated and reported to Baynouna.	No complains or concerns from traditional users of the area's roads routes are received during the construction activities. No incidents or accidents (collisions) are recorded	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Vehicle repairmen and/or maintenance activities are not allowed within the project area. They shall only be carried out within the especially dedicated areas.					
Local communities	Potential implications of local community groups.	• Preparation of a community grievance mechanism and a Stakeholder Engagement Plan (SEP) prior to construction in complicance with IFC guidelines. • Undertake appropriate assessment (recommended during spring season) to confirm the use of the site in terms of seasonal cultivation for producing livestock fodder and identification of such intermittent land users / project affected persons. It is advised to conduct this assessment prior to construction. • Appoint a Community Liaison Officer (CLO) whose responsibility shall include the management of all community related matters for the project. The CLO role shall also be relfected in the SEP.	Ensure to establish specific monitoring procedure for stakeholder consultation and records of grievances where needed.	Throughout the project phases	To Baynouna management	Compliance with IFC guidelines and implementation of community grievance mechanism and SEP. Number of grievances and time taken to resolve them.	Baynouna
	Community Health, Safety and Security	• Appoint a Community Liaison Officer (CLO) whose responsibility shall include the management of all community related matters for the project. The CLO role shall also be relfected in the SEP. • Implementation of approproate security management on site.	Ensure project area is secure and access is well monitored throughout all project phases.	Throughout the project phases	To Baynouna management	Compliance with IFC guidelines and implementation of community grievance	EPC Contractor during Construction and Baynouna

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
						mechanism and SEP. Number of grievances and time taken to resolve them.	during operation.
Worker Community	Labor and Working Conditions	• The Contractor shall take all reasonable steps to ensure that all national legislation on labour and health and safety, the requirements of IFC Performance Standard 2 (Labour and Working Conditions), the World Bank General EHS Guidelines, relevant Standards and Procedures as developed and implemented by Baynouna, and any other relevant standards identified by IFC are complied with. • The Contractor shall provide a Grievance Mechanism for all workers and employees. The Contractor will ensure that all workers are informed about the Grievance Mechanism and that information about the mechanism is posted in relevant areas of the project site. • The Contractor ensure that hiring, recruitment and training plans satisfy the requirements of the provisions of PS2, and the HR procedures are well tailored to comply with local Jordanian Laws, IFC	Ensure that systems are in place to monitor compliance with labor and health and safety standards. Appointment of a manager on site to be responsible for ensuring that labor and health and safety legislation is complied with, and for monitoring supplier and sub-contractor performance. This shall be conducted through Internal	Regularly through project phases	To Baynouna management	Compliance with IFC guidelines and implementation of worker grievance mechanism. Number of grievances reported by workers/employees and time taken to resolve them.	EPC Contractor during Construction and Baynouna during operation.

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		requirements and Baynouna's HR policy and procedures. • The Contractor shall ensure that a safe and healthy working environment is provided for all workers on site and that good international practice on occupational health and safety is followed in line with policies developed by the Contractor. • The Contractor shall not under any circumstance employ workers under the minimum age for employment, as defined in national legislation. Children under the age of 18 will not be employed in hazardous work and a risk assessment will be carried out in respect of any work carried out by such employees. • The Contractor shall ensure that there shall be no use of forced or compulsory labor. • If workers accommodation will be established on site, it is essential to ensure that the camp is established in accordance with the specifications of the International Labour Organisation (ILO) standards and guidance published by EBRD and IFC. Also is is reocmmended to implement an induction program for all workers' resident in the camp to be aware of their rights, and safety measures.	audits and/or inspections to monitor compliance.				

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Archaeological Resources & Cultural Heritage							
Archaeology & Cultural Resources	Only potential concern can be impacts on possible unseen archaeological sites/remains (chance finds)	Based on the Archaeological Survey report docuncted for the project (**APPENDIX D**). Two main recommendations are proposed: 3) Adherence to the project area allocated for the project and not exceed it; and 4) Impementation of Chance Find procedures as per the Jordanian Antiquities Law. This is described as follows: • Construction works shall be ceased if any historical/ culturally sensitive or archaeological sites / remains are chance found during construction activities. • If any known sites were found during construction and may potentially be threatened by construction, the area with the newly discovered remains/sites shall be fenced and the DoA shall be notified immediately and invited for consultations and assessment of the finding and agreement must be reached with the DoA in order to minimize damages to the sites. It shall also be the Contractor's responsibility to notify the supervisor of the Cultural resources Management Office of the DoA are encountered in any area during construction and also specifications set in Article 15 of the Antiquities Law No. 21 (1988).	• Minimum of one site inspection immediately after chance find. • Informing personnel present on site of chance find procedures in case any archaeological or cultural resources were encountered	One site inspection after chance find	To Department of Antiquities (DoA) in case of chance finds.	N/A	EPC Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• The DoA will assess the discovered remains and may carry out an emergency salvage excavation (i.e. archaeological excavation conducted during the construction phase, which should be conducted only when an archaeological site is accidently found (chance found)). • The available short time for salvage excavations cannot be considered an authorization to destroy the discovered remains or site. Each site must be given proper consideration and analysis before its destruction. • Construction work shall be resumed within the newly discovered area only after archaeological experts from DoA and official authorities are consulted and appropriate mitigation measures are implemented, however construction activities can continue at other parts of the site after coordination with DoA. • Baynouna shall employ specialized personnel to oversee and supervise the implementation of mitigation measures.					

Table 38: Environmental and Social Management Plan during Operation Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Physical Environment							
Soil	Potential spillage of stored oil and chemicals	• Implementation of proper housekeeping practices on site at all times. • Specific procedures shall be developed for the removal of waste or spilled fuel, oil and contaminated soil at approved disposal facilities. • Proper storage for chemicals and fuel within confined areas on site and adopting proper safety measures when handling those chemicals to prevent their leakage and infiltration into the soil.	Inspect the presence of any disturbed areas in and around the project site for erosion Visual inspection of oil storage tanks, waste storage area and fuel storage area for spills and leaks	Post rainfall event Weekly	To developer's top management	Maintain readily available records of all workers training on spill response procedures.	EPC Contractor during warranty preiod ; and O&M Contractor during Operation Phase
Visual Amenity	Potential glare from PV panels	The used technology has Anti- Reflective coating that significantly reduce the refelectivity of the PV Panels as elaborated under section 9.2.1.5 – Visual Amenity during Operation Phase.	N/A	N/A	N/A	N/A	EPC Contractor during warranty preiod ; and O&M Contractor during Operation Phase
Waste Management	Potential disrcharge from WWTP.	• Project developer will construct a small scale wastewater treatment plant (WWTP) to treat domestic wastewater and liquid effluent generated from site activities, toilets and sanitation facilities during	• Monitoring the wastewater effluent quality to comply the	Regularly	To developer's top management	Complinance with relevant Jordanian Standards (JS 893:2006)	O&M Contractor during Operation Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		operation phase, treatment plant iffluents shall meet relative Jordanian Standards.	Jordanian standard. • Frequent Sampling of influents and the iffluents of the treatmant plant.			Reclaimed Domestic Wastewater	
	Handling of Broken PV Panels	• The developer will be committed to develpp a process to safely remove the broken modules in accordance with best industry practice & coordination with MoEnv.	• Constant inspection of PV modules.				
Terrestrial Ecology							
Terrestrial Ecology	Potential disturbance and harm to birds	• Minimize human and vehicular contact with faunal species present on site. • Any ground nests found on site shall be translocated outside the project boundary. • Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site. • Apply manual plant removal if needed.	Visual inspection within project site.	Weekly	To Banouna management	No reported harm to any faunal species.	EPC Contractor during warranty preiod ; and O&M Contractor during Operation Phase
Health and Safety							

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Safety risks	Potential of exposure to safety events during operation activities such as slipping and tripping, working at height activities, and fire	• Adopt specific Occupational Health & Safety policies to be complied with during operation. • Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. • Ensure all works and storage areas are tidy, all material deliveries shall be planned to minimize accumulated materials at project site. • Signpost any slippery areas, provide proper footwear during working within slippery areas. • Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. • Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards. • Carry out fire risk assessment during operation to identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire.	Inspection of equipment and tools used during working at height activities Maintain proper housekeeping for the project site Facilities and site inspection. Monitor work areas and activities to identify fire hazards.	Prior to work commencement Continuously Monthly Based on fire Assessmnet Semi-annually	Prepare regular report to developer's top management	Total Recordable Incidence Rate (TRIR) Lost Time Incidence Frequency Number of safety training performed Number of non-conformance events..	EPC Contractor during warranty preiod ; and O&M Contractor during Operation Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. • Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. • Establish and communicate emergency preparedess and response plan with all parties, the EPRP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan. • Adequate first aiders shall be on site in accordance with Jordanian Labour Law requirements. • First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. • Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills.	Fire emergency response drills Maintenance check for fire extinguishers, testing for fire detection system, and other fire fighting equipment.	Monthly			
Socio-economics							

Aspect	**Key Potential Impact**	**Mitigation Measures**	**Monitoring Requirements**	**Frequency**	**Reporting**	**Performance Indicator**	**Responsibility**
Traffic	Potential minimal increase of traffic load	Implementation of a regulated entrance and exit into the facility.	Monitoring of access roads around site Record complaints received from locals or authorities.	Daily	All incidents reported to the proper authority and to Baynouna's Management.	Number of complaints from road users. Number of traffic incidents due to vehicle movement.	EPC Contractor during warranty preiod ; and O&M Contractor during Operation Phase

10.3 Cumulative Impact Assessment

In accordance with the IFC Good Practice Handbook on Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, it is appropriate for developers to conduct a cumulative impact assessment as part of the risks and impact identification process when multiple projects occur in, or are planned for within the same geographic area, and when a series of projects of the same type are planned to be developed and are potentially expected to contribute to cumulative impacts on one of more Valued Environmental Component, i.e. physical features, biological environment, socio-economic conditions.

Cumulative impacts have been defined as “changes to the environment that are caused by an action in combination with other past, present and future human actions” (Hegmann et al 1999).

There has been substantial increase in renewable energy developments in Jordan, particularly solar and wind projects. In addition to the evolving legislation in the country in order to facilitate the introduction of such projects for the purpose of electricity generation.

Solar PV power plants in particular are focused on Ma’an (as part of round 1 projects) – all Ma’an projects are currently operational. Mafraq (as part of round 2 projects) are in the process of commencing construction. It is worth noting that these 2 governorates consist of development areas (Ma’an Development Area and King Hussein Bin Talal Development Area /Mafraq) that have designated land plots for such projects and have attracted investors to develop solar projects there. Other solar projects are also being implemented in Aqaba and Irbid.

The above mentioned projects are located far away from the project area, Ma’an being approximately 195 km away, and Mafraq 53 km away, while Aqaba is more than 250 km away.

The above mentioned facilities are sufficiently distanced from the project area such that their development is not anticipated to add very insignificantly to the potential direct impacts of the Project.

Currently there are no existing utility scale solar and wind power plant projects in close proximity to the project site. However, a planned solar PV project is planned to be situated around 2 km away from Al Manakher electric power plant (IPP4), meaning that it will be located 12 km north-west of the project area as illustrated below. This planned PV project will be considered the nearest to the Baynouna project area when in operation. The planned solar PV plant will have a capacity of 40 MW and will be developed by AES Corporation. Based on communication with NEPCO, the planned project is still under contract negotiation phase.

The existence of this planned solar PV project 12 km away from the project site is not anticipated to cause any significant cumulative impacts.

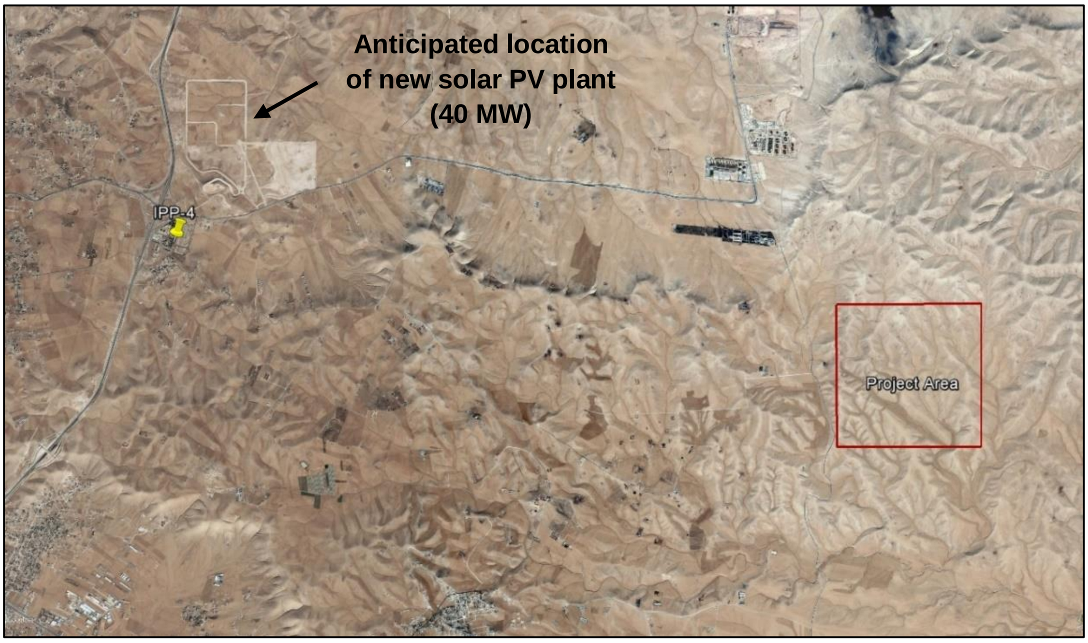

Figure 69: Location of nearest planned new solar PV project to the project area

In the below table, further assumptions of cumulative impacts were considered assuming that more than one solar PV projects are established within close proximity to the project site.

Table 39: Consideration of Cumulative Impacts in the case of establishment of more than one new solar projects in close proximity to the Project

Aspect	Comment
Soil	Site levelling, grading and land clearing (although considered minimal due to poor vegetation in the area) can lead to potential soil disturbance and erosion. However, this is considered to be minor and temporary during construction.
Air Quality / Dust / Traffic	During the operation phase, solar PV projects are not anticipated to result in combined discharges or emissions. The only temporary emissions during construction are expected as a result of exhaust emissions and dust; in addition to increased traffic during certain times if one or more project is undergoing construction. As for the operation phase, the increase in renewable energy projects will have benefits in terms of reduction of carbon footprint and promoting clean energy.
Terrestrial Ecology	Given the low vegetation coverage and minimal faunal diversity within the area and its surroundings combined impacts on terrestrial ecology are considered minimal and if any will be during construction.
Birds	This impact cannot be quantified since the exact locations of potential solar PV plants are unknown; however, outside the direct project area no Important Bird Areas exist and the project is not located at one of the bird migration fly ways. As for the planned 40 MW project, it is not anticipated to contribute to any significant impacts on birds.

Aspect	Comment
Landscape and Visual Impact	The existence of several solar PV facilities may cause some visual impact; however, this is not considered to be significant given that the project area is relatively empty with limited visual resources, cumulative impacts are expected to be minor.
Socio-economics	The establishment of more solar projects are anticipated to contribute positively to local employment opportunities and maximizing CSR initiatives where project developers are expected to collaborate in implementing such initiatives due to their close proximity which can bring about benefits to the surrounding local communities. In terms of benefits to the country as a whole, large scale solar PV projects will help achieve the targets of the Jordan Energy Strategy and increase the percentage of energy generation of renewable sources. It is recommended that in such cases where numerous solar projects are present in close proximity to the project site,

Future projects may be planned after the NEPCO green corridor which is a multi-component programme that aims to enhance the capacity of the electricity transmission network in the south of Jordan and raise the target. It is expected to include:

- Two new transmission lines (400 kV/150 km and 132 kV/51 km)
- Upgrading three existing lines (132 kV/100 km)
- Construction of one new 400/132 kV, 1200 MVA electricity substation

The main objectives of the green corridor are to allow access of renewable electricity projects to the main consumption center of Amman and to replace present and future fossil-based generation as well as strengthening the energy transmission backbone of the country.

The green corridor is expected to be operational by end of 2018 / beginning of 2019. And a 200 MW project may be planned to be construction in Ma’an after the green corridor project is operational. Therefore, at this point in time there is difficulty in terms of making assertions as to future developments in the renewable energy sector since there is no official announcement yet.

In conclusion and as for the time being there are no planned solar PV projects in the direct vicinity of the project (except) for the planned 40 MW project to be located 12 km away. Other than that cumulative impact assessment cannot be fully quantified at this stage. Therefore, the project will not have any significant effects on future activities in the area.

10.4 Decommissioning

The solar power plant facility is considered a large scale long-term investment that will contribute to economic benefits to the country through provision of power supply, designed in accordance with best practice, taking into account all relevant national and internal codes and legislation. The project also fits with the county's energy strategy while at the same time reducing the carbon footprint resulting from the cement plant and mitigate the impact on climate change while providing the cement plant with electrical needs and reduce electrical load on other local electrical stations.

The project aims to provide power supply that is designed in accordance with best practice, taking into account all relevant national and internal codes and legislation.

The design life of the facility will cover the period of approximately 20 years, and will be renewed upon mutual consent between project stakeholders.

The post-design life is expected to involve the following two options:

- Rehabilitation, upgrading and modernization of the facility, with a possible expansion (retrofitting and addition of new technology). As a result, impacts from decommissioning are not expected to arise in the near future unless retrofitting and upgrade of the facility was not feasible; or

- Decommissioning in case there was a need for the facility to be dismantled and end its operations.

As can be noted from the impact assessment **section 9**, no impacts with high significance are anticipated to take place during decommissioning of the project since all facilities will be removed, solar power plant decommissioned and its components disconnected, and PV panels will be dismantled and sent for recycling.

The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. However, it is recommended that before any decommissioning activities take place a Disposal Plan for the PV Panels shall be prepared by the responsible entity undertaking decommissioning activities – also special consideration to be taken into account when handling and recycling thin-film (CdTe) modules; based on a published research though ''large-scale use of CdTe PV modules does not present any risks to health and the environment, and recycling the modules at the end of their useful life completely resolves any environmental concerns. During their operation, these modules do not produce any pollutants''[24].

The Disposal Plan shall consider the following options at a minimum and compare the feasibility and applicability of each:

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[24] http://www.clca.columbia.edu/papers/Life_Cycle_Impact_Analysis_Cadmium_CdTe_Photovoltaic_production.pdf

1) Recycling if PV modules and other components where suitable;

2) Reuse in other technologies;

3) Disposal of the Panels and/or other materials than cannot be reused at existing hazardous waste facilities in Jordan through coordination with the Ministry of Environment.

More certainty with regards to disposal methods will be clarified by then depending on new available technologies and reuse/recycling options and other appropriate disposal facilities.

Therefore, to avoid repetition, please refer to **Table 37** for detailed mitigation measures that overlap with decommissioning as well.

11 OVERVIEW OF ESMS AND AUDITING PROTOCOL

11.1 Environmental and Social Management System (ESMS) Framework

After the identification and assessment of environmental and social risks/impacts generated by the project (throughout the ESIA stage), the project developer will be obliged to manage such risks during the project lifecycle i.e. Construction, Operation and Closure/Decommissioning.

The main tool to manage such risks is through developing an Environmental and Social Management System (ESMS) that are commensurate to the level of risks/impacts identified and as per the requirements of *IFC Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.*

The ESMS developed by the project developer shall apply to the contractor and operator. The ESMS documentation shall be in place prior to construction and may include plans relevant to the project’s identified risks and impacts - mainly related to the following:

- Requirements for environmental and social management;
- Requirements for stakeholder engagement;
- Requirements for management of labor and working conditions;
- Requirements on emergency preparedness and response.
- Requirements for other relevant plans – as requested by the lenders.

11.2 Monitoring and Reporting

After the preparation of the relevant ESMS plans and procedures, the project developer will be required to establish procedures to monitor and measure the effectiveness of the management program during project implementation, as well as compliance with any related legal and/or contractual obligations and regulatory requirements.

Regular monthly reporting from the contractor and operator (at a later stage) shall be submitted to the project developer i.e. Baynouna. The issued reports shall include information and indicators with IFC environmental and social reporting requirements.

11.3 Auditing

Environmental and social audits will assess a projects performance against its project specific ESMS should the need arise.

The audit may be required during the project implementation to review the current operational performance of Baynouna’s existing operations i.e. the PV power plant project. For this project, the audit shall be conducted during the **construction phase** and the **operation phase**, usually by an independent third party consulting Company / E&S Experts.

Key issues that are recommended to be covered under the E&S Audit may include, but not be limited to:

- A review of the company's existing and approved environmental and social management system (ESMS), policies and practices;
- Organizational capacity and resources;
- Human Resources and employment (e.g. child labor, forced labour, non-discrimination and equal opportunity, workers' organizations, contractor management, retrenchment and employment) policies;
- Occupational health and safety (national requirements, key health and safety issues, control and major accident hazards, current health and safety monitoring programme, summary of regulatory compliance status, emergency response practices and procedures etc.);
- Pollution prevention measures available at the PV plant and regulatory compliance with national requirements including applicable Best Available Techniques.
- Community health, safety and security as it relates to the Company's existing operations;
- Management of potentially hazardous works;
- Waste management procedures on site during all project phases ;
- Noise generation during construction and operation;
- Identification of potential environmental liabilities (e.g. potential contamination as a consequence project operations);
- Overview of the supply chain (e.g. suppliers, contractors, sub-contractors of main materials and resources) and identification of relevant environmental, social, labour and/or reputation issues; and
- Public interaction, including responsiveness to public comments, complaints and questions. The audit should also identify the main stakeholder groups and current stakeholder engagement activities in line with IFC guidelines and the Stakeholder Engagement Plan (SEP) conducted specifically for this project. A check on grievance mechanism and the its records and frequency of response shall be conducted,
- Updating Environmental and Social Action Plan (ESAP) accordingly.

The successful implementation of the ESMS will require detailed training of employees and some training of other stakeholders to ensure that they are aware the main objectives and purpose of the ESMS and its benefit to the project.

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APPENDIX A: SCOPING SESSION REPORT

Environmental and Social Impact Assessment (ESIA) for developing a 200 MWac PV Power Plant Project Al-Muwaqqar

Scoping Session Report

February 2017

APPENDIX A

ARABTECH JARDANEH
Define . Design . Deliver

Masdar
A MUBADALA COMPANY

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Figure 1: Pictures from the Scoping Session.. 9

1 INTRODUCTION

Abu Dhabi Future Energy Company PJSC – Masdar, which is the lead developer for this project / represented by Baynouna Solar Energy PSC – as the project company, has been granted an approval from the Government of Jordan, represented by the Ministry of Energy and Mineral Resources (MEMR), to develop a 200 MWac grid connected Photovoltaic project in Muwaqqar.

Baynouna aims to develop the solar energy project using PV technology to generate electricity in Jordan. The project will help to decrease the country's dependency on traditional forms of energy by increasing the availability and use of solar energy. The generated electricity will be injected into the national grid to support the country in meeting its renewable energy target of 10% by 2020.

MEMR and the National Electric Power Company (NEPCO) have successful track record with independent power projects (IPPs) that include top international power developers with active projects in Jordan

Arabtech Jardaneh (AJ) was appointed by Baynouna to prepare the Comprehensive Environment Impact Assessment (ESIA) Study for the project activities during the three phases of the project construction, operation and decommissioning. The ESIA will be prepared in accordance with the requirements of the Jordanian Environmental Impact Assessment (EIA) Regulation no. 37 of 2005, and the International Finance Corporation (IFC) Performance Standards (PSs), in addition to both EBRD Performance Requirements (PRs) and Equator Banks Principles in order to support the application for an environmental permit from the Ministry of Environment (MoEnv).

The Scoping Session is part of the Final Term of Reference (TOR), meanwhile, it is considered as essential part of the ESIA process. The scoping session includes all stakeholders potentially affected by the project, the Ministry of Environment (MoEnv) invited the public and the concerned private sectors to attend the session.

1.1 ESIA Objectives

The ESIA study will be used to support the application for an environmental permit from the MoEnv in line with the Jordanian Environmental Impact Assessment Regulation 37/2005.

In accordance with MoEnv's requirements, the EIA assignment consists of the following phases:

- Preparation of Preliminary ToR (***completed***);
- Attend and document scoping session with stakeholders (***completed***);
- Stakeholders scoping session (***completed***).
- Finalize and submit ToR following input from MoEnv (**this document**);
- Perform ESIA study and prepare ESIA Report;

- Preparation of an environmental and Social Management Plan (ESMP), to be incorporated into the EIA report.

The overall objective of the ESIA is the evaluation of the likely environmental and social impacts for the project activities during the three project phases, construction, operation and decommissioning, then to minimize/eliminate negative impacts and maximize positive impacts, in order to ensure that the environmental & social factors are considered in the decision-making process.

2 PURPOSE OF SCOPING SESSION

The Scoping Session is an essential part of the ESIA process that includes all stakeholders potentially affected by the project, whether from the public or private sectors. The main purpose of the session is to present the proposed project and to solicit feedback concerning environmental and socio-economic impacts.

The objectives of the ESIA scoping session can be summarized as follows:

- Identify the main project stakeholders and their concerns;
- Inform the public about the project;
- Provide the opportunity for identified stakeholders to participate in the process of scoping significant environmental impacts;
- Identify those environmental and social impacts/concerns which are considered to be of key relevance and importance for the ESIA;
- Ensure appropriate approach and adequate focus are adopted during the ESIA;
- Establish the final Terms of Reference for the ESIA study.

The final output of the scoping process is the Final Terms of Reference (ToR) and a Scoping Statement Report which complies with the regulations of MoEnv, and which will further aid the consultant with the ESIA Study.

This Scoping Summary Report has been prepared in order to provide a brief description of the Project, record the feedback and comments received from stakeholders during the scoping session.

The scoping session for this project was held on Thursday, January 26th 2017 at Geneva Hotel in Amman; taking stakeholders comments and feedback into consideration throughout the ESIA in order to produce a comprehensive study that assess and covers all aspects of the Project.

3 SCOPING METHODOLOGY

3.1 Invitations and Logistical Arrangements

Prior to commencement of the ESIA Scoping Session, a Preliminary Terms of Reference (ToR) document was prepared by AJ team and submitted to the MoEnv during the first week of January 2017. The Preliminary ToR provided the MoEnv with a project description, proposed approach to completing the required ESIA study, including provisions of impact assessment criteria and methods for establishing mitigation measures to control (eliminate and/or minimize) those impacts identified as significant, and a list of identified project-related key issues. The ToR Document was submitted to MoEnv before the scoping session in order to facilitate the scoping process.

AJ team coordinated with the MoEnv to hold the Scoping Session on January 26th, 2017.The MoEnv prepared and sent the official invitations to relevant stakeholders including representatives from various ministries and governmental institutions, academia, Non-Governmental Organizations (NGOs), relevant municipalities, National Electric Power Company (NEPCO), The Royal Society for the Conservation of Nature (RSCN) and many others.

The location, date and time of the session were as follows:

Location: Geneva Hotel, at 7th Circle – Amman, Jordan

Date: Thursday, January 26th 2017

Time: 10:00 am – 1:30 pm.

3.2 Scoping Session Components

The Scoping Session consisted of the following:

- Opening Statements by:
    - Eng. Izzat Abu Hamrah, Director of Licensing and Guidance Directorate at the Ministry of Environment.
    - Eng. Basel Dahleh, Project Manager / Clean Energy, MASDAR.
- ESIA Presentation:
    - A Scoping Presentation addressing Project Description and ESIA approach and potential impacts conducted by Ms. Rasha Tomaira– Senior Environmentalist - Environment Section, AJ.
    - Presentation of the project description, operations, and decommissioning in addition to project layout and Project Alternatives considered the Jordan Energy Strategy 2020, the detailed presentation is included in Annex 2.

The following is a general outline of the presentation:

- Introduction (ESIA Scoping)
    - Explanation of Scoping
    - Explanation of ESIA and its Purpose
    - ESIA Report Components
- Project Description
- Legislative Framework
    - Relevant Laws and Regulations to the Project, including MoEnv's Legislation as well as national Legislation.
- Approach to Establishing Baseline Conditions
    - Physical Environment
    - Biological Environment
    - Socio-economic Conditions
    - Cultural Heritage and Archeology
- Impact Assessment
    - ESIA Process
    - Environmental Aspects
    - Impact Significance
- Project Alternatives
- Key Potential Issues
- Environmental and Social Management Plan

Figure 1 below presents some pictures from the scoping session:

Figure 1: Pictures from the Scoping Session

- Discussions and Feedback period during which the stakeholders raised their issues of concern. The detailed comments, deliberations and issues raised are included in Section 3 below. Responses were provided by:
    - Eng. Izzat Abu Hamrah, Director of Licensing and Guidance Directorate at the Ministry of Environment.
    - Eng. Basel Dahleh, Project Manager, MASDAR.
    - Ms. Rasha Tomaira, Senior Environmentalist, AJ.
    - Mr. Khaled Nassar, Environmental Specialist Advisor, AJ.
    - Eng. Ahmad Al-Duhni, Generation’s Contracts and Agreements Section Head, NEPCO.

4 MAIN ISSUES OF CONCERN

The scoping session was attended by stakeholders from a number of organizations including, but not limited to: Ministry of Environment, Ministry of Interior, Civil Defense, Ministry of Water and Irrigation, Ministry of Health, Ministry of Energy and Mineral Resources, NGOs, and many others. A detailed list of participants who attended the scoping session is provided in **Annex 1**. A number of representatives from the above entities raised comments, questions and concerns; a summary of these deliberations is provided in the next Section.

The main issues of that were tackled during the session can be summarized as follows:

- The positive impact on the local community and employment opportunity;
- Panels cleaning method and source of cleaning water;
- The project is considered as a green project.

AJ and MASDAR team will be committed to taking these issues into consideration during the ESIA Study, where relevant.

4.1 Deliberations

A summary of the deliberations is provided below, which includes the outcome from the working groups. All attendees were divided into three working groups, each group introduced their comments and discussed them in front of the remaining attendees. Eng. Basel Dahleh, the representative of MASDAR provided input as well to answer some inquiries.

Table 1: Summary of comments and feedback discussed during the session

Name	Organization	Contact	Comment/Feedback	Response
Dr. Motasem Saidan	Water, Energy, and Environment Center Director / The University of Jordan	0777680086	• Why did this project require a full environmental impact assessment study?	Eng. Izzat clarified that the project produces 200 MWac, and any project that produces more than 20 MWac requires a full environmental impact assessment study as per the ministry of environment requirements.
			• Suggested that the scoping session could have been held somewhere near the project area so more locals can participate in the session.	Eng. Izzat stated that MoEnv's role includes preparing invitations to all relevant stakeholders including local community representatives, and added that the venue shall be somewhere suitable even if in Amman, given that the project area (Muwaqqar) belongs to Amman Governorate.
			• Commented that given the dusty nature of the project area; more than 4 water cleaning cycles for the PV panels will be required.	Masdar stated that they are aware of this issue. And plan not to exceed 2,000 m3 limit of water per cleaning cycle. As a result, a dry cleaning process will be implemented in case the 2000m^3 limit is exceeded to fortify the cleaning process.

Name	Organization	Contact	Comment/Feedback	Response
			• Emphasized that conducting a Grid impact assessment study is essential to such project.	Masdar clarified that a preliminary grid assessment study has been already conducted, and a more advanced and detailed study is currently in progress. Eng. Ahmed Al-Dohni/NEPCO added that Masdar in the process of preparing an advanced and detailed grid assessment in coordination with NEPCO.
Ms. Samia Al-Jbour	Nuqera Organization " (Local community organization)"	0777671002	• Inquired whether the project will have any influence on health?	AJ stated that solar projects are not associated with significant emissions/pollutants, in fact they are green projects with lesser impacts that other conventional electricity producing plants. Also with regards to glaring effects, the PV panel technology consists of an anti-reflecting coating, significantly reducing any glaring effects. Hence, there will be no health impacts.
			• Will the project take into account wind speed calculations?	Masdar stated that all required studies and measurements regarding wind speed and direction have been conducted and been taken in consideration in project design.

Name	Organization	Contact	Comment/Feedback	Response
			- Which source of water will be used? - How will this project benefit the local community?	Masdar clarified that a limit of 2000m^3 per cleaning is set, if proven to be not sufficient other alternatives such as dry cleaning will be considered. Masdar clarified that 70% of project's labor shall be dedicated for Jordanian workforce, with prioritizing locals for these job opportunities, should their qualification match the needed requirements. Moreover, Masdar will be committed to implement a Corporate Social Responsibility (CSR) program where a certain budget will be allocated for such community development activities.
Eng. .Izzat abu Hamra	Ministry of Environment	0799914652	- Inquired whether there will be any on site labor camps? - Emphasized that backfill is a critical issue that requires special attention on site so it	Masdar stated that they will use the close accommodation facilities available in Amman or within the surroundings of the project area. Masdar clarified that the sloppy terrain of the project layout was designed to be in favor of the project area, so the construction team will try to keep conditions as is. Furthermore, a surface water hydrology study was conducted

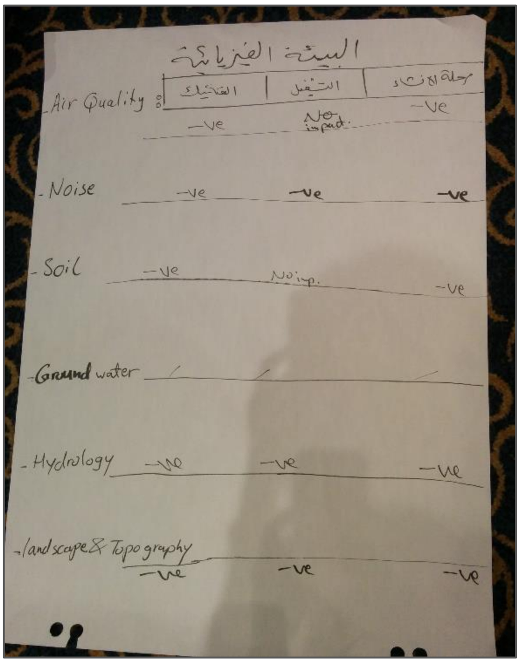
Name	Organization	Contact	Comment/Feedback	Response
			does not result in blocking wadis' paths.	for the project and Masdar is committed to apply the recommendations mentioned in the study – some of these recommendations include using rip raps and also culverts will be used where wadis cross internal and access roads.
Eng. Ali Khawaldeh	Ministry of Energy and Mineral Resources (MEMR)	0777680086 ali@memr.gov	• High wind speed can result in breaking panels, has this been taken in consideration in project design?	Masdar clarified that wind speed and direction are some of the many parameters that were taken in consideration in project design.

4.2 Groups Deliberations

The scoping session attendees were split into three discussion groups (Physical Environment / Biological Environment and Socio-economics), each group was responsible to brainstorm and discuss the potential positive and negative impacts generated on its relevant parameters from all project phases (construction, operation and decommissioning). Towards the end of the group work activity, each group nominated a person to present their discussion outcomes.

Group One: Physical Environment

This group discussed the anticipated positive and negative impacts on the physical environment during all project phases (Construction, Operation, and decommissioning) and the required mitigation measures to reduce these impacts.



البيئة الفيزيائية

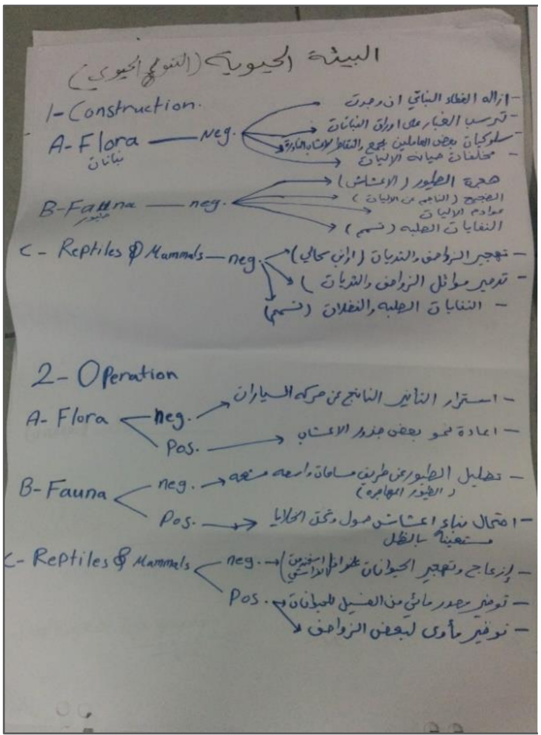
	مرحلة الانشاء	التشغيل	التفكيك
- Air Quality	-ve	No impact.	-ve
- Noise	-ve	-ve	-ve
- Soil	-ve	No imp.	-ve
- Ground water	/	/	/
- Hydrology	-ve	-ve	-ve
- landscape & Topography	-ve	-ve	-ve

Key Issues and Concerns	Comments Response
• **Air quality:** low impact during the construction phase as a result of site levelling and construction vehicles. • **Noise:** low impact during construction and decommissioning since there are almost no surrounding facilities of the project – during operations noise impacts are negligible. • **Soil:** Negative impact caused by potential oil spillage, wastewater leakage, and chemicals in panels. • **Ground Water:** No impact	All these comments shall be taken in consideration where applicable during the preparation of ESIA Report

Key Issues and Concerns	Comments Response
- **Hydrology:** Negative impact if no precautions to be taken in consideration to protect wadis. - **Landscape and Topography:** Negative impact due to leveling activities. Impacts during construction and decommissioning are expected to be similar.	

Group Two: Biological Environment

This group discussed the anticipated positive and negative impacts on the biological environment during all project phases (Construction, Operation, and decommissioning) and the required mitigation measures to reduce these impacts.



البيئة الحيوية (التنوع الحيوي)

1- Construction.

A- Flora (نباتات) — Neg.
- ازالة الغطاء النباتي ان وجدت
- ترسب الغبار على اوراق النباتات
- سلوكيات بعض العاملين بجمع [illegible]
- مخلفات صيانة الآليات

B- Fauna (طيور) — neg.
- هجرة الطيور (الاعشاش)
- الضجيج (الناجم عن الآليات)
- عوادم الآليات
- النفايات الصلبة (تسمم)

C- Reptiles & Mammals — neg.
- تهجير الزواحف والثدييات (ارانب [illegible])
- تدمير موائل الزواحف والثدييات (
- النفايات الصلبة, الفضلات (تسمم)

2- Operation

A- Flora
- neg. — استقرار التأثير الناتج عن حركة السيارات
- Pos. — اعادة نمو بعض جذور الاعشاب

B- Fauna
- neg. — تضليل الطيور عن طريق مساحات واسعة لامعة (الطيور المهاجرة)
- Pos. — احتمال بناء اعشاش حول وتحت الخلايا مستعينة بالظل

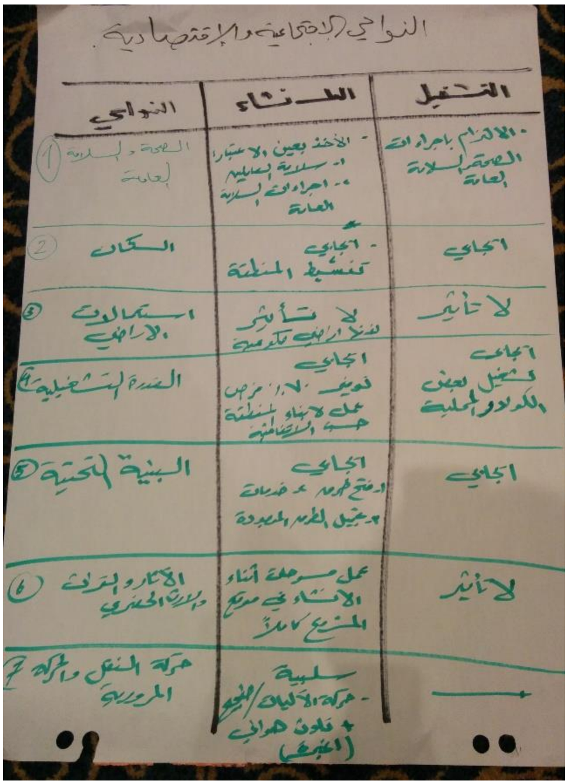
C- Reptiles & Mammals
- neg. — ازعاج وتهجير الحيوانات بعوامل ([illegible])
- Pos. — توفير مصدر مائي من الغسيل للحيوانات
- توفير مأوى لبعض الزواحف

Key Issues and Concerns	Comments Response
- **Flora:** negative impact during the construction phase, positive and some negative impacts during operation phase. - **Fauna (Birds):** Negative impact on birds, noise and vehicles emissions affecting life forms negatively. Induced shade from panels is reflected as a positive impact. - **Reptiles and Mammals:** Negative impact represented by relocation of	All these comments shall be taken in consideration where applicable during the preparation of ESIA Report

mammals and reptiles due to project activities and the different types of wastes produced during project phases. Water used for cleaning can be a drinking water source for some species making a positive impact. On the other hand, if dry cleaning is to be used negative impacts might rise like noise emissions. After the decommissioning phase all above impact will disappear.	

Group Three: Socio- economic

This group discussed the anticipated positive and negative impacts on the Socio- economic conditions during all project phases (Construction and Operation) and the required mitigation measures to reduce these impacts.



النواحي الاجتماعية والإقتصادية.

النواحي	الإنشاء	التشغيل
① الصحة والسلامة العامة	- الأخذ بعين الاعتبار ١- سلامة العاملين ٢- اجراءات السلامة العامة	• الالتزام باجراءات الصحة والسلامة العامة
② السكان	- ايجابي تنشيط المنطقة	ايجابي
③ استعمالات الأراضي	لا تأثير لأن الأراضي حكومية	لا تأثير
④ القدرة التشغيلية	ايجابي توفير ٧٠٪ فرص عمل لأبناء المنطقة حسب الاتفاقية	ايجابي تشغيل بعض الكوادر المحلية
⑤ البنية التحتية	ايجابي ١- فتح طرق وخدمات ٢- تحسين الطرق الموجودة	ايجابي
⑥ الآثار والتراث والموروث الحضري	عمل مسوحات أثناء الإنشاء في موقع المشروع كاملاً	لا تأثير
⑦ حركة النقل والحركة المرورية	سلبية - حركة الآليات/المعدات + تلوث هوائي (الغبار)	———

Key Issues and Concerns	Comments Response
• **Public Health and Safety:** Occupational health and safety must be taken in consideration during construction and operation.	All these comments shall be taken in consideration when applicable during the preparation of ESIA Report

• **Population:** Positive due to employment opportunities. • **Land use:** no impact • **Workforce and employment:** positive impact since the project will provide employment of which 70% will be dedicated to Jordanians with prioritizing locals. • **Utilities and Infrastructure**: Positive impact by improvement of the existing utilities. • **Transportation and Traffic:** Negative impact from heavy vehicles movement and air pollution induced by these vehicles. • **Cultural and Archaeology Heritage:** No Impact if all necessary surveys are conducted and proven that there’s no archeology within the site.	

ANNEX 1: List of Attendees

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Masdar
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وزارة البيئة
المملكة الأردنية الهاشمية

الموضوع: الحلقة التشاورية لدراسة تقييم الأثر البيئي والاجتماعي لمشروع توليد الكهرباء من الطاقة الشمسية في منطقة الموقر
٢٦ كانون ثاني ٢٠١٧، فندق جنيفا / عمان

الرقم No.	الإسم Name	المسمى الوظيفي Title	الشركة / المنظمة Organization / Company	رقم الهاتف / الموبايل Telephone Number	البريد الإلكتروني E-mail
1	باسل سامر الدحلة	مدير مشروع	مصدر	+971566970033	bdahleh@masdar.ae
2	Maryane Severant	Env & Soc. Specialist	IFC	0796787992	m.severant@ifc.org
3	فادية عبدالكريم الكساسبة		الإدارة الملكية لحماية البيئة	0797350682	alkasassbeh.fadia@gmail.com
4	معاذ محمد القضاة	رئيس قسم البيئة	وزارة النقل	0796868496	m.qudah@mot.gov
5	م. وفاء عليان أبوعين	مديرية الدفاع المدني مهندسة كيميائية	مديرية الدفاع المدني	0779629980	wafaabuain@gmall.com
6	د. أسماء الغرايبة	رئيسة قسم البيئة	MOMA	0790179356	asma.g@moma.gov.jo
7	م. [illegible] ريماوي	ر.ق سلامة وصحة مهنية	وزارة العمل	0799946774	mremawi@yahoo.com.
8	م. محمود أبو تيه	مهندس مواصفات	المواصفات والمقاييس	0785673073	mahmoud.abutieeh@JSMO.gov.JO
9	م. عيسى العساف	مدير الجودة والسلامة	شركة الكهرباء الوطنية	079-6602899	eassaf@nepco.com.jo
10	مرسيل جوينات	العلاقات الدولية	وزارة الزراعة	0795652204	marcellejwaniatt@Gmail

الموضوع: الحلقة التشاورية لدراسة تقييم الأثر البيئي والاجتماعي لمشروع توليد الكهرباء من الطاقة الشمسية في منطقة الموقر 2

٢٦ كانون ثاني ٢٠١٧، فندق جنيفا / عمان

الرقم No.	الإسم Name	المسمى الوظيفي Title	الشركة / المنظمة Organization / Company	رقم الهاتف / الموبايل Telephone Number	البريد الإلكتروني E-mail
1	غيث محمد العجارمة	مكتب التنسيق	الادارة الملكية لحماية البيئة	٠٧٧٧٣٢٦٢٤	
2	نور خلدون المواجدة	تطوير منتج/ وزارة السياحة	وزارة السياحة والآثار	٠٧٩٤٤٤٥٤٣	Noor.Al-Mawajdeh@Mota.gov.jo
3	م. محمود الشعلان	مهندس مشاريع	وزارة النقل	٠٧٨٥٠٢٧٧٧٣	Mshalan@mot.gov.jo
4	زين الدين حنيف عطية	عضو هيئة استشارية	جمعية البيئة الاردنية	٠٧٩٧٣٣٥٥٥٧	zainatia@yahoo.com
5	أيمن جابر	رئيس قسم	وزارة المياه والري	0795830380	ayman_Jaber@mwi.gov.jo
6	سليمان موسى الوحش	مهندس مدني	وزارة الاشغال العامة	0790367736	SLMN.ENGINEER@yahoo.com
7	نور خريس	مسؤول الاثر البيئي	RSCN	0775606380	nour.khries@rscn.org.jo
8	رشا حسن أبوحمود	مهندس بيئة	أمانة عمان الكبرى	٠٧٩٨٨٦٤٠٠٢	abuHamou_@gmail.com
9	احمد الدهني	مدير الصحة	الكهرباء الوطنية	0797145212	adahni@nepco.com
10	م. عزت ابو حمرة	مدير البرامج	وزارة البيئة	0799914652	~~Ezzat Abu~~ Hamra izzat.jo@gmail.com

وزارة البيئة
المملكة الأردنية الهاشمية

مصدر
Masdar
A MUBADALA COMPANY

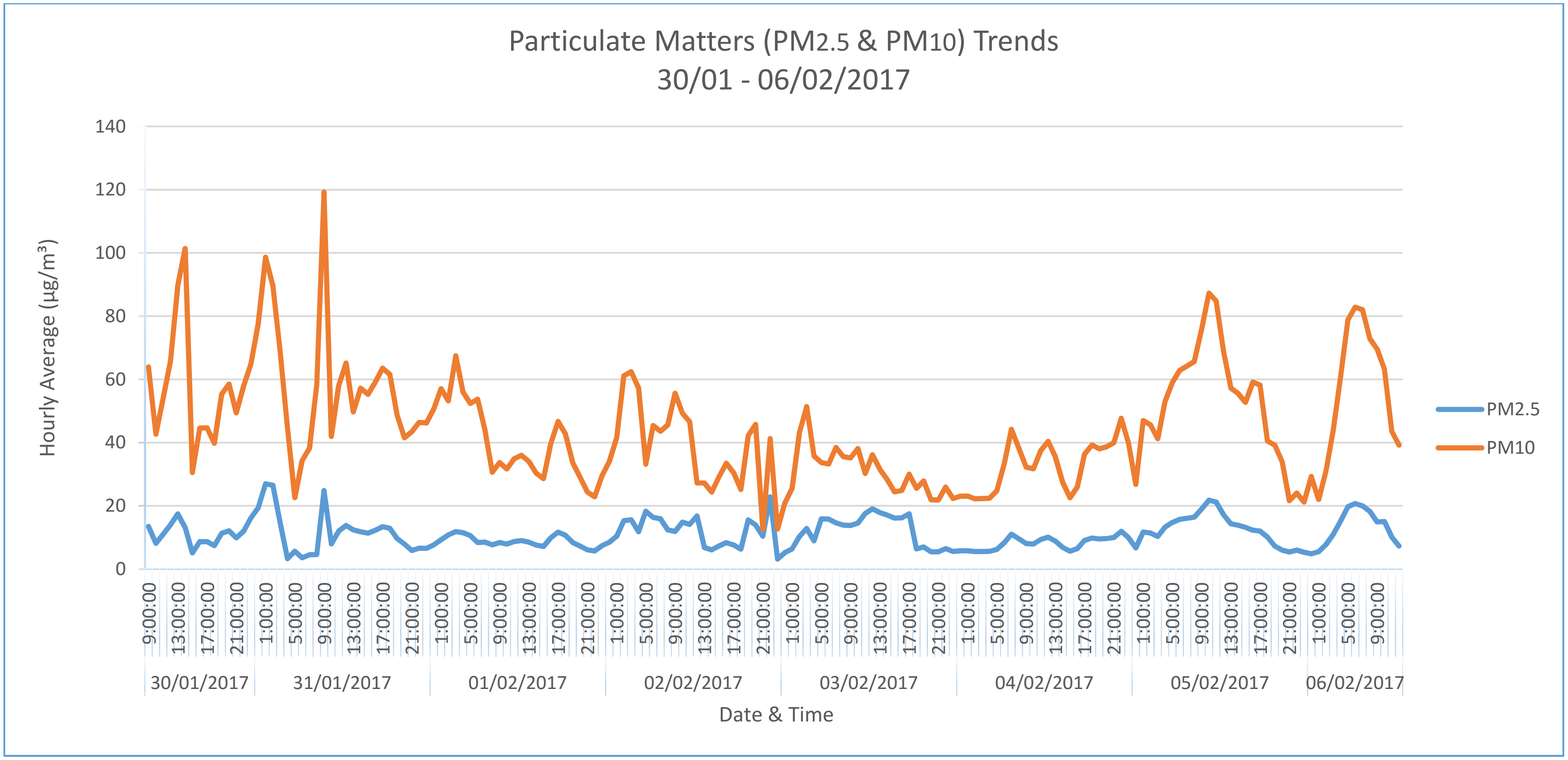
ARABTECH JARDANEH
Define . Design . Deliver

الموضوع: الحلقة التشاورية لدراسة تقييم الأثر البيئي والاجتماعي لمشروع توليد الكهرباء من الطاقة الشمسية في منطقة الموقر
٢٦ كانون ثاني ٢٠١٧، فندق جنيفا / عمان

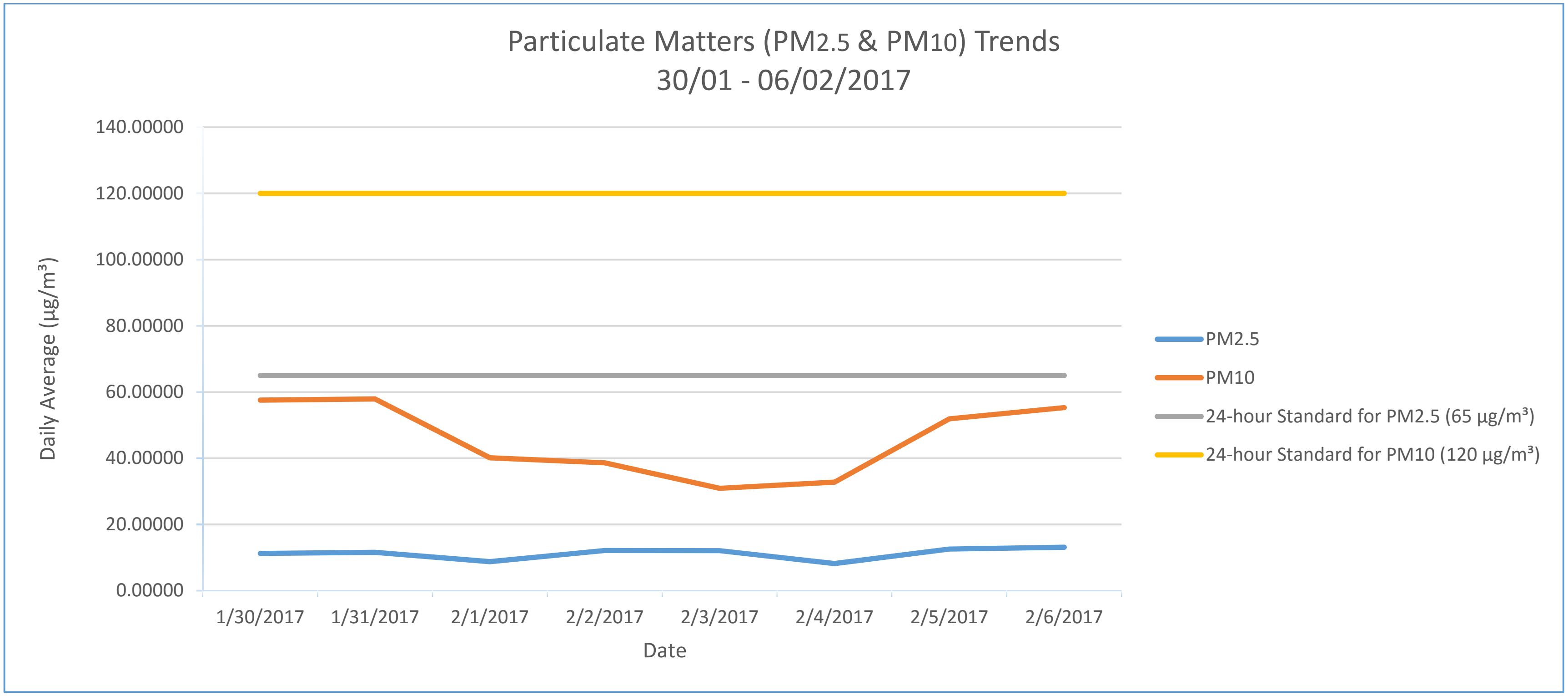
الرقم No.	الإسم Name	المسمى الوظيفي Title	الشركة / المنظمة Organization / Company	رقم الهاتف / الموبايل Telephone Number	البريد الإلكتروني E-mail
1	نسرين الناصر.	PR Manager	Baynouna.	0770070060	nalnasser_c@masdar.ae
2	سعيد صقر الجبور	رئيس جمعية خيريه	الشهره	٠٧٧٧٦٥١٠٠٢	
3	غرام علي الجبور	عضو جمعية الشفقة للتنمية		٠٧٩٨٢٨٠٣٩٨	gharamdjboor@yahoo.com
4	م. علي الحوامده	مدير الطاقة المتجددة	وزارة الطاقة	٠٧٧٢٢٧١٠٨٧	ali@memr.go
5	د. معتصم سعيدان	مدير مركز المياه والطاقة والبيئة	الجامعة الأردنية	٠٧٧٧٦٨٠٠٨٦	m.saidan@gmail.com
6	هشام عبابنه	رئيس قسم البيئة والسلامة العامة	هيئة تنظيم قطاع الطاقة والمعادن	٠٧٩٨١٤٤٤٤١٦٠	ishamabalbneh@yahoo.co.uk
7	أيمن محمود القرآن	مهندس	هيئة تنظيم قطاع الطاقة والمعادن	0795759750	quraan.ayman@yahoo.com
8					
9					
10					

APPENDIX B: AIR QUALITY MONITORING CONCENTRATION TRENDS AND HOURLY RAW DATA

Monitoring Concentrations Trends



Hourly Concentrations of Particulate Matters during the Monitoring Period (30th Jan. – 6th Feb. 2017



Daily Concentrations of Particulate Matters during the Monitoring Period (30th Jan. – 6th Feb. 2017

Hourly Raw Data

PM Monitoring at Telal Al Rukban from 30th Jan. - 6th Feb. 2017
Hourly Average Data

Date	**Hour**	**PM$_{2.5}$ (µg/m^3)**	**PM$_{10}$ (µg/m^3)**
30/01/2017	9:00 AM	13.48652	63.94608
30/01/2017	10:00 AM	8.16617	42.66468
30/01/2017	11:00 AM	11.0514	54.2056
30/01/2017	12:00 PM	13.9496	65.7984
30/01/2017	1:00 PM	17.4306	89.7224
30/01/2017	2:00 PM	13.1012	101.4048
30/01/2017	3:00 PM	5.14082	30.56328
30/01/2017	4:00 PM	8.65095	44.6038
30/01/2017	5:00 PM	8.66721	44.66884
30/01/2017	6:00 PM	7.43537	39.74148
30/01/2017	7:00 PM	11.338	55.352
30/01/2017	8:00 PM	12.1255	58.502
30/01/2017	9:00 PM	9.85607	49.42428
30/01/2017	10:00 PM	11.9738	57.8952
30/01/2017	11:00 PM	16.2254	64.9016
31/01/2017	12:00 AM	19.3802	77.5208
31/01/2017	1:00 AM	26.973	98.623
31/01/2017	2:00 AM	26.4852	89.576
31/01/2017	3:00 AM	14.7155	68.862
31/01/2017	4:00 AM	3.26451	44.548
31/01/2017	5:00 AM	5.64768	22.59072
31/01/2017	6:00 AM	3.56512	34.26048
31/01/2017	7:00 AM	4.5447	38.1788
31/01/2017	8:00 AM	4.57495	58.2998
31/01/2017	9:00 AM	24.8024	119.2096
31/01/2017	10:00 AM	7.99141	41.96564
31/01/2017	11:00 AM	12.004	58.016
31/01/2017	12:00 PM	13.7979	65.1916
31/01/2017	1:00 PM	12.4241	49.6964
31/01/2017	2:00 PM	11.7976	57.1904
31/01/2017	3:00 PM	11.3146	55.2584
31/01/2017	4:00 PM	12.2707	59.0828
31/01/2017	5:00 PM	13.3841	63.5364
31/01/2017	6:00 PM	12.8734	61.4936
31/01/2017	7:00 PM	9.67295	48.6918
31/01/2017	8:00 PM	7.88741	41.54964
31/01/2017	9:00 PM	5.86685	43.4674
31/01/2017	10:00 PM	6.59711	46.38844
31/01/2017	11:00 PM	6.55797	46.23188
01/02/2017	12:00 AM	7.67522	50.70088
01/02/2017	1:00 AM	9.26262	57.05048
01/02/2017	2:00 AM	10.8014	53.2056
01/02/2017	3:00 AM	11.8662	67.4648
01/02/2017	4:00 AM	11.5035	56.014
01/02/2017	5:00 AM	10.5915	52.366
01/02/2017	6:00 AM	8.4246	53.6984
01/02/2017	7:00 AM	8.51498	44.05992
01/02/2017	8:00 AM	7.65677	30.62708

PM Monitoring at Telal Al Rukban from 30th Jan. - 6th Feb. 2017
Hourly Average Data

01/02/2017	9:00 AM	8.42483	33.69932
01/02/2017	10:00 AM	7.91974	31.67896
01/02/2017	11:00 AM	8.72671	34.90684
01/02/2017	12:00 PM	8.9952	35.9808
01/02/2017	1:00 PM	8.49895	33.9958
01/02/2017	2:00 PM	7.58813	30.35252
01/02/2017	3:00 PM	7.15345	28.6138
01/02/2017	4:00 PM	9.92152	39.68608
01/02/2017	5:00 PM	11.6772	46.7088
01/02/2017	6:00 PM	10.6891	42.7564
01/02/2017	7:00 PM	8.40064	33.60256
01/02/2017	8:00 PM	7.28499	29.13996
01/02/2017	9:00 PM	6.09941	24.39764
01/02/2017	10:00 PM	5.71528	22.86112
01/02/2017	11:00 PM	7.37144	29.48576
02/02/2017	12:00 AM	8.50053	34.00212
02/02/2017	1:00 AM	10.3509	41.4036
02/02/2017	2:00 AM	15.2855	61.142
02/02/2017	3:00 AM	15.6063	62.4252
02/02/2017	4:00 AM	11.8135	57.254
02/02/2017	5:00 AM	18.29342	33.17368
02/02/2017	6:00 AM	16.34881	45.39524
02/02/2017	7:00 AM	15.89712	43.58848
02/02/2017	8:00 AM	12.39353	45.57412
02/02/2017	9:00 AM	11.89853	55.59412
02/02/2017	10:00 AM	14.82516	49.30064
02/02/2017	11:00 AM	14.1531	46.6124
02/02/2017	12:00 PM	16.80491	27.21964
02/02/2017	1:00 PM	6.81213	27.24852
02/02/2017	2:00 PM	6.09008	24.36032
02/02/2017	3:00 PM	7.28728	29.14912
02/02/2017	4:00 PM	8.36966	33.47864
02/02/2017	5:00 PM	7.6138	30.4552
02/02/2017	6:00 PM	6.28577	25.14308
02/02/2017	7:00 PM	15.5462	42.1848
02/02/2017	8:00 PM	13.94179	45.76716
02/02/2017	9:00 PM	10.40312	12.60078
02/02/2017	10:00 PM	22.8207	41.2828
02/02/2017	11:00 PM	3.15663	12.62
03/02/2017	12:00 AM	5.19316	20.77
03/02/2017	1:00 AM	6.37849	25.5
03/02/2017	2:00 AM	10.3114	43.2456
03/02/2017	3:00 AM	12.8515	51.406
03/02/2017	4:00 AM	8.93563	35.74252
03/02/2017	5:00 AM	15.91907	33.67628
03/02/2017	6:00 AM	15.80349	33.21396
03/02/2017	7:00 AM	14.6216	38.4864
03/02/2017	8:00 AM	13.88083	35.52332
03/02/2017	9:00 AM	13.78553	35.14212
03/02/2017	10:00 AM	14.52699	38.10796
03/02/2017	11:00 AM	17.56183	30.24732

PM Monitoring at Telal Al Rukban from 30th Jan. - 6th Feb. 2017
Hourly Average Data

03/02/2017	12:00 PM	19.03492	36.13968
03/02/2017	1:00 PM	17.89448	31.57792
03/02/2017	2:00 PM	17.08759	28.35036
03/02/2017	3:00 PM	16.10209	24.40836
03/02/2017	4:00 PM	16.21162	24.84648
03/02/2017	5:00 PM	17.51123	30.04492
03/02/2017	6:00 PM	6.38321	25.53284
03/02/2017	7:00 PM	6.97386	27.89544
03/02/2017	8:00 PM	5.46952	21.87808
03/02/2017	9:00 PM	5.45859	21.83436
03/02/2017	10:00 PM	6.48801	25.95204
03/02/2017	11:00 PM	5.57657	22.30628
04/02/2017	12:00 AM	5.76277	23.05108
04/02/2017	1:00 AM	5.77143	23.08572
04/02/2017	2:00 AM	5.55931	22.23724
04/02/2017	3:00 AM	5.5783	22.3132
04/02/2017	4:00 AM	5.59762	22.39048
04/02/2017	5:00 AM	6.19668	24.78672
04/02/2017	6:00 AM	8.32175	33.287
04/02/2017	7:00 AM	11.0446	44.1784
04/02/2017	8:00 AM	9.56724	38.26896
04/02/2017	9:00 AM	8.05935	32.2374
04/02/2017	10:00 AM	7.92685	31.7074
04/02/2017	11:00 AM	9.36933	37.47732
04/02/2017	12:00 PM	10.1023	40.4092
04/02/2017	1:00 PM	8.88134	35.52536
04/02/2017	2:00 PM	6.86386	27.45544
04/02/2017	3:00 PM	5.63328	22.53312
04/02/2017	4:00 PM	6.47893	25.91572
04/02/2017	5:00 PM	9.08774	36.35096
04/02/2017	6:00 PM	9.81024	39.24096
04/02/2017	7:00 PM	9.50452	38.01808
04/02/2017	8:00 PM	9.66705	38.6682
04/02/2017	9:00 PM	9.99339	39.97356
04/02/2017	10:00 PM	11.92426	47.69704
04/02/2017	11:00 PM	9.95999	39.83996
05/02/2017	12:00 AM	6.69644	26.78576
05/02/2017	1:00 AM	11.73703	46.94812
05/02/2017	2:00 AM	11.40928	45.63712
05/02/2017	3:00 AM	10.3062	41.2248
05/02/2017	4:00 AM	13.2646	53.0584
05/02/2017	5:00 AM	14.7465	58.986
05/02/2017	6:00 AM	15.7071	62.8284
05/02/2017	7:00 AM	16.06	64.24
05/02/2017	8:00 AM	16.4086	65.6344
05/02/2017	9:00 AM	18.9835	75.934
05/02/2017	10:00 AM	21.8133	87.2532
05/02/2017	11:00 AM	21.1946	84.7784
05/02/2017	12:00 PM	17.2063	68.8252
05/02/2017	1:00 PM	14.2971	57.1884
05/02/2017	2:00 PM	13.8795	55.518

PM Monitoring at Telal Al Rukban from 30th Jan. - 6th Feb. 2017
Hourly Average Data

05/02/2017	3:00 PM	13.1853	52.7412
05/02/2017	4:00 PM	12.2855	59.142
05/02/2017	5:00 PM	12.0444	58.1776
05/02/2017	6:00 PM	10.1372	40.5
05/02/2017	7:00 PM	7.29828	39.19312
05/02/2017	8:00 PM	5.98479	33.93
05/02/2017	9:00 PM	5.40278	21.611
05/02/2017	10:00 PM	6.00679	24.027
05/02/2017	11:00 PM	5.30117	21.204
06/02/2017	12:00 AM	4.82613	29.3
06/02/2017	1:00 AM	5.49972	21.99888
06/02/2017	2:00 AM	7.7505	31.002
06/02/2017	3:00 AM	10.9377	43.7508
06/02/2017	4:00 AM	15.1885	60.754
06/02/2017	5:00 AM	19.723	78.892
06/02/2017	6:00 AM	20.7119	82.8476
06/02/2017	7:00 AM	20.0053	82.0212
06/02/2017	8:00 AM	18.2076	72.8304
06/02/2017	9:00 AM	14.8983	69.5932
06/02/2017	10:00 AM	15.0458	63.1832
06/02/2017	11:00 AM	10.1372	43.5488
06/02/2017	12:00 PM	7.29828	39.19312

APPENDIX C: SOARING BIRDS SENSITIVITY MAP TOOL

Soaring Bird Sensitivity Map:

A planning tool for wind energy and other sectors

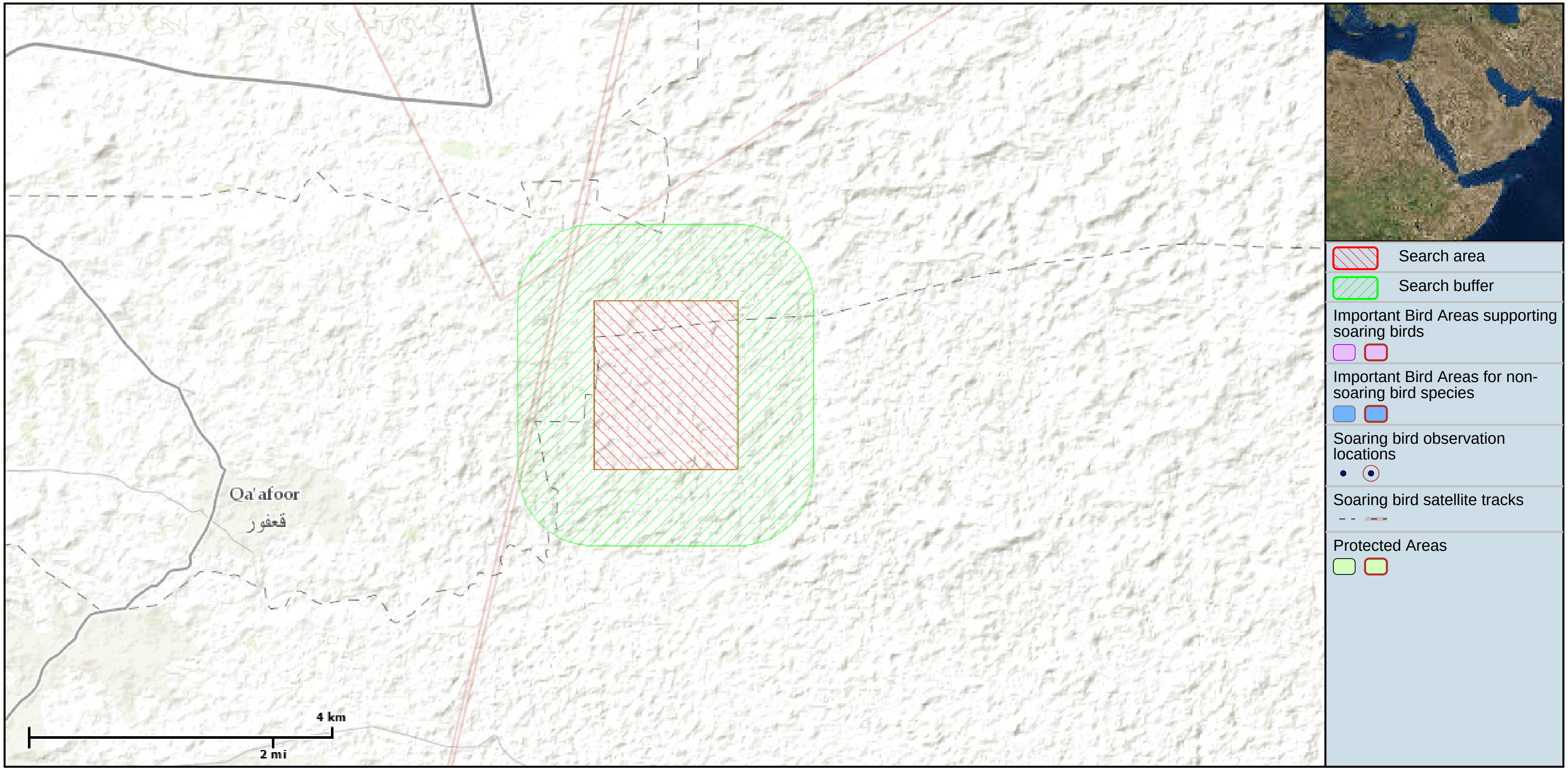
SEARCH SUMMARY

Masder
1km buffer
Countries: Jordan
Centroid: N31.870 E36.210 with 1 km buffer
Combined Sensitivity: Potential (0)
0 soaring bird species observed while a further 25 soaring bird species are thought to occur in this area.
0 soaring bird observation locations.
0 IBAs supporting soaring birds plus a further 0 IBAs for non-soaring bird species.
0 protected sites.
2 satellite tracked migratory routes.

Soaring Bird Sensitivity Map:

A planning tool for wind energy and other sectors

MAP


Qa'afoor
قعفور
4 km
2 mi
▨ Search area
▨ Search buffer
Important Bird Areas supporting soaring birds
Important Bird Areas for non-soaring bird species
Soaring bird observation locations
Soaring bird satellite tracks
Protected Areas

GUIDANCE ON INTERPRETING SEARCH RESULTS

For each search that a user performs, the tool calculates a sensitivity value based on the available soaring bird data and assigns the location to one of six sensitivity categories (defined in more detail below). This calculation takes into account the proportion of each species' global population present, the global conservation status (IUCN Red List) of each species and the inherent collision vulnerability of each species based on their morphology and flight behaviour.

Information for this region is incomplete and an appropriate Environmental Impact Assessments (EIA) should always be undertaken to fully assess the sensitivity of a site. Further information on the underlying methodology can be found in the Instructions section of the web tool.

Sensitivity category: UNKNOWN
There are insufficient soaring bird data on which to base a sensitivity score. This should not, however, be interpreted as meaning that a site has no or low sensitivity.

Sensitivity category: POTENTIAL
A small number of soaring bird records exist within the defined search area suggesting that the site could be sensitive.

Sensitivity category: MEDIUM and HIGH
Soaring bird species are known to be present in significant numbers. Caution advised as development at this location may result in significant impacts on the populations of species present. Development may not be appropriate at or near to this location or may be appropriate only if special mitigation measures are put in place.

Sensitivity category: VERY HIGH and OUTSTANDING
Soaring bird species are known to be present in very significant numbers. Caution advised as development at this location may result in considerable impacts on the populations of species present. Wind energy development is unlikely to be appropriate at or near to this location.

SPECIES (25)

Name	Peak Count	Presence	SVI	Status	Global population	Source
Lesser Kestrel	-	expected	6	LC	170000	BirdLife species range map
Bonelli's Eagle	-	expected	9	LC	10000	BirdLife species range map
Eastern Imperial Eagle	-	expected	9	VU	9250	BirdLife species range map
Steppe Eagle	-	expected	9	LC	160000	BirdLife species range map
White Stork	-	tracked	10	LC	510000	Fiedler et al.
Black Stork	-	expected	10	LC	34000	BirdLife species range map
Hen Harrier	-	expected	8	LC	370000	BirdLife species range map
Pallid Harrier	-	expected	8	NT	36000	BirdLife species range map
Montagu's Harrier	-	expected	8	LC	540000	BirdLife species range map
Greater Spotted Eagle	-	expected	9	VU	9100	BirdLife species range map
Lesser Spotted Eagle	-	expected	9	LC	79000	BirdLife species range map
Saker Falcon	-	expected	6	EN	32700	BirdLife species range map
Eurasian Sparrowhawk	-	expected	6	LC	4000000	BirdLife species range map
Peregrine Falcon	-	expected	6	LC	500000	BirdLife species range map
Eurasian Hobby	-	expected	6	LC	1200000	BirdLife species range map
Common Kestrel	-	expected	6	LC	8000000	BirdLife species range map

SPECIES (25)

Name	Peak Count	Presence	SVI	Status	Global population	Source
Red-footed Falcon	-	expected	6	NT	550000	BirdLife species range map
Common Crane	-	expected	10	LC	365000	BirdLife species range map
Griffon Vulture	-	expected	10	LC	1000000	BirdLife species range map
Booted Eagle	-	expected	9	LC	253000	BirdLife species range map
Osprey	-	expected	7	LC	750000	BirdLife species range map
European Honey-buzzard	-	expected	7	LC	675000	BirdLife species range map
Short-toed Snake-eagle	-	expected	7	LC	170000	BirdLife species range map
Black Kite	-	expected	8	LC	2625000	BirdLife species range map
Long-legged Buzzard	-	expected	7	LC	274000	BirdLife species range map

SATELLITE TRACKS (2)

Count	Species	Source
2	White Stork	Fiedler et al.

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
Lesser Kestrel	-	expected	6	LC	170000	BirdLife species range map
Bonelli's Eagle	-	expected	9	LC	10000	BirdLife species range map
Eastern Imperial Eagle	-	expected	9	VU	9250	BirdLife species range map
Steppe Eagle	-	expected	9	LC	160000	BirdLife species range map
White Stork	-	tracked	10	LC	510000	Fiedler et al.

Name	SI	Type	Distance	Source
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.

Name	Peak Count	Presence	SVI	Status	Global population	Source
Black Stork	-	expected	10	LC	34000	BirdLife species range map
Hen Harrier	-	expected	8	LC	370000	BirdLife species range map
Pallid Harrier	-	expected	8	NT	36000	BirdLife species range map
Montagu's Harrier	-	expected	8	LC	540000	BirdLife species range map
Greater Spotted Eagle	-	expected	9	VU	9100	BirdLife species range map
Lesser Spotted Eagle	-	expected	9	LC	79000	BirdLife species range map
Saker Falcon	-	expected	6	EN	32700	BirdLife species range map

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
Eurasian Sparrowhawk	-	expected	6	LC	4000000	BirdLife species range map
Peregrine Falcon	-	expected	6	LC	500000	BirdLife species range map
Eurasian Hobby	-	expected	6	LC	1200000	BirdLife species range map
Common Kestrel	-	expected	6	LC	8000000	BirdLife species range map
Red-footed Falcon	-	expected	6	NT	550000	BirdLife species range map
Common Crane	-	expected	10	LC	365000	BirdLife species range map
Griffon Vulture	-	expected	10	LC	1000000	BirdLife species range map
Booted Eagle	-	expected	9	LC	253000	BirdLife species range map
Osprey	-	expected	7	LC	750000	BirdLife species range map
European Honey-buzzard	-	expected	7	LC	675000	BirdLife species range map
Short-toed Snake-eagle	-	expected	7	LC	170000	BirdLife species range map
Black Kite	-	expected	8	LC	2625000	BirdLife species range map
Long-legged Buzzard	-	expected	7	LC	274000	BirdLife species range map

DISCLAIMERS

BirdLife International makes no warranties or representations, express or implied, regarding the use of the material appearing on in this report with regard to its correctness, reliability, accuracy, or otherwise. The material and geographic designations in this report do not imply the expressions of any opinion whatsoever on the part of BirdLife International concerning the legal status of any country, territory or area, nor concerning the delimitation of its frontiers or boundaries. Neither BirdLife International nor its affiliated or related entities or its content providers shall be responsible or liable to any person, firm or corporation for any loss, damage, injury, claim or liability of any kind or character based on or resulting from any information contained in this report. BirdLife International may update or make changes to the data provided at any time without notice; however, BirdLife International makes no commitment to update the information contained therein.

Errors and Omissions

BirdLife International endeavours to maintain accurate and up-to-date data at all times. However, if errors or omissions are identified, the user should notify BirdLife International so that they can be corrected in future releases of the data. Users can contact BirdLife International using the details below. Users can contact BirdLife International at MSBtool@birdlife.org

developed by habitat INFO

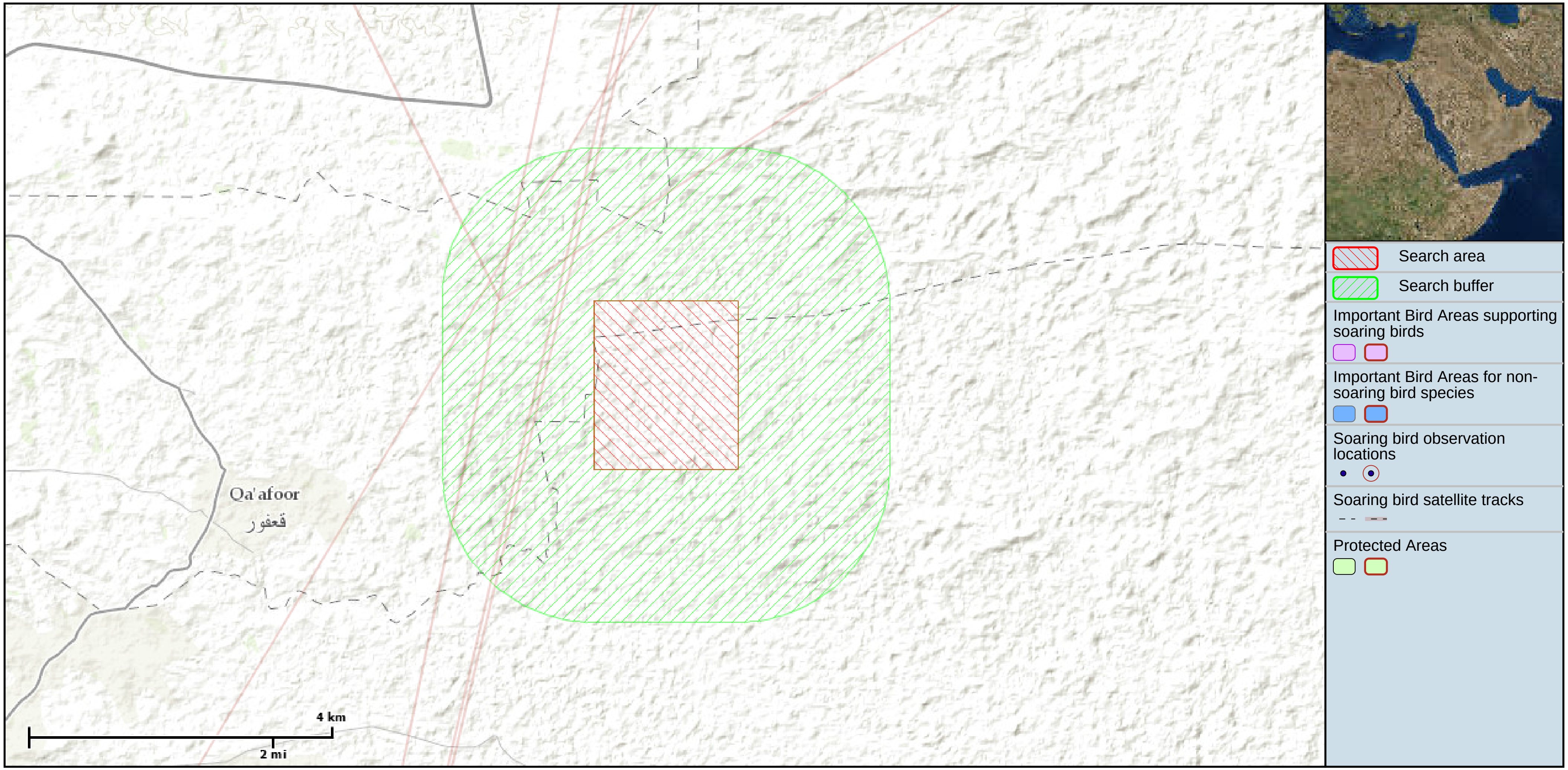
SEARCH SUMMARY

Masder
2km buffer
Countries: Jordan
Centroid: N31.870 E36.210 with 2 km buffer
Combined Sensitivity: Potential (0)
0 soaring bird species observed while a further 23 soaring bird species are thought to occur in this area.
0 soaring bird observation locations.
0 IBAs supporting soaring birds plus a further 0 IBAs for non-soaring bird species.
0 protected sites.
4 satellite tracked migratory routes.

Soaring Bird Sensitivity Map:

A planning tool for wind energy and other sectors

MAP


Qa'afoor
قعفور
4 km
2 mi
Search area
Search buffer
Important Bird Areas supporting soaring birds
Important Bird Areas for non-soaring bird species
Soaring bird observation locations
Soaring bird satellite tracks
Protected Areas

GUIDANCE ON INTERPRETING SEARCH RESULTS

For each search that a user performs, the tool calculates a sensitivity value based on the available soaring bird data and assigns the location to one of six sensitivity categories (defined in more detail below). This calculation takes into account the proportion of each species' global population present, the global conservation status (IUCN Red List) of each species and the inherent collision vulnerability of each species based on their morphology and flight behaviour.

Information for this region is incomplete and an appropriate Environmental Impact Assessments (EIA) should always be undertaken to fully assess the sensitivity of a site. Further information on the underlying methodology can be found in the Instructions section of the web tool.

Sensitivity category: UNKNOWN
There are insufficient soaring bird data on which to base a sensitivity score. This should not, however, be interpreted as meaning that a site has no or low sensitivity.

Sensitivity category: POTENTIAL
A small number of soaring bird records exist within the defined search area suggesting that the site could be sensitive.

Sensitivity category: MEDIUM and HIGH
Soaring bird species are known to be present in significant numbers. Caution advised as development at this location may result in significant impacts on the populations of species present. Development may not be appropriate at or near to this location or may be appropriate only if special mitigation measures are put in place.

Sensitivity category: VERY HIGH and OUTSTANDING
Soaring bird species are known to be present in very significant numbers. Caution advised as development at this location may result in considerable impacts on the populations of species present. Wind energy development is unlikely to be appropriate at or near to this location.

SPECIES (23)

Name	Peak Count	Presence	SVI	Status	Global population	Source
Peregrine Falcon	-	expected	6	LC	500000	BirdLife species range map
Steppe Eagle	-	expected	9	LC	160000	BirdLife species range map
White Stork	-	tracked	10	LC	510000	Fiedler et al.
Black Stork	-	expected	10	LC	34000	BirdLife species range map
Hen Harrier	-	expected	8	LC	370000	BirdLife species range map
Pallid Harrier	-	expected	8	NT	36000	BirdLife species range map
Montagu's Harrier	-	expected	8	LC	540000	BirdLife species range map
Greater Spotted Eagle	-	expected	9	VU	9100	BirdLife species range map
Lesser Spotted Eagle	-	expected	9	LC	79000	BirdLife species range map
Saker Falcon	-	expected	6	EN	32700	BirdLife species range map
Lesser Kestrel	-	expected	6	LC	170000	BirdLife species range map
Eastern Imperial Eagle	-	expected	9	VU	9250	BirdLife species range map
Eurasian Hobby	-	expected	6	LC	1200000	BirdLife species range map
Common Kestrel	-	expected	6	LC	8000000	BirdLife species range map
Red-footed Falcon	-	expected	6	NT	550000	BirdLife species range map
Common Crane	-	expected	10	LC	365000	BirdLife species range map

SPECIES (23)

Name	Peak Count	Presence	SVI	Status	Global population	Source
Griffon Vulture	-	expected	10	LC	1000000	BirdLife species range map
Booted Eagle	-	expected	9	LC	253000	BirdLife species range map
Osprey	-	expected	7	LC	750000	BirdLife species range map
European Honey-buzzard	-	expected	7	LC	675000	BirdLife species range map
Short-toed Snake-eagle	-	expected	7	LC	170000	BirdLife species range map
Black Kite	-	expected	8	LC	2625000	BirdLife species range map
Long-legged Buzzard	-	expected	7	LC	274000	BirdLife species range map

SATELLITE TRACKS (4)

Count	Species	Source
4	White Stork	Fiedler et al.

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
Peregrine Falcon	-	expected	6	LC	500000	BirdLife species range map
Steppe Eagle	-	expected	9	LC	160000	BirdLife species range map
White Stork	-	tracked	10	LC	510000	Fiedler et al.

Name	SI	Type	Distance	Source
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.

Name	Peak Count	Presence	SVI	Status	Global population	Source
Black Stork	-	expected	10	LC	34000	BirdLife species range map
Hen Harrier	-	expected	8	LC	370000	BirdLife species range map
Pallid Harrier	-	expected	8	NT	36000	BirdLife species range map
Montagu's Harrier	-	expected	8	LC	540000	BirdLife species range map
Greater Spotted Eagle	-	expected	9	VU	9100	BirdLife species range map
Lesser Spotted Eagle	-	expected	9	LC	79000	BirdLife species range map
Saker Falcon	-	expected	6	EN	32700	BirdLife species range map

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
Lesser Kestrel	-	expected	6	LC	170000	BirdLife species range map
Eastern Imperial Eagle	-	expected	9	VU	9250	BirdLife species range map
Eurasian Hobby	-	expected	6	LC	1200000	BirdLife species range map
Common Kestrel	-	expected	6	LC	8000000	BirdLife species range map
Red-footed Falcon	-	expected	6	NT	550000	BirdLife species range map
Common Crane	-	expected	10	LC	365000	BirdLife species range map
Griffon Vulture	-	expected	10	LC	1000000	BirdLife species range map
Booted Eagle	-	expected	9	LC	253000	BirdLife species range map
Osprey	-	expected	7	LC	750000	BirdLife species range map
European Honey-buzzard	-	expected	7	LC	675000	BirdLife species range map
Short-toed Snake-eagle	-	expected	7	LC	170000	BirdLife species range map
Black Kite	-	expected	8	LC	2625000	BirdLife species range map
Long-legged Buzzard	-	expected	7	LC	274000	BirdLife species range map

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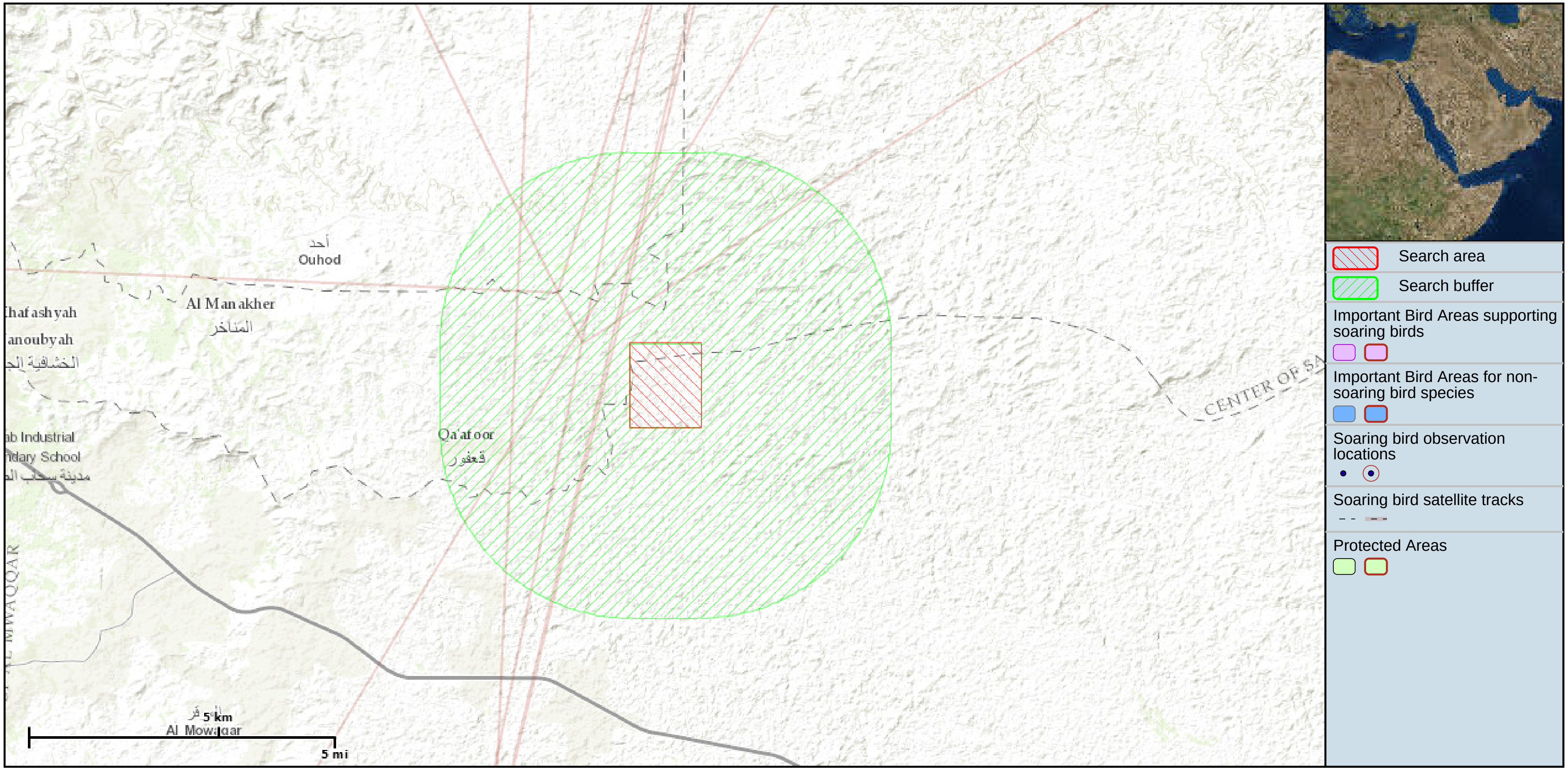
developed by

SEARCH SUMMARY

Masder
5km
Countries: Jordan
Centroid: N31.870 E36.210 with 5 km buffer
Combined Sensitivity: Potential (0)
0 soaring bird species observed while a further 23 soaring bird species are thought to occur in this area.
0 soaring bird observation locations.
0 IBAs supporting soaring birds plus a further 0 IBAs for non-soaring bird species.
0 protected sites.
6 satellite tracked migratory routes.

MAP


أحد
Ouhod
Al Manakher
المناخر
hafashyah
anoubyah
الخشافية الـ
ab Industrial
ndary School
مدينة سحاب الـ
Qa'afoor
قعفور
CENTER OF SA
Al Mowaqqar
5 km
5 mi
▨ Search area
▨ Search buffer
Important Bird Areas supporting soaring birds
Important Bird Areas for non-soaring bird species
Soaring bird observation locations
Soaring bird satellite tracks
Protected Areas

GUIDANCE ON INTERPRETING SEARCH RESULTS

For each search that a user performs, the tool calculates a sensitivity value based on the available soaring bird data and assigns the location to one of six sensitivity categories (defined in more detail below). This calculation takes into account the proportion of each species' global population present, the global conservation status (IUCN Red List) of each species and the inherent collision vulnerability of each species based on their morphology and flight behaviour.

Information for this region is incomplete and an appropriate Environmental Impact Assessments (EIA) should always be undertaken to fully assess the sensitivity of a site. Further information on the underlying methodology can be found in the Instructions section of the web tool.

Sensitivity category: UNKNOWN
There are insufficient soaring bird data on which to base a sensitivity score. This should not, however, be interpreted as meaning that a site has no or low sensitivity.

Sensitivity category: POTENTIAL
A small number of soaring bird records exist within the defined search area suggesting that the site could be sensitive.

Sensitivity category: MEDIUM and HIGH
Soaring bird species are known to be present in significant numbers. Caution advised as development at this location may result in significant impacts on the populations of species present. Development may not be appropriate at or near to this location or may be appropriate only if special mitigation measures are put in place.

Sensitivity category: VERY HIGH and OUTSTANDING
Soaring bird species are known to be present in very significant numbers. Caution advised as development at this location may result in considerable impacts on the populations of species present. Wind energy development is unlikely to be appropriate at or near to this location.

SPECIES (23)

Name	Peak Count	Presence	SVI	Status	Global population	Source
Peregrine Falcon	-	expected	6	LC	500000	BirdLife species range map
Steppe Eagle	-	expected	9	LC	160000	BirdLife species range map
White Stork	-	tracked	10	LC	510000	Fiedler et al.
Black Stork	-	expected	10	LC	34000	BirdLife species range map
Hen Harrier	-	expected	8	LC	370000	BirdLife species range map
Pallid Harrier	-	expected	8	NT	36000	BirdLife species range map
Montagu's Harrier	-	expected	8	LC	540000	BirdLife species range map
Greater Spotted Eagle	-	expected	9	VU	9100	BirdLife species range map
Lesser Spotted Eagle	-	expected	9	LC	79000	BirdLife species range map
Saker Falcon	-	expected	6	EN	32700	BirdLife species range map
Lesser Kestrel	-	expected	6	LC	170000	BirdLife species range map
Eastern Imperial Eagle	-	expected	9	VU	9250	BirdLife species range map
Eurasian Hobby	-	expected	6	LC	1200000	BirdLife species range map
Common Kestrel	-	expected	6	LC	8000000	BirdLife species range map
Red-footed Falcon	-	expected	6	NT	550000	BirdLife species range map
Common Crane	-	expected	10	LC	365000	BirdLife species range map

SPECIES (23)

Name	Peak Count	Presence	SVI	Status	Global population	Source
Griffon Vulture	-	expected	10	LC	1000000	BirdLife species range map
Booted Eagle	-	expected	9	LC	253000	BirdLife species range map
Osprey	-	expected	7	LC	750000	BirdLife species range map
European Honey-buzzard	-	expected	7	LC	675000	BirdLife species range map
Short-toed Snake-eagle	-	expected	7	LC	170000	BirdLife species range map
Black Kite	-	expected	8	LC	2625000	BirdLife species range map
Long-legged Buzzard	-	expected	7	LC	274000	BirdLife species range map

SATELLITE TRACKS (6)

Count	Species	Source
6	White Stork	Fiedler et al.

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
Peregrine Falcon	-	expected	6	LC	500000	BirdLife species range map
Steppe Eagle	-	expected	9	LC	160000	BirdLife species range map
White Stork	-	tracked	10	LC	510000	Fiedler et al.

Name	SI	Type	Distance	Source
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.

Name	Peak Count	Presence	SVI	Status	Global population	Source
Black Stork	-	expected	10	LC	34000	BirdLife species range map
Hen Harrier	-	expected	8	LC	370000	BirdLife species range map
Pallid Harrier	-	expected	8	NT	36000	BirdLife species range map
Montagu's Harrier	-	expected	8	LC	540000	BirdLife species range map
Greater Spotted Eagle	-	expected	9	VU	9100	BirdLife species range map
Lesser Spotted Eagle	-	expected	9	LC	79000	BirdLife species range map

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
Saker Falcon	-	expected	6	EN	32700	BirdLife species range map
Lesser Kestrel	-	expected	6	LC	170000	BirdLife species range map
Eastern Imperial Eagle	-	expected	9	VU	9250	BirdLife species range map
Eurasian Hobby	-	expected	6	LC	1200000	BirdLife species range map
Common Kestrel	-	expected	6	LC	8000000	BirdLife species range map
Red-footed Falcon	-	expected	6	NT	550000	BirdLife species range map
Common Crane	-	expected	10	LC	365000	BirdLife species range map
Griffon Vulture	-	expected	10	LC	1000000	BirdLife species range map
Booted Eagle	-	expected	9	LC	253000	BirdLife species range map
Osprey	-	expected	7	LC	750000	BirdLife species range map
European Honey-buzzard	-	expected	7	LC	675000	BirdLife species range map
Short-toed Snake-eagle	-	expected	7	LC	170000	BirdLife species range map
Black Kite	-	expected	8	LC	2625000	BirdLife species range map
Long-legged Buzzard	-	expected	7	LC	274000	BirdLife species range map

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developed by habitat INFO

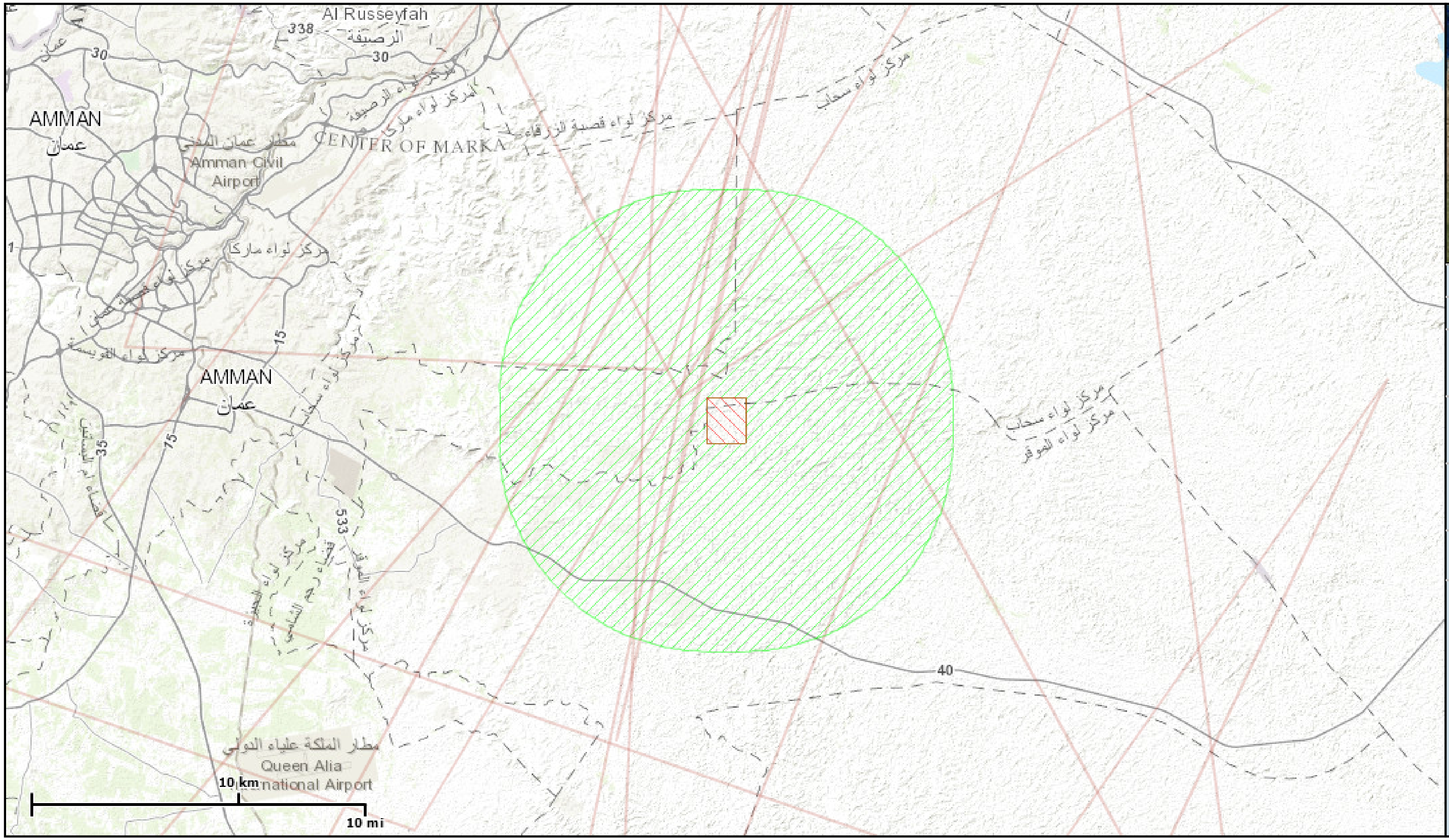
SEARCH SUMMARY

Masder
10km
Countries: Jordan
Centroid: N31.870 E36.210 with 10 km buffer
Combined Sensitivity: Potential (0)
0 soaring bird species observed while a further 25 soaring bird species are thought to occur in this area.
0 soaring bird observation locations.
0 IBAs supporting soaring birds plus a further 0 IBAs for non-soaring bird species.
0 protected sites.
10 satellite tracked migratory routes.

Soaring Bird Sensitivity Map:

A planning tool for wind energy and other sectors

MAP



Al Russeyfah
الرصيفة
AMMAN
عمان
مطار عمان المدني
Amman Civil Airport
CENTER OF MARKA
مركز لواء ماركا
مركز لواء الرصيفة
مركز لواء قصبة الزرقاء
مركز لواء سحاب
مركز لواء الموقر
مركز لواء القويسمة
مركز لواء الجيزة
مطار الملكة علياء الدولي
Queen Alia International Airport
30
338
15
35
533
40
10 km
10 mi

Legend	
▨	Search area
▨	Search buffer
Important Bird Areas supporting soaring birds	▢ ▢
Important Bird Areas for non-soaring bird species	▢ ▢
Soaring bird observation locations	• ⊙
Soaring bird satellite tracks	- -
Protected Areas	▢ ▢

GUIDANCE ON INTERPRETING SEARCH RESULTS

For each search that a user performs, the tool calculates a sensitivity value based on the available soaring bird data and assigns the location to one of six sensitivity categories (defined in more detail below). This calculation takes into account the proportion of each species' global population present, the global conservation status (IUCN Red List) of each species and the inherent collision vulnerability of each species based on their morphology and flight behaviour.

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Sensitivity category: VERY HIGH and OUTSTANDING
Soaring bird species are known to be present in very significant numbers. Caution advised as development at this location may result in considerable impacts on the populations of species present. Wind energy development is unlikely to be appropriate at or near to this location.

SPECIES (25)

Name	Peak Count	Presence	SVI	Status	Global population	Source
Lesser Kestrel	-	expected	6	LC	170000	BirdLife species range map
Bonelli's Eagle	-	expected	9	LC	10000	BirdLife species range map
Eastern Imperial Eagle	-	expected	9	VU	9250	BirdLife species range map
Steppe Eagle	-	expected	9	LC	160000	BirdLife species range map
White Stork	-	tracked	10	LC	510000	Fiedler et al.
Black Stork	-	expected	10	LC	34000	BirdLife species range map
Hen Harrier	-	expected	8	LC	370000	BirdLife species range map
Pallid Harrier	-	expected	8	NT	36000	BirdLife species range map
Montagu's Harrier	-	expected	8	LC	540000	BirdLife species range map
Greater Spotted Eagle	-	expected	9	VU	9100	BirdLife species range map
Lesser Spotted Eagle	-	expected	9	LC	79000	BirdLife species range map
Saker Falcon	-	expected	6	EN	32700	BirdLife species range map
Eurasian Sparrowhawk	-	expected	6	LC	4000000	BirdLife species range map
Peregrine Falcon	-	expected	6	LC	500000	BirdLife species range map
Eurasian Hobby	-	expected	6	LC	1200000	BirdLife species range map
Common Kestrel	-	expected	6	LC	8000000	BirdLife species range map

SPECIES (25)

Name	Peak Count	Presence	SVI	Status	Global population	Source
Red-footed Falcon	-	expected	6	NT	550000	BirdLife species range map
Common Crane	-	expected	10	LC	365000	BirdLife species range map
Griffon Vulture	-	expected	10	LC	1000000	BirdLife species range map
Booted Eagle	-	expected	9	LC	253000	BirdLife species range map
Osprey	-	expected	7	LC	750000	BirdLife species range map
European Honey-buzzard	-	expected	7	LC	675000	BirdLife species range map
Short-toed Snake-eagle	-	expected	7	LC	170000	BirdLife species range map
Black Kite	-	expected	8	LC	2625000	BirdLife species range map
Long-legged Buzzard	-	expected	7	LC	274000	BirdLife species range map

SATELLITE TRACKS (10)

Count	Species	Source
10	White Stork	Fiedler et al.

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
Lesser Kestrel	-	expected	6	LC	170000	BirdLife species range map
Bonelli's Eagle	-	expected	9	LC	10000	BirdLife species range map
Eastern Imperial Eagle	-	expected	9	VU	9250	BirdLife species range map
Steppe Eagle	-	expected	9	LC	160000	BirdLife species range map
White Stork	-	tracked	10	LC	510000	Fiedler et al.

Name	SI	Type	Distance	Source
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.
Flight - 10	Unknown	Track	unavailable	Fiedler et al.

Name	Peak Count	Presence	SVI	Status	Global population	Source
Black Stork	-	expected	10	LC	34000	BirdLife species range map

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
Hen Harrier	-	expected	8	LC	370000	BirdLife species range map
Pallid Harrier	-	expected	8	NT	36000	BirdLife species range map
Montagu's Harrier	-	expected	8	LC	540000	BirdLife species range map
Greater Spotted Eagle	-	expected	9	VU	9100	BirdLife species range map
Lesser Spotted Eagle	-	expected	9	LC	79000	BirdLife species range map
Saker Falcon	-	expected	6	EN	32700	BirdLife species range map
Eurasian Sparrowhawk	-	expected	6	LC	4000000	BirdLife species range map
Peregrine Falcon	-	expected	6	LC	500000	BirdLife species range map
Eurasian Hobby	-	expected	6	LC	1200000	BirdLife species range map
Common Kestrel	-	expected	6	LC	8000000	BirdLife species range map
Red-footed Falcon	-	expected	6	NT	550000	BirdLife species range map
Common Crane	-	expected	10	LC	365000	BirdLife species range map
Griffon Vulture	-	expected	10	LC	1000000	BirdLife species range map
Booted Eagle	-	expected	9	LC	253000	BirdLife species range map
Osprey	-	expected	7	LC	750000	BirdLife species range map

LOCATIONS BY SPECIES

Name	Peak Count	Presence	SVI	Status	Global population	Source
European Honey-buzzard	-	expected	7	LC	675000	BirdLife species range map
Short-toed Snake-eagle	-	expected	7	LC	170000	BirdLife species range map
Black Kite	-	expected	8	LC	2625000	BirdLife species range map
Long-legged Buzzard	-	expected	7	LC	274000	BirdLife species range map

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developed by habitat INFO

APPENDIX D: ARCHAEOLOGICAL SURVEY REPORT

ACES
Arab Center
For Engineering Studies
المركز العربي
للدراسات الهندسية
Partners for Quality Construction

ARCHAEOLOGICAL REPORT FOR THE PROJECT 200 MW PV POWER PLANT AL-MUWAQER, JORDAN

Report No.	S16000094
Revision No.	Rev.0
Status	Archaeological Report
Date	27 August 2016

PREPARED FOR
ABU DHABI FUTURE ENERGY COMPANY- (MASDAR)
ABU DHABI, EMIRATES

Revision History

Rev.0	27 August 2016	For Review	NZ	TW	TW	
Revision No.	**Date**	**Description**	**Prepared**	**Checked**	**Approved**	**QA Check**

ACES
Partners for Quality Construction
Arab Center
For Engineering Studies
المركز العربي
للدراسات الهندسية

Messrs.: Abu Dhabi future Energy Company- (MASDAR)
Abu Dhabi, Emirates

Ref.: S16000094-Rev.0
Date: 27 August 2016

Subject: Preliminary Archaeological Report for the Project 200 MW PV power plant Al-Muwaqer, Jordan

Dear Sirs,

Arab Center for Engineering Studies (ACES) is pleased to submit this Archaeological Survey Report and recommendation for the proposed Power Plant Project to be constructed in Al-Muwaqer, Jordan, based on Ministry of tourism and antiquities / Department of Antiquities investigation. Kindly note that the Archaeological Survey Report is presented in **Attachment A**

1.0 PROJECT DESCRIPTION

Based on the information provided from the client it understood that 200 MW PV Power Plant with a maximum capacity of 200 MW at delivery point will be developed near Amman. This report provides the presence or absence of any archaeological sites in the project Area.

2.0 RECOMMENDATIONS

According to the Ministry of tourism and antiquities / Department of Antiquities Survey Report, the following considerations and recommendations are provided:

- Archaeological Survey Report is covers the Area with the following coordinates:

Table 1: Borders of the Project Area Details

Point No.	Coordinates	
	Northing	Easting
Point-01	235177	3531395
Point-02	237652	3531331
Point-03	237590	3528913
Point-04	235114	3528977

- Ministry of tourism and antiquities / Department of Antiquities gives the permission to start the construction within the project area, however if any archaeological evidences present during the construction activates Department of Antiquities should be notified immediately.

In the event that additional information or clarifications are required, please contact our office at your convenience.

Sincerely yours,
Arab Center for Engineering Studies (ACES)

Thaer Wahshat
Dr. Thaer Wahshat P.E.

ACES Jordan Manager

ATTACHMENT A

ARCHAEOLOGICAL SURVEY REPORT

بسم الله الرحمن الرحيم

وزارة السياحة والآثار
دائرة الآثار العامة

100
Great Arab Revolt Centennial
نهضة

الرقم ٣٠٧٢/١/٥
التاريخ ٢٠١٦/٠٨/٢٥
الموافق

السادة المركز العربي للدراسات الهندسية

اشاره لكتابكم المؤرخ في 2016/8/6 والمتضمن طلب عمل مسوحات اثرية ضمن منطقة مشروع مصدر للطاقة لمحطة الطاقة الحرارية الشمسية- الموقر.

أرجو أن اعلمكم بان دائرة الاثار العامة قامت بعمل المسوحات اللازمة من خلال كوادرها المتخصصة في هذا المجال ، وبناءاً عليه لا مانع لدينا من استكمال الاجراءات الخاصة بهذا المشروع، على ان يتم التوقف عن العمل في حال العثور على اية معالم او لقى اثرية اثناء تنفيذ المشروع وابلاغ دائرة الاثار العامة بذلك.

و اقبلوا الاحترام

د. منذر جمحاوي

مدير عام دائرة الآثار العامة

نسخة / المساعد الفني.
نسخة/ مديرية آثار العاصمة.
نسخة / مديرية التنقيبات الاثريه .

ن ح

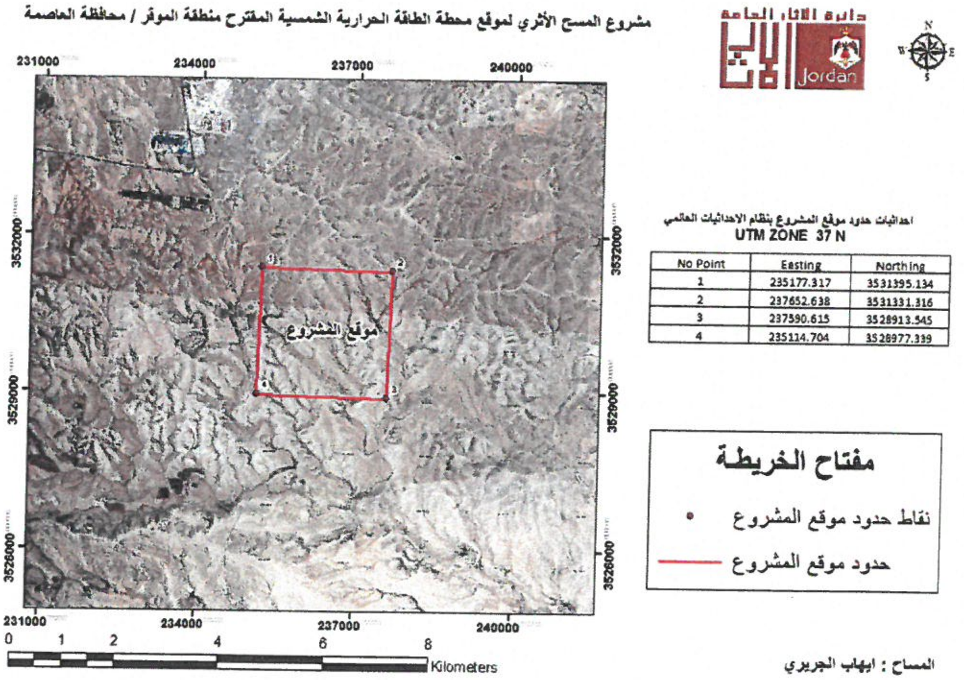
المملكة الأردنية الهاشمية
دائرة الآثار العامة - جبل عمان - شارع سلطان الاطرش -خلف السفارة الجزائرية - عمارة رقم (١٠) ص.ب: (٨٨) عمان ١١١١٨ الاردن
هاتف: ٤٦٤٤٣٣٦، ٤٦٤١٢٧٥، ٤٦٤٤٣٢٠ ٦ ٩٦٢+ فاكس: ٤٦١٥٨٤٨ ٦ ٩٦٢+ www.doa.gov.jo - E-mail:info@doa.gov.jo

مشروع المسح الأثري لموقع محطة الطاقة الحرارية الشمسية المقترح منطقة الموقر / محافظة العاصمة

المقدمة:

تقع المنطقة المطلوب مسحها ضمن قطعة الارض رقم (1) حوض تل الركبان من اراضي جنوب عمان / محافظة العاصمة وبالتحديد على بعد مسافة 10 كم للجنوب الشرقي من موقع الماضونة الاثري وعلى مسافة 11 كم شرق الطريق الرئيسي المؤدي الى مطار الملكة علياء الدولي ، ذات شكل مربع تقريبا أبعاده 2.475 كم * 2.417 كم وبمساحة اجمالية 6000 دونم تقريبا، ويقع حسب الاحداثيات التالية :

No Point	Easting	Northing
1	235177.317	3531395.134
2	237652.638	3531331.316
3	237590.615	3528913.545
4	235114.704	3528977.339


مشروع المسح الأثري لموقع محطة الطاقة الحرارية الشمسية المقترح منطقة الموقر / محافظة العاصمة
دائرة الآثار العامة
Jordan
N
W
E
S
231000
234000
237000
240000
3532000
3529000
3526000
1
2
3
4
موقع المشروع
0
1
2
4
6
8
Kilometers
مفتاح الخريطة
نقاط حدود موقع المشروع ●
حدود موقع المشروع
المساح : ايهاب الجريري

احداثيات حدود موقع المشروع بنظام الاحداثيات العالمي
UTM ZONE 37 N

No Point	Easting	Northing
1	235177.317	3531395.134
2	237652.638	3531331.316
3	237590.615	3528913.545
4	235114.704	3528977.339

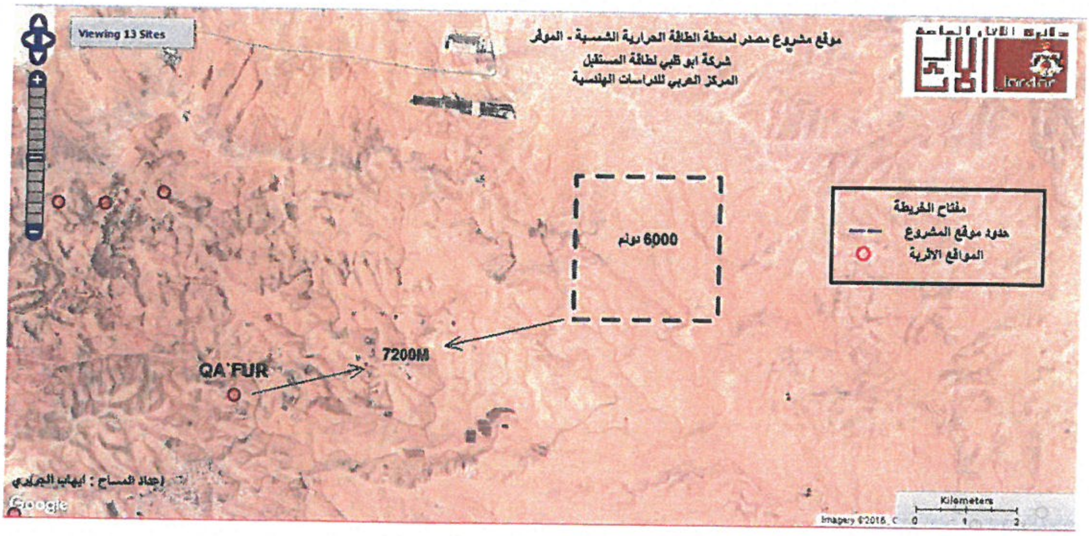
الشكل رقم (1) : صورة جوية لموقع المشروع

الشكل رقم (2) : صورة فتوغرافية لطبيعة موقع المشروع .

أهداف مشروع المسح :

1- توثيق كافة المعالم الاثرية التي توجد داخل المنطقة المقترحة لمشروع الطاقة الحرارية الشمسية.

2- توثيق كافة الاعمال الاثرية والمواقع التي ستشملها اعمال المسح الاثري على قاعدة البيانات لدائرة الاثار العامة (MEGA JORDAN).


Viewing 13 Sites
موقع مشروع مصدر لمحطة الطاقة الحرارية الشمسية - الموقر
شركة ابو ظبي لطاقة المستقبل
المركز العربي للدراسات الهندسية
مفتاح الخريطة
حدود موقع المشروع
المواقع الاثرية
6000 دونم
7200M
QA'FUR
إعداد المساح : ايهاب الجرادي
Google
Kilometers
0
1
2
Imagery ©2016

الشكل رقم (3) : مخطط يبين حدود موقع المشروع وبعده عن اقرب موقع اثري مسجل على موقع برنامج (MEGA JORDAN).

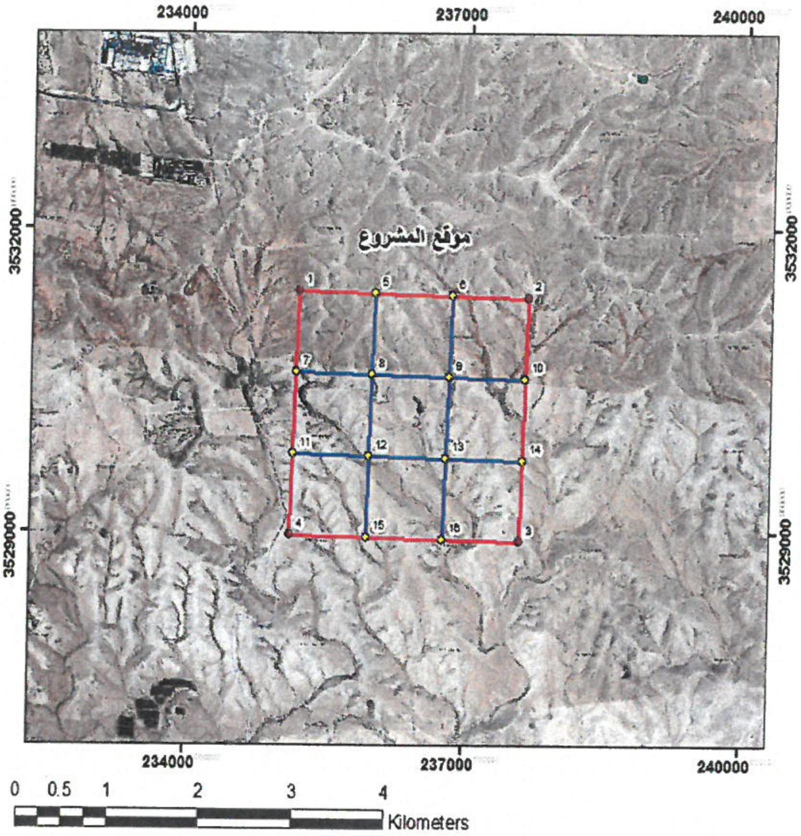
آلية العمل في مشروع المسح الاثري:

تم البدء باعمال المسح من قبل الفريق الاثري حيث تم تقسيم منطقة المشروع الى 9 مربعات لتسهيل عملية المسح الاثري بشكل منظم ودقيق ، والتي تقدر مساحة كل مربع بـ 665 دونم تقريبا .

مشروع المسح الأثري لموقع محطة الطاقة الحرارية الشمسية المقترح منطقة الموقر / محافظة العاصمة

دائرة الآثار العامة

Jordan



احداثيات تقسيم موقع المشروع بنظام الاحداثيات العالمي
UTM ZONE 37 N

No Point	Easting	Northing
1	235177.317	3531395.134
2	237652.638	3531331.316
3	237590.615	3528913.545
4	235114.704	3528977.339
5	236002	3531373
6	236827	3531352
7	235156	3530589
8	235981	3530568
9	236806	3530546
10	237631	3530525
11	235135	3529783
12	235960	3529762
13	236785	3529741
14	237611	3529719
15	235939	3528956
16	236764	3528934

مفتاح الخريطة

● نقاط حدود موقع المشروع
🟥 حدود موقع المشروع
🟦 حدود تقسيم موقع المشروع
○ نقاط_تقسيم_منطقة_المشروع

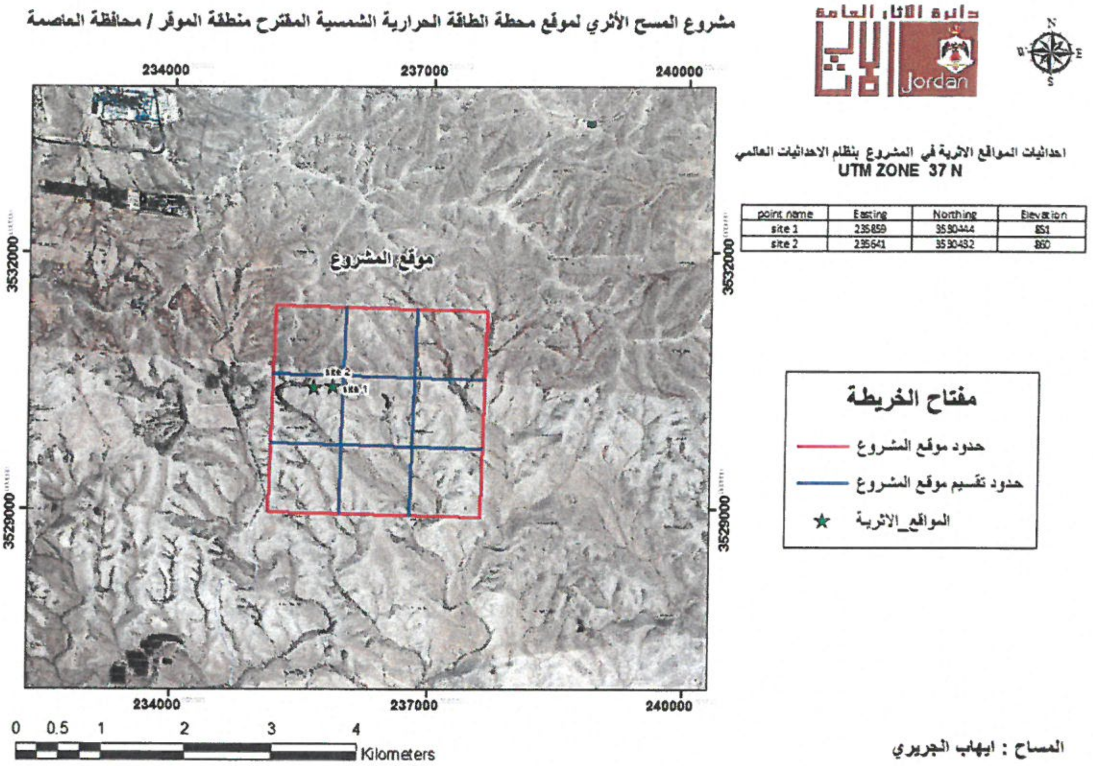
المساح : ايهاب الجريري

الشكل رقم (4) : مخطط يبين تقسيم منطقة المشروع الى مربعات لتسهيل عملية المسح الاثري.

نتائج المسح الاثري :

من خلال اعمال المسح الاثري لمنطقة المشروع تبين وجود موقعين اثريين يقعان بالمربع رقم (4) حسب تقسيم منطقة المشروع .

مشروع المسح الأثري لموقع محطة الطاقة الحرارية الشمسية المقترح منطقة الموقر / محافظة العاصمة



دائرة الآثار العامة
Jordan
N
E
S
234000
237000
240000
3532000
3529000
موقع المشروع
site 2
site 1
0
0.5
1
2
3
4
Kilometers
مفتاح الخريطة
حدود موقع المشروع
حدود تقسيم موقع المشروع
★ المواقع_الاثرية

احداثيات المواقع الاثرية في المشروع بنظام الاحداثيات العالمي
UTM ZONE 37 N

point name	Easting	Northing	Elevation
site 1	235859	3530444	851
site 2	235641	3530432	860

المساح : ايهاب الجريري

الشكل رقم (5) : مخطط يبين المواقع الاثرية التي تم العثور عليها في منطقة المشروع بالتحديد ضمن المربع رقم (4).

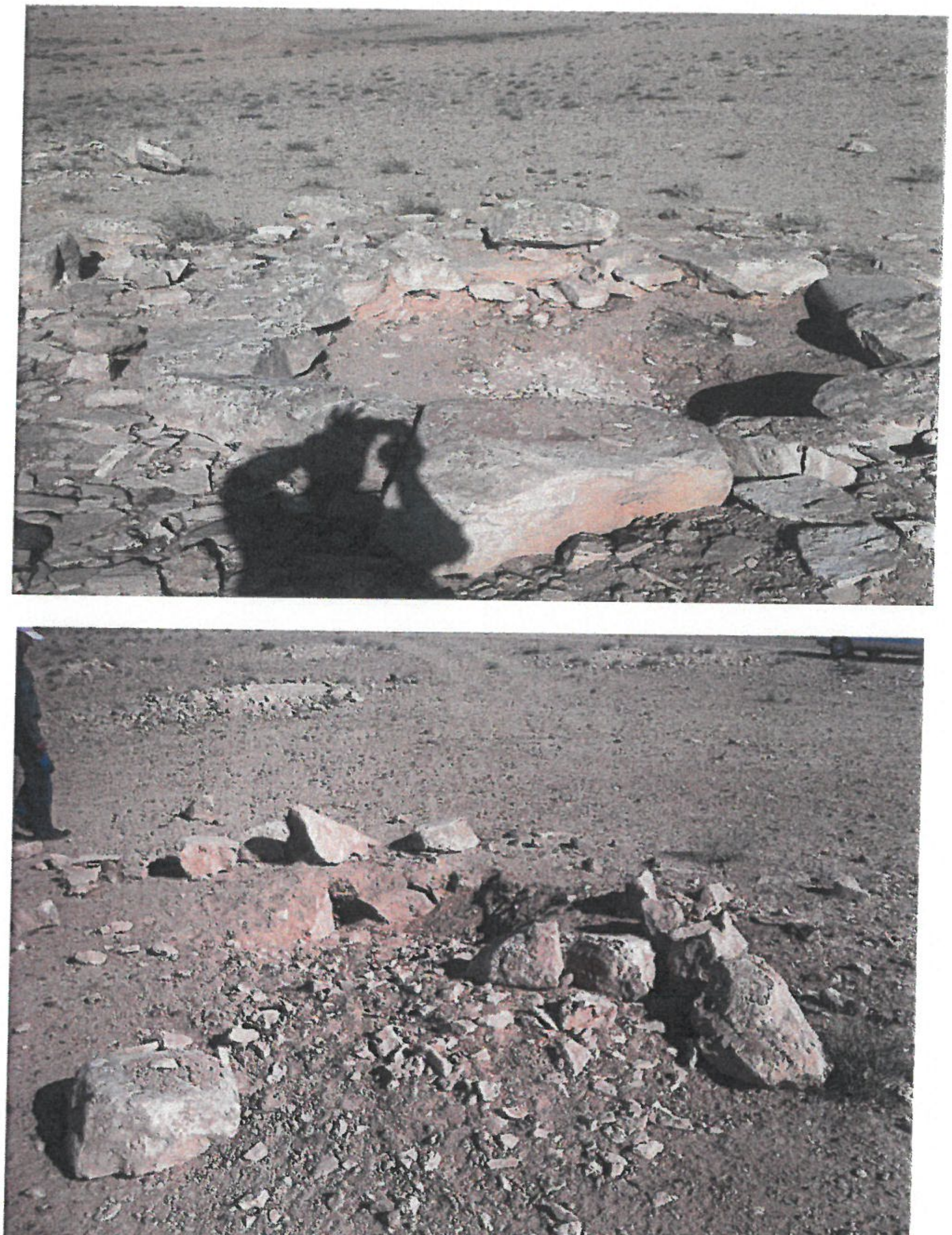
الموقع الأثري رقم (1) :-

بقايا برج عموني صغير ومدمر ومتناثره حجارته بالموقع على شكل دائري قطرة 1 متر تقريبا ، حيث استعملت المنطقة مقبرة من قبل البدو الرحل واصحاب الاغنام وحيث تبلغ ابعادها 15م*15م ، بالاضافة الى وجود اعمال حفر غير شرعي من قبل الهواه وكذلك الباحثين عن الحجارة للبناء ولم يعثر على اية كسر فخارية على السطح . ويقع ضمن الاحداثية التالية:

E: 0235859

N: 3530444

ELE : 851



الشكل رقم (6) : صور فتوغرافية للموقع الاثري رقم (1)

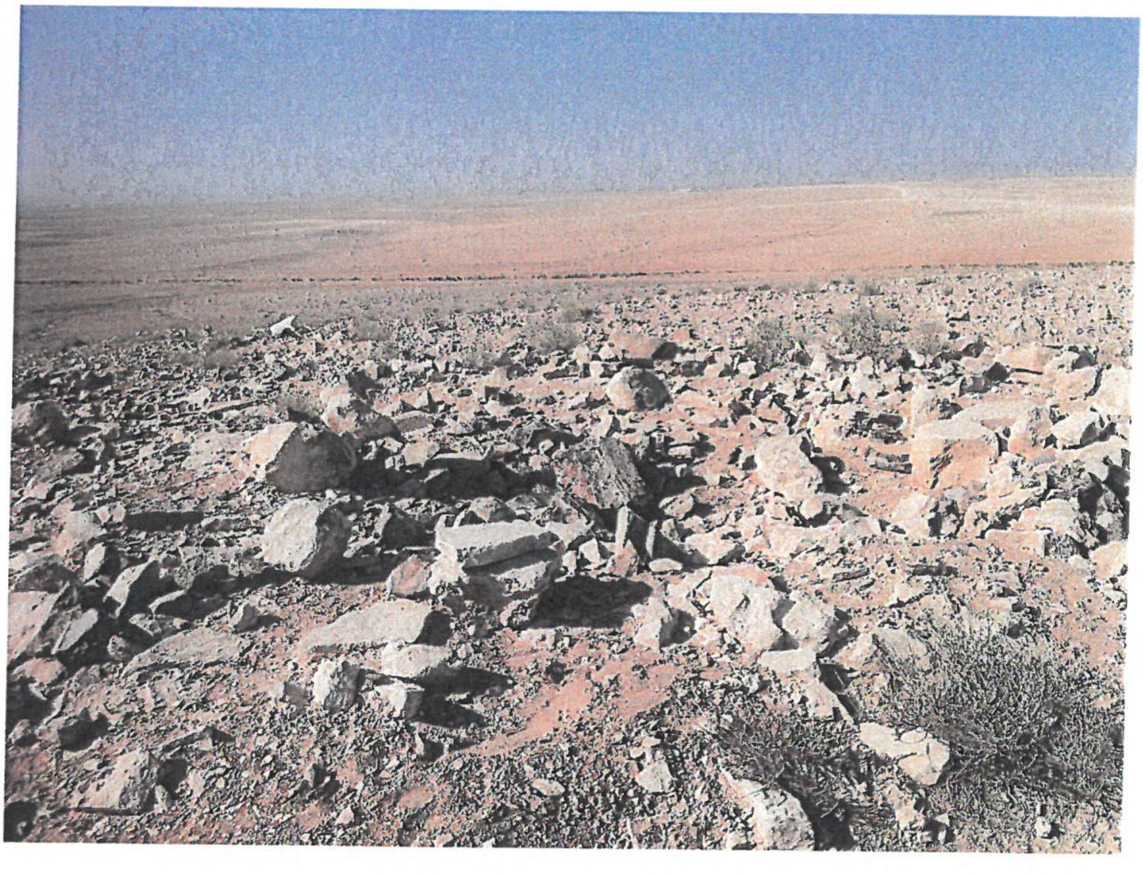
الموقع الأثري رقم (2) :-

بقايا برج عموني صغير مدمر دائري بقطر 3 متر تقريبا يقع على ظهر تلة الى الجهة الغربية من الموقع الاثري رقم (1) ويبعد عنه ما يقارب 220 متر ، حيث لم يعثر على اية كسر فخارية على السطح ، وتم الاعتداء عليه من قبل هواة الباحثين عن الدفائن الذهبية بالاضافة الى اعمال حفر غير شرعية للاستفادة من حجارة الموقع ، حيث تبلغ ابعاد المنطقة التي يشملها البرج 10م*10م . ويقع ضمن الاحداثية التالية :

E: 0235641

N: 3530432

ELE: 860



الشكل رقم (7) : صوره فتوغرافية للموقع الاثري رقم (2)

ومع استمرار اعمال المسح لبقية المربعات لم يعثر على اية معالم اثرية تذكر، حيث ان المنطقة صحراوية مستخدمة من قبل البدو الرحل ومربي الاغنام ، ويظهر على الارض محاولة استغلال بعض الاراضي للزراعة برغم عدم وجود اية مصادر دائمة للمياه واعتمادهم فقط على مياه الامطار ، وهنالك اجزاء من منطقة المشروع طبيعتها ذات حجارة صوانية وجزء اخر ذو طبيعة ترابية حيث يظهر القطع الترابي في الارض على تشكل الوديان نتيجة مياه الامطار المتجمعة فيها .

ولابد من ذكر ان المنطقة هي جزء من المنطقة التي تم مسحها عام 1996 وذلك لغاية فتح شارع (المئه) الدائري والذي يبدأ من الشارع الرئيسي لمقبرة سحاب والمؤدي الى اراضي الزرقاء منطقة وادي العش مرورا بقرية المناخر المحاذية لمنطقة المشروع ولم يعثر بها على اية معالم اثرية تذكر .

التوصيات :

1- التقيد بالمساحة المراد اقامة مشروع محطة للطاقة الحرارية الشمسية ضمن الخطة المقدمة من قبل السادة المركز العربي للدراسات الهندسية.

2- لامانع بالسماح لهم باقامة خطة المشروع شريطة تبليغ دائرة الاثار العامة في حال العثور على اية معالم اثرية اثناء اعمال المشروع.