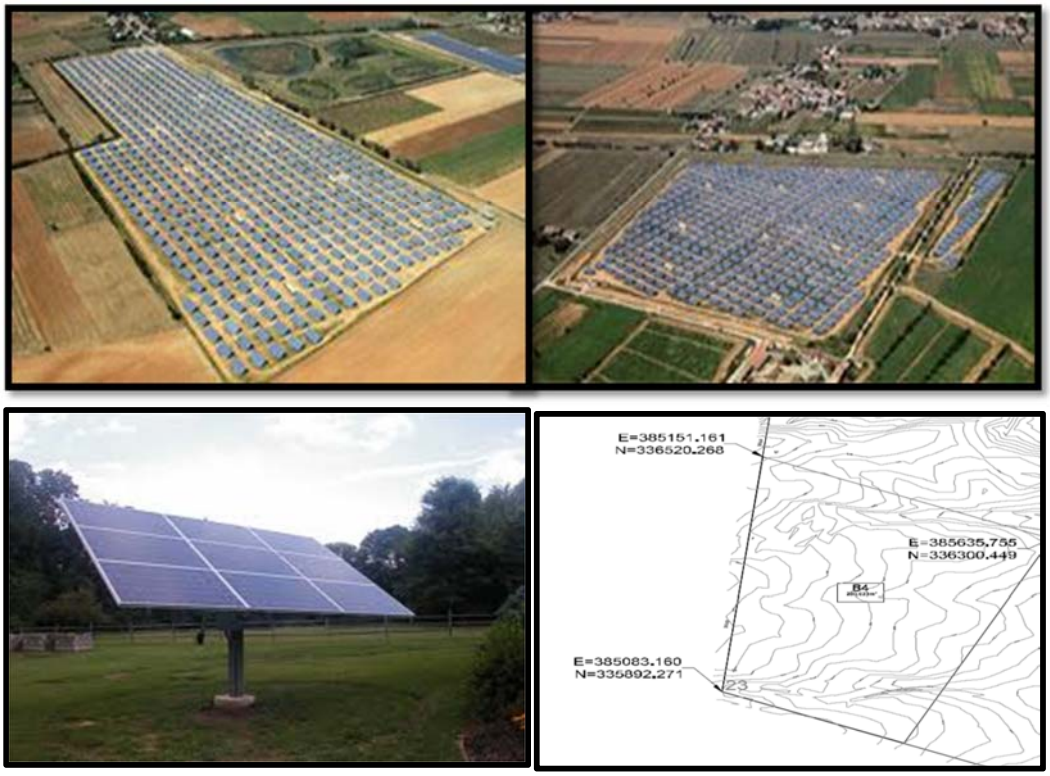
Al Ward
Al Joury

Environment and Social Impact Assessment (ESIA)
For Solar Power Plant Project Plot B4



Final Report

August 2014

ARABTECH JARDANEH
Define . Design . Deliver

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ABBREVIATIONS

AJ	Arabtech Jardaneh
DoS	Department of Statistics
EMS	Environmental Management System
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EPBT	Energy Payback Time
GHG	Green House Gas
GoJ	Government of Jordan
HSE	Health, Safety and Environment
IBA	Important Bird Area
JADIS	The Jordan Archaeological Database and Information System
JISM	Jordan Institute for Standards and Meteorology
LCA	Life Cycle Assessment
MDA	Ma'an Development Area
MEMR	Ministry of Energy and Mineral Resources
MoEnv	Ministry of Environment
PPA	Power Purchase Agreement
PV	Photovoltaic
ToR	Terms of Reference

1. EXECUTIVE SUMMARY

1.1. Introduction

Based on the Request for Expression of Interest (the "REOI") issued by Ministry of Energy and Mineral Resources in order to promote the investment opportunities in renewable energy projects and to select the possible projects under the direct proposal submission procedure set out in the Renewable Energy and Energy Efficiency Law No. (13) For the year 2012.

Al Ward Al Jory for Energy Generation has responded to the REOI and delivered an Expression of Interest (the "EOI") in July 2011 with the proposal to develop a 10 MW PV in Ma'an, furthermore, it became shortlisted and was invited to sign a MOU in May 2012.

Al Ward Al Jory for Energy Generation has received the acceptance letter and signed the Power Purchase Agreement (PPA) in March 2014 and started with the detailed design stage and preparation of the required studies prior to project implementation.

Arabtech Jardaneh (AJ) was appointed by Al Ward Al Jory for energy generation to prepare the Environment and Social Impact Assessment study (ESIA) for the project. The ESIA study is prepared based on the approved Terms of Reference (ToR) that was approved by the Ministry of Environment (MOEnv) on June 9th 2014.

The ESIA Study was subsequently approved by MoEnv on August 17th 2014.

1.2. Project Description

The project plans to develop and construct a photovoltaic (PV) plant in Ma'an governorate within the selected area for this purpose specifically within the Industrial park cluster at the Ma'an Development Area (MDA); the project located in plot B4 and has a total capacity of approximately **10.0** MWp and the system is composed by **8** inverters and **46,530** modules.

The General description of the PV plant is presented below:

Nominal Power	**Peak power**	**N Inverter**	**Total N Modules**	**Modules Per string**
10 MW	11.4 MWp	8	46,530	22

The project will fall within plot B4 having an area of about260, 000 square meters.

The Solar PV system will include modules, inverters, and if applicable roads and the fence around the system.

1.2.1. Project Components

PV Modules

The PV Plant will have an installed peak power of 10.0MWp and will be composed by 46530 PV modules YINGLI – YL245P-29b - YGE 60 Cell, with Multi.-Si technology.

Inverters

The system design was enhanced with the installation of 8 inverters, POWERONE ULTRA-1400.0-TL&ULTRA – 200.0 – TL. The choice for Power One Ultra Inverter 1400 was due to the high efficiency (98.7%) of the inverter and flexibility. It is composed by 4 x 350KW modules with 4 independent Mppts trackers, which guarantee a higher availability and less mismatch losses. The Mppt operation voltage range is [585 to 850 V] for 1400 kW and [645 to 850 V] operating at1560 kW.

Mounting System

This increases the amount of energy produced from a fixed amount of installed power generating capacity. A solar panel in a fixed orientation between the dawn and sunset extremes will see a motion of approximately 75 degrees on either side, and thus, will lose in average 75% of the energy in the morning and evening. Rotating the panels to the east and west can help recapture these losses. A tracker rotating in the east west direction is known as a single axis tracker.

The CLAVIJO SP1000 was considered in the proposal.

Monitoring and Controlling Systems

The use of tracking systems improve significantly the energy produced in a PV plant, trackers are used to minimize the angle of incidence between the incoming light and a photovoltaic panel.

For this proposed project it is intended to install a proprietary monitoring system, which can be accessed by the costumer via web. This system is able to communicate with several devices included in the PV Plant and present these values in an easier and intuitive way.

The data logger will be connected with the inverters, the meter, the irradiance sensor and the temperature sensors. Through a connection tool the information may be read using Internet, as it can be possible to export the collected data into an office environment.

Civil Works

All civil works that will take place during the plant execution will include mounting and installation related with PV modules installation.

Structure

The structure for tracker is mono pile. For safety verification it was considered for the calculations that the modules have a tilt of 00.

Foundation

The soil characteristics permit the use of steel piles which reduce construction time. These elements must be hammered in soil 2 meters deep.

Grid Connection

The PV Facility will be connected to the national grid of NEPCO at the 33 kV level.

Voltage changes at the Delivery Point attributable to the connection and disconnection of generators or generating units do not give rise to inadmissible network disturbances if the maximum voltage change due to the switching operation at an inverter does not exceed a value of 2%, i.e. if Δ umax ≤ 2% (related to agreed service voltage Uc) and does not occur more frequently than once within 3 minutes.

Water Consumption

The project is expected to use limited quantities of fresh water during the three project phase construction, operation, and decommissioning, since such this type of projects considered as a low water consumption projects, the project will be supplied by the water through and combined water and firefighting network as a part of the infrastructure in the project area.

Implementation Schedule

The construction of the project will start early 2015; while the period in between February 2014 to December 2014 will entail preparation and mobilization.

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 visit 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.

1.4. Baseline Conditions

Baseline conditions have been examined for the physical, biological, socio-economic and Occupational Health & Safety (OHS). The baseline section was prepared based on the most up-to-date available information; this information has been collected from various sources, to the extent possible. Some sources include relevant government institutions such as DoS, Jordan Meteorological Department (JMD), MEMR and MWI.

1.4.1. Physical Environment

Topography

The project area is located in a fairly flat area, a mountainous terrain is visible and contribute to the local drainage regime. A Shallow wadi intersects the southernmost section of the Industrial park area. Elevation at the project site is expected to be between 1005 to 1025 meters above the sea level.

Soil

The MDA conducted geotechnical investigation (November, 2013), the engineering analysis for the geotechnical investigation classified the soil as gravel and cobbles of limestone and with brown silty clay.

Furthermore, the soil and rock materials encountered at the site are suitable to be used for different backfilling purposes except sandy silty clay material.

Geology

The project site belongs to the Balqa group within the B4 and B3 formations (Umm Rijam and Muwaqqar formations), which fall within the Paleocene and upper cretaceous systems. In terms of sedimentary rocks these formations consist of chalk, chert, limestone and marl, the B3 formation is sometimes bituminous. 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 the geologic structure.

Climate & Meteorology

The project area climate belongs to the Arid Mediterranean cool Zone, The data that have been obtained from Ma'an weather station. The data averages for the last seven years (2004- 2013), shows that the Avg. Max Temp is 25.5°C and Avg. Min Temp is 10.8°C and the Avg. Mean Temp is 18.1°C. Avg. Mean Humidity is 45%.

Also, wind direction is generally westerly to north-westerly all year round, except in April the wind blows from the southeast of the Arabian Peninsula frequently occurring providing the country with its most uncomfortable weather (khamasin). With an average wind speed 5.4 Knots.

The solar irradiance has been obtained by the industrial park weather station, the monthly averages of daily solar irradiance sums from the October 2010 untilSeptember 2014, where the yearly average of direct solar irradiance daily sum (DN) is 7.40 kWhy/m^2per day.

Air Quality

Aqaba International Laboratories - Ben Hayyan has also conducted provided measurements for PM10 and PM2.5parameters during the period between (9/6/2014 -15/11/2014) -24 hours one week at the project site

Daily average, Hourly average and 15- minutes max average ambient air quality sampling and monitoring were carried in order to present an overview of the ambient quality baseline conditions for the site. The monitoring period extended from (Monday, 00:15), 9/6/2014 to (Sunday, 24:00), 15/6/2014 (one week).

Main findings are as follows

- No exceedances were recorded to the maximum allowable limits for PM10 that specified in Jordanian standards (1140/2006).
- No exceedances were recorded to the maximum allowable limits for PM2.5 that specified in Jordanian standards (1140/2006).

Noise Levels

Spot noise measurements were carried out at proposed construction location for Solar Power Plant Project in order to determine the ambient baseline sound level profile. Measurements were undertaken using data logging Sound Level Meter Model Extech HD600.

The project area is categorized as industrial area; therefore the measured noise level will be compared with limits set for Industrial areas, where Allowable noise 75 dBa at day and 65 dBa at night for Industrial areas.

The measurements were carried out during day time. LAavg is within the allowed limits 34 dBa, while maximum levels are not exceeding the standards 48.4 dBa.

Water Resources

1. Surface Water

The project area is located within the Jafer surface water basin. The mean annual rainfall over the basin ranges from the highs of about 200 mm/yr in the western highlands to less than 25 mm/year in its eastern parts, averaging over the whole basin to about 40 mm/year.

Ma'an Development Zone (MDA) conducted Hydraulic and Hydrological analysis report for the solar panels projects location, the report used Ma'an meteorological data was obtained from Ministry of Water and Irrigation, in addition to Royal Jordanian Geographic Center for contour maps.

Furthermore, site visit has been conducted in order to collect any observations such as hydrologic and hydraulic structures, the existing culverts, the spread of wadis, and evidence of floods in this area have been checked to be further analyzed. Since the Al Hejaz railway borders the project's site, a few culverts have been constructed in this area, which gave a good indication of the direction of floods and their points of concentration.

The proposed project satellite image shows high erosion features where water paths are predicted.

The catchment divided into two sub catchments by Al Husainain Dam, this dam has a great effect in reducing the flood potential in the project's area, as well as reduce the area of the catchment area of the project's site.

2. Groundwater

The project area is included within Jafer groundwater basin. Current use of Jafer already exceeds the available renewable supplies. The deficit is made up by the unsustainable practice of overdrawing the Highland aquifers, resulting in lowered water tables and deteriorating water quality.

The Jafer ground water basin is located in the south-central and south eastern part of Jordan and borders the WadiSirhan Basin to the East, the South and North Wadi Arab and Red Sea Basins to the West, Dead Sea and Zarqa Basins to the north and DisiBasin to the South.

The Basin encompasses a catchment's area of 12,364 km2 or about 15% of the area of Jordan.

Tectonic Setting

The project site lies within the light magnitude of Richter's scale which is illustrated on the seismic hazard distribution map of Jordan, 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.

1.4.2. Biological Environment

Bio-geographic Zone

the project area is located in the zone that covers the most parts of eastern and southern Jordan, namely the Saharo-Arabian zone.

Vegetation Types

The proposed project area has one vegetation type, namely Hammada Vegetation

Most of the Saharo-Arabian region in Jordan is of Hammada type, which comprises about 50 percent of the total area. Four subdivisions of Hammada can be recognized:

1. Run-off hammada
2. Gravel hammada
3. Pebble hammada (Harrah)
4. Sandy hammada

The project area is charecterized with all the above subdivisions of Hammada vegetation except Pebble Hammada.

Faunal Species Diversity

Herpeto-fauna

The projet area has show low abundance od reptiles during the baseline period, that due to the very low vegetation cover and the associated incects communities that comprises the main food for such species.

Mammals

Large mammals are rare and represented by few carnivores (Vulpesvulpes and Hyaenahyaena). On the other hand, rodents are diversified are quite common along the various sections of this area. Jaculusjaculus, Gerbillusdasyurus, Merioneslibycus, Merionescrassus and Psammomysobesus are dominant. In addition, the Desert Hedgehog, Paraechinusaethiopicus is present in this area.

Birds

The project location is located in between two important bird areas in Jordan; Wadi Taraf Important Bird Area and Hizma Basin Important Birds Area.

Detailed Birds Survey is needed to update the status of the ecological relation between the project site and the Birds that are either resident or migrant passenger over this location and the surrounding area.

Birds Survey was made to update the status of the ecological relation between the project site and the Birds that are either resident or migrant passenger over this location and the surrounding area. The results has shown low importance of the project area for birds species due to the poor and degraded ecological characteristics of the area. Few common desert birds species were recorded during the baseline, such as: Desert Lark, Creasted Larck and black Kite. Non of these species are of conservation importance.

Important Ecological Habitats:

The project area dose not have have an ecollogically important habitats, the nearest Important Birds Area is Abu Tarfa IBA which at a distance of 14.9 km. In addition the nearest Rangeland Reserve to the project location is Ras An Naqab which is 22.5 km.

1.5. Socio-Economic Conditions

Population

It is anticipated that the population that will be present within project premises is the project employees.

Land use

The project area is within MDA and is classified as industrial area. The plot allocated for the project is currently empty of any use, surrounding area is also empty. The nearest populated area is the Industrial Park which is part of MDA and located around 1.5 km to the north-east of the project area.

Infrastructure, Utilities, and Transport

The project site can be reached through the international highway connecting Ma'an with the Saudi borders. The project aims to generating electricity, however until starting power generation, electricity and other utilities (water, wastewater and communication) will be provided through MDA.

As for existing infrastructure, none are currently present within the land plot allocated for the project.

1.5.1. Archaeological and Cultural Heritage Resources

An additional survey from the Ministry of Tourism and Antiquities – Archeology Directorate has been done by archeological team in 24/12/2013 at the proposed area for the solar power projects in MDA, and prepared a primary report; the survey team discovered three locations for

Military camp – Ottoman era in addition to some horseshoe metals and piece of the tents cloth, however these identified sites fall outside the project area boundary, as shown in **Figure 53.**

1.6. Stakeholder Identification

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/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 statement report as part of the Final ToR.

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

Security

The project will adopt the prevenetive security approach through building positive relation with the local community and otherstakeholders via open dialougue channels via the community liason persons who are more likely to be from the local community memebers.

1.7. Identification of Environmental and Socio-economic Aspects and Receptors

A definition of environmental aspects adopted for this EIA 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
- 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 in which includes receptors within: Physical Environment; Biological Environment; 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.

1.9. PV Project Lifecycle GHG Emissions

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.

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 greenhouse gas (GHG) emissions for PV technology are presented in this section.

The following are the main findings from the published studies:

- According to NERL, the 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 as illustrated below.
- 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 CO2eq/kwh.
- The latest Carbon Emissions Estimation Tool (CEET) issued by the IFC indicates the following emission factor for a kwh of electricity produced the grid in Jordan:637.42 g CO2eq/kwh,
- This mitigation dimension of PV projects is captured by parameters like the Energy Payback Time (EPBT), which is defined by the International Energy Agency (IEA) as the period for a renewable energy system to generate the same amount of energy (in terms of primary energy equivalent) that was used to produce the system itself. According to

the study conducted by the IEA; applying the EPBT equation to the common PV systems, it was found that an average EPBT of around 1.5 years for these projects. This number is likely to be lower for this project considering that higher efficiency modules that will be used.

1.10. 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 chapter 10 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 (chapter 11).

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

1.11. Environmental and Social Management Plan

The Environmental Management Plan (ESMP) for the respective project phases are presented below:

Table 1: Environmental and Social Management Plan during Construction Phase

spect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
Physical Environment			
Soil	Soil disturbance due to removal of top soil, potential accidental spillage	• 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 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. • 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 storage area, and machinery through conducting regular audits of on-site activities and incident reporting forms. All site workers to be trained in spill response procedures.
Visual Amenity	Visual impacts from construction activities such as materials lay down, excavation,	• The contractor shall ensure general cleanliness and good housekeeping practice at the project site at all times.	Visual inspection of general housekeeping and cleanliness at site in addi-tion to waste manage-ment on site.

spect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
	backfilling		
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
	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
Noise	Increased noise levelsduring 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 dem-onstrate compliance with the National environ-mental noise guidelines using a portable noise meter.
Water Resources	Potential surface water runoff due to high precipitation	Avoid risks from high rainfall and potential flooding the following measures might be necessary for structure and road protection: • Stone ‘’rip-rap’’ or beaching: lining the banks with some rocks or pebbles with a diameter greaterthan 6.26 cm for wadi bed and 4cm for banks.	Follow-up with Ministry of Water and Irrigation and MDA (if needed)

spect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
		• Gabions: a cage cylinder or box filled with rocks, concrete, or sometimes sand and soil used for protecting the road. A gabion wall is a retaining wall made of stacked stone-filled gabions tired together with wire. • Cross veins, weirs or J-hooks from natural materials found on site to decrease the velocity of flow in thw wadi and redirect currents away from road to reduce accelerated flow. • Study the wadi path within the plot and the surface water runoff from road culvert(s) in order to construct the suitable hydraulic structure within the plot such as channels and/ or culverts to reach the adjacent wadi.	
Waste Generation	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	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.

spect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
		management procedures. • The sanitary and organic wastes shall be collected in a septic tankto be installed on site and disposed off regularly.	
Terrestrial Ecology			
Terrestrial Ecology	Potential disturbance to birds	• Minimize human and vehicular contact with fauna, including their burrows / nests and feeding grounds. • Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	Visual inspection within project site.
Health & 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	• 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 Routine Inspection of Equipment and tools used during working at height activities Maintain proper housekeeping for the project site Routine Facilities' and site Inspection Vehicles and mobile plants inspection Preventive maintenance and patrol inspections for all vehicles and mobile plant

spect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
		• 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 minimize 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 response plan (ERP) with all parties, the ERP 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 • 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 minimise bends/junctions, steep gradients and the need for reversing,	Monitor work areas and activities to identify fire and explosions hazards. 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.

spect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
		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 authorized 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 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 and musculoskeletal disorders, hand-arm vibration, temporary or permanent	• 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	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

spect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
	hearing loss, heat stress, and dermatitis	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 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.	protection equipment.

spect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
		• 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.	Obtain open dialogue with the MDA and potential contractors for neighbouring projects that happen to be ongoing during the same time. Monitor vehicle movement to and from the Project area.
Archaeology and Cultural Heritage			
Archaeology & Cultural Resources	Only potential con-cern can be impacts on possible unseen archaeological sites/remains (chance finds)	• All construction works shall be ceased if any historical or archaeological sites are chance found during construction. • In the event potential archaeological and/or cultural resources are discovered during construction activities, the Department of Antiquities (DoA) shall be invited for consultations and assessment of the finding. • Work shall be resumed only after archaeological experts from DoA and official authorities are consulted and appropriate mitigation measures are implemented.	• 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

Table 2: Environmental and Social Management Plan during Operation Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
Physical Environment			
Soil	Potential spillage of stored oil and chemicals	• 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
Visual Amenity	Potential glare from PV panels	The used technology has Anti- Reflective coating that significantly reduce the refelectance of the Pannels (from 2.5% to 2.6% only).	N/A
Terrestrial Ecology	Potential disturbance and harm to birds	• Minimize human and vehicular contact with resident birds including their burrows / nests and feeding grounds. • Groundnests found on site shall be translocated outside the industrial park's boundary. • Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	Visual inspection within project site.
Health and Safety			
Safety risks	Potential of exposure to safety events during operation activities such as slipping and tripping, working at height	• 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	Routine Inspection of Equipment and tools used during working at height activities Maintain proper housekeeping for the project site Routine Facilities' and site Inspection. Monitor work areas and activities to identify fire and explosions hazards.

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
	activities, and fire	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. • 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 response plan with all parties, the ERP 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.	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.

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements
		• 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 exsit into the facility.	Monitoring of access roads around site Record complaints received from locals or authorities.

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 be approximately 20 years. Therefore, the post-design life is expected to involve 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. However, this, EIA Study has considered potential decommissioning impacts in case there was a need for the facility to be dismantled and end operations.

As can be noted from the impact assessment chapter10, 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 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.

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

2. INTRODUCTION

The Government of Jordan (GoJ) (represented by The Ministry of Energy and Mineral Resources (MEMR) issued the Renewable Energy and Energy Efficiency Law No. (13) for the year 2012 (the ''RE&EE Law''), Al Ward Al Jory for Energy Generation was entrusted to be one of the developer in the renewable energy sector.

The Ministry of Energy and Mineral Resources (MEMR) then issued in May 2011 a Request for Expression of Interest (the "REOI") in order to promote the investment opportunities in renewable energy projects and to select the possible projects under the direct proposal submission procedure set out in the RE&EE Law.

Al Ward Al Jory for Energy Generation has responded to the REOI and delivered an Expression of Interest (the "EOI") in July 2011 with the proposal to develop a 10 MW PV in Ma'an, furthermore, it became shortlisted and was invited to sign a MOU in May 2012. Now

Al Ward Al Jory for energy Generation has completed its preparation of final proposal, and has submitted its proposal according to the guide lines and instructions published by MEMR,

Al Ward Al Jory for energy generation has received the acceptance letter and signed the Power Purchase Agreement (PPA) in March 2014and starts with the detailed design stage and prepares the required studies then implements the project,

Arabtech Jardaneh (AJ) was appointed by Al Ward Al Jory for energy generation to prepare the Environment and Social Impact Assessment study (ESIA) for the project activities during the three phases of the project construction, operation and decommissioning. After receiving the Final Terms of Reference (TOR) acceptance letter from the Ministry of environment (MoEnv.) dated June 9th, 2014, the Environment and Social Impact Assessment (ESIA) was prepared, which is considered as second stage of the ESIA process as stipulated within MoEnv's requirements. The ESIA was subsequently approved by the Ministry on August 17th 2014.

It is also worth mentioning that AJ has been extensively involved in preparation of the environmental studies associated with Al Ward Al Jory PV project, given that AJ has successfully completed the Preliminary Impact assessment (PEA) for the project previously and submitted to MEMR on March 2013.

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 "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***(completed);***
- Perform ESIA study and prepare ESIA report***(completed);***
- Preparation of an environmental and social management plan (ESMP), to be incorporated into the ESIA report***(completed);***

2.1. ESIA Objectives

The Environmental and Social Impact Assessment (ESIA) study will be used to:

- 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.
- Evaluate the likely environmental, social and health impacts that may potentially be generated from the project.
- Minimize / eliminate negative impacts, maximize positive impacts.
- Ensure that environmental, social and health factors are considered in the decision-making process.
- Inform the public about the project.

2.2. The Proponent

Al Ward Al Joryfor Energy Genration is the Proponent for the proposed Solar Power Plant Project. The contact details for the proponent's primary contacts are provided below:

Mohammad Abdul-RaoufGhalayini

Partner
252 Prince Mohammad Street Office 203, Amman, Jordan
Telephone: 064619309
Facsimile: 064619308
E-mail: Mohammed@brightpowergroup.com

2.3. The Consultant

AJ has prepared this Final TOR for an ESIA on behalf of the project proponent in accordance with the MoEnvguidelines.
The primary contact for AJ is:
KhaledNassar
Head of Environment
P.O. Box 9532
Amman 11191, Jordan
Telephone: +9626 586 1074

Fax: +9626 586 1075
E-mail: khaled_nassar@aj-group.com

2.4. ESIA Reporting

This ESIA report is submitted to MoEnv. to include the key environmental issues, existing (baseline) conditions, anticipated activities that will cause impacts, a general suite of mitigation measures, and assessment on the likely remaining (residual) impact following mitigation. The ESIA report will be prepared in compliance with the requirements of Al Ward Al Joryas well as the MoEnvrequirements.

The final ESIA report will be submitted within two weeks of receipt of one set of written and consolidated comments from Al Ward Al Jory andMoEnv. With the exception of the Executive Summary, the reporting will be in English.

The final ESIA report, which when approved, will form the basis of the Environmental Permit, together with supporting environmental, social and health management plans, as well as the waste management plan.

The ESIA report will include, at a minimum:

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
Stakeholder Identification and Engagement	Summary of the stakeholder engagement process which will identify the affected parties 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 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

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3. PROJECT DESCRIPTION

3.1. Project Overview

The project plans to develop and construct a photovoltaic (PV) plant in Ma'an governorate; the project has a total capacity of approximately **10.0 MWp** and the system is composed by 8 inverters and **46,530 modules**. A summary of our solution is presented in**Table 3**and the layout in**Figure 1.** The main components will be detailed in the following sub-sections.

Table 3 : PV plant General Description

Nominal Power	Peak power	N Inverter	Total N Modules	Modules Per string
10 MW	11.4 MWp	8	46,530	22

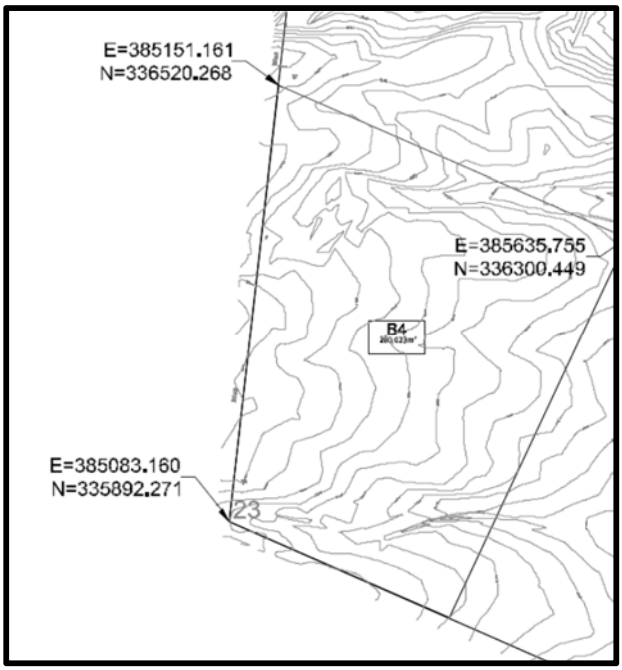


Figure 1 : PV Plant Layout

MDA is located to the east of Ma'an City in Ma'an Governorate, which area is 33,163 km^2; refer to below **Figure 2**andmade up of four clusters that will cover approximately 9 Km^2 of surface area (refer to Figure 2):

- Residential Community
- Industrial Park
- Hajj Oasis
- Skill Development Center

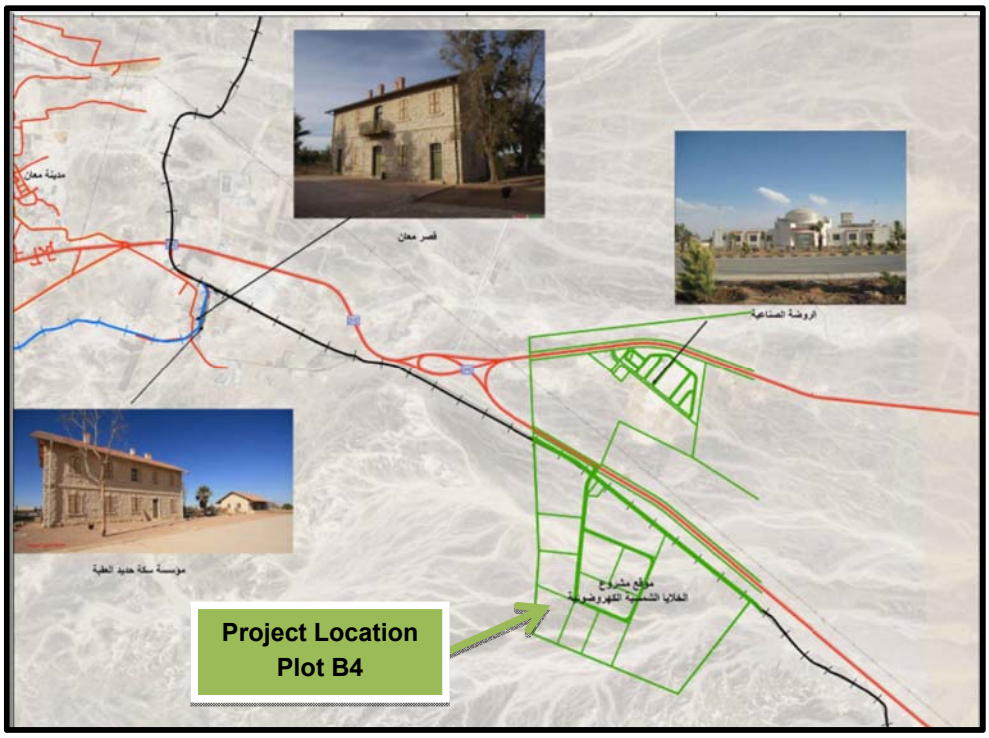


Figure 2: Ma'an Development Area and the project location

The area that was selected for the photovoltaic projectsis around 5 km^2, and it is bordered by the Al Hijaz railway to its North East along with the Ma'an-Mudawara major road within the project's site, a proposed service road has been designed to serve the different plots Figure below shows the location of the project site at plot no. B4relative selected area.

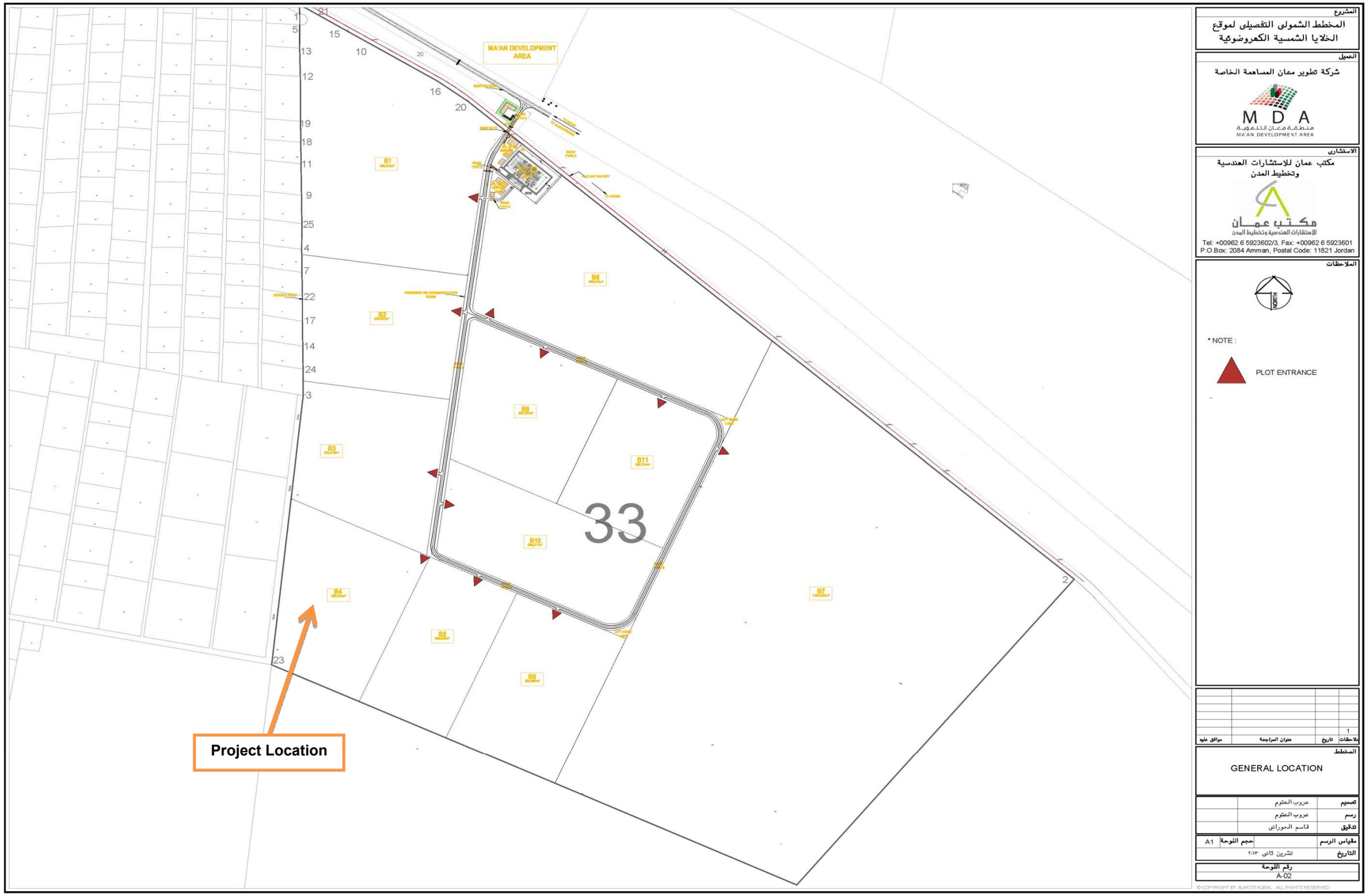
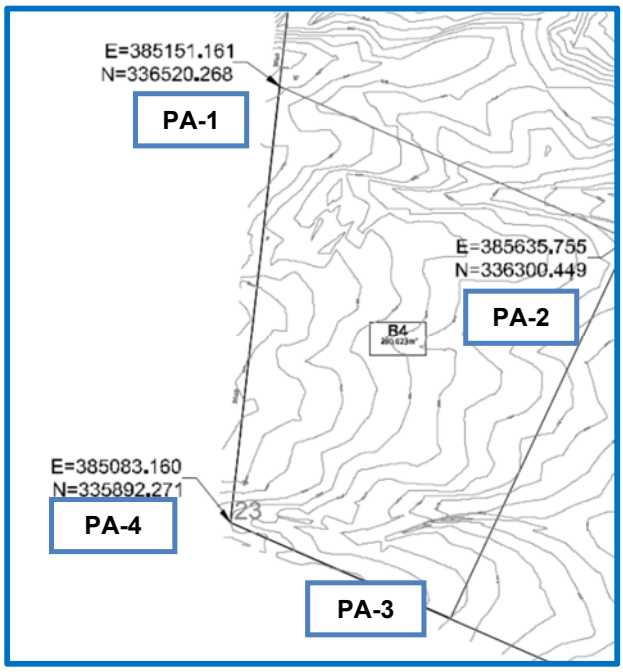


Figure 3: Project Plot Location (B4)

The Site plot B4 is marked by the coordinates PAI, PA2, PA3, and PA4, having an area of about
260,000 square meters.

The Site is situated within the following Jordanian System coordinates:

Table 4: The project Jordanian System coordinates



The PV project contains four major components, whichare:

1. PV modules
2. Invertors
3. Mounting system

The detailed descriptions for the project main components are in the following sections:

3.2. Project Components

3.2.1. PV Modules

The PV Plant will have an installed peak power of 10.0MWp and will be composed by 46530 PV modules YINGLI – YL245P-29b - YGE 60 Cell, with Multi.-Si technology. The **Table 5**below presents the modules main characteristics.

Table 5: PV cells Modules main characteristics

Electrical Characteristics	**YL245C-29b - YGE 60 Cell**	
Peak Power	PMAX	245Wp
Short- circuit current	ICS	8.63 A
Current Pmax	IMPP	8.11 A
Open circuit Voltage	VOC	37.80 V
Voltage at Pmax	VMPP	30.20 V
Module Efficiency	η MOD	15%
Mechanical Specification		
Length X Width X Depth	L X W X H	1650 X 990 X 40 mm
Weight	W	19.10 kg

Yingli is a tier one manufacturer with proven success on PV module market. In this system 245W modules are used with a high efficiency (15%). The 0-5% positive power tolerance guarantees a high peak power. For the whole life time of the Plant there shall be no Potential Induced Degradation (PID) on the photovoltaic modules. This shall be monitored and guaranteed by the module supplier and Contractor "modules are PID free.

3.2.2. Inverters

All the inverters specifications were taken into account when designing the PV plant and setting up the number of modules in series (fixing the voltage value) and the number of string in parallel (fixed power).

The system design was enhanced with the installation of 8 inverters, POWERONE ULTRA-1400.0-TL&ULTRA – 200.0 - TL. The main characteristics of the Inverter are presented in **Table 6**the choice for Power One Ultra Inverter 1400 was due to the high efficiency (98.7%) of the inverter and flexibility. It is composed by 4 x 350KW modules with 4 independent Mppts trackers, which guarantee a higher availability and less mismatch losses. The Mppt operation voltage range is [585 to 850 V] for 1400 kW and [645 to 850 V] operating at1560 kW.

Table 6: Inverter Modules main characteristics

Electrical Characteristics	POWERONE ULTRA-1400.0-TL & ULTRA – 200.0 - TL	
Nominal Power	PNOM(AC)	1400 KW
Output Voltage (AC)	VAC	400
Frequency AC	f	50/60
Maximum input Current	IPV	1440+1440
MPP- Voltage range	VMPP	350-950
Maximum input voltage	VDC	1,000,00 V
Efficiency ERUO	ηEURO	98.7%
Efficiency MAX	ηMAX	98.2%
Mechanical Specification		
Length X Width X Depth	L X W X H	2938 X 4400 X 1520 mm

3.2.3. Mounting System

The use of tracking systems improve significantly the energy produced in a PV plant, trackers are used to minimize the angle of incidence between the incoming light and a photovoltaic panel. This increases the amount of energy produced from a fixed amount of installed power generating capacity. A solar panel in a fixed orientation between the dawn and sunset extremes will see a motion of approximately 75 degrees on either side, and thus, will lose in average 75% of the energy in the morning and evening. Rotating the panels to the east and west can help recapture these losses. A tracker rotating in the east west direction is known as a single axis tracker.

In our proposal we consider the CLAVIJO SP1000, see **Table 7**below, with a North-South single axis alignment.

Table 7: Tracker main characteristics

Tracking Axis	CLAVIJO SP1000 1 AXIS: Polar
Grid configuration 2 row	2 row X 28 meters (extendable up to 2 row X 29 meters)
Grid area 2 rows	78 sqr meters (extendable up to 92.4 sqr meters)
Group area	870 sqr meters (extendable up to 1.015 sqr meters)
Structural material	Hot dip galvanized steel (according to ISO 1461 standard)

3.3. Monitoring and Controlling Systems

A monitoring system consists in acquiring data from several PV Plant devices and creates an historical database with this data. Besides this functionality, a monitoring system is required to improve Operation and Maintenance of the Photovoltaic Plant.

Equipment monitoring through PV Plant Operation intents to maximize produced energy, reduce the down time and consequently prevent equipment failure due to wearing. This allows for early detection of equipment malfunction and failure.

For the present project we intend to install a proprietary monitoring system, which can be accessed by the costumer via web. This system is able to communicate with several devices included in the PV Plant and present these values in an easier and intuitive way.

This system can be tailored in terms of information access. As basic data is presented the following data:

- Voltage and current values at the inverter input side;
- Grid phase voltage and inverter output power;
- Total energy produced;
- Inverter status;
- Module and environment temperature;
- Irradiance sensor cell installed in the plane of generators;
- Wind speed;
- Hourly data;
- Other parameters.

The data logger will be connected with the inverters, the meter, the irradiance sensor and the temperature sensors. Through a connection tool the information may be read using Internet, as it can be possible to export the collected data into an office environment.

Two meteorological stations, composed by different sensors, will be included in this proposal and shall be used and installed along the site in order to achieve more accurate values.

3.4. Civil Works

All the required civil works that will take place during the plant execution that included mounting and installation related with PV modules installation, these civil works including earth works aresummarized below :.

- Cable Trays;
- Foundations to be confirmed in accordance with geological studies, local rules and authorizations;
- Perimeter fencing 2 m height, equipped with two (2) gates;
- Internal roads and paths within the area of the plant;
- Cabins for the inverters;
- Transformer cabins - dimensions can be modified respect the original design, and adjusted to allow the placement of electrical devices.

The description of the suggested steel structure holding skeleton and foundation of the structure systems are follows

3.4.1. Structure

The structure for tracker is mono pile. For safety verification it was considered for the calculations that the modules have a tilt of 00, as presented in the **Figure 4**below:

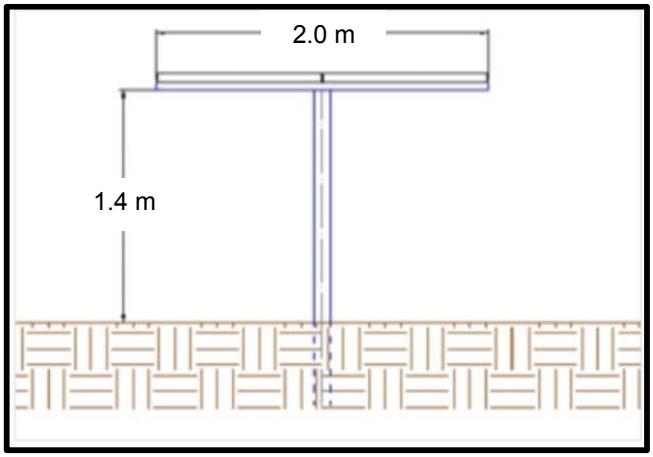


Figure 4: Structure details

3.4.2. Foundation

The soil characteristics permit the use of steel piles which reduce construction time. These elements must be hammered in soil 2 meters deep as per **Figure 5**below.

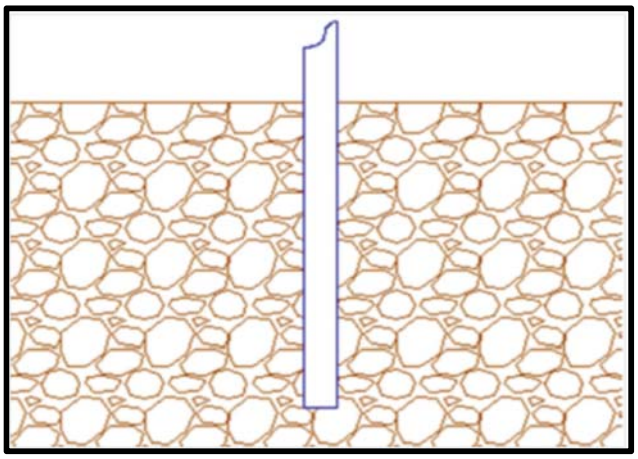


Figure 5: Hammered Steel pile

3.5. Grid Connection

This section describes the minimum requirements for grid connection of PV Facility in Jordan and provides detailed stipulations supporting the current System Grid Code for the connection of PV Facility to the national grid of NEPCO at the 33 kV level.

The System Grid Code requirements comprise the following points which are later on described in more detail:

- Network disturbance requirements:
- Sudden voltage changes
- Long term flicker o Harmonics and inter-harmonics
- Commutation notches o Audio-frequency centralized ripple-control
- Behavior of generating plant (static and dynamic requirements) connected to the network:
- Dynamic network support
- Active power control
- Reactive power control
- Frequency band

3.6. Sudden Voltage Change

Voltage changes at the Delivery Point attributable to the connection and disconnection of generators or generating units do not give rise to inadmissible network disturbances if the maximum voltage change due to the switching operation at an inverter does not exceed a value of 2%, i.e. if Δ umax $\leq$ 2% (related to agreed service voltage Uc) and does not occur more frequently than once within 3 minutes.

3.7. Water Consumption and Wastewater Generation

The project is expected to use limited quantities of fresh water during the three project phase construction, operation, and decommissioning, since such this type of projects considered as a low water consumption projects, the project will be supplied by the water through and combined water and firefighting network as a part of the infrastructure in the project area.

The generated wastewater will be collected in a cesspit tank then to be emptied regularly regarding to the limited quantities of the wastewater.

The expected water consumption for the project is summaries**Table 8**below:

Table 8: Water consumption

	Water consumption (m^3)	**Wastewater Generation (m^3)**
Daily	2.85	2.40
Yearly	1020	860

3.8. Implementation Schedule

The project Implantation Schedule will start in February 24, 2014 and accomplish by October 29, 2015, the detailed activities shown in bar chart in **Figure 6.**

The construction of the project will start early 2015; while the period in between February 2014 to December 2014 will entail preparation and mobilization including the following tasks:

1. Environment Impact Assessment Study.
2. Detailed Design
3. Material Selection

10 MW Implementation Schedule

COD 29/10/2015

ID	Task Name	Duration	Start	Finish
1	PPA sign date	1 day	31/03/14	31/03/14
2	Grid Impact study	60 days	13/04/14	3/07/14
3	Environmental Impact Analysis	75 days	24/02/14	6/06/14
4	Financial Close	1 day	29/09/14	29/09/14
5	Detailed Design & Finalization	60 days	1/09/14	21/11/14
6	Material selections and orders	45 days	19/10/14	18/12/14
7	Mobilization	14 days	4/01/15	21/01/15
8	Site leveling	21 days	14/01/15	11/02/15
9	Drainage work	21 days	1/02/15	27/02/15
10	Fencing and gate	21 days	21/02/15	20/03/15
11	Access Road	14 days	8/03/15	25/03/15
12	Foundation works	30 days	25/03/15	5/05/15
13	Trenching work	30 days	29/03/15	7/05/15
14	Materials on site	1 day	1/04/15	1/04/15
15	Mounting System	35 days	5/04/15	21/05/15
16	Inverter/transformer stations	14 days	17/05/15	3/06/15
17	LV Cabin	30 days	3/05/15	11/06/15
18	MV Cabling	30 days	17/05/15	25/06/15
19	Module Installation	30 days	12/04/15	21/05/15
20	Meteorological Station	14 days	1/06/15	18/06/15
21	Surveillance System	21 days	17/05/15	12/06/15
22	Mechanical Completion	1 day	5/07/15	5/07/15
23	Mechanichal Competion Test	14 days	12/07/15	29/07/15
24	Interconnection Facilty	28 days	22/06/15	29/07/15
25	Ma'an Substation Completion	1 day	29/09/15	29/09/15
26	Interconnection	14 days	27/09/15	14/10/15
27	Commissioning Test	14 days	12/10/15	29/10/15
28	PV Facilty Performance Test	14 days	12/10/15	29/10/15
29	COD	1 day	29/10/15	29/10/15

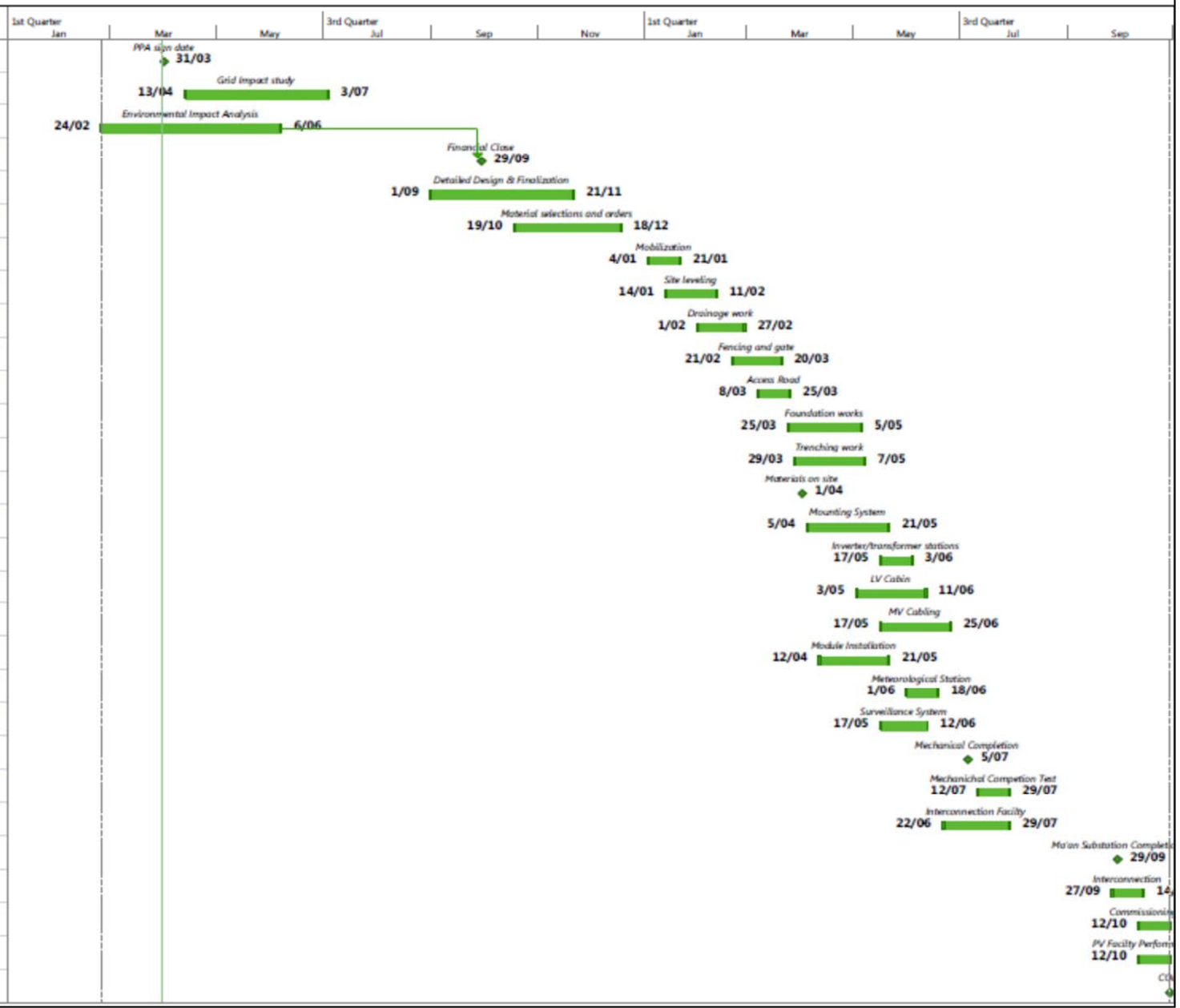


Figure 6: Implementation Schedule

4. LEGISLATIVE FRAMEWORK

The importance of this section is to outline main institutions that are related to environmental issues, in addition to laws, regulations, etc.., relevant to the natural environment of the Jordan and describes relevant international conventions and treaties signed and ratified by Jordan and incorporated into the national law.

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 ESIA
- **Category 2:** Projects that require PEA
- **Category 3:** Projects that don't require an ESIA

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.

Al Ward Al Jory for Energy Generation, the Proponent, is responsible for submitting the ESIA study to MoEnv. upon an agreement with AJ (the ESIA Consultant) who will be conducting an ESIA Study for the project in compliance with all Jordanian legislation mentioned in the following sections.

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 ESIA Regulation no (37) / Year 2005, this project is classified as Category (1), i.e. it needs a full ESIA. In accordance with Article (9), the Project Owner, i.e. Al Ward Al Jory for energy generation submits a preliminary draft of the Terms of Reference (ToR) for the ESIA Study, which has been submitted on April 14th 2014, MoEnv, The project owner and AJ will then agree on a scoping session date in which all relevant stakeholders and concerned parties such as governmental directorates, ministries, Non-Governmental Organizations, relevant associations and institutions and so on will be invited by MoEnv.

The Scoping Session was held on May 8th, 2014 at the Crown Plaza Hotel in Amman, Jordan and the Final ToR was submitted on May 15th, 2014 and approved by the Ministry of Environment on June 9th,2014. Subsequently, the ESIA study was prepared and submitted to MoEnv and reviewed by the technical committee, and was approved on August 17th 2014.

4.2. Other Relevant Ministries

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 neighbouring countries, and attracting international capital for investment in this field, especially the generation of electric power, the generation 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.

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.

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).

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

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 Al Ward Al Jory'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.

Ministry of Municipalities

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.

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.

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.

Jordan Institute for Standards and Meteorology (JISM)

JISM 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 JISM are:

1. Adoption of a national system for standardization and metrology based on accepted international practices.
2. Keeping pace with scientific and technical developments in the fields of standards, metrology, conformity assessment and laboratory accreditation.
3. 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.

4. 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.

Department of Antiquities (DoA)

DoAwas 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.

Electrical Regulatory Commission (ERC)

ERC was established based on the Council of Ministers decision issued in 2001. ERC aims mainly to ensure applying the rights of consumers and to resolve any complaint that may occur between the consumer and Electricity companies and encourage investment in this sector in addition to improving the operational efficiency and sale of electric power at reasonable prices.

ERC also works to ensure the provision of safe, secure, reliable and high quality services in all electric sector fields and to ensure the compliance of the activities in the sector with applicable environment protection standards and general public safety conditions enforced in Jordan.

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.

Ministry of Labour (MoL)

MoL has undertaken the responsibility of accomplishing the general objectives of labour and labourers affairs and issues in Jordan. To keep pace with social and economic development, the Labour 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 labour sector, as well as updating labour legislation so as to meet the needs of the labour 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 labour in the Jordanian Labour Market.
- Maintain available job opportunities to employ Jordanian Labour.
- Building up labour 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.

Development Zones Law;

Transforming the Development Zones vision into a reality, the regulatory framework; manifested in the Development Zones Law No. (2), was passed by the Parliament in early 2008, introducing a legal foundation that facilitates the creation of economic growth within certain zones, and ensures a business-friendly and investment attracting environment.

The law strongly enables and empowers the private sector to lead in the development and management, delegates full power to the Development Zones Commission provides streamlined quality of service and governance, defines a clear land ownership policy, removes all restrictions on foreign capital and offers a comprehensive customs and tax Incentives coupled with transparent implementation practices.

4.3. Principal National Legislation

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
- Labour Law (No. 8, 1996) and its amendments
- Civil Defence Law (No. 18, 1999)
- 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)

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.
- Groundwater Control Regulation (No. 85, 2002), Issued pursuant to Articles 6 and 32 of Water Authority Law No. 18 for the year 1988.
- 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)

Instructions

- Instructions for the Limitation and Control of Noise for the year 2003.
- 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.

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 reclaimed domestic wastewater (No. 893/2006)
- 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):

1. International Plant Protection Convention (24/4/1970);
2. Convention Concerning the Protection of the World Cultural and Natural Heritage (17/12/1975);
3. Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) (14/3/1979);
4. Amendment to the Convention of International Trade in Endangered Species of Wild Fauna and Flora (art. XI) (13/4/1987);
5. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (5/5/1992);
6. Convention on Biological Diversity (10/2/1994);
7. Framework Convention on Climate Change (21/3/1994);
8. International Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (26/12/1996).

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:

9. Ambient Air Quality.

10. Ambient noise

11. Waste Management

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 9**.

Table 9: Ambient Air Quality Standards

Air Pollutant	JS No. 1140/2006			WHO Guidelines ($\mu g/m^3$)
	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
	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 $\mu g/m^3$	3 times within a given month in one year	--
	1 Year	75 $\mu g/m^3$	--	--
PM_{10}	24 Hour	120 $\mu g/m^3$	3 times within a	150 (IT 1)

Air Pollutant	JS No. 1140/2006			WHO Guidelines ($\mu g/m^3$)
	Average Time	Maximum Allowable Concentration in the Ambient Air	Number of Allowed Exceedences	
			given month in one year	
	1 Year	70 $\mu g/m^3$	--	70 (IT 1)
$PM_{2.5}$	24 Hour	65 $\mu g/m^3$	3 times within a given month in one year	75 (IT 1)
	1 Year	15 $\mu g/m^3$	--	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	--

12. IT: Interim Target of the WHO.

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 equipments (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 10.**

Table 10: Maximum Allowable Noise Limits

Area	Allowable Limits for Noise Levels (dBA)

	Day	Night
Residential areas within the City	60	50
Commercial areas	65	55
Industrial areas (Heavy Industry)	75	65

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.

Waste Management

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.

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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 Occupational Health & Safety (OHS) 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 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 DoS, Jordan Meteorological Department (JMD), MEMR and MWI.

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 ,
- Geology of the Area, and
- Meteorological Data.

5.2. Physical Environment

5.2.1. Topography and Geology

Topography

The project is located as mentioned previously in MDA, the MDA lies around Ma'an City, which is located in a fairly flat area of Jordan, although mountainous terrain is visible and contributes to the local drainage regime. A Shallow wadi intersects the southernmost section of the Industrial park (MDA, Rapid Environmental Assessment, 2010)

Figure 7:The landscape of the MDA and the projecr area

The wadies crossing the MDA area, as shown in the below **Figure 8**more details about the wadies and catchment area is explain in impact Section

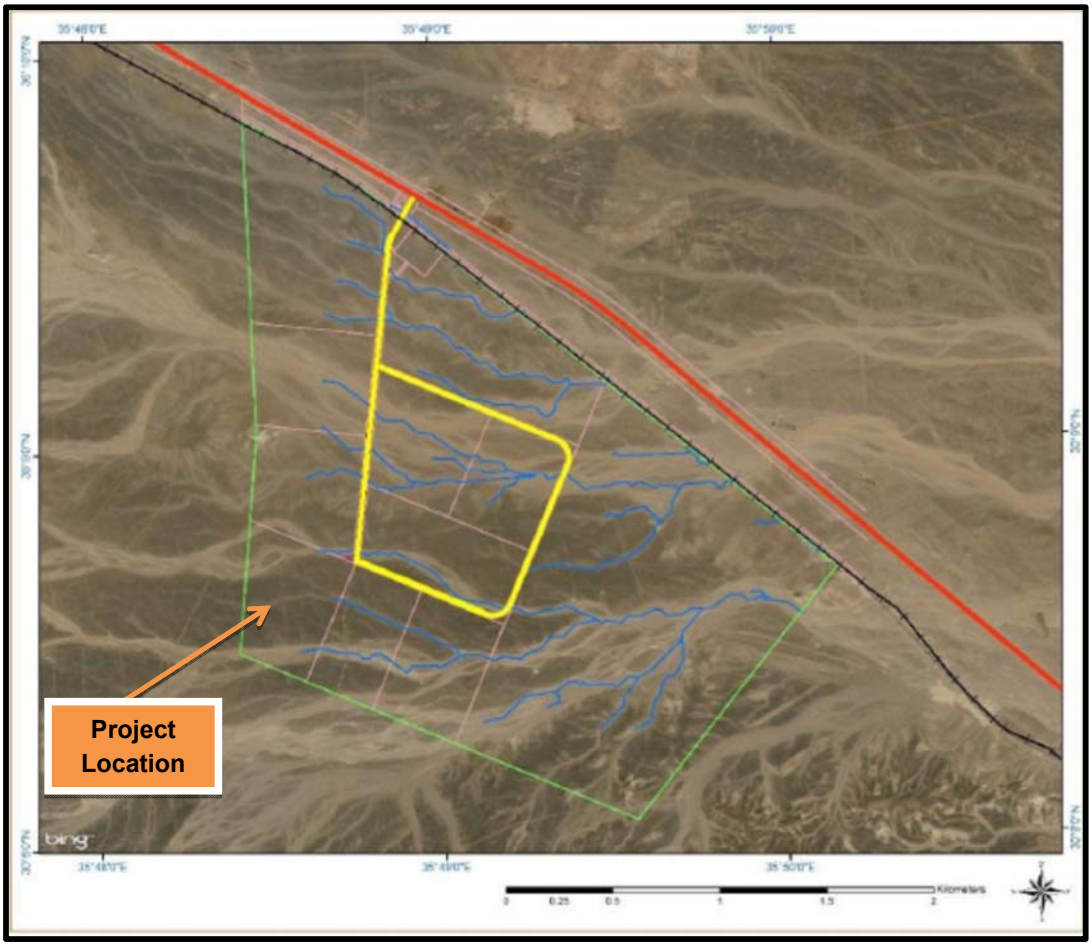


Figure 8:Satelite image for the project location

The Ma`an city elevation is generally between 1005 – 1025 meter above sea level, the **Figure 9**displays range of elevation with different colours.

The elevation map of Ma`an, Jordan is generated using elevation data from NASA's 90m resolution SRTM data. The map also provides idea of topography and contour of Ma`an. Ma`anElevation Map is displayed at different zoom levels (http://www.floodmap.net/Elevation/ElevationMap).

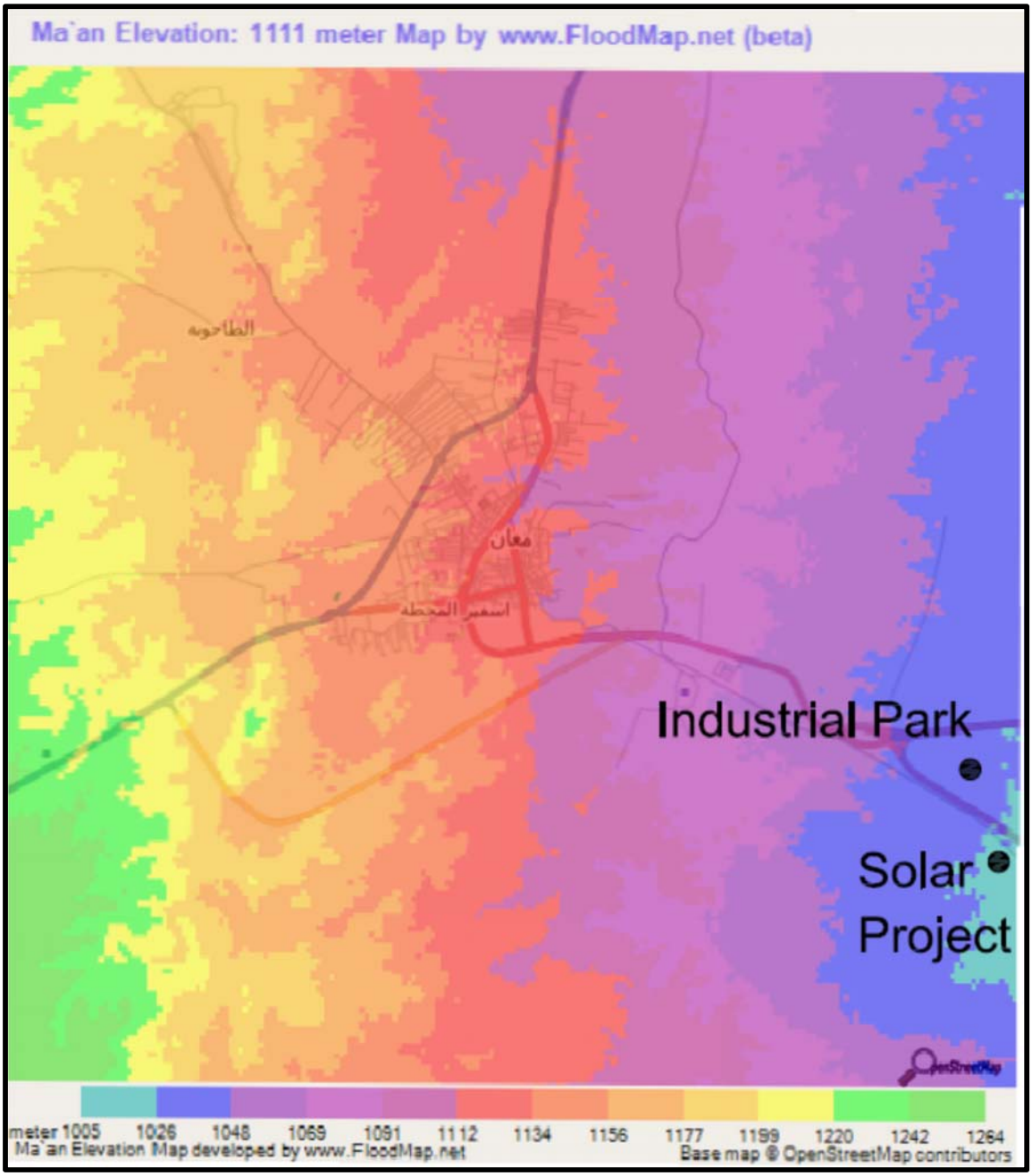


Figure 9:Land scape of the residentional community of MDA and the project area

Soil

The project is located in the periphery of the Jafr basin that lies at about 1000 m a.s.l in the north, east and south, reaches 1430 m a.s.l in the southeast near Jebel el Batra.. The main soil types include typiccalciorthids and camborthids on colluvial and alluvial fans associated with cambicgypsiorthids. Torriorthents are also found in the steeply sloping, stony colluvium of the highly dissected margins of the basin.

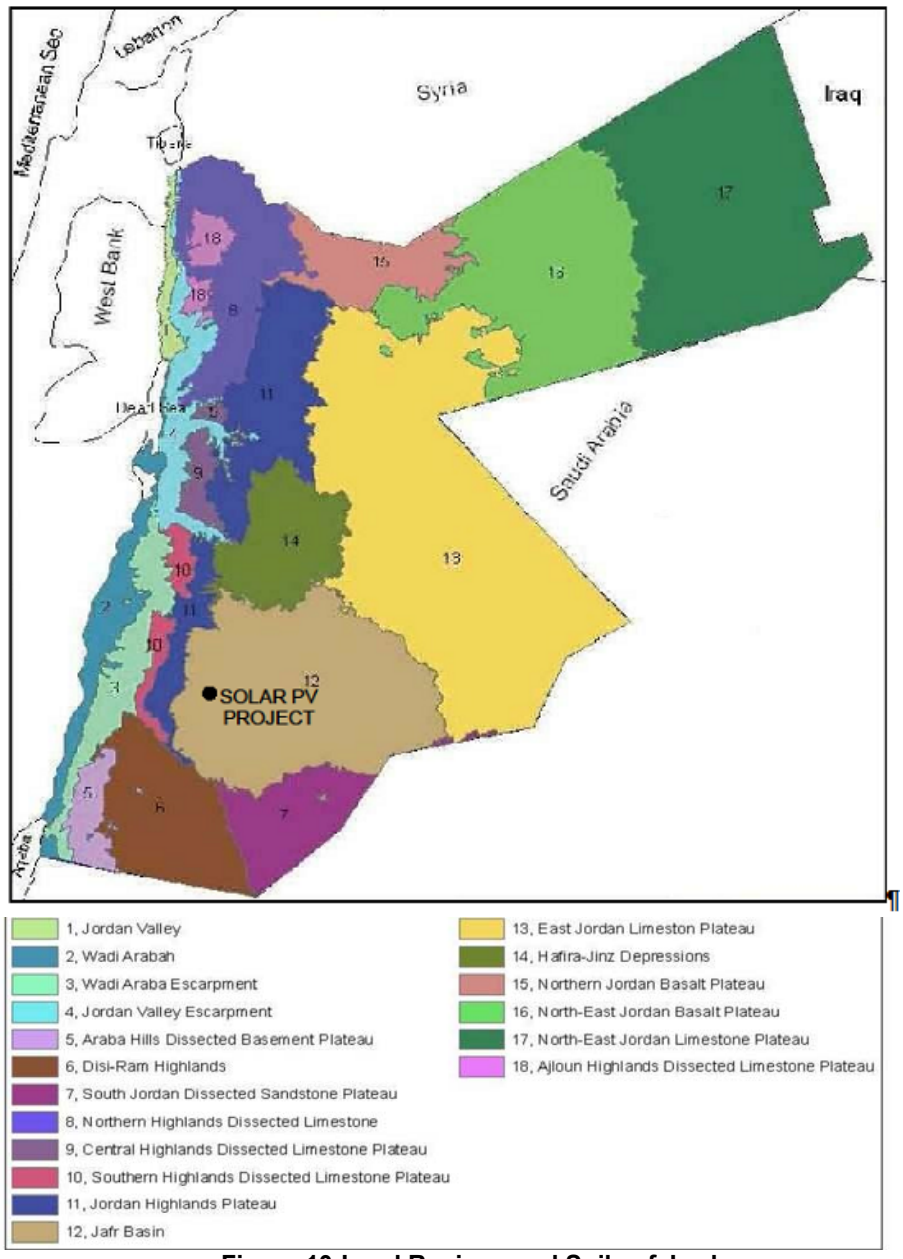


Figure 10:Land Regions and Soils of Jordan

The MDA conductedageotechnicalinvestigation(November, 2013) for the all area as a requirement of the development, the test pits are spread over the area with total number five test pits as the following**Figure 11**, the closest test pits to the project Location plot B4 is TP3.

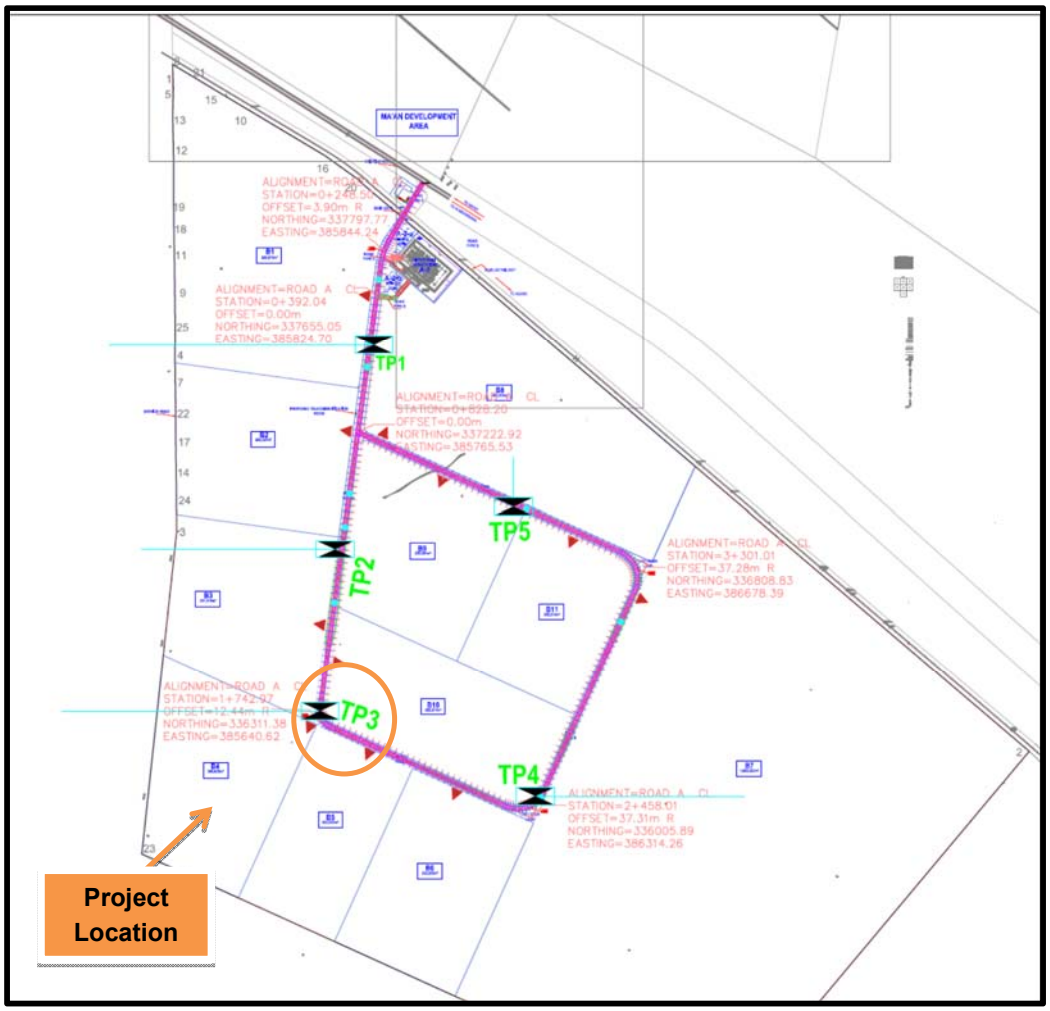
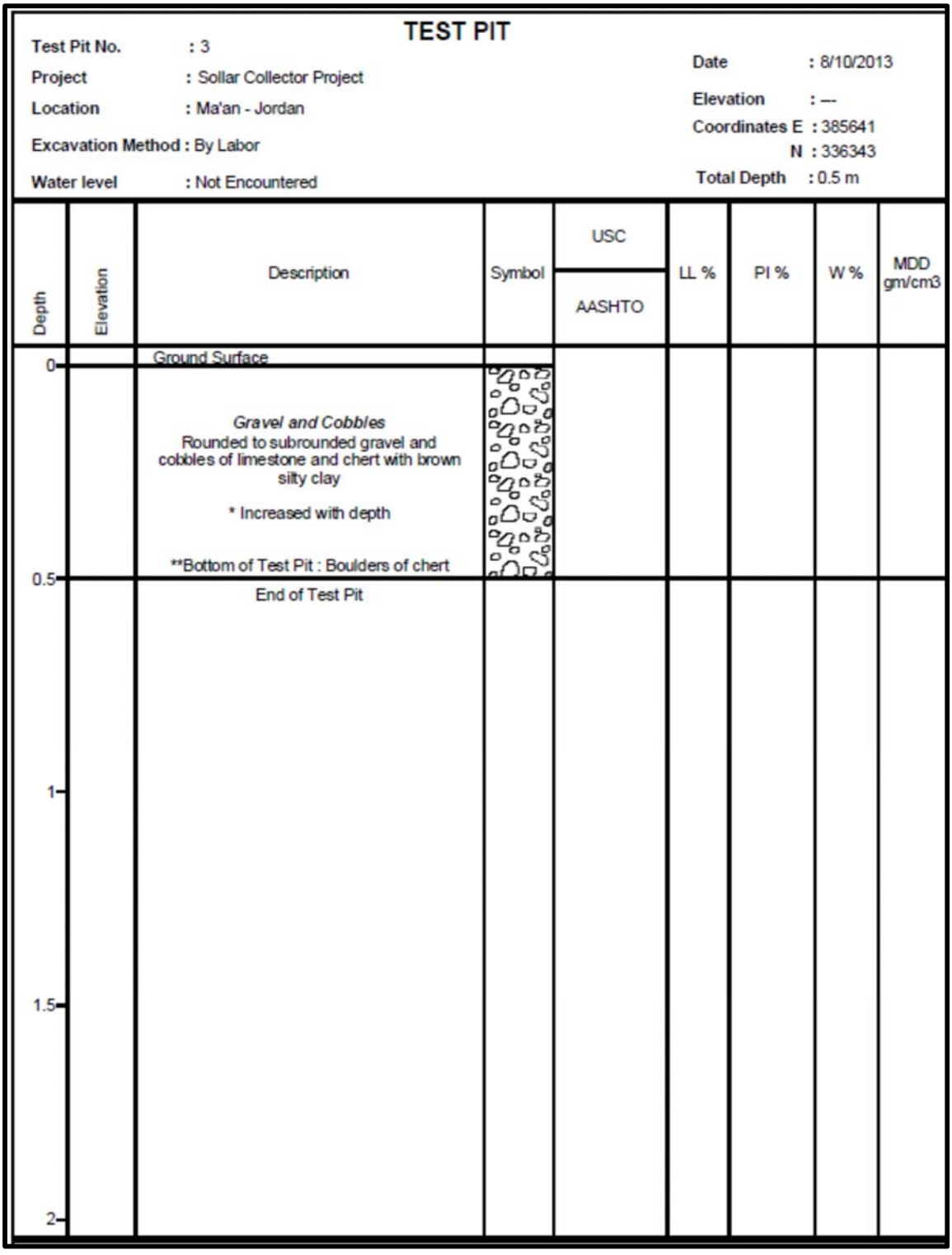


Figure 11 :Test Pits location within MDA .

The test pit TP3 locates south to the project plot with depth about 0.5 meters (detailed in **Figure 12**), the pit excavation was carried by manual techniquessupervised by geotechnical engineers in accordance with local codes, ASTM 2488and BS 5930.

The engineering analysis for the geotechnical investigation classified the soil as gravel and cobbles of limestone and with brown slity clay, the following figure describe the test pit.

Furthermore, the soil and rock materials encountered at the site are suitable to be used for different backfilling purposes except sandy silty clay material. However, testing must be carried out after excavation in order to check if these materials are confirming with the MPWH specifications. However the excavated materials may need crushing of the over sizecobbles and screening to comply with Ministry of Public Works and Housing (MPWH) specification.



TEST PIT

Test Pit No. : 3
Project : Sollar Collector Project
Location : Ma'an - Jordan
Excavation Method : By Labor
Water level : Not Encountered

Date : 8/10/2013
Elevation : ---
Coordinates E : 385641
N : 336343
Total Depth : 0.5 m

Depth	Elevation	Description	Symbol	USC / AASHTO	LL %	PI %	W %	MDD gm/cm3
0		Ground Surface						
		Gravel and Cobbles Rounded to subrounded gravel and cobbles of limestone and chert with brown silty clay * Increased with depth **Bottom of Test Pit : Boulders of chert						
0.5		End of Test Pit						
1								
1.5								
2								

Figure 12 : TB3-Soil test pit within the project area.

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 WadiArabah. Magnificent outcrops of the Palaeozoic sandstone in southern Jordan are present along the eastern shoulder of WadiArabah until the north-east tip of the Dead Sea.

The geologic map presented in **Figure 12**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 15 explaining the rock units, their age, lithology and water bearing properties.

According to**Figure 13 and Figure 14,** the project site belongs to the Balqa group within the B4 and B3 formations (Umm Rijam and Muwaqqar formations), which fall within the palaeocene and upper cretaceous systems. In terms of sedimentary rocks these formations consist of chalk, chert, limestone and marl, the B3 formation is sometimes bituminious. 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 the geologic structure. Flowing wells are common in areas of low elevation (U.S Geological Survey, 1998).

Meanwhile, thegeotechnical investigation classified the project area geological formation as a part of the Alluivium formation and Muwaqqar formation, the description of these formations is below:

1. Alluvium Formation: Alluvium deposits which belong to quaternary period is frequently encountered within wadies on lower angle hillsides, in the vicinity of wadies and in low land areas, where drainage is restricted. It is fine to coarse grained soil resulting from controlled deposition of materials in a hydraulic environment.

2. Muwaqqar Formation (B3): The site and surrounding areas are corresponding to Mowaqqar Formation (B3) the upper Cretaceous period. It consists of chalk, marly chalk and marl materials.

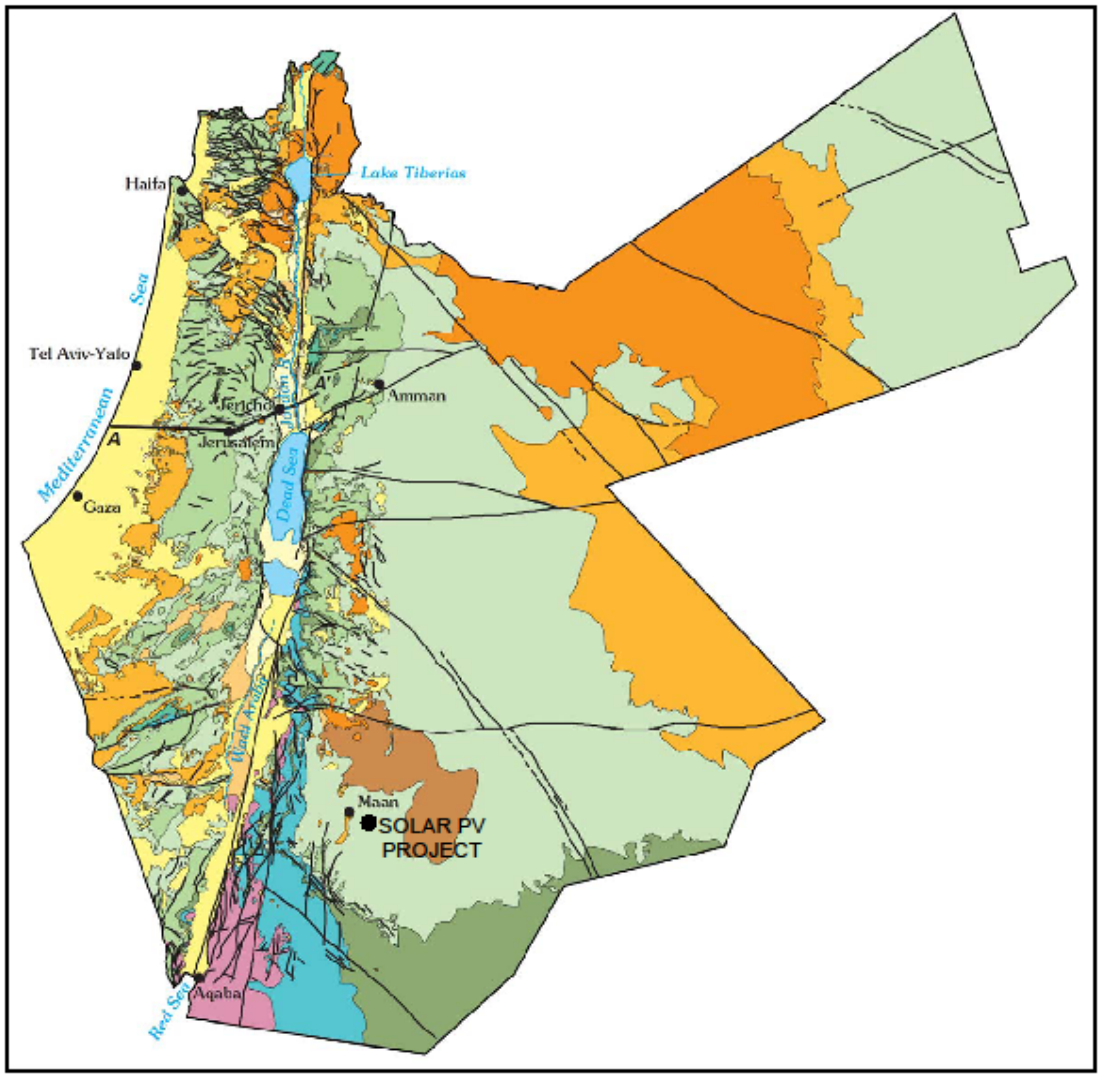


Figure 13: The Geology of Jordan

System/ Series		Stage	West of Jordan River and Wadi Araba Group	West of Jordan River and Wadi Araba Unit	East of Jordan River and Wadi Araba Group	East of Jordan River and Wadi Araba Unit	This report	SEDIMENTARY ROCKS Unit description
Quaternary	Holocene		Kurkar	Qa	Jordan Valley	Alluvium 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				
				Qs				
				Tp		Absent		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	Kumub	Kk	Kumub	K		Sandstone, dolomite, marl, sand, shale, clay, sandy lime-stone. Upper part mostly consists of shale and carbonates forming aquiclude; lower part mostly consists of water-bear-ing 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		
				Pn				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.
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 hydraul-ically 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 14: Generalized Geologic Units and Water-Bearing Properties.

5.2.2. 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 khamasin period April-May).

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 (MoE, Environmental Profile of Jordan, 2006).

According to JMD, historical data collected suggests a decreasing trend for annual precipitation, which in turn is expected to impact related ecosystems and available water resources.

A map showing the bioclimatic zones of Jordan is presented in**Figure 16**.TheFigure indicates that the project area belongs to the Arid Mediterranean cool Zone.

Moreover, Two weather stations are located within Ma'an governorate, The first weather station is located at Ma'an city with about 5.6 Km to the Project location as shown in Figure 8 below; below details clarify the location for the Ma'an Weather Station:

Elevation	**1069 m**
Latitude	**30°10'0.00"**
Longitude	**35°45'0.00"**

However, the second weather station is located within the Industrial park, the station measure the solar radiation, temperature, wind speed and wind direction,and humidity.

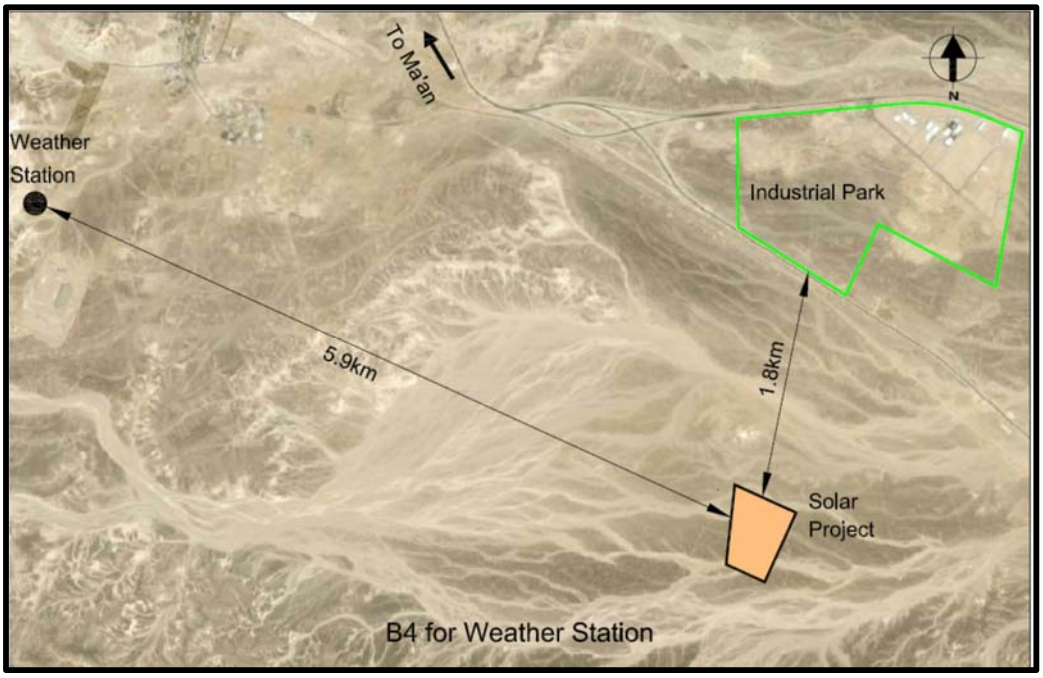


Figure 15:Location of the Weather Station in Relative to the Project Area

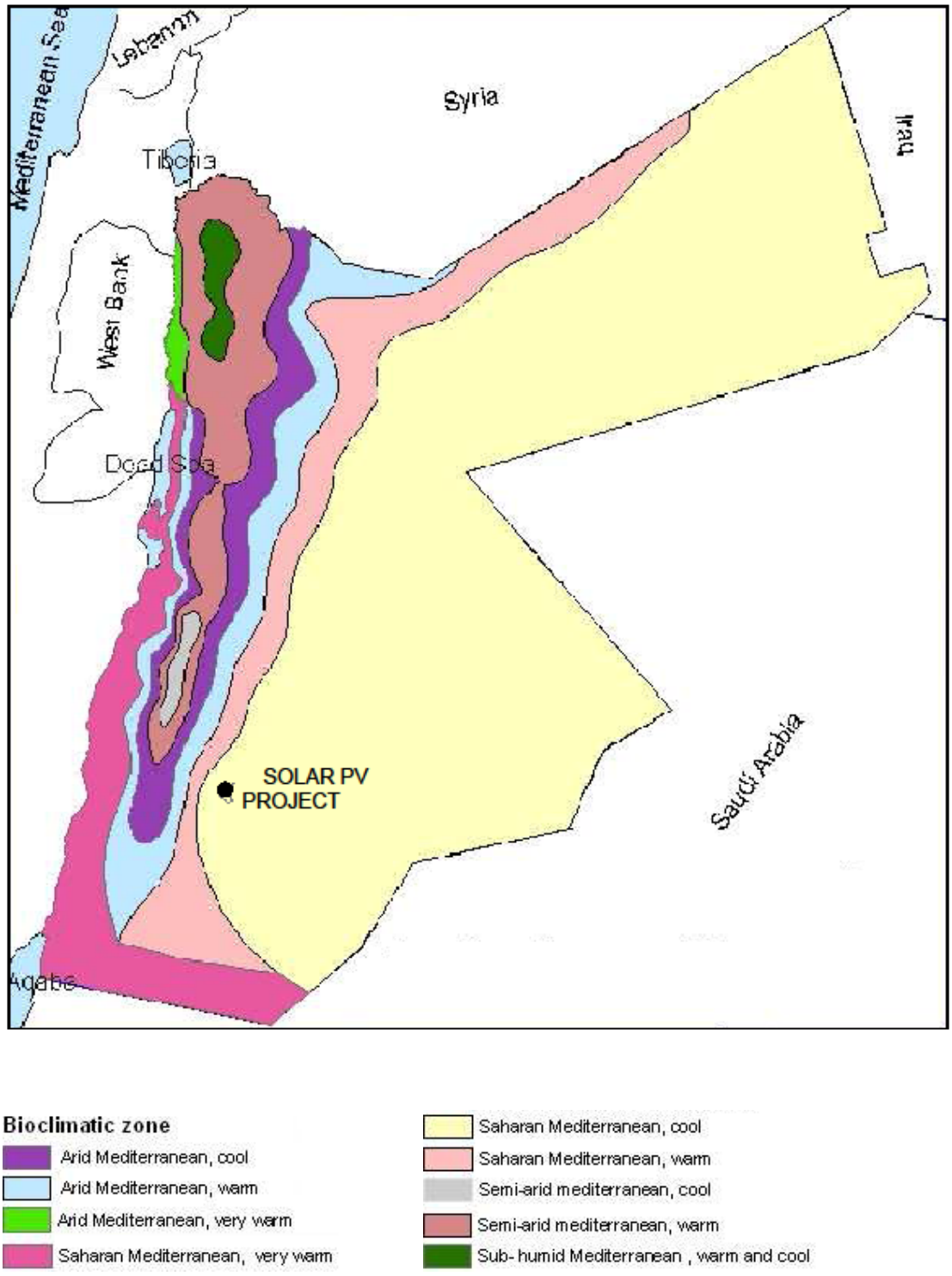


Figure 16: Bioclimatic Zones of Jordan

The initial meteorological characteristics from Ma'anweather station have been obtained based on the data averages for the last seven years year (2004- 2013) recorded in the weather station. The raw data provided by JMD and DOS. **Table 11:Main Meteorological Parameters for Weather Stations**below summarizes the average annual temperature, rainfall, and wind speed readings, over the period of year (2004-2013) as registered in Ma'an weather station.

Table 11:Main Meteorological Parameters for Weather Stations

Parameter	Ma'an Weather Station
Ave. Max Temp (ºC)	25.50
Ave. Min Temp (ºC)	10.75
Ave. Mean Temp (ºC)	18.13
Ave. Annual Rainfall Amount (mm)	30.09
Ave. Mean Humidity (%)	45.14
Ave. Mean Wind speed (Knot)	5.46

All parameters mentioned above are calculated based on data for ten years period (2004 - 2013); the following Figures represent part of monthly averages records.

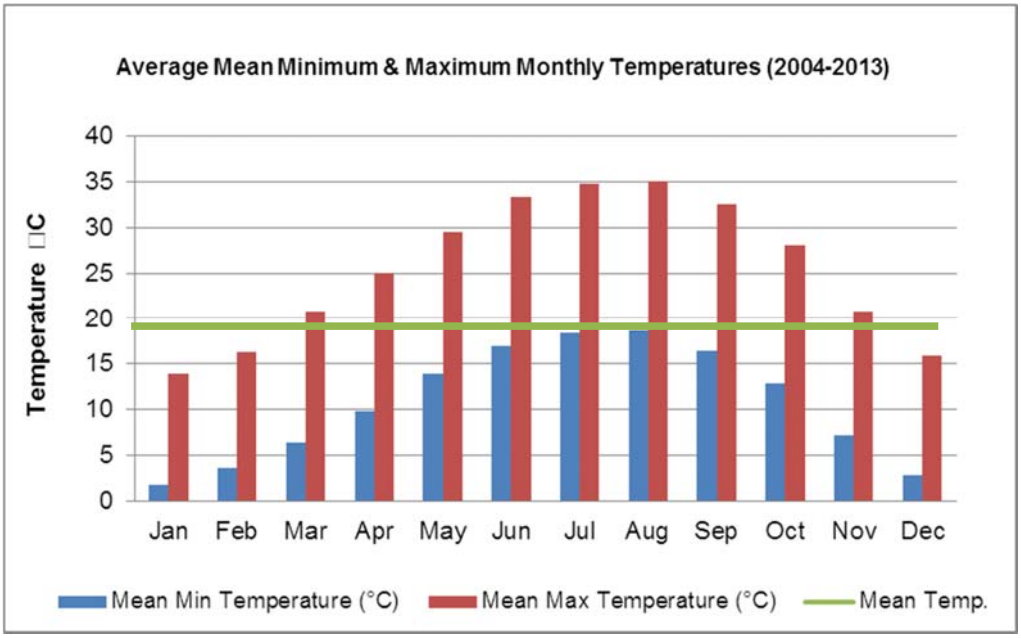


Figure 17: The Average Mean Minimum and Maximum Monthly Temperature for the Period (2004-2013)

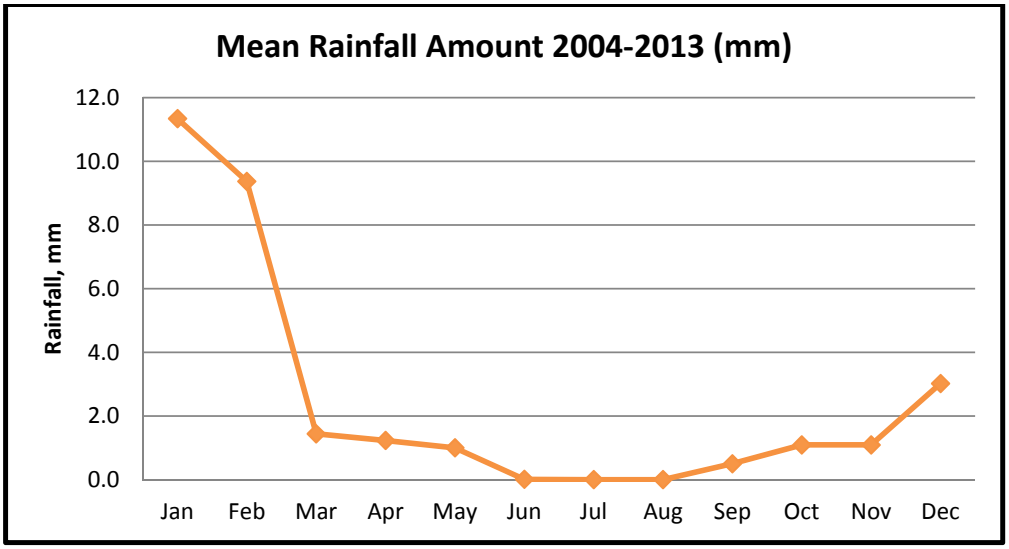


Figure 18:The Mean Rainfall Amount for the Period (2004-2013)

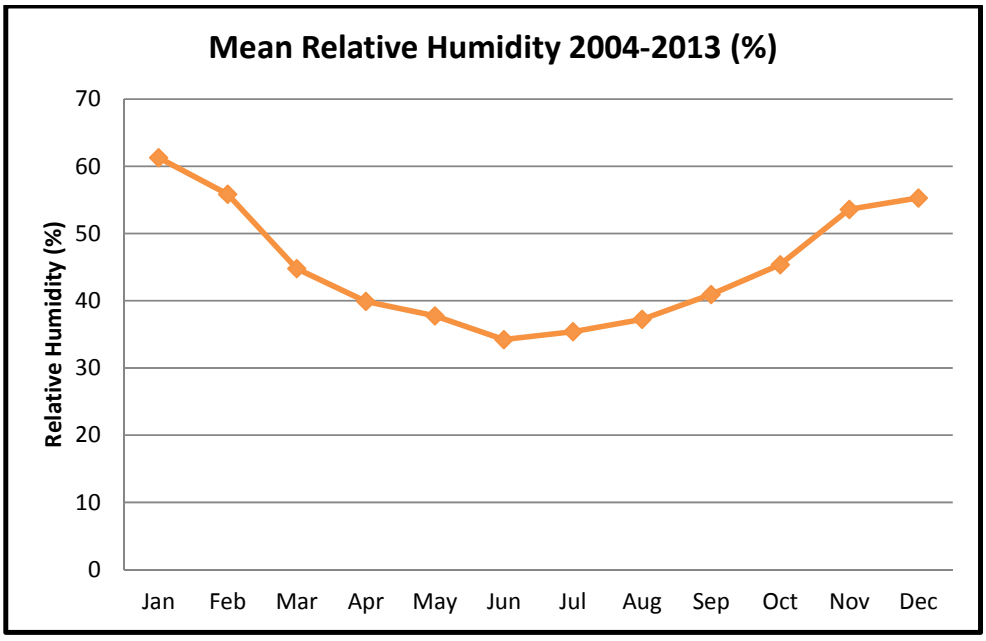


Figure 19:The Mean Relative Humidity for the years 2004-2013

The yearly average wind velocity in Ma'an is 3.31 meter per second. Comparison of the annual average wind velocity in selected locations in Jordan is provided in **Figure 20**(MDA, Rapid Environmental Assessment, 2010).

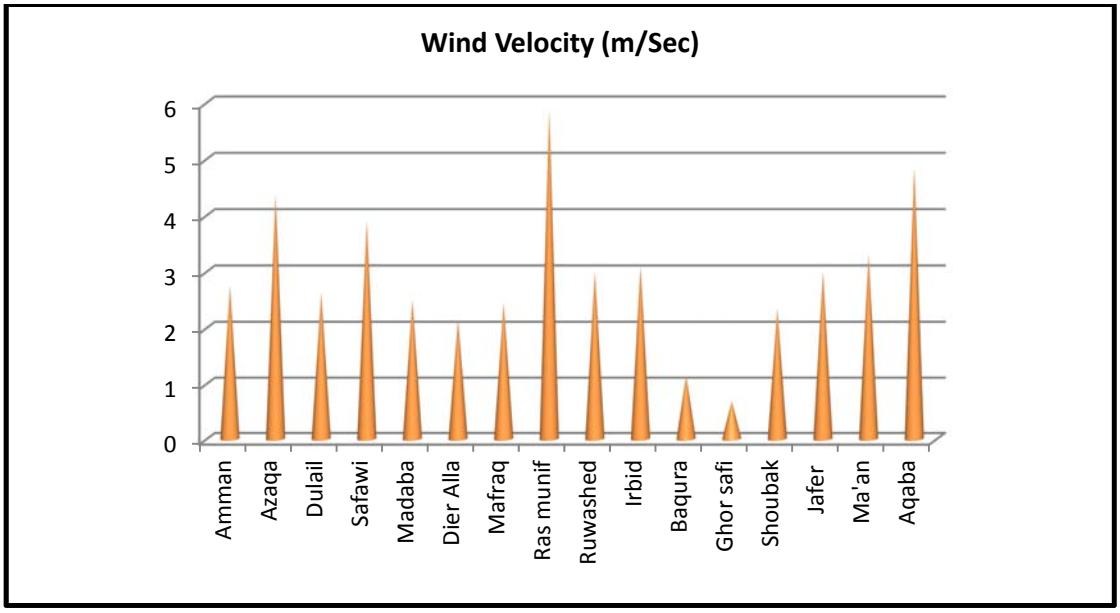


Figure 20: Average Wind Speed in Selected Locations in Jordan

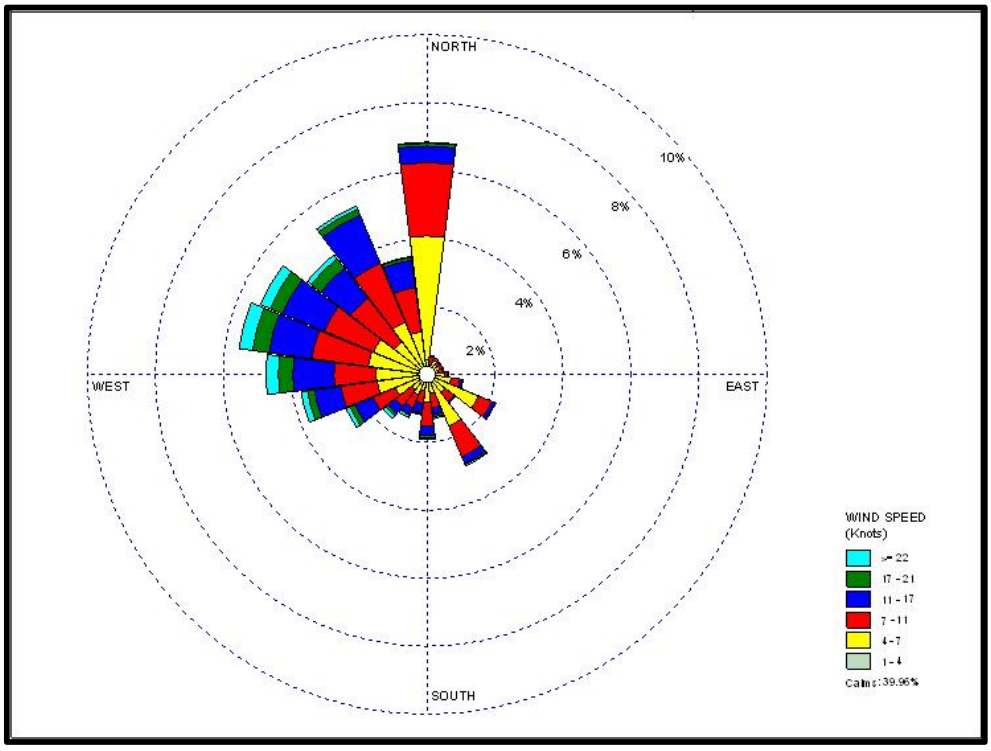


Figure 21:Windspeed and direction in Ma'an weather station for the Year (2004-2010)

The solar irradiance has been obtained by the industrial park weather station, the monthly averages of daily solar irradiance sums from the October 2010 until September 2014 are presented in the following **Figures** where the yearly average of direct solar irradiance daily sum (DN) is 7.40 kWhy/m^2per day:

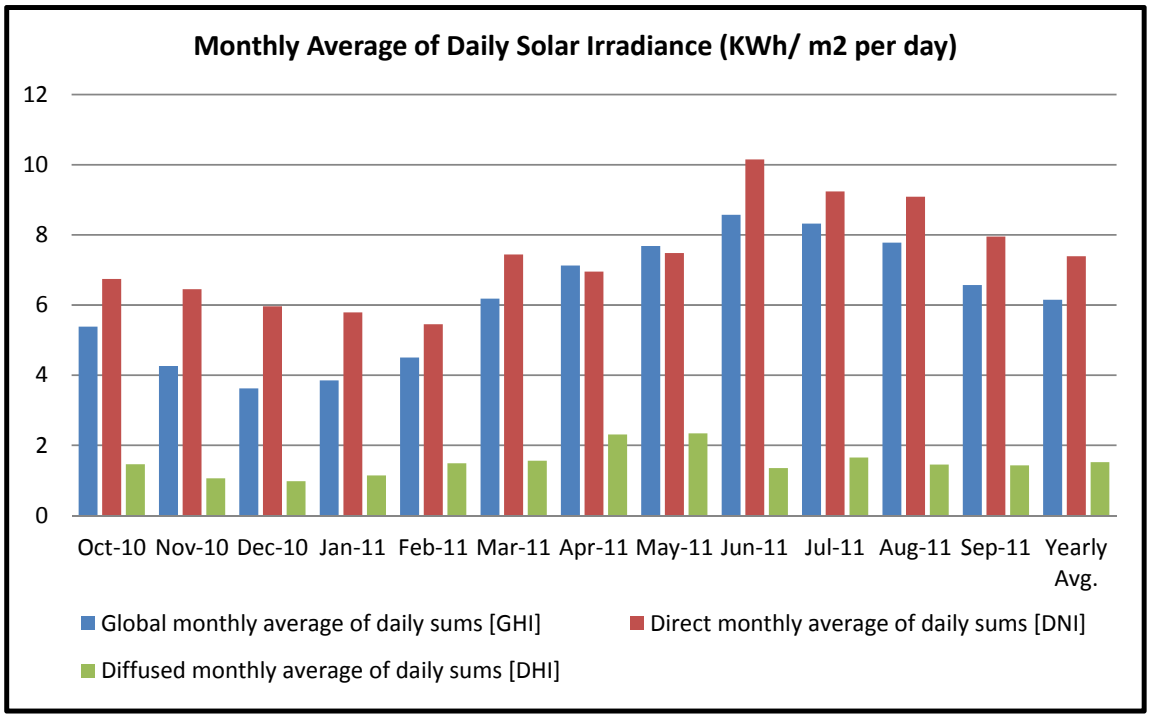


Figure 12:Monthly Average (December)of Daily Solar Irradiance Sums (kWhy/m2 perday)

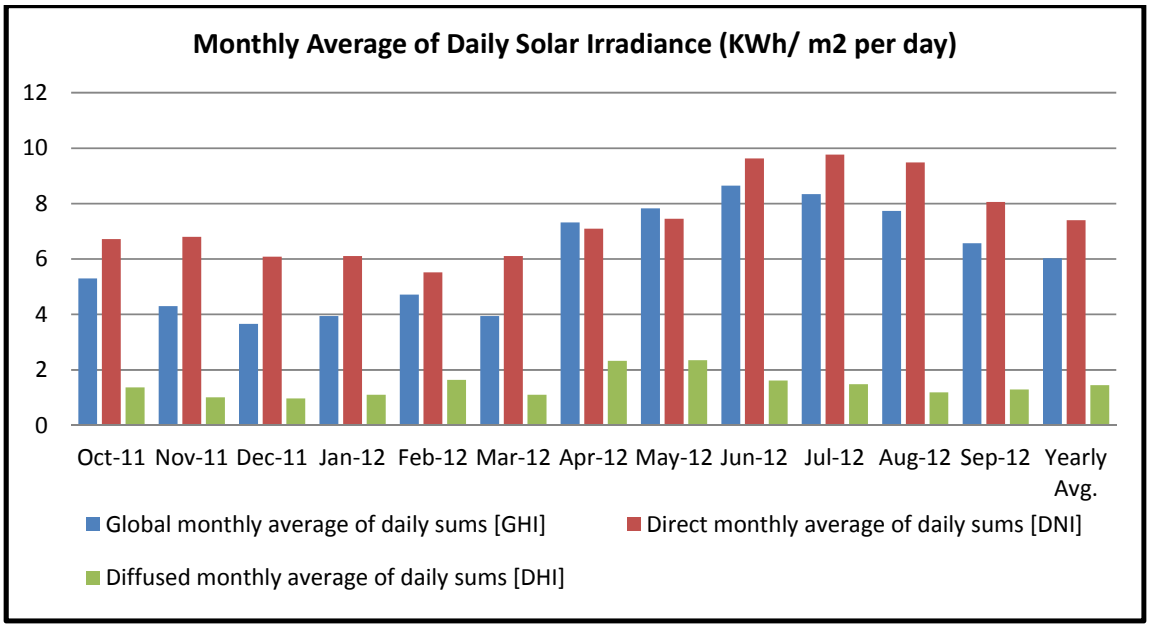


Figure 22:Monthly Average (December)of Daily Solar Irradiance Sums (kWhy/m^2 perday)

5.2.3. 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 vehiclesduring construction phase. Those emissions will be mainly to CO, CO2 and PM10, 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 impacted and increase the concentration of the PM10 and PM2.5 then in order to monitor the PM concentration within the project area

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.

Furthermore, Aqaba International Laboratories - Ben Hayyan has also conducted provided measurements for PM10 and PM2.5parameters during the period between (9/6/2014 - 15/11/2014) -24 hours one week at the project site as shown in the below Figure.

Location : MDA zone Station	
Coordinates 36 R 0771283 **3341281**	**N 30 10. 359** **E 35 49.026**

Figure 23:The location of the Mobile Montoring Station.

Daily average, Hourly average and 15- minutes max average ambient air quality sampling and monitoring were carried in order to present an overview of the ambient quality baseline conditions for the site. The monitoring period extended from (Monday, 00:15), 9/6/2014 to (Sunday, 24:00), 15/6/2014 (one week).

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 standard include specifications for sitting monitors, use of only equipment that has demonstrated the capability, repeatability, and reliability needed to collect accurate data, and operation of the equipment within established methods. A tremendous amount of effort was expended to ensure that the Jordanian standard is followed. All monitoring and sampling equipment were calibrated immediately before use.

Major Findings:

- No exceedances were recorded to the maximum allowable limits for PM10 that specified in Jordanian standards (1140/2006).
- No exceedances were recorded to the maximum allowable limits for PM2.5 that specified in Jordanian standards (1140/2006).

Table 12 :Maximum Averages of the air monitoring parameters.

Pollutant	Max. 15-Min. Average	Max. Hourly Average	Max. Daily Average	JS Allowable Max.	
				Hourly	Daily
PM10, µg/m^3	269.1	208.5	52.9	--	120
PM2.5, µg/m^3	56.5	51.8	23.4	--	65

Figure 24to**Figure 32**show the daily, hourly and 15- minutes average for PM10 and PM2.5 over monitored period (7 days). Detailed tables of all relevant averages of all parameters are shown in **APPENDIX A.**

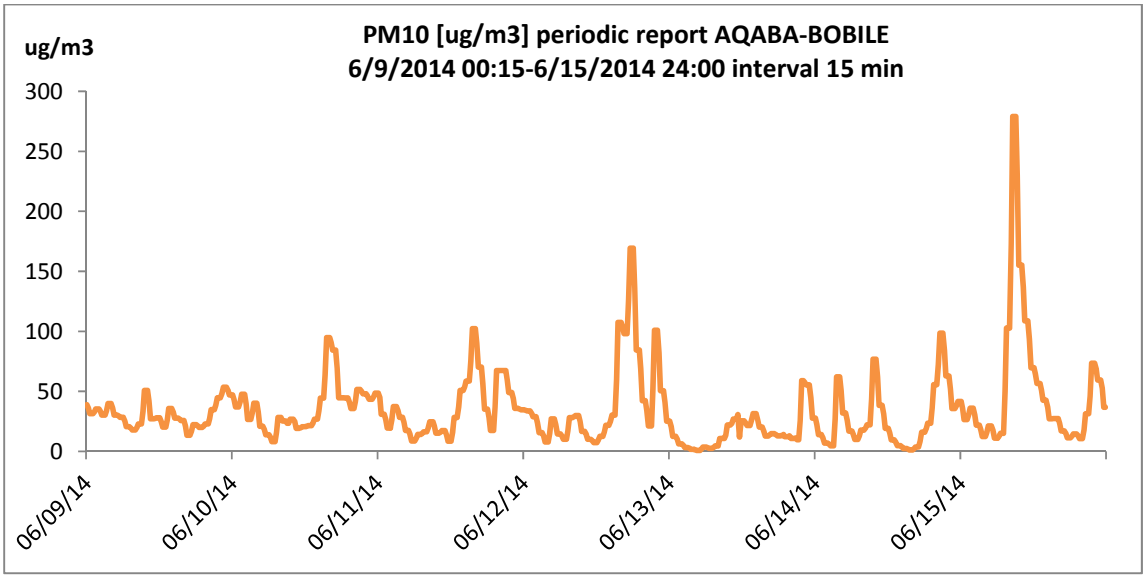


Figure 24:PM10 Concentration- 15 min average at theproject site.

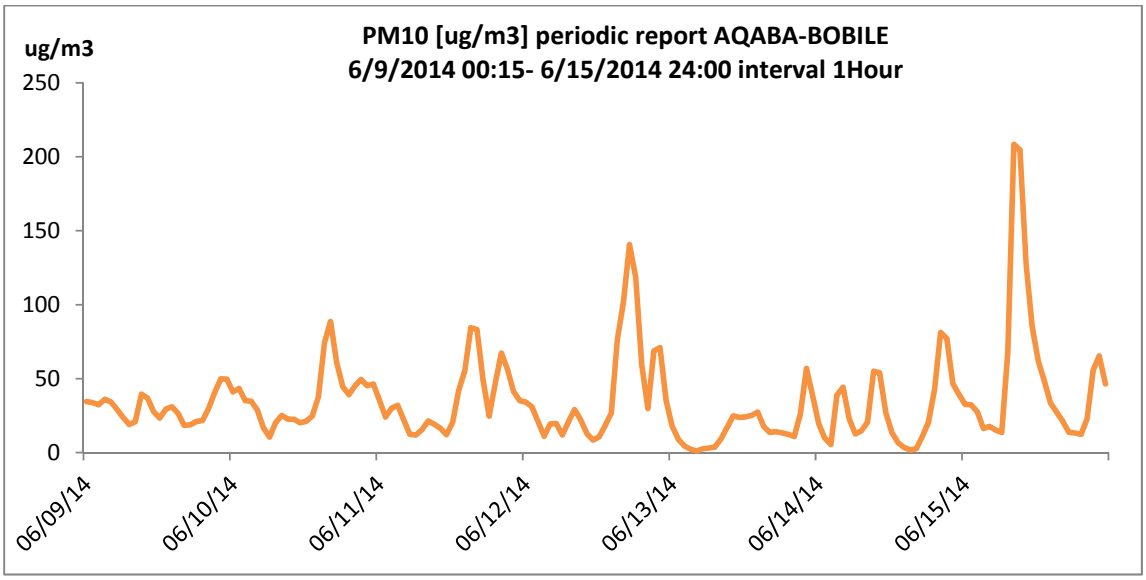


Figure 25:PM10 Concentration- 1 hour at theproject site.

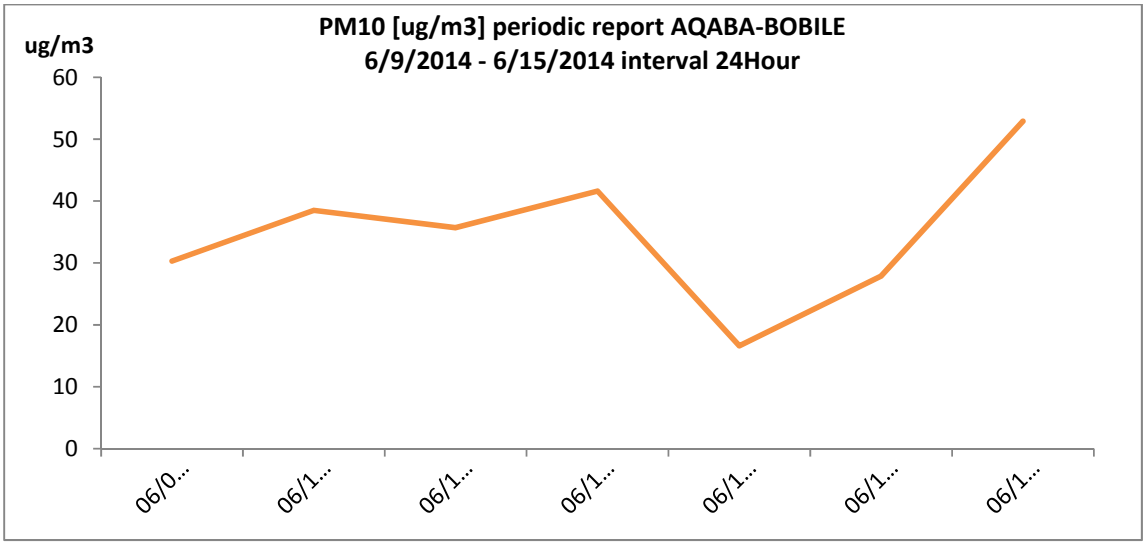


Figure 26:PM10 Concentration- 24 hours at the project site.

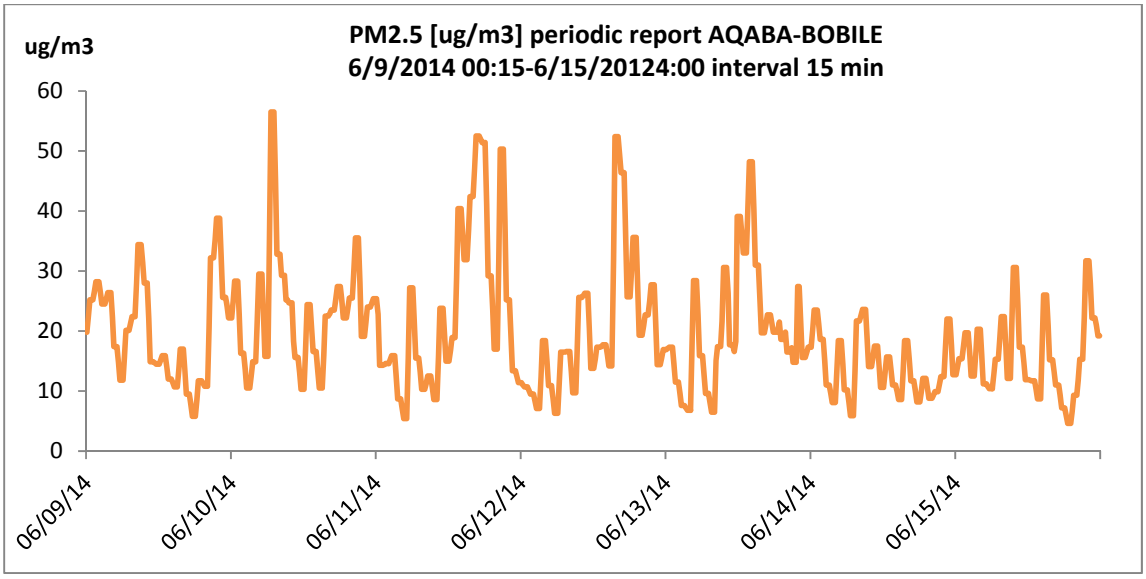


Figure 27:PM 2.5 Concentration- 15 min average at the project site.

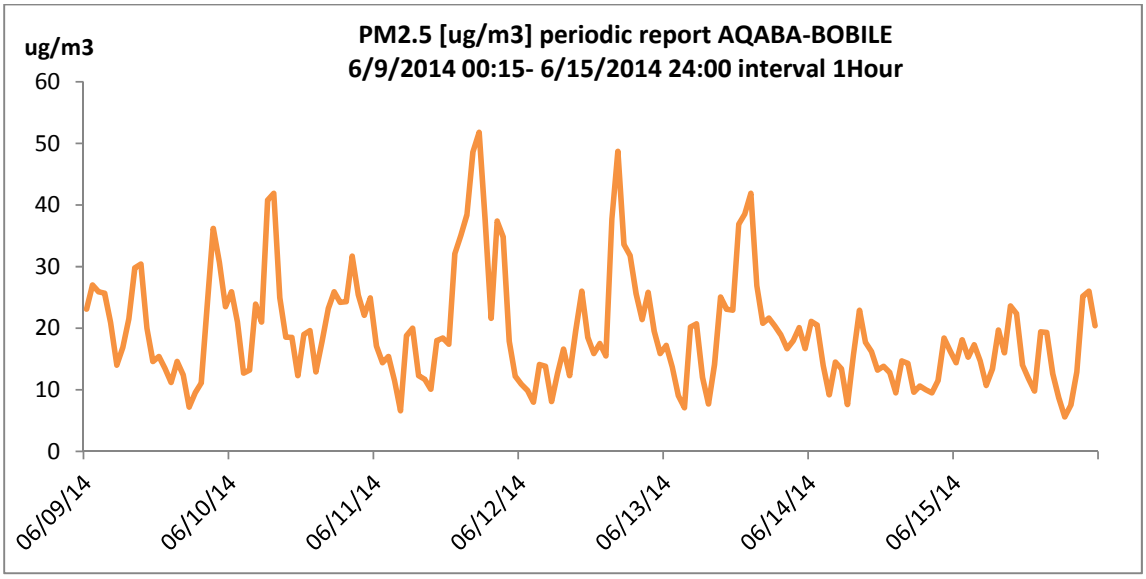


Figure 28:PM 2.5 Concentration- 1 jour at the project site.

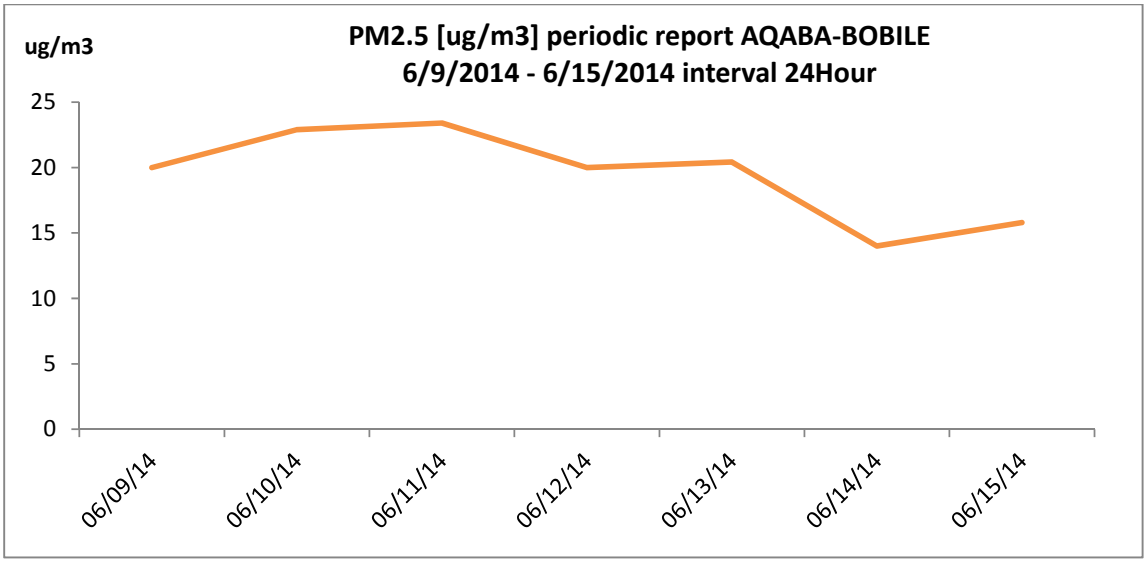


Figure 29:PM 2.5 Concentration- 24 hours at the project site.

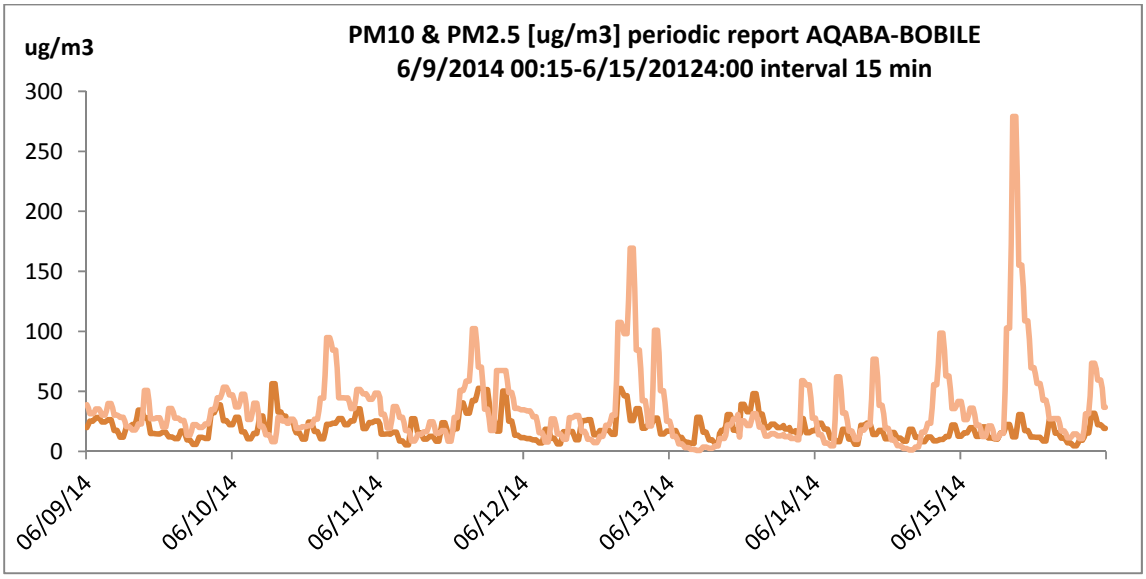


Figure 30:PM 2.5 & Pm 10 Concentration- 15 min Avaerage at the project site.

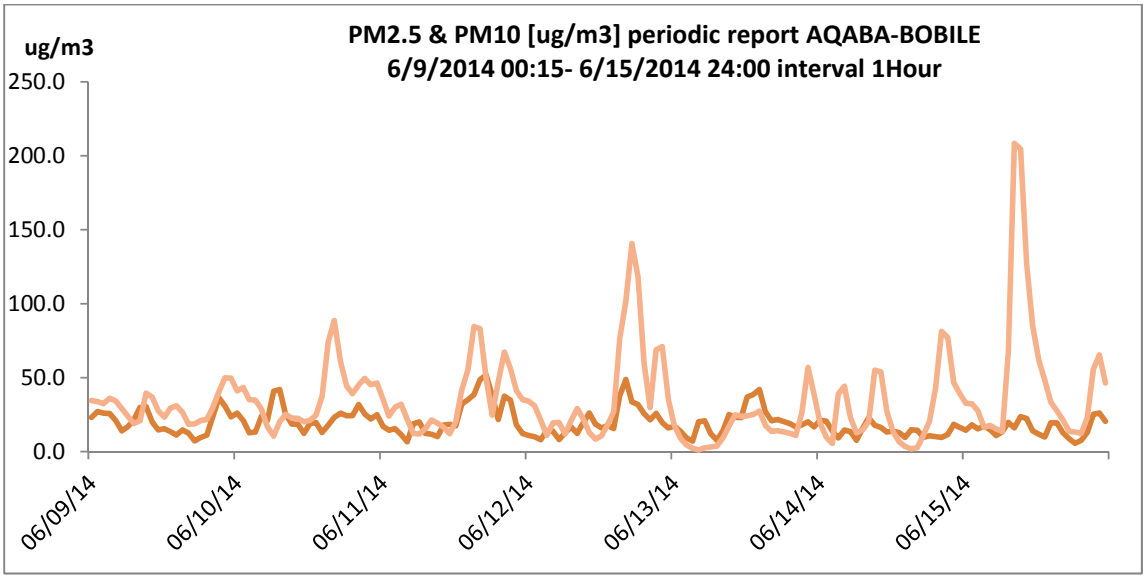


Figure 31:PM 2.5 & Pm 10 Concentration- 1 hour at the project site.

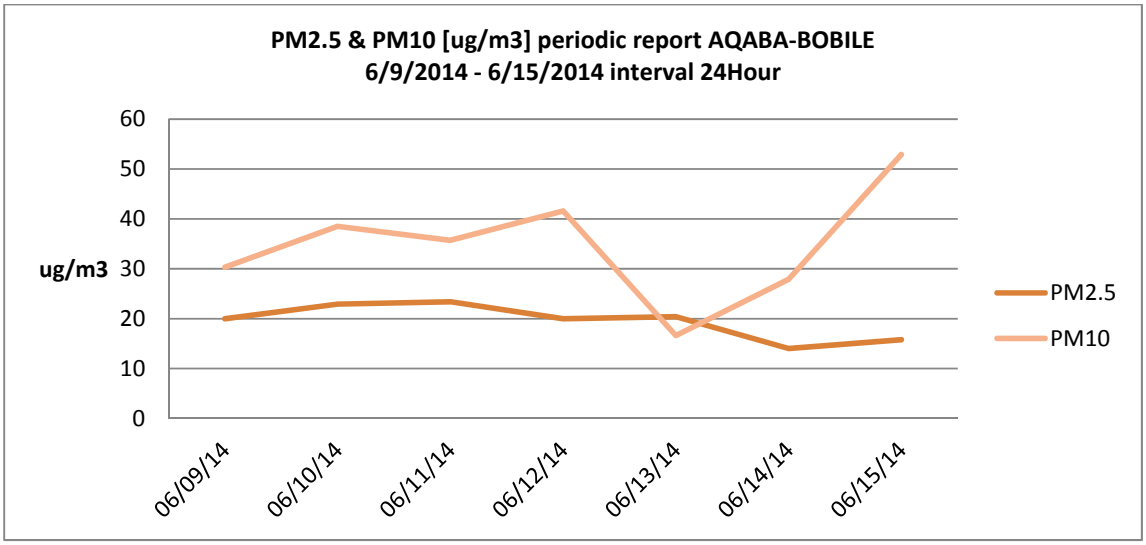


Figure 32:PM 2.5 & Pm 10 Concentration- 24 hours at the project site.

5.2.4. Noise Levels

Spot noise monitoring was carried out at proposed construction location for Solar Power Plant 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 effects of noise pollution on human beings include communication interruption, hearing loss, lack of concentration, and fatigue. (American Industrial Hygiene Association, 1997) and (ILO, 1998).

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 LA_{eq}, 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.

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 13**. These limits are applicable for ambient noise outside workplace, for noise limits within workplace; instructions issued by Ministry of Labour are adopted.
- The project area is categorized as industrial area; therefore the measured noise level will be compared with limits set for Industrial areas.

Table 13: 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

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. One central monitoring location was chosen as illustrated in **Figure 33**.

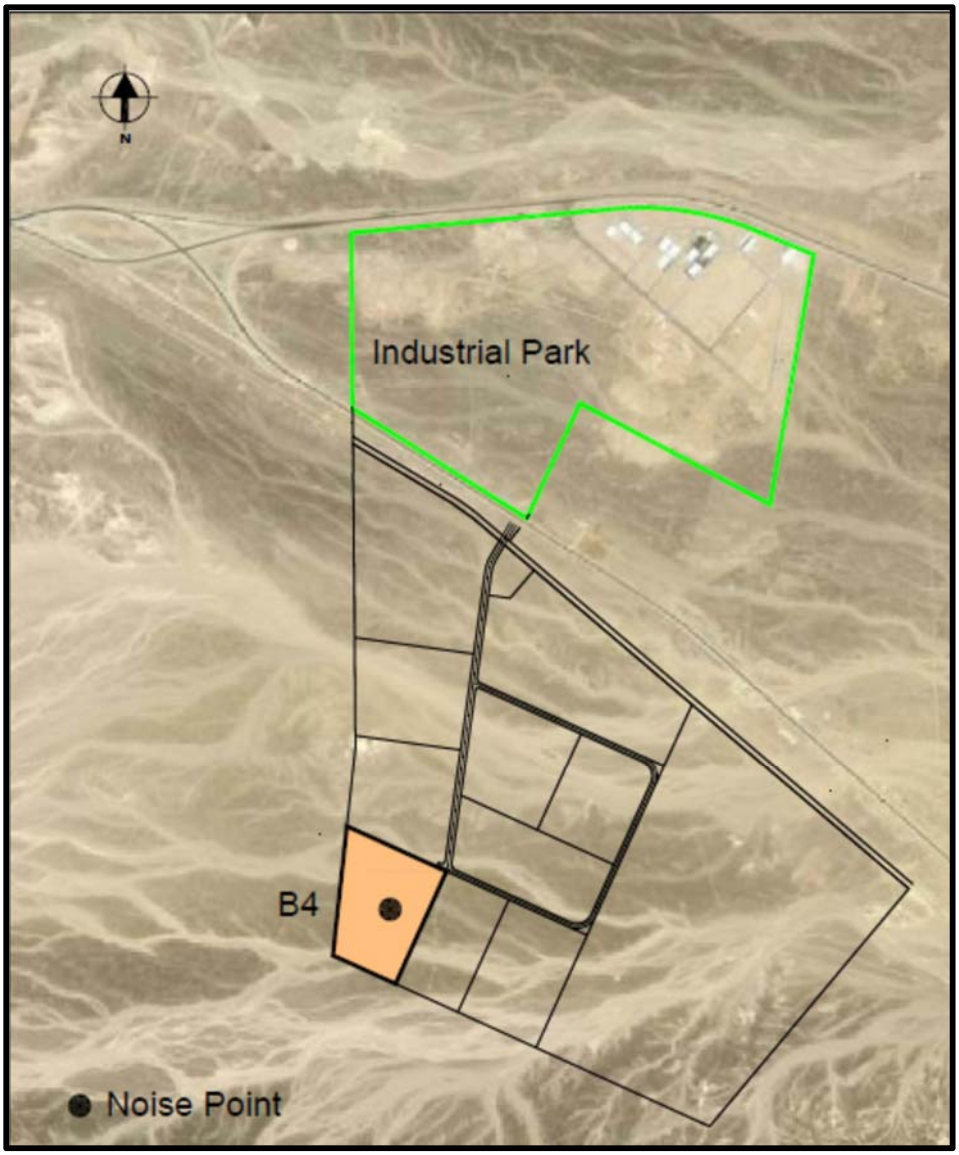


Figure 33: Noise Monitoring Location

The results of noise level monitoring are shownin**Figure 34** below. The measurements were carried out during day time. As can be seen from these data, LAavg is within the allowed limits, while maximum levels are not exceeding the standards. Any additional noise generated from the Project construction activities needs 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.

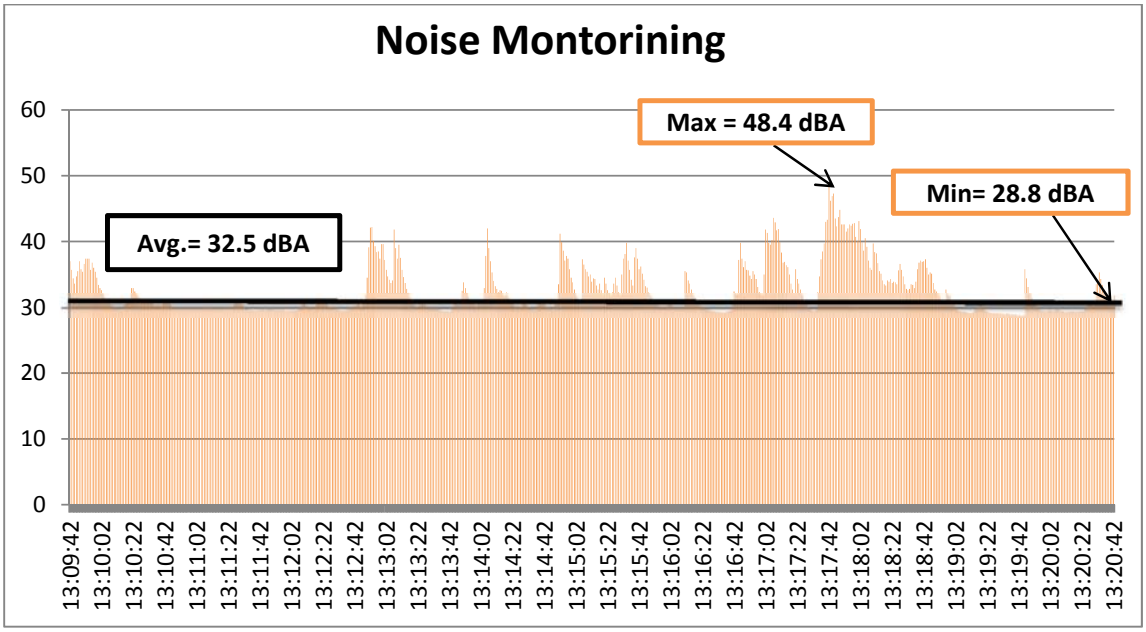


Figure 34:Results of Noise Monitoring

5.2.5. 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 m³/cap/year at present to about 90 m³/cap/year by 2025, putting Jordan in the category of absolute water shortage. Due to the limited water resources, 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 (MoE, Environmental Profile of Jordan, 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, NWMP, National Water Master Plan, 2004). Water desalination, on the other hand, could be considered a future source of water supply.

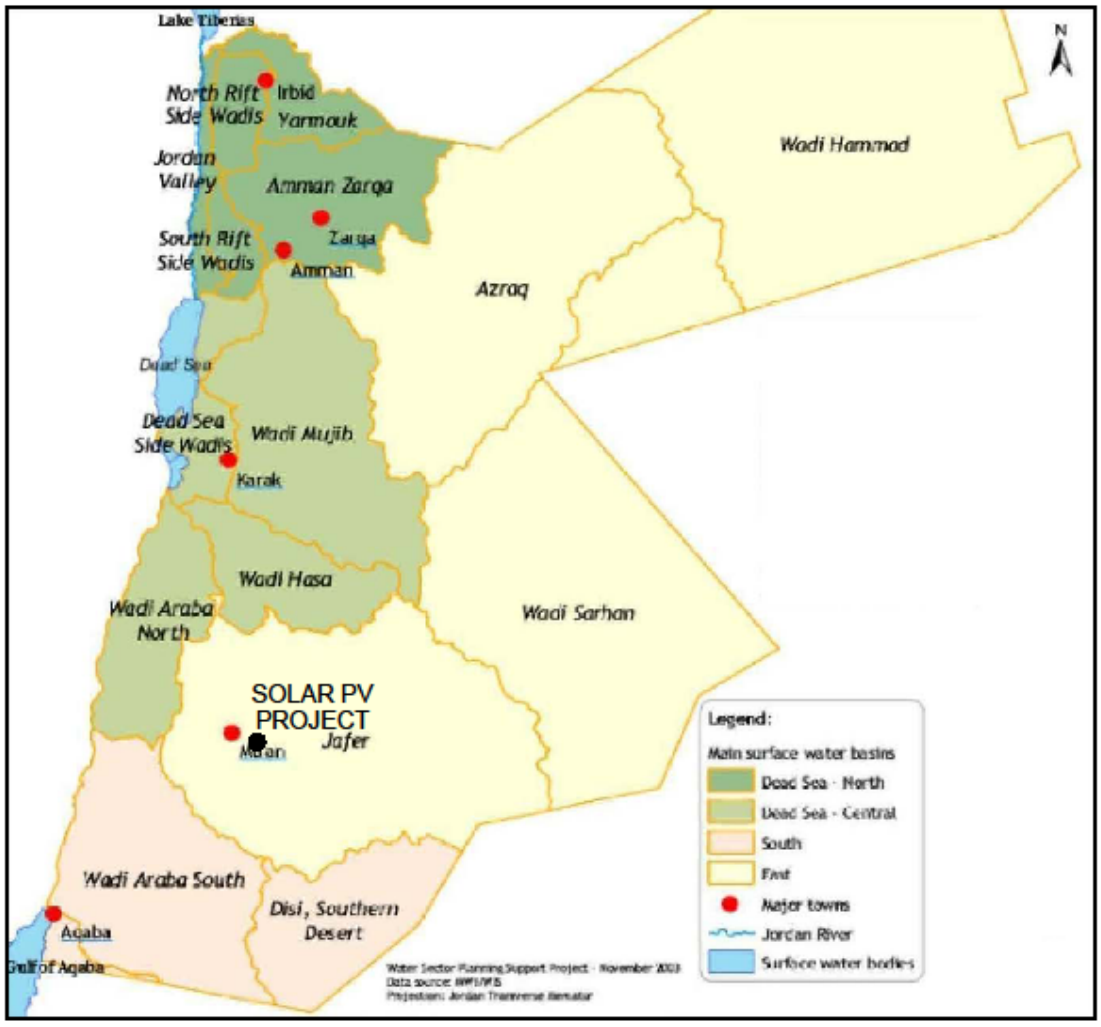
Below is a description of surface and groundwater hydrology, existing water pollution discharges, and receiving water quality for water resources related to location of proposed project.

5.2.5.1. Surface Water

Main surface water basins in Jordan are depicted in**Figure 35**. According to this figure, the project area is located within the East main surface water basin, also surface water basins are depicted in Figure 18. According to this figure, the project area is located within the Jafer surface water basin (MoE, Environmental Profile of Jordan, 2006)

The Jafr basin is located in the southern part of the central Jordan uplands. It has an area of about 12,400 km2, most of which is classified as an arid desert. The drainage pattern is almost radial from the encircling western highlands towards the central Jafer Mudflat area. Ground elevation ranges from about 850 m.a.m.s.l. in the Jafer Playa to about 1,750 m.a.m.s.l. in the western highlands. The main sub-catchments of Jafer Basin are WadiJurdaneh, WadiWheida, WadiHuseinan, WadiShidiya and Wadi El Ghubeya.

The mean annual rainfall over the basin ranges from the highs of about 200 mm/yr in the western highlands to less than 25 mm/year in its eastern parts, averaging over the whole basin to about 40 mm/year.



*Source: GTZ, NWMP, Surface Water-Main Report, Surface water Resources, 2004

Figure 35:Main Surface Water Basins

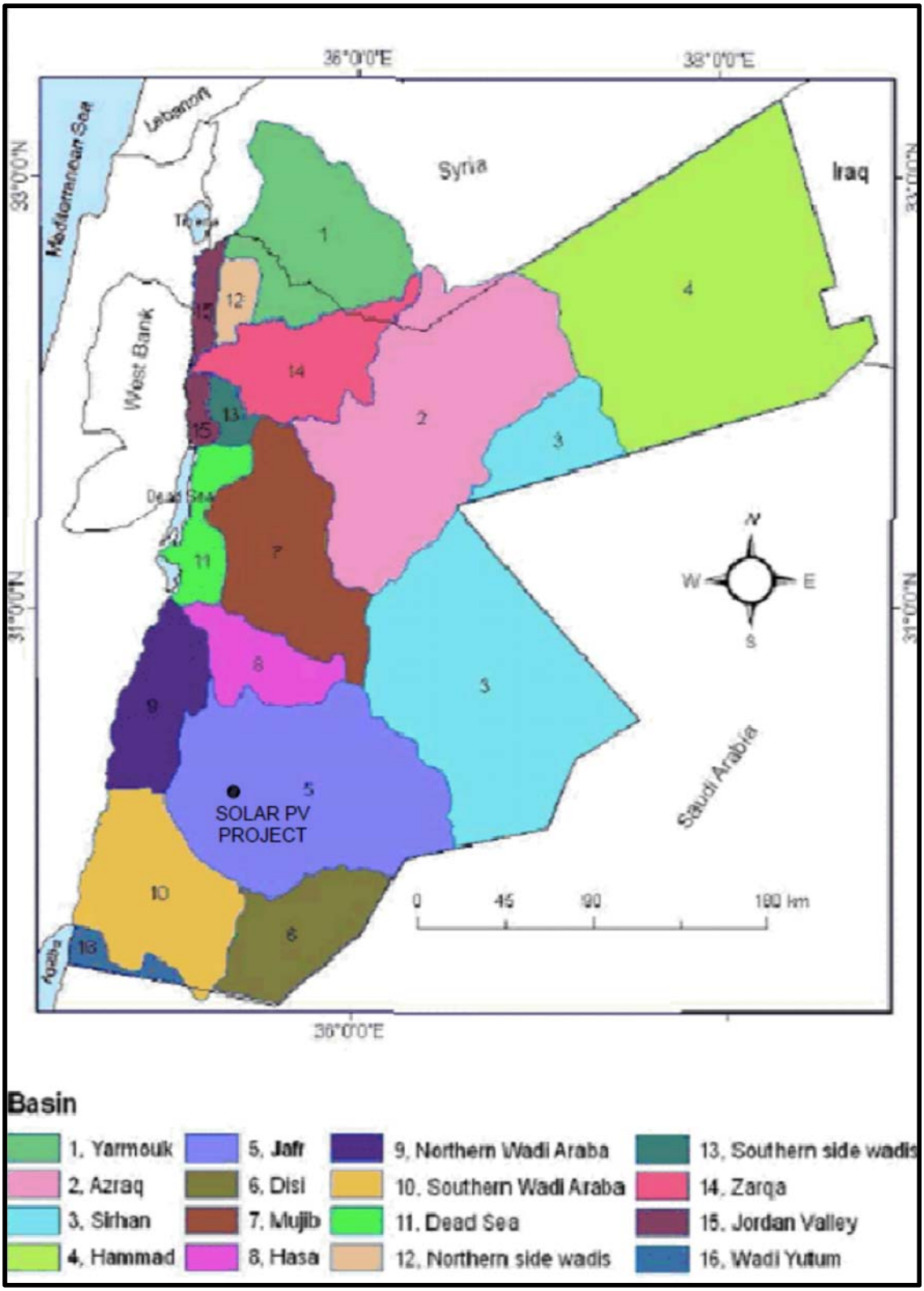


Figure 36:Surface Water Basin

Ma'anDevelopment Zone (MDA) conducted Hydraulic and Hydrological analysis report for the solar panels projects location, the report used Ma'anmeteorological data was obtained from Ministry of Water and Irrigation, in addition to Royal Jordanian Geographic Center for contour maps.

Furthermore, site visit has been conducted in order to collect any observations such as hydrologic and hydraulic structures, the existing culverts, the spread of wadis, and evidence of floods in this area have been checked to be further analyzed. Since the Al Hejaz railway borders the project's site, a few culverts have been constructed in this area, which gave a good indication of the direction of floods and their points of concentration. **Figure 37**shows the observed culverts; **Figure 38** describes Al Hejaz Railway Bridge, and **Figure 39** explain the culverts over Ma'an and Al Mdawwara Road

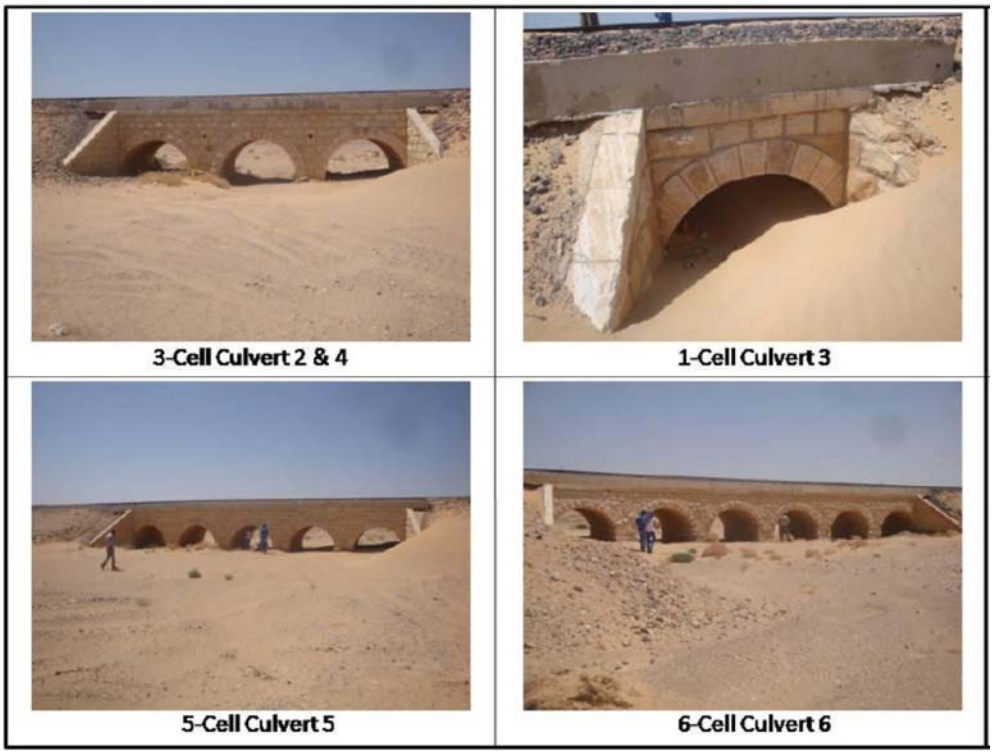


Figure 37:Culverts observed in the project site.

Figure 38:The Al Hejaz Railway Bridge near the project site.

Figure 39:Ma'an and Al Mdawwara Road Culvert near the project Site.

The proposed project satellite image shows high erosion features where water paths are predicted as shown in **Figure 40**below.

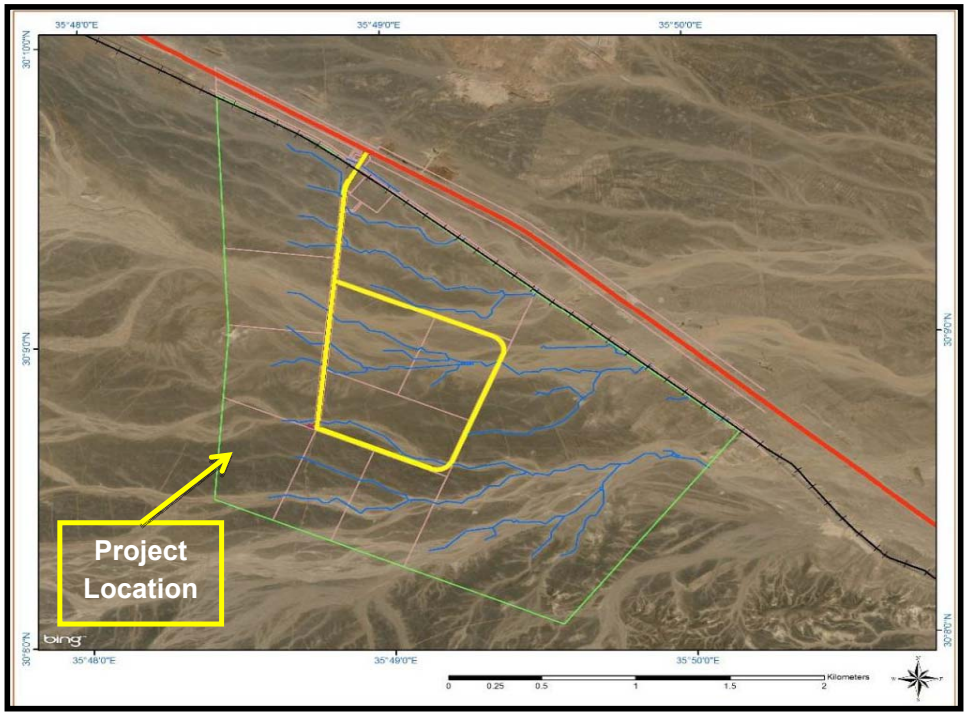


Figure 40:Satelie image for the wadies within the project area.

The catchment is divided into two sub catchments by Al Husainain Dam, this dam has a great effect in reducing the flood potential in the project's area, as well as reduce the area of the catchment area of the project's site.

Figure 41shows the catchment, sub catchments and the Dam location, and then the **Table 14**presents the sub-catchments characteristics. .

Table 14:Sub Catchment Charaterticies

Parameter	Dam Upstream Sub-catchment	Dam Downstream Sub-catchment
Area (Km^2)	47	88.2
Stream Slope(m/m)	0.086	0.0279
Maximum Stream Length (Km)	11.7	30.2
Maximum Stream Slope (m/m)	0.0111	0.0113
Distance From the longest stream to centroid	9.63	15.25

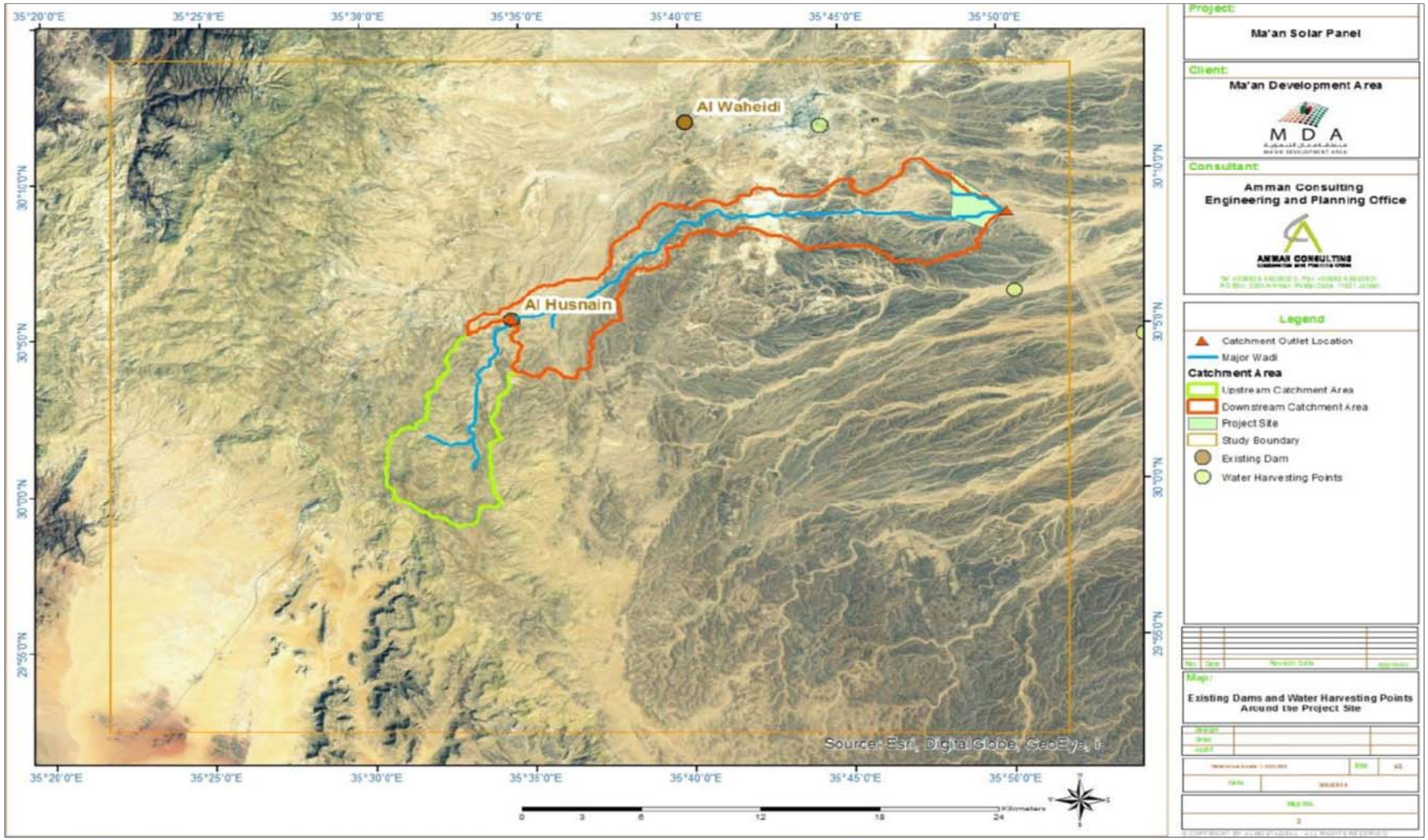


Figure 41:Semiluation reasluts for Delineation of contributing catchment area.

5.2.5.2. 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.

Groundwater recharge is extremely important. 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 "transboundary 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 spatial distribution of these groundwater basins is shown in **Figure 42**. Groundwater development was rapid in the 1980s and early 1990s, as successive Governments freely awarded licenses for tube-wells. As a result, by the mid-1980s, a pattern of systematic overdrawing of groundwater had been established. Over-abstraction is evident in six of the basins where the safe yields have been exceeded by more than 100 percent in some cases space. The total groundwater abstraction from eleven basins in 2003 was about 506 MCM representing an over-draft of about 226 MCM. Water levels in the main aquifers are declining due to this over-exploitation with some aquifers showing considerable deterioration of their water quality due to salinity.

The groundwater basins of project area are presented in **Figure 43**.The project area is included within Jafer groundwater basin.

Current use of Jafer already exceeds the available renewable supplies. The deficit is made up by the unsustainable practice of overdrawing the Highland aquifers, resulting in lowered water tables and deteriorating water quality. Projections differ on the amount of future supply and demand for water, but they agree, without exception, that there is a serious gap and that comfortable, realistic solutions to close it are not apparent. With this alarming prospect, it is of the utmost importance for Jordan to plan and manage the available water resources with care, efficiency and resolve.

The Jafer ground water basin is located in the south-central and south eastern part of Jordan and borders the WadiSirhan Basin to the East, the South and North Wadi Arab and Red Sea Basins to the West, Dead Sea and Zarqa Basins to the north and DisiBasain to the South (**Figure 42**). The Basin encompasses a catchment's area of 12,364 km2 or about 15% of the area of Jordan.

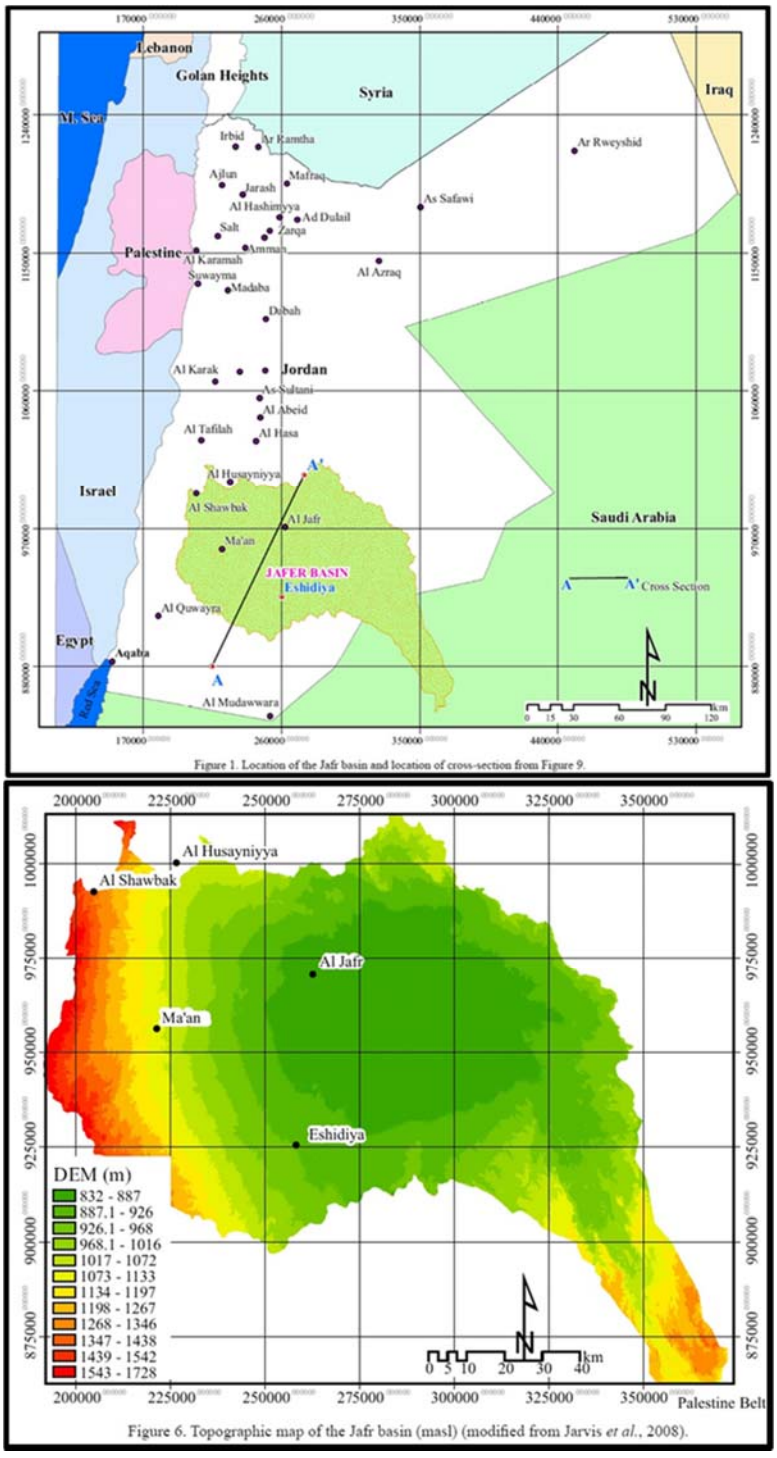


Figure 42:The location and Topography of Al Jafer Basin

The aquifer systems in the study area have been recognized in argillaceous, arenaceous and/or carbonate rocks of the Cambrian to Paleogene age such as Disi, Kurnub, lower Ajlun (A1-6), Amman-Wadis Sir (B2/A7), and Rijam (B4) (Howard Humphyeres,1984). In this study, attention was focused on the aquifers in the Ajlun and Balqa Groups such as Al-6, B2/A7 and B4. The groundwater resources are available within three successive aquifer systems: The Shallow Aquifer System (The Um Rijam aquifer B4): occurs at El Jafr area where it is exploited mainly for irrigation. The aquifer suffers from high salinities due to irrigation returns and has a limited yield. The Rijam aquifer is underlain by the chalky marls and thick impervious shales of the Muwaqqar Formation which form the base of this aquifer (Rimawi, 1985).The Middle Aquifer System (The Amman Wadis Sir aquifer B2/A7): is the majoraquifer system that feed the area with water for domestic and industrial uses. It lies beneath the shallow aquifer or exposed at the land surface. In the western highlands of the Jafr Basin, west of the Arja-Uweinaflexture the B2/A7 receives replenishment fromrain fall (mean annual rainfall 150 – 200 mm) and characterized by spring flows, high water table elevations which exceeds 1100 m above sea level and fresh waters(Howard Humphyeres, 1984). In the Maa'n-Shidiya area, the aquifers do not receive replenishment from rainfall because the annual rainfall is less than 40 mm. The Deep Aquifer System (Disi and Kurnub): which is composed of sandy materials, classified as non-renewable water resource and is not utilized yet. However, few wells were drilled by JPMC to extract water from this aquifer at the Shidiya mining area.

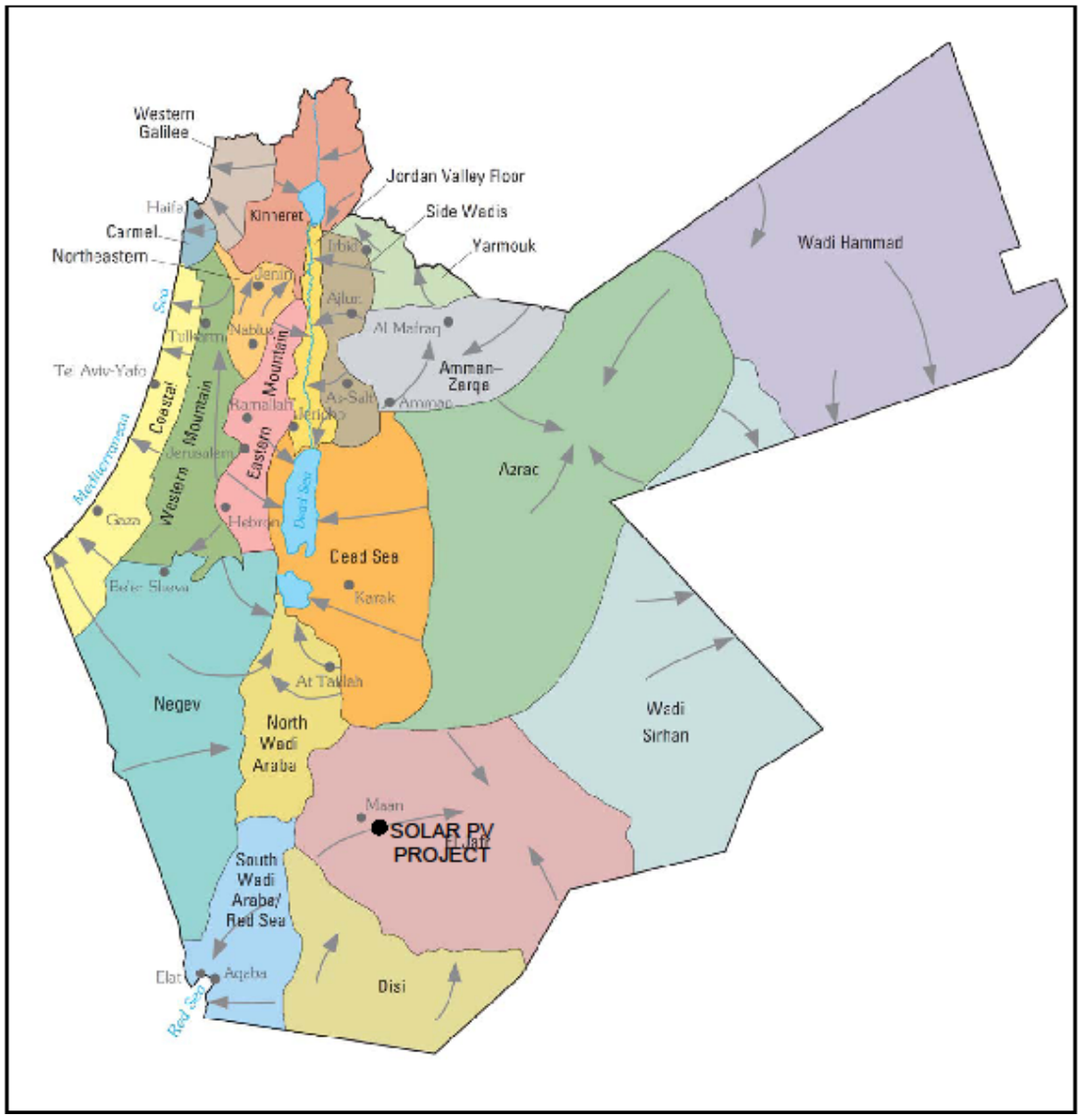


Figure 43:Project Area Relative to Groundwater Basins

5.2.6. Tectonic Setting

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 ± 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).

Extensional, rift-related tectonics dominated Jordan during late Precambrian-early Cambrian periods. The North-west / South-east Najd fault system which originated in this period has resulted in the formation of large depressions that were subsequently filled with Paleozoic clastics (Petroleum and Oil shale Directorate, NRA-2006).

Passive margin conditions with periods of transgressions and regression dominated Jordan during early Paleozoic period, whereas an active tectonic movement of deep erosion has dominated the late Paleozoic period. The most important sediments that were deposited during that period were upper Ordovician glacial clastics and lower Silurian organic-rich shale (Petroleum and Oil shale Directorate, NRA-2006).

Most of Paleozoic basins in Jordan are compartmentalized by Cretaceous-Tertiary wrench faults related to the late Cretaceous fragmentation of Arabian Plate (Petroleum and Oil shale Directorate, NRA-2006).

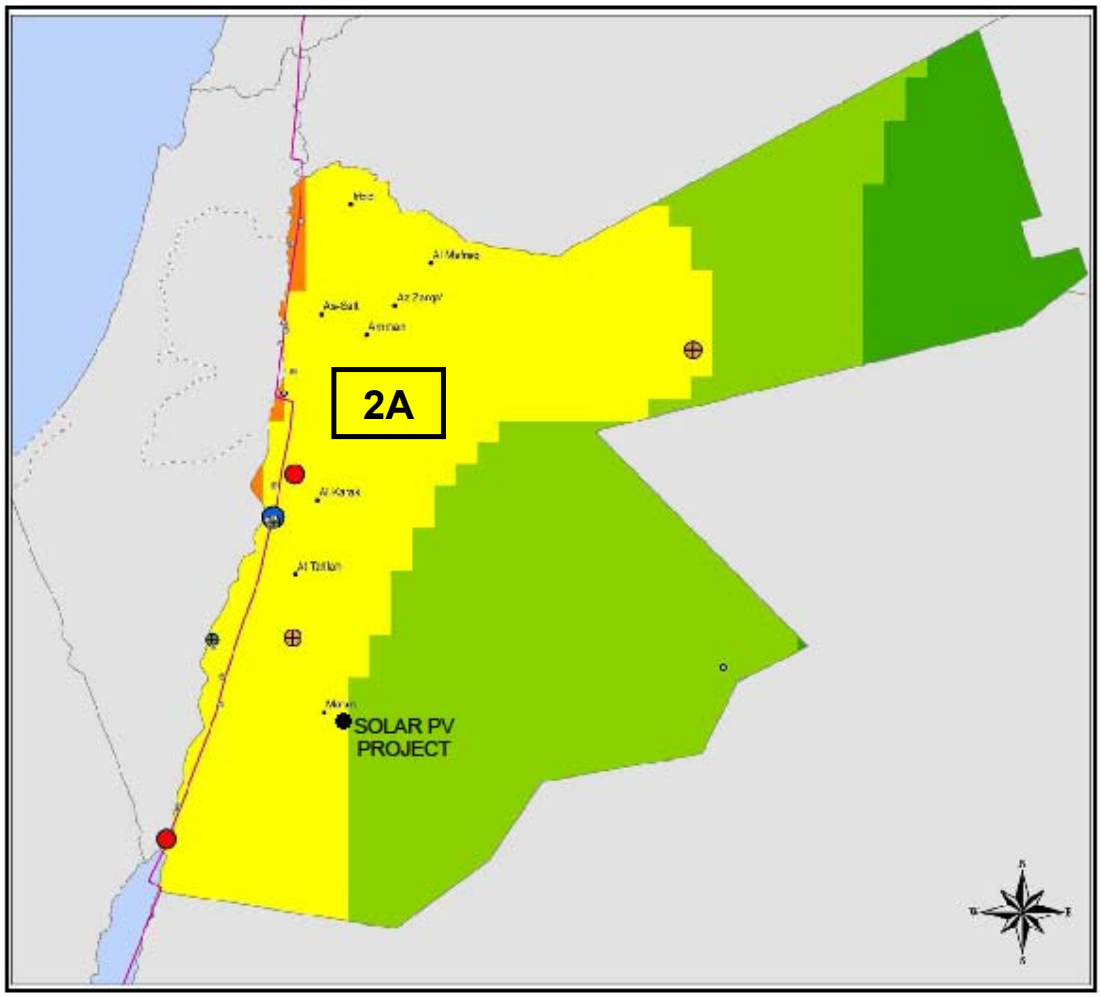
During the Permo-Triassic period, extensional tectonics has rifted Arabia from Turkish-Iranian Gondwana fragments. Although extensional tectonics were a prominent characteristic of Jordan during the late Cretaceous period, the western margin of the Levant was characterized by East-West to West North-West and East South-East compression feature known as Syrian Arc (Petroleum and Oil shale Directorate, NRA-2006).

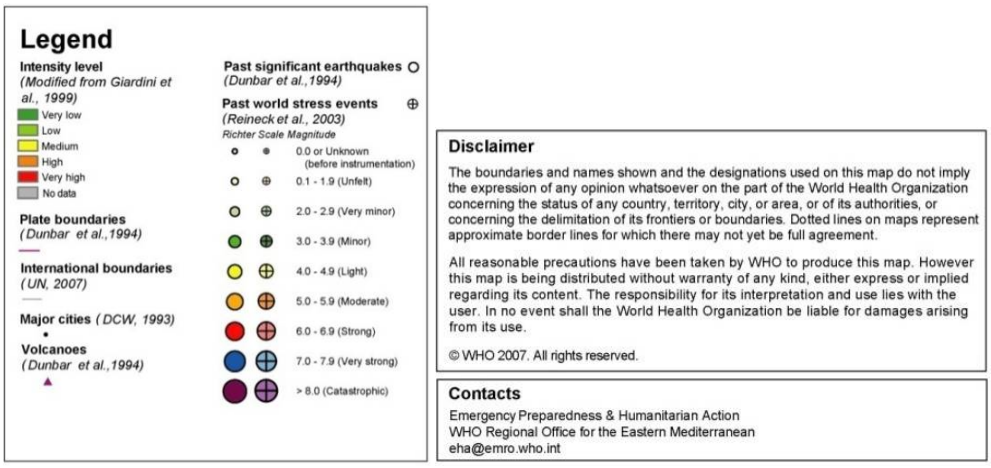
Mesozoic-Cenozoic basins in Jordan are dominantly rift-related (Azraq, Safawi and Northern Highlands) (Petroleum and Oil shale Directorate, NRA-2006).

A mid-Tertiary tectonic phase has resulted in opening of the Red Sea and has led to the development of Dead Sea-WadiAraba plate boundary that separated the Arabian plate from the African plate, and has sutured the Arabian plate to Eurasia. Consequently, this phase resulted in pull-apart basins of thick sedimentary piles (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.

The project site lies within the light magnitude of Richter's scale which is illustrated on the seismic hazard distribution map of Jordan shown in**Figure 44**. Therefore, if an earthquake was induced in that area, it is anticipated that the intensity will fall between the 4.0 to 4.9 magnitude (yellow color) 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).





Source: World Health Organization (WHO), 2007

Figure 44:Seismic Hazard Distribution Map of Jordan

5.3. Biological Environment

This section describesthe current biological environment in the project area; this includes the following elementsof the biological environment:

- Flora of the project area: This includes vegetation coverage and vegetation communities, rare and endangered plant species.
- Fauna of the project area: Among this large taxonomic group, there will be certain smaller groups to study. These groups are considered easy to assess bio-indicators for the status of the fauna because of their higher trophic levels.
- These groups are large mammals, conservation important small mammals, birds especially the conservation important resident species and conservation important reptiles.
- Sensitive Habitats: These are the areas of biological importance, which include; Protected Areas, National Parks, Range land Reserves, Important Bird Areas, Wetlands under Ramsar Sites, Unique Habitats and Ecosystems and isolated natural sites (Biodiversity Islands).

5.3.1. Bio-geographic Zones

Jordan is classified into 4 main biogeographic zones as illustrated in Figure 21 below; the project area is located in the zone that covers the most parts of eastern and southern Jordan, namely the Saharo-Arabian zone.

Saharao-Arabian Zone

this region is called Badia, since it has different set of characters other than those of typical deserts known anywhere else. In typical deserts there are lots of sand dunes, while in Jordan desert, the land is clayey and covered by gravels or pebbles. Accordingly the parts of the Badia are called Hammada or Hammad or Harra. Usually the Harra is covered by black basaltic pebbles, while Hammada is covered by gravels.

This area is characterized by having very cold winter and usually very dry, hot summer, temperature may exceed 40^{o}C in the hot season, while it might go down up to -10^{o}C during the coldest days of the year. The soil is very poor and mostly of the type Hammada, saline, sandy-loam or mud flats in some parts. Rainfall ranges from 50-100 mm/year, the mean annual rainfall is almost 50 mm. Altitude is usually about 600-700 m above sea level, rarely exceeds that in some parts. This area comprises the majority of Jordan and borders the Irano-Turanian on the East forming the largest share of the area of Jordan.

The vegetation is mostly composed of fleshy plants which can resist the hot conditions. Animals mostly reptiles, some birds, rodents and some mammals. The vegetation is very poor and sometimes non-existent, especially in the mud flats. Most of the plant cover is restricted to the watershed in the wadis where enough soil moisture is available to hold some vegetation. The most common species are *Artemisia herba-alba, Achilleafragrantissima, Phlomis, Astragalus, Stipa, Trigonella*.

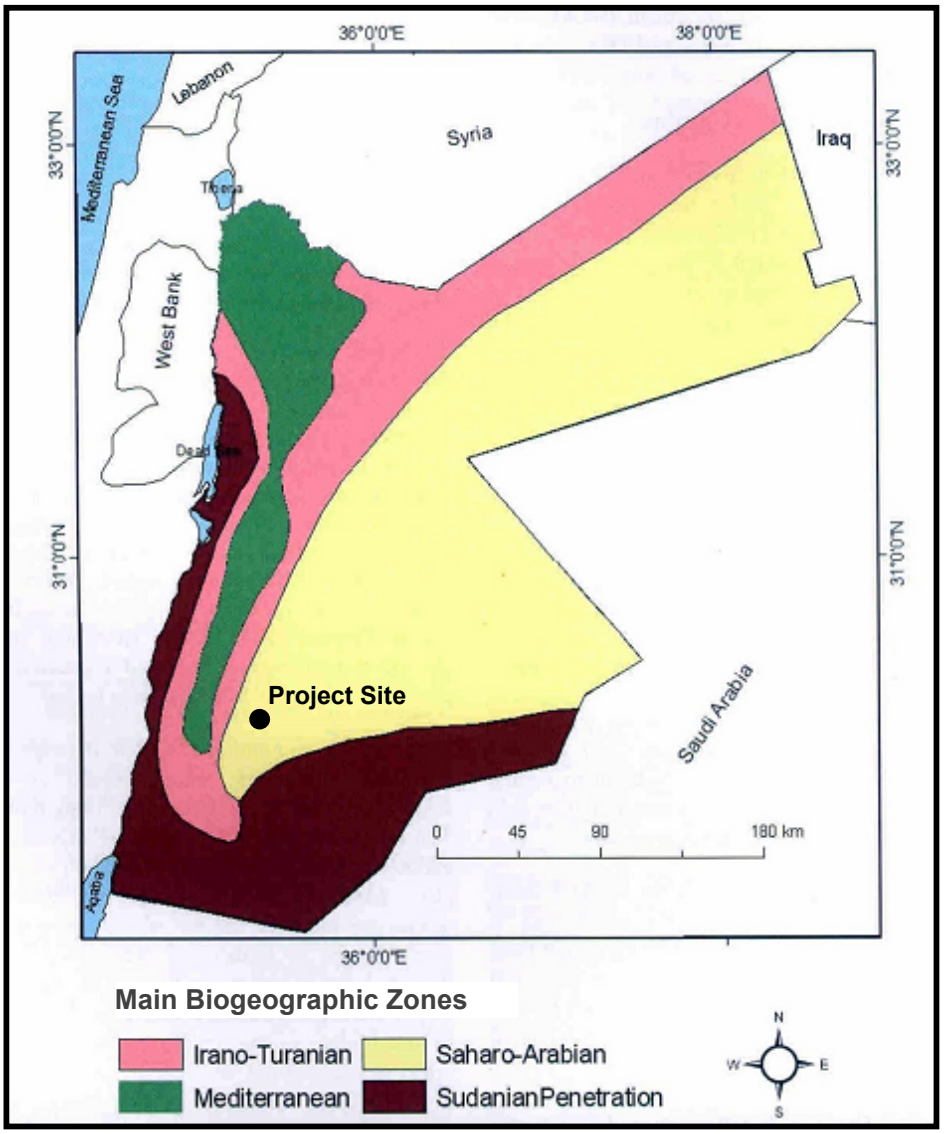


Figure 45:Bio-geographic Zones of Jordan (MoE, Environmental Profile of Jordan,2006)

5.3.2. Vegetation Types

The proposed project area has one vegetation type, namely Hammada Vegetation (Al-Eisawi, Vegetation of Jordan, 1996), refer to Figure 22.

Most of the Saharo-Arabian region in Jordan is of Hammada type, which comprises about 50 percent of the total area. Four subdivisions of Hammada can be recognized:

5. Run-off hammada
6. Gravel hammada
7. Pebble hammada (Harrah)

8. Sandy hammada

The project area is charecterized with all the above subdivisions of Hammada vegetation except Pebble Hammada.

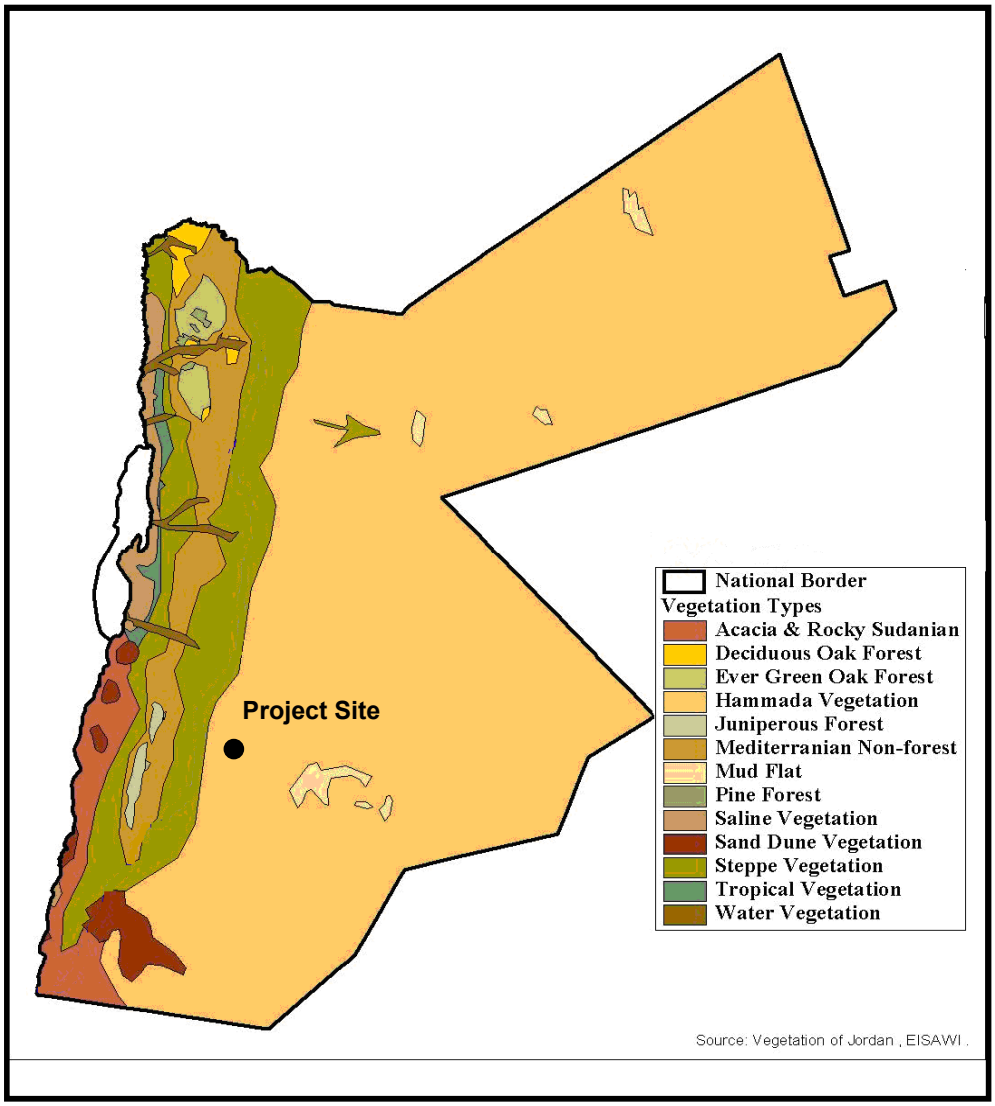


Figure 46:Vegetation Types of Jordan

Run-off hammada

The vegetation here is mainly confined to the wadis and water-shed places. Usually the vegetation is rich and dense in comparison with the surrounding areas. Run-off places vary in width from few meters to hundreds of meters. The vegetation varies from place to another, for example some wadis along the road from Ma'an to Mudawwarah at Saudi Arabia borders, the wadi has *Acacia tortilis, A.raddiana, Tamarlxspp., Artemisia judaica* and *A.monosperma*. In general the leading species are:

- *Retama raetam*
- *Atriplex halimus*
- *Tamarix spp.*
- *Peganum harmala*

- *Lycium europaeum*
- *Artemisia herba-alba*
- *Achillea fragrantissima*
- *Phlomis brachyodon*
- *Astragalus spp.*
- *Anabasis articulata*
- *Atractylis mutica*
- *Gynandriris sisyrinchium*

Gravel hammada

Gravel Hammada is the largest, flattest part of Jordan, restricted to middle of the Eastern Desert. It is made of mostly clayey loam covered by gravels. The vegetation is dominated by some low shrubs such as *Seiditzia rosmarinus* in association with some annual herbs and succulent plants. The following are some of the leading species:

- *Seiditzia rosmarinus*
- *Spergularia diandra*
- *Herniaria hirsuta*
- *Aaronsohnia factorovskyi*
- *Anthemis deserti*
- *Asteriscus pygmaeus*
- *Mesembryanthemum nodiflorum*
- *Filago desertorum*
- *Gymnarrhena micrantha*
- *Stipa capensis*
- *Bromus spp.*
- *Trigonella stellata*

Sandy hammada

Most common along the borders with Iraq and Saudi Arabia, along the road to Al-Wisad police station, and partially in Ash-Shumari reserve. The land is a mixture of either type of Hammada, gravel or pebbles, with sandy soil coming from Saudi Arabia. In some cases the sandy soil will be dominant and dunes formations may occur. The leading Species are:

- *Seidlitzia rosmarinus*
- *Atriplex spp.*
- *Artemisia herba-alba*
- *Anabasis articulata*
- *Achillea fragrantissima*
- *Halocnemum strobilaceum*
- *Capparis leucophylla*
- *Ephedra transitoria*
- *Deverra triradiata*
- *Calligonum tetrapterum*
- *Zilla spinosa*

5.3.3. Faunal Species Diversity

Herpeto-fauna

The projet area has show low abundance od reptiles during the baseline period, that due to the very low vegetation cover and the associated incects communities that comprises the main food for such species. Generally, the Reptiles of the project area are represented by lizards of various families: (*Gekkonidae: Bunopustuberculatus, Hemidactylusturcicus, Ptyodactylusguttatus, Stenodactylusgrandiceps, Lacertidae: Acanthodactylusboskianus, Acanthodactylusgrandis, Mesalinabrevirostris, Mesalinaguttulata, Agamidae: Trapeluspallidus, Scincidae: Eumecesschneideri and Varanidae: Varanusgriseus*). Snakes are diversified and include at least seven species (*Coluberrogersi, Eireniscoronella, Eirenisrothi, Malpolonmoilensis, Psammophisschokari, Spalerosophisdiadema and*

Pseudocerastesfieldi).None of the previously recorded species are of conservvation importance.

Mammals

Large mammals are rare and represented by few carnivores (Vulpesvulpes and Hyaenahyaena). On the other hand, rodents are diversified are quite common along the various sections of this area. *Jaculusjaculus, Gerbillusdasyurus, Merioneslibycus, Merionescrassus and Psammomysobesus* are dominant. In addition, the Desert Hedgehog, Paraechinusaethiopicus is present in this area.

Birds

The project location is located in between two important bird areas in Jordan; Wadi Taraf Important Bird Area and Hizma Basin Important Birds Area. The project area is at the vicinity of major birds migration routes especially for Autumn Migration of Raptors. The common Birds Species at the area are:

- *Desert Lark*
- *Desert Finch*
- *Crested Lark*
- *Common Buzzard*
- *Black Kite*
- *Steppe Buzzard*
- *Common Kestrel*

Birds Survey was made to update the status of the ecological relation between the project site and the Birds that are either resident or migrant passenger over this location and the surrounding area. The results has shown low importance of the project area for birds species due to the poor and degraded ecological characteristics of the area. Few common desert birds species were recorded during the baseline, such as: Desert Lark, Creasted Larck and black Kite. Non of these species are of conservation importance.

Important Ecological Habitats:

The project area dose not have have an ecollogically important habitats, the nearest Important Birds Area is Abu Tarfa IBA which at a distance of 14.9 kmas illustrated in**Figure 47**below. In addition the nearest Rangeland Reserve to the project location is Ras An Naqab which is 22.5 km far as shown at**Figure 48**below.

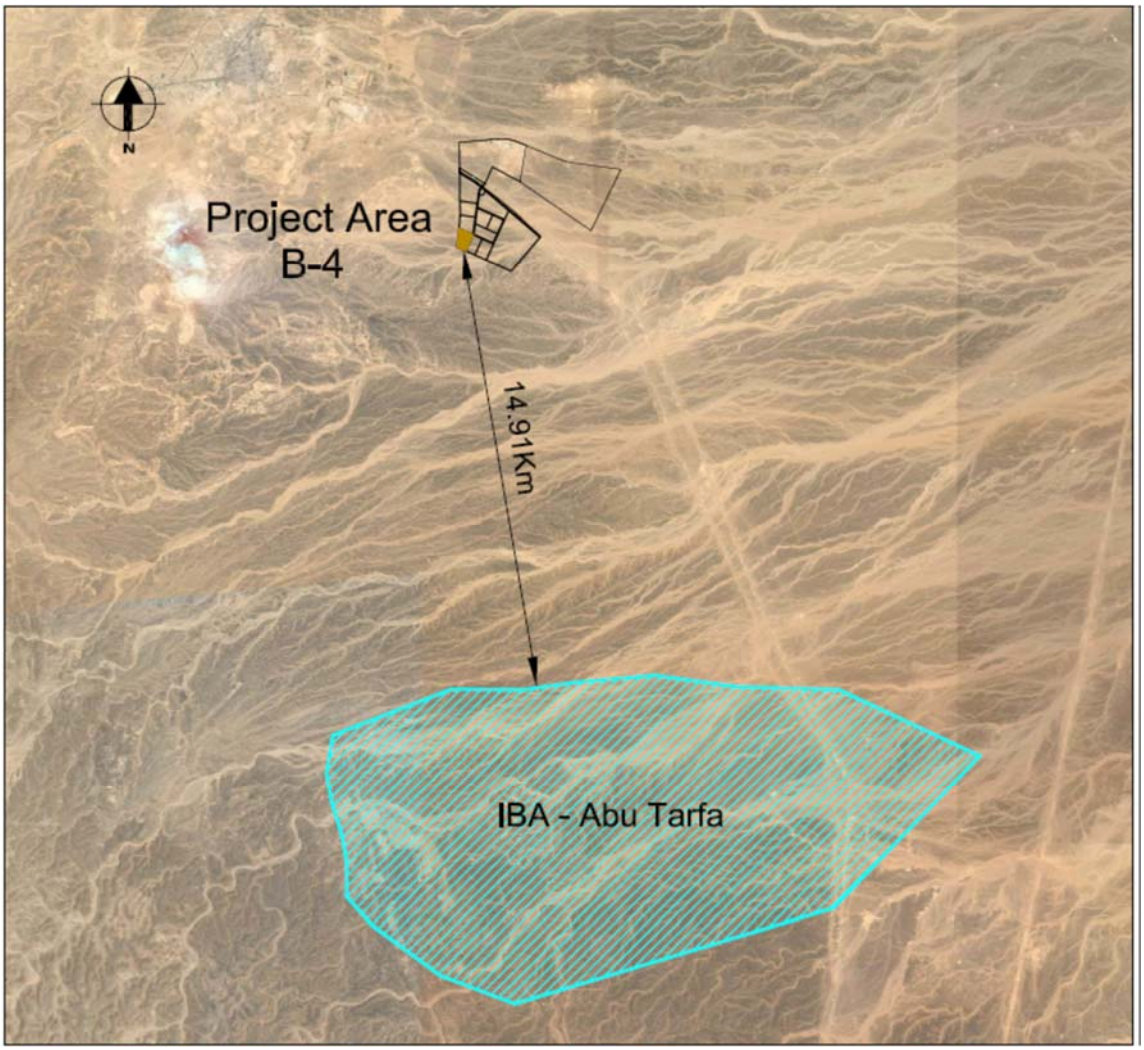


Figure 47 : The nearest IBA to the project location.

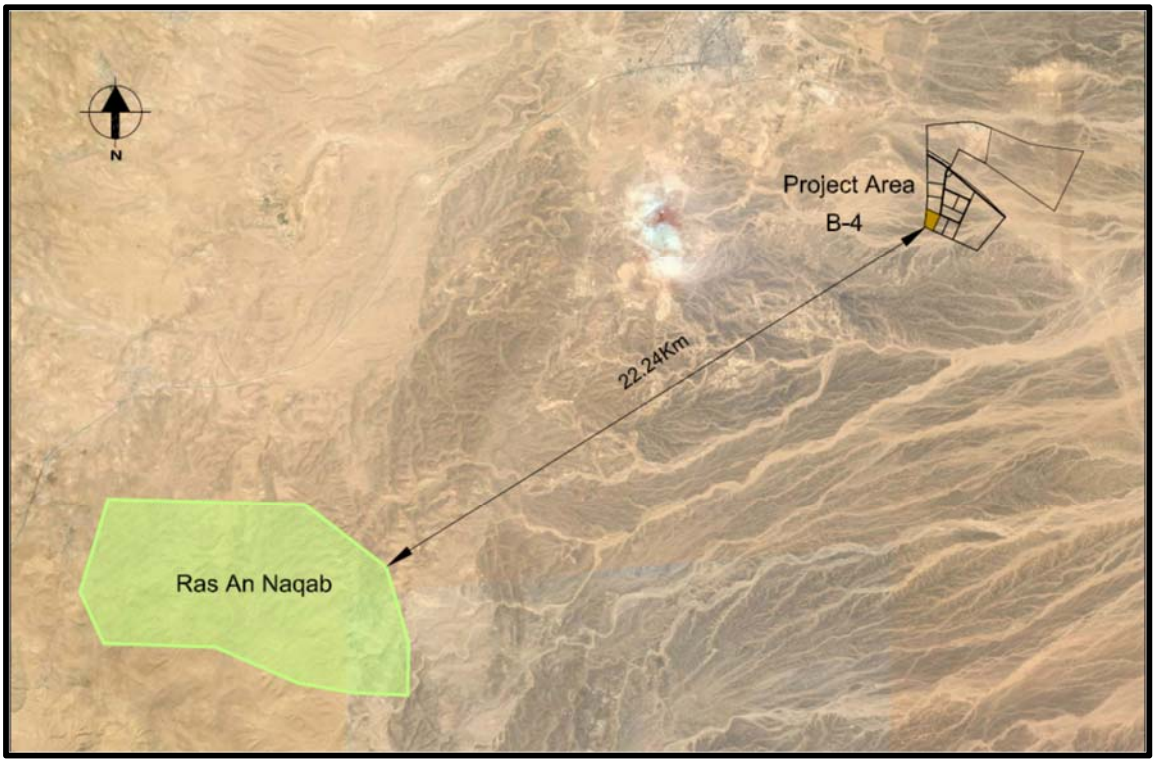


Figure 48 : The nearest Rangland Reserve to the project location.

5.4. Socio-Economic Conditions

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, aesthetic as well as public health and safety conditions.

5.4.1. Population

Ma'an is Jordan largest governorate in terms of area in Jordan with 33% of Jordan total area, but with the second smallest population between all governorates with 1.9% of Jordan total population with a total of 111,200 citizens of which females constitute 47.6% of Ma'an total population (DOS, 2009).

The age structure of Ma'an population shows that it is a young community having 37.8% of the community below the age of 15 years, and 70.9% of the community is below the age of 30 years.

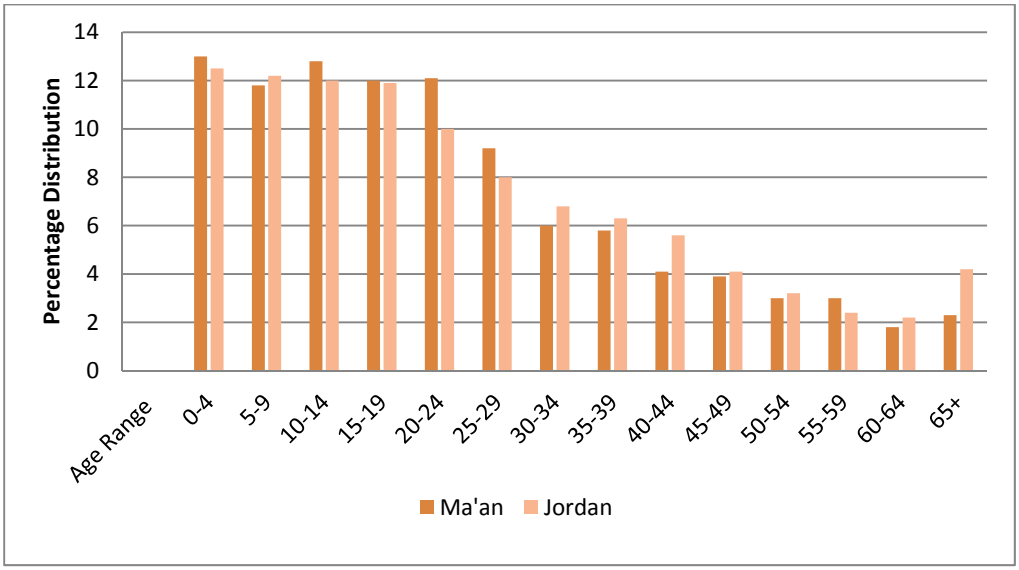


Figure 49:Percentage disterbultion of Ma'an Population according to age.

Ma'an governorate is characterized by three major social environments; these are the city style, the village style, and nomadic. The city style is represented by Ma'an city. Since the establishment of the King Hussein Ben Talal University Ma'an area became more attractive to residents in south Jordan, especially Ma'an, less repulsive to young people and as will melting pot for different cultures came from different parts of Jordan and to less extent from the nearby Arab countries simple village life style is the dominant in the villages and small settlements scattered along the governorate, and still the base and the govern reference for all social relations in Ma'an area.

It is anticipated that the population that will be present within project premises is the project employees.

5.4.2. Land Use

The project area is within MDA and is classified as industrial area. The plot allocated for the project is currently empty of any use, surrounding area is also empty. The nearest populated area is the Industrial Park which is part of MDA and located around 2.5 km to the north-east of the project area. While the nearest town is Ma'an city located about 5.0 km to the north-west of the project site as well as a private farm located to the north-west,**Figure 50**shows the distance between the project location and closest settlement.

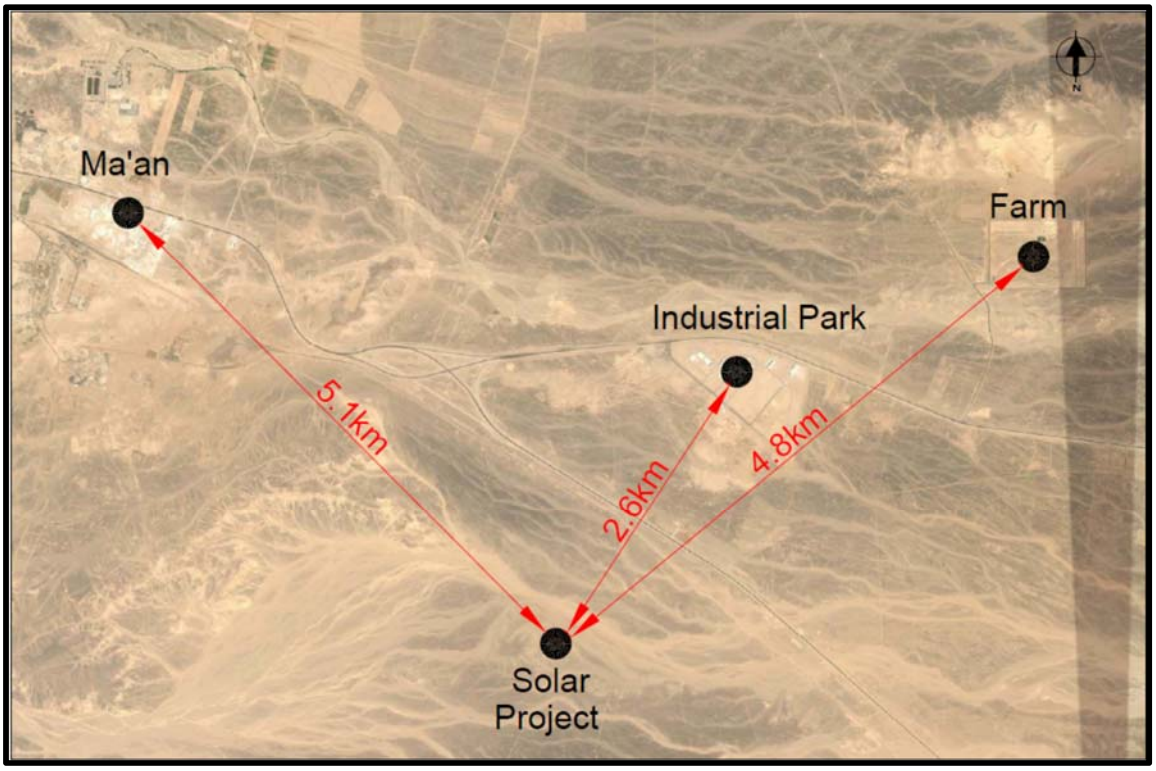


Figure 50:The closest settlementto the project location.

5.4.3. Infrastructure, Utilities, and Transport

The project site can be reached through the international highway connecting Ma'an with the Saudi borders. The project aims to generating electricity, however until starting power generation, electricity proposed to be connected to NEPCO network via main sub station located in the entrance of the project as ilstrate in the **Figure 51**.

The water will be provided to the project by combined water and fire fighting network, furthermore, the wastewater will be collected by septic tanks and emptied regularly based on the water consumption in the site.

The site other infrastructure such as roads will be served with internal roads with length 32 m and width 1.7, as well as all the other services will be available such as telecommunication and internet, Moreover, the Location will be fenced in order to protect the project from any foreigners or animals, All these utilities will be provided through MDA as a part of it mission to develop the investment in Ma'an Governorate.

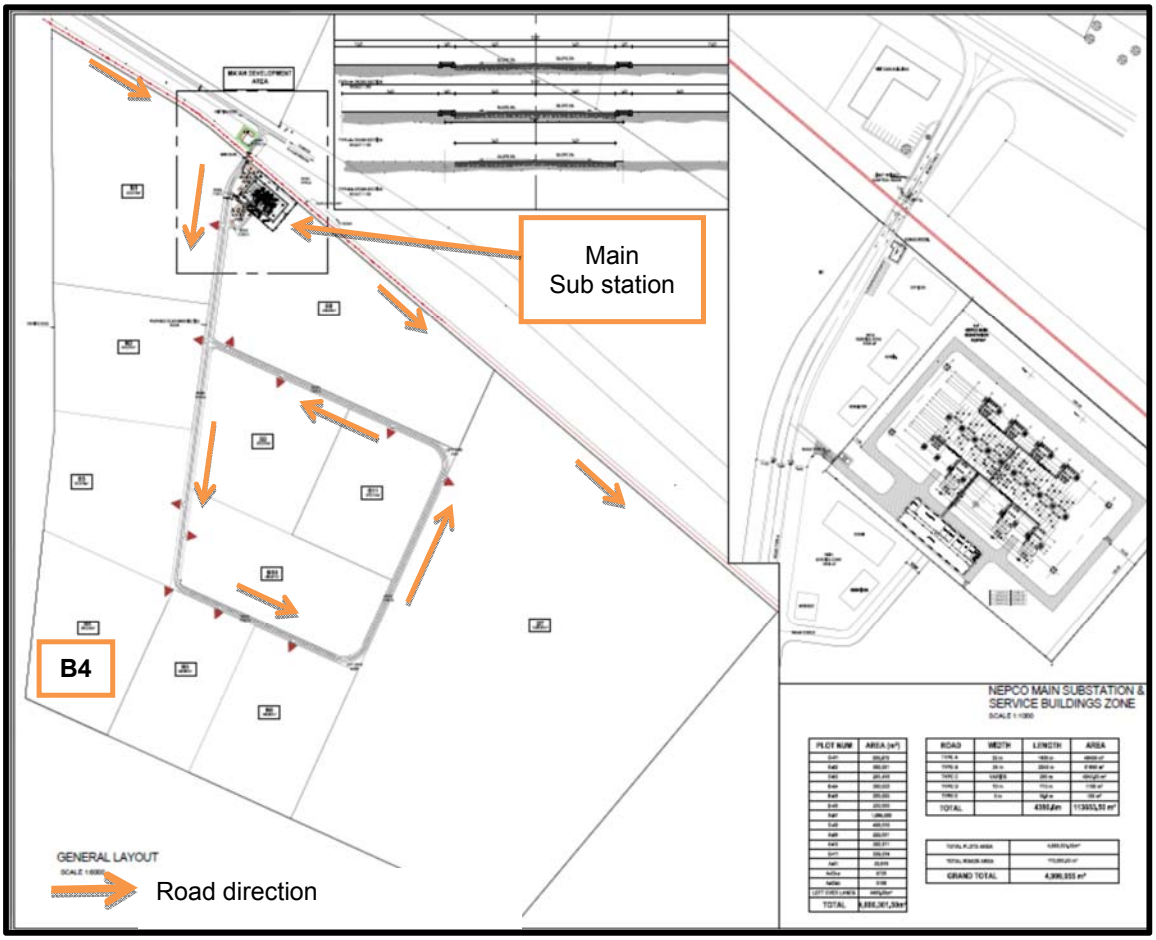


Figure 51:The project location proposed utilities

5.5. Archaeology and Cultural Heritage Resources

The Ministry of Tourism and Antiquities with cooperation with Bristol University and London UK University has been prepared a survey about the Modern Conflict Archeology for the Ottoman era, the survey covered Al Haj path including Ma'an city as an important station for Al Haj in order to record all remain the archeology with the path strip.

An additional survey from the Ministry of Tourism and Antiquities – Archeology Directorate has been done by archeological team in 24/12/2013 at the proposed area for the solar power projects in MDA, and prepared a primary report; the survey team discovered three locations for Military camp – Ottoman era in addition to some horseshoe metals and piece of the tents cloth, Furthermore, the team observed that the military tents were circle shapedas shown in **Figure 52**.

However, it is worth noting that these identified sites fall outside the project area.

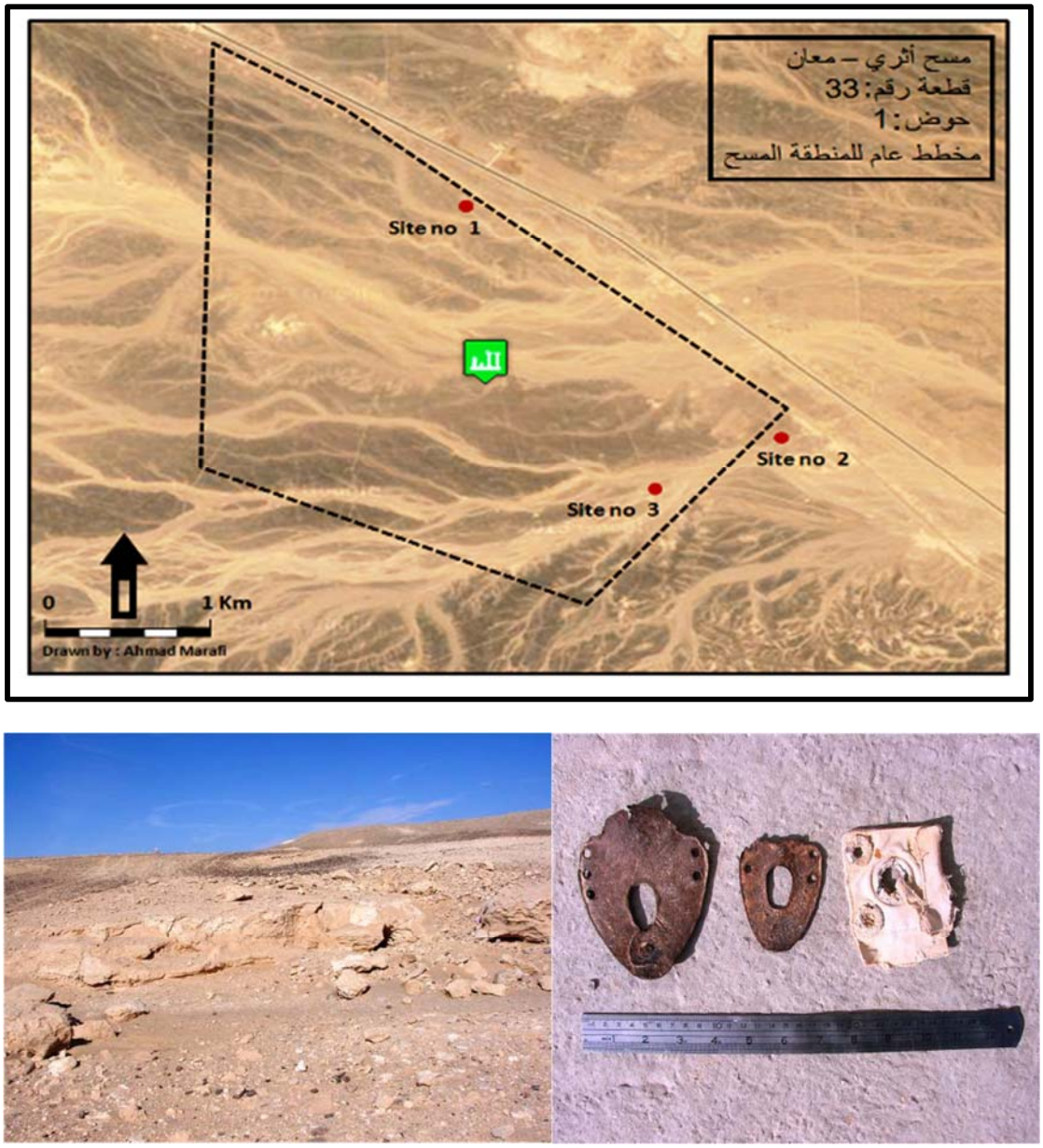


Figure 52:The three sites of Otteman era within MDA

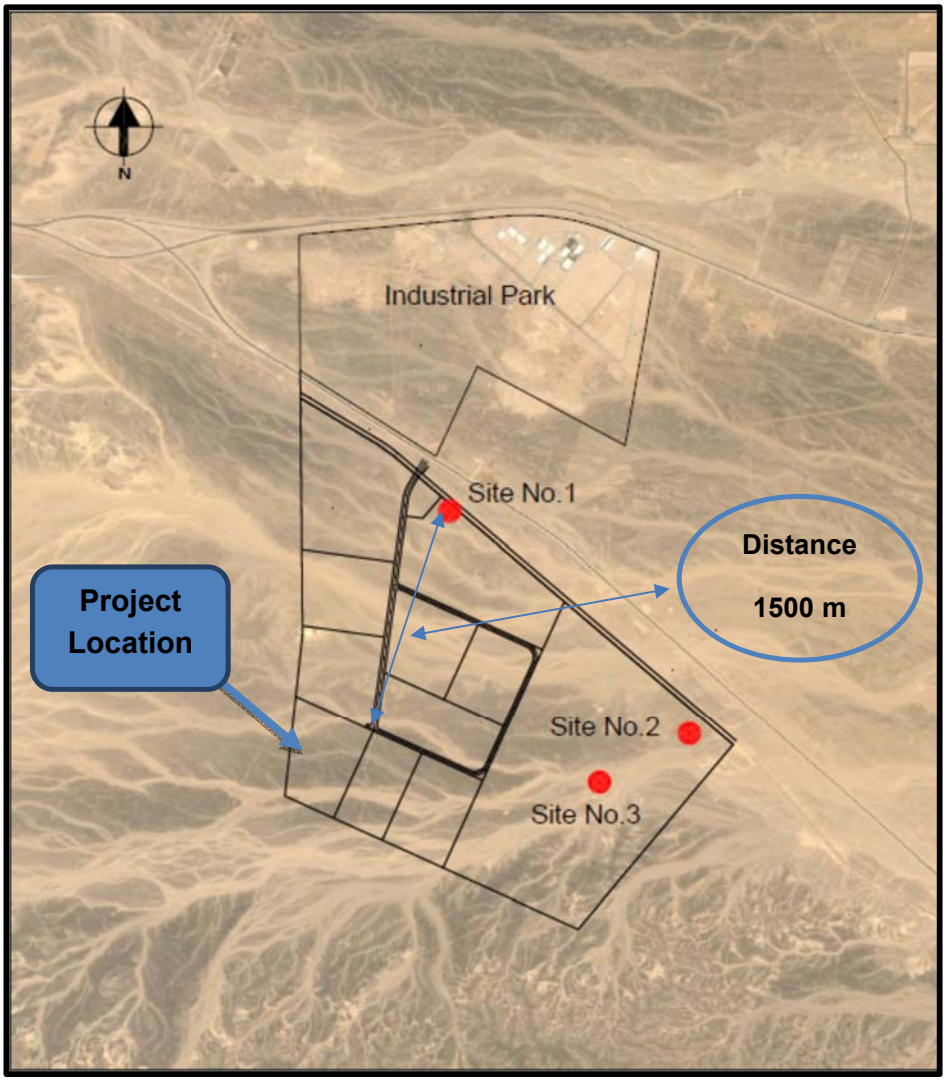


Figure 53:The project Location and the Archology sites..

The closest site to the project location is site No.1, the distance between the project location plot B4 and site No.1 about 1500 m as present on the figure above.

The Archeological report main recommendation relevant to this project isas followings:

- The project developer is obliged to inform the Ministry of Tourism and Antiquities – Directorate of Ma'an in the case of more findings are observed during the construction phase

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/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 statement report as part of the Final ToR.

6.2. Stakeholder Engagement

Upon submission of the application and categorization of the Project, the ESIA Scoping Process was initiated for the purpose of providing the identified stakeholders with information pertaining to the proposed Project, outlining the ESIA preparation and review process, and obtaining stakeholders views on the key environmental and social issues that should be considered during the design and implementation of the Project. The Scoping Statement report that was submitted as part of the Final ToR to MoEnv has already identified the key environmental impacts likely to be associated with the project as well as a methodology and execution plan for assessment.

The scoping workshop for this project, organized MoEnv.and AJ in collaboration with Al Ward Al Jory, was held on May8th, 2014 at the Crown Plaza Hotel, Amman, Jordan. The scoping program focused on describing the project and the key potential impacts identified in the Terms of Reference (ToR). A scoping statement that summarizes the deliberations of the workshop, the participating stakeholders and the issues identified to be of potentially significant impacts was prepared and as part of the Final ToR that was submitted to MoEnv on May15th 2014and approved on June9th 2014.

The list of invitees to the scoping session included concerned stakeholders from government agencies, institutions, organizations, municipalities, and non-governmental organizations (NGOs) including, but not limited to, the following:

Table 15: Stakeholder Categories

No.	Stakeholder Category	Examples
1	Government	Government Ministries, Ministry of Energy and Mineral Resources, Ministry of Environment, Ministry of Health, Ministry of Planning, Ministry of Agriculture, Ministry of Water and Irrigation, Ministry of Tourism & Antiquities, Ministry of Municipalities and Municipal Affairs.
2	Community	Community Leaders, women, children, tribal and unemployed groups
3	Shareholders	Shareholders and project staff
4	NGOs	Environmental, social, Education, Sustainable Development, Health, Ecotourism, Cultural, Archaeology BGOs (national and international with local representations. E.g. Royal Society for the Conservation of Nature (RSCN); Jordan Environment Society (JES); Friends of the Environment (FOE); IUCN, etc.
5	Media	Press, Broadcast, Radio, Key Journalists
6	Academic	Universities and Research Institutes

The detailed list of invited stakeholders is included within the scoping statement, and the list of stakeholders that attended the scoping session is presented in the scoping statement as well.

The main issues of concern can be summarized as follows:

- The positive impact on the local community and employment opportunity.
- Extend the project after decommissioning phase ;
- Rehabilitation the existing cables in order to connect the project;
- The wastrewater Treatment and Ruse;
- The project 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.

6.3. Security

The project will be fenced and the access to the project site will be controlled by the entrance gate. The project will be secured by a private security contractor who will be appointed by the company where civilian security measures will be implemented on site. The security contractor who is licensed for such service is connected with official security authorities for any security threats or alarms when occurred. In addition to the security measures that will be implemented by the project, MDA also has its own security arrangements in coordination with the developers at the DA and the relevant security authority to maintain the whole area under proper and adequate security measures.

The project will adopt the preventive security approach through building positive relation with the local community and otherstakeholders via open dialogue channels via the community liaison persons who are more likely to be from the local community members.

7. IDENTIFICATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC ASPECTS AND RECEPTORS

Project environment covering physical, biological,socio-economic and 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 tablebelow.

Table 16: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 specially activity related to transportation and execution might have a potential impact upon.
Soil	The soils of the project area on which construction, operation and decomissioning 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 Heath and Safety	
Construction Team	Staff on project site which are subject to occupational hazards effects such as noise, dust, etc.
4-Socio-economic Environment	
Public Heath & 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 polpulated areas. Hence, there is no population (people) utilising the project area.

Aspects/ Receptors	Details
Land Use & Land Ownership	The project area is owned by MDA and shall be leased by Adenium for the project duration.
Workforce & Employment	New work oppurtuntues are expeted mainly construction phase and opetaion phase
Utilities and infrastructure	The utilities (e.g. power supply, water, telecomunications, sewage services) which the project construction and operation activities might have a potential impact upon.
Transport & Traffic	Road transport systems of the area in which the Project activities are to occur during the construction phase, and minory 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 EIA process are presented in table below for all planned and unplanned activities in addition to take natural disasters into consideration:

Table 17: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 Heritage	Liability / Reputation
Planned Activities																			
Construction	Access road to site	●	●	●			●	●		●	●	●			●	●	●	●	●
	Accommodations	●	●	●			●	●		●	●		●		●	●	●		●
	Haulage	●	●	●		●		●	●	●	●	●			●	●	●		●
	Site survey	●	●					●							●		●		●
	Site soil Investiagation	●	●	●	●	●		●			●				●			●	
	Clearing and grading	●	●	●		●	●	●	●	●	●	●			●	●		●	●
	Trenching & detching	●	●	●			●	●		●	●	●			●	●		●	●
	Excavation & digging	●	●	●			●	●		●	●	●			●	●		●	●
	Earthworks	●	●	●			●	●		●	●	●			●				●
	Mobilization/demobilization of labour & equipment	●	●	●		●	●	●	●	●	●	●			●	●	●		●
	Structures construction	●	●	●		●	●	●	●	●	●	●		●	●			●	●
	Waste generated from construction activities			●		●	●	●		●	●	●	●	●	●				●
	Wastewater generated by site workers			●		●	●	●		●	●	●	●	●	●	●			●
Operation	Wastewater discharge			●		●	●	●	●	●	●	●	●		●	●			●
	Municipal solid waste handling	●		●		●	●	●	●	●	●	●	●	●	●				●
	Hazardous/chemical waste storage and disposal	●		●		●	●	●	●	●	●	●	●	●	●	●			●

Activity	Receptor	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 Heritage	Liability / Reputation
	Chemical / oil storage	●		●		●		●	●	●	●	●	●		●				●
	Vehicles operation	●	●								●	●			●		●		●
	Maintenance activities	●	●	●		●	●	●		●	●	●			●	●	●		●
Decommissioning	Equipment Dismantling		●	●			●	●		●	●	●	●		●		●		●
	Demolishing	●	●				●	●	●	●	●	●	●		●		●		●
	Fence Removal		●					●			●	●	●		●		●		●
	Excavation & backfilling	●	●	●		●	●	●	●	●	●	●	●		●	●	●		●
Unplanned Project Activities																			
Construction	Vehicle collision	●	●	●				●	●	●	●	●	●				●		●
	Spill of chemicals or liquid fuels	●		●		●	●	●	●	●	●	●	●						●
	Ignitions of flammable materials / accidental fires	●		●			●	●	●	●	●	●	●				●		●
Operation	Vehicle collision	●	●	●				●	●	●	●	●	●				●		●
	Spill of chemicals or liquid fuels	●		●		●	●	●	●	●	●	●	●						●
	Ignitions of flammable materials / accidental fires	●		●			●	●	●	●	●	●	●				●		●
Natural Disasters																			
Construction	Earthquake "Seismic Activities"		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	
	Flooding			●		●	●	●	●	●		●	●	●		●	●		

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 Heritage	Liability / Reputation
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 MDA.

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 18 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 18: 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 19 is presenting the methodology of evaluation the overall impacts and ‘symbol’ takes into consideration that a degree of mitigation is applied.

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 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.

Table 19: Comparison of overall environmental impacts as a result of the Proposed Project against the 'No-Project' Alternative

Environmental Components	Project Options	
	Proposed Project	No-Project Alternative
Terrestrial Ecology	S-	*
Air Quality	*	*
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	*
Energy Production	S+	s-
Employment and Job Oppertunitiy	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. 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.

Figure 54presentsthe demand scenarios in correlation with the growth rate, in the following the description of these scenarios:

- The demand for primary energy for the year 2007 about 7858 thousand for the high demand scenario and 17108 thousand 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 to raise in the year 2020 to 13057 thousand at an annual growth rate of 4.5% for the period (2007-2020).

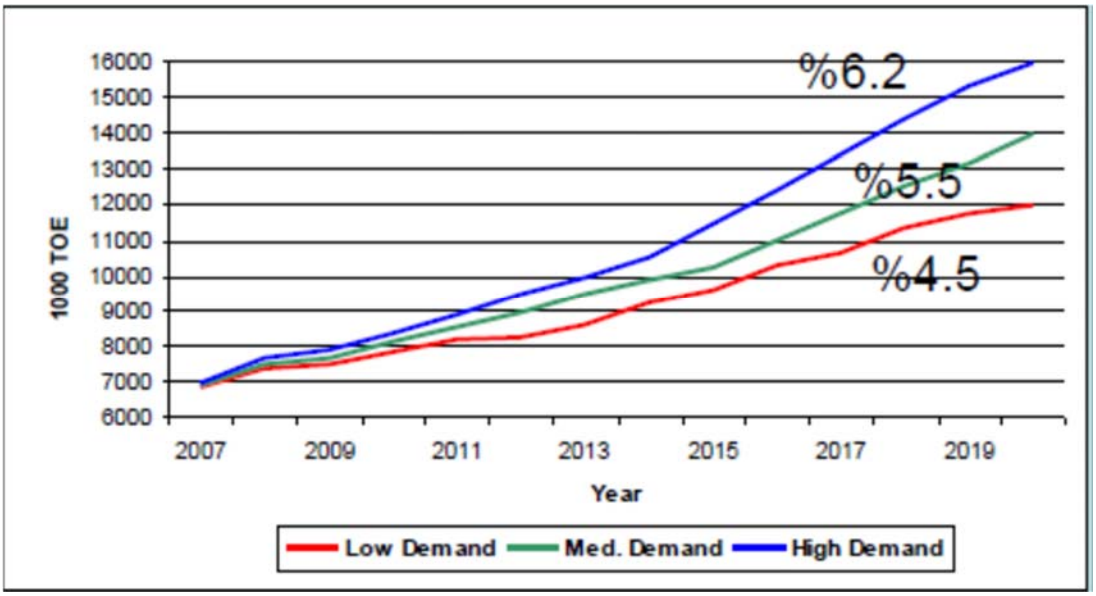


Figure 54: Energydemand inreasing rates.

The Energy strategy 2020 planning to increase the renewable energy as a clean technology for energy generation to cover 10% of total demand, as well as increase the local energy resources share to 39% of the total demand as illustrate in the figure below.

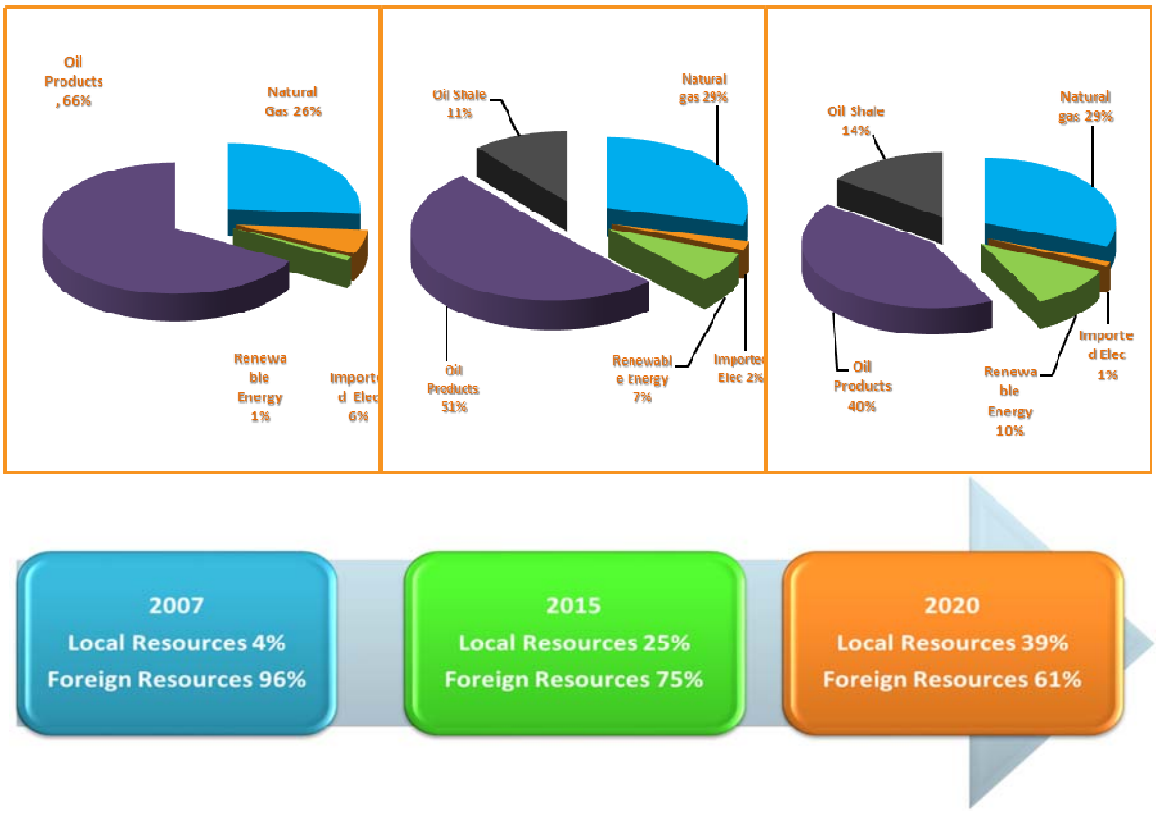


Figure 55:The Energy straegy up to the Year 2020

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[1] 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.
- High efficiency.

9. PV PROJECT LIFECYCLE GHG EMISSIONS

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 diagram below generated by the International Energy Agency (IEA, 2011)

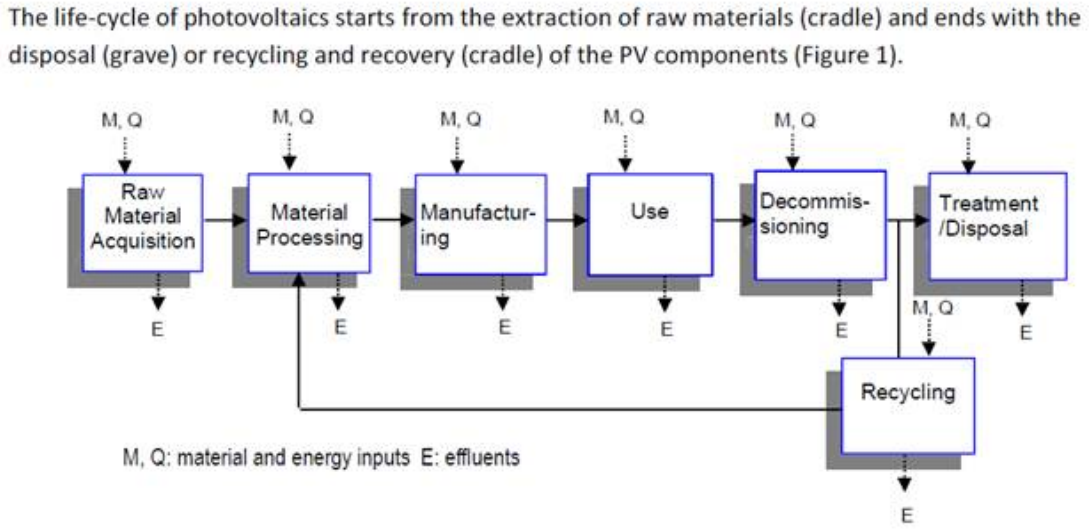


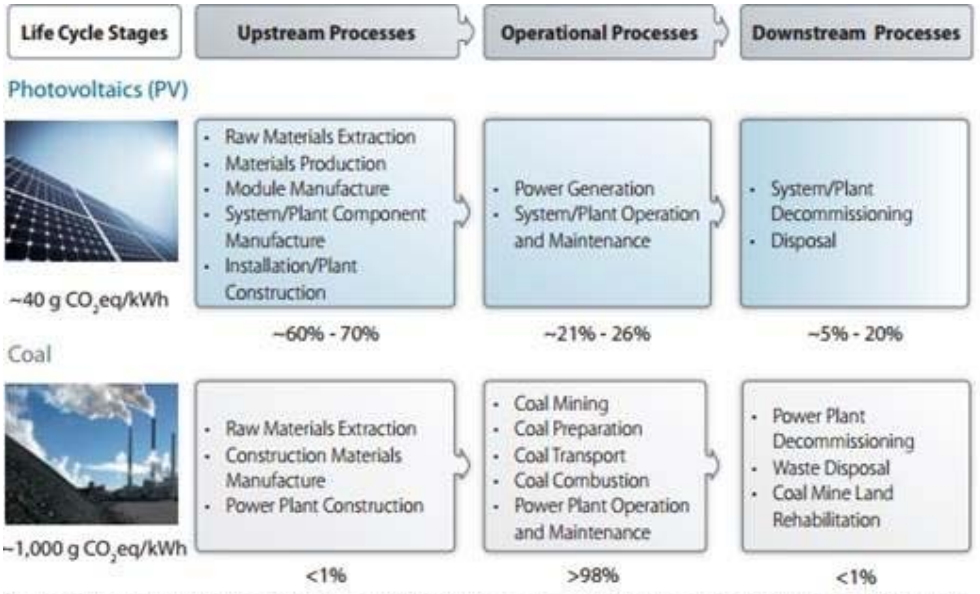
Figure 56: Material and energy inputs / outputs during the PV project lifecycle from cradle to grave (or cradle) (IEA.2011)

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/m2/yr
    - System lifetime at 30 years
    - Crystalline Module Efficiency at 14% and 13.2% respectively for mono and multi-crystalline modules , respectively
    - Performance ration 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 plantsas illustrated below.



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 57: 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 reaching up to 2800 kwh/m^2/yr in the project area near Ma'an as can be seen in the figure below.

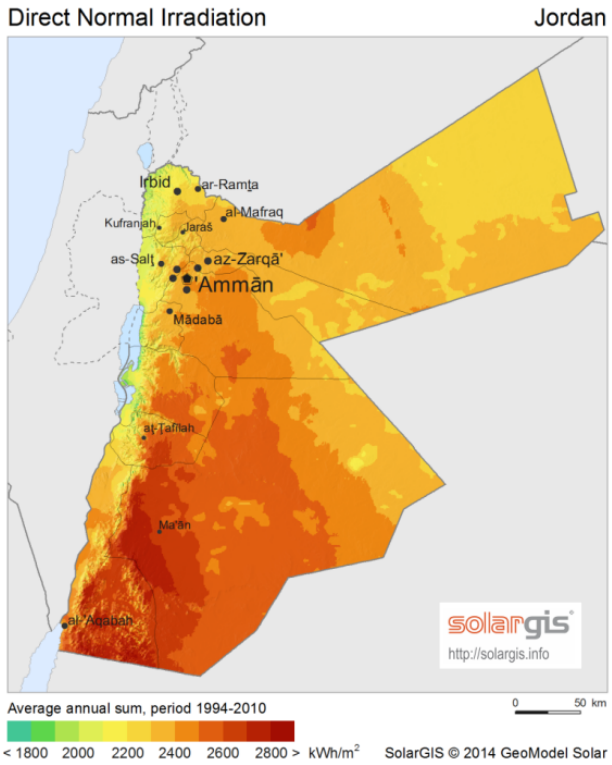


Figure 58: Jordan solar irradiation map in (kwh/m²/yr) (Source: solargis)

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.

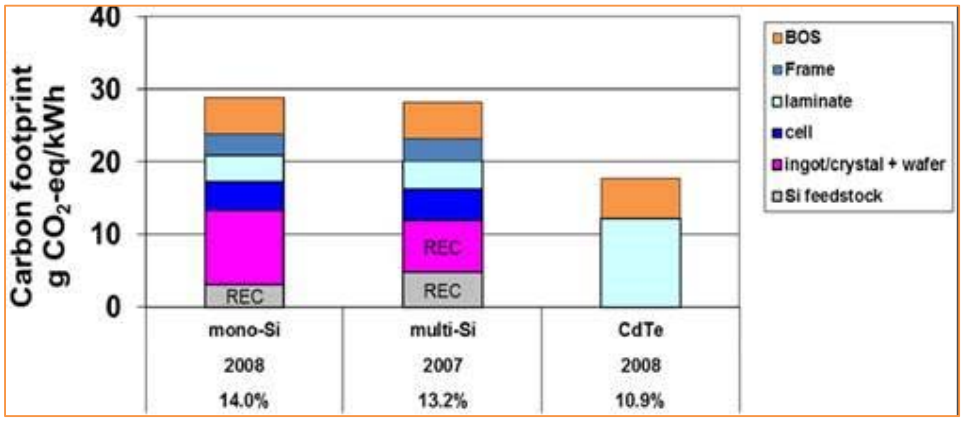


Figure 59: Carbon foot print of crystalline and thin-film roof mounted PV systems (IEA, 2011)

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 in the table below:

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

Figure 60: IFC Renewable Energy Emission Factors

Based on the above, for this 10 MW project, **292 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 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 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

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. This number is likely to be lower for this project considering that higher efficiency modules that will be used.

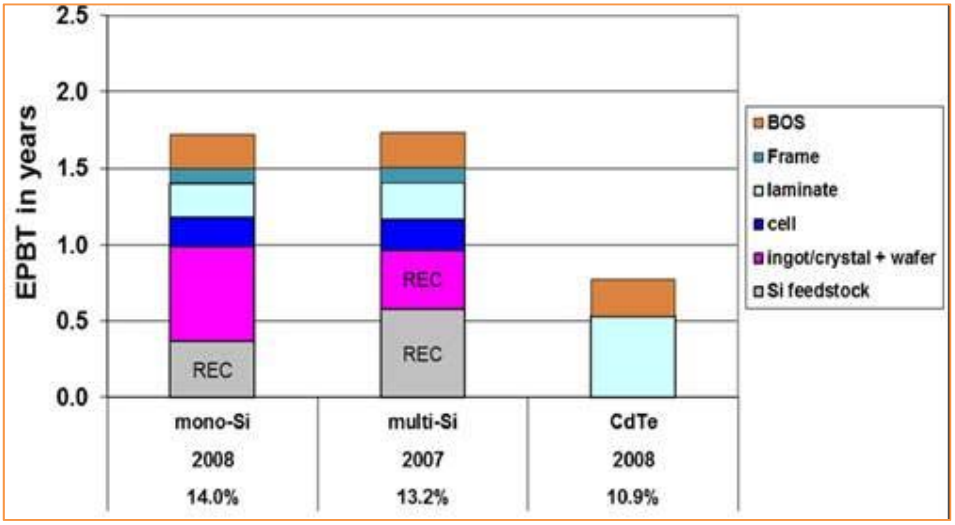


Figure 61: Energy payback time (EPBT) for PV technologies (Source: IEA,2011)

10. 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 assessmentcovers all Project areas and was undertaken in accordance with relevant MoEnv regulations and applicable local, national and international standards and guidelines.

10.1. 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 62below illustrates the EIA process adopted during the EIA study phases.

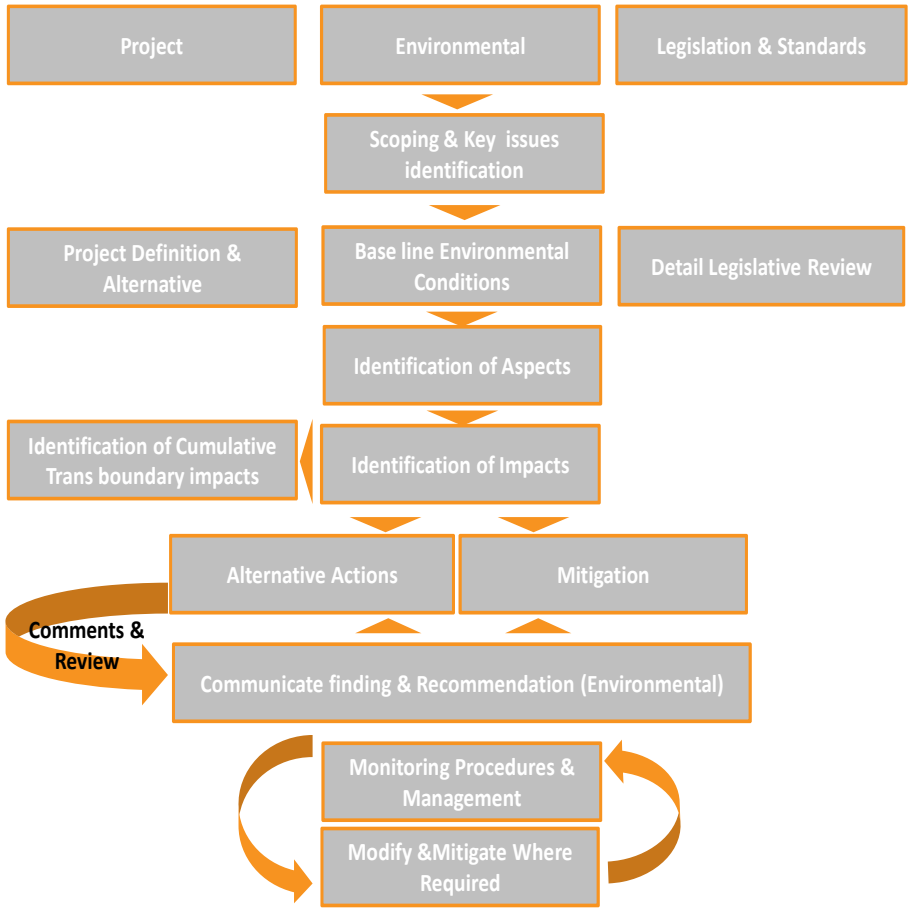


Figure 62: EIA Process

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.

10.1.1. 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 20.**

Table 20: 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 neighbourhood. 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.

10.1.2. Liklihood

To assign likelihood to each activity, five categories are defined and ranked. The criteria for likelihood are shown in **Table 21.**

Table 21: Liklihood 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

10.1.3. 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 63illustrates all possible product results for the five consequence and likelihood categories.

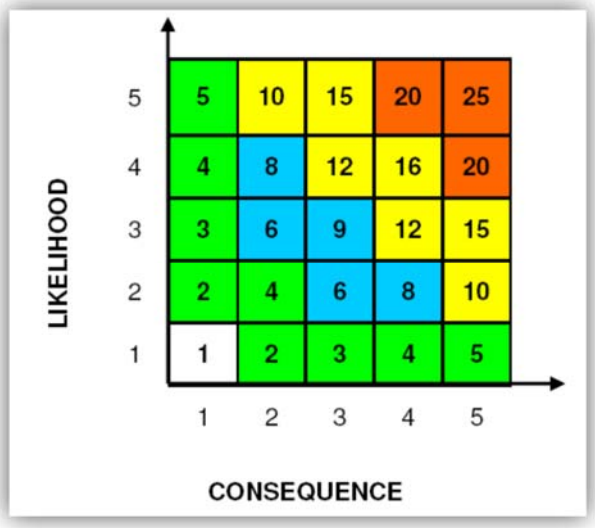


Figure 63: Product Results for Consequence & Likelihood Categories

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

Table 22: 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.

10.1.4. 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.

10.2. 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 Solar 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, solar 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 solar power plant.

- **Operation Phase:** This refers to the solar power plant operation processes.
- **Retrofit or Decommissioning Phase:**Following the operation phase, determination as to whether the facility can be retrofitted i.e. upgrade and addition to 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 will be quite similar.

10.2.1. Physical Environment

10.2.1.1. Soil

Construction Phase

Construction activities are not expected to result in significant soil loss; however excavation, leveling and other earthworks may disturb the soil due to the removal of top soil, which could trigger soil erosion process.

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, since the project area is designated for solar projects within MDA, they do not have any agricultural significance.

Through implanting spill response procedures, and proper storage and handling of any chemicals on site, the impact probability will be reduced.

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 possibleaccidental leakageof fuel, oil, or chemicals during demolition 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).**

10.2.1.2. Visual Amenity

Construction Phase

The construction activities that are likely to create a visual intrusion and a disruption to aesthetics include: materials lay down, excavation, backfilling, and spoil.

The project site consists of areas that are sparsely vegetated or have no vegetative covers, and hence no trees or bushes will need to be removed as part of construction. Also, there are no close communities that would be within the visual radius of the project. Therefore visual intrusions are anticipated to be limited to employees. Hence, the visual effects of the construction will be of low significance within the project area and largely limited to effect only employees living in the company's temporary camp facilities during construction (if any).

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 it is situated far from any airports, nor residential dwellings, moreover, no potential visual disturbance to birds are expected given the fact that IBAs located are far from the project area (almost 15 km away), and as a result, there is no migratory bird flyway over the project area.

Therefore, it is not anticipated that visual impacts will be generated due to the PV system design, which is specifically designed to include dark, light-absorbing materials and covered with an anti-reflective coating (ARC) for glass surfaces, which reduces the reflectance from PV panels to 2.5%-2.6% while at the same time improving their efficiency.

As a result, the reflectance of the PV modules is comparable to that of water or black asphalt; therefore, the project developer will select PV modules that are unlikely to constitute a risk for glare.

This technology utilized on the PV modules not only minimizes glare, but is also designed to trap more light, which gives the PV system a characteristic of being primarily absorptive, which make them suitable to be installed at airports.

It is 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 Solar power plant is considered **unlikely (2)** given that PV panels have very minimal reflectance, with a **negligible (1)** consequence, thus an overall impact significance of **low (2).**

Decommissioning Phase

During the dismantling of the solar 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 solar 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.

10.2.1.3. 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 project developershall 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 SO2, NOx, CO, CO2, and PM10 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 areaand 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 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).** Therefore, no mitigation measures are needed.

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.

10.2.1.4. Noise

Construction Phase

Construction activities for solar power plant will contribute to noise impacts. There are several noise generating activities such as opening access roads to construction personnel camp and facilities (if needed), 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 community to the project area is the city of Ma'an which is approximately 8 km away from the industrial park.Hence, it can be considered that the only people who could potentially be impacted by the noise are the employees working within the project site; these increased noise levels are considered occupational noises that require occupational health and safety measures. 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.

However, these noise impacts are not considered to significantly harm animals nor cause impacts on a population level.

Since the activities will occur under normal operating conditionsand 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 solar power as a facility is not considered to exhibit any significant noisy operations, although the facility's inverters and transformers may produce noise, but this is not considered a serious issue, since they will not generate any significant noise. In addition, there will be no close by sensitive receptors such as labor camps or residential dwellings within the project site.

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 solar 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 solar 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.

10.2.1.5. Water Resources

The water resources impact are divided in ground and surface water resources., the impact assesmsnt for both are below sections:

Construction Phase

Surface water

The MDA prepared a hydroloic and hydrology analysis report. The hydrology anaylsis was built based on the data received from the Ministry of Water and Irrigation included locations of dams and other water harvesting structures, meteorological stations, wells location, and base flows and floods in wadis in the Ma'an municipality. The information have been filtered in order to identify the locations of different water sources within or affecting the catchment area of the project site, as shown in the below figure

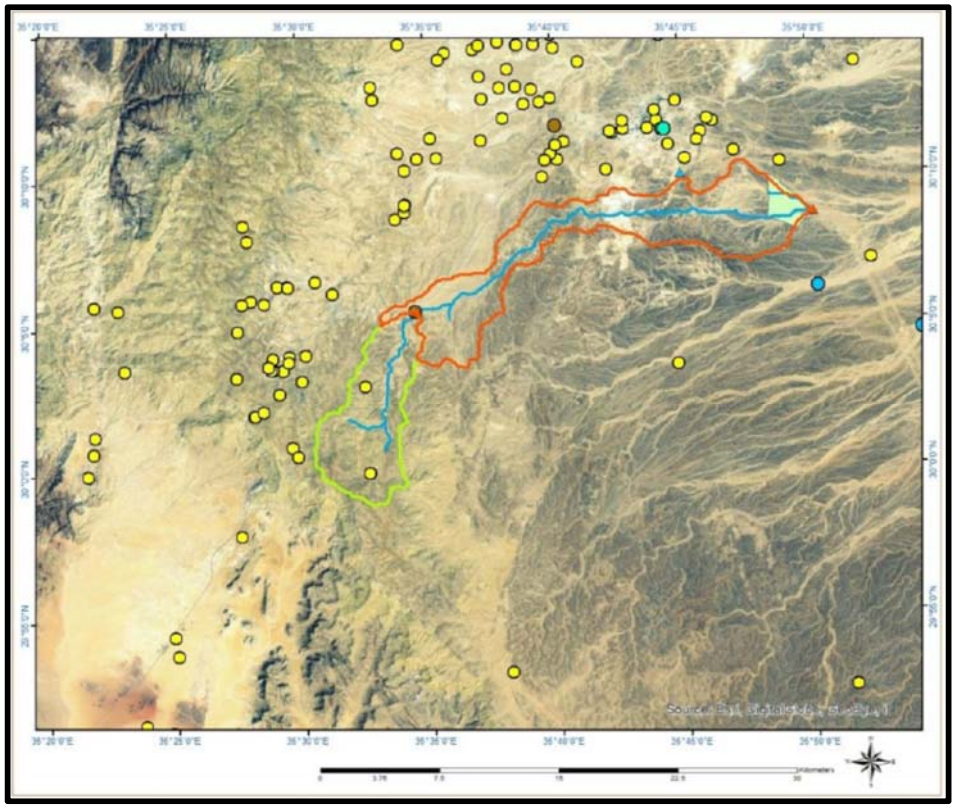


Figure 64: Map of wells, rainfall and water level measuring stations

The proposed road passing through the site cuts the wadis. These intersection points need to be looked at to avoid water overflowing and damaging the street. In order to carefully study the flow paths on site, WMS software was used to predict flow accumulation according to 0.5m contours collected by the project surveyor. Figure below shows the critical points (in Red) where hydraulic structure will be needed as shown in the next figure..

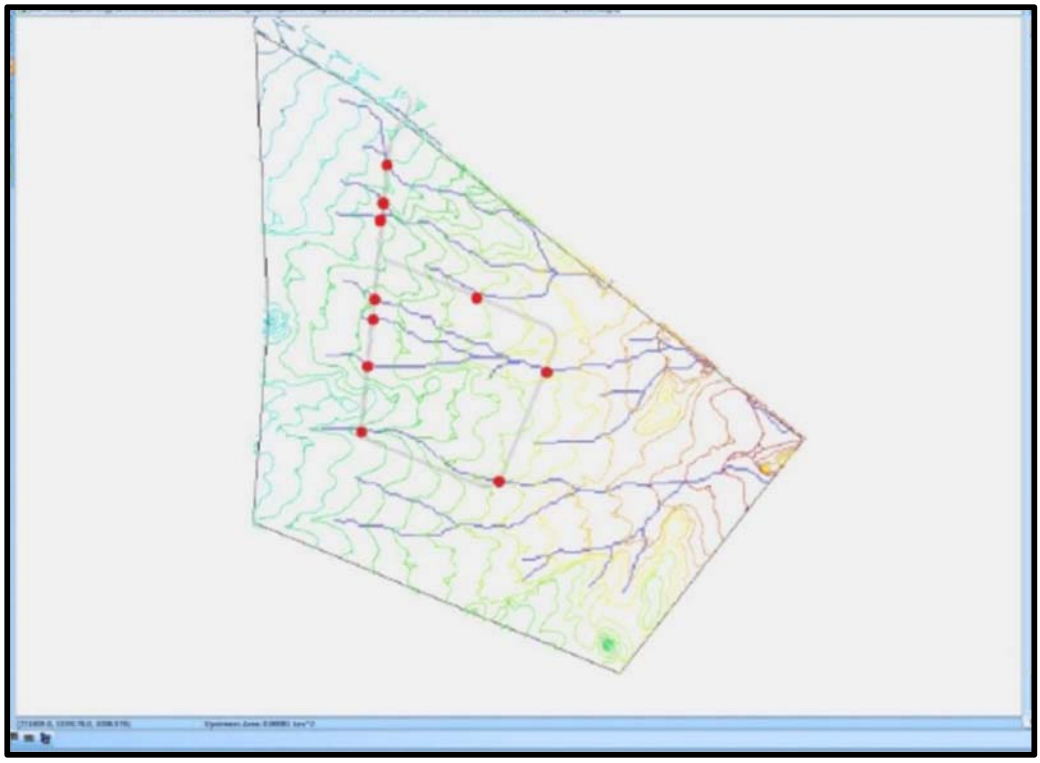


Figure 65: WMS Simulation for Wadi and Road intersection Points

The Model calculated the peak flow and the design for water protection structures is necessary. There already exist culverts onsite that help drain water from the site, however, the proposed service road should be protected from possible flooding. The flow paths onsite have been predicted using WMS software to identify the location of high flooding risk where the mitigation measures to eliminate the risk in the ESMP in next section.

A conservative approach was taken to estimate the number, type, and location ofneeded culverts. The peak flow of the site was assumed to be passing through theproposed road. Culvert Master, a wildly used hydraulic design software, was used toestimate the dimension and number of the needed culverts for the peak flow of 22m3/s. The street profile wasstudied to determine the best location of the culverts. The total number of culvertscame out to be 10, distributed at wadi and road intersections according to calculatedflow. Figure below show the location of culvert installation.

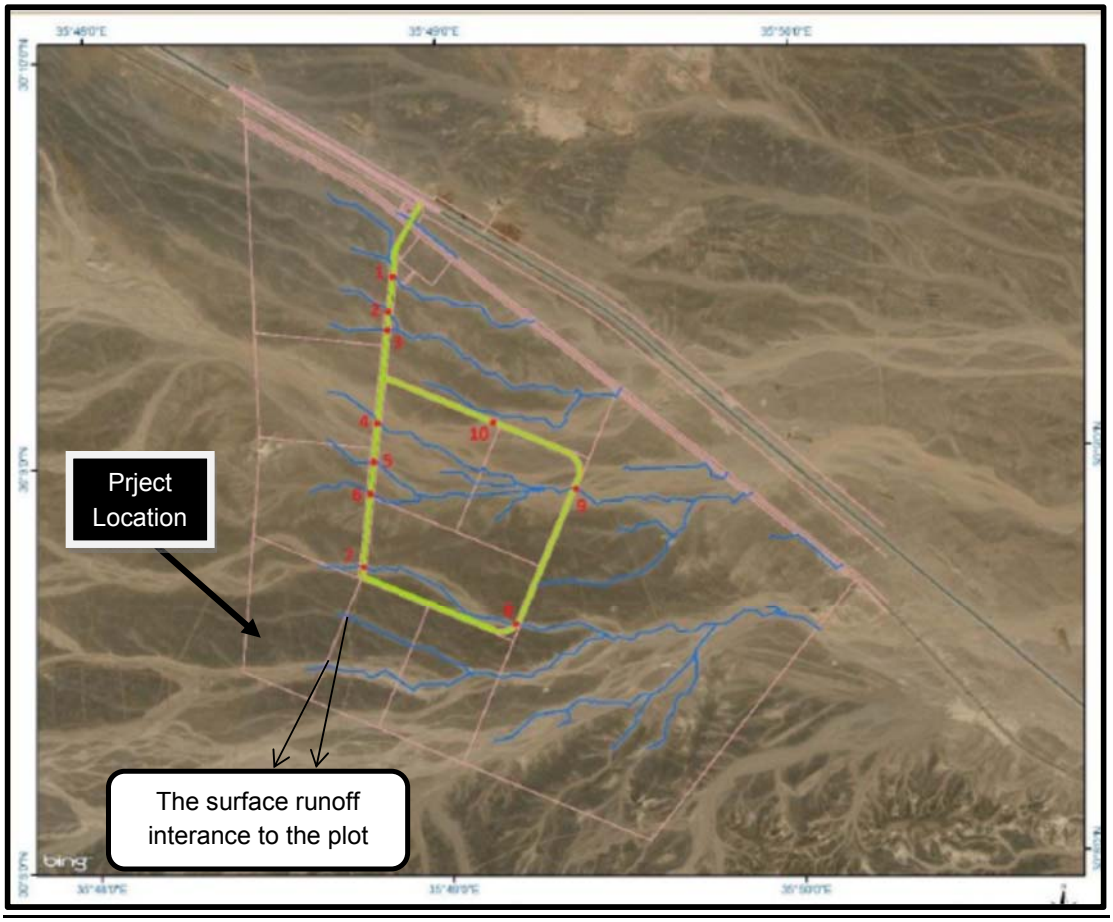


Figure 66: Culvert Location under Proposed Road

Based on the above, surface water runoff is considered a significant impact to the project and the infrastructure,in addition to the environment. Therefore, the impact likelihood is assessed as **likely (3),** with a **Critical (3)** consequence, yielding a **Medium (9)** impact significance.

Operation and Decommissioning Phases

Potential impacts to surface water and groundwater during operation and decommissioning phases are not anticipated given that fact that proposed mitigation measures will be implemented during the construction phase of the project.

Ground Water

As describe in the baseline, Current use of Jafer already exceeds the available renewable supplies and resulting in lowered water tables and deteriorating water quality, whilst, the high water table level not exceed 1100 m above the sea level.

The project activities during three phases construction, operation, and decommission will not impact the ground water since the water table level is very deep in project location,

The ground water resources during the project phases are considered insignificant impacts to the environment or health on site and ground water quality. Therefore, the impact likelihood is assessed as **very unlikely (1),** with a **negligible (1)** consequence, yielding a **negligible (<2)** impact significance.

10.2.1.6. Waste Generation

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 construction site will be 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 wastes 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 generated at site will be collected in septic tanks. These shall be transported to the nearest approved municipal wastewater treatment facility.

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 present on site. Therefore, the impact likelihood is assessed as **very unlikely (1),** with a **negligible (1)** consequence given that the number of personnel on site during operations will be minimal (less than 5 persons), yielding a **negligible (<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 his 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.

It is not expected that hazardous wastes will be generated from dismantling the solar power plant since the project developer will opt for recycling PV panels of the facility.

Therefore, 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).**

10.2.2. Terrestrial Ecology

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 baseline description, the project area does not encompass natural systems, which means that no significant flora and fauna are present.

As a result, construction activities are not anticipated to pose any risks on the terrestrial ecology within or in the vicinity of the project site.

However, it may cause temporary disturbance to resident birds with ground nestsdue to noise, dust and particulate emissions, and possible illegal hunting by construction workers. Moreover, reptiles 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 does not encompass any natural systems and characterized with sparsely vegetated wadis supporting low population sizes of desert dwellers

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 solar power plant and removal 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).**

10.2.3. Health and Safety

Construction Phase

The construction activities include site preparation, infrastructure utilities installation, building structures. Therefore, there 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 causes of accidental death and injury are:

Safety Risks:

- Tripping due to uneven surfaces, obstacles, trailing cables: the impact likelihood is **likely** (**3**) with **marginal** (**2**) consequence, as a result, the impact is found to be of **medium** (**6**) significance.
- Falling during working at height due to fall from fragile surfaces, roof edges and ladders: the likelihood impact is **unlikely** (**2**) with **critical** (**3**) consequence, as a result, the impact is found to be of **medium** (**6**) significance.
- Fire due to hot works, smoking, failure in electrical installations: the impact likelihood is **unlikely** (**2**) with **marginal** (**2**) Consequence, as a result, the impact is found to be **low** (**4**) significance.
- Mobile plant and vehicles: the likelihood impact is very **unlikely** (**1**) with **Critical** (**3**) Consequence, as a result, the impact is found to be of **low** (**3**) significance.
- Electrical shocks: the impact likelihood is **likely** (**3**) with **critical** (**3**) Consequence, as a result, the impact is found to be **medium** (**9**) significance.

Health Risks

- Manual handling and musculoskeletal disorders: typical construction activities that can cause injury such as lifting, lowering, pushing, pulling and carrying, the impact likelihood is **likely** (**3**) with **marginal**(**2**) consequence, as result, the impact is found to be **medium** (**6**) significance.
- Hand-arm vibration: people work with hand-held or hand-guided power-tools and machines, such as: concrete breakers, pokers and compactors, sanders, grinders and disc cutters, hammer drills, chipping hammers, chainsaws, scrabbles and needle guns. The impact likelihood is **unlikely** (**2**) with **marginal** (**2**) consequence, as result, the impact is found to be **low** (**4**) significance.
- Temporary or permanent hearing loss which usually comes from noise generated from machinery used for excavation or piling work and from compressors and concrete mixers etc. The impact likelihood is **unlikely** (**2**) with **critical** (**3**) consequence, as result the impact is found to be **medium** (**6**) significance.

- Heat stress and working during high temperatures: the impact likelihood is **likely** (**3**) with **marginal** (**2**) Consequence, as a result, the impact is found to be **medium** (**6**) significance.
- 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 impact likelihood is **likely** (**3**) with **marginal** (**2**) Consequence, as a result, the impact is found to be **medium** (**6**) significance.

Therefore, the Contractor, under the supervision of developer, 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 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 producers through training, awareness and supervising. Moreover, the contactor shall provide all appropriate resources (Personnel and Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

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.

- Slipping and tripping: the impact likelihood is **veryunlikely** (**1**) due to uneven surfaces, obstacles, trailing cables, and wet or slippery surfaces with **marginal** (**2**) consequence, as a result, the impact is found to be of **low** (**2**) significance.
- Falling during working at height is **unlikely** (**2**) due to fall from fragile surfaces, roof edges and ladders with **marginal** (**2**) consequence, as a result, the impact is found to be of **low** (**4**) significance.
- Fire: the impact likelihood is **unlikely** (**2**) due to smoking, failure in electrical installations with **marginal** (**2**) Consequence, as a result, the impact is found to be of **low** (**4**) significance.
- Heat stress and working during high temperatures: the impact likelihood is **veryunlikely** (**1**) with **negligible** (**1**) Consequence, as a result, the impact is found to be **negligible** (**<2**) significance.

Therefore, the project developer shall ensure all risks from operation activities to be assessed and to establish specific work procedures for tasks during operation phase including all safety prevention and mitigation measures to avoid non-conformance events.

Decommissioning Phase

The decommissioning activities will include equipment dismantling and 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:

- Tripping due to uneven surfaces, obstacles, trailing cables: the impact likelihood is **likely** (**3**) with **marginal** (**2**) consequence, as a result, the impact is found to be of **medium** (**6**) significance.
- Falling during working at height due to fall from fragile surfaces, roof edges and ladders: the likelihood impact is **unlikely** (**2**) with **critical** (**3**) consequence, as a result, the impact is found to be of **medium** (**6**) significance.
- Fire due to hot works, smoking, failure in electrical installations: the impact likelihood is **unlikely** (**2**) with **marginal** (**2**) Consequence, as a result, the impact is found to be **low** (**4**) significance.
- Mobile plant and vehicles: the likelihood impact is very **unlikely** (**1**) with **Critical** (**3**) Consequence, as a result, the impact is found to be of **low** (**3**) significance.
- Electrical shocks: the impact likelihood is **likely** (**3**) with **critical** (**3**) Consequence, as a result, the impact is found to be **medium** (**9**) significance.

Health Risks

- Manual handling and musculoskeletal disorders: typical construction activities that can cause injury such as lifting, lowering, pushing, pulling and carrying, the impact likelihood is **likely** (**3**) with **marginal**(**2**) consequence, as result, the impact is found to be **medium** (**6**) significance.
- Hand-arm vibration: people work with hand-held or hand-guided power-tools and machines, such as: concrete breakers, pokers and compactors, sanders, grinders and disc cutters, hammer drills, chipping hammers, chainsaws, scrabbles and needle guns. The impact likelihood is **unlikely** (**2**) with **marginal** (**2**) consequence, as result, the impact is found to be **low** (**4**) significance.
- Temporary or permanent hearing loss which usually comes from noise generated from machinery used for excavation or piling work and from compressors and concrete mixers etc. The impact likelihood is **unlikely** (**2**) with **critical** (**3**) consequence, as result the impact is found to be **medium** (**6**) significance.
- Heat stress and working during high temperatures: the impact likelihood is **likely** (**3**) with **marginal** (**2**) Consequence, as a result, the impact is found to be **medium** (**6**) significance.
- 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 impact likelihood is **likely** (**3**) with **marginal** (**2**) Consequence, as a result, the impact is found to be **medium** (**6**) significance.

Therefore, the project developerwill 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.

10.2.4. Socio-economics

10.2.4.1. Employment Opportunities

Construction and Operation Phases

Positive benefits of the project may arise either from short-term job opportunities during construction, or long-term job opportunities during operation. It is important that construction and operation jobs to be targeted to the local people within Ma'anGovernorate where feasible.

Moreover, MDA plays a significant role in the training and employment process since it is considered a one-stop-shop for investors who can obtain potential candidates through MDA according to their need. In addition, MDA currently collaborates with vocational training centers to train persons (including males and females) on several relevant topics that will enable the local community to find employment opportunities within the industrial park that are not only limited to the proposed solar projects, but to other industrial developments in the area.

As a result, the impact significance can be considered **Positive (+).**

Decommissioning Phase

Short-term job opportunities may be arise during decommissioning, however, this can negatively impact permanent personnel at the solar 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.

10.2.4.2. Economy and Society

The project is anticipated to have benefits to society since it will contribute to skill transfer to Al Hussein Bin Talal University, and will provide a clean and pollution free energy, as a result, improved public health.

Moreover, solar projects in Jordan are expected to improve Jordan's economy as more investors are attracted to the MDA area to establish clean energy projects, this will consequently provide electricity for the sectored communities within the southern parts of Jordan.

The solar projects will also lead to upgrading the economic status of the local community in addition to potential increase in land prices and improvement in welfare conditions in the long run. Therefore, this impact is considered to be **Positive (+).**

10.2.4.3. Traffic

Construction Phase

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. 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.

Operation Phase

Impacts from traffic are not expected to occur during the operation phase due to minimal 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.

Decommissioning Phase

The anticipated impacts during decommissioning are similar to those for the construction phase, where the heavy machinery that transports disassembled parts of the project solar 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).**

10.2.5. Archaeology and Cultural Resources

Construction & Decommissioning Phases

The field visits conducted at the project site and published studies determined that there are no evident archaeological and cultural heritage sites within the project's plot B4.

Although it is very unlikely that undiscovered archaeological remains are present, the consequence of finding such remains will be minor if construction was coupled with effective monitoring and early coordination with the Jordanian Department of Antiquities. 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 the 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).**

11. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The project developer is committed to achieving and maintaining environmental standards, such that Jordanian environmental regulations 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.

11.1. 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 monitoring programs;
- Periodic review of the Environmental 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.

11.2. 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 EIA 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 23: Environmental and Social Management Plan during Construction Phase

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
Physical Environment							
Soil	Soil disturbance due to removal of top soil, potential accidental spillage	• 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 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. • 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 storage area, and machinery through conducting regular audits of on-site activities and incident reporting forms. All site workers to be trained in spill response procedures.	Weekly	All unplanned incidents/accidents must be recorded by the contractor.	Number of spills or incidents to be recorded during on-site audits. Training records of personnel trained in spill response procedures must be filed	Contractor
Visual Amenity	Visual impacts from construction activities such as materials lay	• The contractor shall ensure general cleanliness and good housekeeping practice at the project site at all times.	Visual inspection of general housekeeping and cleanliness at site in addition to waste	Daily	N/A	Good housekeeping and tidiness of work areas within the project site.	Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	down, excavation, backfilling		manage-ment on site.			The fill material is maintained in a clean and tidy manner.	
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	Contractor shall prepare and submit a report to the project developer in the case of compliants	No visible dust plumes originating from constructio n sites.	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 maintenanc e records	Contractor
Noise	Increased noise levelsduring to	• The contractor shall use heavy equipment, machinery, and fuels in compliance with national regulations. The contractor shall perform regular maintenance on all	Noise measurements to be undertaken	Every 6 months, and after receiving	To project developer case of any exceedanc	Compliance with MoEnv and National	Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	constrcution & machinery	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.	during construction activities, at the site in order to dem-onstrate compliance with the National environ-mental noise guidelines using a portable noise meter.	any com-plaints from workers or third parties.	e	guideline limits for environmental noise at sensitive receptors:	
Water Resources	Potential surface water runoff due to high precipitation	Avoid risks from high rainfall and potential flooding the following measures might be necessary for structure and road protection: • Stone ''rip-rap'' or beaching: lining the banks with some rocks or pebbles with a diameter greaterthan 6.26 cm for wadi bed and 4cm for banks. • Gabions: a cage cylinder or box filled with rocks, concrete, or sometimes sand and soil used for protecting the road. A gabion wall is a retaining wall made of stacked stone-filled gabions tired together with wire. • Cross veins, weirs or J-hooks from natural materials found on site to decrease the velocity of flow in thw wadi and redirect currents away from road to reduce accelerated flow. • Study the wadi path within the plot and the surface water runoff from road culvert(s) in order to	Follow-up with Ministry of Water and Irrigation and MDA (if needed)	During rainy seasons	To project developer in case of high precipitation events.	N/A	Contractor in collaboration with project developer

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		construct the suitable hydraulic structure within the plot such as channels and/ or culverts to reach the adjacent wadi.					
Waste Generation	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. • The sanitary and organic wastes shall be collected in a septic tankto be installed on siteand disposed offregularly.	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 report to Project Developer.	Compliance with waste management procedures. Current and complete records of regular waste pickup and disposal.	Contractor
Terrestrial Ecology							
Terrestrial Ecology	Potential disturbance to birds	• Minimize human and vehicular contact with fauna, including their burrows / nests and feeding grounds. • Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on	Visual inspection within project site.	During mi-gration season	N/A	N/A	Contractor

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		site.		(in spring and autumn)			
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	• 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. • 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.	Visual inspection by user before each activity Routine Inspection of Equipment and tools used during working at height activities Maintain proper housekeeping for the project site Routine Facilities' and site Inspection Vehicles and mobile plants inspection Preventive maintenance and patrol	Prior activity Monthly Continuously Monthly Pre-Use Monthly	Contrctors shall prepare and submit monthly report to the developer	Total Recordable Incidence Rate(TRIR) Lost Time Incidence Frequency Fatal Accident Rate Number of safety training performed Number of non-conformance events. Reports.	Contractor and developer

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		• 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 response plan (ERP) with all parties, the ERP 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 • 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 minimise 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	inspections for all vehicles and mobile plant Monitor work areas and activities to identify fire and explosions hazards. Fire Emergency Response Drills Inspection for fire extinguishers, testing for fire detection system, and other fire fighting equipment. Maintenance for fire extinguishers,	Continuously Based on Fire risk assessment Monthly Semi-annually			

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		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 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.	testing for fire detection system, and other fire fighting equipment.				
	Exposure to health events during construction activities such as manual handling and musculoskeletal disorders, hand-arm	• 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	Monitor the health of workers Monitor work areas and operations to identify noise hazards. Inspection for use hear	Continuously Continuously Prior Use	Contrctors shall prepare and submit monthly report to the developer	Total Recordable Incidence Rate(TRIR) Lost Time Incidence Frequency Fatal Accident Rate	Contractor and developer

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	vibration, temporary or permanent hearing loss, heat stress, and dermatitis	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 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.	protection equipment Fit Testing Maintenance & Care for Hear protection equipment.	 Annually Monthly		Medical Treatment Case (MTC) No. Restricted Work Day Cases (RWDC) No. Restricted Work Days (RWD) HSE Training Hours Number of non-conformance events. Reports	

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							

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
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.	Obtain open dialogue with the MDApotential contractors for neighbouring projects that happen to be ongoing during the same time. Monitor vehicle movement to and from the Project area.	Continuously	All incidents to be reported to project management contractor and to traffic department.	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	Contractor
Archaeological Resources & Cultural Heritage							
Archaeology & Cultural Resources	Only potential con-cern can be impacts on possible unseen archaeological sites/remains	• All construction works shall be ceased if any historical or archaeological sites are chance found during construction. • In the event potential archarological and/or cultural resources are discovered during construction activities, the Department of Antiquities (DoA) shall be invited for consultations and assessment of the finding.	• Minimum of one site inspection immediately after chance find. • Informing	One site inspection after chance find	To Department of Antiquities (DoA) in case of chance	N/A	Contractor / Department of Antiquities (DoA)

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	(chance finds)	• Work shall be resumed only after archaeological experts from DoA and official authorities are consulted and appropriate mitigation measures are implemented.	personnel present on site of chance find procedures in case any archaeological or cultural resources were encountered		finds.		

Table 24: 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	• 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.	Project Developer
Visual Amenity	Potential glare from PV panels	The used technology has Anti- Reflective coating (ARC) that significantly reduce the refelectance of the Pannels (from 2.5% to 2.6% only).	N/A	N/A	N/A	N/A	Project developer
Terrestrial Ecology							
Terrestrial Ecology	Potential disturbance and harm to birds	• Minimize human and vehicular contact with resident birds including their burrows / nests and feeding grounds. • Groundnests found on site shall be translocated outside the industrial park's boundary. • Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	Visual inspection within project site.	Weekly	To developer's top management	No reported harm to birds.	Project Developer

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
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	• 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. • 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	Routine Inspection of Equipment and tools used during working at height activities Maintain proper housekeeping for the project site Routine Facilities' and site Inspection. Monitor work areas and activities to identify fire and explosions hazards. Fire Emergency Response Drills Inspection for fire extinguishers, testing for fire	Monthly Continuously Monthly Continuously Based on fire Assessmnet Monthly	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. Reports.	The developer

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
		identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. • Establish and communicate emergency response plan with all parties, the ERP 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.	detection system, and other fire fighting equipment. Maintenance for fire extinguishers, testing for fire detection system, and other fire fighting equipment.	Semi-Annually			
Socio-economics							
Traffic	Potential minimal increase of	Implementation of a regulated entrance and exsit into the facility.	Monitoring of access roads around site	Daily	All incidents reported to the proper	Number of complaints from road	Project Developer

Aspect	Key Potential Impact	Mitigation Measures	Monitoring Requirements	Frequency	Reporting	Performance Indicator	Responsibility
	traffic load		Record complaints received from locals or authorities.		authority and to Ma'an Development Company (MDC).	users.	

11.3. 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 be approximately 20 years. Therefore, the post-design life is expected to involve 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. However, this, EIA Study has considered potential decommissioning impacts in case there was a need for the facility to be dismantled and end operations.

As can be noted from the impact assessment chapter 10, 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 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.

Therefore, to avoid repetition, please refer to **Table 23**for detailed mitigation measures that are overlap with decommissioning as well.

12. REFERENCES

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- Water Resources in Jordan, GTZ, 2004.
- Environmental Profile of Jordan, MoEnv. 2006.
- IFC Climate Business Group, GHG Accounting Guidance Note: Manufacture of Renewable Energy Climate Related Products, September 2011
- International Energy Agency (IEA), Life Cycle Inventories and Life Cycle Assessments of Photovoltaic Systems, Report IEA-PVPS T12-02:2011, 2011
- National Renewable Energy Laboratory (NREL), US Department of Energy Life Cycle Greenhouse Gas Emissions from Solar Photovoltaic, 2012
- WWW.flood map.net.
- www.hse.gov.uk/guidance/index.htm

APPENDIX A

Air Quality Report

Ambient Air Quality Monitoring at *Ma'an MDA Zone*

Progress Report

(9-15,June 2014)

Location: MDA zone Station.

Coordinates: 36 R 0771283 N 30°10.359
3341281 E 35°49.026

Major Findings:

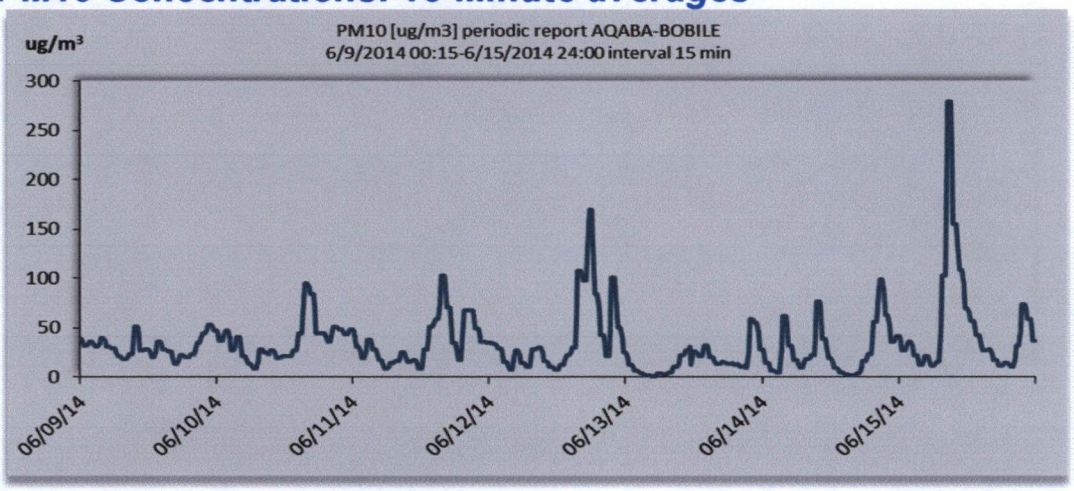
- No exceedances were recorded to the maximum allowable limits for other pollutants that specified in Jordanian standards (1140/2006).

▶Table (1): Maximum Averages

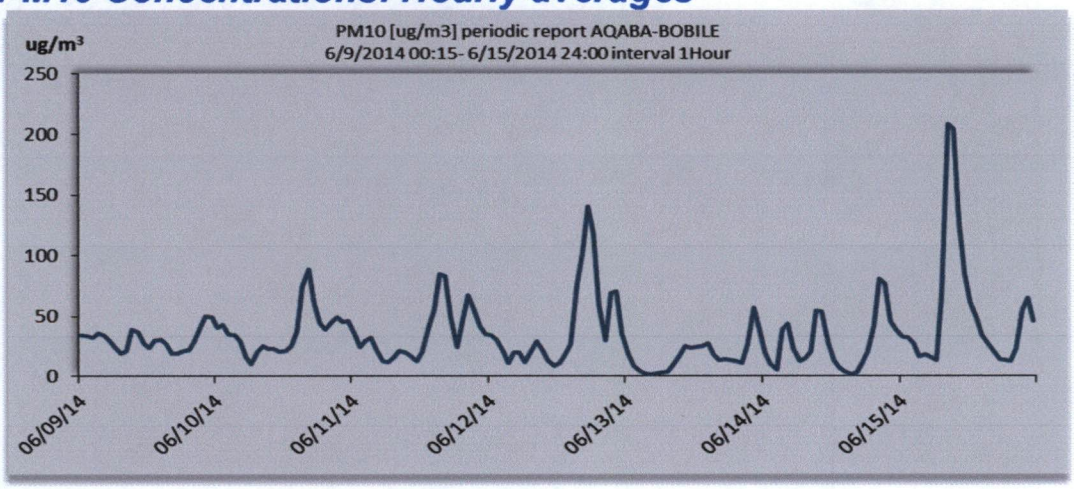
Pollutant	Max. 15-Min. Average	Max. Hourly Average	Max. Daily Average	JS Allowable Max.	
				Hourly	Daily
PM10, µg/m^3	269.1	208.5	52.9	---	120
PM2.5, µg/m^3	56.5	51.8	23.4	---	65

Detailed tables of all relevant averages of all parameters are shown in Annex (1).

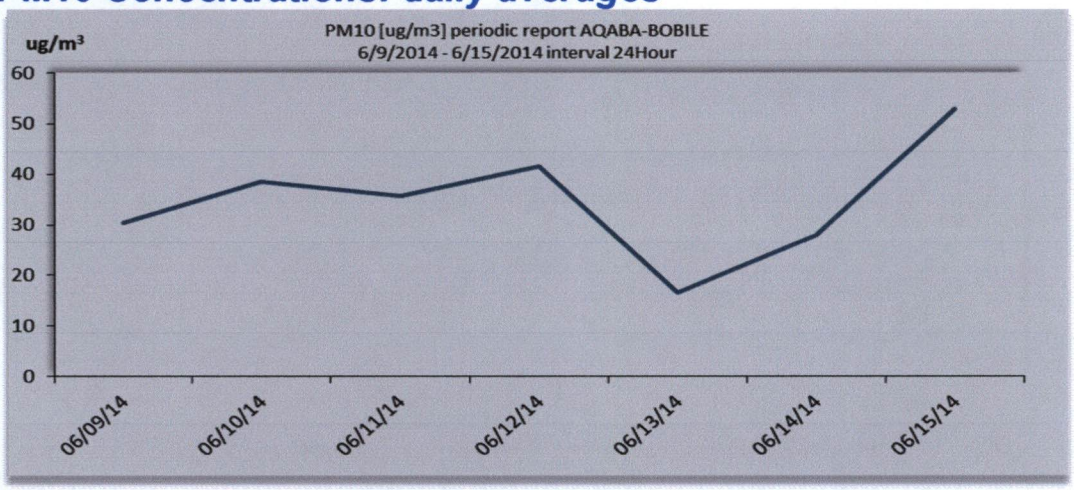
PM10 Concentrations: 15-Minute averages



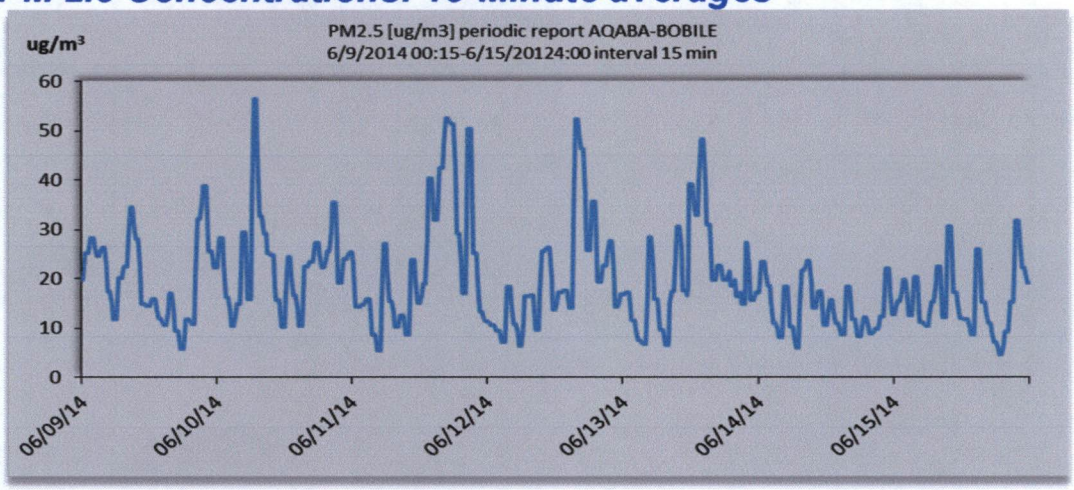
PM10 Concentrations: Hourly averages



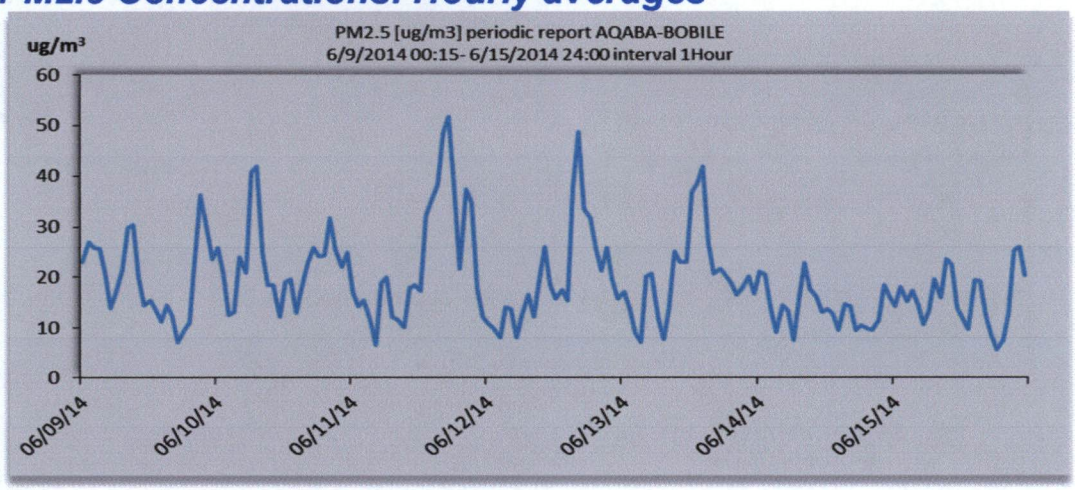
PM10 Concentrations: daily averages



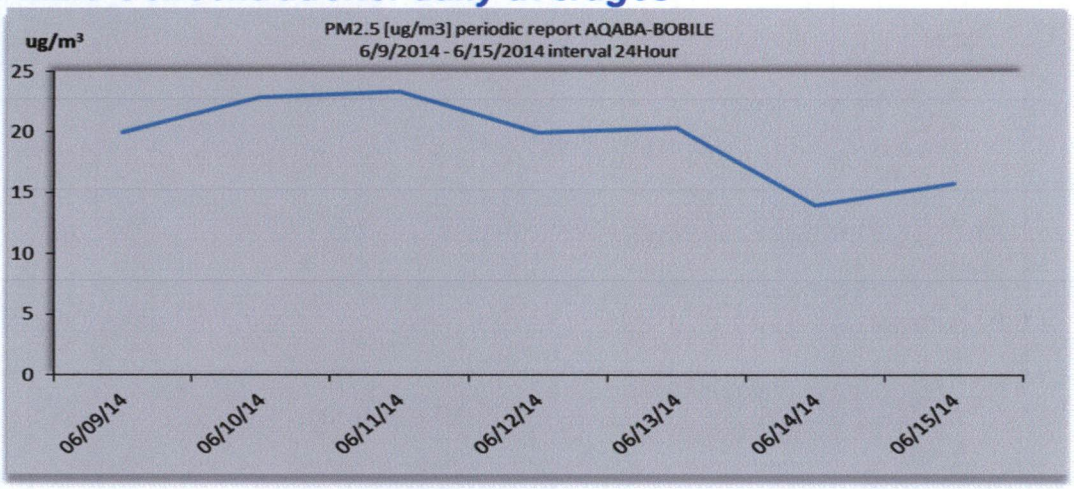
PM 2.5 Concentrations: 15-Minute averages



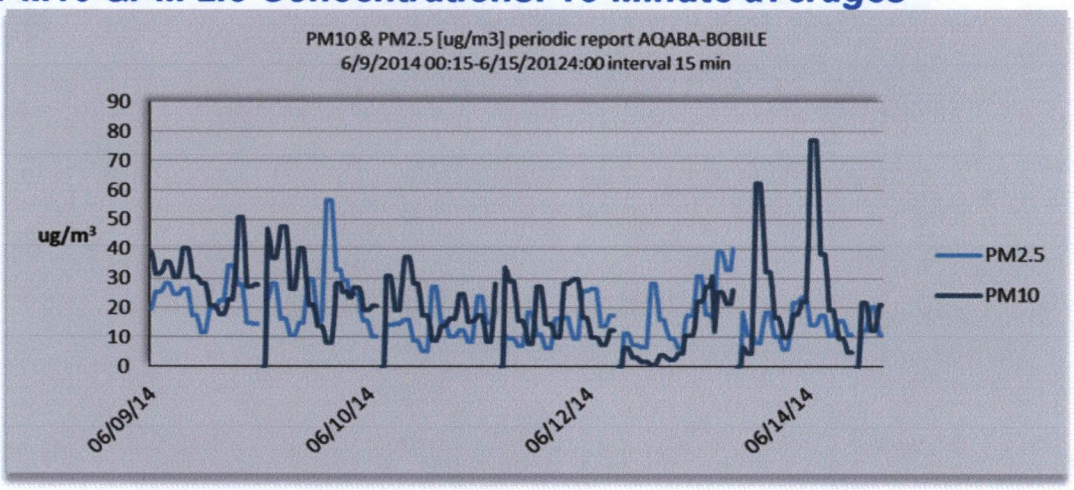
PM2.5 Concentrations: Hourly averages



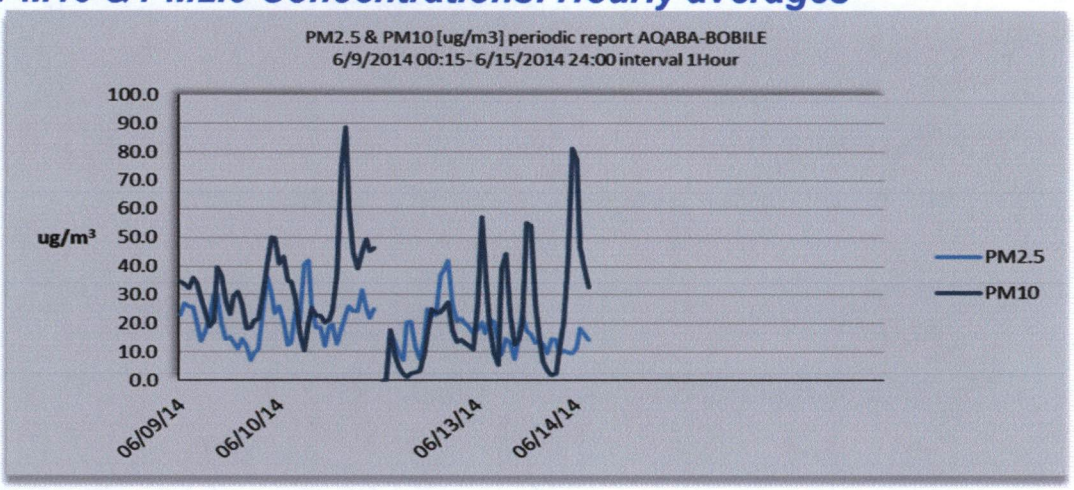
PM2.5 Concentrations: daily averages



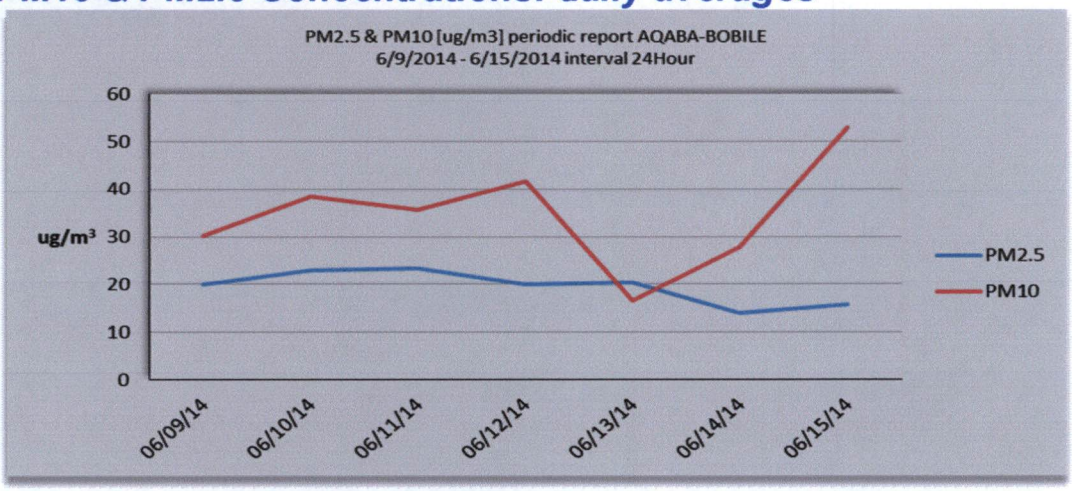
PM10 &PM 2.5 Concentrations: 15-Minute averages



PM10 & PM2.5 Concentrations: Hourly averages



PM10 & PM2.5 Concentrations: daily averages



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Annex

Results of Monitored Parameters (Tables)

Table 1: 15 min. average values of monitored parameters in MDA during (9-15/6/2014)

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/09/14	00:15	19.8	38.9
06/09/14	00:30	22.3	36.1
06/09/14	00:45	25.2	31.4
06/09/14	01:00	25.2	31.4
06/09/14	01:15	25.2	31.4
06/09/14	01:30	26.5	32.9
06/09/14	01:45	28.2	35.4
06/09/14	02:00	28.2	35.4
06/09/14	02:15	28.2	35.4
06/09/14	02:30	26.5	33.4
06/09/14	02:45	24.5	30.3
06/09/14	03:00	24.5	30.3
06/09/14	03:15	24.5	30.3
06/09/14	03:30	25.4	33.9
06/09/14	03:45	26.4	39.9
06/09/14	04:00	26.4	39.9
06/09/14	04:15	26.4	39.9
06/09/14	04:30	22.3	36.3
06/09/14	04:45	17.4	30.3
06/09/14	05:00	17.4	30.3
06/09/14	05:15	17.4	30.3
06/09/14	05:30	14.8	29.6
06/09/14	05:45	11.8	28.4
06/09/14	06:00	11.8	28.4
06/09/14	06:15	11.8	28.4
06/09/14	06:30	15.7	25.4
06/09/14	06:45	20.1	20.6
06/09/14	07:00	20.1	20.6
06/09/14	07:15	20.1	20.6
06/09/14	07:30	21.2	19.5
06/09/14	07:45	22.4	17.8
06/09/14	08:00	22.4	17.8
06/09/14	08:15	22.4	17.8
06/09/14	08:30	27.9	19.7
06/09/14	08:45	34.4	22.9
06/09/14	09:00	34.4	22.9
06/09/14	09:15	34.4	22.9
06/09/14	09:30	31.4	33.4
06/09/14	09:45	28.0	50.8
06/09/14	10:00	28.0	50.8
06/09/14	10:15	28.0	50.8
06/09/14	10:30	22.1	42.0
06/09/14	10:45	14.9	27.1
06/09/14	11:00	14.9	27.1
06/09/14	11:15	14.9	27.1
06/09/14	11:30	14.7	27.4
06/09/14	11:45	14.5	28.0
06/09/14	12:00	14.5	28.0

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/09/14	12:15	14.5	28.0
06/09/14	12:30	15.2	25.0
06/09/14	12:45	15.9	20.2
06/09/14	13:00	15.9	20.2
06/09/14	13:15	15.9	20.2
06/09/14	13:30	14.1	26.0
06/09/14	13:45	12.0	35.7
06/09/14	14:00	12.0	35.7
06/09/14	14:15	12.0	35.7
06/09/14	14:30	11.4	32.6
06/09/14	14:45	10.7	27.7
06/09/14	15:00	10.7	27.7
06/09/14	15:15	10.7	27.7
06/09/14	15:30	13.6	27.0
06/09/14	15:45	17.0	25.7
06/09/14	16:00	17.0	25.7
06/09/14	16:15	17.0	25.7
06/09/14	16:30	13.6	21.1
06/09/14	16:45	9.5	13.4
06/09/14	17:00	9.5	13.4
06/09/14	17:15	9.5	13.4
06/09/14	17:30	7.8	16.8
06/09/14	17:45	5.8	22.2
06/09/14	18:00	5.8	22.2
06/09/14	18:15	5.8	22.2
06/09/14	18:30	8.6	21.3
06/09/14	18:45	11.7	20.0
06/09/14	19:00	11.7	20.0
06/09/14	19:15	11.7	20.0
06/09/14	19:30	11.3	21.0
06/09/14	19:45	10.8	22.8
06/09/14	20:00	10.8	22.8
06/09/14	20:15	10.8	22.8
06/09/14	20:30	20.6	27.3
06/09/14	20:45	32.2	34.7
06/09/14	21:00	32.2	34.7
06/09/14	21:15	32.2	34.7
06/09/14	21:30	35.2	38.5
06/09/14	21:45	38.8	44.7
06/09/14	22:00	38.8	44.7
06/09/14	22:15	38.8	44.7
06/09/14	22:30	32.7	48.0
06/09/14	22:45	25.6	53.5
06/09/14	23:00	25.6	53.5
06/09/14	23:15	25.6	53.5
06/09/14	23:30	24.1	51.0
06/09/14	23:45	22.2	47.0
06/09/14	24:00	22.2	47.0

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/10/14	00:15	22.2	47.0
06/10/14	00:30	25.0	43.1
06/10/14	00:45	28.3	37.0
06/10/14	01:00	28.3	37.0
06/10/14	01:15	28.3	37.0
06/10/14	01:30	22.9	41.1
06/10/14	01:45	16.3	47.6
06/10/14	02:00	16.3	47.6
06/10/14	02:15	16.3	47.6
06/10/14	02:30	13.6	39.7
06/10/14	02:45	10.5	26.6
06/10/14	03:00	10.5	26.6
06/10/14	03:15	10.5	26.6
06/10/14	03:30	12.5	31.8
06/10/14	03:45	14.9	40.1
06/10/14	04:00	14.9	40.1
06/10/14	04:15	14.9	40.1
06/10/14	04:30	21.7	32.7
06/10/14	04:45	29.5	20.9
06/10/14	05:00	29.5	20.9
06/10/14	05:15	29.5	20.9
06/10/14	05:30	23.0	18.3
06/10/14	05:45	15.8	13.8
06/10/14	06:00	15.8	13.8
06/10/14	06:15	15.8	13.8
06/10/14	06:30	34.4	11.6
06/10/14	06:45	56.5	8.1
06/10/14	07:00	56.5	8.1
06/10/14	07:15	56.5	8.1
06/10/14	07:30	45.4	15.8
06/10/14	07:45	32.8	28.2
06/10/14	08:00	32.8	28.2
06/10/14	08:15	32.8	28.2
06/10/14	08:30	29.3	25.3
06/10/14	08:45	29.3	25.3
06/10/14	09:00	29.3	25.3
06/10/14	09:15	25.2	23.5
06/10/14	09:30	25.2	23.5
06/10/14	09:45	24.7	26.8
06/10/14	10:00	24.7	26.8
06/10/14	10:15	24.7	26.8
06/10/14	10:30	18.3	24.9
06/10/14	10:45	15.6	19.2
06/10/14	11:00	15.6	19.2
06/10/14	11:15	15.6	19.2
06/10/14	11:30	13.1	19.7
06/10/14	11:45	10.3	20.6
06/10/14	12:00	10.3	20.6
06/10/14	12:15	10.3	20.6

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/10/14	12:30	16.8	20.9
06/10/14	12:45	24.4	21.4
06/10/14	13:00	24.4	21.4
06/10/14	13:15	24.4	21.4
06/10/14	13:30	20.7	23.5
06/10/14	13:45	16.6	26.9
06/10/14	14:00	16.6	26.9
06/10/14	14:15	16.6	26.9
06/10/14	14:30	13.8	33.7
06/10/14	14:45	10.5	44.4
06/10/14	15:00	10.5	44.4
06/10/14	15:15	10.5	44.4
06/10/14	15:30	16.0	63.4
06/10/14	15:45	22.5	94.8
06/10/14	16:00	22.5	94.8
06/10/14	16:15	22.5	94.8
06/10/14	16:30	22.9	90.7
06/10/14	16:45	23.5	84.4
06/10/14	17:00	23.5	84.4
06/10/14	17:15	23.5	84.4
06/10/14	17:30	25.3	69.4
06/10/14	17:45	27.4	44.7
06/10/14	18:00	27.4	44.7
06/10/14	18:15	27.4	44.7
06/10/14	18:30	25.0	44.6
06/10/14	18:45	22.2	44.5
06/10/14	19:00	22.2	44.5
06/10/14	19:15	22.2	44.5
06/10/14	19:30	23.8	41.0
06/10/14	19:45	25.5	35.7
06/10/14	20:00	25.5	35.7
06/10/14	20:15	25.5	35.7
06/10/14	20:30	30.1	41.7
06/10/14	20:45	35.5	51.5
06/10/14	21:00	35.5	51.5
06/10/14	21:15	35.5	51.5
06/10/14	21:30	27.9	50.1
06/10/14	21:45	19.1	47.9
06/10/14	22:00	19.1	47.9
06/10/14	22:15	19.1	47.9
06/10/14	22:30	21.4	46.1
06/10/14	22:45	24.0	43.4
06/10/14	23:00	24.0	43.4
06/10/14	23:15	24.0	43.4
06/10/14	23:30	24.7	45.4
06/10/14	23:45	25.4	48.5
06/10/14	24:00	25.4	48.5
06/11/14	00:15	25.4	48.5
06/11/14	00:30	22.8	45.0

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/11/14	00:45	14.3	30.9
06/11/14	01:00	14.3	30.9
06/11/14	01:15	14.3	30.9
06/11/14	01:30	14.4	26.4
06/11/14	01:45	14.6	19.4
06/11/14	02:00	14.6	19.4
06/11/14	02:15	14.6	19.4
06/11/14	02:30	15.2	26.4
06/11/14	02:45	15.9	37.2
06/11/14	03:00	15.9	37.2
06/11/14	03:15	15.9	37.2
06/11/14	03:30	12.6	33.8
06/11/14	03:45	8.7	28.3
06/11/14	04:00	8.7	28.3
06/11/14	04:15	8.7	28.3
06/11/14	04:30	7.1	24.3
06/11/14	04:45	5.4	17.5
06/11/14	05:00	5.4	17.5
06/11/14	05:15	5.4	17.5
06/11/14	05:30	15.5	14.2
06/11/14	05:45	27.2	8.7
06/11/14	06:00	27.2	8.7
06/11/14	06:15	27.2	8.7
06/11/14	06:30	21.8	10.8
06/11/14	06:45	15.5	14.0
06/11/14	07:00	15.5	14.0
06/11/14	07:15	15.5	14.0
06/11/14	07:30	13.1	14.9
06/11/14	07:45	10.3	16.3
06/11/14	08:00	10.3	16.3
06/11/14	08:15	10.3	16.3
06/11/14	08:30	11.3	19.5
06/11/14	08:45	12.5	24.7
06/11/14	09:00	12.5	24.7
06/11/14	09:15	12.5	24.7
06/11/14	09:30	10.7	21.1
06/11/14	09:45	8.6	15.2
06/11/14	10:00	8.6	15.2
06/11/14	10:15	8.6	15.2
06/11/14	10:30	15.7	16.0
06/11/14	10:45	23.8	17.3
06/11/14	11:00	23.8	17.3
06/11/14	11:15	23.8	17.3
06/11/14	11:30	19.6	13.9
06/11/14	11:45	15.0	8.6
06/11/14	12:00	15.0	8.6
06/11/14	12:15	15.0	8.6
06/11/14	12:30	16.8	16.0
06/11/14	12:45	18.9	28.2

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/11/14	13:00	18.9	28.2
06/11/14	13:15	18.9	28.2
06/11/14	13:30	28.9	37.0
06/11/14	13:45	40.4	50.8
06/11/14	14:00	40.4	50.8
06/11/14	14:15	40.4	50.8
06/11/14	14:30	36.4	53.8
06/11/14	14:45	31.9	58.6
06/11/14	15:00	31.9	58.6
06/11/14	15:15	31.9	58.6
06/11/14	15:30	36.9	75.1
06/11/14	15:45	42.4	102.2
06/11/14	16:00	42.4	102.2
06/11/14	16:15	42.4	102.2
06/11/14	16:30	47.1	89.9
06/11/14	16:45	52.5	70.2
06/11/14	17:00	52.5	70.2
06/11/14	17:15	52.5	70.2
06/11/14	17:30	52.0	56.3
06/11/14	17:45	51.4	35.1
06/11/14	18:00	51.4	35.1
06/11/14	18:15	51.4	35.1
06/11/14	18:30	41.1	28.4
06/11/14	18:45	29.2	17.5
06/11/14	19:00	29.2	17.5
06/11/14	19:15	29.2	17.5
06/11/14	19:30	23.5	36.9
06/11/14	19:45	17.0	67.3
06/11/14	20:00	17.0	67.3
06/11/14	20:15	17.0	67.3
06/11/14	20:30	32.2	67.3
06/11/14	20:45	50.3	67.3
06/11/14	21:00	50.3	67.3
06/11/14	21:15	50.3	67.3
06/11/14	21:30	38.5	59.5
06/11/14	21:45	25.2	49.1
06/11/14	22:00	25.2	49.1
06/11/14	22:15	25.2	49.1
06/11/14	22:30	19.7	44.0
06/11/14	22:45	13.4	35.9
06/11/14	23:00	13.4	35.9
06/11/14	23:15	13.4	35.9
06/11/14	23:30	12.4	35.3
06/11/14	23:45	11.4	34.6
06/11/14	24:00	11.4	34.6
06/12/14	00:15	11.4	34.6
06/12/14	00:30	11.0	34.2
06/12/14	00:45	10.7	33.7
06/12/14	01:00	10.7	33.7

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/12/14	01:15	10.7	33.7
06/12/14	01:30	10.1	31.9
06/12/14	01:45	9.5	28.9
06/12/14	02:00	9.5	28.9
06/12/14	02:15	9.5	28.9
06/12/14	02:30	8.4	23.7
06/12/14	02:45	7.1	15.6
06/12/14	03:00	7.1	15.6
06/12/14	03:15	7.1	15.6
06/12/14	03:30	12.3	12.7
06/12/14	03:45	18.4	7.8
06/12/14	04:00	18.4	7.8
06/12/14	04:15	18.4	7.8
06/12/14	04:30	14.9	15.2
06/12/14	04:45	10.9	27.1
06/12/14	05:00	10.9	27.1
06/12/14	05:15	10.9	27.1
06/12/14	05:30	8.8	22.3
06/12/14	05:45	6.3	14.6
06/12/14	06:00	6.3	14.6
06/12/14	06:15	6.3	14.6
06/12/14	06:30	11.1	12.8
06/12/14	06:45	16.5	10.0
06/12/14	07:00	16.5	10.0
06/12/14	07:15	16.5	10.0
06/12/14	07:30	16.5	17.1
06/12/14	07:45	16.6	28.1
06/12/14	08:00	16.6	28.1
06/12/14	08:15	16.6	28.1
06/12/14	08:30	13.3	28.8
06/12/14	08:45	9.7	29.8
06/12/14	09:00	9.7	29.8
06/12/14	09:15	9.7	29.8
06/12/14	09:30	17.1	25.0
06/12/14	09:45	25.6	16.7
06/12/14	10:00	25.6	16.7
06/12/14	10:15	25.6	16.7
06/12/14	10:30	25.9	14.3
06/12/14	10:45	26.3	10.1
06/12/14	11:00	26.3	10.1
06/12/14	11:15	26.3	10.1
06/12/14	11:30	20.4	9.1
06/12/14	11:45	13.8	7.3
06/12/14	12:00	13.8	7.3
06/12/14	12:15	13.8	7.3
06/12/14	12:30	15.4	9.4
06/12/14	12:45	17.3	12.6
06/12/14	13:00	17.3	12.6
06/12/14	13:15	17.3	12.6

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/12/14	13:30	17.4	16.2
06/12/14	13:45	17.7	21.7
06/12/14	14:00	17.7	21.7
06/12/14	14:15	17.7	21.7
06/12/14	14:30	16.0	24.9
06/12/14	14:45	14.2	30.2
06/12/14	15:00	14.2	30.2
06/12/14	15:15	14.2	30.2
06/12/14	15:30	31.8	59.8
06/12/14	15:45	52.4	107.5
06/12/14	16:00	52.4	107.5
06/12/14	16:15	52.4	107.5
06/12/14	16:30	49.6	103.8
06/12/14	16:45	46.4	98.1
06/12/14	17:00	46.4	98.1
06/12/14	17:15	46.4	98.1
06/12/14	17:30	36.6	126.2
06/12/14	17:45	25.7	169.3
06/12/14	18:00	25.7	169.3
06/12/14	18:15	25.7	169.3
06/12/14	18:30	30.4	135.9
06/12/14	18:45	35.6	84.6
06/12/14	19:00	35.6	84.6
06/12/14	19:15	35.6	84.6
06/12/14	19:30	28.1	68.6
06/12/14	19:45	19.3	42.3
06/12/14	20:00	19.3	42.3
06/12/14	20:15	19.3	42.3
06/12/14	20:30	20.9	34.1
06/12/14	20:45	22.7	21.2
06/12/14	21:00	22.7	21.2
06/12/14	21:15	22.7	21.2
06/12/14	21:30	25.0	52.2
06/12/14	21:45	27.7	100.9
06/12/14	22:00	27.7	100.9
06/12/14	22:15	27.7	100.9
06/12/14	22:30	21.6	81.9
06/12/14	22:45	14.4	50.5
06/12/14	23:00	14.4	50.5
06/12/14	23:15	14.4	50.5
06/12/14	23:30	15.5	40.8
06/12/14	23:45	16.9	25.2
06/12/14	24:00	16.9	25.2
06/13/14	00:15	16.9	25.2
06/13/14	00:30	17.1	20.4
06/13/14	00:45	17.3	12.6
06/13/14	01:00	17.3	12.6
06/13/14	01:15	17.3	12.6
06/13/14	01:30	14.6	10.2

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/13/14	01:45	11.5	6.3
06/13/14	02:00	11.5	6.3
06/13/14	02:15	11.5	6.3
06/13/14	02:30	9.6	5.1
06/13/14	02:45	7.6	3.2
06/13/14	03:00	7.6	3.2
06/13/14	03:15	7.6	3.2
06/13/14	03:30	7.2	2.6
06/13/14	03:45	6.8	1.6
06/13/14	04:00	6.8	1.6
06/13/14	04:15	6.8	1.6
06/13/14	04:30	17.1	1.3
06/13/14	04:45	28.4	0.8
06/13/14	05:00	28.4	0.8
06/13/14	05:15	28.4	0.8
06/13/14	05:30	22.6	1.9
06/13/14	05:45	15.9	3.7
06/13/14	06:00	15.9	3.7
06/13/14	06:15	15.9	3.7
06/13/14	06:30	12.9	3.2
06/13/14	06:45	9.6	2.5
06/13/14	07:00	9.6	2.5
06/13/14	07:15	9.6	2.5
06/13/14	07:30	8.1	3.3
06/13/14	07:45	6.5	4.5
06/13/14	08:00	6.5	4.5
06/13/14	08:15	6.5	4.5
06/13/14	08:30	15.1	10.7
06/13/14	08:45	17.4	10.8
06/13/14	09:00	17.4	10.8
06/13/14	09:15	17.4	10.8
06/13/14	09:30	21.6	13.5
06/13/14	09:45	30.6	22.0
06/13/14	10:00	30.6	22.0
06/13/14	10:15	30.6	22.0
06/13/14	10:30	26.3	23.3
06/13/14	10:45	17.7	27.0
06/13/14	11:00	17.7	27.0
06/13/14	11:15	17.7	27.0
06/13/14	11:30	16.6	30.6
06/13/14	11:45	18.3	11.9
06/13/14	12:00	39.1	25.5
06/13/14	12:15	39.1	25.5
06/13/14	12:30	39.1	25.5
06/13/14	12:45	36.3	23.7
06/13/14	13:00	33.0	21.5
06/13/14	13:15	33.0	21.5
06/13/14	13:30	33.0	21.5
06/13/14	13:45	40.0	26.1

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/13/14	14:00	48.2	31.5
06/13/14	14:15	48.2	31.5
06/13/14	14:30	48.2	31.5
06/13/14	14:45	40.2	26.2
06/13/14	15:00	31.0	20.2
06/13/14	15:15	31.0	20.2
06/13/14	15:30	31.0	20.2
06/13/14	15:45	25.8	16.8
06/13/14	16:00	19.7	12.9
06/13/14	16:15	19.7	12.9
06/13/14	16:30	19.7	12.9
06/13/14	16:45	21.1	13.8
06/13/14	17:00	22.7	14.8
06/13/14	17:15	22.7	14.8
06/13/14	17:30	22.7	14.8
06/13/14	17:45	21.3	13.9
06/13/14	18:00	19.8	12.9
06/13/14	18:15	19.8	12.9
06/13/14	18:30	19.8	12.9
06/13/14	18:45	20.2	13.2
06/13/14	19:00	21.5	14.0
06/13/14	19:15	18.6	12.1
06/13/14	19:30	18.6	12.1
06/13/14	19:45	18.6	12.1
06/13/14	20:00	19.8	12.9
06/13/14	20:15	16.5	10.8
06/13/14	20:30	16.5	10.8
06/13/14	20:45	16.5	10.8
06/13/14	21:00	17.2	11.2
06/13/14	21:15	14.8	9.7
06/13/14	21:30	14.8	9.7
06/13/14	21:45	14.8	25.6
06/13/14	22:00	27.4	59.0
06/13/14	22:15	27.4	59.0
06/13/14	22:30	21.9	57.6
06/13/14	22:45	15.6	55.4
06/13/14	23:00	15.6	55.4
06/13/14	23:15	15.6	55.4
06/13/14	23:30	16.4	44.6
06/13/14	23:45	17.3	27.7
06/13/14	24:00	17.3	27.7
06/14/14	00:15	17.3	27.7
06/14/14	00:30	20.2	22.3
06/14/14	00:45	23.5	13.9
06/14/14	01:00	23.5	13.9
06/14/14	01:15	23.5	13.9
06/14/14	01:30	21.2	11.2
06/14/14	01:45	18.6	6.9
06/14/14	02:00	18.6	6.9

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/14/14	02:15	18.6	6.9
06/14/14	02:30	15.0	6.0
06/14/14	02:45	11.0	4.6
06/14/14	03:00	11.0	4.6
06/14/14	03:15	11.0	4.6
06/14/14	03:30	9.6	26.9
06/14/14	03:45	8.1	62.1
06/14/14	04:00	8.1	62.1
06/14/14	04:15	8.1	62.1
06/14/14	04:30	13.0	50.7
06/14/14	04:45	18.4	32.0
06/14/14	05:00	18.4	32.0
06/14/14	05:15	18.4	32.0
06/14/14	05:30	14.5	25.9
06/14/14	05:45	10.2	16.9
06/14/14	06:00	10.2	16.9
06/14/14	06:15	10.2	16.9
06/14/14	06:30	8.2	14.1
06/14/14	06:45	5.9	9.9
06/14/14	07:00	5.9	9.9
06/14/14	07:15	5.9	9.9
06/14/14	07:30	13.3	12.9
06/14/14	07:45	21.7	17.7
06/14/14	08:00	21.7	17.7
06/14/14	08:15	21.7	17.7
06/14/14	08:30	22.6	19.5
06/14/14	08:45	23.6	22.1
06/14/14	09:00	23.6	22.1
06/14/14	09:15	23.6	22.1
06/14/14	09:30	19.1	43.7
06/14/14	09:45	14.1	76.8
06/14/14	10:00	14.1	76.8
06/14/14	10:15	14.1	76.8
06/14/14	10:30	15.7	61.9
06/14/14	10:45	17.5	38.4
06/14/14	11:00	17.5	38.4
06/14/14	11:15	17.5	38.4
06/14/14	11:30	14.2	31.1
06/14/14	11:45	10.6	19.2
06/14/14	12:00	10.6	19.2
06/14/14	12:15	10.6	19.2
06/14/14	12:30	13.1	15.5
06/14/14	12:45	15.7	9.6
06/14/14	13:00	15.7	9.6
06/14/14	13:15	15.7	9.6
06/14/14	13:30	13.5	7.7
06/14/14	13:45	11.0	4.8
06/14/14	14:00	11.0	4.8
06/14/14	14:15	11.0	4.8

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/14/14	14:30	9.9	3.8
06/14/14	14:45	8.6	2.4
06/14/14	15:00	8.6	2.4
06/14/14	15:15	8.6	2.4
06/14/14	15:30	13.3	1.9
06/14/14	15:45	18.4	1.2
06/14/14	16:00	18.4	1.2
06/14/14	16:15	18.4	1.2
06/14/14	16:30	15.3	2.1
06/14/14	16:45	11.7	3.6
06/14/14	17:00	11.7	3.6
06/14/14	17:15	11.7	3.6
06/14/14	17:30	10.1	8.4
06/14/14	17:45	8.2	15.9
06/14/14	18:00	8.2	15.9
06/14/14	18:15	8.2	15.9
06/14/14	18:30	10.0	18.8
06/14/14	18:45	12.1	23.5
06/14/14	19:00	12.1	23.5
06/14/14	19:15	12.1	23.5
06/14/14	19:30	10.5	36.1
06/14/14	19:45	8.8	55.6
06/14/14	20:00	8.8	55.6
06/14/14	20:15	8.8	55.6
06/14/14	20:30	9.3	72.5
06/14/14	20:45	9.9	98.4
06/14/14	21:00	9.9	98.4
06/14/14	21:15	9.9	98.4
06/14/14	21:30	11.1	84.3
06/14/14	21:45	12.4	62.8
06/14/14	22:00	12.4	62.8
06/14/14	22:15	12.4	62.8
06/14/14	22:30	17.0	52.1
06/14/14	22:45	22.0	35.8
06/14/14	23:00	22.0	35.8
06/14/14	23:15	22.0	35.8
06/14/14	23:30	17.6	38.1
06/14/14	23:45	12.7	41.7
06/14/14	24:00	12.7	41.7
06/15/14	00:15	12.7	41.7
06/15/14	00:30	14.0	35.8
06/15/14	00:45	15.4	26.5
06/15/14	01:00	15.4	26.5
06/15/14	01:15	15.4	26.5
06/15/14	01:30	17.4	30.2
06/15/14	01:45	19.7	36.0
06/15/14	02:00	19.7	36.0
06/15/14	02:15	19.7	36.0
06/15/14	02:30	16.3	30.4

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/15/14	02:45	12.5	21.8
06/15/14	03:00	12.5	21.8
06/15/14	03:15	12.5	21.8
06/15/14	03:30	16.1	18.2
06/15/14	03:45	20.3	12.4
06/15/14	04:00	20.3	12.4
06/15/14	04:15	20.3	12.4
06/15/14	04:30	16.0	15.9
06/15/14	04:45	11.2	21.2
06/15/14	05:00	11.2	21.2
06/15/14	05:15	11.2	21.2
06/15/14	05:30	10.8	17.3
06/15/14	05:45	10.4	11.1
06/15/14	06:00	10.4	11.1
06/15/14	06:15	10.4	11.1
06/15/14	06:30	12.7	12.7
06/15/14	06:45	15.3	15.1
06/15/14	07:00	15.3	15.1
06/15/14	07:15	15.3	15.1
06/15/14	07:30	18.7	50.2
06/15/14	07:45	22.4	102.7
06/15/14	08:00	22.4	102.7
06/15/14	08:15	22.4	102.7
06/15/14	08:30	17.5	173.3
06/15/14	08:45	12.1	279.1
06/15/14	09:00	12.1	279.1
06/15/14	09:15	12.1	279.1
06/15/14	09:30	21.0	229.5
06/15/14	09:45	30.6	155.2
06/15/14	10:00	30.6	155.2
06/15/14	10:15	30.6	155.2
06/15/14	10:30	24.3	136.8
06/15/14	10:45	17.3	108.7
06/15/14	11:00	17.3	108.7
06/15/14	11:15	17.3	108.7
06/15/14	11:30	14.8	93.5
06/15/14	11:45	11.9	69.7
06/15/14	12:00	11.9	69.7
06/15/14	12:15	11.9	69.7
06/15/14	12:30	11.8	64.5
06/15/14	12:45	11.7	56.6
06/15/14	13:00	11.7	56.6
06/15/14	13:15	11.7	56.6
06/15/14	13:30	10.3	51.1
06/15/14	13:45	8.7	42.7
06/15/14	14:00	8.7	42.7
06/15/14	14:15	8.7	42.7
06/15/14	14:30	16.8	36.7
06/15/14	14:45	26.0	27.2

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/15/14	15:00	26.0	27.2
06/15/14	15:15	26.0	27.2
06/15/14	15:30	20.9	27.3
06/15/14	15:45	15.2	27.4
06/15/14	16:00	15.2	27.4
06/15/14	16:15	15.2	27.4
06/15/14	16:30	13.2	23.3
06/15/14	16:45	11.0	17.1
06/15/14	17:00	11.0	17.1
06/15/14	17:15	11.0	17.1
06/15/14	17:30	9.3	14.9
06/15/14	17:45	7.2	11.3
06/15/14	18:00	7.2	11.3
06/15/14	18:15	7.2	11.3
06/15/14	18:30	6.0	12.5
06/15/14	18:45	4.6	14.5
06/15/14	19:00	4.6	14.5
06/15/14	19:15	4.6	14.5
06/15/14	19:30	6.6	13.2
06/15/14	19:45	9.3	10.7
06/15/14	20:00	9.3	10.7
06/15/14	20:15	9.3	10.7
06/15/14	20:30	11.8	17.8
06/15/14	20:45	15.3	31.4
06/15/14	21:00	15.3	31.4
06/15/14	21:15	15.3	31.4
06/15/14	21:30	22.2	45.9
06/15/14	21:45	31.7	73.4
06/15/14	22:00	31.7	73.4
06/15/14	22:15	31.7	73.4
06/15/14	22:30	27.9	69.0
06/15/14	22:45	22.2	59.4
06/15/14	23:00	22.2	59.4
06/15/14	23:15	22.2	59.4
06/15/14	23:30	21.0	52.5
06/15/14	23:45	19.2	36.8
06/15/14	24:00	19.2	36.8
MAX		**56.5**	**76.8**
AVG		**17.9**	**21.9**

Table 2: Hourly average values of monitored parameters MDA zone during (9-15/6/2014)

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/09/14	01:00	23.1	34.5
06/09/14	02:00	27.0	33.8
06/09/14	03:00	25.9	32.3
06/09/14	04:00	25.7	36.0
06/09/14	05:00	20.9	34.2
06/09/14	06:00	14.0	29.1
06/09/14	07:00	16.9	23.8
06/09/14	08:00	21.5	18.9
06/09/14	09:00	29.8	20.8
06/09/14	10:00	30.4	39.5
06/09/14	11:00	20.0	36.8
06/09/14	12:00	14.6	27.6
06/09/14	13:00	15.4	23.3
06/09/14	14:00	13.5	29.4
06/09/14	15:00	11.2	30.9
06/09/14	16:00	14.6	26.5
06/09/14	17:00	12.4	18.4
06/09/14	18:00	7.2	18.7
06/09/14	19:00	9.5	20.9
06/09/14	20:00	11.1	21.6
06/09/14	21:00	23.9	29.8
06/09/14	22:00	36.2	40.6
06/09/14	23:00	30.7	49.9
06/09/14	24:00	23.5	49.6
06/10/14	01:00	25.9	41.0
06/10/14	02:00	21.0	43.3
06/10/14	03:00	12.7	35.1
06/10/14	04:00	13.2	34.7
06/10/14	05:00	23.9	28.7
06/10/14	06:00	21.0	16.7
06/10/14	07:00	40.8	10.4
06/10/14	08:00	41.9	20.1
06/10/14	09:00	25.0	25.2
06/10/14	10:00	18.6	22.5
06/10/14	11:00	18.5	22.5
06/10/14	12:00	12.3	20.1
06/10/14	13:00	19.0	21.1
06/10/14	14:00	19.6	24.7
06/10/14	15:00	12.9	37.4
06/10/14	16:00	17.9	74.4
06/10/14	17:00	23.1	88.6
06/10/14	18:00	25.9	60.8
06/10/14	19:00	24.2	44.6
06/10/14	20:00	24.3	39.2
06/10/14	21:00	31.7	45.1
06/10/14	22:00	25.4	49.4
06/10/14	23:00	22.1	45.2
06/10/14	24:00	24.9	46.4

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/11/14	01:00	17.1	35.6
06/11/14	02:00	14.4	24.0
06/11/14	03:00	15.4	30.0
06/11/14	04:00	11.5	31.9
06/11/14	05:00	6.6	21.9
06/11/14	06:00	18.8	12.3
06/11/14	07:00	20.0	11.9
06/11/14	08:00	12.3	15.4
06/11/14	09:00	11.7	21.3
06/11/14	10:00	10.1	19.1
06/11/14	11:00	18.0	16.4
06/11/14	12:00	18.4	12.1
06/11/14	13:00	17.4	20.3
06/11/14	14:00	32.1	41.7
06/11/14	15:00	35.1	55.5
06/11/14	16:00	38.4	84.5
06/11/14	17:00	48.6	83.1
06/11/14	18:00	51.8	49.2
06/11/14	19:00	37.7	24.6
06/11/14	20:00	21.6	47.3
06/11/14	21:00	37.4	67.3
06/11/14	22:00	34.8	56.2
06/11/14	23:00	17.9	41.2
06/11/14	24:00	12.2	35.1
06/12/14	01:00	10.9	34.1
06/12/14	02:00	9.9	30.9
06/12/14	03:00	8.0	21.0
06/12/14	04:00	14.1	11.0
06/12/14	05:00	13.8	19.3
06/12/14	06:00	8.1	19.6
06/12/14	07:00	12.6	11.9
06/12/14	08:00	16.6	20.8
06/12/14	09:00	12.3	29.1
06/12/14	10:00	19.5	22.1
06/12/14	11:00	26.0	12.8
06/12/14	12:00	18.5	8.4
06/12/14	13:00	15.9	10.5
06/12/14	14:00	17.5	18.1
06/12/14	15:00	15.5	26.8
06/12/14	16:00	37.7	76.2
06/12/14	17:00	48.7	101.9
06/12/14	18:00	33.6	140.7
06/12/14	19:00	31.8	118.6
06/12/14	20:00	25.6	59.5
06/12/14	21:00	21.4	29.7
06/12/14	22:00	25.8	68.8
06/12/14	23:00	19.5	70.9
06/12/14	24:00	15.9	35.4

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/13/14	01:00	17.2	17.7
06/13/14	02:00	13.7	8.8
06/13/14	03:00	9.1	4.4
06/13/14	04:00	7.1	2.2
06/13/14	05:00	20.2	1.1
06/13/14	06:00	20.7	2.5
06/13/14	07:00	12.0	3.0
06/13/14	08:00	7.7	3.7
06/13/14	09:00	14.1	9.2
06/13/14	10:00	25.1	17.1
06/13/14	11:00	23.1	24.8
06/13/14	12:00	22.9	23.8
06/13/14	13:00	36.9	24.1
06/13/14	14:00	38.6	25.2
06/13/14	15:00	41.9	27.3
06/13/14	16:00	26.9	17.5
06/13/14	17:00	20.8	13.6
06/13/14	18:00	21.6	14.1
06/13/14	19:00	20.3	13.3
06/13/14	20:00	18.9	12.3
06/13/14	21:00	16.7	10.9
06/13/14	22:00	18.0	26.0
06/13/14	23:00	20.1	56.9
06/13/14	24:00	16.7	38.9
06/14/14	01:00	21.1	19.4
06/14/14	02:00	20.5	9.7
06/14/14	03:00	13.9	5.5
06/14/14	04:00	9.2	38.9
06/14/14	05:00	14.5	44.2
06/14/14	06:00	13.4	22.9
06/14/14	07:00	7.6	12.7
06/14/14	08:00	15.7	14.6
06/14/14	09:00	22.9	20.4
06/14/14	10:00	17.7	54.9
06/14/14	11:00	16.2	53.9
06/14/14	12:00	13.2	27.0
06/14/14	13:00	13.8	13.5
06/14/14	14:00	12.8	6.7
06/14/14	15:00	9.5	3.4
06/14/14	16:00	14.7	1.7
06/14/14	17:00	14.3	2.6
06/14/14	18:00	9.6	10.9
06/14/14	19:00	10.6	20.4
06/14/14	20:00	10.0	42.7
06/14/14	21:00	9.5	81.2
06/14/14	22:00	11.5	77.1
06/14/14	23:00	18.4	46.6
06/14/14	24:00	16.3	39.3
06/15/14	01:00	14.4	32.6

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/15/14	02:00	18.1	32.2
06/15/14	03:00	15.3	27.5
06/15/14	04:00	17.3	16.2
06/15/14	05:00	14.7	17.7
06/15/14	06:00	10.7	15.2
06/15/14	07:00	13.4	13.5
06/15/14	08:00	19.7	67.7
06/15/14	09:00	16.0	208.5
06/15/14	10:00	23.6	204.7
06/15/14	11:00	22.4	127.3
06/15/14	12:00	14.0	85.4
06/15/14	13:00	11.8	61.9
06/15/14	14:00	9.8	48.3
06/15/14	15:00	19.4	33.5
06/15/14	16:00	19.3	27.3
06/15/14	17:00	12.6	21.2
06/15/14	18:00	8.7	13.7
06/15/14	19:00	5.6	13.2
06/15/14	20:00	7.5	12.3
06/15/14	21:00	12.9	22.8
06/15/14	22:00	25.2	56.0
06/15/14	23:00	26.0	65.3
06/15/14	24:00	20.4	46.4
MAX		**41.9**	**88.6**
AVG		**19.2**	**28.1**

Table 3: daily average values of monitored parameters MAD zone during (9 - 5/6/2014)

Date	Time	PM2.5	PM10
		µg/m3	µg/m3
06/09/14	24:00	20.0	30.3
06/10/14	24:00	22.9	38.5
06/11/14	24:00	23.4	35.7
06/12/14	24:00	20.0	41.6
06/13/14	24:00	20.4	16.6
06/14/14	24:00	14.0	27.9
06/15/14	24:00	15.8	52.9
Max		**23.4**	**52.9**